ATTACHMENT 1

Species Assessment and Listing Priority Assignment Form: Lesser Prairie-Chicken

USFWS. 2008. Species Assessment and Listing Priority Assignment Form: Lesser Prairie-Chicken. Available online: http://ecos.fws.gov/docs/candforms_pdf/r2/B0AZ_V01.pdf. Accessed 31 January 2009.

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: October, 2008

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. During the past 12 months, almost our entire national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements, emergency listings, and essential litigation-related, administrative, and program management functions. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken, see the discussion of "Progress on Revising the Lists" in the current CNOR, which can be viewed on our Internet website (http://endangered.fws.gov/).

_X_ Listing priority change
Former LP: _8_
New LP: _2_

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 (CO), Kansas (KS), New Mexico (NM), Oklahoma (OK), Texas (TX) / USA

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: CO, KS, NM, OK, TX / USA

LAND OWNERSHIP: Currently, 95 percent (61,193 square kilometers (sq km); 23,626 square miles (sq mi)) of occupied range is privately owned; 4 percent (3,221 sq km; 1,244 sq mi) is managed by the Bureau of Land Management (BLM) in NM, and the U. S. Forest Service (USFS) in CO, KS, OK and NM; 1 percent is State trust land in NM

LEAD REGION CONTACT: Pat Mehlhop, (505) 248-6663

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

BIOLOGICAL INFORMATION

Species Description

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) (LPC) 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. LPC body length ranges from 38-41 centimeter (cm; 15-16 inches) (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).

LPC are polygynous and exhibit a lek mating system. The lek is a place where males gather to conduct a competitive mating display. Male LPC 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 1-3 km (0.6-2 mi) from the lek (Giesen 1994a, p. 97), and lays an average clutch of 10-14 eggs (Bent 1932, p. 282). 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.

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 CO, Giesen (1998, p. 11) observed that spring and summer home ranges for males were 211 hectares (ha; 512 acres) and for females were 596 ha (1,473 acres (ac)). In TX, 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 NM and OK, LPC home ranges increase during periods of drought (Giesen 1998, p. 11). Davis (2005, p. 3) states that the combined home range of all LPC at a single lek is about 49 sq km (19 sq mi—12,100 ac).

Diet of the LPC 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. LPC have a relatively short life span and high annual mortality. Campbell (1972, p. 694) estimated a 65 percent annual mortality rate and a 5-year maximum life span, although an individual nearly 7 years old has been recently documented in the wild (Wolfe et al., Unpubl. Manuscript, p. 2) Giesen (1998, p. 2-9) provides a comprehensive summary of LPC breeding behavior, habitat, and phenology.

Taxonomy

The LPC 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 1957, p. 137; Jones 1964, p. 65-73). The LPC 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 LPC taxonomy is found in Giesen (1998, p. 2, 3).

Habitat

The preferred habitat of the LPC is mixed sand sagebrush- (*Artemesia filifolia*) or shinnery oak- (*Quercus havardii*) grasslands (hereafter described as native rangeland) (Taylor and Guthery 1980b, p. 6, Giesen 1998, p. 3-4). Trees and other tall woody vegetation are typically absent from these grassland ecosystems, except along water courses. Native grasslands occupied by the LPC often includes small shrubs which are important for summer shade, winter protection and as supplemental foods (Johnsgard 1979, p. 112). Landscapes supporting less than 63 percent native rangeland appear incapable of supporting self-sustaining LPC 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 LPC 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 acres), 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 LPC range in NM, OK, and TX (Peterson and Boyd 1998, p. 2). Shinnery oak is a rhizomatous 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 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 83 ha (205 ac) over an estimated timeframe of 13,000 - 43,000 years (Cook 1985, 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 LPC habitat has been demonstrated by several studies (Fuhlendorf et al. 2002, pp. 624-626, Bell 2005 p.15, 19-25). In a study conducted in west TX, Haukos and Smith (1989, p. 625) documented strong nesting avoidance by LPC of shinnery oak rangelands had been treated with the herbicide tebuthiuron (also see discussion under Factor E). Similar behavior was confirmed by three recent studies in NM examining aspects of LPC habitat use, survival, and reproduction relative to shinnery oak density and herbicide application to control shinnery oak.

First, Bell (2005, p. 20-21) documented strong thermal selection for, and dependency of LPC broods on, sand shinnery oak dominance in shrubland habitats. In this study, LPC hens and broods used sites within the sand shinnery community that had statistically higher percent cover and greater density of shrubs. Within these sites, microclimate differed statistically between occupied and random sites, and LPC survival was statistically higher in microhabitat that was cooler, more humid, and less exposed to the wind. Survivorship was statistically higher for LPC that used sites with >20 percent cover of shrubs than for those choosing 10–20 percent cover; in turn, survivorship was statistically higher for LPC choosing 10–20 percent cover than for those choosing <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 LPC hen home ranges. Hens were detected more often than randomly in or near pastures that had not been treated wto 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 LPC.

Finally, a third study conducted by the Sutton Avial Research Center (Sutton Center), in cooperation with NMDGF, showed that over the course of four years and five nesting seasons, LPC in the core of occupied range in NM distributed themselves non-randomly among shinnery

oak rangelands treated and untreated with tebuthiuron (Patten et al. 2005a, 1273-1274). They demonstrated statistically that LPC strongly avoided habitat blocks treated with tebuthiuron, but were not affected by cattle grazing. Further, herbicide treatment explained nearly 90 percent of the variation in occurrence among treated and untreated areas. Over time, radio-collared LPC 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 ridges or grassy knolls (Giesen 1998, p. 4). Several authors, as discussed in Giesen (1998, p. 4) observed that roads, oil and gas pads, and other forms of human disturbance may encourage lek establishment. 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.

Nests are constructed by females and 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). Typical nesting habitat can be described as native rangeland, although there is some evidence that the height and density of forbs 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 feet) or less. After the broods break up, the juveniles form mixed flocks with adult birds (Giesen 1998, p. 9) and 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 require large expanses (i.e., 1024-10,000 ha) 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 LPC. As reported by Giesen (1998, p. 11) and Taylor and Guthery (1980a, p. 522), a single LPC may have a home range of 211 ha (512 ac) to 1,945 ha (4,806 ac). More recently, studies in KS 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 LPC movements in west TX 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 LPC population long-term. More recently, observations by scientists involved in LPC conservation have speculated that over 16,000 ha (40,000 ac) may actually be needed to sustain a single LPC lek (D. Wolfe, Pers. Com. 2008). Because LPC 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 LPC. Hagen et al. (2004 p. 76) recommended that LPC management areas be at least 4096 sq km (1581 sq mi) in size. Because a population viability analysis for the LPC has

not yet been conducted, the specific extent of habitat needed to sustain a viable LPC population is unknown.

Historical Range/Distribution

Historically, the LPC occupied native rangeland in portions of southeastern CO (Giesen 1994b, p. 175-182, southwestern KS (Schwilling 1955, p. 10), western OK (Duck and Fletcher 1944, p. 68), the TX Panhandle (Henika 1940, p. 15; Oberholser 1974, p. 268), and eastern NM (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 TX. In 2007, cooperative mapping efforts by the CO Division of Wildlife (CDOW), KS Department of Wildlife and Parks (KDWP), NM Department of Game and Fish (NMGDF), OK Department of Wildlife Conservation (ODWC), and TX Parks and Wildlife Department (TPWD), in cooperation with the Playa Lakes Joint Venture, re-estimated the maximum occupied range (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 (PLJV) 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 CO, 76,757 sq km (29,640 sq mi) in KS, 52,571 sq km (20,300 sq mi) in NM, 68,452 sq km (26,430 sq mi) in OK, and 236,398 sq km (91,280 sq mi) in TX.

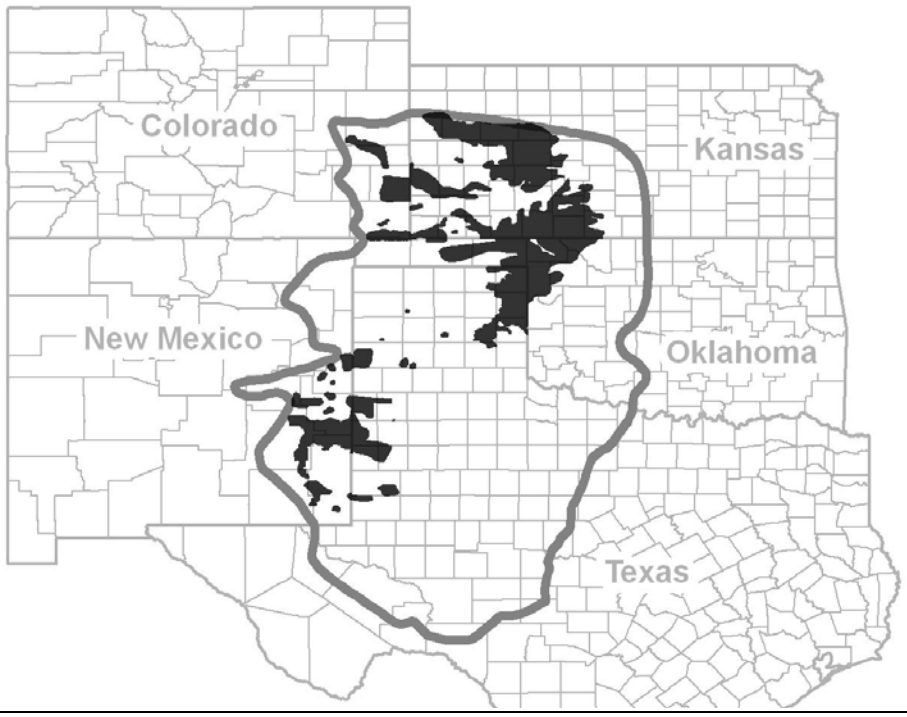

Figure 1. Estimated historic (perimeter circle) and current (black polygons) occupied LPC range in CO, KS, NM, OK and TX. Current (2007) range map layer courtesy of TPWD.

