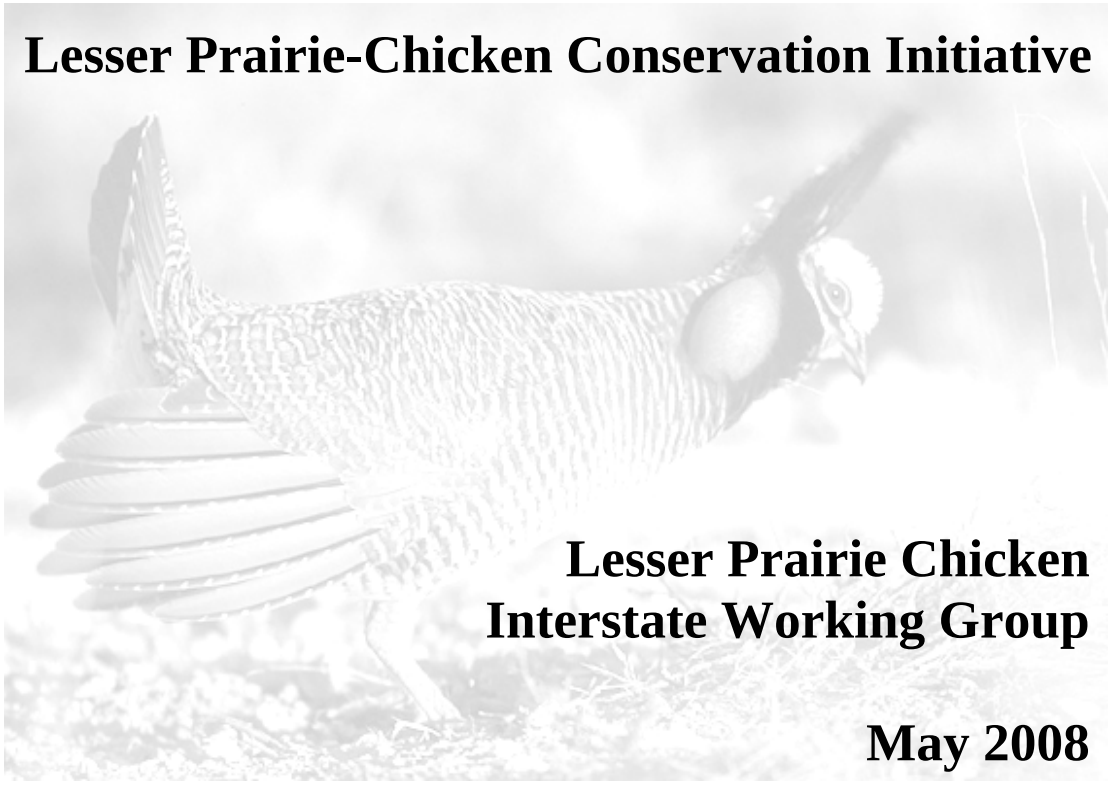
Lesser Prairie-Chicken Conservation Initiative



Lesser Prairie Chicken Interstate Working Group

May 2008

Dawn M. Davis
New Mexico Department of Game and Fish/
University of Idaho
Russ E. Horton
Oklahoma Department of Wildlife Conservation
Eric A. Odell
Colorado Division of Wildlife
Randy D. Rodgers
Kansas Department of Wildlife and Parks
Heather A. Whitlaw
Texas Parks and Wildlife Department

LESSER PRAIRIE-CHICKEN CONSERVATION INITIATIVE

Dawn M. Davis
New Mexico Department of Game and Fish
1 Wildlife Way
Santa Fe, NM 87505
dawn.davis@vandals.uidaho.edu

Russ E. Horton
Oklahoma Department of Wildlife Conservation
1801 North Lincoln Boulevard
Oklahoma City, OK 73105
rhorton270@sbcglobal.net

Eric A. Odell
Colorado Division of Wildlife
317 W. Prospect Road
Ft. Collins, CO 80526
eric.odell@state.co.us

Randy D. Rodgers
Kansas Department of Wildlife and Parks
P.O. Box 338
Hays, KS 67601
Hrandyr@wp.state.ks.us

Heather A. Whitlaw
Texas Parks and Wildlife Department
Box 42125, TTU
Lubbock, TX 79409-2125
heather.whitlaw@tpwd.state.tx.us

This report should be cited as:

Davis, D. M., R. E. Horton, E. A. Odell, R. D. Rodgers and, H. A. Whitlaw. 2008. Lesser Prairie- Chicken Conservation Initiative. Lesser Prairie Chicken Interstate Working Group. Unpublished Report. Colorado Division of Wildlife, Fort Collins, CO. USA.

Cover photo credit: Don MacCarter

Contributors

Grant M. Beauprez
Lesser Prairie-chicken Biologist
New Mexico Department of Game and Fish
800 Laurelwood Dr., #1
Clovis, NM 88101

Steve DeMaso
Upland Game Program Leader
Texas Parks and Wildlife Department
4200 Smith School Rd.
Austin, TX 78744

Christian A. Hagen
Sage Grouse Conservation Coordinator
Oregon Department of Fish and Wildlife
237 South Hines Boulevard
P.O. Box 8
Hines, OR 97738

Jonathan B. Haufler
Executive Director
Ecosystem Management Research Institute
210 Borderlands
P.O. Box 717
Seeley Lake, MT 59868

John Hughes
U.S. Fish and Wildlife Service
West Texas Suboffice
P.O. Box 713
Canadian, TX 79014

Christopher Rustay
Shortgrass Prairie BCR Coordinator
Playa Lakes Joint Venture
1824 Stanford Drive NE
Albuquerque, NM 87106

Doug Schoeling
Oklahoma Dept. of Wildlife Conservation
P.O. Box 53465
Oklahoma City, OK 73152

Trent Verquer
Terrestrial Biologist
Colorado Division of Wildlife
2500 South Main
Lamar, CO 81052

Donald H. Wolfe
Senior Biologist
George Miksch Sutton Avian Research Center
P.O. Box 2007
Bartlesville, OK 74005-2007

Jeffrey A. Yost
Terrestrial Biologist
Colorado Division of Wildlife
P.O. Box 775777
Steamboat Springs, CO 80477

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LESSER PRAIRIE-CHICKEN CONSERVATION INITIATIVE

Executive Summary

There are few sights in the world of wildlife more spectacular than the spring mating displays of the diminutive lesser prairie-chicken (*Tympanuchus pallidicinctus)*. Probably as a result of its captivating displays, this bird has become an iconic representative for wildlife species that depend on the prairies of the southern High Plains. It is a flagship species whose presence signals a healthy ecosystem with broad, open horizons in which many grassland/shrubland species can survive. Conversely, its absence points to prairie habitats in decline. Not all is well with the lesser prairie-chicken.

Within the 5 states of its historic range, the lesser prairie-chicken remains present on sand sagebrush (*Artemesia filifolia*) and mixed-grass prairies of western Kansas and eastern Colorado, through portions of northwest Oklahoma, the northeast Texas panhandle, and into the shinnery oak (*Quercus havardii*) and sand sage habitats of eastern New Mexico and adjacent Texas. While historic records are too limited to precisely define the species' original range, about 90% is no longer suitable for occupation by lesser prairie-chickens. Most evident among the many reasons for this loss have been the extensive conversion of southern High Plains prairies to croplands and the degradation of many remaining prairie habitats by improper management.

Available evidence indicates lesser prairie-chicken populations historically benefited from the initial limited establishment of grain-producing agriculture in the late 19th century, perhaps peaking when croplands constituted roughly 20% of the landscape. But continued conversion of southern High Plains prairies to cropland hastened the species' decline. Populations reached drastically low levels during the drought and Dust Bowl period of the 1930's. While the species' numbers slowly recovered after this catastrophic period, numerous other threats to the species' long-term survival subsequently developed. The compounding of these new threats along with continued conversion and degradation of prairie habitats in recent decades precipitated a long-term decline in numbers of lesser prairie-chicken breeding populations. Recent estimates of the species' total population generally range between 30,000 and 50,000 breeding birds.

In 1995, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list the lesser prairie-chicken as threatened under provisions of the Endangered Species Act. The Service's finding was that the listing was "warranted but precluded" indicating that evidence supported listing the species, but also that the agency had higher-priority species to work with, given its limited resources. Since that determination, the lesser prairie-chickens has subsequently been considered a "candidate" species, effectively elevating the species status in attracting attention and funding for conservation-oriented management and research.

Only about 14% of the range occupied by the species occurs on publicly-owned lands. Much of this public land is managed by the Bureau of Land Management in New Mexico, but the U.S. Forest Service also controls significant tracts of suitable or potential

habitat in Colorado, Kansas, and Oklahoma. The states also own some suitable habitat, particularly in New Mexico. Given the relatively small proportion of the remaining range in public ownership, although critically important, the long-term fate of the lesser prairie-chicken will largely be dependent on conservation efforts directed toward private lands.

Over the past decade, lesser prairie-chicken populations recovered from a sharp decline that occurred during the 1990's. Subsequent to that recovery, populations have continued to increase in some areas, but overall have been considered stable to slowly declining. This overall assessment, however, belies the serious and immediate threats to the species that are occurring over significant portions of the range.

Many of these threats are directly or indirectly related to increasing demands for energy. The infrastructure and activity associated with oil and gas extraction have fragmented and degraded lesser prairie-chicken habitats. Recently, intensive drilling in the northeast Texas Panhandle exemplifies this threat, but much-increased oil and gas development is occurring across the remaining range. Wind power generation poses a very serious threat to the species in that lesser prairie-chickens have been shown to avoid man-made structures during the critical nesting and brood-rearing phases of their life cycle. Compounding this problem is the fact that the wind power industry often targets the same type of lands that lesser prairie-chickens still occupy. Rising energy consumption has also magnified demand for biofuels, particularly ethanol, which in turn has increased commodity prices and created mounting pressure to convert more grassland to cropland. The production of cellulosic ethanol from perennial grasses, if properly managed, might eventually provide limited opportunities to enhance lesser prairie-chicken habitats but this remains uncertain.

Habitat degradation resulting from improper grassland management remains a threat and, if anything, is accelerating. Long-term fire suppression has resulted in invasive trees altering many habitats to the point that they are no longer suitable for lesser prairie-chicken use. In northeastern sections of the species' range, eastern red cedar (*Juniperus virginiana*) has spread rapidly. Mesquite (*Prosopis glandulosa*) has done the same further south. Fire suppression has also allowed shinnery oak to gain excessive stature in parts of Texas and Oklahoma, also rendering these habitats unsuitable. Underlying this problem is the habitat fragmentation created by man-made structures and tree plantings that, in effect, create a need for fire suppression. Excessive grazing pressure in some grasslands further suppresses the vigor of native grasses. In turn, reduced grass vigor diminishes habitat quality directly, but also lessens fire frequency, and provides a competitive advantage to invasive trees. Diminished habitat quality exposes lesser prairie-chickens to increased predation, including a new suite of predators that take advantage of invasive trees.

As the range of the lesser prairie-chicken has contracted and fragmented, the potential for genetic isolation with lowered reproductive capacity has become an additional threat. Isolated populations are also more vulnerable to decline and disappearance as a result of catastrophic events, particularly drought. Climate change threatens to increase the frequency, intensity, and duration of droughts on the High Plains. Habitats that were

once adequate to support the species could become insufficient for lesser prairie-chickens if an increase in weather extremes accompanies global warming as predicted. Under such circumstances, only the very best of habitats may remain suitable.

Many positive steps have been taken on behalf of the lesser prairie-chicken by state, federal, and private organizations and individuals. A reconstituted program of research has helped identify previously unknown threats to the species and pointed toward management solutions. Educational outreach and materials have done much to bring the conservation needs of lesser prairie-chickens to the attention of government and private entities. This education not only provided the opportunity to positively influence the species but it may have also helped prevent or minimize negative effects that might have otherwise occurred. By targeting federal resources made available through United States department of Agriculture (USDA) programs (e.g., Conservation Reserve Program (CRP), Wildlife Habitat Incentive Program (WHIP), Environmental Quality Incentive Program (EQIP), and programs available through the USFWS and state wildlife agencies (e.g., Landowner Incentive Program (LIP), State Wildlife Grants (SWG), Partners for Wildlife), new habitats have been created and previous habitats have been restored on private lands. Notably, lesser prairie-chickens have responded positively to native-mixture grasslands established through the CRP and invasive trees have been removed from some existing grasslands. Many landowners who have implemented active conservation measures benefiting lesser prairie-chickens have been extended formal assurances that their efforts will not negatively affect their operations should the species eventually be listed under provisions of the Endangered Species Act.

Despite the positive efforts undertaken to benefit the lesser prairie-chicken, challenges to the species' long-term welfare are mounting, even accelerating. It is clear that efforts to conserve viable populations of the species must further increase and be sustained even beyond the foreseeable future. Member states of the Lesser Prairie-Chicken Interstate Working Group have established goals that collectively aim at achieving range wide breeding populations averaging about 80,000 birds over time.

To have any chance of reaching these goals, agencies and organizations must intensify their efforts to work with the private landowners and land managers on whose properties most of the remaining or potential lesser prairie-chicken habitat exists. This will include providing them the information, motivation, technical assistance, and financial incentives necessary to improve or restore suitable habitats. Maintaining and establishing high-quality CRP grasslands in or near occupied lesser prairie-chicken range and improvements in efforts to restore degraded native habitats are critical. Existing efforts to implement lesser prairie-chicken conservation on publicly-owned lands must be given even higher priority.

Great responsibility for the future conservation of the lesser prairie-chicken lies with energy-production industries. Whether active in fossil-fuel extraction or renewable energies, or energy transmission and delivery, the importance of their decisions corresponds with the massive scale of their potential impacts on remaining occupied habitats. Decisions these industries make in locating their infrastructure and managing

their activities will be a linchpin for survival of the species. Where energy infrastructure /lesser prairie-chicken conflicts cannot be resolved through appropriate siting or management, it is incumbent upon these industries to bring their considerable resources to bear on mitigating probable losses.

With this document, it is the sincere intent of the Lesser Prairie-Chicken Interstate Working Group to provide a framework for conservation of the species. It outlines the biology, population status, threats, actions already taken, and recommends conservation strategies that should be implemented. We recognize that unforeseen threats as well as new conservation opportunities could arise that are not here addressed and stress that conservation efforts must remain sufficiently flexible to react to such changes. We believe the future of the lesser prairie-chicken depends on the willingness of industry, government, and private organizations to step well beyond what may be perceived as minimum efforts necessary to maintain populations at current levels.

CHAPTER 1. CONSERVATION STATUS OF LESSER PRAIRIE-CHICKEN POPULATIONS

1.1 Introduction

The lesser prairie-chicken (*Tympanuchus pallidicinctus*; hereafter LEPC) historically occupied sandhill habitat characterized by mixed-grass prairies, shinnery oak (*Quercus havardii*)-bluestem (*Andropogon* spp.) and sand sagebrush (*Artemisia filifolia*)-bluestem communities in the plains of eastern New Mexico (Bailey 1928, Ligon 1961, Hubbard 1978) and portions of southeastern Colorado (Hoffman 1963, Giesen 1994a), southwestern Kansas (Schwilling 1955, Horak 1985, Thompson and Ely 1989, Jensen et al. 2000), western Oklahoma (Duck and Fletcher 1944, Copelin 1963, Horton 2000), and the Texas panhandle (Henika 1940, Oberholser 1974, Sullivan et al. 2000). They are dependent on vegetative components available in those native rangelands. Since the 19th century, LEPC, and the habitats upon which they depend, have diminished in the area about 90% (Crawford and Bolen 1976a, Taylor and Guthery 1980a). Habitat losses through conversion of native prairie to cropland (Crawford and Bolen 1976a), poor grazing management practices (Jackson and DeArment 1963, Riley et al. 1992), habitat fragmentation from oil and gas development (Hunt 2004), and prolonged drought throughout their range (Giesen 1998) are contributing factors leading to the decline in LEPC numbers and further isolated distribution.

Concern has been expressed that LEPC populations, habitat quality, and habitat quantity continue to degrade throughout the range of LEPC. In response to declining LEPC abundance and distribution, a petition was submitted to the U.S. Fish and Wildlife Service (USFWS) in 1995 to list the LEPC as threatened under provisions of the federal Endangered Species Act (ESA). The USFWS's finding was that listing was "warranted but precluded," indicating the USFWS felt the species warranted protection but was precluded from listing by higher priority species (Federal Register 63:110, 31400-31406). The status of the bird is reviewed annually in a candidate notice of review (CNOR), and LEPC remains a candidate species for federal listing today.

1.2 State Laws and Existing Regulatory Mechanisms

In this chapter we outline state wildlife laws, existing regulatory mechanisms, and the status of conservation planning efforts in the various states within the occupied range of LEPC. Currently, regulatory authority of the LEPC rests entirely with the states. However, the USDA Forest Service (USFS) regards the LEPC as a sensitive species and a Management Indicator Species on the Comanche and Cimarron National Grasslands (USDA–FS 2003). The Bureau of Land Management (BLM) also considers the LEPC in its regional management plans (BLM 2005).

New Mexico

New Mexico manages LEPC under the statutory authority of Chapter 17 of New Mexico Statutes Annotated 1978 as follows:

"17-1-1. It is the purpose of this act and the policy of the state of New Mexico to provide an adequate and flexible system for the protection of the game and fish of New Mexico and for their use and development for public recreation and food supply, and to provide

for their propagation, planting, protection, regulation and conservation to the extent necessary to provide and maintain an adequate supply of game and fish within the state of New Mexico."

In 1997, New Mexico Department of Game and Fish (NMDGF) was petitioned to investigate the status of the LEPC for listing. The Department found that the prospects for survival and recruitment of the LEPC are not jeopardized to a degree that constitutes classification as threatened or endangered under the Wildlife Conservation Act (Davis 2006). The Department's recommendation regarding the LEPC Investigation was brought before the State Game Commission in November 2006. The motion to accept the Final Listing Investigation Report and recommendation that the LEPC not be listed under the Wildlife Conservation Action was carried unanimously.

Texas

Texas Parks and Wildlife Department (TPWD) manages LEPC under the authority of PWC Title 2 Chapters 11 and 12, and PWC Title 5 Chapters 61 and 64 (see http://tlo2.tlc.state.tx.us/statutes/pw.toc.htm). The mission of TPWD is to manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing, and outdoor recreation opportunities for the use and enjoyment of present and future generations.

Oklahoma

The Oklahoma Department of Wildlife Conservation (ODWC) manages LEPC under authority given by Title 29, Oklahoma Statutes, §29-3-103 Functions, powers and duties of the Commission, which states:

"A. The Wildlife Conservation Commission shall constitute an advisory, administrative and policymaking board for the protection, restoration, perpetuation, conservation, supervision, maintenance, enhancement, and management of wildlife in this state as provided in the Oklahoma Wildlife Conservation Code…." (http://www.lsb.state.ok.us/OKStatutes/CompleteTitles/os29.rtf)

The mission of the ODWC is to manage Oklahoma's wildlife resources and habitat to provide scientific, educational, aesthetic, economic and recreational benefits for present and future generations of hunters, anglers and others who appreciate wildlife.

LEPC are considered game birds in Oklahoma, but there has been no open season since 1997.

Kansas

The Kansas Department of Wildlife and Parks (KDWP) mandate regarding its conservation obligations, including managing LEPC, is contained in Kansas Statutes Annotated (KSA) 32–702 which states:

"It shall be the policy of the state of Kansas to protect, provide and improve outdoor recreation and natural resources in this state and to plan and provide for the wise

management and use of the state's natural resources, thus contributing to and benefiting the public's health and its cultural, recreational and economic life. For these purposes, the secretary, the commission and the department are hereby vested with the duties and powers hereinafter set forth."

LEPC are hunted in Kansas.

Colorado
Colorado Division of Wildlife (CDOW) has responsibility for the management and conservation of wildlife resources, including the conservation and management of threatened and endangered species, within their borders as defined and directed by state laws (i.e., Colorado Revised Statutes, Title 33, Article 1). Title 33 Article 1-101, Legislative declaration states:

"It is the policy of the State of Colorado that the wildlife and their environment are to be protected, preserved, enhanced and managed for the use, benefit, and enjoyment of the people of this state and its visitors. It is further declared to be the policy of this state that there shall be provided a comprehensive program designed to offer the greatest possible variety of wildlife-related recreational opportunity to the people of this state and its visitors and that, to carry out such program and policy, there shall be a continuous operation of planning, acquisition, and development of wildlife habitats and facilities for wildlife-related opportunities."

In Colorado, the LEPC was listed as threatened in 1973 under the Nongame and Endangered or Threatened Species Act (Davies 1992).

1.3 Conservation and Management Plans

The long-term conservation of LEPC requires the integration and implementation of conservation efforts at local, state, and range-wide levels. It is through implementing actions at the state and local level that projects and other actions of most immediate benefit to LEPC will grow.

Conservation actions are planned, coordinated, funded and accomplished by cooperative partnerships among state and federal agencies, private landowners, industry, non-governmental organizations, and the public. Conservation planning and implementation have been accomplished by local LEPC working groups and state plans throughout the 5-state range occupied by LEPC. These actions identify threats, issues, and strategies to consider in LEPC management and provide a comprehensive framework that facilitates the development and implementation of local, state, and range-wide plans.

New Mexico
NMDGF completed management plans for LEPC in New Mexico in 2001 and has made significant progress toward implementing long-term LEPC conservation efforts. As part of the Department's outreach efforts, concerned officials with NMDGF, in collaboration with the USFWS, Bureau of Land Management (BLM), New Mexico State Land Office (SLO), and Wildlife Management Institute, proposed that a "Southeast New Mexico

Lesser Prairie-Chicken Working Group" of appropriate public and private stakeholders begin meeting to devise a conservation strategy for the LEPC in southeastern and east-central New Mexico. The organizers hoped the various constituencies would be able to negotiate a collaborative plan that would, when implemented, improve the status of the species such that federal listing would no longer be warranted, while protecting the interests of the participating parties. In 2005, the Working Group adopted a conservation strategy and recommendations which laid out general approaches, priorities and parameters for achieving the goal of LEPC conservation and recovery while maintaining economic values and traditional land uses. The strategy document outlines and prioritizes a variety of recommended programs, projects, and practices for reducing threats to the LEPC while maintaining other uses of the land.

Texas
To date, Texas has not produced a state LEPC conservation strategy; it remains in draft form. Texas has initiated the process of developing a LEPC Working Group to assist in the drafting of the state plan.

Oklahoma
To date, Oklahoma has not developed a LEPC conservation plan.

Kansas
Kansas has formed a committee to produce a state LEPC plan; however, to date the statewide conservation plan for LEPC is not complete.

Colorado
Colorado has a Lesser Prairie Chicken Recovery Plan (Davies 1992). The goal of that plan was to down list the LEPC to a species of special concern by 2005 if, "The number of LEPC reaches 2,500 birds and remains stable (fluctuating no more than + or – 10% per year) or increasing for a period of five years." Currently those goals have not been met.

U.S. Bureau of Land Management
Presently, the BLM is developing a resource management plan amendment of the 1988 Carlsbad Resource Management Plan (RMP), including its 1997 amendment, and the 1997 Roswell RMP. This RMP amendment maintains and protects existing habitat for LEPC and enhances habitat for LEPC while simultaneously permitting the multiple uses and actions on public land in southeast New Mexico. The Planning Area amounts to about 2% of New Mexico and is located in the southeastern part of the State, comprising 1,852,946 acres of private, federal and state trust lands.

U.S. Forest Service (National Grasslands)
The USFS administers the National Grasslands where management efforts are focused on maintaining habitat structure, particularly LEPC nesting cover. Grazing rotations emphasize leaving residual cover and increasing or maintaining bunchgrasses. Several grazing rotations have been, or are being, established that incorporate both private and public pastures. This allows more refined grazing management to be applied over a wider area. In addition to these efforts, seasonal restrictions are placed on surface-

disturbing activities, to lessen disruption of nesting. A detailed habitat assessment is currently underway on the Comanche and Cimarron National Grasslands to further define suitable habitat.

Range-Wide Strategies

In 1997, a multi-agency LEPC Interstate Working Group (LPCIWG) was established and a range-wide conservation strategy to coordinate efforts among the five states with occupied LEPC habitat was prepared (Mote et al. 1998). In 2005, the LPCIWG worked with the Western Association of Fish and Wildlife Agencies (WAFWA) to develop a Memorandum of Understanding between the 5 state wildlife agencies within the planning area and USDA Natural Resources Conservation Service, USDA Farm Services Agency, USFS, USFWS, and Playa Lakes Joint Venture (PLJV) to facilitate cooperation among participating agencies in the development and implementation of conservation programs for LEPC and their associated habitats (Appendix I).

CHAPTER 2. NATURAL HISTORY

2.1 Species Taxonomy

The LEPC is a member of the Order Galliformes, Family Phasianidae, and subfamily Tetraonidae (grouse and ptarmigan) and is one of twelve species of grouse found in North America. Although generally comparable in morphology, plumage, and behavior to the greater prairie-chicken (*T. cupido*), the LEPC is smaller, occupies a different range, and is recognized as a species separate from the greater prairie-chicken (AOU 1957, 1983; Giesen 1998, Hagen and Giesen 2005)

2.2 Seasonal Activities and Habitats

During the breeding season (mid-February through early May, but primarily during March and April), male LEPC congregate on traditional lek sites and perform courtship displays to attract hens for mating. Nests are initiated mid-April through late May, typically within 2 weeks of lek attendance and copulation (e.g. Bent 1932, Copelin 1963, Snyder 1967, Merchant 1982, Haukos 1988). Hatching peaks in late May through mid-June throughout the range (e.g. Copelin 1963, Merchant 1982). Re-nests (following nest depredation or abandonment of the initial clutch) are initiated mid-May through early June, with hatching mid-June through early July (e.g. Merchant 1982, Pitman et al. 2006). In the autumn and winter, birds assemble into mixed flocks feeding primarily in sand sage, shinnery oak, or mixed-grass prairies, but also often feed on waste grains (Giesen 1998).

Habitat components necessary to fulfill LEPC life history needs include nesting habitat, brood-rearing and summer habitat, and autumn/winter habitat. The average home range of an individual bird is about 4 square miles (Bidwell et al. 2003). However, the collective home range of all birds that attend a particular lek site averages approximately 19 square miles (>12,000 acres) (Bidwell et al. 2003). Although the minimum habitat patch size to support LEPC is not clear, several studies have speculated that habitat mosaics containing patches ranging from 1,200 to 25,000 acres of contiguous native rangelands may be necessary to sustain viable LEPC populations (Davison 1940, Copelin 1963, Crawford and Bolen 1976a, Taylor and Guthery 1980b, Wildlife Management Institute 1999, Woodward et al. 2001, Bidwell et al. 2003).

Lek Sites

LEPC have high fidelity to lek sites (Campbell 1972) and males often use traditional leks sites year after year. Lek sites are characterized by sparse, low vegetation (<10 cm) and are often located on a knoll or ridge, or grama-grass (*Boutela* spp.) flat (Jones 1963, Copelin 1963, Cannon and Knopf 1979, Taylor and Guthery 1980a, Giesen 1991). Disturbed areas such as roads, abandoned oil and gas drill pads, areas around livestock watering facilities, windmills, and herbicide treatments (Crawford and Bolen 1976a, Davis et al. 1979, Sell 1979, Taylor 1979, Ahlborn 1980, Locke 1992), or prairie dog towns (Bidwell et al. 2003) may also be used as lek sites. Applegate and Riley (1998) recommended clusters of 6-10 or more leks, each with a minimum of six males, separated from one another by a distance of 1.2 miles or less to ensure viable LEPC populations. A number of studies have reported inter-lek distances of a mile or less (Crawford 1974,

Crawford and Bolen 1976a, Taylor 1979, Locke 1992, Jamison et al. 2002a). At this density, a complex of 6-10 lek sites could fall within a habitat patch size of roughly four square miles. If each lek in the cluster was surrounded by a two-mile radius area (i.e., the minimum breeding season patch size around a lek), the entire lek and core habitat complex might occupy up to 32 square miles (~21,000 acres), with a wider perimeter of habitat for autumn and winter foraging and escape cover. This is more or less consistent with the 25,000-acre estimate of Bidwell et al. (2003).

Nesting Cover

Hens typically select nest sites within 2 miles of leks where they were captured (Suminski 1977, Riley 1978, Giesen 1994b). The importance of herbaceous cover for nesting as a key component influencing nest fate of LEPC is well documented (Table 2.1). In Conservation Reserve Program (CRP) grasslands planted to mixed, native warm-season grasses, nests are predominately found in mid- and tall grasses such as western wheatgrass (*Pascopyrum smithii*), little bluestem (*Schizachyrium scoparium*), big bluestem (*A. gerardi*), and switchgrass (*Panicum virgatum*), where clumps of tall residual vegetation from the previous growing season are common (Fields 2004). In sand sage-grasslands, nests are most often in sand sage or in tall bunchgrasses (Giesen 1994b, Pitman et al. 2005, and Pitman et al. 2006). In shinnery oak-grasslands, successful nests are typically associated with tall perennial grasses (e.g., bluestem species), although shrubs are always present (Davis et al. 1979, 1981; Riley et al. 1992). The height and density of shrubs, forbs, or residual grasses are greater at the nest site than in the surrounding rangeland (Table 2.2), and are greater at successful nests than at unsuccessful nests (Riley 1978, Davis et al. 1979, Wisdom 1980, Haukos and Smith 1989, Riley et al. 1992, Pitman et al. 2005). Where residual herbaceous cover is less abundant, LEPC become more dependent on shrubs for nesting (Riley 1978, Sell 1979, Merchant 1982, Johnson et al. 2004).

Table 2.1 Habitat characteristics of successful and unsuccessful LEPC nests from four studies in New Mexico and Kansas (adapted from Hagen et al. 2004).

	Successful					Unsuccessful				
State	**VOR (dm)**	**Shrub %**	**Grass %**	**Forb %**	**Bare %**	**VOR (dm)**	**Shrub %**	**Grass %**	**Forb %**	**Bare %**
NM[a] (1)	87.4[d]	32.5	64.0	3.5	--	36.6[d]	31.3	49.6	19.1	--
NM[a] (2)	55.9[d]	41.8	55.1	3.1	--	39.5[d]	48.1	44.5	7.4	--
NM[a] (3)	50.0[d]	66.2	23.8	10.0	--	31.2[d]	54.7	37.9	7.4	--
KS[b]	2.7	18.4	37.6	8.9	15	2.2	13.7	38.9	8.4	15
KS[c] (R)	4.6	0	56.5	13.0	30.5	2.1	3.1	74.7	6.0	14.7
KS[c] (C)	3.0	0	81.2	3.1	15.6	2.9	0	76.4	3.8	19.2
NM[e]	5.1	44.0	12.6	1.8	4.6	4.0	37.5	17.1	2.1	8.1

[a]Riley et al. (1992) 1 = High Plains Bluestem Subtype (HPBS-1), 2 = HBPS-2, and 3 = HBPS-3 in southeastern New Mexico

[b] Pitman (2003) quantified vegetation in sand sagebrush cover types.

[c] T. Fields (personal communication). R = rangeland, C = Conservation Reserve Program grasslands. This study area contained only very limited shrub habitat. No rangeland nests were successful in the extreme drought year of 2002, the first of 2 years in this study.

[d] Visual obstruction readings (VOR) were measured (cm) by the plant growing nearest to the nest (Riley et al. 1992).

[e] Nest site characteristics were measured in shinnery oak dominated rangelands (NMDGF, unpublished data).

Table 2.2 Habitat characteristics at nest sites and brood-rearing locations for LEPC across the 5-state range (adapted from Hagen et al 2004, Robb and Schroeder 2005).

		Nest-site				Brood-rearing			
Habitat type	**State**	**Shrub (%)[a]**	**Grass (%)**	**Forb (%)**	**VOR (dm)[b]**	**Shrub (%)**	**Grass (%)**	**Forb (%)**	**Reference**
Sand sagebrush	KS	7	29	1					Bent 1963
	OK					23	8	16	Jones 1963 a, b
	CO	7	29	1					Giesen 1994
	KS	15	37	8	2.4				Pitman 2003
	KS					17	26	11	Hagen et al. 2004
	KS	0	70	9	2.2				Fields 2004
Shinnery oak	OK					14	51	35	Donaldson 1969[c]
	TX		42						Haukos and Smith 1989
	TX	25	8	2					Wilson 1982
	NM	46	46	8					Riley et al. 1992
	NM					30	50	20	Ahlborn 1980
	NM					42	43	15	Riley and Davis 1993
	NM	42	14	2	4.7				NMDGF (unpublished data)
Mixed grasslands/CRP	KS[d]	0	81	2	3.0				Fields 2004
	KS[e]	0	77	6	2.8				Fields 2004
Cropland (Wheat)	KS	0	58	0	8.8				Fields 2004

[a] Methods for estimating percent canopy cover varied across studies; thus percentages are not directly comparable.
[b] VOR = visual obstruction reading
[c] Study was conducted in both shinnery oak and sand sagebrush habitats.
[d] CRP fields consisting only of grass species.
[e] 50% of grass CRP interseeded with forbs.

Brood Habitat

Habitats used for brood-rearing are usually within 1.8 miles of lek sites and typically are more open (roughly 25% canopy cover) than nest areas, with more forbs, less grass cover, and lower grass height (Ahlborn 1980, Applegate and Riley 1998) (Table 2.2).

Brood-rearing locations are usually associated with higher levels of insect abundance (Jamison et al. 2002b, Hagen et al. 2005) and allow young chicks to move easily on the ground (Bidwell et al. 2003). Active sand dunes with shrubs, especially within shinnery oak or sand sage habitats, are common in brood-rearing habitat. Shrubs are often used for shade in summer (Copelin 1963, Donaldson 1969, Bell 2005).