By the 1880s, the area occupied by LPC 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).

Current Range/Distribution

LPC still occur within each state (Giesen 1998, p. 3). During the 2007 mapping effort (PLJV, 2007, p. 1), the State wildlife agencies estimated the current LPC 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 CO, 29,130 sq km (11,250 sq mi) in KS, 8,570 sq km (3,310 sq mi) in NM, 10,969 sq km (4,235 sq mi) in OK, and 12,126 sq km (4,680 sq mi) in TX.

The overall distribution of LPC within all states except KS has sharply declined, 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, p. 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 LPC population size prior to 1900. Litton (1978, p. 1) suggested that as many as two million birds may have occurred in TX 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 LPC was reportedly quite common throughout their range in CO, KS, NM, OK, and TX 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, Lee 1950, p. 475, Oberholser 1974, p. 268, Sands 1968, p. 454). LPC 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 LPC provided us with information regarding the current status of the LPC within their respective states, and most of the following information was taken directly from agency reports, memos, and other status documents. Most states collect data 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. In the absence of bird density, the number 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). Because birds or leks per square mile is the standard unit of measure for LPC population trend estimates, the following statewide status assessments are reported in that way, rather than using square kilometers as the unit of measure.

Colorado. LPC were likely resident in six counties in CO prior to European settlement (Giesen

2000, p. 140). At present, LPC 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 CO and adjacent states (Giesen 2000, p. 144). The LPC has been state-listed as threatened in CO since 1973. CDOW estimated 800 to 1,000 LPC in the state in 1997. Giesen (2000, p. 137) estimated the current 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. The new methodology resulted in the discovery of more leks and the documented use of CRP fields by LPC in CO. The number of LPC 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 LPC populations in Kiowa and Cheyenne Counties are stable to increasing.

LPC numbers 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 2007 decline in the number of LPC observed (Verquer 2007, p. 2-3).

In addition to CDOW surveys, four individual routes with listening points were run on the USFS Comanche National Grasslands (NG) in Baca County. These routes were configured to pass through areas of native range and sand sage habitats where the LPC is known to occur. These routes complement lek counts conducted by the CDOW. On the Comanche NG, surveys revealed that the estimated area occupied by the LPC over the past 20 years was approximately 65,168 acres (Augustine 2005a). 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 one male. 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 NG 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/lek in 2005 declined nearly 75 percent from that of 1988, from 174 males/lek to 32 males/lek respectively. A comparision of the most recent information revealed that population estimates, based on counts of males at observed leks, on the Comanche NG have declined by 50 percent since 1995 (Augustine 2005b). In spring 2007, only two active leks and 18 males were counted (B. Cox, Comanche NG, pers. comm. 2007).

<u>Kansas.</u> In the early part of last century, LPC historical range included all or a part of 38 counties, but by 1997 the species was known to exist in only 19 counties. Since 1999, biologists have documented LPC expansion and reoccupation of 16 counties north of the Arkansas River,

primarily attributable to favorable habitat conditions created by implementation of the CRP program in those counties. Currently, LPC occupy approximately 29,130 sq km (11,247 sq mi) within all or portions of 35 counties in western KS. Greater prairie-chickens (GPC) in KS also have expanded their range and as a result, mixed leks of both lesser and greater prairie-chickens are increasingly common throughout an overlap zone of approximately 2,500 sq km (965 sq mi) in western KS, and hybridization of the species is now evident (Bain and Farley 2002, pp.683-687). The zone of overlap between GCP and LPC in KS covers all or portions of 11 counties. Two of the survey routes used by KDWP are located within this overlap zone; however, hybrids have been observed on only one of those routes. Hybrids make up about 2.5 percent of the number of birds observed on that route. Although the hybrids have not been removed from the population estimate, the number of hybrids observed are low.

In 2006, KDWP surveys along 15 LPC survey routes estimated 16.3 LPC per sq km (6.3 per sq mi), which is not statistically different from the 2005 estimate of 14.2 LPC per sq km (5.5 per sq mi). (Rodgers 2006, p. 3, Rodgers 2007b, p. 4). The average number of birds per lek increased slightly from 14.5 in 2005 to 15.4 in 2006, but the increase was not statistically significant. KDWP estimated the 2006 breeding population of LPC 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 LPC range statewide. Severe drought conditions during the spring and early summer of 2006 throughout KS, coupled with deep snow cover in January and February 2007 in southwestern counties, reduced the estimated 2007 population in KS to 3.9 birds/mi^2, a 38 percent decrease from 2006, which was statistically significant (Rodgers 2007b, p. 2).

On the USFS Cimarron NG, LPC are present primarily south of the Cimarron River. Surveys conducted on the Cimarron NG during 1988-1997 identified 44 leks and indicated that all NG land south of the Cimarron River (64,387 acres) was occupied. Spring lek counts conducted in 2005 along the KDWP survey route showed a decline from a mean of 10.1 birds/square mile during the first 15 years of the survey (1964-1978) to a mean of 4.9 birds/square mile during 1989-2004. More intensive census surveys conducted on the Cimarron NG during 1995-1999 and 2005 involved repeated counts of birds on all known leks. This lek-census method showed a stable population during 1995-1999 and provided population estimates for the NG varying annually from 173-283 birds (Smith and Smith 1999). This survey method was repeated in 2005 and gave a population estimate of 249 birds, indicating a stable population on the Cimarron NG between 1995 and 2005 (D. Augustine, USFS, pers. comm. 2005). Since 2005, Cimarron NG and KDWP have observed a dramatic population decline to an estimated 124 individuals in 2006 and 86 in 2007 (B. Cox, USFS, pers. comm. 2007). This represents a 65 percent decline over the last three years.

New Mexico. In the 1920s and 1930s, the former range of the LPC in NM was described as all of the sand hill rangeland of eastern NM, from TX to CO, and as far west as Buchanan in De Baca 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 NM as encompassing all or portions of 12 counties. In the 1950s and 1960s, occupied range was more extensive than 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 LPC are known or suspected from portions of seven counties and the occupied range of LPC in NM 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 NM was estimated to be 8,570 sq km (3309 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 counties. Approximately 59 percent of the historic LPC range in NM 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 LPC 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). NMDGF currently estimates the LPC population on non-Federal lands to be approximately 3,800 and the statewide population to be about 6,363 (Beauprez 2007, p. 16). However, other species experts consider the total number of LPC in NM to be much lower. Johnsgard (2002, p. 51) estimated the number of LPC in NM to number fewer than 1,000 individuals by 2001. Similarly, the Sutton Center, based on recent observations made over a 7 year period, estimate the NM LPC population to number between 1,500-3,000 individuals (D. Wolfe, Sutton Center, pers. comm. 2008, M. Patten, Sutton Center, pers. comm. 2007).

Roadside listening routes were first established to survey LPC in NM 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 modified to consist of 29 townships. The survey used 19 routes from the 1998 survey and routes in 10 new, randomly selected townships within the core of LPC populations in east-central NM. In 2003, NMDGF established 10 additional roadside routes in the northeastern part of LPC historical range, east and south of Clayton, NM and east and south of Amistad, NM. These routes had been previously surveyed by NMDGF 1999. These new routes included areas near reported LPC sightings.

Since initiating the additional routes in 2003, NMDGF reports that no leks have been detected in northeastern NM, providing strong evidence that LPC no longer occupy their historical range within Union, Harding, and portions of northern Quay counties. However, individual LPC were photographed in northeastern NM by a local wildlife law enforcement agent in late 2007, indicating that the habitat in northeastern NM is still capable of supporting the species (G. Beauprez, NMDGF, pers. comm. 2008). The lack of any known leks in this region since 2003 suggests LPC populations in northeastern NM, if present, are very small.

In 2007, all 29 roadside routes within the core of occupied range in east central NM were surveyed. Of these 29 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 23 in 1998 to a high of 68 in 2007 (Beauprez 2007, p. 8). However, the population trend, average number of birds per lek, along these routes has remained statistically stable.

The New Mexico State Game Commission owns and manages 29 Prairie-chicken Areas (PCAs)

ranging in size from 10 to 3,171 ha (29 to 7,800 ac) within the core of occupied range in east central NM. Additionally, the NMDGF purchased the 2,135 ha (5,275 ac) Sandhills Prairie Conservation Area (formerly the Lewis ranch) east of Milnesand in 2007. Surveys will be conducted on this area in 2008. These PCAs total 109 sq km (42 sq mi), or roughly 1.6 percent of the total occupied LPC range in NM. Instead of the typical roadside routes, the NMDGF conducts saturation surveys on each individual PCA to determine the presence of LPC leks and individual birds over the entire area of each PCA. In 2006, 27 of the 29 PCAs were surveyed, with 183 leks detected, either audibly or visually, on or near the PCAs (Davis 2006, p. 4). A total of 1,117 LPC were observed and counted across 100 of those leks. An increase in survey effort over the last 11 years has resulted in an increase in the number of leks detected and the number of LPC observed on PCAs. In 2007, 164 leks were detected on or near the PCAs, down slightly from 2006 (Beauprez 2007, p. 1). A total of 757 LPC were observed and counted across 89 of those leks. The PCAs are obviously important to persistence of the LPC in NM. However, considering the overall areal extent of the PCAs and that many PCAs are small and isolated, management of the surrounding private and federal lands is integral to viability of the LPC in NM.

In southeastern NM (i.e., area south of NM Highway 380), data from NMDGF surveys suggest LPC populations in this region remain low and continue to decline. The majority of historically occupied LPC habitat located south of Highway 380 occurs on BLM land. Snyder (1967, p. 121) has suggested that this region may be only marginally populated except during favorable climatic periods. In 2006, only one lek was detected and no leks were detected in 2007 (Beauprez 2007, p. 12). Best et al. (2003, p. 232) concluded anthropogenic factors have, in part, rendered LPC habitat south of Highway 380 inhospitable for long-term survival of LPC in southeastern NM. Similarly, NMDGF suggests that habitat quality currently limits recovery of these populations (Beauprez 2007, p. 12).

Oklahoma. LPC historically occurred in 22 OK counties. By 1961, Copelin (1963, p. 53) reported LPC from only 12 counties. By 1979, LPC were verified in eight counties, and the remaining population fragments encompassed an estimated area totaling 2,791 sq km (1,078 sq mi), a decrease of approximately 72 percent since 1944. At present, the ODWC reports LPC 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 OK LPC 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, p. 2, 6). Between 1987 and 2007, the estimated density of active leks within occupied habitat varied from a high of 0.85 leks per sq km (0.33 per sq mi) in 1988 to a low of 0.13 leks per sq km (0.05 per sq mi) in 2004 and again in 2007. The ODWC is aware of 96 known historic and currently occupied leks in OK. 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 occupied leks is unknown.

Texas. Systematic surveys to identify TX counties inhabited by LPC began in 1940 (Henika 1940, p. 4). Annual surveys to determine population trends of LPC in TX were initiated in 1952 (Lionberger 2005, p). From the early (Henika 1940, p. 15, Sullivan et al. 2000) to mid (Litton 1978, pp. 11-12)1940's to the early 1950's (Seyffert 2001, pp.108-112), the range of the LPC in TX 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). In 2005, TPWD reported that the number of occupied counties likely has not changed since the 1989 estimate. In March 2007, TPWD reported that LPC 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). LPC populations in TX currently persist in two disjunctive regions; the Permian Basin/Western Panhandle region and the Northeastern Panhandle (see Fig. 1.).

Annual LPC lek surveys were most recently conducted by TPWD in April of 2007 within the Permian Basin/Western Panhandle (study areas in Bailey, Yoakum, and Gaines 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 have been repeatedly surveyed since at least 1999. In 2006, the Permian Basin/Western Panhandle surveys estimated 7.9 males/lek and the lek density was estimated at 1.9 leks per sq km (0.74 per sq mi). These values are indicative of stable to increasing populations in this study area. The Northeastern Panhandle surveys estimated 7.7 males/lek with an estimated lek density of).54 leks per sq km (0.21 per sq mi). These values are indicative of stable to slightly declining populations in this study area (Lionberger 2007).

Occupied acreage in TX during March of 2007 was estimated to be 7,234 sq km (2,793 sq mi), based on those portions of the 13 counties where LPC are known to persist. Using an estimated mean density of 0.0088 LPC/ac (range 0.0034-0.0135 LPC/ac), the TX population is estimated at a mean of 15,730 with a broad range in the estimate of 6,077 to 24,132 LPC in the 13 counties where LPC are known to occur (Lionberger 2007).

Summary of State Information.
As described above, LPC populations can fluctuate considerably from year-to-year. For example, the number of males per active lek in OK varied from a high of 16.5 in 1975 to a low of 4.6 in 2000, and the estimated density of leks between 1987 and 2007 varied from a high of 0.85 leks per sq km (0.33 per sq mi) in 1988 to a low of 0.13 leks per sq km (0.05 per sq mi) in 2004 and again in 2007. In NM, the state reported the number of LPC counted at leks increased about 83 percent from 2001 through 2005, yet their analysis of lek survey data from 1998 to 2006 shows a statistically stable population trend. Fluctuations in wildlife populations are natural responses to variable weather conditions. The fluctuations add to the difficulty of evaluating population trends, particularly short-term trends, e.g. periods less than 5 years. Thus is possible to have statistically significant changes from one year to the next, but have a statistically stable population when considered over a longer period of time. This situation

makes it difficult to interpret very recent declines, such as the decline in 2007, as it is not clear whether it is a natural fluctuation related to drought, or represents a decline for other reasons and will persist. Table 1 summarizes the information described above regarding LPC populations in each state.

Table 1. Range and current population indices for LPC by state.

State	Historic Range	Current Range	Current Population Estimates 2005	2006	2007	Current Lek Estimates 2005	2006	2007
CO	6 counties	4 counties	203	296	74	32 active	34 active	18 active
KS	38 counties	35 counties 29,987 sq km (11,578 sq mi)	5.5/sq mi 19,700 – 31,100 (in 2006)	6.3/sq.mi	3.9/sq mi			
NM	7 counties 22,390 sq km (8,645 sq mi)	7 counties 5,698 sq km (2,200 sq mi)	6,363 (in 2007)			Within core area surveyed, leks ranged from a low of 23 in 1998 to a high of 64 in 2006, stable trend		
OK	22 counties	8 counties 950 sq km (367 sq mi)	< 3,000 (in 2000)			11 active 0.09/sq mi	7 active 0.05/sq mi	
TX	34 counties (1940's-50's)	13 counties 7,234 sq km (2,793 sq mi)	6,077 – 24, 132 (in 2007)			Permian Basin/Western Panhandle study area - 2006 0.74 leks/sq mi; stable to increasing populations Northeastern Panhandle study area – 2006: 0.21 leks/sq mi; stable to slightly declining populations		

THREATS

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>.

<u>Conversion to Cultivated Agriculture</u>.
Because LPC require large areas (i.e., 1024-10,000 ha) of intact landscapes of mixed-grass, short-grass, and shrubland habitats (Giesen 1998, p.3-4, Bidwell et al. 2002, p. Hagen et al 2004, p. 71, 77), fragmentation and conversion of these mixed-grass, short-grass, and shrubland habitats have contributed to a significant reduction in the extent of LPC occupied range. Woodward et al. (2001 p. 271) concluded that habitat stability, particularly in shrublands, was extremely important to persistence of LPC within the landscape. Many habitats, once converted to other uses such as cultivated cropland, no longer provide suitable reproductive habitat for the LPC and restoration of ecologically meaningful amounts of converted rangeland is doubtful in the short term.

Several LPC experts have identified conversion of native sand sagebrush and shinnery oak rangeland to cultivation as an important factor in the decline of LPC 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, LPC 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 some grain crops provided increased winter food supplies, 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 LPC 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, p .4-5). Bragg and Steuter (1996) 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 LPC (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 LPC showed a decline in the amount of rangeland acreage over that time period, indicating that loss of important LPC habitat may have continued to occur since the 1980s. However, estimates of rangeland between 1982 and 1992 for counties specifically within LPC range showed no statistically significant change, possibly due to small sample size and large variation about the mean.

The CRP was initiated 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). CRP habitat encompasses a very significant portion of currently occupied range in most LPC states, particularly in KS where expansion of the LPC population is directly related to the amount of land enrolled in native CRP. Estimates of the extent of CRP in habitat occupied by LPC, as derived from the cooperative mapping effort delineated in Figure 1, is available for KS, OK and TX. Kansas has just over 363,000 ha (897,000 ac), OK has over 91,600 ha (226,000 ac) and TX 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 KS comprise some 12.5 percent of the occupied LPC range, 8.3 percent of the occupied range in OK, and 13.8 percent of the occupied range in TX.

The importance of CRP habitat to the status and survival of LPC was recently emphasized by Rodgers and Hoffman (2005, p. 122-123). They determined that the presence of CRP which had been planted to native species of grasses facilitated the expansion of LPC range in CO, KS, and NM. The range expansion in KS resulted in strong population increases there (Rodgers and Hoffman 2005, p. 122-123). In OK and TX, and some portions of NM, CRP fields were planted with a monoculture of introduced grasses. Where introduced grasses were planted, LPC 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 LPC habitat. This is particularly relevant in KS where CRP acreages planted to native grass mixtures facilitated an expansion of LPC range in that state. A reduction in CRP acreage could lead to contraction of the currently occupied range and reduced numbers of LPC 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 (FSA) 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. FSA 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. FSA required that holders of contracts set to expire in 2007 make known to FSA, by Sept. 30, 2006, their intention to either re-enroll their existing contract or allow it to expire. FSA also requested that holders of 2008-2010 expiring contracts make their intentions known to FSA by Dec. 31, 2006. In March of 2007 the USDA expected that some 23.9 million acres out of the total 28 million acres of eligible CRP contracts would be re-enrolled. The remaining 4.1 million acres 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 LPC populations, some eventual benefits have been identified. In particular, an analysis of LPC habitat quality within a subsample of 1,019 CRP contracts across all five LPC states was recently conducted by the Rocky Mountain Bird Observatory (Ripper and VerCauteren 2007, p 1-42). They found that, particularly in OK and TX, early signup contracts allowed planting of exotic monoculture grasses, such as old-world bluestem and weeping lovegrass, which provides poor quality habitat for LPC (Ripper and VerCauteren 2007, p. 11). While the report identified areas for habitat improvement among all CRP 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 LPC 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 LPC are largely dominated by a diversity of drought tolerant perennial grasses and shrubs. Grazing has always been an ecological force within the ecosystems of the Great Plains. 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, Knopf and Samson 1997). While livestock grazing is not inherently harmful to LPC, levels of grazing that alters the composition and structure of mixed grass habitats historically used by the LPC can be detrimental Much of the remaining remnants of mixed-grass prairie and rangeland, while still important to LPC, 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 LPC. While native rangeland still persists in many areas of LPC historic range, modification of that rangeland has altered the suitability of those areas for LPC.

Because LPC depend on medium and tall grass species that are preferentially grazed by cattle, in regions of low rainfall, LPC habitat is easily overgrazed (Hamerstrom and Hamerstrom 1961, p. 290). Overgrazing and related deteriorated range condition is most readily observed through changes in plant composition and other vegetative characteristics (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 proportion of less desirable species. When grasslands are in a deteriorated condition due to overgrazing, the soils have less water-holding capacity, and the availability of succulent vegetation and insects utilized by LPC chicks are reduced. The effects of overgrazing on habitat quality are similar to drought and are likely exacerbated by actual drought conditions (Davis et al. 1979, Merchant 1982, pp. 31-33) (see Factor E).