Autumn/Winter Habitat

LEPC typically range across larger areas during the autumn and winter months, occupying the same general habitats as are used for nesting and brood-rearing. (Giesen 1998). LEPC use mixed-grass prairies, sand sage-grassland, or shinnery oak-grassland for resting and roosting (Taylor and Guthery 1980a). The birds also feed in this habitat, or in nearby agricultural fields with waste grains if they are located in the vicinity of rangelands that provide adequate cover for resting and concealment (Jones 1964, Crawford and Bolen 1976c, Ahlborn 1980, Taylor and Guthery 1980b, Jamison 2000). Shinnery oak provides leaves, catkins, acorns, and insect galls as food resources. Planted food plots may provide additional food. However, food plots <10 acres or far from rangeland escape cover may attract predators and enhance predation (Bidwell et al. 2003).

2.3 Diet

The LEPC diet consists of insects, seeds, leaves, buds, and cultivated grain crops (Copelin 1963, Jones 1963; 1964, Donaldson 1969, Crawford 1974, Crawford and Bolen 1976c, Davis et al. 1979, Olawsky 1987, Riley et al. 1993). Invertebrates are important to LEPC throughout their life cycle, but particularly in the diet of juveniles <10 weeks old (Davis et al. 1979, Jones 1964). Grain fields are also used for winter foraging in areas where cultivated lands occur in the vicinity of rangelands (Jones 1964, Crawford and Bolen 1976c, Ahlborn 1980, Taylor and Guthery 1980b, Jamison 2000). The importance of grain crops in helping maintain LEPC populations when native food resources are limited is not known. Bidwell et al. (2003) suggested that food is generally not a limiting factor for upland game birds such as the LEPC; however, food plots might benefit small populations in fragmented habitats.

The LEPC obtains necessary moisture through food (Snyder 1967) and is not limited to rangelands having free surface water; however, LEPC will use surface water, typically from stock ponds, when available (Crawford and Bolen 1973).

CHAPTER 3. LESSER PRAIRIE-CHICKEN STATUS AND DISTRIBUTION

3.1 Historic Distribution and Abundance

The LEPC is endemic to the shinnery oak, sand sagebrush, and mixed-grass dominated rangelands of the southern Great Plains in Colorado, Kansas, Oklahoma, New Mexico, and Texas (Giesen 1994a, 1998; Mote et al. 1998, Hagen et al. 2004). Although few records exist to verify the historical distribution of LEPC, the geographic distribution of the LEPC during the 1800s is speculated to have encompassed 138,000 square miles (Taylor and Guthery 1980a based on Aldrich 1963). By 1969 this area had been reduced to 48,000 square miles, (Taylor and Guthery 1980a based on Aldrich 1963). This represents a 78% decrease in the distribution of the LEPC since 1963 and a 92% decrease since European settlement (Taylor and Guthery 1980a).

Historical records of population numbers are lacking but suggest that during the early decades of the 20th century LEPC were relatively common within their 5-state range (Sands 1968, Crawford 1980). However, by the 1930s, populations were near extirpation in Colorado, Kansas, and New Mexico and markedly declined in Oklahoma and Texas (Baker 1953, Crawford 1980). Although accurate estimates are not available, populations are believed to have fluctuated range-wide throughout the 1940s and 1950s. Populations increased through the 1980s but appeared to decline again during the 1990s (Mote et al. 1998). Survey data collected during the past decade indicate that populations have declined in Oklahoma and Texas, remained stable in Colorado, and have increased in Kansas and New Mexico.

New Mexico

In the 1920s and 1930s, the former range of the LEPC in New Mexico was described as all of the sandhill rangeland of eastern New Mexico from the Colorado line south to the Texas line and west to the Pecos River Valley (Ligon 1961). Ligon (1927) mapped the 1920's range and it encompassed portions of 12 counties.

The LEPC has been extirpated from nearly 56% of its historical range in New Mexico and persists in sparse and scattered populations in 23% of its former distribution (Bailey and Williams 2000). The core of LEPC distribution occurs in east-central New Mexico where LEPC occupy portions of 6 counties (Davis 2006), comprising 21% of their former range (Bailey and Williams 2000) (Table 3.1). Estimates of occupied range in New Mexico over the last century suggest a pattern of periodic decline and increase, including reoccupation of former range (Snyder 1967).

Precise estimates of the historic abundance of LEPC in New Mexico are lacking (Bailey and Williams 2000). Sands (1968) estimated a peak population of 40,000 to 50,000 birds between 1949 and 1961 and by 1968 judged the population had fallen to between 8,000 to 10,000 individuals. In 1979, Crawford (1980) speculated the population was again 10,000 birds. Although no population estimates are available for lands administered by the BLM, lek survey data from 1971 through 1997 show a clear and substantial population decline after 1988, particularly in the southern periphery of their range

(Johnson and Smith 1999). In 2000, the population was believed to have fallen to <1,000 birds (Johnsgard 2002), but have subsequently recovered (Davis 2006).

Table 3.1 Number of active leks in eastern New Mexico, 2005.

County	Estimated number of active leks					
	Absent	<10	10-25	25-30	50-100	>100
Union	■					
Harding	■					
Quay		■				
Curry			■			
DeBaca		■				
Chaves					■	
Roosevelt						■
Lea					■	
Eddy[1]	■					
San Miquel	■					
Guadalupe	■					
Colfax	■					

[1]Although no leks sites have been documented, LEPC have been sighted and/or the existence of leks is suspected.

Texas

Early records from Texas indicate that LEPC occurred throughout the Permian Basin occupying the northeastern and southeastern regions of the Texas panhandle (Texas Game, Fish, and Oyster Commission 1945, Jackson and DeArment 1963, Litton 1978). Systematic surveys of the number of Texas counties where LEPC occurred began in 1940 (Henika 1940, Texas Game, Fish, and Oyster Commission 1945, Litton 1978). From the early (Henika 1940, Sullivan et al. 2000) to mid 1940s (Texas Game, Fish, and Oyster Commission 1945, Litton 1978) to the early 1950s (Seyffert 2001), it is estimated that the range of the LEPC in Texas encompassed portions of 34 counties. Researchers considered the occupied range at the mid-20th century (1940-1950) to be a reduction from the historical range (ca. 1900). Between 1963 and 1980 the historical distribution was marked by a large reduction in the range, particularly in the southwest and east-central panhandle; however, populations in the northeastern panhandle remained relatively stable (Sullivan et al. 2000). In 1989, TPWD produced an occupied range map that indicated LEPC inhabited portions of 12 counties (Sullivan et al. 2000).

Historical Texas LEPC abundances are difficult to ascertain. Litton (1978) speculated that up to 2 million birds were present prior to 1900. However, this figure seems highly improbable given that it implies a density exceeding 20 LEPC/mi^2 across the entire historic range of Texas. In 1937, Texas Game, Fish, and Oyster Commission (1945) estimated 12,000 LEPC in the state. In 1974, Litton (1978) estimated approximately

17,000 birds in Texas. In 1979, Crawford (1980) estimated 11,000-18,000 LEPC in the state.

Oklahoma

The historical range of LEPC in Oklahoma encompassed portions of 22 counties (Horton 2000). Although the historic breeding population is unknown, Duck and Fletcher (1944) estimated a total population of >14,000 LEPC in 11 counties during the 1940s. In 1963, Copelin (1963) estimated that the spring population remained at approximately 15,000 birds across 12 counties, including Blaine County where LEPC were apparently absent in 1944. By 1978, LEPC occupied 8 counties and the population had declined to 7,500 birds (Cannon and Knopf 1980).

Kansas

There is little information available on the abundance of LEPC in Kansas prior to European settlement. The LEPC was not even recognized as a distinct species until 1885 (Baker 1953). After gleaning what he could from historical accounts, Schwilling (1955) indicated "they were not as abundant as many supposed and were probably originally found only in moderate numbers." Their distribution, however, was apparently quite uneven within their broader range. Schwilling (1955) interviewed long-term resident and hunter of Garden City, Frank Schulman, who indicated they "never had many chickens on the flatlands." Schulman also stated that "the large numbers, often spoken of, were found only in the rough sandhill-sagebrush areas along the Arkansas and Cimarron Rivers as well as sagebrush areas along the streams and rivers further north."

Both Baker (1953) and Schwilling (1955) indicated that populations of this species sharply increased following initial settlement and the relatively primitive agriculture that came with it. This increase may have been a result of improved food supplies available in grain fields. Evidence suggests that LEPC were sufficiently abundant prior to the 1930s that they supported both local subsistence hunting and some level of market hunting with no apparent adverse population effect. Continued conversion of prairie to cropland eventually proved detrimental to the species.

The combination of drought and clean-tillage farming that produced the Dust Bowl of the 1930s decimated LEPC populations. It seems highly unlikely that anyone had clear knowledge of the distribution of LEPC populations in Kansas following the drought of the 1930's, but Baker (1953) reported the comments of Edward Gebhard of Meade who believed that only two small flocks were left in Kansas at that time. One of those two sites, the XI Ranch in Meade County, was reported to contain only one small flock on the entire 75 square mile ranch. In any case, the 1930s almost certainly represented the low point of the species' populations in both Kansas and throughout its range.

A very generalized distribution of LEPC in southwest Kansas was first produced by Baker (1953). Schwilling (1955) depicted a more-specific distribution that was somewhat less extensive than indicated 8 years later by White (1963). This may suggest a continuation of the population recovery that began sometime after the 1930's drought. However, a distribution map produced by Waddell and Hanzlick (1978) indicated a loss

of range as compared to that depicted by White (1963). Waddell (1977) estimated the entire breeding population of LEPC in Kansas was about 17,400 birds. In the interim between White and Waddell's work, center-pivot irrigation was developed and quickly spread into some of Kansas' best remaining sandsage prairie habitats. Prior to center-pivot irrigation these sandy soils could not be productively farmed. The abundant ground-water resources under many of these areas coupled with the ability of a center pivot to travel across rough ground made cultivation of some sandsage habitats possible. Southern Finney County and southeastern Kearny County, in particular, were heavily converted to center pivots between the late 1960s and the early 1980s, representing a significant loss of some of Kansas' best remaining LEPC habitat. This conversion resulted in displacement of prairie-chickens that temporarily created artificially high breeding densities, reaching up to 50 birds per square mile, on remaining blocks of sandsage habitats in the vicinity. Fortunately, further development of center pivots along the Arkansas River corridor was halted by imposition of an Intensive Groundwater Use Control Area (IGUCA) by the Kansas Division of Water Resources and the local groundwater management district.

Colorado

Although records of LEPC in Colorado prior to 1900 are lacking, the species likely occupied at least 6 counties in southeast Colorado prior to European settlement (Giesen 2000). The dust-bowl era of the 1930s was marked by precipitous declines in LEPC populations. A modest increase in LEPC numbers was observed between 1959 and 1962; however, the occupied range represented only a small fraction of the historical distribution (Hoffman 1963). By 1979, the total autumn population was estimated to have reached 400-500 birds (Crawford 1980). Systematic surveys of LEPC populations throughout the state were not initiated by CDOW until 1980 (Giesen 2000). In 1980, two populations of LEPC were known to reside in Prowers (2 leks) and Baca (20 leks) counties (Taylor and Guthery 1980a). Survey efforts by CDOW were intensified during the 1980s, when the breeding population is believed to have peaked at 1,000-2,000 birds (Giesen 2000). By the late 1980s the breeding population was known to be distributed in Baca, Prowers, and Kiowa counties (Giesen 1994a). Fewer than 50 leks were known to exist during the early 1990s (Andrews and Righter 1992). By the mid-1990s, the known distribution of LEPC included small populations in southeastern Baca County (primarily on the Comanche National Grasslands), in Baca County southeast of Springfield, and in Prowers and Kiowa counties (Giesen 1994a). The CDOW estimated at total population of 800-1,000 LEPC in the state in 1997 (USFWS 2002). A small potentially isolated population was discovered on private land in Cheyenne County in 1998. This area was only lightly historically surveyed and even since has not received intensive effort.

3.2 Current Status and Distribution

The current distribution of the LEPC includes southeast Colorado including Baca, Prowers, Kiowa, and Cheyenne counties (Giesen 2000); southwest Kansas from the Oklahoma border north to Wallace and Ellis counties and east to Ellis, Stafford, and Barber counties (Jensen et al. 2000); the panhandle and western Oklahoma including isolated parts of Cimarron, Texas, Beaver, Harper, Ellis, Roger Mills, Woods, and Woodward counties (Horton 2000); eastern New Mexico including portions of Quay,

Curry, Roosevelt, DeBaca, Chaves, and Lea counties (Bailey and Williams 2000, Davis 2006); and the panhandle of Texas in parts of Andrews, Bailey, Carson, Cochran, Deaf Smith, Donley, Gaines, Gray, Hemphill, Hockley, Lamb, Lipscomb, Moore, Ochiltree, Oldham, Randall, Roberts, Swisher, Terry, Wheeler and Yoakum counties (Figure 3.1, Appendix II) (H. A. Whitlaw, TPWD, personal communication).

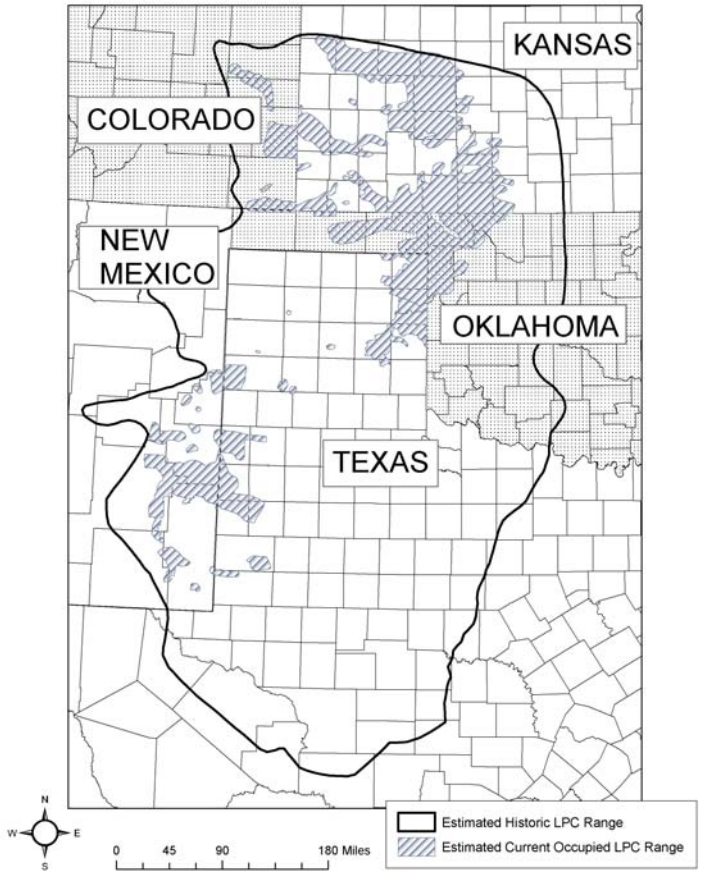


Figure 3.1 Estimated occupied range and estimated historic range of LEPC as of 2007

New Mexico

Bailey and Williams (2000) divided the LEPC range in New Mexico into three categories: northeast, east-central, and southeastern New Mexico. Northeastern New Mexico contains the smallest amount of suitable LEPC habitat (Ligon 1927, Frary 1957, Snyder 1967) and is defined as the area above 35 degrees north (Bailey and Williams 2000). NMDGF has received few verifiable reports of LEPC in the northeastern part of the historical range since 1993 and survey efforts by NMDGF provide additional evidence that LEPC no longer occupy their historical range within Union, Harding, and portions of northern Quay County in northeastern New Mexico.

Within east-central New Mexico (between 33 and 35 degrees north), scattered populations occur in two areas: southeast Chaves County south of Highway 380, and

areas north of 34 degrees latitude, primarily north Roosevelt and Curry counties but also including small portions of east DeBaca and southern Quay counties (Bailey and Williams 2000). Department surveys suggest LEPC no longer occupy their historical range in west and central DeBaca and Guadalupe counties west of Fort Sumner. Declines in sparse and scattered populations in north Roosevelt, Curry and east DeBaca counties may be indicative of changes in land use (e.g., wind power development, juniper (*Juniperus* sp.) encroachment), which might have impacted LEPC populations (Davis 2005).

The core of remaining LEPC populations in New Mexico lies in south Roosevelt, north Lea, and northeast Chaves counties and contains the largest contiguous amount of available habitat (Davis 2006). Population trends (indicated by average birds per lek) increased in the late 1990s and peaked in 2000, but seem to have leveled off in recent years ($r^2 = 0.44$, $P = 0.02$) although the overall trend is increasing (Figure 3.2) (Beauprez 2007).

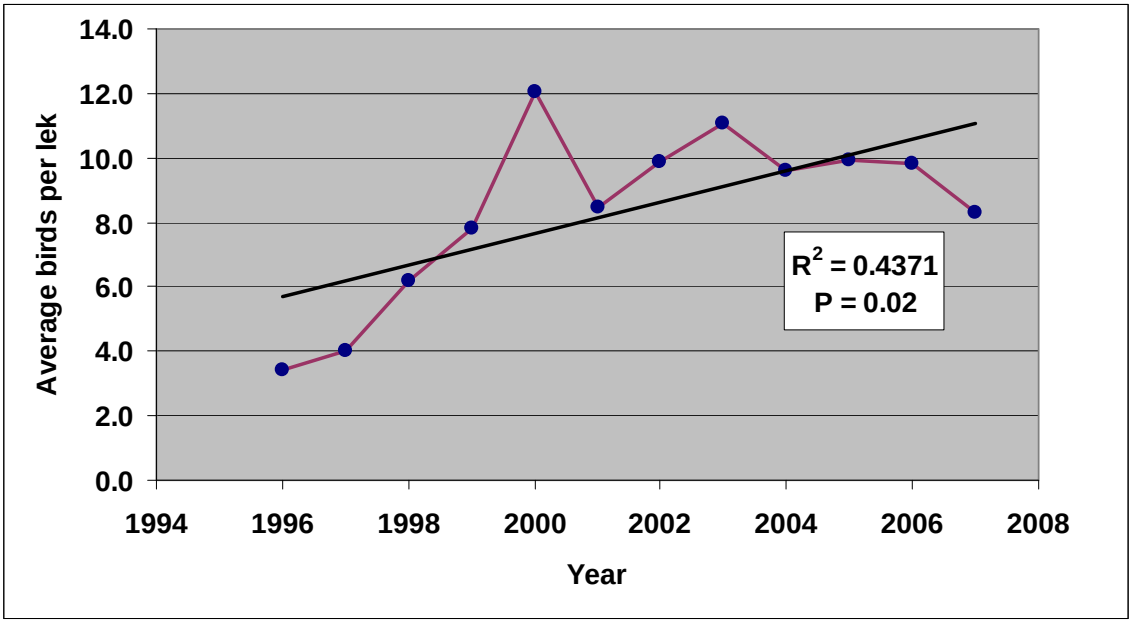


Figure 3.2 Changes in lek size (birds per lek) for LEPC observed on or near 15 Prairie Chicken Areas surveyed annually in eastern New Mexico 1996-2007.

In addition to NMDGF surveys, the BLM visits known and historic lek sites to assess activity and birds present on public lands (Table 3.2). Annual surveys conducted by the BLM Roswell Field Office indicate the number of active leks detected on the Caprock Wildlife Habitat Area more than doubled from 1999 through 2005 and the number of birds observed per lek was up from 6.00 in 1999 to 8.73 in 2005 (E. Jaquez, BLM, personal communication).

In 2007, 68 active leks were observed within the core of occupied range within east-central New Mexico, with a total of 692 LEPC, or 9.6 birds/active lek. These numbers

are down from the 94 active leks observed in 2006 with 1,099 LEPC, or 10.6 birds/active lek. Such a downward trend was expected because of poor reproductive conditions in 2006 due to extremely hot and dry conditions during the nesting season. Despite the drop from the 2006 numbers, the 692 birds was the second highest total recorded since 1988. Variation in survey effort among years and in the number of leks visited and observed has occurred. As a result, the number of active leks detected each year may be a biased measure of trend.

The southeast area (below 33 degrees north) represents the southern periphery of LEPC range and may only be occupied during favorable climatic periods (Snyder 1967). LEPC populations south of Highway 380 in New Mexico on public lands administered by the BLM and surrounding areas are near extirpation. In 2007, intensive spring lek surveys on the Carlsbad BLM Resource Area detected only one remaining active lek with 8 birds (T. Allen, BLM, personal communication); though LEPC have been sighted in other areas and the existence of additional leks is suspected. Best et al. (2003) concluded anthropogenic factors (energy development) have rendered LEPC habitat south of Highway 380 inhospitable for long-term survival of LEPC in extreme southeastern New Mexico. Similarly, NMDGF survey data suggest quality of habitat may be limiting the recovery of these populations (Davis 2005). While it is desirable to maintain and/or re-establish LEPC in their historical range within southeast New Mexico, populations in east Eddy and southern Lea counties are not considered necessary for continued viability of the species in New Mexico (Bailey 1999).

Although numbers of leks detected and numbers of LEPC counted in the core population are down from 2006, the overall trend has increased since 2001 (Figure 3.3). The decrease from 2006 may be attributed to the very dry spring and summer that year which reduced reproductive effort and success (Beauprez 2007). The total occupied range of LEPC in New Mexico is approximately 2,200 square miles and supports a minimum spring breeding population that is conservatively estimated to be about 6,300 birds (Beauprez 2007) (Table 3.2, Figure 3.3).

Table 3.2. Number of active leks detected and LEPC counted in New Mexico, 2001-2007.

	Year						
Parameter	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
NMDGF							
# leks detected	121	172	150	170	189	270	256
# leks counted	49	64	65	69	88	111	99
# birds counted	389	652	684	621	825	1274	857
Mean birds/lek	7.94	10.19	10.52	9.00	9.38	11.48	8.66
BLM (RFO/CFO)							
# leks detected	27	34	37	48	64	94	79
# leks counted	27	34	37	48	64	94	68
# birds counted	213	365	438	415	559	1099	692
Mean birds/lek	7.89	10.74	11.84	8.65	8.73	11.69	10.18
Private Lands[1]							
# leks counted	35	46	59	57	56	------	6
# birds counted	429	566	718	547	506	------	65
Mean birds/lek	12.26	12.30	12.17	9.60	9.04	------	10.83
Totals							
# leks detected	183	252	246	275	309	364	341
# leks counted	111	144	161	174	208	205	173
# birds counted	1031	1583	1840	1583	1890	2373	1614
Mean birds/lek	9.29	10.99	11.43	9.10	9.09	11.58	9.33
Population Estimate	**3400**	**5541**	**5623**	**5004**	**5615**	**8427**	**6363**

[1]State Game Commission Regulation 19 NMAC 33.4 requires locations of LEPC found on private lands be kept strictly confidential.

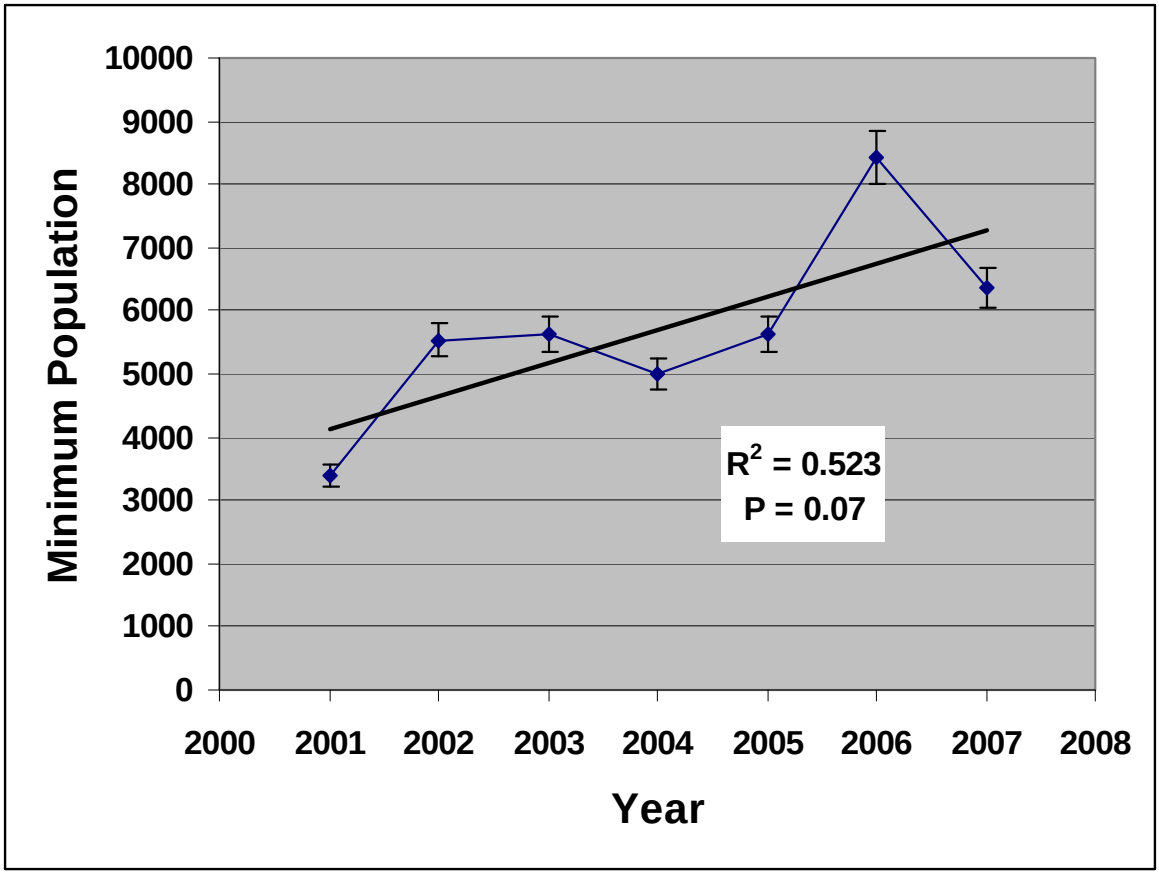


Figure 3.3. Minimum spring breeding population of LEPC in New Mexico. Error bars indicate + or – 5%.

Texas

Annual surveys to assess population trends of LEPC in Texas were initiated in 1952 (Lionberger 2007). In September 2007, TPWD confirmed LEPC were in portions of 14 counties (Ochiltree, Lipscomb, Roberts, Hemphill, Gray, Wheeler, Donley, Deaf Smith, Bailey, Lamb, Cochran, Hockley, Yoakum, and Terry) and suspected them in portions of another 7 counties (Moore, Carson, Oldham, Randall, Swisher, Gaines, and Andrews) (Figure 3.1).

Maximum possible occupied acreage in Texas in September 2007 was 3,159,730 acres, including both known and suspected population groups (*n* = portions of 20 counties). The more reasonable and conservative estimate of occupied acreage is 1,787,594 acres in portions of the 13 counties where LEPCs are known to occur. At an estimated mean density of 0.0088 LEPC/acre (range 0.0034-0.0135 LEPC/acre), the Texas population is estimated at a mean of 15,730 (range = 6,077-24,132) LEPC in the 13 counties (representing 1,787,594 acres) where LEPCs are known to occur. Because of the large and seasonal habitat requirements of LEPCs, the fragmentation of available and suitable habitat in Texas and the variability in estimating acreage values of occupied range, TPWD recommends and strongly encourages use of the minimum estimate of 6,000 birds in the state as the working population estimate.

In April 2007, TPWD staff conducted annual LEPC lek surveys on Study Areas in 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). All Study Areas are located on private land; all Study Areas have been surveyed since at least 1999. The Permian Basin/Western Panhandle surveys estimated 7.9 males/lek and the lek density was estimated at 0.74 leks/square mile; these values indicate stable to increasing populations in this Study Area. The Northeastern Panhandle surveys estimated 4.5 males/lek with an estimated lek density of 0.12 leks/square mile; these values indicate declining populations in this Study Area (H. A. Whitlaw, TPWD, personal communication). (Figure 3.4)

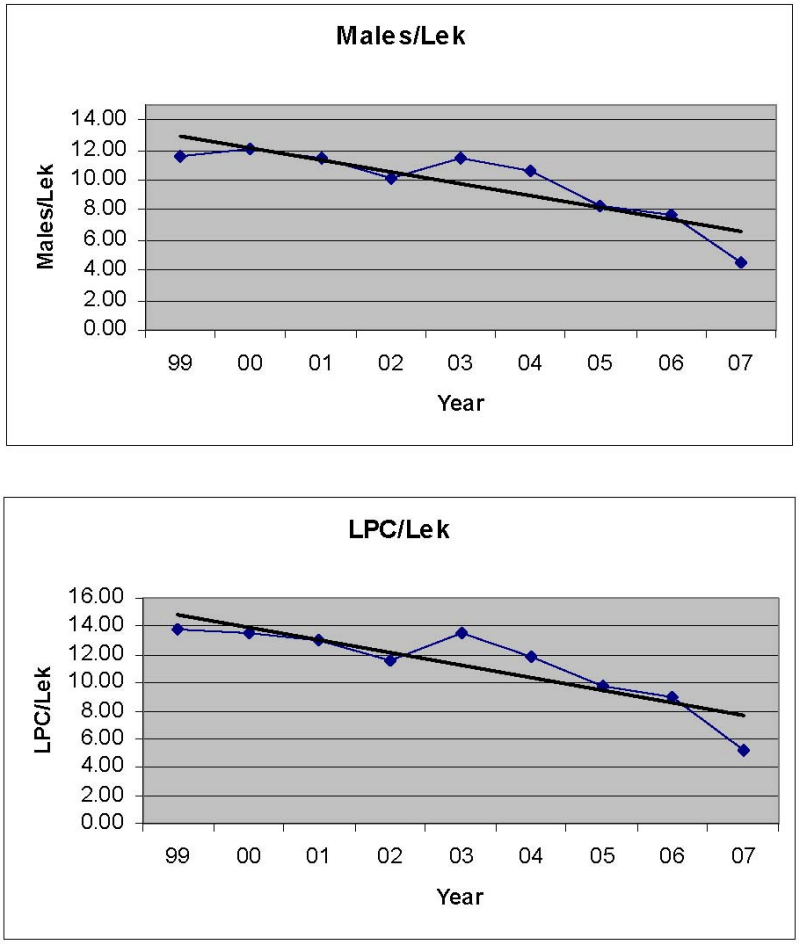


Figure 3.4. LEPC population parameters on for the NE Texas Study Area (portions of private land in Gray, Hemphill and Wheeler counties), 1998-2007.

Oklahoma

The geographic distribution of LEPC in Oklahoma has decreased to 37% of its former distribution and presently occurs in only 8 of the 22 counties it was known to occupy

historically (Horton 2000). The most recent population estimate is <3,000 birds (Horton 2000) (Figure 3.5).

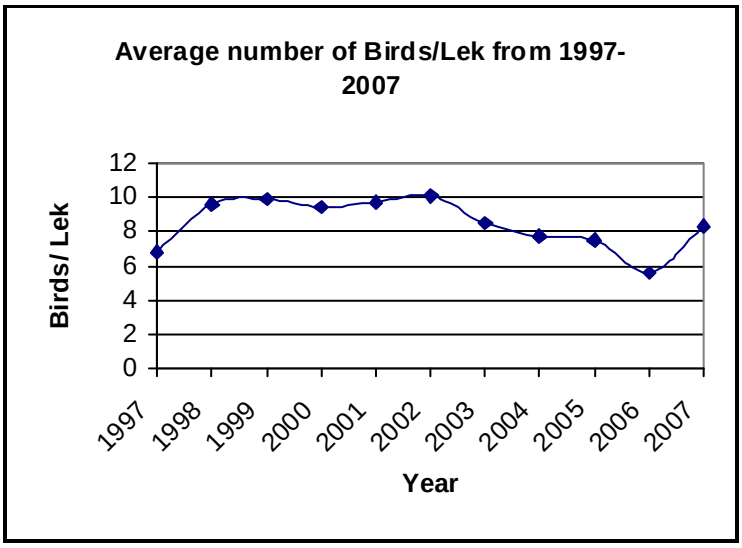


Figure 3.5 Average number of LEPC per lek from 1997- 2007 in Oklahoma.

Kansas

First reported by Rodgers (1999), LEPC populations have increased remarkably in west-central Kansas since native species CRP grasslands became a significant part of the western Kansas landscape. Reports of prairie-chickens in areas where they had not previously been present for at least 60 years were first received by the KDWP in the late 1990s. Subsequent investigation revealed that both lesser and greater prairie-chickens were involved in this expansion, with LEPC being the more-abundant species roughly south of Interstate Highway 70. Over the course of 6 years (1999–2004), more than 200 LEPC display sites were audibly located through cursory roadside listening surveys in west-central Kansas. These LEPC populations also exist at good densities, as exemplified by the numbers found along 3 new lek-survey routes established in Hodgeman, Gove, and Ness counties. It is important to understand that these birds were not simply "previously unknown." Of the 4 LEPC distribution maps from the 1950's through the 1970's (Baker 1953, Schwilling 1955, White 1963, Waddell and Hanzlick 1978) only Schwilling (1955) and White (1963) indicated a presence, albeit very limited, of prairie-chickens north of the Arkansas River in west-central Kansas. LEPC have apparently responded most to the addition of CRP grasslands in areas where those stands are in relatively close (0–2 miles) proximity to native prairie. Since it was roughly 12 years from the time of the first Kansas CRP seedings in 1986 to when LEPC were first reported in significant numbers in west-central Kansas, it appears it took several years for remnant numbers to effectively utilize and demographically respond to this new habitat, even after the roughly 4 years needed for these mixed native grass seedings to mature. A new LEPC distribution map for Kansas that reflects this expansion was completed in 2005 through the cooperation of the KDWP and the Kansas Biological Survey. By integrating this distribution map, GAP landcover data, and data from 14 standard lek survey routes, the 2005 breeding population of LEPC in Kansas was estimated to be between 18,000 and 29,000 birds (Rodgers and Houts 2005) (Figure 3.6).