Grazing management favorable to persistence of LPC must ensure that a diversity of plants and cover types, particularly 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 LPC nests are adequately concealed from predators. Information on the extent of overgrazing throughout LPC habitat is lacking. However, some studies have shown that overgrazing in portions of LPC occupied range is detrimental to the LPC. Taylor and Guthery (1980b, p. 2) believed overgrazing explained the demise of the LPC in TX but thought LPC could maintain low populations in some areas with high intensity, long-term grazing. In NM, Patten et al. (2006 p. 11, 16) found that grazing did not have an overall influence on where LPC occurred within their study areas but there was evidence that LPC did not nest in portions of the study area subjected to cattle grazing. In some areas within LPC range, long-term high intensity grazing results in insufficient amounts of lightly grazed habitat available to support successful nesting (Jackson and DeArment 1963, p. 737; Davis et al. 1979; Taylor and Guthery 1980b, p. 12,; Davies 1992, p. 8, 13). Grazing of native rangelands with domestic livestock often differs from grazing regimes historically present when these areas were grazed by free roaming herd of bison. Grazing regimes tend to be more uniform and are confined to specific pastures. When uniform livestock grazing of rangeland leaves less than adequate residual cover in the spring, it is detrimental to LPC populations (Bent 1932, p. 280; Davis et al. 1979; Cannon and Knopf 1980, p. 73-74; Crawford 1980, p. 3; Bidwell and Peoples 1991; 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; Wisdom 1980, p. 33; Riley et al. 1992, p. 386; Giesen 1994a). Fencing to facilitate livestock management, while often necessary, leads to structural fragmentation of the landscape. This can be particularly detrimental to LPC in OK where settlement patterns resulted in smaller parcels (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.

<u>Fragmentation.</u> Because much suitable habitat for LPC has been destroyed due to 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 LPC, fragmentation of the remaining suitable habitat contributes to further alteration of LPC range (Crawford 1980, p. 5; Braun et al. 1994; Knopf 1996, p 146, Patten et al. 2005b, p. 235-236). Spatial habitat fragmentation often has a negative impact on population persistence and may

exacerbate the species extinction process (Wilcove et al. 1986) through several mechanisms. Once fragmented, the remaining fragments may be inadequate to support crucial life history requirements (Samson 1980). Habitat between remaining suitable fragments may support high densities of predators or brood parasites; and the probability of recolonization of unoccupied fragments decreases as distance from the nearest suitable habitat increases (Wilcove et al. 1986). 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). Patten et al. (2005b, p. 245), based on observations of radio tracked LPC in OK and NM, suggested that increased fragmentation in OK resulted in higher rates of mortality than in the less fragmented habitat in NM. In summarizing much of the literature on LPC conservation, Hagen et al. (2004, p. 76-77) stated that most experts agree that LPC 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 LPC and forces avoidance or abandonment of otherwise suitable habitats (Hagen et al. 2004, pp. 74-75; Robel 2002). 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, 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 LPC and other prairie grouse.

Most large remaining tracts of untilled native rangeland, and hence LPC 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 LPC (Pitman et al. 2005, p.1267-1268) indicate that prairie grouse exhibit strong avoidance of tall vertical features such as utility transmission lines. Robel (2002) 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, p. 1267-1268), avoidance of elevated structures by LPCs has been identified, with no nesting or brood rearing within 300 m of power lines. This research also found no LPC nesting or lekking within 0.8 km (0.5 mi) of a gas line compressor station. LPC generally avoided human activity and seldom nested within 0.4 km (0.25 mi) of inhabited dwellings; LPC also were documented to avoid habitat within a 1.6 km (1 mi) radius of a coal-fired power plant (Pitman et al. 2005, p. 1267-1268).

Oil and gas development activities, particularly drilling, and road and highway construction also contributes to surface fragmentation of LPC 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 LPC. A more thorough discussion of oil and gas activities within the range of the LPC is discussed below.

<u>Wind Energy Development.</u> According to the American Wind Energy Association (AWEA), a non-profit organization that promotes the wind energy industry, the 5 states within the historic range of the LPC are all among the top 12 states having the highest wind energy potential in the

U.S. (AWEA 2008a, p.1; citing a Pacific Northwest Laboratory 1991 report). The tubular towers of most commercial, utility scale onshore wind turbines are between 65 (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. 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 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 5-10 rotor diameters to avoid interference between turbines.

Commercial wind energy cannot be a viable enterprise when the ability to transmit the power to the users is lacking. Any discussion of the effects of wind energy development must also take into consideration the influence of the transmission lines critical to distribution of the energy generated by these structures. Transmissions 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 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 LPC 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, p. 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) 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 LPC 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, p. 1267-1268) observed that female LPC 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 LPC nests within 400 m of transmission lines and improved roads. Similar work by Hagen, as presented in Hagen et al (2004, p. 75) indicated that areas used by LPC were significantly further from these same types of features than areas not used by LPC. The Service has recommended that, due to behavioral avoidance of wind turbines, a 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 LPC and likely render otherwise suitable habitat as unsuitable.

Wind energy development is already occurring within the historic range of the LPC, some of which has impacted occupied habitat. As of June 30, 2008, the AWEA's database of existing

and planned wind projects showed 24 existing wind projects within the current occupied range of the LPC (www.awea.org/projects). Four of those projects were located in CO, 4 in KS, 5 in NM, 6 in OK and 5 in TX. Within the historic range of the LPC, but excluding the occupied range, another 72 projects were in the AWEA database, 68 of those projects were in TX. By the end of 2007, TX had the greatest installed megawatt capacity for wind energy of all states and CO had the sixth greatest (AWEA 2008b, p.7).

The potential influence of anticipated wind energy development to the status of the LPC can readily be evaluated for OK. In cooperation with ODWC, Service personnel in 2005 quantified the potential degree of wind energy development in relation to existing populations of LPC in OK. Using ArcView mapping software, all active and historic LPC lek locations in OK, as of the mid 1990s (n = 96), and the current occupied range, were compared with the OK Neural Net Wind Power Development Potential Model map created by the OK Wind Power Assessment (OWPA) project. The mapping analysis revealed that 35 percent of the recently occupied range in OK is within areas designated by OWPA 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 is 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 in the mid 1990s. Roughly 91 percent of the known LPC lek sites in OK are within 8 km (5 mi) of land classified as "excellent" for wind development (C. O'Meilia, Service, pers. comm. 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 LPC is about 10 sq km (4 sq mi) and that a majority of LPC nesting generally occurs within 1.6 km (1 mi) of active leks (Hagen and Giesen 2005). 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 – 1 mi), development of commercial wind farms likely will have a significant adverse influence on reproduction of the LPC.

Unfortunately, similar analyses are not available for the other states due to a lack of appropriate data layers for those states. However, southwestern KS currently supports the largest population and distribution of LPC of all states. The influence of wind energy development on the LPC in KS would likely be no less severe than in OK. In 2006, the Governor of KS initiated the Governor's 2015 Renewable Energy Challenge, an objective of which is to have 1,000 megawatts (MW) of renewable energy capacity in KS 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 KS. 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 KS if this goal is to be met. While not all of those turbines would directly overlap occupied range, the best wind potential in KS occurs in the western portions of the state (U.S. Department of Energy 2008). Inappropriate siting of wind energy facilities and associated facilities, including electrical transmission lines, appears to be a serious threat to LPC in western KS within the near future (R. Rodgers, KDWP, pers. comm. 2007).

In TX, the Public Utility Commission of TX 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 2007). ERCOT is a regional transmission organization with jurisdiction over most of TX. The remainder, largely the TX panhandle, lies within the jurisdiction of the Southwest Power Pool. The establishment of Competitive Renewable Energy Zones (CREZs) by ERCOT within the state of TX will facilitate wind energy development throughout western TX (Figure 2). A recent assessment from ERCOT identified more than 130,000 MW of high-quality wind sites in TX, more electricity than the entire state currently uses. Wind energy development in the TX panhandle and portions of west TX represents a serious threat to extant LPC populations in the state. Once established, wind farms and associated transmission features would severely hamper future efforts to restore population connectivity and gene flow between existing populations which are currently separated by unfavorable land use in the TX panhandle.