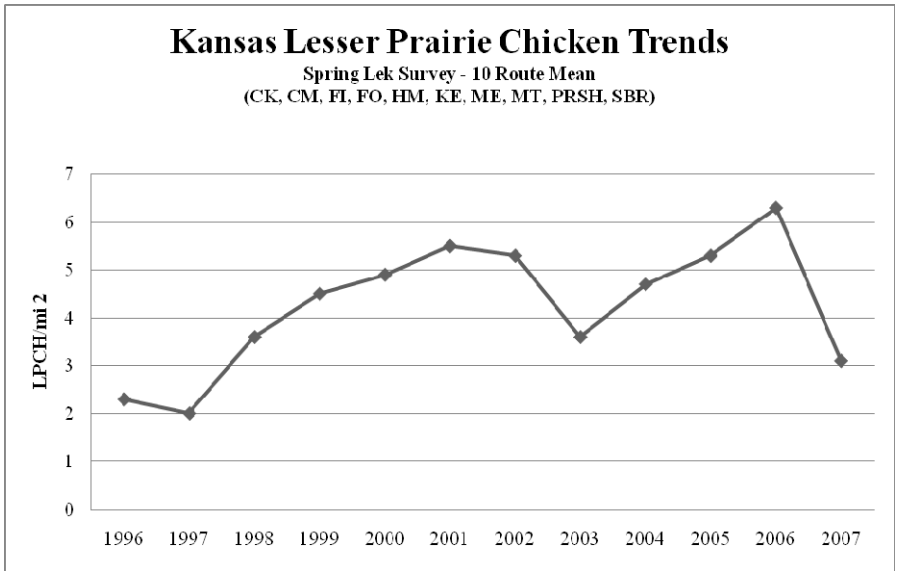


Figure 3.6. Trend in LEPC/mi^2 observed in Kansas, 1996-2007

Colorado

LEPC occupy at least 4 of the 6 counties within the historic distribution of LEPC in Colorado (Giesen 2000). Survey data collected during 2000 indicated the presence of 317 birds on 27 leks (USFWS 2001). During 2001, 298 LEPC were counted on a total of 30 leks, a decrease of 6% from the previous year (USFWS 2002). Overall, survey data collected by CDOW from the 1950s to the present suggest that the abundance of LEPC in Colorado has remained relatively stable or has increased slightly in recent decades (Giesen 2000). Currently, isolated populations of LEPC (<100 birds) occur in Kiowa and Cheyenne counties, although it is important to note these counties have not received intensive survey efforts (Giesen 2000). Historically, the core of LEPC in the state occurred east of Campo on the Comanche National Grassland (Giesen 1994a); however, in recent years there has been a downward trend for LEPC populations on the Comanche National Grassland (USFS 2003). There is a trend for an increasing population in Prowers County, directly correlated with CRP acreage. The stronghold of Colorado's known population of LEPC now occurs in Prowers County. In 2000, the statewide population estimate was <1,500 breeding individuals (Giesen 2000).

In recent years (2004-2006), the LEPC population in Baca County continued a steady decline, while the Prowers County population increased (Figure 3.7). Three new lek sites were detected in Prowers County during spring surveys in 2006, as well as seven in 2005 and four new sites were found in 2004. Limited data suggest stable to increasing populations in Kiowa and Cheyenne counties. Habitat conditions across most of southeast Colorado have improved dramatically over the past three springs (2003-2006) with increased precipitation and abundant cover at most locations. 2006 was extremely dry over most of the LEPC range and habitat quality suffered. Limited amounts of forbs were

available and most grass stands did not green up. However, good residual cover in CRP fields provided refuge for LEPC.

Despite the poor habitat conditions in 2006, the decreasing trend of LEPC on public lands in Baca County has been troubling. One hypothesis is that birds moved away from areas severely affected by drought conditions and have not returned. Another hypothesis is that grazing regimes and resultant ground cover (or lack thereof) during the drought years has had a greater impact on LEPC reproduction than on quail reproduction in the same areas. More survey effort is needed in Baca County away from traditional sand sage habitat in CRP areas. Most recently discovered Prowers county leks are in or adjacent to CRP. Several of these are quite distant from traditional sand sage habitat. It is reasonable to assume that LEPC are probably using CRP in Baca County as well, particularly in the northeast and eastern parts of the county. Survey effort is needed to assess whether or not this is the case.

Southeast Colorado was hit with numerous blizzards during the winter of 2006-2007. The storms left several feet of snow over the entire region, and cold temperatures lasted several months. While it is unknown at the time of writing this Conservation Initiative the impacts of this series of storms, there is potential that LEPC could have been severely impacted in Colorado.

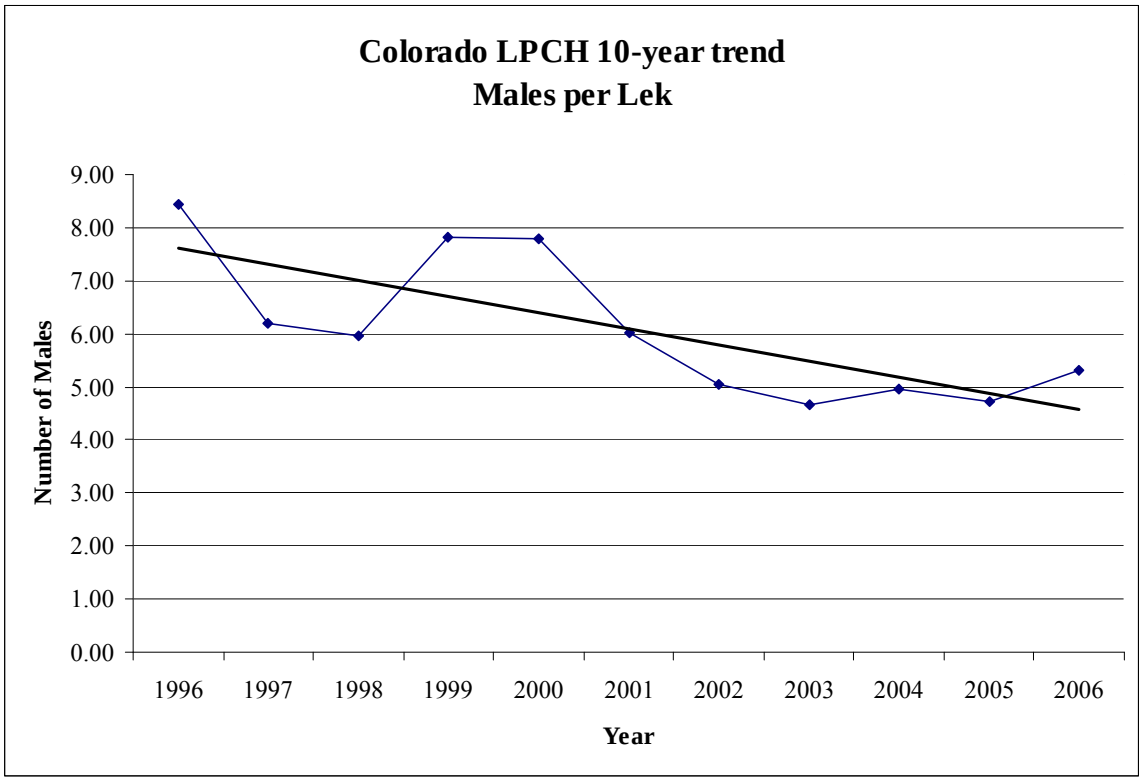


Figure 3.7. Trend in males per lek for LEPC observed in Colorado, 1996-2006.

3.3 Population Reintroduction

LEPC have been transplanted into Colorado at least ten times (1961-1996), usually into known historical range or occupied habitats, although at least two transplants were to locations outside of their historical range. None were successful in establishing or increasing populations (Giesen 1998). However, there have been occasional reports of birds in close proximity to the areas of these transplants although no leks have been detected in the spring during random lek surveys. New Mexico transplanted LEPC into uninhabited ranges in the 1930s and 1940s, but efforts were unsuccessful in establishing populations (Snyder 1967). Attempts to re-establish LEPC in Texas and Oklahoma have also failed (Taylor and Guthery 1980a, Horton 2000).

3.4 Current Approaches to Inventory and Monitoring Efforts

All states within the occupied range of LEPC monitor LEPC breeding populations annually, however, monitoring efforts have differed markedly among agencies and inferences have been made about populations using a variety of methods. This variation in survey effort complicates attempts to understand LEPC population trends and make comparisons among areas and agencies difficult. Despite problems associated with the collection and analysis of lek count data, these datasets represent the only long-term database available for LEPC populations and generally appear to provide reliable data on population trends.

New Mexico

Presently, four types of surveys for active leks in eastern New Mexico have been conducted annually through cooperative efforts between NMDGF, USFWS, and BLM. These include roadside route surveys, surveys on State Game Commission-owned Prairie Chicken Areas (PCAs), private land surveys, and surveys within the respective jurisdictions of the Roswell and Carlsbad BLM.

Roadside Surveys

Roadside route selection and survey procedures were previously described in Davis (2004). Roadside routes were first established in 1998. Survey routes were located within the known occupied and potential range of LEPC. The original boundary of the survey area included 182 townships, which were comprised of habitats consisting of sandy and deep sand range sites supporting shinnery oak and bluestem grasses. In 1999, the survey boundary was modified and consisted of twenty-nine townships; 19 routes from the 1998 survey and routes in 10 new randomly selected townships within the core of LEPC populations in east-central New Mexico. In 2003, 10 additional roadside routes were established in the northeastern part of the LEPC historical range, east and south of Clayton, NM and east and south of Amistad, NM (which were previously surveyed by NMDGF in 1999) and areas near reported sightings of LEPC. The number of routes chosen reflected the personnel resources available to assist with surveys while allowing the collection of meaningful data.

Prairie Chicken Management Areas (PCAs)

The New Mexico State Game Commission owns and manages 29 PCAs ranging in size from 29 to 7,800 acres. They lie from 20 miles south of Taiban (T2S, R28E) in the

northwest to 3 miles southeast of Tatum (T13S, R36E) in the southeast and from the Texas border (T7, 8, 9S, R38E) to 30 miles northwest of Tatum (T10S, R31E) in the west. The goal of PCA surveys is to determine presence of LEPC leks over the entire area of each PCA, i.e., a "saturation" survey. The assumption is that LEPC vocalizations can be heard up to 1 mile. Listening points are located along established roads. The first listening point is located at the entrance point of a PCA and each additional listening point is 0.5 to 1 mile apart depending upon terrain and noise disturbance. The observer counts all leks heard during 5 minute listening periods, but counts only the number of birds per lek on those leks that could be seen from public access or occur on public land. When visual confirmation is made, the location is recorded in Universal Transverse Mercator (UTM) coordinates and lek location(s) are noted on a topographic map.

Bureau of Land Management LEPC Surveys

Both the BLM Roswell Field Office (RFO) and Carlsbad Field Office (CFO) conduct annual surveys for LEPC within their respective jurisdictions. Approximately 245,000 acres of LEPC habitat, containing 191 known lek sites, occur within the Caprock Wildlife Habitat Area (WHA). The RFO visits known historic lek sites within the Caprock WHA from 20 March – 1 May each year to determine activity and birds present; however, annual survey efforts have varied since surveys were initiated in 1971. All active leks are documented and counts are made of birds present. From 2003-2006, the CFO has conducted roadside route surveys, which included visits to historic lek sites and previously unsurveyed areas of northern Lea County. Routes were selected based on the presence of shinnery oak and/or its proximity to historical lek sites. Listening points were spaced at 0.5 mile intervals. Surveys began approximately 30 minutes before local sunrise and concluded at approximately 8:30 a.m. In addition to listening route surveys, CFO conducted surveys of historic leks sites. Surveys were conducted after 8:30 a.m. and lek sites were examined for evidence of recent LEPC activity (e.g., tracks, feathers, and scat) at least twice during the breeding season with at least one week between surveys of the same site. Because of resource limitations, NMDGF currently cannot survey all suitable LEPC range. As such, NMDGF relies on data collected by the BLM with the understanding that since survey methodology are different, direct comparisons will not be appropriate.

Limitations

Current survey methods conducted by the NMDGF are useful to detect long-term population trends or presence of LEPC in local areas (Autenrieth et al. 1982) and to track population distribution (Applegate 2000). While there has been considerable annual variation in the total number of leks detected and number of LEPC observed along the 29 roadside routes, fluctuations between years might be associated with variation in survey effort (e.g., observer consistency), changes in detection probability, and changes in lek attendance rates rather than variation in population size. While failure to detect the presence of all lek locations may affect the precision of roadside route surveys, training of observers by NMDGF prior to data collection and standardization of lek count protocols has improved the reliability and efficiency of roadside route.

PCA surveys determine the presence of LEPC leks over the entire area of each PCA and may provide a reliable index to lek size (assuming 100% detectability). Lek density is not being determined by current NMDGF surveys. To convert from an index to an estimate of actual density of leks, the observer must know the proportion of the total population that is observable in the sample and the range occupied by LEPC must be known for the sample area(s) in question (Caughley and Sinclair 1994). Detection distances need to be determined in the range of habitats and topography LEPC occur. Potentially evaluating the detectability of leks as a function of distance can be assessed from PCA surveys in which listening points are close enough to determine distances beyond which leks remain undetected. This would be foundational to measuring LEPC densities and would provide validity to the assumption that booming male LEPC can be heard an average of 1 mile. Provided lek counts from PCAs are based on data collected with consistent survey effort and methods it may be possible to derive a population estimate for each PCA once a long-term data set is established; however these results should not be extrapolated across the range of LEPC.

Texas

Annual surveys to assess population trends of Texas Panhandle LEPC were initiated in 1952 on 2 study areas; one on a 100,000 ac area in Hemphill County and another on a 6,500 ac area in Wheeler County. Survey efforts were expanded in 1986 to locate leks throughout previously occupied LEPC range in the Panhandle. Survey methodology was modified in 1997 by establishing Study Areas on private land at various locations to allow monitoring of the major populations through subsampling efforts. The purpose of the Study Area methodology is to intensively collect demographic data in an area as a subsample of the larger regional population. Data collection efforts on Study Areas are divided among all leks within the Area. Study Areas in the Permian Basin/Western Panhandle include a 13,440-ac Area in Gaines County, a 9,221-ac Area in Bailey County, and a 12,378-ac Area in Yoakum County (this Area was initiated in 1999). Study Areas in the northeastern Panhandle include a 67,298-ac Area in Hemphill County, a 6,720-ac Area in Wheeler County, and a 6,540-ac Area in Gray County (this Area was initiated in 2000). In addition to data collected annually on the 6 Study Areas, efforts to locate additional leks through driving routes and listening points also continue as time, personnel and resources allow.

In spring 2004, TPWD initiated a road-survey effort in an attempt to increase distribution data. TPWD field staff, in cooperation with other project partners (staff from USDA-NRCS and USFS Rita Blanca-Kiowa National Grasslands) developed and implemented a survey methodology and data collection procedure for road survey efforts on public roads. Efforts were intended to improve and supplement existing knowledge of LEPC distribution in portions of select counties.

TPWD is sponsoring research through Texas Tech University (TTU) and partnering with TNC-New Mexico, USFWS, and BLM New Mexico (Carlsbad and Roswell Field Offices) to evaluate the effectiveness of aerial survey methodologies for identifying new leks and estimating lek and bird densities within project areas. This project is scheduled for completion in 2009.

Oklahoma

Booming Ground Census

The booming ground census has been conducted longer than any other population monitoring effort in Oklahoma. The number of displaying males on historic lek sites is counted each year between 25 March and 01 May. The counts are conducted on fair weather mornings (no or light winds, and clear skies), if possible. The recommended procedure is to count each lek site at least twice each year: the greatest number of birds seen on each lek is recorded for that survey period.

The count of displaying males has been replaced with a flush count. Each lek site located is flushed and the number of birds present (without regards to gender) is recorded. The displaying male count and flush count were conducted simultaneously from 1999 – 2001. Since 2001, only the flush count has been recorded.

Both the number of birds observed on each lek, as well as the average number of birds for all leks counted, has been recorded.

Lek Density Detection Routes

Lek density detection routes were established beginning in 1982. Lek detection routes are a ten mile route with a listening stop at one mile intervals. Observers listen for 3 minutes per stop and record all leks heard. It is assumed that any lek within one mile of the listening stop can be heard, and thus also assumed that 20 square miles are surveyed per route.

Initially, this survey was used only in Ellis County, but was expanded to include Beaver and Harper counties in 1983, Woodward County in 1985, Roger Mills and Texas counties in 1986, and Woods county in 2001. No lek sites were detected on the Roger Mills county route after 1990, and it was officially dropped from the survey in 1996.

Results of this survey are recorded as number of leks per square mile, giving an estimate of lek density in each county, and an overall estimated lek density.

Limitations

The amount of effort given to these surveys has varied considerably over the years. It should also be noted that weather and topography also appear to greatly affect the results of both surveys. Ideally, these surveys would be conducted numerous times throughout the breeding season, but time and manpower restraints have, and continue to limit the amount of effort given to these surveys.

Neither survey could be used with any confidence to generate a total population estimate, but they are probably representative of long-term population trends. Significant annual population fluctuations could go undetected and/or be falsely recorded.

Kansas

As of 2006, the KDWP annually monitored 15 standard survey areas for LEPC. All but 2 of the survey routes consist of 20 mi^2 of land and, in all, cover 279 mi^2. However, this was not always the case. LEPC were first surveyed in Kansas with the initiation of 3 survey routes (Finney, Meade, Morton counties) in 1964. One additional route (Clark County) was added in 1966. These remained the sole LEPC survey routes until 1977 when a 5-mi^2 public-land route (Finney Game Refuge – now called the Sandsage Bison Range) was added in Finney County. Additional routes have been added over time including routes in Kearny County (1978), Hamilton County (1979), the 14-mi^2 public-land Pratt Sandhills (1980), Ford County (1988), Comanche County (1991), Barber County (2000), Kiowa and Hodgeman counties (2001), Gove County (2004), and Ness County (2006).

As a result of this gradual expansion of LEPC monitoring in Kansas and some early problems with the Finney County survey, long-term trend averages can only be calculated for 3 routes since 1966, for 8 routes since 1984, and for 10 routes since 1991. The long-term trends for Kansas shown by Jensen et al. (2000) are not legitimate population trends in that they resulted from a misunderstanding of Kansas survey data and a misapplication of statistical procedure.

Kansas LEPC surveys are conducted from March 20 through April 20, but are occasionally extended as late as April 25 if weather conditions make normal completion difficult. Excepting the 2 public-land routes, each route consists of the lands extending 1 mile on either side of a 10-mile driving route. Weather conditions for the survey primarily include a requirement that winds not exceed 12 mph with no rain or fog (clouds are acceptable provided they are high and do not threaten precipitation). Surveyors begin listening for LEPC at 40 minutes before sunrise at their initial listening station and record the direction and estimated distance to any leks they hear during a 3-minute listening interval. Upon completion of the first station, the procedure is repeated at 1-mile intervals at each of the remaining 10 listening stations. Aural triangulation between stations allows observers to mark the general location of the leks heard. Upon completion of the listening survey, observers immediately begin locating leks and obtaining flush counts, however, flush counts are discontinued 90 minutes after sunrise. Observers are instructed to complete 2 listening surveys and obtain 2 flush counts from each lek located within the survey area during the survey period. Due to staff time constraints and difficult weather conditions, only a single flush count is sometimes conducted.

The greater of the 2 flush counts for each lek is used to calculate the route flush count. The route flush count is then doubled and divided by the number of square miles in the survey area to obtain an estimated population density. This takes into account that: 1) most birds flushed from leks are males, 2) some males are not present on leks, and 3) that some hens may be present on leks. Route densities are averaged (the smaller public-land routes are weighted according to the area covered) to obtain the full-survey population-density index. Annual change is calculated only with those survey routes that were satisfactorily completed by the same observer in both years.

Colorado

Survey information for the LEPC in Colorado has been collected in various ways over the years. The first surveys were conducted in 1959 when three leks with six cocks were counted. For the next 20 years surveys were conducted haphazardly and with no consistent methodology by CDOW personnel. In some years thorough surveys were conducted in sand sage habitat by several employees, in other years very few surveys, if any, were conducted. Beginning in 1976, regular surveys have been conducted, although methodology has changed over the course of that time period.

The original survey method was to go out to known lek sites and count all birds, male and female, observed on the lek sometime during March, April, or May. In addition, listening posts were run using automobiles by going out into suitable habitat and stopping every half mile to listen for prairie-chicken gobbling. When birds were heard the observer tried to locate the lek. As surveys progressed in the late 1990s more intensive search efforts were used to count known leks and survey for new leks. Currently several methods are combined for LEPC counts in Colorado. Surveys are still conducted during the months of March, April and early May. However the degree of effort and method used changes on a rotational basis. Every year two CDOW temporary employees and several permanent personnel count LEPC on known leks. In addition, USFS personnel run a series of listening routes on the Comanche National Grasslands in Baca County. Every 3rd year 20-30 volunteers and resource professionals participate in an "intensive" search for LEPC. During these intense searches an attempt is made to cover all known lek sites and as much potential LEPC habitat as possible in Baca, Bent, Cheyenne, Kiowa, Lincoln, and Prowers Counties using lek counts and driving routes.

Survey method for counting known leks consists of arriving at the leks 30 minutes prior to sunrise but no later than 9:00 a.m. (occasionally evening counts are conducted). Upon arriving at the lek a minimum of 3 counts are made, one count every three to five minutes. Every effort is made to count all males, all females, and all unknowns to obtain a total bird count. Data is recorded on CDOW grouse lek survey forms including any leks visited where no grouse activity is observed. An attempt is made each spring to visit all known leks in Baca, Cheyenne, Kiowa, and Prowers counties a minimum of three times during April. This includes historic lek sites that may no longer be active. Lek locations are recorded in UTM coordinates.

The intensive survey is conducted by assigning sections of potential habitat in four mile square blocks to the surveyors who then spend one morning in each block searching for LEPC. This method focused mainly on sand sage habitat and the associated lands in Baca County, particularly the Comanche National Grasslands. Another method used for the first time in 2004 was designed to cover a much broader scale of habitat types and a vast geographic area. For the 2004 intensive search participants ran a total of 52 twenty five mile long routes covering approximately 1,300 total miles spread out over six counties. Protocol for the routes was to arrive at the route starting point by automobile 30 minutes prior to sunrise. Depending on the route and the terrain volunteers got out of their vehicles at one-half to one mile intervals to listen for LEPC for three to five minutes per

stop. If LEPC were seen or heard along the route the location was recorded for a follow up visit by CDOW personnel as soon as possible to verify the information. This method was used to document LEPC use of lands enrolled in CRP and to gain better understanding of the possible range of LEPC in Colorado. Use of this method since 2004 has verified LEPC use of CRP in Colorado, particularly in Prowers County (Table 3.3).

Table 3.3. LEPC monitoring and population trends associated with CRP in Colorado, 2004-2006.

Year	No. of new leks	Total birds	No. of new leks in CRP
2004	6	53	5
2005	7	52	7
2006	3	30	2

Limitations

None of the annual survey methods employed by CDOW provide a true measure for assessing the status of the number of birds and leks in Colorado. With such a small population of LEPC and a low density of birds and leks where they do occur, it is difficult to cover all potential LEPC habitats with driving routes. Many areas are dominated by large private ranches with few public access roads. In areas where there is good access, such as on the Comanche National Grasslands, the accessible areas can be saturated with observers, while other areas go virtually un-surveyed. The intensive search covers the largest possible land mass but uses many observers with little experience searching for prairie-chickens. Although lek surveys alone do not measure range expansion into new areas, they do provide a reliable index of trend on known leks.

3.5 Harvest Estimates

The LEPC is considered a gamebird and was once hunted throughout all 5 states within its range (Giesen 1998); currently it is hunted only in Kansas and Texas. Overall, long-term trends in annual LEPC harvests have declined across the range of LEPC (Hagen et al. 2004; Figure 3.8).

New Mexico

In New Mexico, the LEPC is a game species managed by the NMDGF. Limited hunting of the species was allowed in 1948 and continued periodically through 1966. Within this 19-year period, approximately 15,000 birds were harvested with no noticeable effect on the population (Sands 1968). During 1958-1995, responses from post-season harvest survey questionnaires indicated the estimated harvest of LEPC peaked at about 4,000 birds in 1988. The estimated harvest declined abruptly in 1989 and 1990 and continued to decline to the lowest level of an estimated 50 birds in 1995 (Figure 3.8). The hunting season was closed in 1996.

Texas

In 1937, the Texas Legislature ended legal hunting of LEPC. However, population surveys conducted in 1967 indicated a surplus of birds, and a two-day season was held in

the northeastern Panhandle, followed by a similar season in 1970 in the southwest Panhandle (Permian Basin). LEPC hunters were required to obtain a special permit, issued at no cost, from 1987 through 1992. This permit requirement was reinstated in 1997. In 2005, regulation changes precluded hunting of LEPC in Texas, except on properties involved in a TPWD approved wildlife management plan focusing on LEPC habitat enhancement and harvest recommendations. Population monitoring and harvest records are also required under this regulation. This program is referred to as the Managed Lands Lesser Prairie-Chicken Permit Program (MLLPCPP).

LEPC harvest regulations were reviewed and the following changes were proposed to the Regulations Committee of the TPWD Commission during the 26 January 2005 session. It was proposed that the current regulations (8 legal counties with a 2 day, 2 birds per day bag limit) be modified to restrict the LEPC season to only those properties with (and implementing) a TPWD approved Wildlife Management Plan (WMP) with a LEPC enhancement component. In particular, it was proposed that on those properties with a WMP, there would be a harvest quota or recommendation in place, although the property would still be subject to the same restricted season (2 days) and personal possession limits (2 birds per person per day). Finally, it was proposed that these properties under an LEPC WMP would be required to conduct at least 5 designated management practices (including, but not limited to, habitat improvements and data reporting/record keeping). Public comments were solicited on the proposed regulations changes through the TPWD Public Comment Process. The Regulations Committee of the TPWD Commission approved the proposed regulation changes in April 2005.

Table 3.4. Managed Lands Lesser Prairie-Chicken Permit Program data for Texas (2005-2007).

Season	Counties (LO)	Number of Landowners	Total Acreage	Permits Issued	LEPC Harvested
2005	Lipscomb (1), Cochran (1), Yoakum (1)	3	25,031	15	12
2006	Lipscomb (2), Cochran-Yoakum (2), Yoakum (1)	5	26,721	15	9* 2 LO did not participate or harvest birds
2007 Projected and Tentative	Lipscomb (2), Cochran-Yoakum (2), Yoakum (1)	5	29,441		

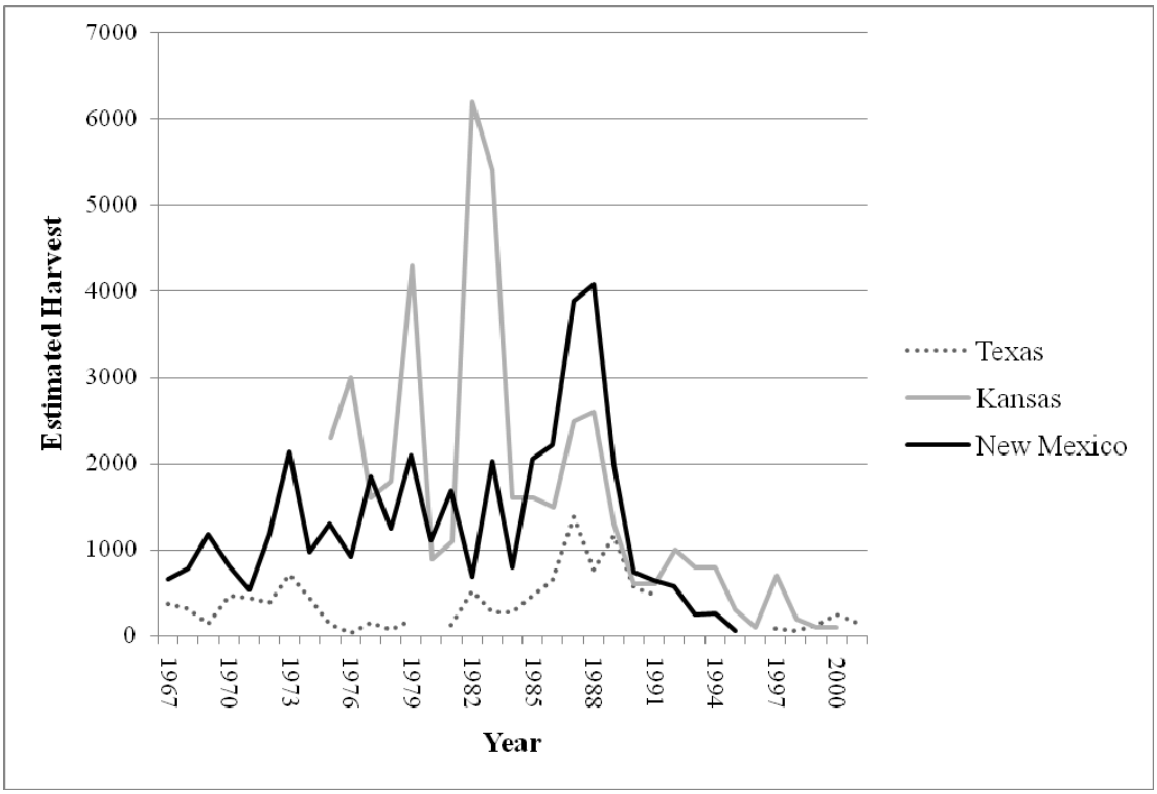


Figure 3.8. Trend in annual LEPC harvests in New Mexico, Kansas, and Texas. Note: Hunting season was restructured in Kansas in 1995. Data from Texas are estimated harvest values prior to implementation of the Managed Lands Permit Program for LEPC; (See Table 3.3).

Under the new regulations adopted in April 2005, hunting of LEPC is precluded except for properties involved in a TPWD WMP that includes habitat management, population monitoring and harvest recommendations. In 2005, 15 LEPC harvest permits were issued to 3 properties. One property was in the Northeastern Panhandle and two properties were in the Southwestern Panhandle and Permian Basin. Of the 15 permits issued, 12 LEPC were harvested. Of the 12 LEPC harvested, 9 were harvested in the Southwestern Panhandle and Permian Basin (Cochran and Yoakum Counties) and 3 were harvested in the Northeastern Panhandle (Lipscomb County). Since implementation of the MLLPCPP, a total of 21 birds have been harvested in the state since 2005 (Table 3.4). As a result of this program, an additional 25,000 acres of privately owned and managed lands have been put under WMP for LEPC.

Prior to regulation changes, harvest estimates were estimated utilizing responses from the LEPC harvest survey. Surveys were mailed to holders of a free LEPC hunting permit that was issued to purchasers of hunting licenses at point of sales (POS) locations, regardless of whether the intent to hunt LEPC was indicated.

Oklahoma
There has been no open season for LEPC in Oklahoma since 1997, although LEPC are still considered a game species. Prior to 1997, the general LEPC season began on the second Saturday prior to Thanksgiving, and ran for 9 consecutive days, with a daily bag limit of two prairie chickens, and a season bag limit of 4 birds.

Harvest estimates (Figure 3.9) were determined by a telephone survey (no survey was conducted in 1985). The survey, however, did not differentiate between LEPC and greater prairie-chickens, both of which were legal game species. Any attempt to estimate LEPC harvest was, at best, speculative.

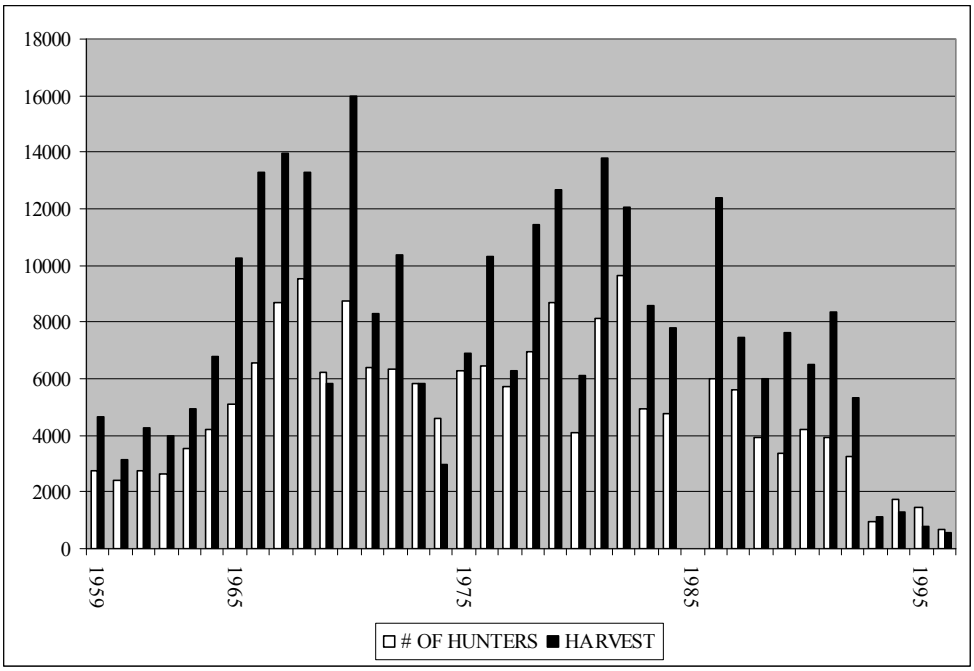


Figure 3.9. LEPC harvest estimates in Oklahoma, 1969-1997.

Kansas
Kansas currently maintains the highest and most widespread populations of the LEPC among the 5 states where these birds are present. Based on lek surveys on 15 routes covering 279 square miles of LEPC range, in combination with estimates of habitat available to this species (from GAP data), it was estimated that the Kansas breeding population of this species was between 19,000 and 31,000 birds in the spring of 2006. Estimated hunter harvest of LEPC in 2006 (the most recent harvest information available) was 120. Since the Kansas season on LEPC was modified in 1995 (December 1 – January 31; daily bag limit = 1), estimated hunter harvest of this species has varied between 100 and 700 birds per year, representing a very conservative annual harvest rate of < 2% of fall populations. The hunting season was further modified in 2005 to create a common opening date for both greater and lesser prairie-chickens. This change (3rd Saturday in November – December 31; daily bag limit = 1) extended the season by about

2 weeks into November, but eliminated January hunting of LEPC for an overall decrease in season length.

There is no evidence that hunting mortality has played any role in the long-term decline of the LEPC throughout its 5-state range. Some states (e.g., Oklahoma) have closed their seasons on LEPC, in response to its status as a candidate species for listing under the ESA. Even while maintaining a conservative hunting framework in Kansas, evidence obtained over the past two decades indicates that LEPC numbers in Kansas are stable and have probably increased modestly. A significant expansion of this bird's range has occurred in western Kansas as a result of the native grass mixtures that were seeded in that region as part of the CRP. KDWP, while recognizing the candidate status of the LEPC, has taken the position that closure of the hunting season on LEPC would send a false message to the public; one that might imply that hunting, rather than habitat loss, was responsible for the status of the species. KDWP wishes to maintain the public's focus on habitat threats and habitat improvement for this species. A limited, very conservative harvest of the species probably fosters greater overall interest in LEPC conservation.

Colorado

The LEPC has been state listed as a Threatened species in Colorado since 1973. No hunting for prairie grouse in the range occupied by the LEPC has been allowed since 1973.

CHAPTER 4. POTENTIAL THREATS TO LESSER PRAIRIE-CHICKENS

The southern Great Plains has changed dramatically since settlement by Europeans. This chapter presents the dominant factors that have influenced LEPC habitats across shinnery oak, sand sage, and mixed-grass prairie communities. Potential threats to LEPC were presented as separate entities but emphasize the cumulative effects of these stressors on ecological processes affecting LEPC habitats and their combined influence on upland grassland ecosystem diversity across the Great Plains.

4.1 Habitat Fragmentation

Habitat fragmentation occurs when large areas of habitat are broken into smaller, isolated patches of habitat. Because much suitable habitat for LEPC has been lost due to conversion to agriculture and modified through grazing practices and other factors, much of the remaining suitable habitat is fragmented (Crawford 1980, Braun et al. 1994). Fragmentation may threaten local LEPC populations through several mechanisms: habitat juxtaposition and remaining patches of rangeland may be smaller than necessary to support populations (Samson 1980); necessary habitat heterogeneity may be lost; habitat patches may accommodate high densities of predators; and LEPC interchange among suitable patches of habitat may decrease, possibly affecting genetic viability (Wilcove et al. 1986, Knopf 1996).

Direct conversion of rangeland to some other land use is the most prevalent of a number of developments that can result in fragmentation of LEPC habitat. Other sources of impact on the structure and continuity of grassland habitats include infrastructure associated with resource extraction and wind farm development, (roads, power lines, fences, buildings), as well as tree plantings and tree invasion. As a group, prairie grouse may be particularly sensitive to habitat fragmentation due to their limited dispersal distances and landscape scale habitat requirements (Braun et al. 1994). Recent LEPC declines in the southern portion of its range in New Mexico, although probably at least in part drought-related, have led to concern over the effects of fragmentation caused by oil exploration and drilling. While it is often difficult to describe cause-and-effect linkages among specific sources of fragmentation and eventual population responses, recent studies have found LEPC population declines in Oklahoma and New Mexico to be associated with several measures of overall habitat fragmentation, including patch size, edge density, and total rate of landscape change (Woodward et al. 2001, Fuhlendorf et al. 2002).

Fences and power lines are also a significant cause of direct mortality by collision (Wolfe et al. 2007). Historical settlement patterns in Oklahoma were characterized by ownership tracts divided into approximately 158 acre parcels; whereas, New Mexico retained larger (>600 ac), more contiguous patches of rangeland (Samson and Knopf 1994). A recent study found the increased extent of fencing in Oklahoma was associated with higher mortality of female LEPC and 4 of every 10 LEPC deaths was attributed to collisions with a fence, powerline, or vehicle (Wolfe et al. 2007, Patten et al. 2005). Ligon (1951) expressed concern that spread of these features in eastern New Mexico might severely

limit LEPC populations, however, the full extent of collision mortality is not known and is difficult to measure.

Impacts of fragmentation are cumulative and often result in behavioral responses to whatever changes are occurring on the land. A growing body of evidence suggests that LEPC actively avoid areas of human activity, noise, and proximity to vertical structures that may provide hunting perches for raptors, particularly during nesting (Robel et al. 2004, Pitman et al. 2005). Data from several studies indicate that prairie grouse, including LEPC, may avoid or nest at reduced rates in areas near roads, power lines, compressor stations, and inhabited dwellings (Braun et al. 2002, Lyon and Anderson 2003, Robel et al. 2004, Pitman et al. 2005). Pitman et al. (2005) showed that LEPC seldom nest within approximately 580 feet of oil or gas wellheads, 1,200 feet from electrical transmission lines, 2,600 feet of improved roads, and 4,000 feet from buildings. The authors calculated that nesting avoidance at these distances would effectively eliminate a large percentage of available nesting habitat over a three-county area in southwestern Kansas. Thus, the presence of such features may result in LEPC nest displacement in areas containing a high percentage of otherwise suitable habitat, effectively increasing the impact of these features far beyond their physical footprint.

4.2 Livestock Grazing

Grazing is one of the dominant land uses on public and private lands throughout the range of LEPC. The evolutionary history of the mixed-grass prairie resulted in endemic bird species adapted to a mosaic of lightly to heavily grazed areas (Bragg and Steuter 1996, Knopf and Samson 1997). Grazing by wildlife or domestic livestock is essential to maintain the health of native grasslands and moderately and lightly grazed areas are necessary on a landscape scale to maintain LEPC habitat (Bidwell et al. 1995). In some areas within LEPC range, where heavy grazing has removed tall- and mid-grass cover, insufficient amount of lightly grazed habitat is available to support successful nesting (Crawford 1980, Jackson and DeArment 1963, Davis et al. 1979, Taylor and Guthery 1980a, Davies 1992). Uniform or widespread livestock grazing of rangeland to a degree that leaves less than adequate residual cover remaining in the spring is considered detrimental to LEPC populations (Bent 1932, Davis et al. 1979, Crawford 1980, Bidwell and Peoples 1991, Riley et al. 1992, Giesen 1994b), because grass height is reduced below that necessary for nesting cover and desirable food plants are markedly reduced. Residual 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, Riley et al. 1992, Giesen 1994b).

The impacts of grazing on LEPC can vary widely, depending on climatic conditions, the state or health of range vegetation, and the type of grazing regime utilized. Drought tends to magnify grazing impacts, as both processes reduce plant cover (Giesen 2000). When forage is reduced by drought, what remains tends to be grazed more heavily unless animal numbers are reduced. As a result, some grazed areas may supply adequate habitat during periods of normal rainfall, but may be unable to support LEPC during droughts (Merchant 1982). Intensive and/or persistent grazing may reduce or eliminate residual tallgrass cover needed for nesting (Davis et al. 1979, Riley et al. 1992). Heavy grazing

that repeatedly interrupts plant succession over a broad area may result in the conversion of tallgrass prairie to shortgrass or forb-dominated habitat (Hoffman 1963, Jackson and DeArment 1963, Litton et al. 1994) or shrub-dominated landscapes.

4.3 Changing Land Uses

Change in land use refers to a change from wildlife habitat to another land use that represents a long-term or permanent change. Many authors cite conversion of native grasslands to areas of cultivation as an important factor in the decline of LEPC (Copelin 1963, Jackson and DeArment 1963, Crawford and Bolen 1976a, Crawford 1980, Taylor and Guthery 1980a, Braun et al. 1994). Landscapes in which more than 37% of native rangeland has been lost may be incapable of supporting LEPC, and populations have declined in areas with only 20% rangeland conversion (Crawford and Bolen 1976a). In Kansas, LEPC avoided nesting within 300-400 yards of fields with center-pivot irrigation, effectively increasing the impact footprint of agricultural lands (Pitman et al. 2005). Irrigated cropland has eliminated or fragmented a significant amount of sand sagebrush prairie within the range of the LEPC in Kansas (Jensen et al. 2000). However, since 1981 water conservation measures have limited the increase in center-pivot irrigation (Robb and Schroeder 2005). Irrigation drawing on the Ogallala aquifer has resulted in extensive conversion of LEPC rangelands to croplands in Texas and Oklahoma, but this has not been considered a major factor in New Mexico (Leslie et al. 1999, Massey 2001). In recent years, however, areas of LEPC habitat in Curry and Roosevelt counties have been converted to grow crops or forage for a rapidly growing dairy industry in eastern New Mexico (Melcher 2006).

Tree plantings, windbreaks, and woody encroachment by eastern red cedar (*J. virginiana*), mesquite (*Prosopis glandularis*), and Osage orange (*Maclura pomifera*) further fragment remaining grasslands and create abrupt boundaries that can intensify edge effects. Additionally, the suppression of ecological processes (e.g., fire) has allowed an increase in woody encroachment into grassland habitats (Bidwell et al. 2003). Studies indicate grassland birds are sensitive to small increases (1-2%) in the amount of tree cover within landscapes and woody vegetation had a deleterious effect on prairie grouse occurrence, density, and/or nesting success (Berger and Baydack 1992, McKee et al. 1998, Merrill et al. 1999, Hanowski et al. 2000, Niemuth 2000, Fuhlendorf et al. 2002).

Shinnery oak is a critical component of LEPC habitat in much of southeastern New Mexico and portions of Texas and Oklahoma, providing both escape cover and a winter food source (Riley et al. 1992, Giesen 1998). Herbicides and defoliants are sometimes used to reduce shinnery oak cover and increase forage production. The effects of this practice on LEPC habitat may be highly variable, depending on the manner and extent of treatment and impacts of livestock grazing following treatment. Past widespread application of herbicides, such as Tebuthiuron, has eliminated shinnery oak over large areas (156 square miles) administered by the BLM in southeastern New Mexico, resulting in extensive loss of habitat (Peterson and Boyd 1998). However, limited reduction in densities of shinnery oak and sand sage after herbicide applications did not reduce LEPC populations if adequate cover and foods remained (Donaldson 1969,

Olawsky and Smith 1991) and subsequent livestock management allowed an increase in tall grasses (Davis et al. 1979, Doerr and Guthery 1983). In some locations, competition from shinnery oak impedes restoration of grasses and forbs needed for LEPC nesting and brood-rearing. When this occurs, limited use of chemical treatment can help achieve vegetative standards for quality habitat (C. Dixon, personal communication). When carried out on a limited basis, shinnery oak control may help increase tallgrass cover associated with high quality habitat and LEPC nesting success (Copelin 1963, Donaldson 1969, Ahlborn 1980, Haukos and Smith 1989).

4.4 Predation

LEPC have a short life expectancy and, as with most prairie grouse, eventually die from predation (Bergerud 1988). Rough-legged hawk (*Buteo lagopus*), red-tailed hawk (*Buteo jamaicensis*), prairie falcon (*Falco mexicanus*), Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), ferruginous hawk (*Buteo regalis*), golden eagle (*Aquila chrysaetos*), great horned owl (*Bubo virginianus*), coyote (*Canis latrans*), and badger (*Taxidea taxus*) have all been identified as predators of LEPC adults and chicks (Campbell 1950, Copelin 1963, Davis et al. 1979, Sell 1979, Ahlborn 1980, Merchant 1982, Haukos 1988). Nesting hens, eggs, and chicks are most vulnerable to predation, especially where nesting cover and brood habitat are inadequate to provide for concealment and escape. Predators of nests include Chihuahuan raven (*Corvus cryptoleucus*), striped skunk (*Mephitis mephitis*), ground squirrels (*Spermophilus spilosoma*), and bullsnakes (*Pituophis melanoleucus*), as well as coyotes and badgers (Davis et al. 1979, Giesen 1998, Haukos 1988, Riley et al. 1992, Jamison 2000).

Predation of prairie grouse is often considered a consequence of habitat quality and juxtaposition, prairie grouse density, and predator numbers (Schroeder and Baydack 2001). Inadequate habitat quality may increase the predation risk for birds attempting to locate escape cover (Svedarsky 1988, Connelly et al. 1991, Riley et al. 1992, Gregg et al. 1994). Numerous studies have found higher rates of nest predation on European grouse species in fragmented landscapes containing more edge and smaller patch sizes (Andrén et al 1985, Andrén and Angelstam 1988, Kurki et al. 1997). The introduction of trees, power lines, or other vertical structures into prairie habitats provides hunting perches for raptors and may indirectly increase raptor predation on LEPC (Bidwell et al. 2003, Robb and Schroeder 2005).

4.5 Hunting and Poaching

While market hunting and overutilization of LEPC during the 1930s and 1950s were factors attributed to the long-term downward trend in LEPC populations (USFWS 2001), legal harvest of LEPC populations does not appear to have been a factor in LEPC population declines. Nevertheless, where remaining LEPC populations are small, isolated, and naturally exhibit a clumped distribution on the landscape, concern exists that local, small populations may be vulnerable to concentrated hunting pressure (Crawford 1980, Taylor and Guthery 1980a).

Poaching is the illegal hunting of a game species. Because this activity often takes place during seasons of the year when the birds are vulnerable because of some biological

requirement in their life history, the potential exists for long-term poaching to contribute to a population decline. It is difficult to estimate the level of impact that poaching may have on LEPC populations.

4.6 Disturbance

Disturbance refers to direct interference with LEPC, rather than a habitat disturbance, and can include many types of disruption. Increased traffic on a road that formerly had little traffic and is located near a lek is an example of disturbance that may cause the birds to abandon a lek. The impact of military flyovers has been raised as a concern, but studies have not been conducted to assess if impacts actually occur. The amount of LEPC mortality due to vehicular traffic is unknown. Off Road Vehicles (ORVs) are used both by recreationists and by hunters seeking access to hunting areas. Construction of roads for energy development may open up areas to increased ORV use. While data on ORV impacts are lacking, their presence clearly has the potential to disturb lekking and nesting activities. However, designating areas specifically for these recreational activities might minimize the disturbance and potential habitat degradation by confining the disturbance to a relatively small area on the landscape.

One new factor that has the potential to negatively affect individual populations is the growing occurrence of recreational viewing of LEPC leks during the breeding season. Site-specific impacts of recreational observations on LEPC at leks are currently unknown. However, disturbance is likely to be minimal at the population level if observers remain in vehicles or blinds until LEPC naturally disperse from the lek and if observations are confined to a limited number of days and leks. Very little work has been done to document this possibility.

4.7 Parasites and Disease

Hagen and Giesen (2005) reported no available information on ectoparasites or infectious diseases in LEPC, although several endoparasites including nematodes and cestodes are known to infect the species (Addison and Anderson 1969, Stabler 1978, Pence and Sell 1979, Robel et al. 2003). In a recent study in New Mexico, LEPC tested positive for *Eimeria* and *Plasmodium* species, however the parasite load was not perceived as a significant contributor to LEPC mortality (Smith et al. 2003). Hagen et al. (2002a) found low levels (<5%) of *Mycoplasma* spp. antibodies in LEPC sera in Kansas and also concluded that such levels were not limiting to populations. The significance of the parasite infestations noted in the literature is unknown.

In Texas, Peterson et al. (2002) documented the first incidences of infectious bronchitis antibodies in LEPC. Although there has been no documented exposure of LEPC to the West Nile virus, the virus has significantly impacted some greater sage-grouse (*Centrocercus urophasianus*) populations (Naugel et al. 2004) and its potential effect on LEPC populations should be investigated. While density-dependent transmission of disease is unlikely to have a significant effect on LEPC populations, Mote et al. (1998) noted that given the generally small and scattered nature of LEPC populations, a disease transmitted independently of population density could have drastic effects.

4.8 Climate and Weather

Drought impacts LEPC through its effect on seasonal growth of vegetation necessary to provide nesting and roosting cover, food, and escape from predators (Merchant 1982, Peterson and Silvy 1994, Morrow et al. 1996). Major droughts of the 1930s, 1950s, and early 1990s markedly reduced LEPC populations across their range (Hagen and Giesen 2005). Increased annual precipitation resulted in small population increases in the mid-1980s, but drought conditions in early 1990s caused noticeable range-wide declines (Giesen 1998). The sensitivity of LEPC to drought was discussed by Crawford (1980) and Hamerstrom and Hamerstrom (1961); home ranges may be larger in drought years (Copelin 1963, Merchant 1982), and recruitment may be less likely after drought years (Merchant 1982, Morrow 1986, Giesen 1998). Southern portions of LEPC range in New Mexico, which on average receive less total precipitation (e.g., the Carlsbad region), are impacted more frequently and more severely by drought. LEPC populations in these areas may have always been smaller and more variable than those farther to the north, although population data are insufficient to say this with certainty. Along with other prairie grouse, LEPC have a high reproductive potential in years of adequate conditions. Thus, drought conditions are unlikely to be the sole causative factor in long-term LEPC population declines. The effects of drought on population growth rate may be more significant in small, fragmented populations.

Global climate change (global warming) poses a significant threat to LEPC through a variety of mechanisms. Increasing temperatures will likely result in a northward shift of the climatic conditions most suitable to the species, possibly resulting in the southernmost parts of the current LEPC range becoming unsuitable. Such range shifts are already occurring in many species (Root et al. 2003). This climatic shift appears likely to occur more quickly than appropriate habitats can correspondingly shift northward, potentially creating a disconnect between appropriate climatic conditions and suitable habitat conditions (Inkley et al. 2004). Fortunately, extensive habitats that are probably suitable for the species (sandsage prairie and mixed-grass prairies) already exist to the north of the current LEPC range, particularly in northeastern Colorado and western Nebraska. Habitat fragmentation, however, could impede or prevent LEPC from gradually shifting into these more-northern habitats as temperatures increase.

Climate change may bring with it changes in seasonality that could impact reproduction. Decreased synchrony between photostimulated events (e.g., mating and nesting) and temperature stimulated events (e.g., habitat greenup, insect availability) could negatively impact reproductive success. Temperature increases could also increase the potential for LEPC to encounter new pathogens and new invasive species could affect their habitats (Inkley et al. 2004).

Predictive models of climate change suggest greater fluctuations in weather patterns at all temporal scales. Increased weather fluctuations may create new patterns that persist over multiple years and/or create extreme conditions in both seasonal and daily time frames. Weather extremes typically carry negative implications for reproduction and survival. Increased frequency and intensity of droughts are particularly predicted for the High Plains and this may pose the greatest threat to LEPC relative to climate change. Habitat

quality may play an even greater role in LEPC reproduction and survival in the future. Habitats that were adequate for the species under normal conditions could become unsuitable if weather fluctuations become more extreme, with only the highest-quality habitats remaining suitable.

4.9 Oil and Gas Development

Energy exploration and development occur on public and private lands throughout the range of LEPC. Although the effects of oil and gas developments on LEPC are poorly understood, recent studies suggested that development of oil and gas resources negatively impacts prairie grouse, particularly during the breeding season (Lyon and Anderson 2003, Pitman et al. 2005). LEPC require large, mostly-contiguous tracts of prairie ecosystems to fulfill their life history requirements. The cumulative impacts of roads and increased traffic, well pads, pipelines, overhead transmission lines, compressor stations, and production facilities not only result in direct habitat loss but fragment remaining suitable habitat deterring use by LEPC (Pitman et al. 2005). Prairie grouse avoid areas near improved roads, power lines, and other man-made infrastructures (Pitman et al. 2005). Crawford and Bolen (1976b) noted that LEPC leks adjacent to heavily traveled roads were abandoned at higher rate than those found further from anthropogenic disturbance. The effect of daily vehicular traffic associated with maintenance of oil and gas operations along these road networks can also impact breeding activities and may further decrease the availability of habitat (Braun et al. 2002). Collisions with overhead transmission lines cause direct mortality to LEPC and may further limit LEPC populations (Bidwell et al. 2003). Construction of transmission lines also provides perches for various raptor species, which could potentially increase the mortality rate of LEPC (Bidwell et al. 2003). Noise associated with pumping and oil field activities may impact breeding activities if background noise interferes with mating display vocalizations. Further, sage-grouse lek attendance was lower on breeding grounds located in close proximity to active mineral resource developments compared to less disturbed lek sites (Braun et al. 2002). Braun (1986) speculated if noises associated with pumping and oil field activity deter recruitment of yearling sage-grouse males to breeding grounds, leks could become extinct.

Studies to assess whether noise from oil and gas exploration may have played a role in the abandonment of a number of historically active lek sites in southeast New Mexico show that abandoned lek sites were exposed to higher ambient sound levels than active sites (Hunt 2004). The same study also reported a significantly higher number of operating wells within one mile of abandoned lek sites. Whether this pattern of lek abandonment reflects sensitivity to noise or some other form of disturbance associated with intensive oil and gas development, or is a response to factors not associated with drilling, remains unknown. However, all of these studies emphasize the importance of taking behavioral avoidance into consideration when assessing development impacts on LEPC habitat.

Also see section 4.1 for discussion of fragmentation resulting from oil and gas development.

4.10 Wind Energy Development

Presently, little is known on how wind power developments affect LEPC and/or LEPC habitats. Areas within the range of LEPC are currently being monitored for suitability as wind energy sites. These developments include the towers and turbines that harness the energy, as well as access roads, and transmission line connections to substations or other existing power grids. Physical disturbance affected by the construction of turbines, turbine noise, and physical movement of turbines during operation have the potential to disturb nesting LEPC (Robel et al. 2004). However, behavioral avoidance of these facilities by prairie grouse has the potential to greatly broaden the negative impacts of the project area. The effects of habitat fragmentation may indirectly affect local LEPC populations by decreasing the area of habitat available for nesting and brood-rearing (Pitman et al. 2005). The behavioral response of the greater prairie-chicken is similar to that of the LEPC and it has been predicted that nesting and brood-rearing hens of both species will avoid large wind turbines by at least a one-mile radius (Robel et al. 2004). Fragmentation and changes in habitat structure may increase the amount of edge, which may serve as travel lanes for terrestrial predators (Kuehl and Clark 2002). Such areas are consequently avoided by nesting prairie grouse (Robel 2002a, Pitman et al. 2005). In addition to the effects of habitat fragmentation, prairie grouse avoidance of vertical structures (Anderson 1969, Manes et al. 2002) and human disturbance activities may further impact LEPC movements and habitat use (Robel 2002a, b). Therefore, this type of land use change has a variety of potential impacts to LEPC.

4.11 Population Isolation

Continued habitat loss and fragmentation may increase the risk of loss of genetic variation in small, isolated LEPC populations. Genetic diversity is necessary for a population to respond to environmental change, thus a loss of genetic variation may jeopardize the persistence of fragmented populations (Shaffer 1981). Populations, such as LEPC, that have undergone large decreases in population size are likely to lose genetic variation (Nei et al. 1975, Maruyama and Fuerst 1985). In a range-wide evaluation of LEPC, birds from New Mexico had the fewest haplotypes and were markedly different from other populations, suggesting that LEPC in New Mexico have been isolated from other populations across their range (Hagen 2003). In addition, estimates of genetic diversity within 4 semi-isolated leks from the Caprock Wildlife Habitat Management Area in New Mexico suggested increased inbreeding leading to an increase in homozygosity within the leks studied (Bouzat and Johnson 2004). Although no deleterious effects to demographic rates have been documented in New Mexico populations (Van Den Bussche et al. 2003), a loss of genetic diversity may be associated with inbreeding and a reduction in reproductive fitness (Bouzat et al. 1998 a, b).

In Colorado, the LEPC is limited to a few sparse and scattered populations in the southeast corner of the state. Genetic variability is a concern for potentially isolated populations in Kiowa and Cheyenne counties where populations possibly number less than 100 birds, respectively (Giesen 2000). Although Kansas has the largest estimated number of LEPC, landscape configuration in the southwest is characterized by isolated patches of native grassland (Jensen et al. 2000). This level of fragmentation may influence demographic processes such as dispersal and, consequently, genetic

interchange (Bellinger et al. 2003, Johnson et al. 2003, Bouzat and Johnson 2004, Johnson et al. 2004). Resistance to disease and the ability of populations to respond to environmental perturbations may also decrease with the loss of genetic variation (Lacy 1997). Thus, loss of genetic variation may negatively impact the long-term viability of LEPC populations across their 5-state range.

4.12 Hybridization

Historically, the breeding distributions of LEPC and greater prairie-chickens overlapped in a zone approximately 50 miles wide in west-central Kansas (Schwilling 1955, Aldrich 1963). The range of sharp-tailed grouse (*Tympanuchus phasianellus*) also overlapped LEPC range in both western Kansas and southeastern Colorado (Aldrich 1963). It is likely all 3 of these prairie grouse species hybridized to a limited extent in these historical areas of overlap, just as sharp-tailed grouse and greater prairie-chickens have continued to hybridize in the Nebraska Sandhills (Sisson 1976). Range contractions eliminated these regions of prairie grouse overlap in west-central Kansas, approximately from the 1930's forward (Schwilling 1955).

With the addition of extensive native, mixed-species grasslands provided by CRP in Kansas, both LEPC and greater prairie-chickens extended their modern ranges back into the historical zone of overlap in west-central Kansas (Rodgers 1999, Rodgers and Hoffman 2005). In this region, mixed leks and limited hybridization between these species have again occurred (Bain 2002, Rodgers and Hoffman 2005). With approximately 10 years passing since mixed leks and hybrids were first identified in Kansas, monitoring by the KDWP in the region of overlap has not detected any change in the prevalence of either species or in the proportion of hybrids present. Bain (2002) detected no instances of successful mating by hybrids. Thus, it appears this reuniting of LEPC and greater prairie-chickens within their historic range of overlap poses no threat to the genetic integrity of either species.

4.13 Nest Parasitism and Interspecific Competition

Although interspecific competition and nest parasitism by ring-necked pheasants (*Phasianus colchicus*) and northern bobwhite (*Colinus virginianus*) have been reported for other gallinaceous species (Sharp 1957, Follen 1966, Vance and Westemeier 1979, Kimmel 1988, Westemeier et al. 1989, Westerkov 1990, Westemeier et al. 1998), little information is available on the effect of pheasants on LEPC populations. Pittman et al. (2006) found a 3% incidence of nest parasitism by ring-necked pheasants on LEPC nests during a study in Kansas; however, the potential impacts of nest parasitism on LEPC are unknown. Fields (personal communication) observed no nest parasitism of LEPC during her study in Gove County, Kansas.

4.14 Altered Fire Regimes

Fire was a naturally occurring form of disturbance on the pre-Columbian Great Plains and was ignited not only by lightning but, for at least 12,000 years, also by aboriginal Americans. The impact of fire was a major force in shaping the structure of the vegetation community (e.g., Kay 1998). The long history of large ungulate herbivores on the Great Plains is also well accepted (Milchunas et al. 1988). Large ungulates are

attracted to recently-burned areas by the new growth that is typically more palatable and of greater nutritional quality than vegetation in unburned areas. In turn, recently burned and, consequently, heavily-grazed areas supported more forbs and were less likely to burn in subsequent years due to a reduction in grass litter. This effect of this prehistoric pattern, known as the fire-grazing interaction, was to create a mosaic of patches (burned/unburned, heavily grazed/lightly grazed, dominated by forbs/dominated by grasses) that shifted spatially over time (Vinton et al. 1993, Hartnet et al. 1996, Fuhlendorf and Engle 2001). Since LEPC tend to nest in areas with greater heights and density of grasses (e.g. Riley et al. 1992) but then move their just-hatched chicks to areas with less grass, more forbs, and greater insect availability (e.g. Bidwell et al. 2003, Jamison et al. 2002b), this prehistoric shifting mosaic well satisfied their critical reproductive needs.

Average intervals of fire return to any given area varied and were generally more frequent in eastern sections of the Great Plains where litter accumulation rates were greater. Within the range of the LEPC, fire return intervals varied from an average of 5 years in eastern sections of the range to 10-20 years in the more-arid, westernmost parts of the species' range (Hann 2003, Zollner 2003, Masters 2004). Since widespread European settlement in the 1800's, the frequency and scale of deliberately-set fires have greatly diminished and, where possible, lightning-ignited fires have been actively suppressed. Suppression of the pre-historic fire regime, along with fencing of the prairies, interrupted the fire-grazing interaction and initiated an alteration of vegetation communities on the Great Plains that has diminished habitat quality for LEPC. Not only has the shifting mosaic been muted but, with little or no fire, woody plants have encroached onto grasslands where they were once uncommon. Fire suppression has also increased the stature and dominance of shrubby species (e.g. shinnery oak) and the vigor of herbaceous prairie vegetation has been diminished. With insufficient fire, woody invasion is accelerating in a positive-feedback process that seriously threatens the quality of the grasslands remaining available to LEPC.

Even in those few cases where land managers are currently willing to utilize prescribed fire as part of their rangeland management, such fires are typically less intense than the fires that helped mold the Great Plains landscape. With manmade structures scattered across many landscapes, prescribed fires are seldom set when wind speeds exceed 15 mph or when humidity is low. Such fires are not as intense and, as a result, are less effective at suppressing woody vegetation than those that preceded European settlement.

If habitats of adequate quality for LEPC are to be maintained over the long term, biases against rangeland burning that currently prevail in western sections of the Great Plains must be overcome. Even in the more arid portions of the LEPC range, fire can play a critical role in restoring and maintaining the ecological integrity of these habitats.

4.15 Biofuels

The development of the biofuels industry is being driven by diminishing supplies of fossil fuels, political instability in major fossil-fuel exporting countries, and by serious negative environmental consequences (e.g., global warming) associated with fossil fuel

production and consumption. This development has the potential to produce both negative and positive effects on populations of LEPC. Given the semi-arid nature and limited water resources in the historic LEPC range, the biofuels industry may be slower to develop here than in areas with greater precipitation. However, some biofuel development is already occurring within the LEPC range and much more is possible.

In the short term (<10 years), ethanol production from grain will probably be the biofuel sector most likely to affect LEPC. Ethanol currently can be competitively produced from corn (*Zea mays*) and grain sorghum (*Sorghum* spp.). Within the range of the LEPC, most corn production occurs in irrigated fields, however, grain sorghum is a reliable dryland crop and the reliability of new drought-resistant varieties of corn is rapidly increasing. While limited (<25% by area) production of grains within regions occupied by LEPC has the potential to benefit populations, this percentage has long been surpassed in most of the species' range. Consequently, to the extent that ethanol demand results in new conversion of occupied grassland or shrubland to cropland, LEPC populations will almost certainly decline.

Over the long term (>10 years), production of ethanol from cellulose will probably be more viable than ethanol from grain. This probability could increase the amount of grassland on the landscape, possibly benefiting LEPC. Benefits to LEPC will be contingent upon: 1) the use of appropriate seeding mixtures, 2) compatible management and harvest of the biomass, and 3) close proximity (< 2 miles) of such stands to range occupied by LEPC. Sustainable polycultures hold greater potential for ethanol production and are more carbon negative (sequester carbon) than biomass from grass monocultures or crop residues (Tilman et al. 2006). Biomass seeding mixtures that contain native tallgrasses or mid-grasses and nitrogen-fixing legumes (including non-native alfalfa) could produce valuable habitat for LEPC, but only provided the biomass from such stands is harvested late in the dormant period (February–March). Annually shifting unharvested blocks (25–33%) of such grasslands would provide critical nesting cover.

The transition from grain-based ethanol to cellulose-based ethanol production offers a potential opportunity, over time, to replace poor-quality CRP grasslands with high-quality, biomass-producing habitats. Exotic old world bluestems (*Bothriochloa* spp.) and weeping lovegrass (*Eragrostis curvula*) were extensively seeded in CRP tracts in Texas, New Mexico, and Oklahoma sections of the LEPC range but offer virtually no habitat value for LEPC (Rodgers and Hoffman 2005). Efforts to replace these exotics with native species have been largely unsuccessful due to the difficulty in killing the exotic grasses (either by short-term tillage or with herbicides) and their highly competitive nature (preventing establishment of native species). Multiple-year cropping of such stands, perhaps to produce non-irrigated corn or sorghum for ethanol, should be sufficient to eliminate the undesirable exotic grasses that were originally seeded. Once that is accomplished, appropriate multi-species stands could be established on these same lands to supply biomass for ethanol and simultaneously benefit LEPC.

CHAPTER 5. HABITAT ASSESSMENTS: CURRENT STATUS AND TRENDS

5.1 Habitat Quality

The quality of available habitat within the southern Great Plains ecosystem contributes to the effectiveness of many of the other factors regulating LEPC populations. Drought, disease, predation, hunting, and disturbances are less likely to affect populations and the individual birds and the populations are quick to recover when habitat quality is high. Population impacts from unfavorable weather conditions are also ameliorated by having high quality habitats. Managing for quality habitats, while maintaining and restoring habitat quantity, are likely the two most important factors for long-term sustainability of LEPC populations.