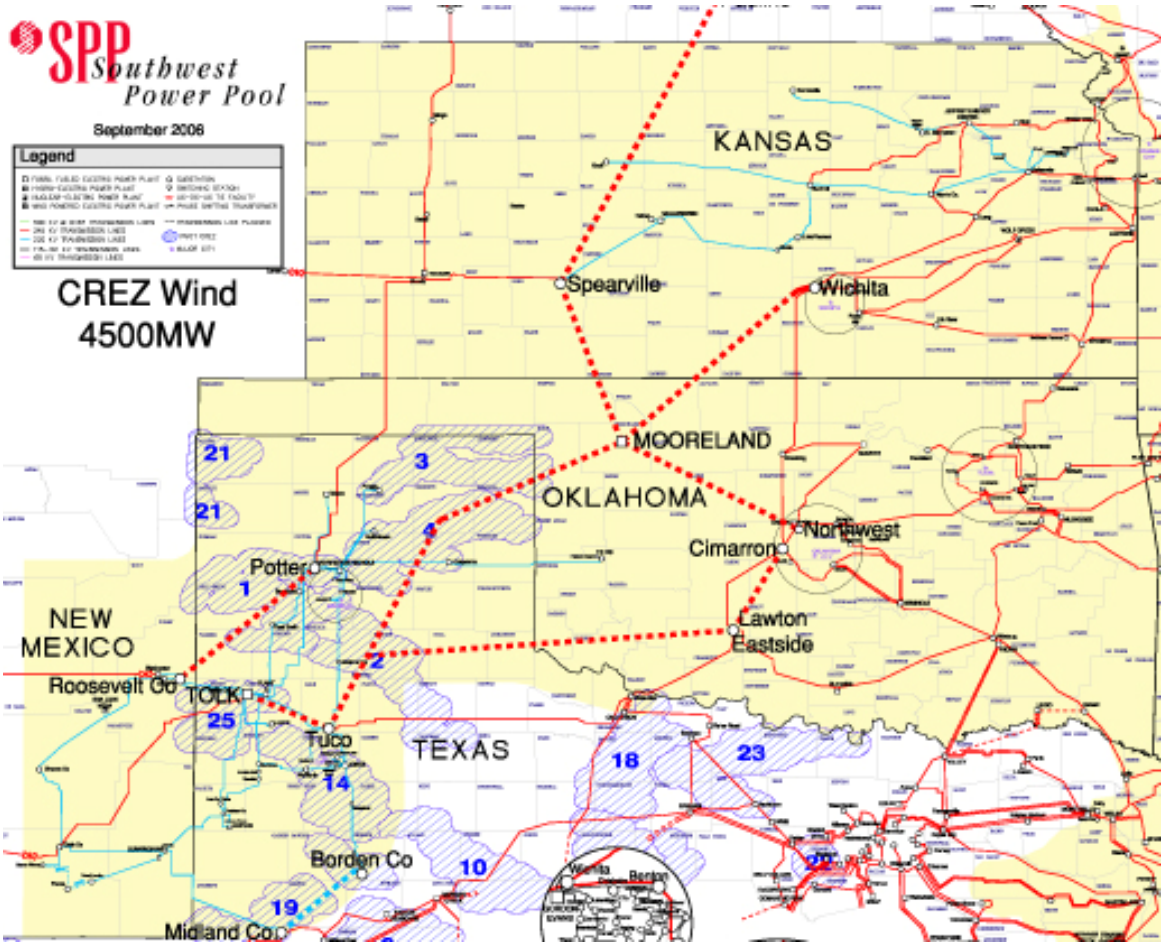

Figure 2. Planned transmission lines known as the X Plan (dashed red lines) that would provide access for 4,500 MW of new wind development in the TX Panhandle to major markets and cross currently occupied LPC habitat in KS, NM, OK, and TX. Competitive Renewable Energy Zones (in blue) are prioritized for development by number. The top four zones fall within occupied LPC range and within the only likely habitat corridor capable of reconnecting extant populations.

The TPWD LPC biologist reports that commercial wind energy development, based on the existing CREZ, threatens remaining LPC populations in both the Permian Basin/Western Panhandle and the Northeastern Panhandle regions of TX (Whitlaw 2007; see Fig. 2). The high

level of overlap between the LPC currently occupied range in TX and the CREZ which are designated for future wind energy development in the TX panhandle is shown in Figure 3. In addition, the Public Utility Commission of TX recently directed ERCOT to develop transmission plans for wind capacity to accommodate between 10,000 and 25,000 MW of power (AWEA 2007). The numbers within the identified CREZ, as shown on Figure 2, identify the development priority of each zone. The top four zones are located within occupied and historic LPC habitat in the TX panhandle.

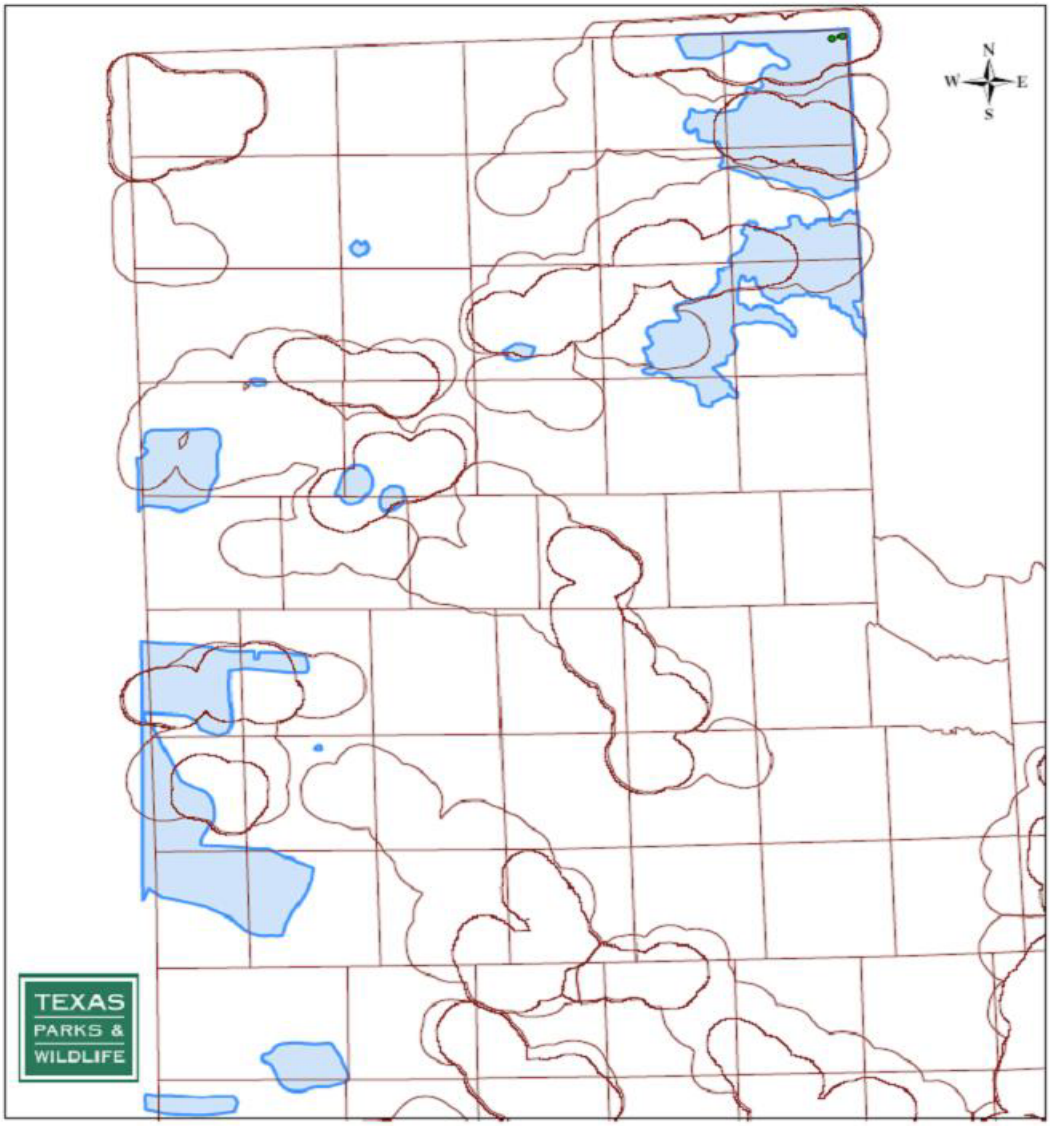

Figure 3. Map depicting the degree of overlap between occupied LPC habitat in TX (shaded) and Competitive Renewable Energy Zones designated for future wind energy development in the TX panhandle.

Development of high capacity transmission lines is critical to the development of the anticipated wind energy resources. According to AWEA (2007) every $1 billion invested in new transmission capacity enables the construction of $6 billion of new wind farms. Depicted on Figure 2 are the currently proposed electric transmission line upgrades which were provided to

the Service by the Southwest Power Pool. This map identifies approximately 423 km (263 mi) of proposed new transmission lines, commonly referred to as the "X Plan", that would be constructed to facilitate the completion of six proposed wind energy projects within LPC range in OK (Southwest Power Pool 2006). Completion of the "X Plan" also is intended to connect transmission capacity throughout all or portions of occupied LPC range in the four remaining states. Some portions of the "X Plan" have already been improved and completion of these and other sections of the plan will undoubtedly catalyze extensive wind energy development throughout much of the remaining occupied LPC range in KS, OK, and TX.

In CO, the U.S. Department of Energy (2008) rated the southeastern corner of CO as having good wind resources, the largest area of CO with that ranking. The area almost completely overlaps the currently occupied range of the LPC in CO. CDOW reported that commercial wind development is occurring in CO, but that most of the effort is currently centered north of the occupied range of LPC in southeastern CO.

Wind energy development in NM is a lower priority than other states within the range of the LPC. In NM, the potential for wind energy development in the currently occupied range of the LPC are only rated as fair (U.S. Department of Energy 2008). However some parts of northeastern NM, within LPC historical range have been rated as excellent. Northeastern NM is important to LPC conservation because this area is vital to efforts to re-established or re-connect the NM LPC population to those in CO and the TX panhandle.

In summary, wind energy development is occurring within occupied portions of LPC habitat. Where such development has occurred, these areas are no longer suitable for LPC even though many of the typical habitat components used by LPC 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 LPC populations. Additional areas that are currently unoccupied but lie within the historic range and provide suitable habitat for the LPC also could be developed. These areas of unfragmented habitat are crucial to ongoing efforts to conserve the LPC. Fragmentation of these areas would further modify or curtail the range of the LPC 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 KS, northwestern OK and the TX 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 LPC habitat is important and some wind power developers appear sensitive to concerns about siting such facilities.

<u>Oil and Gas Development.</u> Oil and gas development affects LPC by disrupting reproductive behavior (Hunt and Best 2004, p. 41) and by habitat fragmentation and conversion (Hunt and Best 2004, p. 92). Smith et al.(1998, p.) observed that almost one-half, 13 of 29, of the abandoned leks examined in southeastern NM had a moderate to high level of noise. Hunt and Best (2004, p. 92) found that abandoned leks in southeastern NM 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 LPC (Hunt and Best 2004, p. 92)

Impacts from oil and gas development and exploration are reasons for the species' near absence throughout previously occupied portions of the Carlsbad BLM unit in southeastern NM (Belinda 2003). This is supported by research examining LPC losses over the past twenty years on Carlsbad BLM lands (Hunt and Best 2004). In this study, factor analysis 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 LPC range. Although the Service presently lacks the information to specifically quantify and analyze drilling activity throughout the entire historic and occupied range of the LPC, 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 TX Panhandle and western OK, 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 acres). In May, 2005, the TX 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 pers. comm. 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 TX panhandle within portions of Hemphill, Lipscomb, and Wheeler counties, TX is occurring at a rapid rate (Whitlaw 2007; J. Hughes, Biologist, Service, pers. comm. 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 (Presentation by Forest Oil Corporation, March 6, 2008, Granite Wash Conference, Oklahoma Geological Survey).