Lands enrolled in CRP might provide an important management opportunity for increasing and improving LEPC habitat (Table 5.1). LEPC have expanded their range in response to multiple-species native grass CRP stands in the central plains, particularly in west-central Kansas (Rodgers 2005, Rodgers and Hoffman 2005). CRP grasslands in Kansas comprise 13% of the total area of 15 core counties in southwestern counties enrolled in CRP (http:www.fsa.usda.gov/crpstorpt/r1sumsn/ks.htm) and in one case provide the only available grassland habitat. CRP grasslands comprise a similar portion of LEPC range in Colorado; i.e., 17% of the total area of Baca, Kiowa, and Prowers counties is enrolled in CRP (http://www.fsa.usda.gov/crpstorpt/r1sumsn/co.htm).

Although historic evidence suggested that birds in Colorado occasionally used CRP grasslands as roosting cover (Giesen 2000), recent survey efforts have found LEPC using CRP grasslands as lekking and roosting sites. This has been directly correlated with increasing LEPC populations in Prowers County. In 2006, there was a minimum of 10 leks in Prowers County in CRP, accounting for 117 birds. Much of the early CRP-enrolled acreage in southeast Colorado was planted to mixtures containing sideoats grama (*Bouteloua curtipendula*) which became dominant, stunted, and formed a dense sod. The result was extremely low quality habitat. Sideoats-dominated stands provide insufficient cover and lack both the diversity and abundance of native grass and forb species when compared to native habitat (Sullivan et al. 2000, Fields 2004).

In New Mexico, conversion of cropland to CRP grasslands was believed to have been detrimental to LEPC populations by decreasing winter food resources (Bailey and Williams 2000); however about 70-80% of the original CRP seedings in eastern New Mexico consisted of dense, single-species stands of weeping lovegrass or Caucasian bluestem (*B. bladhii*). LEPC populations have generally not increased in response to the monocultures noted, but have increased slightly in range and population in an area outside what Ligon (1927) described as suitable LEPC range in northern Curry County where mixed stands that included sand dropseed (*Sporobolus cryptandrus*), sideoats grama, and blue grama (*B. gracilis*) are more prevalent (D. M. Davis, NMDGF, unpublished data).

CRP grasslands in Texas were established as monocultures of weeping lovegrass, King Ranch bluestem (*B. ischaemum*), or klinegrass (*Panicum coloratum*) that provide little

brood-rearing or winter cover. Establishment of CRP grasslands in the Texas Panhandle apparently has not been detrimental to LEPC, and the vegetative structure in those fields may provide suitable habitat for the species as CRP fields age and become more populated with native species (H. A. Whitlaw, TPWD, unpublished data).

Table 5.1. Number of acres enrolled in CRP in counties occupied by LEPC.

State	Number of Counties	CRP (acres) [a]
New Mexico	7	577,000
Texas	21	1,650,000
Oklahoma	7	646,000
Kansas	31	1,883,000
Colorado	5	822,000
Totals		**5,578,000**

[a] Acres based on active contracts for all program years (1992-2008) as of 31 May 2007 and has been rounded to nearest 1000 ac (http://content.fsa.usda.gov/crpstorpt/r1sumyr/r1sumyr.htm).

5.2 Land Status and Ownership

New Mexico
Currently, 59% of historic LEPC range in New Mexico is privately held. The BLM, USFS, and New Mexico SLO manage the remaining 41% of historical and occupied range of LEPC in eastern New Mexico with the exceptions of federal holdings managed by the Department of Energy in Eddy County, Department of Defense in Roosevelt County, and State Game Commission-owned PCAs administered by NMDGF (Table 5.2).

Current estimates of change in rangeland acreage between 1997 and 2002 for counties within LEPC range in eastern New Mexico showed no significant change in land use, although notable increases in acres of irrigated cropland were observed in Lea and Roosevelt counties (National Agriculture Statistics Service 2004).

Table 5.2. Land ownership status within the historic and occupied range of the LEPC in New Mexico (adapted from Bailey 1999).

		Land Ownership (%)			
Portion of LEPC range	LEPC range (mi^2)	Private	State Trust	BLM	Other
Northeast	1,292	78	22	--	--
East-central	4,291	78	16	4	1
Southeast	3,062	24	23	53	< 1
Totals	**8,645**	**59**	**19**	**21**	**1**

Texas
Approximately 98% of Texas is held in private ownership. All known LEPC populations occur on privately owned lands. It is possible that LEPC may move onto or use briefly the TPWD-owned Gene Howe Wildlife Management Area in the northeast portion of the state. USFS-owned National Grasslands (Rita Blanca-Kiowa and Black Kettle) are also within historic LEPC range in Texas, but no known populations exist on these properties.

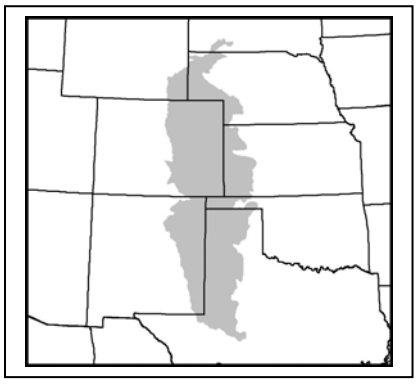
Oklahoma
Approximately 97% of Oklahoma is held in private ownership. While historic range comprised over 12,000 mi^2, <50% of that remains in grassland and/or shrubland habitat, and only a portion of that area remains occupied. Within the known, occupied range in Oklahoma, there are 108 mi^2 of state-owned (ODWC) Wildlife Management Areas. In addition, USFS-owned National Grasslands (Black Kettle and Rita Blanca) comprise another 72.3 mi^2, although both are located outside the fringe of currently occupied range.

Kansas
There is an estimated 11,210 mi^2 within the range of the LEPC in Kansas and approximately 6,389 mi^2 (57%) of that is in grassland and/or shrubland habitat types that are usable by the species. Only 119 mi^2 (1.9%) of these usable habitats are in public ownership. The Cimarron National Grasslands comprises 100 mi^2 of this public land with the remainder located on the Sandsage Bison Range (5 mi^2) and the Pratt Sandhills Wildlife Area (14 mi^2) managed by the KDWP.

Colorado
Less than 15% of LEPC habitat in Colorado occurs on public lands (Comanche National Grasslands). Known occupied range is approximately 1,420 mi^2.

5.3 Bird Conservation Region Assessments

Shortgrass Prairie Bird Conservation Region - BCR 18



Status and Importance

Within the Shortgrass Prairie Bird Conservation Region (BCR 18), is the Pecos and Staked Plains (PSP) physiographic area which stretches from the western panhandle of

Texas, through portions of the western Oklahoma panhandle, and covers extensive areas of eastern New Mexico. Native shortgrass prairie within the PSP is characterized by two dominant grass species, blue grama and buffalograss (*Buchloe dactyloides*). There are also extensive areas of shinnery oak and mid-grass prairie interspersed with low shrubs. Within this region, approximately 52% (~108,000 mi^2) of native shortgrass prairie remains (Samson et al. 2004). Dry-land agriculture includes non-irrigated field crops (e.g., wheat (*Triticum* spp.), hay, and sorghum) or fallow fields. Land enrolled in CRP was once in agricultural production, but now is planted with cover, either native or non-native, intended to improve water quality and wildlife habitat, and control soil erosion.

The Central Shortgrass Prairie (CSG) physiographic region covers much of eastern Colorado and smaller portions of western Kansas, southwestern Nebraska, and southeastern Wyoming. The dominant habitat in this physiographic area is shortgrass prairie. The shortgrass prairie is characterized by two low-growing warm-season grasses: blue grama and buffalograss; western wheatgrass is also present, along with taller vegetation including widespread prickly-pear cactus (*Opuntia* spp.), yucca (*Yucca* spp.), and cholla (*Cylindropuntia* spp.) in the south. Sandsage prairie is found where sandy soils occur and is dominated by sand sagebrush and the grasses sand bluestem (*A. hallii*) and prairie sandreed (*Calamovilfa longifolia*). Mixed grass (needle-and-thread (*Stipa* spp.), sideoats grama, little bluestem) and tallgrass (big bluestem, switchgrass (*Panicum virgatum*)) communities occur locally.

Priority Species, Species Assemblages, and Habitat Requirements

Much of the PSP and CSG is predominately used for ranching and continues to support native bird populations. Conversion to agriculture with the use of center-pivot irrigation has eliminated or fragmented a significant amount of native rangeland, particularly in eastern portions of the physiographic area. An ecologically sound grazing regime with some rest and rotation that allows moderate fuel buildup that would allow for the reintroduction of fire could provide long-term benefits to producers and priority grassland bird species. Native rangeland surrounding LEPC lek sites should be retained and grazing should be managed to create conditions necessary to meet the life history requirements of this species. Ephemeral playas and non-riparian wetlands are common features of PSP in which grazing and water level management can benefit many grassland birds. Termination of detrimental practices of residual pesticide run-off, dumping of oil and gas waste by-products, and pitting of clay bottoms for the creation of more permanent water sources will help maintain playa integrity.

Central Mixed-Grass Prairie – BCR 19

Status and Importance

Within the Central Mixed-Grass Prairie Bird Conservation Region (BCR 19) and the range of the LEPC are the Rolling Red Plains (RRP), Rolling Plains and Breaks (RPB), and Great Bend Sand Plains (GBSP) physiographic regions. The RRP extends north from the Edwards Plateau in Texas, through western Oklahoma and just into southern Kansas. The RPB extends from northern Meade and Clark counties in southern Kansas north and northeastward into southern Nebraska. The RPB's southeastern boundary contacts the western portion of the GBSP and the northernmost part of the RRP. The GBSP covers parts of 7 counties in southcentral Kansas south of the Great Bend of the Arkansas River and its southern border contacts the northernmost extension of the RRP. Each of these areas was historically grassland with shrubs particularly present on sandy soils.

Grass species that historically were prevalent in the RRP included big bluestem, sand bluestem, Indiangrass (*Sorghastrum nutans*), and plains bristlegrass (*Setaria vulpiseta*). These species decreased with domestic livestock grazing, giving way initially to species such as little bluestem, switchgrass, black grama (*B. eriopoda*), and giant sandreed (*Calamovilfa gigantea*). As grazing became more intense, even these species diminished, partially replaced by sideoats grama, silver bluestem (*Bothriochloa saccharoides*), sand dropseed, hairy grama (*B. hirsuta*), buffalograss and other increaser species. Sandy soils in particular supported shrubs such as sand sagebrush, shinnery oak, Chickasaw plum (*Prunus angustifolia*), and aromatic sumac (*Rhus aromatica*). Honey mesquite and juniper were present in fire-protected areas. The historical average fire-return interval was about 10 years (Zollner 2003). With European settlement and the accompanying suppression of fire, mesquite and juniper have increased greatly in range and density with severe negative implications for LEPC. Cultivated crops that are most common in the RRP today include cotton (*Gossypium* spp.), peanuts (*Arachis hypogaea*), and wheat.

Historically, prevalent grasses in the RPB included big bluestem and Indiangrass, but species such as little bluestem, sideoats grama, and switchgrass increased with livestock grazing. Under more intense grazing pressure, shortgrass species became more dominant including silver bluestem, blue grama, hairy grama, buffalograss, threeawns (*Aristida* spp.), and dropseeds. Shrubs were and still remain a minor vegetational component, and are found primarily in fire-protected areas. The historical average fire-return interval was

about 8 years. Suppression of fire has increased the occurrence of trees in some areas, but tree invasion of these prairies has not occurred to the degree that is evident in the RRP. Cultivated crops most common in the RPB include wheat, grain sorghum, corn, and sunflower (*Helianthus* spp.).

The GBSP region was historically sand prairie bordered on the north by the riparian system along the Arkansas River. Dominant grasses were sand bluestem, big bluestem, Indiangrass, and giant sandreed. Under moderate grazing pressure, grass species such as little bluestem, switchgrass, and sideoats grama increased, with species such as sand dropseed, sand lovegrass (*Eragrostis trichodes*), Scribner's panicum (*Dicanthelium oligosanthes*), blue grama, hairy grama and threeawns becoming more prevalent under heavy grazing. This area contains only minimal amounts of sand sagebrush, but Chickasaw plum, aromatic sumac, and golden currant (*Ribes aureum*) historically were common shrubs in this region and remain relatively common today. The historical average fire-return interval was about 5 years and played a particularly important role in maintaining this ecosystem. With the fire suppression that occurred since European settlement, eastern red cedar and other tree species have invaded these prairies with serious negative impacts on LEPC. Also, extensive systems of woody shelter belts were planted in much of this region, providing additional sources for tree invasion of prairie remnants in this area. Common cultivated crops include wheat, corn, grain sorghum, and soybeans (*Glycine max*). Corn and soybeans, particularly, are grown under center-pivot irrigation that is made possible by the abundant groundwater availability. These pivots account for much of the cultivated land in western portions of this sandy-soil region.

Priority Species, Species Assemblages, and Habitat Requirements

The present status of many of the priority bird species in the RRP, RPB, and GBSP reflects the change in land use over the past century. The LEPC was once common in each of these regions, occupying mid and tallgrass prairies, particularly if they contained a significant shrub component. Much LEPC habitat has been lost to cultivation, tree invasion, and poor range management. These same habitat changes have also been detrimental to northern bobwhite, Cassins's sparrow (*Aimophila cassinii*), lark sparrow (*Chondestes grammacus*), upland sandpiper (*Bartramia longicauda*), and Dickcissel (*Spiza americana*). Peripheral species that have also showed declines include scaled quail (*Callipepla squamata*) and burrowing owl (*Athene cunicularia*). Removal of invasive trees and restoration of prescribed fire regimes that somewhat mimic the historic fire-grazing interaction are critical needs for assuring the maintenance of remaining LEPC habitats in BCR 19.

5.4 Lesser Prairie-Chicken Habitat Management Recommendations

Agricultural Practices

Ecology and status

Settlement of the southern Great Plains introduced farming and an accompanying availability of small grains. This changed the foraging habits of LEPC throughout the 5-

state range. Early farms were scattered, relatively small in acreage, and dryland cropping methods (e.g., corn, wheat, sorghum) were inefficient. This resulted in localized winter food sources and possibly increased over winter survival. However, as the landscape pattern shifted from predominantly prairie with a scattering of grain fields to the inverse, the reduced nesting and brood-rearing cover began to have a detrimental effect on LEPC populations. Much of the arable lands for dryland crops were in use by the 1960s. The development of center-pivot irrigation systems resulted in another period (1970-1985) of extensive habitat conversion from native grassland to irrigated corn, alfalfa (*Medicago sativa*), wheat, cotton, and peanut fields. LEPC persist in these agricultural regions, using waste grains as winter forage, and alfalfa to a lesser extent during spring.

Identified problems

Extensive conversion of native range to cropland is primarily responsible for declines in LEPC habitat, as it directly impacts available nesting habitat and reduced numbers of breeding birds (Crawford 1974). Extensive cropland effectively reduces and/or eliminates nesting and brood-rearing habitats as well as summer habitat for males and non-nesting females.

Cropland recommendations

While some cropland acres provide a winter food source it is unclear if winter food sources can be a limiting factor. Because nesting and brood-rearing are critical to population stability (Hagen 2003), further conversion of native rangeland to cropland in LEPC habitat should be discouraged. Specifically, discouraging further conversion of grassland surrounding leks is critical, as most nesting and brood-rearing sites occur within 1-2 miles of lek sites (Giesen 1998, Woodward et al. 2001, Pitman et al. 2006). However, planting small grains or corn in existing agricultural fields that are adjacent to native prairie may provide additional winter food sources. Minimum-till or no-till techniques will reduce soil erosion and may benefit LEPC that are using the fields by maintaining waste grain on the soil surface.

Grasslands (Pasture/Hayland/Rangeland)

Ecology and status

Historically, grasslands and shrub steppes were critical habitats for LEPC across the range. Shinnery oak savannahs extended from eastern New Mexico and west Texas into western Oklahoma. Sand sagebrush prairies followed the Arkansas, Cimarron, and Canadian Rivers in Colorado, Kansas, Oklahoma and northern Texas. LEPC also occupied mixed-grass prairies in Kansas, Oklahoma, Texas, Colorado, and New Mexico. Over the last 150 years several factors have reduced the quality and quantity of these grassland habitats: 1) conversion of grassland to cropland, 2) continuous livestock grazing, 3) fire suppression which has yielded invasions of detrimental woody species, and 4) construction of anthropogenic features (e.g., dwellings, power lines, natural gas compressor stations) on remnant prairie fragments.

Native grasslands evolved at the interface of intermittent grazing (by bison, *Bison bison*), periodic drought, and wild fires. These factors promoted heterogeneous grasslands with a

mosaic of various successional stages of vegetation (Fuhlendorf and Engle 2001). This provided the necessary habitat requirements for LEPC. Early successional stages characterized by low vegetation were suitable for breeding sites (leks), mature stages were ideal for nesting cover and possibly wintering sites, and mid-successional vegetation was likely best for brood-rearing and general habitat usage during summer. The dynamics of this system were lost as the prairies were converted to cropland, which resulted in a highly fragmented distribution of native habitat. The resulting islands of native grassland were subsequently used for continuous grazing within confined pastures that promoted homogenous stands of shorter vegetation. Additionally, fire suppression in these fragments has lead to increases (complete colonization in some cases) in eastern red cedar, mesquite, Osage orange, and Russian olive (*Elaeagnus angustifolia*), and such encroachment has resulted in degraded and/or eliminated available LEPC habitat.

Identified problems

Improper grazing (i.e., grazing practices that do not leave adequate residual cover) is a major reason for declines in numbers of LEPC, because of degradation to nesting habitat (Taylor and Guthery 1980a, Leslie et al. 1999, Mote et al. 1998, Bailey et al. 2000). In sandy soils, heavy grazing may result in a shortage of the tall residual cover (Berg et al. 1997, Sims and Gillen 1999) that is required for successful nesting (Hoffman 1963, Jackson and DeArment 1963, Litton et al. 1994). In firmer soils, heavy grazing pressure may result in conversion of tall and mid-grass communities to a shortgrass-dominated habitat (Quinn and Walgenbach 1990).

Prairie restoration from agricultural land to grassland has had mixed results on the LEPC. CRP grasslands can provide suitable habitat (Rodgers and Hoffman 2005), but few data are available that quantify benefits of CRP to LEPC. Exotic, warm-season monoculture seedings (e.g., old-world bluestem) have not provided additional habitat to LEPC (Rodgers and Hoffman 2005).

The effects of shrub-specific herbicides on LEPC probably are compounded by interactions with livestock grazing, the size of the treated area, and resulting herbaceous cover (Jamison et al. 2002a). Herbicide treatment reduces shrub cover and allows an increase in grass cover, if grass cover is not reduced by heavy grazing (Donaldson 1966, Doerr and Guthery 1983, Olawsky 1987, Olawsky and Smith 1991). The negative effects of herbicide treatment on shrub cover may not become evident until ≥ 3-years following herbicide applications as the treated shrubs structurally deteriorate (Rodgers and Sexson 1990, Jamison et al. 2002a).

Grassland recommendations

Grassland areas sufficient to support LEPC populations may occur in various configurations, including contiguous blocks as well as mosaics of smaller tracts interspersed with croplands.

Grassland areas of 20,000 or more total acres are believed to be sufficient to support self-sustaining populations of LEPC, provided the habitat is of good quality. Multiple areas, each containing >5,000 grassland acres, can support LEPC if they are sufficiently

juxtaposed (<6 mi.) to other such areas to allow birds to readily exchange between them (e.g. two 10,000 acre areas). Suitable grasslands may also include mixed native-grass CRP stands where they occur near (<2 mi.) sandsage, shinnery-oak, or mixed-grass prairie habitats.

For grassland/cropland mosaics to support LEPC, an absolute minimum of 40% of the mosaic must be suitable grassland habitat and some contiguous keystone tracts of at least 2 mi^2 of good-quality grassland must be present. Concentrated grassland mosaics with ≥ 60% grassland habitat, including many good-quality keystone tracts, are much more likely to support viable LEPC populations. Smaller grassland patches can contribute to the habitat base within a grassland mosaic, but their value to LEPC is directly related to their size (larger is better) and quality, and inversely related to their distance from keystone tracts (<2 mi.).

Regardless of whether LEPC occur in mosaic or contiguous-block areas, populations that occur within 19 miles of other such populations have some opportunity for interchange critical for disaster recovery and genetic health (Bidwell et al. 2003). Governmental programs and private efforts should strive to maintain and/or enhance all such existing areas and should seek to create new ones, as well inter-population grassland corridors that could facilitate genetic exchange.

Moderate grazing in sandy regions can yield greater basal cover of mid-grasses and forbs (Quinn and Walgenbach 1990, Sims and Gillen 1999) that may be beneficial to both nesting success and brood rearing, respectively. A grazing system that maintains middle to late stages of plant succession interspersed with early stages of plant succession is optimal for LEPC (Bidwell et al. 2003). To achieve this heterogeneity, grazing systems must incorporate periods of rest. Because excessive grazing yields lower quality concealment cover and reductions in foraging habitat, continuous grazing is not recommended (Bidwell et al. 2003). Alternatively, light or moderate grazing will ensure that 60–70% of key herbaceous species (Holochek et al. 1989) will be available as residual nesting cover (Berg et al. 1997, Snyder 1997, Sims and Gillen 1999). At least 20–33% of rangelands should be annually rested for an entire growing season in rotations of about once every 3–5 years (Bidwell et al. 2003). This vegetative response can be maintained within individual pastures using patch-burning methods where 20–33% of an area is burned annually (Bidwell et al. 2003).

In sand sagebrush and shinnery oak habitats, quality nesting habitat is provided by areas with high densities of shrubs and grasses exceeding 40 cm in height that provide at least 75% vertical screening in the first 33 cm above ground (Hagen et al. 2004). In all habitat types, grazing should be managed to maintain an average height of 25 cm of residual grasses and forbs, with some patches exceeding 50 cm (Hagen et al. 2004).

For suitable brood-rearing in sand sagebrush grasslands, provide habitat with 20–40% canopy of shrubs, forbs, or grasses that are 24–30 cm in height (Hagen et al. 2004). In shinnery oak habitats, provide vegetation dominated by warm-season grasses and shinnery oak with about 60% bare ground (Riley and Davis 1993). Vegetation should be

composed of about 43–60% grasses, 24–43% shrubs (primarily shinnery oak), and 13–26% forbs (Riley and Davis 1993).

CRP grasslands should range from 30–75 cm in height, as stands <30 cm are generally inadequate for concealment cover and >75 cm seem to be avoided (Rodgers and Hoffman 2005). Multi-species seedings create height and growth form heterogeneity, and must include native bunchgrasses forbs, particularly legumes (important in terms of structure and as a food source), and native shrubs should be considered. Aggressive grasses that can crowd out other components of the mixture or grass monocultures must be avoided, including sideoats grama in southeast Colorado**.**

Prescribed burns should be conducted with greater frequency in LEPC habitats than currently occurs. Some nesting habitats may require 7-years or more to recover until they provide adequate concealment following a fire (Synder 1997). Prescribed fire is an excellent tool to reduce juniper encroachment (Wright 1974). Mechanical removal of invasive junipers may be necessary in situations where they can no longer be adequately and safely controlled with prescribed burning.

Until herbicide treatments have been demonstrated to benefit LEPC, herbicides should be used cautiously. Minimize the use of herbicides, except to control invasive non-native vegetation. However, if herbicides must be used, treatments should not reduce sand sagebrush or shinnery oak to less than 25% of the canopy within 1 year after treatment (Hagen et al. 2004). Shrub removal treatments should provide a mosaic of treated and untreated areas to provide an interspersion of habitats for nesting cover and brood-rearing.

Consideration of Human Impacts

Ecology and status

LEPC habitat has become increasingly fragmented by human development such as utility right-of-ways, fossil fuel extraction, wind energy, and suburban housing developments. However, the effects of anthropogenic features on LEPC demography and habitat use have received little attention. Recent research in Kansas has provided the first quantitative treatment of these associations (Pitman et al. 2005).

Identified problems

Although abandoned oil-drilling sites may be used as lek sites, exploration and development for gas and oil production can cause lek abandonment (Candelaria 1979, Davis et al. 1979). In Texas, displaying males abandoned one lek after an elevated road was built across it (Crawford and Bolen 1976b).

Powerlines placed near leks may negatively affect breeding activity of males as raptors perching and hunting from these poles may result in increased mortality risk and reduced lekking activity. Acoustical disturbance (noise pollution) from oil or gas pumps may also affect lekking displays.

The presence of such anthropogenic features may eliminate otherwise suitable habitat from nest site selection. Pitman et al. (2005) reported that females selected nest sites in southwestern Kansas that were significantly farther from anthropogenic features (e.g., powerlines, pump-jacks, improved roads, and buildings) than expected at random. Hagen (2003) found that areas used by radiomarked male and non-nesting-female LEPC were significantly farther from these same features than areas not used by LEPC. These studies indicated that LEPC likely prefer less disturbed areas even though vegetation composition or structure may be similar between disturbed and undeveloped sites. Proposed wind generation farms also may increase visual fragmentation of rangeland and cause abandonment of lekking or nesting sites. Additional research is needed to assess the specific effects of energy exploration and development on LEPC.

Recommendations

Construction of anthropogenic features should be avoided within 1.2 miles of a lek site or known nesting areas. If construction is unavoidable then such activity should occur outside of the nesting and brood rearing period (15 March-15 July) to avoid disturbance to displaying males and nesting females.

Power lines and other features should be directed through cropland acres rather than grasslands. If grassland corridors must be used, power lines should be placed as close to agricultural edge as possible because these areas are not readily used by LEPC. Clustering human infrastructures may minimize disturbance to larger areas of native rangeland.

BCR Habitat Recommendations and Opportunities

Recovery of priority bird species within BCRs 18 and 19 is dependent upon the restoration of native mid-grass prairie. Restoration can take many forms, ranging from reseeding cropland areas to native vegetation, promotion of ecologically sound grazing practices that provide bird nesting habitat, and the reintroduction of fire to the ecosystem to reduce woody plant encroachment. An important aspect of restoration is education pertaining to plant ecology and the role of natural disturbance. Many land managers do not realize the importance of fire in maintaining midgrass prairie, or are afraid to implement prescribed fire on a large scale. Moreover, the ecology of native shrubs such as shinnery oak is not well understood by land managers.

In areas where cultivated lands are the dominant land use, efforts should be made to encourage the planting of "bird-friendly" crops. Anecdotal evidence suggests that LEPC populations reached their peak when small farms were intermingled with large, contiguous blocks of rangeland habitat, and when crops consisted primarily of sorghums (Hagen and Giesen 2005). These crops provided resident and wintering birds a food source that is currently absent from the landscape. Sorghums could provide greater benefit to birds than large acreages of cotton and peanuts, which offer little to no benefit to wintering birds and are very dependent on the use of pesticides. Cultivation practices should also emphasize minimum tillage and the use of cover crops to reduce soil erosion, pesticide use, and provide some foraging habitat for birds.

The best potential for habitat enhancement in BCR 18 and 19 is effective, conservation-driven use of USDA conservation title programs. With an appropriate framework to ensure that native species are planted and cost-shared practices are beneficial to avian habitat, the CRP, Wildlife Habitat Incentives Program (WHIP), and Environmental Quality Incentives Program (EQIP) have vast potential to improve avian habitat. To promote better application of these programs, resource managers from other agencies need to provide meaningful input in the USDA decision-making process. These managers include personnel from the USFWS (particularly those responsible for the implementation of the Partners for Fish and Wildlife Program), state wildlife agencies, Playa Lakes Joint Venture (PLJV), and non-governmental organizations. Working together, both USDA and non-USDA cost-share programs can be better tailored to meet priority bird habitat objectives.

Perhaps the greatest opportunity for bird habitat in BCRs 18 and 19 lies in CRP. If implemented in an effective manner, this program has the potential to complement existing native prairie and provide high quality, undisturbed habitat for grassland birds. All new CRP acres should be planted exclusively to native grasses, native forbs (also including non-native alfalfa (Rodgers and Hoffman 2005)), and where appropriate, native shrubs. Periodic burning of these stands should be encouraged. Existing CRP stands with introduced grasses should no longer be enrolled in CRP and should be replaced with native grasses and forbs. New stands should have native mixtures tailored to specific range sites.

To meet habitat objectives, land management activities on the few publicly-owned lands within BCR 18 and 19 need to be improved and serve as demonstration projects for private landowners. Lands owned by the USFS, BLM, and state wildlife agencies should serve as examples of good habitat management. Historic disturbance regimes should be implemented on these properties to provide habitat for priority bird species, and outreach and educational tools need to be developed to get the habitat management message out to the public.

Evaluation of Assumptions

Habitat improvement for priority bird species needs to be quantified so past successes can be repeated, and failures avoided. An adaptive management approach is needed to accomplish this goal, and monitoring of restoration activities is a key component of such an approach. The following are suggestions for improving the delivery of habitat management goals within BCR 18 and 19:

- Improve interagency cooperation between resource agencies and formulate common restoration goals by habitat type;
- Encourage agencies who manage public lands to implement management practices beneficial to priority bird species;
- Resource professionals should take an active role in shaping USDA conservation program policy;

- Tie habitat restoration to ongoing monitoring activities such as the Breeding Bird Survey, and implement new monitoring protocol (e.g., MAPS) where feasible;
- Resource professionals need to maintain close ties with university researchers, and encourage the application of research results where appropriate.

CHAPTER 6. RELATIONSHIPS TO OTHER PLANS AND ESTABLISHING LEPC OBJECTIVES FOR EACH STATE

Estimation of habitat and population goals for LEPC across their current 5-state range, and for each state and BCR, has been a challenge for managers. Land use – land cover data have not been available until recently, and in some cases are still not available in an ideal format. Previously, LEPC population and occupied acreage estimates have not been sufficiently reliable for generation of goals and objectives.

The LPCIWG has partnered and worked with the North American Grouse Partnership (NAGP) and their *Grassland Plan for Prairie Grouse* effort, in addition to working with the PLJV habitat modeling process for all birds of the playa lakes region. As a result of these partnerships, new habitat modeling tools have been developed to address a variety of landscape-level planning needs. This chapter briefly describes these other plans, and includes reference to their entirety (section 6.1). The second section (6.2) outlines the state-level objectives for LEPC conservation and management. These objectives are based in part on the NAGP and PLJV modeling efforts, in combination with other state-level factors unique to each state. The final section of this chapter (6.3) outlines state-level achievements related to LEPC conservation and management.

6.1 Relationship to Other Plans

North American Grassland Plan for Prairie Grouse and Ecosystem Diversity Assessment. Prairie grouse have adapted to the diversity of ecological communities that historically occurred within the various ecoregions they occupied. The ecosystem diversity approach evaluates prairie grouse habitat relative to what occurred historically at a specific site or location. The ecosystem diversity approach is directed at maintaining or restoring functional prairie ecosystems that represent the full array of grass and shrub ecosystems that occurred within the Great Plains. Prairie grouse serve as flagship species to demonstrate the need for maintenance and restoration of grassland ecosystems as well as to evaluate proposed amounts and distributions of these ecosystems. More specifically, this approach has been applied across the historical and current distribution of the LEPC.

The LPCIWG partnered with NAGP in development of its *North American Grassland Plan for Prairie Grouse*, which includes landscape-level planning for prairie grouse species using the above-described Ecosystem Diversity Assessment tools (Vodehnal 2007, Vodehnal and Haufler 2008). The status of LEPC within a given county was derived from information received from each of the cooperating 5 state wildlife agencies within the occupied range of LEPC. After each county was rated it was spatially joined with the Major Land Resource Area (MLRA) layer (using NRCS ecological site descriptions that assess range resources). The ecosystem diversity assessment focused on providing sufficient amounts of functionally similar ecosystems to those that were present historically to provide for LEPC habitat needs to maintain viable populations and desired population sizes of native species. Ecosystem representation based on the historical reference identifies an estimate of the threshold level to “represent” each

ecological community that occurred under historical disturbance regimes. Representation levels of 10, 15 and 20% were set for each MLRA to achieve desired levels for maintenance or enhancement of LEPC habitat, with higher priority MLRAs receiving the 20% designation. Specific recommended acres of habitats for representation of each ecological community are presented in Vodehnal and Haufler (2008). In addition, the Grassland Plan's chapters follow Bird Conservation Regions (BCR) to set acreage goals for ecosystem diversity (Vodehnal 2007, Vodehnal and Haufler 2008). LEPC are found in BCRs 18 and 19; acreage goals for grassland conservation based on ecosystem diversity representation are approximately 12 million acres for BCR 18 (Shortgrass Prairie) and 11 million acres for BCR 19 (Central Mixed-Grass Prairie).

Playa Lakes Joint Venture Planning and Model Development for the Lesser Prairie-Chicken. Habitat assessment is crucial to bird conservation planning. To understand current habitat availability, the PLJV developed a continuous landcover map of bird habitats across its six-state region. In consultation with the LPCIWG and other partners, the PLJV developed target habitat association and condition descriptions which became the landcover classes for the final map. The best available spatial data layers were acquired, processed, or developed on a state-by-state basis to create a new landcover map for the PLJV.

The next step of the process was to develop the Habitat Carrying Capacity Database and the Hierarchical All-Bird Strategy (HABS) Database (Dobbs 2006). PLJV staff compiled a database of relevant research on bird species response to habitats and habitat conditions. Densities of LEPC from various habitat types were developed from published and unpublished literature with the help of the LPCIWG. The centerpiece of the PLJV planning process is the HABS database which links PLJV areas (or BCR portions of states) to habitats, which are then aligned with species (by season). The database functions to calculate current carrying capacity of bird species within PLJV habitats, sum these for an area and compare them to national population objectives. The HABS database assists users in determining where and what kind of habitat work needs to be done to benefit a particular species. This system will be used to evaluate scenarios involving habitat programs and their likely affect on targeted species as well as associated species. Using the HABS database, PLJV also derived LEPC population estimates using a consistent methodology across the range of the LEPC (C. Rustay, PLJV, personal communications; http://www.pljv.org/cms/planning) (Rich et al. 2004).

PLJV conducted LEPC-specific habitat modeling within this process because LEPC require larger blocks of habitat than most other landbirds in the southern Great Plains. Additionally, a certain configuration of native habitat in relation to cropland with an intolerance of woody encroachment, roads and other infrastructure, and urban/suburban areas is required. In order to best determine a population estimate and to examine the required future configuration of the landscape the PLJV partnered with LPCIWG to build a GIS model to describe where LEPC are currently and areas where they can reasonably be expected to occupy if certain characteristics of the landscape were appropriately altered.

Starting with the Grassland Bird Conservation Area model developed by Partners in Flight in the mid-west (using the greater prairie-chicken as an umbrella species) and modifying it, first with data from KDWP and then by reviewing data from the model output itself, PLJV and LPCIWG determined that 3 models (LEPC in sand sage-dominated habitats, LEPC in shinnery-dominated habitats, and LEPC in grass-dominated habitats) could be used as a first step to being able to determine an appropriate population estimate (see http://www.pljv.org/cms/planning).

These models are being further refined as data are collected to support changes. Major changes to these models are expected to take place when at least one of the following occurs: 1) a CRP GIS layer is available to state partners (currently only available in Kansas, 2) native CRP grass predominates within a state (again, currently only the case in Kansas), 3) an appropriate eastern red cedar layer is developed for Oklahoma, Kansas, and Texas within LEPC range or 4) more refined GIS layers are available in Texas. Models are currently judged to be the least accurate in Texas and Oklahoma.

6.2 Habitat and Population Objectives

LEPC population and occupied acreage estimates have not previously been adequate to permit predictive generation of goals and objectives. LPCIWG member states and partners have worked to address this issue, and as a result have derived state-by-state habitat and population objectives. Methodologies to calculate these objectives vary among states, and are stated within each state's section. However, the consistent goal of stating and working toward habitat and population objectives is constant within LPCIWG.

New Mexico
Neville et al. (2005) reported that 1,373 square miles of suitable habitat are occupied by LEPC in east-central and southeastern New Mexico. The mean, minimum spring breeding population for LEPC since 2001 is 6,662 birds (average of 10.13 birds per lek) (Beauprez 2007). Using these two values:

6,662 birds/1,373 mi^2 = 4.85 birds per mi^2 in suitable, occupied habitat

Neville et al. (2005) also showed that an additional 1,630 square miles are used (1) seasonally, (2) as transition areas, or (3) have the potential to be restored as LEPC habitat. Therefore:

1,630 mi^2 x 4.85 birds per mi^2 = 7,906 additional birds

Add this to the current minimum spring breeding population and the projected population is 14,568 birds. However, Davis (2006) stated that current LEPC populations occupy an area of approximately 2,200 square miles. Based on this, the upper limit of the current population would be 10,670 birds (2,200 mi^2 x 4.85 birds per mi^2). A reasonable goal for the New Mexico LEPC population is a projected range of 14,000-18,000 birds by the year 2017.

An additional 1,292 mi^2 (826,880 acres) (Table 5.2) is available in the northeast portion of the state, although it is unknown how many acres are suitable as habitat for LEPC. Historically, this portion of the state could have supported as many as an additional 6,266 birds (1,292 mi^2 x 4.85 birds per mi^2). It would be useful to conduct another GIS study similar to Neville et al. (2005) to show the extent of available habitat in this portion of the state in order to identify potential areas for translocation and areas that have the potential to be restored.

According to Neville et al. (2005), the majority of high-quality vegetation types in New Mexico occur in patches smaller than 12.35 mi^2, (equivalent to a 2 mile radius around a lek) making them below the minimum size required by LEPC. Habitat management should concentrate on creating larger blocks of habitat (>12.35 mi^2) and concentrated mosaics of habitat as defined by the PLJV/LEPC model outlined below:

- Convert or maintain at least 40% of the CRP acreage within LEPC range (or 362 mi^2) to native grasses found in sand sage prairie, including forbs and legumes.
- Target CRP acreage within LEPC range so that at least 663 mi^2 contribute to large blocks of habitat (currently it is estimated that 194 mi^2 do so).
- Target areas of mixed-grass prairie so that at least 58 mi^2 contribute to large blocks of habitat (currently 19 mi^2 do so).
- Target areas of sand sage prairie so that at least 83 mi^2 of sand sage contribute to large blocks of habitat (currently it is estimated that 9 mi^2 do so).
- Target areas of shinnery oak so that at least 1,171 mi^2 contribute to large blocks of habitat (currently it is estimated that 411 mi^2 do so).

Texas

Maximum estimated occupied acreage in Texas in September 2007 was 4,937 mi^2, including both known and suspected population groups (i.e., in portions of 20 counties). A more reasonable and conservative estimate of current occupied acreage is 2,793 mi^2 which encompasses only portions of the 13 counties where LEPC are known to occur. At an estimated mean density of 5.63 LEPC/mi^2 (range 2.18-8.64 LEPC/mi^2), the Texas population is estimated at a mean of 15,730 (range = 6,077-24,132) LEPC in the 13 counties (representing 2,793 mi^2) where LEPC are known to occur. Because of the large and seasonal habitat requirements of LEPC, the fragmentation of available and suitable habitat in Texas, and the variability in estimating acreage values of occupied range, TPWD recommends the use of a conservative estimate of 6,100 birds in the state as the working population estimate.

The Texas LEPC population goal is to triple the population in the next 30 years. After consideration of the estimates provided in the discussion above, this translates to 18,300 birds. Given the sizable variation in current acreage and population density estimates, the 30-year Texas LEPC goal is rounded up to 20,000 birds.

Habitat management should focus on creating large blocks or concentrated mosaics of habitat as outlined below and following the PLJV planning and model development process for lesser prairie-chickens:

In BCR 18 - Texas (assuming that most of the habitat within LEPC areas of southwest Texas is either in cropland or shinnery oak), work to convert all CRP within LEPC range to native grass mixtures interseeded with forbs and legumes. Ensure that 250 mi^2 of CRP contributes to large blocks of habitat (following the PLJV LEPC large block model). Currently it is estimated that 22 mi^2 contribute. Ensure that 620 mi^2 of shinnery oak contributes to large blocks of habitat. Currently it is estimated that 80 mi^2 contribute. In order to have CRP and shinnery oak contribute to large blocks of habitat, place CRP on the landscape so that the final configuration supports the PLJV LEPC model.

In BCR 19 – Texas (assuming that most of the habitat within LEPC areas of northeast Texas is either in mixed grass or shinnery oak and that little cropland is available) work to convert all CRP within LEPC range to native grass mixtures interseeded with forbs and legumes. Ensure that 410 mi^2 of mixed grass contributes to large blocks of habitat. Currently it is estimated that 12 mi^2 contribute. Ensure that 400 mi^2 of shinnery oak contributes to large blocks of habitat. Currently it is estimated that 4 mi^2 contribute. Ensure that 90 mi^2 of CRP contributes to large blocks of habitat. Currently it is estimated that 3 mi^2 contribute. In order to have CRP and shinnery oak contribute to large blocks of habitat place, CRP on the landscape so that the final configuration supports the PLJV LEPC model.

Oklahoma

A process of determining current population levels and distribution in Oklahoma is currently in progress. Our goal is to increase the population by 25% over the next 20 years.

A considerable amount of the CRP acres within LEPC range in Oklahoma are introduced grass monocultures. Improving the habitat on CRP tracts by modifying the grass mixture on the re-enrolled acres (conversion of introduced grass monocultures to a native grass/forb/legume mix), and planting only native grass mixtures on all newly enrolled acres is an important goal. In order to reenroll the acres it will be necessary to remove the introduced grass and replace it with native grasses and forbs. All newly enrolled acres will need to be planted with a native grass/forb/legume mixture and managed to benefit LEPC.

Another goal is to work with landowners where LEPC exist to help them manage their remaining LEPC habitat, and to encourage restoration of the habitat surrounding those areas to benefit LEPC's. On the present native acres available in Oklahoma, energy-development companies are being encouraged to place any new structures away from the current LEPC range to minimize direct disturbance and habitat fragmentation.

State and federally owned lands are being improved to benefit LEPC habitat and private landowners around these areas are encouraged to do the same (financial incentives

available). We are continuing to work with other agencies to ensure that current and future programs address protection and restoration of LEPC habitat and in return increase the number of LEPC in Oklahoma.

Kansas

Since 2000, population estimates for LEPC in Kansas have been derived by integrating survey data with GAP land-cover data. These estimates have varied from a low of about 14,000 to a high of about 34,000 breeding birds. Using the midpoint of these values (24,000) as a baseline, a goal of eventually maintaining an average of 40,000 breeding LEPC within the Kansas range may be attainable with concerted and sustained efforts, both public and private. Assuming an average breeding density of 10 birds per mi^2, it will be necessary to add or restore at least 1,600 mi^2 (about 1 million acres) of LEPC habitats to lands that are currently unoccupied by the species. Qualitative improvements to currently-occupied habitats could supplement or replace some of the need to add new habitat. These new or improved habitats must not only provide appropriate habitat structure and species diversity, but they must also occur or be located in such a way that they are accessible and of sufficient size to be used by LEPC. This can be partly accomplished by restoring and improving management on previously-occupied or under-occupied rangelands where habitat quality has been degraded through improper grazing or tree invasion. New range can be created by targeting grassland restoration programs (e.g., CRP) such that existing stands are maintained and new stands are created within 2 miles of existing large rangeland blocks or concentrated rangeland mosaics. This process should be guided by a goal of creating large-scale (> 80 mi^2) landscape mosaics composed of a minimum of 40% of closely-connected grasslands with a strong preference for mosaics with > 60% grasslands. As this process occurs, it must not be assumed that currently occupied habitats will remain stable. Ongoing efforts will be necessary to assure that these habitats are maintained in suitable condition.

Colorado

Colorado is on the periphery of LEPC range, and current habitat conditions do not support a growing population of this species. Colorado is committed to engaging in conservation practices to benefit this species, and conservation goals are meant to be realistic and achievable. Population goals in Colorado are to increase current numbers of LEPC by 25% over the next 20 years. These goals are meant to be achieved by targeting habitat improvements in existing CRP, influencing CRP re-enrollment, and working with other partners and private landowners to enhance existing habitat. Additionally, targeting habitat improvements on public lands (specifically the Comanche National Grasslands) will assist in accomplishing this goal.

Specific to CRP acreage, enhancing 50% of the existing low-quality LEPC CRP habitat in or near currently occupied LEPC habitat in Colorado to a more appropriate grass stand is the primary goal. This can be accomplished through diversifying the seed mixes used for future plantings, converting current monoculture CRP through an extensive series of practices to ensure reseeding success, interseeding forbs into existing CRP, and other appropriate practices. Additional partnership opportunities that target habitat improvement/enhancement will be explored with various agencies, non-governmental

organizations and private landowners. Specifically, relationships with local FSA offices will be fostered so as to help achieve these goals.

6.3 State-Level Management Practices and Accomplishments 1997-2007

New Mexico

Habitat Conservation, Development, Enhancement, and Restoration: As mentioned previously, NMDGF completed management plans for LEPC in New Mexico in 2001 and has made significant progress toward implementing long-term LEPC conservation efforts.

The Department is also working cooperatively with the USFWS, Natural Resources Conservation Service (NRCS), and private landowners in eastern New Mexico to facilitate partnerships to bear or share the costs of maintaining or improving LEPC habitat on private lands. To date, >157,000 acres of private rangelands in New Mexico has been committed to conservation actions that are intended to enhance or recover rangeland condition to benefit LEPC for at least 10 years.

Approximately $1.3 million has been committed to habitat improvement projects for the LEPC with private landowners through the Landowner Incentive Program (LIP). An additional $153,000 was received for grassland habitat management and playa lake conservation on the high plains of eastern New Mexico and $160,000 was awarded to multiple counties in eastern New Mexico and the Texas Panhandle to enhance habitat for LEPC along the Canadian River through the Private Stewardship Grant Program (PSG). In 2006, 2 habitat projects in Roosevelt County and 1 in northern Curry County were developed with private landowners under the PLJV Site Capacity Grant to improve the carrying capacity of lands enrolled in CRP for the LEPC and other priority grassland bird species.

In addition to conservation efforts on private lands, the SLO has withdrawn leasing of new oil and gas wells within 1.5 miles of active leks, affecting >100,000 acres of LEPC habitat. Currently, the Roswell District of the BLM maintains a large (221,339 acres) LEPC Core Management Area (CMA) composed of several discreet land segments where no oil and gas leases have been issued since 1997. Also, the BLM is developing an ambitious habitat reclamation program in the shinnery oak-sand dune habitat complex (~20,000 acres), focusing reclamation efforts on lands disturbed by historic oil and gas exploration and development (e.g., access roads, well pads, and right-of-ways) in the Permian Basin of southeast New Mexico.

Conservation of LEPC requires large, contiguous patches of native rangeland be protected and managed largely or exclusively as LEPC habitat. Along with on-the-ground efforts to improve the quality of rangeland habitat, NMDGF administers approximately 21,000 acres of State Game Commission-owned Prairie Chicken Areas dedicated to LEPC conservation. However, such protected areas should not be limited to east-central New Mexico where stable LEPC populations currently exist. Habitat acquisition in areas where isolated and sparse and scattered populations occur is particularly important to

prevent further fragmentation and to help maintain or re-establish habitat patches capable of supporting viable LEPC populations in these areas. Protected areas should form a broad network, linked wherever possible by habitat corridors to maintain or re-establish connectivity between populations. The basis of such a network already exists, consisting of designated BLM core management areas, PCAs administered by NMDGF, and private holdings on which significant habitat restoration is taking place. This includes the recent acquisition of 18,500 acres of prime LEPC habitat by the Nature Conservancy (TNC) in Roosevelt County, New Mexico.

Public and Professional Awareness: In addition to these habitat projects, NMDGF hosts the annual High Plains Prairie-Chicken Festival in Milnesand, New Mexico which is an effective venue for spreading awareness of LEPC conservation needs, reaching both residents of eastern New Mexico and several interest groups (including private landowners, state and federal agency personnel, bird watchers, and other environmental organizations) from other areas. The Festival provides opportunities for participants to view lekking LEPC while learning about the biology of the species, habitat requirements, and conservation status from local experts. Additionally, NMDGF has created educational and outreach resource materials (e.g., flyers and brochures) for private landowners, which are focused on LEPC and associated habitat conservation issues.

Research: Research into the biology, habitat, and recovery of the LEPC are ongoing in New Mexico. The NMDGF has an agreement with a private rancher in eastern New Mexico to determine the effects of shrub control and grazing on habitat quality and reproductive success of LEPC. This project is attempting to find a balance between the habitat needs of LEPC while still achieving profitable grazing opportunities for landowners. NMDGF is also researching the feasibility of conducting a translocation of LEPC into northeastern New Mexico in an effort to expand the bird's range. These research projects address questions critical to the recovery of the LEPC and contribute to the net conservation of the species

Texas

Texas is a large and ecologically complex state where conservation of wildlife species depends on landowners who manage the majority of the important habitats, and thus maintain wildlife diversity (TPWD 2002). TPWD recognizes the intrinsic value of good stewardship and supports landowners who assume this responsibility. The TPWD WMP process is an integral component of the Department's Private Lands and Public Hunting Program (PLPH), which also includes programs and services such as the technical guidance to landowners and managers, technical and financial assistance through the Landowner Incentive Program, Wildlife Management Tax Valuation planning assistance, information on conservation easements and other long term conservation tools, and recognition of exceptional land stewardship through the Lone Star Land Steward Awards Program. The TPWD PLPH focuses on a diverse array of programmatic responsibilities for wildlife habitat management and development, technical assistance, incentive programs, and habitat conservation. TPWD Wildlife Division personnel provide technical assistance to land managers and landowners upon written request for assistance to develop plans and recommendations for voluntary conservation, enhancement and/or

development of wildlife habitat. In particular, at the request of landowners, TPWD prepares a written Wildlife Management Plan that incorporates recommendations for the specific area and addresses the conservation goals and objectives of the landowner.

Texas has completed a Candidate Conservation Agreement with Assurances (CCAA) for LEPC in the state. The purpose of the CCAA is for TPWD to join with the USFWS to implement conservation measures for the LEPC in Texas, in support of TPWD's ongoing and future efforts to manage, conserve, and recover the species. The CCAA pertains to lands in Texas encompassed by the current distribution of LEPC, those lands that are unoccupied potential habitat, and those that could provide potential habitat if the current population and distribution of LEPC should increase. TPWD will be the sole non-federal cooperator in the CCAA, and will be responsible for implementing and administering the CCAA. TPWD will enroll property owners under the CCAA through issuance of Certificates of Inclusion to those property owners who have entered into a TPWD-approved WMP for LEPC and are actively implementing conservation measures for the species. TPWD will process and monitor all Certificates of Inclusion to document that the conservation measures implemented on private property will provide a conservation benefit to LEPC. The USFWS will issue a draft permit to TPWD under section 10(a)(1)(A) of the ESA of 1973, as amended in accordance with 50 CFR 17.22(d) or 17.32 (d), that will become effective if and when the LEPC is listed as threatened or endangered. Property owners will enroll in the CCAA by agreeing to participate in a TPWD-approved WMP (which will include a list of recommended conservation measures for LEPC and their habitats) and by completing and submitting a Certificate of Inclusion (CI) application. An approved CI will provide the property owner protection under the Enhancement of Survival Permit associated with the CCAA if the species is listed under the ESA in the future. The property owner will complete and maintain the conservation measures outlined in the WMP in order to maintain a valid and approved CI. Participating landowners will allow TPWD personnel (or an agreed upon designee) to survey enrolled lands for the presence of LEPC, and for suitability as habitat. Participating landowners will allow TPWD personnel (or an agreed upon designee) access to the enrolled lands for purposes of monitoring LEPC populations and habitat.

Other management practices and incentive programs in place for LEPC conservation on privately owned and operated lands in TX include the LIP, the Bailey-Lamb Sandhills Incentive Program, and the NRCS-administered EQIP for LEPC. All of these programs provide financial incentives to landowners who are implementing habitat improvement practices for LEPC.

Oklahoma

Although currently there are no programs in Oklahoma designed exclusively to benefit LEPC, there are several programs available to improve habitats of other species in the LEPC range. One of the most promising programs that can be used to benefit LEPC is the Quail Habitat Restoration Initiative (QHRI). This program uses EQIP funds to restore native habitat in selected focal areas. One focal area is in LEPC range and during the first year of the program, $300,000 was spent to improve 21,500 acres. Allowable habitat improvement practices are varied, but since eastern red cedar invasion is a big

problem over much of the state, including LEPC range, the majority of money is being spent on cedar removal. Funds are also being used to install firebreaks and conduct prescribed burning to help control the invasion of cedar trees. The QHRI is a 5-year program with a statewide funding commitment of $4,000,000. While there are ongoing projects in 3 other focal areas, thus far the greatest share of funds has been spent in the northwest focal area, resulting in the enhancement of more acres of LEPC habitat than other habitats in the state. Federal funds provided by the Wildlife Habitat Incentives Program (WHIP) have also been used to improve LEPC habitat. Oklahoma has been among the top 3 states in the amount of WHIP funds received and a large amount of that support has been used to improve the LEPC habitat. To date, $385,000 has been spent to enhance nearly 23,000 acres in LEPC range. There are a variety of habitat management practices allowable with the WHIP program, but like QHRI, much of the money was spent on eastern red cedar removal and native grass planting. Additional funds were spent on prescribed burns to help control invasion of woody plants. Oklahoma remains in the top three for the program because of the large number of people that request assistance. The demand for assistance is so great that ODWC was able to hire four technicians dedicated solely to work with this program. This has resulted in the selection and design of better projects and more time to follow up with landowners to assure the projects are completed. Oklahoma maintains a very good working relationship with the State Technical Committee, Farm Services Agency, and the Natural Resource Conservation Service; therefore, when new programs become available that have the opportunity to benefit LEPC they are used to their full potential.

Another program that has improved LEPC habitat in Oklahoma is the Partners For Wildlife Program administered through the USFWS. This program has contracted with landowners to help improve LEPC habitat. State, Federal and NGO organizations all help promote this program in hopes of being able to work with more landowners resulting in the enhancement or restoration of a larger amount of habitat. Since 1999, about 130,000 acres of habitat in LEPC range has been enhanced or restored. Removal of eastern red cedar and other invasive species as well as assistance in conducting prescribed burns to maintain the restored habitat have been the focus of the program. The Partners Program has enabled biologists to establish and maintain a working relationship with many landowners. Ideally, these landowners will provide valuable assistance by spreading the word about improving LEPC habitat resulting in a larger landscape affect throughout LEPC range.

Oklahoma also has a State Wildlife Habitat Improvement Program (WHIP) that helps benefit the LEPC. Since the inception of WHIP, about 20 percent of the funding has been used within the occupied range of LEPC. Annual expenditures for habitat improvement are limited to $5,000 per landowner with this program. As with all of the previously mentioned programs, there are a variety of practices that are allowed through the State WHIP program. Biologists are able to provide written recommendations to help the landowners improve the habitat and explain how the improvements will help the habitat so the landowners are able to understand. Most of the landowner visits are just for technical assistance and this is available to landowners that want to develop the natural

habitat on their land. This assistance includes a site visit, an evaluation, and suggestions from Oklahoma Wildlife Department personnel to improve the habitat on their land.

There have been several research studies on LEPC in Oklahoma. The Sutton Avian Research Center has been conducting research on LEPC for several years. An ongoing study is focusing on LEPC collisions with barbed wire fences and whether simple marking of fences might result in a decreased number of collisions. Early findings indicate marked fences have had a dramatic impact on reducing the number of collisions.

Using Section 6 funding made available through the Endangered Species Act, Oklahoma is initiating a project (scheduled to begin in the spring of 2008) to determine the location of all rangelands in Oklahoma occupied by LEPC, to develop a reasonable LEPC population estimate, and to determine vegetation characteristics of occupied sites. The resulting information will be useful not only in identifying areas where LEPC exist, but potential areas where LEPC range expansion is possible.

Using funds made available through the State Wildlife Grants (SWG) program, the ODWC recently purchased a 3,407 acre tract in LEPC range. This tract of native upland habitat is currently occupied by LEPC and offers potential to manage additional acres for LEPC.

Kansas

Research: Three MS projects and 1 PhD project (KSU) were completed on LEPC population dynamics and habitat use of sand sage prairie in the Garden City area. Perhaps the most important finding from this work was the avoidance of man-made structures by nesting hens. One MS project (FHSU) was completed on behavioral interactions between LEPC and greater prairie-chicken on mixed leks in Ness and Ellis counties. Another MS project (CSU) documented the relative productivity of LEPC and GPCH in CRP and rangeland habitats in Gove County and showed that CRP stands were very important for nesting. Testing for Reticular endothelial virus (REV) in LEPC in cooperation with a larger study was completed and all birds tested negative. Genetic assessment of Kansas' LEPC populations was completed and Kansas' populations appeared to have healthy genetic heterogeneity. Research was initiated in Kansas in 2006 to study the effects of industrial wind power on prairie chickens. This project is focusing on greater prairie-chicken but has relevance to LEPC.

Monitoring: Five new 20-mi^2 survey areas in Barber, Kiowa, Hodgeman, Gove and Ness counties were added to the 10 areas already monitored via the KDWP annual lek survey. An additional survey area was set up to monitor LEPC on the new 51-mi^2 Wheatland area southwest of Garden City. Over 200 new LEPC leks were located north of the Arkansas River in an area where LEPC were rare or absent prior to the CRP. A new Kansas LEPC range map reflects this change. A method to estimate the LEPC population was developed to extrapolate from population and GAP habitat estimates from Kansas' 15 survey areas to the full Kansas LEPC range.

Public and Professional Awareness: Ranchers were invited to 2 "Ranch Conversations" in Lakin and Ashland where they were invited to learn about LEPC and asked to make comments on potential LEPC management. Presentations were made to numerous groups on the status and conservation needs of LEPC in Kansas. Of particular importance, in this regard, was the training provided to USDA-FSA and NRCS staff. An article on tree invasion of Kansas prairies appeared in the 2003 Sep.–Nov. Kansas Wildlife and Parks magazine 60(5):17-24. Several thousand reprints were distributed to ranchers and other landowners through a variety of agencies and organizations. Awareness has been raised on the potential threat of wind power development to LEPC and efforts to direct such developments away from LEPC range have, to date, been successful. KDWP staff met with the Kansas Forest Service to increase their understanding of threats that inappropriate tree planting and tree invasion pose to Kansas prairie and prairie wildlife. A conference on invasive trees in Kansas was held February of 2008. A brochure was produced and distributed on enhancement of existing CRP for wildlife. A 40-minute video on LEPC conservation was produced by KDWP; 4,000 DVD and VHS copies were produced for 5-state distribution with >1,000 distributed in Kansas. In 2005, a presentation was made at the USDA/USGS CRP symposium in Ft. Collins on the value and shortcomings of the CRP relative to prairie grouse, including LEPC. Two papers were published in the USDA proceedings of this conference with suggestions for improving the CRP. This effort has significantly enhanced the awareness USDA officials have of the needs of LEPC. An article on patch burning appeared in the 2007 Mar.-April Kansas Wildlife and Parks magazine 64(2):2-8. Patch burning is being tested within the Kansas LEPC range.

Habitat Conservation, Development, Enhancement, and Restoration: Efforts by the wildlife profession to raise awareness within USDA of the value of forbs to grassland birds resulted in USDA requiring forb interseeding or the addition of forbs to initial seed mixtures on an estimated 320,000 acres of CRP grasslands within the Kansas LEPC range. KDWP and the USFWS provided native forb seed to enhance the quality of USDA interseedings on an estimated 16,800 acres of CRP in Finney, Ford, Gove, Gray, Kearny and Logan counties within the Kansas LEPC range. KDWP paid for the entire cost of forb interseeding on about 15,000 acres of CRP in Gove and Logan counties that were not covered by the above USDA interseedings.

Through the cooperative efforts of KDWP and USDA, a CRP Conservation Priority Area (CPA) was established. About 182,000 acres of new CRP grasslands were enrolled in the 6-county Kansas LEPC CPA through signups 26 ('03), 29 ('04), and 33 ('06). A total of 410,000 acres were enrolled in Kansas counties occupied by LEPC. About 8,000 additional acres of CRP were gained in Kansas LEPC range (not enrolled without CPA) due to a Pheasant Initiative CPA established cooperatively by KDWP and USDA. Kansas wildlife professionals (most notably KDWP and Pheasants Forever) have worked closely with USDA and the Kansas congressional delegation to create or modify federal programs in ways that will enhance LEPC habitat availability and quality. These include USDA's CRP, EQIP, WHIP, and the Grassland Reserve Program (GRP).

Cooperative agreements, with cost sharing, for tree removal, grassland re-establishment, or enhanced grazing management have been developed through the USFWS Partners for Wildlife program on about 120,000 acres in the Kansas LEPC range. This was done in partnership with the Comanche Pool Prairie Resource Foundation and KDWP. A Memorandum of Understanding was developed between KDWP and the Kansas Forest Service to limit the planting of trees in areas where they might threaten blocks of prairie. In 2006, USDA FSA in Kansas mandated the removal of invasive trees on all CRP grassland contracts in Kansas, including 1.75 million acres in 31 counties where LEPC are present. It was estimated that these habitat improvements were needed and accomplished on 200,000–400,000 acres of CRP stands in or near the Kansas LEPC range. In 2006, the KDWP was granted $680,000 to administer a Landowner Incentive Program (LIP) aimed at conservation of priority wildlife habitats. Specifically, LEPC are a focus species for LIP and much of this work will be directed at removing invading trees from grasslands, pasture/grazing improvements, and native grass seedings. KDWP district biologists also administer USDA WHIP funds and much of this has been directed toward tree removal from grasslands.

As part of the development of new electric power plants near Holcomb, Kansas, Wheatland Electric has purchased 51 mi^2 of center-pivot irrigated cropland to obtain access to the groundwater. These pivots, which occur in a largely contiguous block are being reseeded (2006–2010) to grass/forb mixtures that should eventually provide high-quality LEPC habitat. KDWP staff has worked with numerous developers and/or federal regulators on such issues as power line routes and wind-power siting in a effort to minimize negative impacts that could occur to LEPC, other wildlife, or their habitats.

Colorado

Habitat Conservation, Development, Enhancement, and Restoration: LEPC is identified in Colorado's Comprehensive Wildlife Action Plan as a Tier 1 species. Various habitat improvement programs exist to assist landowners in creating habitat improvements directed at LEPC. The Colorado Division of Wildlife has the Cooperative Habitat Improvement Program (CHIP), which is an 85% cost share opportunity, funding up to $4000 per project. This program can be used to leverage other sources of funding, including NRCS Conservation programs from the Farm Bill, FSA CRP, USFWS Partners for Wildlife Program and other sources of funds. The CDOW has shared in the purchase of a seed drill that is used specifically for interseeding existing CRP contracts. This is managed through the local conservation district. These efforts complement similar on-going work of CDOW and USFWS-PFW who currently have recruited 6 landowners and are implementing interseeding on over 500 acres. Other efforts in the region include private land surveys for Lesser Prairie Chicken being conducted by Prairie Partners (Rocky Mountain Bird Observatory) with support from USFWS-PFW, CDOW and local conservation districts.

Colorado has recently submitted a proposal to NRCS for the State Acres for Wildlife Enhancement (SAFE) program. This project's goals are to restore and enhance 2,900 acres of short and midgrass sand sagebrush prairie to maintain and enhance lesser prairie chicken populations in Colorado. This project seeks to accomplish this goal in two years

and to begin active management of the restored acres in year four. A site-specific seed mix is created for each area.

A conservation easement was secured on a privately held piece of property to protect LEPC habitat. This is a perpetual easement totaling 1,280 acres closed on 29 November 2005 and was focused primarily on LEPC habitat. The property is located on the border of Colorado and Kansas (in the Lamar area) and does have a population of birds occupying the landscape. The habitat is primarily mid-grass dominated with some interspersed forbs and some woody vegetation and is surrounded by center pivot irrigated agricultural land (corn). There is one small (approximately 40 acre) prairie dog (*Cynomys ludovicianus*) colony on site. The rest of the property is dominated by sandy/sandy loam soils.

Research: Colorado Division of Wildlife Avian Research Section has conducted research on prairie grouse, and specifically LEPC in recent history. (See Giesen 1987a, 1987b, 1988, 1991, 1994a, 1994b, 1998.)

Public and Professional Awareness: The CDOW Watchable Wildlife program also sponsors viewing opportunities. The general public is provided approximately 6 weeks of viewing opportunity from blinds at leks with 3 visitor days per week for a total of 200 viewers. Additionally, a private landowner offers tours for approximately an additional 70 people. Tevebaugh Ranch offers guided LEPC tours in Baca County, as well. As an alternative source of income, private landowners in LEPC range allow visitors on the Colorado Birding Trail© to view LEPC leks on their property.

Additional outreach efforts to connect with private landowners throughout the plains of Colorado occur on a regular basis. In 2006, 7 workshops were held, reaching over 1400 private landowners. While this effort is not directed primarily at LEPC conservation, conservation needs of this species are discussed. The DVD produced by the LPCIWG in 2006 is distributed when these meeting are held in appropriate locations.

Local CDOW biologists and District Wildlife Managers meet approximately 2-3 times per year with partner agencies including the USFWS Partners for Wildlife Biologist, Natural Resources Conservation Service Range Conservationists and Biologists, and USFS Biologists on the Comanche National Grasslands to discuss conservation activities and survey efforts for the coming year. The local LEPC working group is trying to find ways to better utilize Farm Bill programs to benefit LEPC. PFW has been working with CDOW, NRCS, the local Baca Conservation District and Rocky Mountain Bird Observatory (RMBO) to interseed existing CRP with forbs.

CHAPTER 7. ECONOMIC IMPACTS

7.1 Commercial and Recreational Value

Revenue from hunting and non-consumptive wildlife-related recreation is often generated as income by local communities through proceeds from access fees on private lands, equipment, fuel, food, and lodging.

In 2001, an estimated 13.5 million sportspersons and recreationalists (Table 7.1) spent an estimated $6.8 billion (Figure 7.1) on wildlife recreation across the 5-states involved in the LPCIWG (excluding fishing; National Survey of Fishing, Hunting, and Wildlife-Associated Recreation 2001). Of that total, wild bird observers made up 5.2 million (39%) of U.S. residents participating in wildlife-related activities in New Mexico, Texas, Oklahoma, Kansas, and Colorado.

Table 7.1. Number of participants who hunted or wildlife watched within the 5-states involved in the LPCIWG, 2001.