In the BLM's special status species record of decision and approved resource management plan amendment (RMPA)(BLM 2008) some limited protections for the LPC in NM 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 (BMP) for development and reclamation. The RMPA provides guidance for management of some 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 NM. 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 LPC occupied range in NM. The effect of these BMP on the status of the LPC is unknown, particularly considering some 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 LPC and sand dune lizard 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 extent is currently unknown. Some development is anticipated in Baca County, CO, although the timeframe for initiation of those activities is uncertain (CDOW 2007). In OK, oil and gas

exploration statewide continues at a high level. 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 OK (Boyd 2007).

Fire Suppression. In grassland ecosystems, such as those in the Great Plains, which evolved with fire and ungulate grazing, the frequency and intensity of disturbances are critical to ecological processes, biological diversity and heterogeneity across multiple spatial scales (Collins 1992, pp. 2003-2005; Fuhlendorf and Smeins 1999, p. 732, 737). North American grasslands and shrub lands evolved under, and are maintained by, ungulate grazing and frequent fire. Both grazing patterns 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 LPC 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 LPC can survive. For example, Coppedge et al. (2001, pp. 51-57) examined avian response to eastern red cedar (*Juniperus virginianus*) invasion into native and CRP grasslands in western OK 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 LPC habitat is characterized by extensive patches of treeless grassland and shrubland habitat (Giesen 1998, p. 3-4), the invasion of remaining native habitat within LPC 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 OK by OK State University and the OK Cooperative Extension Service indicated that by 1995, eastern red cedar invasion would consume approximately 308 ha (762 ac) of rangeland habitats in OK each day, on average, amounting to over 121,400 ha (300,000 ac) annually (T. Bidwell pers. comm. 2005). More recently, a time series infrared satellite mapping analysis conducted by the OK NRCS in 2005 revealed that eastern red cedar trees alone are invading native rangelands in western OK at a rate of approximately 5 percent per year (J. Eckroat, Eastern Red Cedar Taskforce, OK NRCS pers. comm. 2007; http://www.okcc.state.ok.us/Publications/redcedar-pub.pdf). Given that southern KS and the northeastern TX panhandle have similar rates of precipitation, fire exclusion, and grazing pressure compared to western OK, this rate of spread is likely also occurring throughout occupied LPC 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, p. 270-271)

documented a negative association between landscapes with increased woody cover and LPC population indices. Similarly, Fuhlendorf et al. (2002, p.625) examined the effect of landscape structure and change on population dynamics of LPC in western OK and northern TX. They found that landscapes with declining LPC populations had significantly greater increases in tree cover types (riparian, windbreaks, and eastern red cedar encroachment) than landscapes with sustained LPC populations.

Summary of Habitat Loss, Modification and Curtailment. LPC habitat destruction and modification range wide is presently occurring and the threatened destruction, modification and curtailment of LPC habitat and range is substantial due to human land use. The possible conversion of over a million acres of currently enrolled CRP grasslands within the next two years has the potential to cause the destruction or modification of 14 percent of occupied habitat. Wind energy development with its associated infrastructure development is on-going and the potential for additional wind energy facilities is substantial within nearly all occupied habitat in all states except NM, where it may impact historical habitat important to linking the NM 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 invasion due to fire suppression, oil and gas development, and fragmentation are rendering portions of previously occupied range uninhabitable for the species.

B. Overutilization for commercial, recreational, scientific, or educational purposes.
In the late 19th century, LPC 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 LPC is classified as a game species in KS, NM, OK, and TX, although the legal harvest is now closed in NM and OK.

In KS, the bag limit is one bird daily for LPCs located south of Interstate 70 and two birds for LPCs located north of Interstate 70. During the 2006 season, KS hunters expended 1,900 hunter-days and harvested approximately 200 LPC. Given the low number of LPCs harvested per year in KS relative to the population size, the statewide harvest is probably insignificant at the population level. In TX, LPC harvest is not allowed except on properties with an approved wildlife management plan specifically addressing the LPC. New harvest regulations in TX, which prohibit hunting except on lands with an established conservation plan for the species, and which limit maximum harvest to no more than five percent of the annual estimated population may protect the species from localized over-harvest while creating incentives for habitat improvement.

Collectively, the total annual harvest in both KS and TX is estimated to be 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 LPC 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) 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.

One new activity that has the potential to negatively affect individual LPC 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 LPC 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 LPC 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 LPC.

In summary, it is possible that LPCs 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 problem in some areas. We are not aware of any other forms of utilization that are negatively impacting LPC populations. Consequently, we conclude that overutilization is not a basis for concluding that listing the LPC is warranted.

C. Disease or predation.

Giesen (1998, p. 10) reported no available information on ectoparasites or infectious diseases in LPC, although several endoparasites, including nematodes and cestodes, are known to infect the species. In the spring of 1997, a sample of 12 LPC from Hemphill County, TX, 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). The Lesser Prairie-chicken Interstate Working Group (1997) concluded that, while density-dependent transmission of disease was unlikely to have a significant effect on LPC populations, a disease that was transmitted independently of density could have drastic effects.

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

The impact of West Nile Virus (WNV) on LPC is unknown. Ruffed grouse have been documented to harbor WNV infection rates similar to some corvids. For 130 Ruffed Grouse tested in 2000, all distant from known WNV epicenters, 21 percent tested positive. This was remarkably similar to American crows and blue jays (23 percent for each species), species with known susceptibility to WNV (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 hosts have the potential to extirpate small, isolated prairie grouse populations (Peterson 2004).

Non-parasitic diseases caused by mycotoxins, as well as pesticides and other toxic compounds, have the potential to influence population dynamics. Further research is needed to establish

whether parasites regulate prairie grouse populations. Peterson (2004) urged natural resource decision makers to be aware that macro- and micro-parasites cannot be safely ignored as populations such as LPC 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 LPC populations and at this time we have no basis for concluding that disease or parasite loads are threatening any LPC populations.

Prairie falcon (*Falco mexicanus*), northern harrier (*Circus cyaneus*), great-horned owl (*Bubo virginianus*), other unspecified raptors, and coyote (*Canis latrans*) have been identified as predators of LPC adults and chicks (Davis et al. 1979, Merchant 1982, p. 49, Haukos and Broda 1989, p. 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, Giesen 1998, p. 8). LPC predation varies in both form and frequency throughout the year, with raptor predation increasing coincident with lek attendance (Wolfe et al. 2007, p. 100).

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 LPC 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). Recent demographic research on LPC in southwestern KS 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. 2008).

The community of prairie mammals has undergone a significant restructuring due to destruction of habitat, removal of keystone species 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, Benedict et al. 1996, p. 157). These mesopredators are known to reduce nest success in ducks, quail and other ground nesting birds such as bobwhite quail and LPC (Guthery and Beasom 1977, p. 404, Sargeant et al. 1984, Garrettson et al. 1996, Henke and Bryant 1999 pp. 1066-1067).

Rates of predation on LPC 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 LPC 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 LPC populations.

Although we have information on disease in LPCs and impacts of predators on LPCs 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 LPC is warranted.

D. The inadequacy of existing regulatory mechanisms.
In 1973, the LPC was listed as threatened in CO 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 LPC habitat. In the remaining states, the LPC is classified as a game species, although the legal harvest is now closed in NM and OK. Accordingly, the State wildlife agencies do have the authority to regulate possession of the LPC, 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 LPC within NM. This request began the process for potential listing of LPC under NM's Wildlife Conservation Act. In 1999 the recommendation to list the LPC 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 LPC would not be state-listed in NM. NM's Wildlife Conservation Act, under which the LPC could have been listed, offers little opportunity to prevent otherwise lawful activities, including that activities addressed under factor A.

Regardless of each state's listing status, most occupied LPC 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 LPC as a species of conservation concern and management priority in their respective State Wildlife Action Plans. While identification of the LPC as a species of conservation concern does help heighten the public's awareness of the plight of the LPC, this designation provides no protection form direct take or habitat destruction or alteration.

The National Forest Management Act (NFMA) 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 plans (LRMP) 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 Ch. 11, Section 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 LRMP 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 LPC was included as a species-of-concern (USFS 2008, p. 35) The LRMP currently retains the Comanche LPC 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 LPC. The area provides a special viewing area for the LPC, which has been closed. 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 plan specifies that the desired future condition of the area would be to retain habitat conditions suitable for the LPC. 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 sandsage prairie ecosystem for the LPC. Within the LPC Habitat Area, over the next 15 years a minimum of 500 acres would be treated to increase native plant diversity.

Design criteria identified in the current LRMP for management of the sandsage prairie include 1) limited construction of new structures or facilities typically within 3.2 km (2 mi) of a known LPC leks or populations if those structures and facilities would negatively impact the LPC, 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 LPC Habitat Area, design criteria include limiting or using livestock grazing in a manner that does not negatively impact LPC nesting habitat. The USFS also committed to monitoring any changes in distribution and abundance of the LPC on the National Grasslands.

The USFS, under the old planning rule, also contracted with LPC 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 LPC (Robb and Schroeder 2005, p. 8) was completed and confirms the need to retain sensitive species status designation for the LPC. 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 LPC 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 provides 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 web at http://www.fs.fed.us/r2/projects/scp/assessments.