	Recreational activity		
State	**Hunting**	**Wildlife-watching**	**Wild bird observers**
New Mexico	130,000	671,000	531,000
Texas	1, 200,000	3,200,000	2,300,000
Oklahoma	261,000	1,100,000	760,000
Kansas	291,000	807,000	569,000
Colorado	281,000	1,600,000	1,100,000
Totals	**833,000**	**7,378,000**	**5,260,000**

Many opportunities exist for non-consumptive wildlife recreation activities, however the potential commercial value of LEPC viewing has not been measured. The public has become increasingly interested in recreational viewing of LEPC during the breeding season. This growing interest can be illustrated by the initiation of the annual High Plains Prairie Chicken Festival in Milnesand, New Mexico and by the activities generated by the Texas Prairie Rivers Association based in Canadian, Texas. Marketing opportunities could provide important income to local businesses that cater to bird watchers and increase outreach and education for the species. Public education and outreach about LEPC conservation can become more effective through the development of strong partnerships between state and federal agencies, non-government organizations, and the public.

For wildlife conservation to be effective, landowners and land managers must value wildlife assets in their operations. There is concern that listing the LEPC by the USFWS, or by state agencies, would result in additional legal obligations that would restrict economic activity (e.g., livestock grazing) on both public and private lands. If landowners consider wildlife an asset, they will take the necessary measures to ensure its protection. It is essential to keep local governments, private landowners, and land

managers informed about LEPC conservation efforts and to provide public and private land managers with information on effective tools and techniques that can be used to achieve LEPC conservation goals.

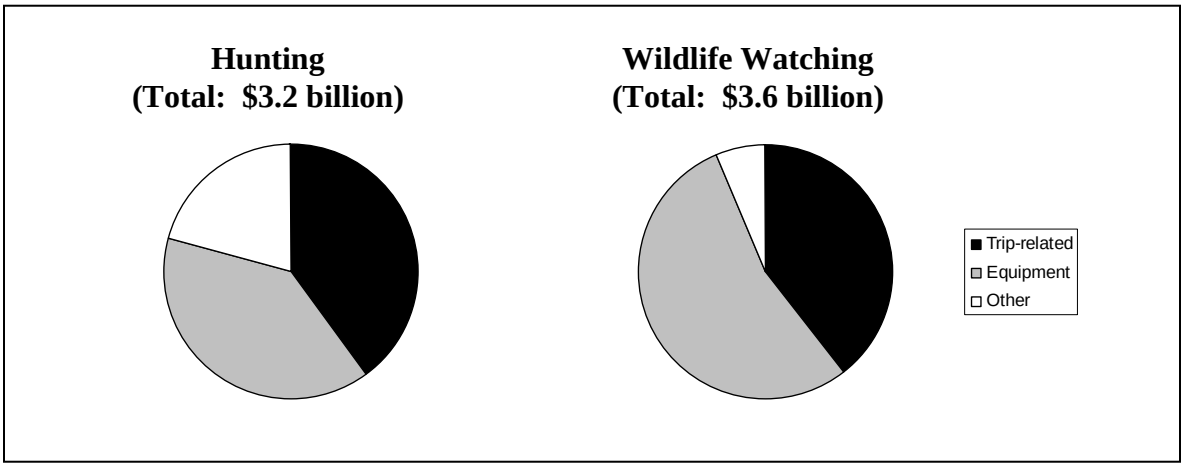


Figure 7.1. Hunting and wildlife-associated expenditures in New Mexico, Texas, Oklahoma, Kansas, and Colorado during 2001.

7.2 Biotic Value

The LEPC are but one component of the Great Plains ecosystem. This ecosystem of interacting plants, animals, and their physical environment has produced the soil that sustains today's agriculture. The remaining native prairie ecosystem maintains a livestock industry and protects the soil from erosion. The prairie has value that exceeds the sum of the values of its individual species. This value will be diminished whenever ecosystem components are lost through extirpation or extinction.

The LEPC is a particularly important indicator of ecosystem health. The observed drastic population declines of LEPC indicate a significant alteration of habitat components, and suggest that other unmeasured species are also being affected. Maintenance of viable populations of LEPC would indicate that the southern Great Plains ecosystem, including its many species and their interactions, is being maintained.

7.3 Scientific Value

Science, through enhanced understanding of how the world works, has produced immeasurable benefits for mankind. Every component of the world, including populations of wild animals, has value as object for scientific study. Should LEPC become extinct, we will have lost the opportunity to learn from this unique grouse.

7.4 Aesthetic Value

Aesthetic values are the most personal and variously conceived of wildlife values. The LEPC is enjoyed as an object of beauty and historical significance. It is the unique grouse of the southern prairies; it shares the interesting and fascinating lek-behavior of the grouse subfamily. Vocalizations of LEPC males announce the arrival of another

springtime morning. LEPC habitat provides a panorama of the plains that welcomed our ancestors who first settled the region and nomadic tribes who once called it home. The species is highly valued by the ever-increasing number of bird enthusiasts in the United States and internationally.

CHAPTER 8. CONSERVATION STRATEGY

Long Range Goal

Manage, conserve, enhance, and expand LEPC populations and their habitats in the southern and central Great Plains of North America to maintain viable populations in all 5 states.

Objective

Develop a LEPC conservation initiative and strategy through a collaborative effort of cooperating federal and state agencies, other interested parties, and stakeholders, in the species' 5-state range that ensures the long-term viability of populations and improves the quality and quantity of required habitats for future generations.

Issues and Strategies

Issue 1: Current LEPC numbers, distribution, and habitat needs are not fully described and/or understood within portions of their 5-state range. Improved population monitoring, and better knowledge of LEPC distribution and habitats will allow conservation measures to be better focused to benefit the species at state-wide and range-wide scales.

Strategy 1: Continue to monitor and assess population numbers and distributions across the 5-state range.

Strategy 2: Look for opportunities to improve and standardize current survey methodologies, and evaluate effectiveness, compatibility with other data sets, and scientific rigor.

Strategy 3: Evaluate the feasibility of a centralized database for lek location coordinates and use history, while respecting confidentiality and data-ownership concerns.

Strategy 4: Inventory and monitor the abundance and distribution of suitable habitat.

Strategy 5: Identify priority areas for conservation efforts.

Strategy 6: Initiate habitat work in priority areas that prevents habitat fragmentation, maintains, restores or increases population connectivity, and encourages population expansion.

Strategy 7: Encourage federal and state agencies and other land management partners that own/manage habitats capable of supporting LEPC, to make management for the species a high priority. Appropriate LEPC-focused management of such publicly-owned habitats must not be compromised by excessive resource extraction or management emphasis on common game species (e.g., deer (*Odocoileus* spp.), turkey (*Meleagris gallopavo*).

Issue 2: Much of the habitat that is currently occupied or could potentially be reoccupied by LEPC is threatened by habitat degradations (e.g., tree invasion, improper management). Given that most LEPC habitat occurs on private lands, there is concern that private land managers may not have adequate knowledge, motivation, and/or resources available to maintain/enhance LEPC habitats on their lands.

Strategy 8: Develop and implement science-based management and conservation guidelines for viable LEPC populations and habitat. Particularly address grazing practices, the use of prescribed fire, and brush control practices.

Strategy 9: Identify the issues, challenges, and opportunities (e.g., controlling tree invasion) related to LEPC habitat management on privately owned lands. Work with landowners to develop programs and incentives that meet their needs.

Strategy 10: Utilize opportunities provided by the Federal Farm Bill such as EQIP Wildlife Emphasis Areas, CRP Priority Areas, CREP development, SAFE CRP or other methods to assist landowners in the management/development of habitats for LEPC and other grassland-dependent species. Where necessary, work to modify/improve existing Farm Bill programs or create new programs that will benefit LEPC.

Strategy 11: Utilize, improve, and, if necessary create other private lands incentive and cost-share programs to encourage landowners to better manage LEPC habitats.

Strategy 12: Assist landowners with economic enterprises (e.g., nature-tourism, hunting) related to LEPC on private lands.

Issue 3: Energy development infrastructure and activities threaten to fragment or otherwise make many potential LEPC habitats unsuitable for the species.

Strategy 13: Educate energy developers (e.g., fossil fuel, wind power) and distributors (e.g., utilities, pipeline companies) about the need for LEPC conservation, and their role in it. This can be best accomplished through direct contacts such as personal visits, phone conversations, and attending and speaking at corporate meetings or industry conventions. Providing the LEPC DVD may be helpful.

Strategy 14: Educate energy consumers about the impacts their energy providers may have or potentially have on LEPC habitats and populations. Wider distribution of the LEPC DVD may be particularly helpful in this regard.

Strategy 15: Work directly with energy developers and distributors to redirect infrastructure and disturbances away from LEPC populations and habitats. Use of best available technology to reduce/minimize disturbance to core LEPC habitats should be requested.

Strategy 16: If energy infrastructure or disturbances cannot be satisfactorily directed away from LEPC populations and habitats, mitigation strategies should be implemented. Appropriate mitigation strategies should be developed for all potential types of energy development within each habitat type and region, and for all combinations thereof.

Strategy 17: Appropriate mitigation should be voluntarily funded by energy developers, distributors, and consumers. If voluntary mitigation proves insufficient, (in terms of frequency of adoption, scale, or quality), then mechanisms to regulate development or require mitigation could be pursued. At an extreme, this may include potential listing of LEPC under provisions of the federal Endangered Species Act. On Federal lands the appropriate mitigation measures are set as Conditions of Approval on Applications for Permits to Drill. These mitigation measures should not be voluntary.

Strategy 18: Work with federal/state entities (e.g., BLM, National Grasslands, State Land Offices, and other land management partners) to develop and implement

guidelines for energy development on their properties in order to reduce or eliminate detrimental effects to LEPC. Resource Management Plans, Energy Stipulations pertaining to LEPC conservation should be standardized and adopted by the BLM in states throughout the species range.

Strategy19: A review of BLM's stipulations on all Resource Management Plans within the LEPC core habitats within the 5-state region should be conducted. If found deficient, a coordinated effort to update the RMP's with appropriate stipulations/non-surface occupancy rules.

Issue 4: Outreach, education, information transfer, and technical assistance are critical for effective conservation delivery. However, issues and topics related to LEPC conservation, management, and ecology are not sufficiently well understood by the general public and stakeholders.

Strategy 20: Continue and increase personal contacts to directly inform, motivate, and technically assist all stakeholders in LEPC conservation and management.

Strategy 21: Create, update, and disseminate outreach products that motivate LEPC conservation, identify land use/management practices with positive or negative implications for LEPC, and encourage reporting of LEPC sightings.

Strategy 22: Host public meetings throughout historic and current LEPC range to provide information on management efforts to preclude listing and to receive information on what landowners want and/or need in order to manage their lands for LEPC and LEPC habitat.

Issue 5: Management and conservation of LEPC populations, LEPC habitat, and habitat for other grassland-dependent species is a large, complex, and comprehensive undertaking. The scale of these efforts requires development and maintenance of partnerships in order to implement conservation practices.

Strategy 23: Develop and/or maintain active involvement with relevant conservation initiatives and partnerships. Partner with other state and multi-state delivery organizations and grassland bird initiatives.

Strategy 24: Identify and partner with interested parties and stakeholders (including producer groups) within the 5-state range.

Strategy 25: In cooperation with LEPC conservation partners, address the issue of how success will be measured (e.g., acres of LEPC habitat maintained, created, or restored; population levels and trends).

Strategy 26: Work with USDA-NRCS and USDA-FSA to improve delivery and implementation of cost-share and incentive conservation programs within the Federal Farm Bill for LEPC and grassland bird habitat conservation and management.

Strategy 27: The Lesser Prairie Chicken Interstate Working Group should work in a unified manner to lobby for increased program funding for LEPC conservation.

Strategy 28: Develop a LEPC working group in each state.

Strategy 29: Develop Candidate Conservation Agreements with Assurances (CCAA) where necessary within the 5-state range to improve delivery of LEPC conservation on private lands.

Issue 6: Continued research is an important and necessary component of LEPC management and conservation. Long-term scientific research on various land uses and their impacts on LEPC habitats and populations should be a priority.

Strategy 30: Identify funding sources for LEPC research.

Strategy 31: Conduct a spatially explicit population viability analysis for LEPC across their 5-state range, including genetic analysis.

Strategy 32: Evaluate the role(s) that changes in production agriculture have had, continue to exert, and may exert (e.g., biofuel production) on LEPC populations.

Strategy 33: Expand knowledge of seasonal habitat requirements across the 5-state range.

Strategy 34: Evaluate the potential for translocation efforts to establish populations, enhance isolated populations, or as a strategy for adjustment to climate change.

Strategy 35: Identify potential corridors through which LEPC populations may shift northward in response to climate change. Determine what barriers must be overcome and what may be done to facilitate such a shift.

Strategy 36: Continue to investigate the role of shrubs (shinnery oak, sagebrush) and vegetation structure relative to LEPC habitat needs across the 5-state range.

Strategy 37: Disseminate research findings through workshops, publications, personal contact, and electronic media.

Strategy 38: Evaluate the role of disease in LEPC population dynamics. West Nile Virus is one of the various diseases that managers need a better understanding of.

Strategy 39: Evaluate relationships among lek locations (primary and satellite) with other LEPC seasonal habitat requirements and/or use patterns (e.g., brood-rearing, feeding, winter cover, loafing, and nesting cover).

LITERATURE CITED

Addison, E. M., and R. C. Anderson. 1969. *Oxyspirura lumdsdeni* n. sp. (Nematoda: Thelaziidae) from Tetraonidae in North America. Canadian Journal of Zoology 47:1223-1227.

Ahlborn, G. G. 1980. Brood-rearing habitat and fall-winter movements of lesser prairie chickens in eastern New Mexico. Thesis. New Mexico State University, Las Cruces, New Mexico, USA.

Aldrich, J. W. 1963. Geographic orientation of American Tetraonidae. Journal of Wildlife Management 27:529:545.

Anderson, R. K. 1969. Prairie chicken responses to changing booming-ground cover type and height. Journal of Wildlife Management 33:636-643.

Andrén, H., and P. Angelstam. 1988. Elevated predation rates as an edge effect in habitat islands: experimental evidence. Ecology 69:544-547.

Andren, H., P. Angelstam, E. Lindstrom, and P. Widen. 1985. Differences in Predation Pressure in Relation to Habitat Fragmentation: An Experiment. Oikos 45(2): 273-277.

Andrews, R., and R. Righter. 1992. Colorado birds: a reference to their distribution and habitat. Denver Museum of Natural History, Denver, Colorado, USA.

Applegate, R. D. 2000. Use and misuse of prairie chicken lek surveys. Wildlife Society Bulletin 28:457-463.

_____, and T. Z. Riley. 1998. Lesser prairie-chicken management. Rangelands 20:13-15.

Autenrieth, R., W. Molini, and C. Braun. 1982. Sage grouse management practices. Western States Sage Grouse Committee Technical Bulletin 1. Idaho Department of Fish and Game, Twin Falls, Idaho, USA.

Baker, M. F. 1953. Prairie chickens of Kansas. University of Kansas Museum of Natural History and Biological Survey of Kansas. Miscellaneous Publication 5, Lawrence, Kansas, USA.

Bailey, F. M. 1928. Birds of New Mexico. Judd and Detweiler, Inc., Washington D.C.

Bailey, J. A. 1999. Status and trend of the lesser prairie-chicken in New Mexico and recommendation to list the species as threatened under the New Mexico Wildlife Conservation Act. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

_____, and S. O. Williams. 2000. Status of the lesser prairie-chicken in New Mexico, 1999. Prairie Naturalist 32:157-168.

_____, J. Kline, and C. A. Davis. 2000. Status of nesting habitat for lesser prairie-chicken in New Mexico. Prairie Naturalist 32:149-156.

Bain, M. R. 2002. Male-male competition and mating success on leks attended by hybrid prairie chicken. Thesis. Fort Hays State University, Hays, Kansas, USA.

Beauprez, G. M. 2007. Survey for active lesser prairie-chicken leks: spring 2007. Federal Aid Report W-138-R-5. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

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

Bellinger, R., J. Johnson, J. Toepfer, and P. Dunn. 2003. Loss of genetic variation in greater prairie-chickens following a population bottleneck in Wisconsin, U.S.A. Conservation Biology 17:717-724.

Bent, A. C. 1932. Life histories of North American gallinaceous birds. U.S. National Museum Bulletin 162.

Berg, W. A., J. A. Bradford, and P. L. Sims. 1997. Long-term soil nitrogen and vegetation change on sandhill rangeland. Journal of Range Management 50: 482-486.

Berger, R. P., and R. K. Baydack. 1992. Effects of aspen succession on sharp-tailed grouse, *Tympanuchus phasianellus*, in the Interlake Region of Manitoba. Canadian Field Naturalist 106:185-191.

Bergerud, A. T. 1988. Population ecology of North American grouse. Pages 578-685 *in* A. T. Bergerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. University of Minnesota, Minneapolis, Minnesota, USA.

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 55:225-234.

Bidwell, T., and A. Peoples. 1991. Habitat management for Oklahoma's prairie chickens. Bulletin Number 9004, Cooperative Extension Service, Division of Agriculture, Oklahoma State University, Oklahoma, USA.

Bidwell, T. G., C. B. Green, A. D. Peoples, and R. E. Masters. 1995. Prairie chicken management in Oklahoma. Oklahoma State University Extension Circular E-945, Oklahoma Cooperative Extension Unit, Stillwater, Oklahoma, USA.

_____, S. Fuhlendorf, B. Gillen, S. Harmon, R. Horton, R. Manes, R. Rodgers, S. Sherrod, and D. Wolfe. 2003. Ecology and management of the lesser prairie-chicken in Oklahoma. Oklahoma State University Extension Circular E-970, Oklahoma Cooperative Extension Unit, Stillwater, Oklahoma, USA.

Bouzat, J. L., H. H. Cheng, H. A. Lewin, R. I. Westemeier, J. D. Brawn, and K. N. Paige. 1998a. Genetic evaluation of a demographic bottleneck in the greater prairie-chicken. Conservation Biology 12:836-849.

_____, H. A. Lewin, and K. N. Paige. 1998b. The ghost of genetic diversity past: historical DNA analysis of the greater prairie-chicken. American Naturalist 152:1-6.

_____, and K. Johnson. 2004. Genetic structure among closely spaced leks in a peripheral population of lesser prairie-chickens. Molecular Ecology 13:499-505.

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

Braun, C. E. 1986. Changes in sage grouse lek counts with advent of surface coal mining. Proceedings Issues and Technology in the Management of Impacted Western Wildlife 2:227-231.

_____, K. Martin, T. E. Remington, and J. R. Young. 1994. North American grouse: issues and strategies for the 21st century. Transactions of the North American Wildlife and Natural Resource Conference 59:428-437.

_____, O. O. Oedekoven, and C. L. Aldridge. 2002. Oil and gas development in western North America: effects on sagebrush steppe avifauna with particular emphasis on sage grouse. Transactions of the North American Wildlife and Natural Resources Conference 67:337-349.

Bureau of Land Management. 2005. Special status species resource management plan amendment. Analysis of a management situation. USDI Bureau of Land Management, Pecos District, Roswell, New Mexico, USA.

Campbell, H. 1950. Note on the behavior of marsh hawks toward lesser prairie chickens. Journal of Wildlife Management 14:477-478.

_____. 1972. A population study of lesser prairie chickens in New Mexico. Journal of Wildlife Management 36:689-699.

Candelaria, M. A. 1979. Movements and habitat-use by lesser prairie chickens in eastern New Mexico. Thesis. New Mexico State University, Las Cruces, New Mexico, USA.

Cannon, R. W, and F. L. Knopf. 1979. Lesser prairie-chicken responses to range fires at the booming ground. Wildlife Society Bulletin 7:44-46.

_____, and _____. 1980. Distribution and status of the Lesser Prairie Chicken in Oklahoma. Pp.71-74 *in* Proceedings Prairie Grouse Symposium (P. A.Vohs, and F. L. Knopf, eds.). Oklahoma State University, Stillwater, Oklahoma, USA.

Caughley, G., and A. R. E. Sinclair. 1994. Wildlife ecology and management. Blackwell Science, Cambridge, Massachusetts, USA.

Connelly, J. W., W. L. Wakkinen, A. P. Apa, and K. P. Reese. 1991. Sage grouse use of nest sites in southeastern Idaho. Journal of Wildlife Management 55:521-524.

Copelin, F. F. 1963. The lesser prairie-chicken in Oklahoma. Oklahoma Department of Wildlife Technical Bulletin 6, Oklahoma City, Oklahoma, USA.

Crawford, J. A. 1974. The effects of land use on lesser prairie chicken populations in west Texas. Dissertation. Texas Tech University, Lubbock, Texas, USA.

_____. 1980. Status, problems, and research needs of the lesser prairie chicken. Pages 1-7 *in* Proceedings Prairie Grouse Symposium (P. A. Vows and F. L. Knopf, editors). Oklahoma State University, Stillwater, Oklahoma, USA.

_____, and E. G. Bolen. 1973. Spring use of stock ponds by lesser prairie chickens. Wilson Bulletin 85:471-472.

_____, and _____. 1975. Spring lek activity of lesser prairie-chickens in west Texas. Auk 92:808-810.

_____, and _____. 1976a. Effects of land use on lesser prairie-chickens in Texas. Journal of Wildlife Management 40:96-104.

_____, and _____. 1976b. Effects of lek disturbance on lesser prairie-chickens. Southwestern Naturalist 21:238-240.

_____, and _____. 1976c. Fall diet of lesser prairie chickens in west Texas. Condor 78:142-144.

Davies, B. 1992. Lesser prairie chicken recovery plan. Colorado Division of Wildlife, Colorado Springs, Colorado, USA.

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. Department of Fish and Wildlife Science, New Mexico Agriculture Experiment Station, Las Cruces, New Mexico, USA.

_____, C. G. Ahlborn, S. S. Merchant, and D. L. Wilson. 1981. Evaluation of lesser prairie chicken habitat in Roosevelt County, New Mexico. Final report to New Mexico Department of Game and Fish, Contract 516-67-05. New Mexico State University, Las Cruces, New Mexico, USA.

Davis, D. M. 2003. Survey for active lesser prairie-chicken leks: spring 2003. Federal Aid Report W-138-R-1. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

_____. 2004. Survey for active lesser prairie-chicken leks: spring 2004. Federal Aid Report W-138-R-2. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

_____. 2005. Survey for active lesser prairie-chicken leks: spring 2005. Federal Aid Report W-138-R-3. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

_____. 2006. Final investigation report: the lesser prairie-chicken in New Mexico. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

Davis, R. B. 1993. Lesser prairie chicken recovery plan. Colorado Division of Wildlife, Denver, Colorado, USA.

Davison, V. E. 1940. An 8 year census of lesser prairie-chickens. Journal of Wildlife Management 4:55-62.

Dobbs. 2006. A review of distribution, habitat use, and population density data in the hierarchical all bird strategy (HABS) database, technical companion document to the PLJV implementation planning guide. Playa Lakes Joint Venture, Lafayette, CO.

Doerr, T. B., and F. S. Guthery. 1983. Effects of tebuthiuron on lesser prairie-chicken habitat and foods. Journal of Wildlife Management 47:1138-1142.

Donaldson, D. D. 1966. Brush control and the welfare of lesser prairie chickens in western Oklahoma. Oklahoma Academy of Science Proceedings 46: 221-228.

_____. 1969. Effect on lesser prairie chickens of brush control in western Oklahoma. Dissertation. Oklahoma State University, Stillwater, Oklahoma, USA.

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

Fields, T. L. 2004. Breeding season habitat use of Conservation Reserve Program (CRP) land by lesser prairie chickens in west central Kansas. Thesis. Colorado State University, Fort Collins, Colorado, USA.

_____, G.C. White, W. C. Gilgert, and R. D. Rodgers. 2006. Nest and brood survival of lesser prairie chickens in west central Kansas. Journal of Wildlife Management 70:931-938.

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

Frary, L. G. 1957. Evaluation of prairie chicken ranges. Federal Aid Job Completion Report W-77-R-3, Job 6. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

Fuhlendorf, S. D., and D. M. Engle. 2001. Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. BioScience 51:625-632.

_____, A. J. Woodward, D. M. Leslie Jr., and J. S. Shackford. 2002. Multiscale effects of habitat loss and fragmentation on lesser prairie-chicken populations. Landscape Ecology 17:601-615.

Giesen, K. M. 1987a. Evaluation of aerial and ground transects to inventory lesser prairie-chickens in southeast Colorado. Proceedings of the Annual Conference of the Central Mountains and Plains Section, The Wildlife Society 32 (abstract).

_____. 1987b. Evaluation of aerial and ground transects to inventory lesser prairie-chickens in southeast Colorado. Proceedings of the Prairie Grouse Technical Council 17 (abstract).

_____. 1988. Status of lesser prairie-chickens in Colorado. Colorado Field-Ornithologist 22:57-58.

_____. 1991. Population inventory and habitat use by lesser prairie-chickens in southeast Colorado. Federal Aid in Wildlife Restoration Report W-152-R, Colorado Division of Wildlife, Colorado, USA.

_____. 1991. Movements and nest site selection by lesser prairie-chicken hens in Colorado. Proceedings of the Prairie Grouse Technical Council 19:14 (abstract).

_____. 1994a Breeding range and population status of lesser prairie-chickens in Colorado. Prairie Naturalist 26: 175-182.

_____. 1994b. Movements and nesting habitat of lesser prairie-chicken hens in Colorado. Southwestern Naturalist 39:96-98.

_____. 1998. Lesser prairie-chicken. *In* The birds of North America, No. 364 (A. Poole and F. Gills, editors). The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

_____. 2000. Population status and management of lesser prairie-chicken in Colorado. Prairie Naturalist 32: 137-148.

Gregg, M. A., J. A. Crawford, M. S. Drut, and A. K. Delong. 1994. Vegetative cover and predation of sage grouse nests in Oregon. Journal of Wildlife Management 58:162-166.

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

_____, S. S. Crupper, R. D. Applegate, and R. J. Robel. 2002a. Prevalence of *Mycoplasma* antibodies in lesser prairie-chicken sera. Avian Diseases 46:708-712.

_____, B. E. Jamison, R. J. Robel., and R. D. Applegate. 2002b. Ring-necked Pheasant parasitism of Lesser Prairie-Chicken nests in Kansas. Wilson Bulletin 114:522-524.

_____, _____, K. M. Giesen, and T. Z. Riley. 2004. Guidelines for managing lesser prairie-chicken populations and their habitats. Wildlife Society Bulletin 32:69-82.

Hagen, Christian A. and Kenneth M. Giesen. 2005. Lesser Prairie-Chicken (Tympanuchus pallidicinctus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/364

_____, G. C. Salter, J. C. Pitman, R. J. Robel, and R. D. Applegate. 2005. Lesser prairie-chicken brood habitat in sand sagebrush: invertebrate biomass and vegetation. Wildlife Society Bulletin 33:1080-1091.

Hamerstrom, F. N. Jr., and F. Hamerstrom. 1961. Status and problems of North American grouse. Wilson Bulletin 73:284-294.

Hann, W. 2003. Reference conditions for Desert Grassland. *In*:Interagency and The Nature Conservancy fire regimes condition class website (http://www.frcc.gov). USDA Forest Service, US Department of the Interior, The Nature Conservancy, and Systems for Environmental Management.

Hanowski, J. M., D. P. Christian, and G. J. Niemi. 2000. Landscape requirements of prairie sharp-tailed grouse *Tympanuchus phasianellus campestris* in Minnesota, USA. Wildlife Biology 6:257-263.

Hartnet, D. C., K. R. Hickman, L. E. Fischer-Walter. 1996. Effects of bison grazing, fire, and Topography on floristic diversity in tallgrass prairie. Journal of Range Management 49:413–420.

Haukos, D. A. 1988. Reproductive ecology of lesser prairie-chickens in west Texas. Thesis. Texas Tech University, Lubbock, Texas, USA.

_____, 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 Naturalist 49:624-626.

_____, and _____. 1999. Effects of lek age on age structure and attendance of lesser prairie-chickens (*Tympanuchus pallidicinctus*). American Midland Naturalist 142:415-420.

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, Project 1-R.

Hoffman, D. M. 1963. The lesser prairie chicken in Colorado. Journal of Wildlife Management 27:726-732.

Holocheck, J. L., H. Gomez, F. Molinar, and D. Galt. 1999. Grazing studies what we've learned. Rangelands 21: 12-16.

Horak, G. J. 1985. Kansas prairie chickens. Wildlife Bulletin 3, Kansas Fish and Game Commission, Pratt, Kansas, USA.

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

Hubbard, J. P. 1978. Revised check-list of the birds of New Mexico. New Mexico Ornithological Society Publication Number 6, Albuquerque, New Mexico, USA.

Hunt, J. L. 2004. Investigation into the decline of the lesser prairie-chicken (*Tympanuchus pallidicinctus* Ridgway) in southeastern New Mexico.Dissertation. Auburn University, Auburn, Alabama, USA.

Inkley, D. B., M. G. Anderson, A. R. Blaustein, V. R. Burkett, B. Felzer, B. Griffith, J. Price, and T. L. Root. 2004. Global climate change and wildlife in North America. Wildlife Society Technical Review 04-2. The Wildlife Society, Bethesda, Maryland, USA. 26pp.

Jackson, A. S., and R. DeArment. 1963. The lesser prairie chicken in the Texas Panhandle. Journal of Wildlife Management 27:733-737.

Jamison, B. E. 2000. Lesser prairie-chicken chick survival, adult survival, and habitat selection and movements of males in fragmented rangelands of southwestern Kansas. Thesis. Kansas State University, Manhattan, Kansas, USA.

_____, J. A. Dechant, D. H. Johnson, L. D. Igle, C. M. Goldade, and B. R. Eulis. 2002a. Effects of management practices on grassland birds: lesser prairie-chicken. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA.

_____, R. J. Robel, J. S. Pontius, and R. D. Applegate. 2002b. Invertebrate biomass: associations with lesser prairie-chicken habitat use and sand sagebrush density in southwestern Kansas. Wildlife Society Bulletin 30:517-526.

Jensen, W. E., D. G. Robinson, Jr., and R. D. Applegate. 2000. Distribution and population trend of lesser prairie-chicken in Kansas. Prairie Naturalist 32:169-175.

Johnsgard, P. A. 2002. Grassland grouse and their conservation. Smithsonian Institution Press, Washington D. C.

Johnson, J. A., J. E. Toepfer, and P. O. Dunn. 2003. Contrasting patterns of mitochondrial and microsatellite population structure in fragmented populations of greater prairie-chickens. Molecular Ecology 12:3335-3347.

_____, M. R. Bellinger, J. E. Toepfer, and P. Dunn. 2004. Temporal changes in allele frequencies and low effective population size in greater prairie-chickens. Molecular Ecology 13:2617-2630.

Johnson, K., and H. Smith. 1999. Lesser prairie-chicken habitat use on the Sand Ranch and population status in the Caprock Wildlife Habitat Management Area, 1999. Report to U.S. Bureau of Land Management, Roswell, New Mexico, USA.

_____, B. H. Smith, G. Sabot, T. B. Neville, and P. Neville. 2004. Habitat use and nest site selection by nesting lesser prairie-chickens in southeastern New Mexico. 49:334-343.

Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. Journal of Wildlife Management 27:757-778.

_____. 1964. Habitat used by lesser prairie chicken for feeding related to seasonal behavior of plants in Beaver County, Oklahoma. Southwestern Naturalist 9:111-117.

Kay, C. E. 1998. Are ecosystems structured from the op down or bottom-up? A new look at an old debate. Wildlife Society Bulletin 26:484–498.

Kimmel, R. O. 1988. Potential impacts of ring-necked pheasants on game birds. Pages 253-265 *in* Pheasants: symptoms of wildlife problems on agricultural lands. (D. Hallet, W. Edwards, and G. Burger, Eds.). North Central Section, The Wildlife Society, Bloomington, Indiana, USA.

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

_____, and F. B. Samson. 1997. Conservation of grassland vertebrates. Ecological Studies 125:273-289.

Kuehl, A. K., and W. R. Clark. 2002. Predator activity related to landscape features in northern Iowa. Journal of Wildlife Management 66:1224-1234.

Kurki, S., A. Nikula, P. Helle, and H. Linden. 1997. Landscape-dependent breeding success of forest grouse in Fennoscandia. Wildlife Biology 3:295.

Lacy, R. C. 1997. Importance of genetic variation to the viability of mammalian populations. Journal of Mammology 78:320-335.

Leslie, D. M. Jr., J. S. Shackford, A. Woodward, S. Fuhlendorf, and C. B. Green. 1999. Landscape-level evaluation of the decline of the lesser prairie chicken in Oklahoma, Texas, and New Mexico. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma, USA.

Ligon, J. S. 1927. Wildlife in New Mexico. Its conservation and management. New Mexico State Game Commission, Santa Fe, New Mexico, USA.

_____. 1951. Prairie chickens, highways, and power lines. New Mexico Magazine 29:29.

_____. 1961. New Mexico birds and where to find them. University of New Mexico Press, Albuquerque, New Mexico, USA.

Lionberger, J. E. 2007. Lesser Prairie-Chicken Monitoring and Harvest Recommendations. Performance Report to Federal Aid in Wildlife Restoration (Texas). Federal Aid Grant No. W-126-R-15. Texas Parks and Wildlife Department, Austin, TX.

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

_____, R. L. West, D. F. Dvorak, and G. T. Miller. 1994. The lesser prairie-chicken and its management in Texas. Federal Aid Report Series No. 33. Contribution of

Federal Aid Project W-129-M. Texas Parks and Wildlife Department, Austin, Texas, USA.

Locke, B. A. 1992. Lek hypothesis and the location, dispersion, and size of lesser prairie chicken leks. Dissertation. New Mexico State University, Las Cruces, New Mexico, USA.

Lyon, A. G. and S. H. Anderson. 2003. Potential gas development impacts on sage rouse nest initiation and movement. Wildlife Society Bulletin 31:486-491.