The other Federal land occupied by LPC is administered by the BLM in NM. The BLM currently manages approximately 342,969 surface ha (847,491 ac) in eastern NM. They also

oversee another 120,529 ha (297,832 ac) of Federal minerals below private surface ownership. The core of currently occupied LPC habitat in NM 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 NM. Roughly 41 percent of the known historic and most of the currently occupied LPC range occurs on BLM land. The BLM's amended RMPA (BLM 2008) provides some limited protections for the LPC in NM 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 LPC occupied range in NM. The effect of these BMP on the status of the LPC is unknown, particularly considering some 60,000 ha (149,000 ac) have already been leased in those areas (BLM 2008, p. 8). The amended RMPA lacks explict measures designed to improve the status of the LPC, has no level of certainty that resources will be available to carry out the management plan, has limited regulatory or procedural mechanisms in place to carry out the efforts, lacks monitoring efforts, and allows exceptions to the BMP 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 LPC 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 LPC 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, 11). Considering Hunt and Best (2004, p. 92) concluded that petroleum development at intensive levels likely is not compatible with populations of LPC, additional development in the Core Management Area and the Primary Population Area may hinder long-term conservation of the species in NM. The RMPA allows lease applicants to voluntarily participate in a power line removal credit to encourage removal of idle power lines (BLM 2008, p. 2-41). In the Sparce and Scattered Population Area and the Isolated Population Area to the south, where LPCs are now far less common than in previous decades (Best and Hunt 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) 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 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). Additional research on the effect of petroleum

development on LPC is needed. However available information on the LPC (Hagen et al. 2004, p. 74-75, Hunt and Best 2004, p. 92, Pitman et al. 2005, p. 1267-1268) indicates that the effect is often detrimental.

Prior to an unofficial moratorium in the late 1990's on spraying tebuthiuron on shinnery oak on State and BLM lands, 100,000 acres of shinnery oak in
NM and 1,000,000 acres of shinnery oak in TX were treated for agriculture and cattle grazing. In September 2007, the NRCS issued Biology Technical Note 53 (NRCS 2007), which is guidance on herbicide management of shinnery oak in the lesser prairie chicken and dunes sagebrush lizard (*Sceloporus arenicolus*) occupied range. The guidance is not supported by prairie chicken specialists, and was not supported by the Service. Generally the NRCS recommends that shinnery oak should not exceed 20 percent of the total ungrazed plant composition, by weight, on sites where it naturally occurs. Consequently, landowners may apply to NRCS to receive federally-funded cost share assistance to reduce shinnery levels to 20 percent of the total plant composition on their land, typically by applying tebuthiuron or other herbicides. In some instances, landowners receiving these funds instruct herbicide applicators to apply herbicides at rates which effectively achieve full eradication of shinnery oak, using private funds to offset the additional cost. 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 LPC (Bell 2005, p. 20-21). NRCS is currently revising their guidance and spraying schedule to better address shinnery oak habitat for the LPC. Of additional concern is that the NM State Land Office has adopted the NRCS (2007) guidance for use on State property.

Because less than four percent of the species' overall range occurs on Federal lands, the Service recognizes that the LPC cannot be fully recovered on Federal lands alone. However, no laws or regulations currently protect LPC 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 LPC 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 LPC habitat has raised concerns about 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 LPC 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 LPC habitat.

In conclusion, most occupied LPC habitat occurs on private land, where State wildlife agencies have little authority to protect LPC or facilitate and monitor management of LPC habitat beyond regulating recreational harvest. Because most LPC 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 LPC 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 LPC 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 LPC 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 the listing the LPC 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). In this way, drought may impact LPC 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 LPC to drought was discussed by Crawford (1980, p. 4, 5) and Hamerstrom and Hamerstrom (1961, p. 289). Precipitation appears to affect LPC 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).

LPC 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, LPC have high

reproductive potential in years of adequate precipitation conditions. Although drought conditions are unlikely to be the sole causative factor in long-term LPC population declines, the effects of drought on population growth rate may exacerbate the extirpation risk to small, fragmented populations.

The current five-year weighted drought trend throughout large portions of LPC range in the southwestern U. S. is predicted to continue in the short term (D. Darndt, Climatologist, OK Climatological Survey, pers. comm. 2007). Consequently, LPC population indices are expected to decline rapidly in most states in 2007 and remain low possibly through the spring of 2008 (CDOW 2007, Rodgers 2007a, p. 1). While the spring 2008 lek surveys were not completed as of this writing, biologists in most states have verbally confirmed a continued reduction of LPC population indices following drought conditions in 2006 and severe winter conditions in 2006 and early 2007 (R. Rodgers, KDWP, pers. comm.; R. Horton, ODWC, pers. comm., D. Wolfe, Sutton Center, pers. comm., B. Cox, USFS, pers. com. 2007) For example, in 2007 LPC lek indices from surveys in Hamilton county, KS declined by nearly 70 percent from 2006 levels, and are the lowest on record (R. Rodgers, KDWP, pers. comm., 2007). 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 (OK Climatological Survey 2007), as an additional threat to vulnerable portions of the remaining population throughout all states.

<u>Nest Parasitism and Competition by Exotic Species.</u> Pheasants (*Phasianus colchicus*) are non-native species that overlap the range of the LPC in KS and portions of CO, OK, and TX (Johnsgard 1979, p. 121). Hen pheasants have been documented to parasitize nests of several species, including lesser 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, 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 LPC nest parasitism by pheasants exists (Hagen et al. 2002, pp. 522-524, although biologists from KPWD, ODWC, Sutton Center, TPWD, and the OK Cooperative Fish and Wildlife Research Unit have given more than10 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 research 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 of LPC nests in KS, the sample size was small (3 of 75 nests), 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 LPC 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 LPC populations range wide.

Insecticides. To date, no studies have been conducted examining potential effects of agricultural insecticide use on LPC 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 LPC 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 LPC 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 LPC 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 LPC 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 LPC (Fuhlendorf et al. 2002, pp. 624-626, Bell 2005 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 LPC. Bell (2005, p. 20-21) documented strong thermal selection for, and dependency of LPC broods on, sand shinnery oak dominance in shrubland habitats. Both Bell (2005, p.) and Patten et al. (2005a, p.) revealed that survivorship was statistically higher for LPC that used sites with >20 percent cover of shrubs than for those choosing 10–20 percent cover; in turn, survivorship was statistically higher for LPC choosing 10–20 percent cover than for those choosing <10 percent cover. In particular, shrub cover (especially of shinnery oak), canopy height, and mid-height density were markedly and statistically higher at LPC nest sites than at random sites.

These findings are important for two reasons. First, the distribution of shinnery oak overlaps much of the historic LPC range in NM, OK, and TX (Peterson and Boyd 1998, p. 2). Both Bell (2005) and Patten et al. (2005b) found that LPC 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), little documentation exists that shinnery oak acorns successfully germinate

in the wild (Wiedeman 1960, Dhillion et al. 1994, p. 52). In addition, shinnery oak produces an acorn crop in only about three of every 10 years (Pettit 1986). A more thorough synthesis of shinnery oak life history and management can be found in Peterson and Boyd (1998. p. 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 LPC 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) asserted that it is likely that LPC will become extinct if permanent losses of shrubland plant communities continue.

Second, in most LPC 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. In 2008, the NRCS informed the Service that it plans to implement its recent guidance (NRCS 2007) and resume spraying shinnery oak in 2008 in LPC habitat. In its recently released RMPA (BLM 2008), the BLM will allow spraying of shinnery oak in LPC habitat where it does not overlap with the dunes sagebrush lizard.

Although the Service cannot at this time quantify how many acres of shinnery oak are treated annually with tebuthiuron or other herbicides using Federal cost share funds, we can determine that the effect of such treatments, which reduce shinnery cover to 20 percent or lower, are detrimental to LPC. 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 significant. Efforts by the Service to quantify this potential threat range wide are ongoing.

Hybridization. The sympatric occupation of habitat and leks by greater prairie-chicken and LPC in central KS may pose a potential threat to the species in that region. Historical records document that the species' ranges overlapped considerably, 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. Because current populations north of the Arkansas River in KS 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 LPC 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, agricultural fields, and public roads. As a result, thousands of miles of fencing, primarily barbed wire, have been constructed throughout LPC range. Like most grassland wildlife throughout the Great Plains, LPC 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 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 LPC, the Sutton Center began to investigate line collision and collision mortality in LPC. From 1999 to 2004, researchers recovered 322 carcasses of radio marked LPC in NM, OK, and portions of the TX panhandle. For LPC in which the cause of death could be determined, 42 percent of mortality in OK was attributable to collisions with fences, power lines or automobiles. In NM, 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).

With between 14 and 42 percent of adult LPC mortality currently attributable to collision with human-induced structures, Wolfe et al. (2007, p. 101) assert that the negative effect of fence collisions on long term population viability for LPC cannot be understated. 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 LPC habitat, the Service obtained information from the OK NRCS regarding the construction of new fencing through Federal cost-share assistance in Fiscal Year 2006 in occupied LPC counties (R. Zetterberg pers. comm. 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 LPC habitat in OK 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. More investigation is necessary to fully quantify the magnitude of this ongoing activity and its impact on LPC range wide.

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 (IPCC 2007a, p. 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 (IPCC 2007a, p. 89). However, very little specific information related to the effects of climate change on LPC status is known. While populations of LPC in the southwestern part of their range are likely to be most acutely affected, populations throughout their range into CO and KS are likely to be impacted as well.

Warmer air temperatures may influence LPC habitat quality through factors such as increased evapo-transpiration, 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 LPC (Bell 2005, p. 16, 21) and bobwhite quail (Guthery et al. 2001, p.113-115). Patten et al. (2005a, p.1275) observed that on average LPC 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 global 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). While some limited information points to possible impacts to the LPC or its habitat from climate change, we lack of sufficient information to predict the effect of climate change on the LPC.

Small Population Size And Lek Mating System. A number of harmful effects, such as reduced reproductive success and loss of genetic variation/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 fittest males. Lek breeding already tends to promote inbreeding owing to the limitations caused by relatively few males siring offspring. The tendency of female LPC 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 LPC populations which exist over portions of the currently occupied range indicates that such harmful effects may already be, or soon will be occurring. Further examination of the viability of existing LPC populations will be needed to thoroughly describe the effects of small population size on persistence of the species.

In summary, threats to LPC survival from natural and manmade factors include drought, pheasant nest parasitism and harassment, herbicide use, collision mortality, and small population size. The effects of climate change on the LPC are largely unknown but could be expected to exacerbate certain threats such as drought. All of these factors can affect habitat quality and reduce LPC survival and reproductive success. The long term effect of hybridization with greater prairie-chickens is unknown, but is likely symptomatic of weakened populations coupled with human alteration of historic landscapes. The application of shrub-killing herbicides continues throughout the species' range. The effects of drought, and of human-caused impacts such as deaths due to collisions (e.g., as a result of fencing) collectively are contributing to the basis for concluding that listing the LPC is warranted.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

Since 2004, the Sutton Center has worked to reduce or eliminate the significant LPC mortality

observed from fence collisions on their study areas in OK and TX. Through Private Stewardship Grant Funding, the Sutton Center has either physically removed unnecessary fencing or applied visual fence markers of their own design on the top wires of approximately 204 km (127 mi) of barbed wire fence in Beaver and Ellis counties, OK, and Hemphill County, TX. These actions have been concentrated within 1.6 km (1 mi) of active LPC leks. Collectively, these conservation activities have the potential to significantly reduce the threat of collision mortality on 32,633 ha (81,060 ac) of prime occupied LPC 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 LPC (D. Wolfe, Sutton Center, pers. comm. 2008). The Service's NM Partners for Fish and Wildlife Program is initiating a similar fence marking effort this year in NM. While Sutton's fence marking efforts have the potential for significant benefit to the LPC 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 that that has been removed by Sutton (K. Norton, NRCS, pers. comm. 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 amount of mortality due to fence collisions likely would be higher.

TPWD hosted a series of landowner meetings and listening sessions in six of the 13 counties confirmed to be occupied by the LPC in TX (Hemphill, Wheeler, Gray, Bailey, Cochran, and Gaines). Private landowners and the general public were invited to discuss LPC conservation and management, receive information, and provide input on programs and incentives that are available for managing LPC 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 LPC in TX in 2006. To date, however, TPWD has received no enrollments under this CCAA (H. Whitlaw pers. comm. 2008; T. Cloud pers. comm. 2008).

TPWD also continues to fund LPC research projects. In conjunction with several TX universities, TPWD is evaluating the use of aerial line transects and forward-looking infrared (FLIR) technology to survey LPC; TPWD also is providing initial funding and coordination support for development of a spatially explicit population viability analysis for LPC in TX. Other ongoing research includes evaluation of LPC population response to shinnery oak treatments, and evaluation of relationships among LPC, raptors, and oil-gas infrastructure. Additionally, in 2007 The Nature Conservancy of TX acquired approximately 6,000 acres of private ranchland in Yoakum and Terry counties to restore and protect habitat for the LPC. The Service views this as a geographically important acquisition that helps secure LPC 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 LPC (Robb and Schroeder 2005, p. 8) was completed and

confirms the need to retain sensitive species status designation for the LPC. This document can be found on the web 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 LPC and sand dune lizard (SDL) in NM. 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 BLMs Special Status Species Resource Management Plan Amendment (RMPA), approved in April 2008, which also addresses the concerns and future management of LPC and SDL habitats on BLM lands, and established the LPC Habitat Preservation Area of Critical Environmental Concern. Both plans prescribe active cooperation among all stakeholders to reduce and/or eliminate threats to these species in NM. 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 (CEHMM), and participating cooperators that addresses the conservation needs of the LPC and SDL on BLM lands in NM. Through this CCA, CEHMM will work with participating cooperators who voluntarily commit to implementing or funding specific conservation actions that will reduce and/or eliminate threats to these species. The CCA builds upon the BLMs RMPA for southeast NM. 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 Candidate Conservation Agreement with Assurances (CCAA) has been developed in association with the CCA to facilitate conservation actions for the LPC and SDL on private and State lands in southeastern NM. The CCA/CCAA has been open for public comment and is anticipated to be signed and officially adopted by the Service and BLM in December 2008.

Other important conservation actions in NM occurred in 2007; principal among them was the acquisition of 2,137 ha (5,280 ac) of private ranchland in Roosevelt County by the State Game Commission using NM State Land Conservation Appropriation funding. This property adjoins two existing Commission-owned PCAs, and is expected to provide local conservation benefit for LPC in portions of NM.

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 LPC 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 (Strategy). The LPC portion of this Strategy is being developed under the leadership of the

Lesser Prairie-chicken Interstate Working Group in cooperation with the Playa Lakes Joint Venture, and is independently identified as the Lesser Prairie-chicken Conservation Initiative. This Strategy would provide clear recovery actions and define the levels of funding necessary to achieve management goals for all species of grouse in North America. The final draft of the prairie grouse portions of this strategy, encompassing 65 million acres of grassland habitat in the U. S. and Canada, was officially released and unanimously endorsed by the Association of Fish and Wildlife Agencies in late March, 2008.

The Service views the increased emphasis and exposure for prairie grouse as positive for the conservation and recovery of the LPC. 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 lesser prairie-chicken 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 lesser prairie-chicken 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 LPC 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 five miles 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 LPC 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 range wide 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 LPC populations and habitats.
5. Work with partners to target re-enrollments and new contracts under CRP and related agricultural conservation programs to benefit LPC.
6. Minimize further fragmentation of remaining Federal lands within current and historic LPC 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 LPC habitats should be limited.
7. Establish secure and well-funded financial incentive mechanisms for private landowners to provide ungrazed or very lightly grazed native rangeland habitats that are suitable for LPC use, and are not subject to herbicidal shrub control practices.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	**2***
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: We have determined that the overall magnitude of threats to the LPC throughout its range is now high. The magnitude of threats to LPC 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. Since last year's LPC candidate assessment, reports indicate that funding for and construction of primary transmission lines to facilitate extensive wind generation construction throughout LPC occupied portions of KS, OK and TX is planned to begin this year, concomitant with wind energy development in all LPC states. In addition,

projected, near-term changes in CRP enrollments, largely due to escalating commodity prices and emphasis on biofuel production, are likely to result in massive conversion of important LPC habitat to cropland production. This is especially problematic in KS where native CRP plantings have resulted in increased LPC populations and range over the last decade. As a result of the coalescence and interaction of these threats, the Service concludes that the cumulative magnitude of threats to the LPC and its habitat is now high.

Imminence: The majority of threats to remaining LPC 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 populations of LPC in the Permian Basin/western panhandle of TX, populations residing on USFS lands in southeastern CO and areas south of Highway 380 in southeastern NM. The impending loss of these populations, together with the magnitude of threats to the species overall, supports the Service's decision to elevate the listing priority for the LPC.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: CO, KS, NM, OK, and TX

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

LITERATURE CITED

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

American Wind Energy Association. 2007. Wind Energy Weekly #1203, #1225.

American Wind Energy Association. 2008a. Top 20 states with wind energy resource potential. Fact Sheet. 2 pp. Viewed April 21, 2008 at www.awea.org/pubs/factsheets/.

American Wind Energy Association. 2008b. AWEA 2007 market report. 12 pp. Viewed April 21, 2008 at www.awea.org/Market_Report_Jan08.pdf).

American Ornithologist's Union. 1957. Checklist of North American birds. Fifth edition. Port City Press, Inc., Baltimore, MD. 691 pp.

American Wind Energy Association (AWEA). 2007. Wind Energy Weekly, Vol. 26, #1249, 20 July 2007.

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. 2005a. Unpublished LPC status report for the Cimarron and Comanche National

Grasslands; presented to the Lesser Prairie-chicken Interstate Working Group. 4 pp.

Augustine, D. 2005. Personal communication via telephone to US Fish and Wildlife Service, Oklahoma Ecological Services.

Augustine, D. 2006. Unpublished LPC 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. 2007. Survey for active lesser prairie chicken leks: Spring 2007. New Mexico Dept. of Game and Fish Fed. Aid in Wildlife Restor. Proj. W-138-R-5. 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.

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. 2000. Reindeer *Rangifer tarandus* fences as a mortality factor for ptarmigan *Lagopus* spp. Wildl. Biol. 6:121-127.

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.

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., 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.

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. 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. 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.

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: a field experiment. Ecol. 73:2001–2006.

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. 1979. 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.

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

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 Bul. 3.

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.

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

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.

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. Vol. 39.

Giesen, K.M. 1994b. Breeding range and population status of lesser prairie-chickens in Colorado. Prairie Nat. Vol. 26.

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., 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. 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 Laboratory 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, 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., B.K. Sandercock, J.C. Pitman, and R.J. Robel. 2008. Spatial variation in lesser prairie-chicken demography: a sensitivity analysis of population dynamics and management alternatives. In review.

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. 23:182-183.

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. 63:1066-1081.

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

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.

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.

Intergovernmental Panel on Climate change. 2007. Climate Change 2007 The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Technical Summary. 91 pp.

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

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*. University of Nebraska Press, Lincoln.

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

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. 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. Ecological Studies 125:273-289.

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. 2005. 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.

Lionberger, J.E. 2007. 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.

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.

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. 2007. 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.

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

Oklahoma Climatological Survey. 2007. Annual climate history with 5-year weighted trends. Online Report. http://climate.ocs.ou.edu/climate_trends.html

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.

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.

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. 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.

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, 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.

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.

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.

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.

Robb, L.A. and M.A. Schroeder. 2005. Lesser prairie-chicken (*Tympanuchus pallidicinctus*): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: 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.

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. 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.

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.

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.

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.

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

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. 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 State Energy Conservation Office. 2007. Online report: www.seco.cpa.state.tx.us/index.htm

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

U.S. Department of Energy. 2008. Wind powering America. Website providing wind resource information by state at http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp.

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.

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.

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.

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 conversation with Ken Collins on October 8, 2008

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.

Wolfe, D.H., F. Sakoda, and M.A. Patten. 2008. Longevity of the lesser prairie-chicken. *In review*. Prairie Nat.

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.

2008 Candidate Assessment – lesser prairie-chicken

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: _____ 4/24/2008
Regional Director, Fish and Wildlife Service Date

Concur: _____ 11/26/2008
Deputy Director, Fish and Wildlife Service Date

Do not concur: _____ _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: October, 2008
Conducted by: Stephanie A. Manes and Ken Collins