Manes, R., S. A. Harmon, B. K. Overseer, and R. D. Applegate. 2004. Wind energy and wildlife in the Great Plains: identification of concerns an ways to alleviate them. Proceedings of the Great Plains Wind Power and Wildlife Workshop, March 19-20, 2003, Kansas City, Missouri, USA.

Maruyama, T., and P. A. Fuerst. 1985. Number of alleles in a small population that was formed by a recent bottleneck. Genetics 111:675-689.

Massey, M. 2001. Long-range plan for the management of lesser prairie chickens in New Mexico 2002-2006. New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

Masters, R. 2004. Reference conditions for bluestem prairie, mixed, and tallgrass prairie. *In*: Interagency and The Nature Conservancy fire regimes condition class website (http://www.frcc.gov). USDA Forest Service, US Department of the Interior, The Nature Conservancy, and Systems for Envirmental Management.

McKee, G. M., R. Ryan, and L. M. Mechlin. 1998. Predicting greater prairie-chicken nest success from vegetation and landscape characteristics. Journal of Wildlife Management 62:314-321.

Melcher, C. P. 2006. Trends in important bird habitats in the Playa Lakes Joint Venture region: a synthesis of the literature and expert knowledge. Unpublished Report, PLJV, Lafayette, Colorado, USA.

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

Merrill, M. D., K. A. Chapman, K. A. Poiani, and B. Winter. 1999. Land-use patterns surrounding greater prairie-chicken leks in northwestern Minnesota. Journal of Wildlife Management 63:189-198.

Milchunas, D.G., O.E. Sala, and W.K. Lauenroth. 1988. A generalized model of the effects of Grazing by large herbivores on grassland community stucture. American Naturalist 132:87–106.

Morrow, M. E. 1986. Ecology of Attwater's prairie chicken in relation to land management practices on the Attwater Prairie Chicken National Wildlife Refuge. Dissertation. Texas A&M University, College Station, Texas, USA.

_____, 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. Wildlife Society Bulletin 24:593-601.

Mote, K. D., R. D. Applegate, J. A. Bailey, K. M. Giesen, R. Horton, and J. L. Sheppard. 1998. Assessment and conservation strategy for the lesser prairie-chicken (*Tympanuchus pallidicinctus*). Kansas Department of Wildlife and Parks, Emporia, Kansas, USA.

Naugel, D. E., C. L. Aldridge, B. L. Walker, T. E. Cornish, B. J. Moynahan. M. J. Holloran, K. Brown, G. D. Johnson, E. T. Schmidtmann, R. T. Mayer, C. Y. Kato, M. R. Matchett, T. J. Christiansen, W. E. Cook, T. Creekmore, R. X. Falise, E. T. Rnkes, and M. S. Boyce. 2004. West Nile virus: pending crisis for greater sage-grouse. Ecology Letters 7:704-713.

Nei, M., T. Maruyama, and R. Chakraborty. 1975. The bottleneck effect and genetic variability in populations. Evolution 29:1-10.

Neville, P., T. Neville, and K. Johnson. 2005. Lesser prairie-chicken habitat map for portions of Eastern New Mexico. Publication No. 05-GTR-285. Natural Heritage New Mexico, Museum of Southwestern Biology, University of New Mexico. Albuquerque, New Mexico, USA.

Niemuth, N. D. 2000. Land use and vegetation associated with greater prairie-chicken leks in an agricultural landscape. Journal of Wildlife Management 64:278-286.

Oberholser, H. C. 1974. The birdlife of Texas. Volume 1. University of Texas Press, Austin, Texas, USA.

Olawsky, C. D. 1987. Effects of shinnery oak control with tebuthiuron on lesser prairie chicken populations. Thesis. Texas Tech University, Lubbock, Texas, USA.

_____, and L. M. Smith. 1991. Lesser prairie-chicken densities on tebuthiuron-treated and untreated sand shinnery oak rangelands. Journal of Range Management 44:364-368.

Patten, M. A., D. H. Wolfe, E. Shochat, and S. K. Sherrod. 2005. Habitat fragmentation, rapid evolution, and population persistence. Evolutionary Ecology Research 7:1-15.

Pence, D. B., and D. L. Sell. 1979. Helminths of the lesser prairie chicken, T*ympanuchus pallidicinctus* (sic) (Ridgway) (Tetraonidae), from the Texas panhandle. Proceedings of the Helmintholical Society 46:146-149.

Peterson, M. J., and N. J. Silvy. 1994. Spring precipitation and fluctuations in Attwater's prairie-chicken numbers: hypothesis revisited. Journal of Wildlife Management 58:222-229.

_____, P. J. Ferro, M. N. Peterson, R. M. Sullivan, B. E. Toole, and N. J. Silvy. 2002. Infectious disease survey of lesser prairie-chickens in north Texas. Journal of Wildlife Diseases 38:834-839.

Peterson, R. S. and C. S. Boyd. 1998. Ecology and management of sand shinnery communities: a literature review. USDA, Forest Service, General Technical Report RMRS-GTR-16.

Pitman, J. C. 2003. Lesser prairie-chicken nest site selection and nest success, juvenile gender determination and growth, and juvenile survival and dispersal in southwestern Kansas. Thesis. Kansas State University, Manhattan, Kansas, USA.

_____, C. A. Hagen, R. J. Robel, T. M. Loughin, and R. D. Applegate. 2005. Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance. Journal of Wildlife Management 69:1259-1269.

_____, C. A. Hagen, B. E. Jamison, R. J. Robel, T. M. Loughin, and R. D. Applegate. 2006. Nesting ecology of lesser prairie-chickens in sand sagebrush prairie of southwestern Kansas. Wilson Journal of Ornithology 118:23-35

Quinn, M. A., and D. D. Walgenbach. 1990. Influence of grazing history on the community structure of grasshoppers of a mixed-grass prairie. Environmental Entomology 90: 1756-1766.

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S. W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E.Iñigo-Elias, J.A. Kennedy, A. M Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, New York, USA.

Riley, T. Z. 1978. Nesting and brood rearing habitat of lesser prairie chickens in southeastern New Mexico. Thesis. New Mexico State University, Las Cruces, New Mexico, USA.

_____, C. A. Davis, M. Ortiz, and M. J. Wisdom. 1992. Vegetative characteristics of successful and unsuccessful nests of lesser prairie chickens. Journal of Wildlife Management 56:383-387.

_____, and _____. 1993. Vegetative characteristics of lesser prairie-chicken brood foraging sites. The Prairie Naturalist 25:243-248.

_____, _____, and R. A. Smith. 1993. Autumn-winter foods of the lesser prairie-chicken (*Tympanuchus pallidicinctus*) (Galliformes: Tetraonidae). Great Basin Naturalist 53:186-189.

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

Robel, R. J. 2002a. Expected impacts on greater prairie-chickens of establishing a wind turbine facility near Rosalie Kansas. Unpublished Report, Kansas State University, Manhattan, Kansas, USA.

_____. 2002b. the plight of Kansas prairie grouse. Shooting Sportsmen May/June:37-40.

_____, T. L. Walker, C. A. Hagen, R. K. Ridley, K. E. Kemp, and R. D. Applegate. 2003. Helminth parasites of the lesser prairie-chicken in southwestern Kansas: incidence, burdens, and effects. Wildlife Biology 8:460-464.

_____, J. A. Harrington, Jr., C. A. Hagen, J. C. Pitman, and R. R. Reker. 2004. Effect of energy development and human activity on the use of sand sagebrush habitat by lesser prairie-chickens in southwest Kansas. Transactions of the North American Wildlife and Natural Resources Conference 68: *in press*.

Rodgers, R. D. 1999. Recent expansion of lesser prairie-chickens to the northern margin of their historic range. *In* Proceedings of the Prairie Grouse Technical Council, Gimli, Manitoba, Canada.

_____. 2005. Conservation reserve program successes, failures, and management needs for open-land birds. Pp. 123-134 *in* A. W. Allen and M. W. Vandever, eds. The Conservation Reserve Program – Planting for the Future: Proceedings of a National Conference, Fort Collins, Colorado, June 6-9, 2004. USGS, Biological Resources Division, Scientific Investigation Report 2005-5145. 248 pp.

_____, and M. L. Sexon 1990. Impacts of extensive chemical control of sand sagebrush on breeding birds. Journal of Soil and Water Conservation 45:494–497

_____, and R. W. Hoffman. 2005. Prairie grouse population response to conservation reserve grasslands: an overview. Pp 120-128 *in* A. W. Allen and M. W. Vandever, eds. The Conservation Reserve Program – Planting for the Future: Proceedings of a National Conference, Fort Collins, Colorado, June 6-9, 2004.

_____, and M. E. Houts. 2005. Estimating Kansas lesser prairie chicken populations by integrating lek surveys with GAP landcover data. *In* Proceedings of the Prairie Grouse Technical Council, Valentine, Nebraska, USA.

Root, T. L., J. T. Price, K. R. Hall, S. H. Schneider, C. Rosenszweig, and J. A. Pounds. 2003. Fingerprints of global warming on animals and plants. Nature 421:57–60.

Samson, F. B. 1980. Island biogeography and the conservation of prairie birds. Proceedings of the North American Prairie Conference 7:293-305.

_____, and F. Knopf. 1994. Prairie conservation in North America. BioScience 44:418-421.

_____, _____, and W. R. Ostlie. 2004. Great Plains ecosystems: past, present, and future. Wildlife Society Bulletin 32:6-15.

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

Schroeder, M. A., and R. K. Baydack. 2001. Predation and the management of prairie grouse. Wildlife Society Bulletin 29:24-32.

Schwilling, M.D. 1955. A study of the lesser prairie chicken in Kansas. Job completion report, Kansas Forestry, Fish and Came Commission, Pratt, Kansas, USA.

Sell, D. L. 1979. Spring and summer movements and habitat use by lesser prairie chickens in Yoakum County, Texas. Thesis. Texas Tech University, Lubbock, Texas, USA.

Seyffert, K. D. 2001. Birds of the Texas Panhandle: Their Status, Distribution, and History. Texas A&M University Press, College Station, Texas, USA.

Shaffer, M. L. 1981. Minimum population sizes for species conservation. Biosciences 31:131-134.

Sharp, W. M. 1957. Social and range dominance in gallinaceous birds – pheasants and prairie grouse. Journal of Wildlife Management 21:242-244.

Sims, P. L., and R. L. Gillen. 1999. Rangeland and steer responses to grazing in the southern Plains. Journal of Range Management 52: 651-660.

Sisson, L. 1976. The sharp-tailed grouse in Nebraska. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Smith, B. H., D. W. Duszynski, and K. Johnson. 2003. Survey for coccidian and haemosporidia in the lesser prairie-chicken (*Tympanuchus pallidicinctus*) from New Mexico with a new *Eimeria* species. Journal of Wildlife Disease 39:347-353.

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

Snyder, W. D. 1997. Sandsage-bluestem prairie renovation to benefit prairie grouse. Special Report No. 71. Colorado Division of Wildlife, Denver, Colorado, USA.

Stabler, R. M. 1978. Plasmodium (Giovannolaia) pedioecetii from the lesser prairie chicken, *Tympanuchus pallidicinctus*. Journal of Parasitology 64:1125-1135.

Suminski, H. R. 1977. Habitat evaluation for lesser prairie chickens in eastern Chaves County, New Mexico. Thesis. New Mexico State University, Las Cruces, New Mexico, USA.

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. Prairie Naturalist 32:177-188.

Svedarsky, W. D. 1988. Reproductive ecology of female greater prairie-chickens in Minnesota. Pages 193-239 *in* A. T. Begerud and M. W. Gratson, editors. Adaptive strategies and population ecology of northern grouse. University of Minnesota, Minneapolis, Minnesota, USA.

Taylor, M. A. 1979. Lesser prairie chicken use of man-made leks. Southwest Naturalist 24:706-707.

_____, and F. S. Guthery. 1980a. Status, ecology, and management of the lesser prairie chicken. USDA Forest Service General Technical Report RM-77, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.

_____, and _____. 1980b. Fall-winter movements, ranges, and habitat use of lesser prairie-chickens. Journal of Wildlife Management 44:521-524.

Texas Game, Fish, and Oyster Commission. 1945. Principal Game Birds and Mammals of Texas: Their Distribution and Management. Von Boeckmann-Jones Co. Press, Austin, Texas, USA.

Texas Parks and Wildlife Department. 2002. Land and Water Resources Conservation and Recreation Plan. Austin, Texas, USA.

Thompson, M. C., and C. Ely. 1989. Birds in Kansas. Volume 1. University of Kansas Museum of Natural History. Public Education Service Number 11.

Tilman, D., J. Hill, and C. Lehman. 2006. Carbon negative biofuels from low-input high diversity grassland biomass. Science 314:1598–1600.

USDA Forest Service. 2003. Land and resource management plan and monitoring report. Pike and San Isabel National Forests, Cimarron and Comanche National Grasslands. Pueblo, Colorado, USA.

U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

U.S. Fish and Wildlife Service. 2001. Twelve-month administrative finding on petition to list the lesser prairie-chicken (*Tympanuchus pallidicinctus*) as threatened. Ecological Services, USFWS, Tulsa, Oklahoma, USA.

_____. 2002. Twelve-month administrative finding on petition to list the lesser prairie chicken (*Tympanuchus pallidicinctus*) as threatened. Ecological Services, USFWS, Tulsa, Oklahoma, USA.

Van Den Bussche, R. A., S. R. Hoofer, D. A. Wiedenfeld, D. H. Wolfe, and S. K. Sherrod. 2003. Genetic variation within and among fragmented populations of Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*). Molecular Ecology 12:675-683.

Vance, D. R., and R. L. Westemeier. 1979. Interactions of pheasants and prairie chickens in Illinois. Wildlife Society Bulletin 7:221-225.

Vinton, M. A., D. C. Hartnett, E. J. Finck, and J. M. Briggs. 1993. Interactive effects of fire, bison (*Bison bison*) grazing, and plant community composition in tallgrass prairie. American Midland Naturalist 129:10–18.

Vodehnal, W. L. 2007. A plan for prairie grouse. Grouse Partnership News 8:6-7.

Vodehnal, W. L., and J. B. Haufler. 2008. A Grassland Conservation Plan for Prairie Grouse. North American Grouse Partnership. Fruita, Colorado, USA.

Waddell, B.H. 1977. Lesser prairie chicken investigations – current status evaluation. Kansas Forestry, Fish, and Game Commission. 42 pp.

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

Weltzin, J.F., S. Archer, and R.K. Heitschmidt. 1997. Small-mammal regulation of vegetation structure in a temperate savanna. Ecology 78:751-763.

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

_____, J. E. Buhnerkempe, W. R. Edwards, J. D. Brawn, and S. A. Simpson. 1998. Parasitism of greater prairie-chicken nests by ring-necked pheasants. Journal of Wildlife Management 62:854-863.

Westerskov, K. 1990. Partridges and pheasants: competitors or sharers? Pages 183-201 *in* K. Church, R. Warner, and S. Brady, editors. Perdix V: Gray partridge and ring-necked pheasant workshop. Minnesota Department of Natural Resources, Mankato, Minnesota, USA.

White, C. E. 1963. Distribution of prairie chicken. Federal Aid in Wildlife Restoration Project W-23-R-01. Kansas Forestry Fish, and Game Commission, Pratt, Kansas, USA.

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

Wildlife Management Institute. 1999. Lesser prairie-chicken (*Tympanuchus pallidicinctus*). Fish and Wildlife Management Leaflet No. 6. Natural Resources Conservation Service, Wildlife Habitat Management Institute, Madison, Mississippi, USA.

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

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

Woodward, A. J., S. D. Fuhlendorf, D. M. Leslie Jr., and J. Shackford. 2001. Influence of landscape composition and change on lesser prairie-chicken (*Tympanuchus pallidicinctus*) populations. American Midland Naturalist 145:261-274.

Wright, H. A. 1974. Effects of fire on southern mixed grass prairies. Journal of Range Management 27:417-419.

Zollner, D. 2003. Reference conditions for Texas Savannah. *In*:Interagency and the Nature Conservancy fire regime condition class website (http://www.frcc.gov). USDA Forest Service, US Department of the Interior, The Nature Conservancy, and Systems for Environmental Management.

APPENDIX I

Lesser Prairie-Chicken Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING FOR CONSERVATION AND MANAGEMENT OF LESSER PRAIRIE-CHICKENS AND ASSOCIATED SPECIES AND THEIR HABITATS

I. Purpose

The purpose of this Memorandum of Understanding (MOU) is to provide, under auspices of the Western Association of Fish and Wildlife Agencies (WAFWA), for interagency cooperation in conservation and management of lesser prairie-chickens (*Tympanuchus pallidicinctus*) and associated species and their habitats across their current 5-state range (i.e. parts of Colorado, Kansas, New Mexico, Oklahoma, and Texas). The purpose of this MOU is also to provide for cooperation among participating agencies in the development and implementation of conservation programs for lesser prairie-chickens (LEPC) and their associated habitats. The participating agencies agree that cooperation is necessary to collect and analyze data on lesser prairie-chickens and their habitats, and to plan and implement actions necessary to establish and/or maintain viable LEPC populations that are sufficient to preclude present or future endangerment, within the constraints of approved budgets.

Parties to this MOU are collectively referred to herein as Signatories.

II. Background

Long-term declining trends in lesser prairie-chickens and their associated habitats throughout the species' 5-state range have prompted concern for the conservation and management of lesser prairie-chickens. In 1998, the US Fish and Wildlife Service (USFWS) determined that the lesser prairie-chicken warranted listing as a candidate species under the Endangered Species Act, but precluded its listing in response to needs of other species in greater need of listing. As of the last dated signature on this MOU, the LEPC remains a Candidate Species across its 5-state range.

The Signatories have been involved in a variety of long-standing and recently initiated efforts to conserve and manage lesser prairie-chickens and their habitats within the species' 5-state range. Many of these efforts have been conducted with a "local" or "state-level" approach. Despite successes to date, the Signatories believe it is in their best long-term interest to move toward a multi-state landscape-level approach that enables better planning and coordination, efficiency in time and scale of accomplishment, and greater cost effectiveness. The Signatories recognize that although such a framework is currently in place with the existence of the Lesser Prairie-Chicken Interstate Working Group (LPCIWG) this transition will take time, require adaptive management to respond to emerging needs and priorities, and present unique challenges in terms of process

management, shared decision-making, data-sharing, and increased emphasis on community based conservation. This lesser prairie-chicken MOU is a contribution of the Signatories to conservation of lesser prairie-chickens and those midgrass and shrub-midgrass systems that lesser prairie-chickens inhabit.

III. Objectives

The Signatories agree that lesser prairie-chickens are an important component of grassland systems and are an indicator of system health. Providing for the presence and abundance of lesser prairie-chickens reflects the Signatories commitment to maintaining, restoring, and/or improving native components and natural processes within grassland systems and landscapes. Specific objectives of this MOU are to:

1. Develop a Rangewide Lesser Prairie-Chicken Conservation Strategy by December 15, 2006. This Strategy will address conservation needs across geographic scales and will provide recommendations:
   a. For cooperation and integration related to funding and implementation of the Strategy;
   b. To protect and improve occupied or potential lesser prairie-chicken habitats;
   c. For techniques, policies and programs to improve grassland systems on private and public land;
   d. To reduce or minimize fragmentation of native grassland habitats;
   e. To address issues not related to habitat that may be limiting lesser prairie-chicken populations; and
   f. Regarding desired population levels and the distribution and condition of suitable habitats rangewide.
2. Develop state-specific lesser prairie-chicken management plans, or integrate lesser prairie-chicken management components into other state-specific and/or regional landscape-based or multi-species action plans, as appropriate, by December 31, 2006.
3. Participate in the development of a cohesive shortgrass prairie conservation strategy by December 31, 2009 that integrates the appropriate components of companion efforts for the black-tailed prairie dog, black-footed ferret, swift fox, burrowing owl, ferruginous hawk, Swainson's hawk, loggerhead shrike, and, as appropriate, other shrub and grassland species in the Western Great Plains (e.g., Massasauga rattlesnake, Texas horned lizard, long-billed curlew, Cassin's sparrow, vesper sparrow). This objective is intended to provide contributions to existing WAFWA shortgrass prairie conservation efforts and thus contribute to integration with a larger WAFWA-sponsored project.
4. Cooperate to maintain and enhance, to the extent practicable, lesser prairie-chicken and associated species' populations, distributions, and habitats pursuant to this MOU.
5. Identify the effects of major land uses on lesser prairie-chickens and associated species, and determine the primary causes for changes in abundance and distribution of lesser prairie-chickens.

6. Enhance awareness of the Signatories and other governmental organizations, and local communities, industries, nongovernmental organizations, and private individuals regarding this conservation effort, and encourage and enhance their participation in partnerships to accomplish mutually agreeable conservation objectives.
7. Remain aware of, and inform WAFWA on, any legal, regulatory, or policy action associated with the species addressed pursuant to the MOU and/or this addendum.

IV. Actions

1. WAFWA will identify a State Director to serve as Sponsor for this MOU.
2. The State Sponsor or their designee will:
   a. Approve additional Signatories and modifications to this MOU;
   b. Collaborate with Texas Parks and Wildlife Department (TPWD) sponsorship of an Interstate LEPC Program Coordinator (Interstate Coordinator), for as long as TPWD is willing and able to make a staff person available; and
   c. Provide support and appropriate guidance to the Interstate Coordinator for managing this MOU, including ensuring timely, effective coordination with companion WAFWA conservation efforts (e.g., sagebrush and sage-steppe habitats and species therein, shortgrass prairie habitats and species therein).
3. The Interstate Coordinator will:
   a. Serve as the liaison between the Signatories, companion WAFWA habitat conservation programs, the LPCIWG, and other LEPC conservation partners that are not signatories to this MOU;
   b. Facilitate the Signatories' efforts to jointly identify and implement methods to collect and synthesize LEPC population and habitat data;
   c. Assist in integrating LEPC strategies into companion WAFWA conservation efforts (e.g., shortgrass prairie conservation); and
   d. Provide an Annual Report to WAFWA in July of each year.
4. The Signatories will:
   a. Assist the Interstate Coordinator as necessary to:
      i. ensure timely, effective, and well-coordinated activities and completion of products and services pursuant to this MOU; and
      ii. collect lesser prairie-chicken population and habitat data;
   b. Assist and cooperate with implementation of state conservation plans and the Rangewide Conservation Strategy;
   c. Cooperate to identify research needs and strategies, and conduct joint assessments and research, as feasible.
   d. Cooperate to maintain, and enhance to the extent practicable, viable LEPC populations and habitats, pursuant to this MOU;
   e. Assist the Interstate Coordinator in keeping local governments, communities, private citizens, and other interested and affected parties and

stakeholders informed on the status of this conservation effort, including ways that might provide local economic benefits;

f. Recognize and respect the separate authorities of each signatory agency and the interests of other affected or interested parties; and
g. Provide facilities, equipment, logistical support, authorizations, and permits as necessary, justifiable, and available to implement this MOU.

5. State Agencies who are signatories to this MOU will establish or coordinate with state-level LEPC conservation teams and/or work groups as necessary to implement this MOU. Work groups will be comprised of local citizens and representatives of local, state, federal, and tribal governments, as appropriate.

V. Authorities

This MOU is among various WAFWA States and USDA Natural Resources Conservation Service, USDA Farm Services Agency, USDA Forest Service, and U.S. Fish and Wildlife Service, under provisions of the following Federal laws:

Federal Land and Policy Management Act of 1976 (43 U.S.C. 1701 et seq.)
Fish and Wildlife Act of 1956 (16 U.S.C. 742 et seq.)
Fish and Wildlife Coordination Act (16 U.S.C. 661-667)
Multiple-Use Sustained-Yield Act [of 1960] (16 U.S.C. 528-531)
Forest and Rangeland Renewable Resources Research Act of 1978 (16 U.S.C. 1641-48)
National Forest Management Act of 1976 (16 U.S.C. 1600 et seq.)
Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.)
National Wildlife Refuge Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C 668dd et seq.)

VI. Terms and Conditions

It is mutually agreed and understood by and between the Signatories that:

1. This MOU is neither a fiscal nor a funds obligation document. Nothing in this agreement may be construed to obligate state partners, Federal Agencies or the United States to any current or future expenditure of resources in advance of the availability of appropriations from Congress or state legislatures. Any endeavor involving reimbursement or contribution of funds between the Signatories to this MOU will be handled in accordance with applicable regulations, and procedures, including those for federal government procurement and printing. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the Signatories and shall be independently authorized in accordance with appropriate statutory authority. This MOU does not provide such authority.
2. This MOU in no way restricts the Signatories from participating in similar activities with other public or private agencies, organizations, and individuals.
3. This MOU is executed as of the last date shown below and expires five years

from the execution date, at which time it will be subject to review, renewal, or expiration. Process of review and update will be initiated at least 60 days prior to the expiration date of this MOU.

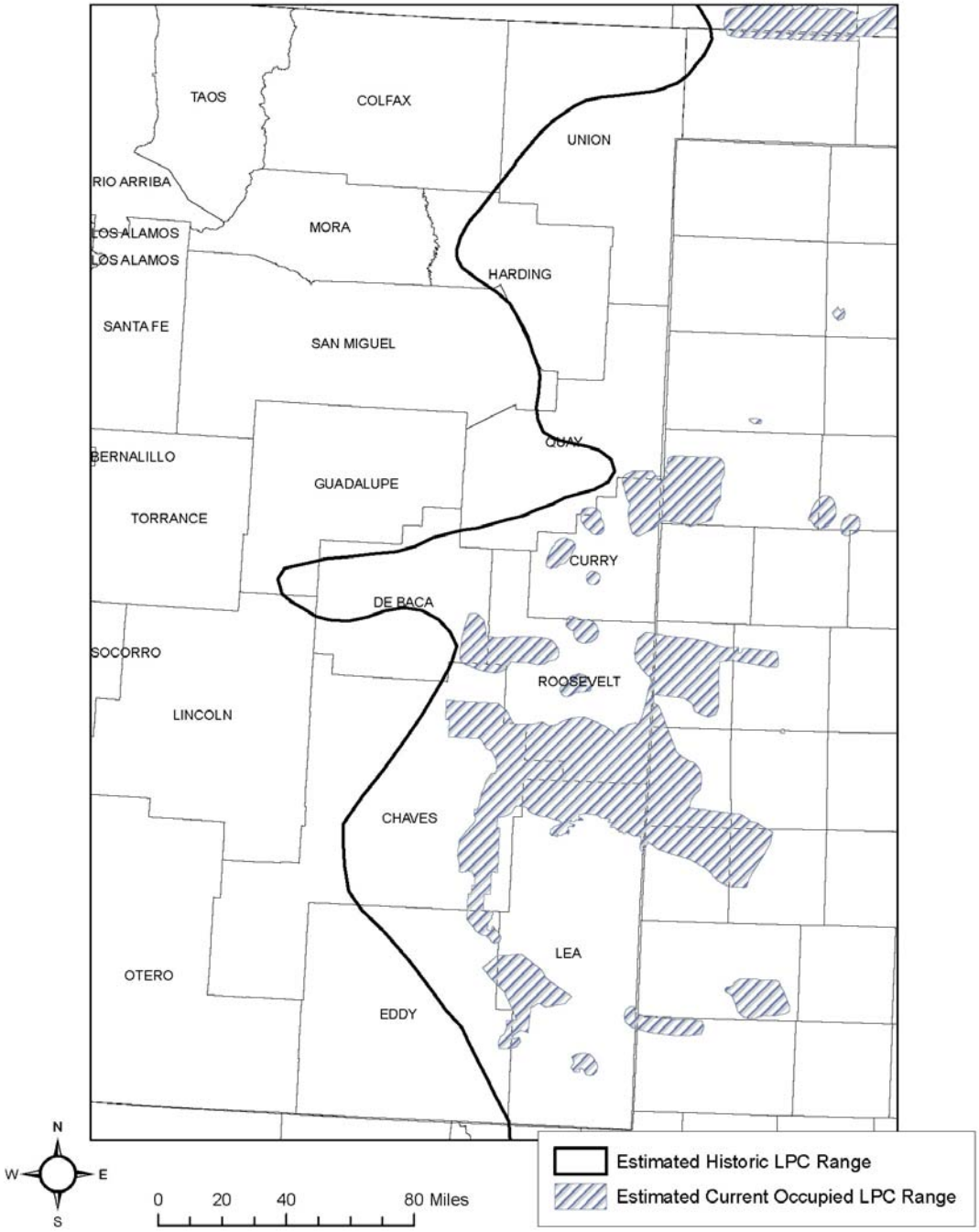
4. Modifications within the scope of this MOU shall be made by issuance of a mutually executed modification prior to any changes being performed.
5. Any party to this MOU may withdraw with a 60-day written notice to the State Sponsor. No party is relieved of obligations to provide funds or resources specifically committed prior to withdrawal.
6. Any press releases with reference to this MOU, the Signatories, or the relationship established between the Signatories of this MOU, shall be reviewed by the Interstate Coordinator and State Sponsor prior to release.
7. In any advertising done by any of the Signatories, this MOU shall not be referred to in a manner that states or implies that any Signatory approves of or endorses unrelated activities of any other.
8. During the performance of this MOU, the Signatories agree to abide by the terms of Executive Order 11246 on nondiscrimination and will not discriminate against any person because of race, age, color, religion, gender, national origin, or disability.
9. No member of or delegate to Congress, or resident Commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise from, but these provisions shall not be construed to extend to this agreement if made with a corporation for its general benefits.
10. The Signatories agree to implement the provisions of this MOU to the extent personnel and budgets allow. In addition, nothing in the MOU is intended to supersede any laws, regulations, or directives by which the Signatories must legally abide.
11. Information provided to New Mexico is subject to the Inspection of Public Records Act unless otherwise specifically excluded under state statutes.

VII. Approval

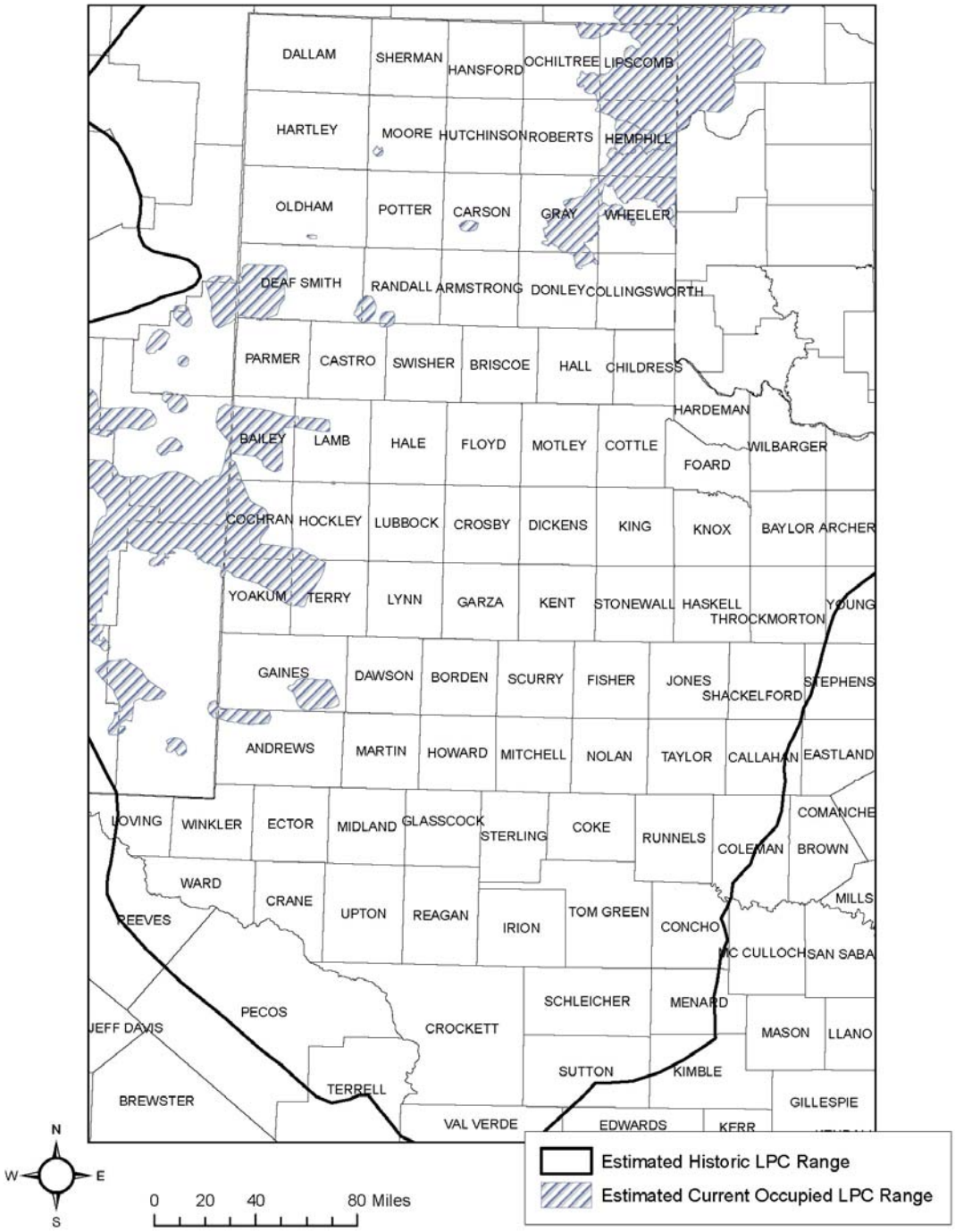
In witness thereof, the Signatories hereto have executed this Memorandum of Understanding as of the last written date below.

APPENDIX II

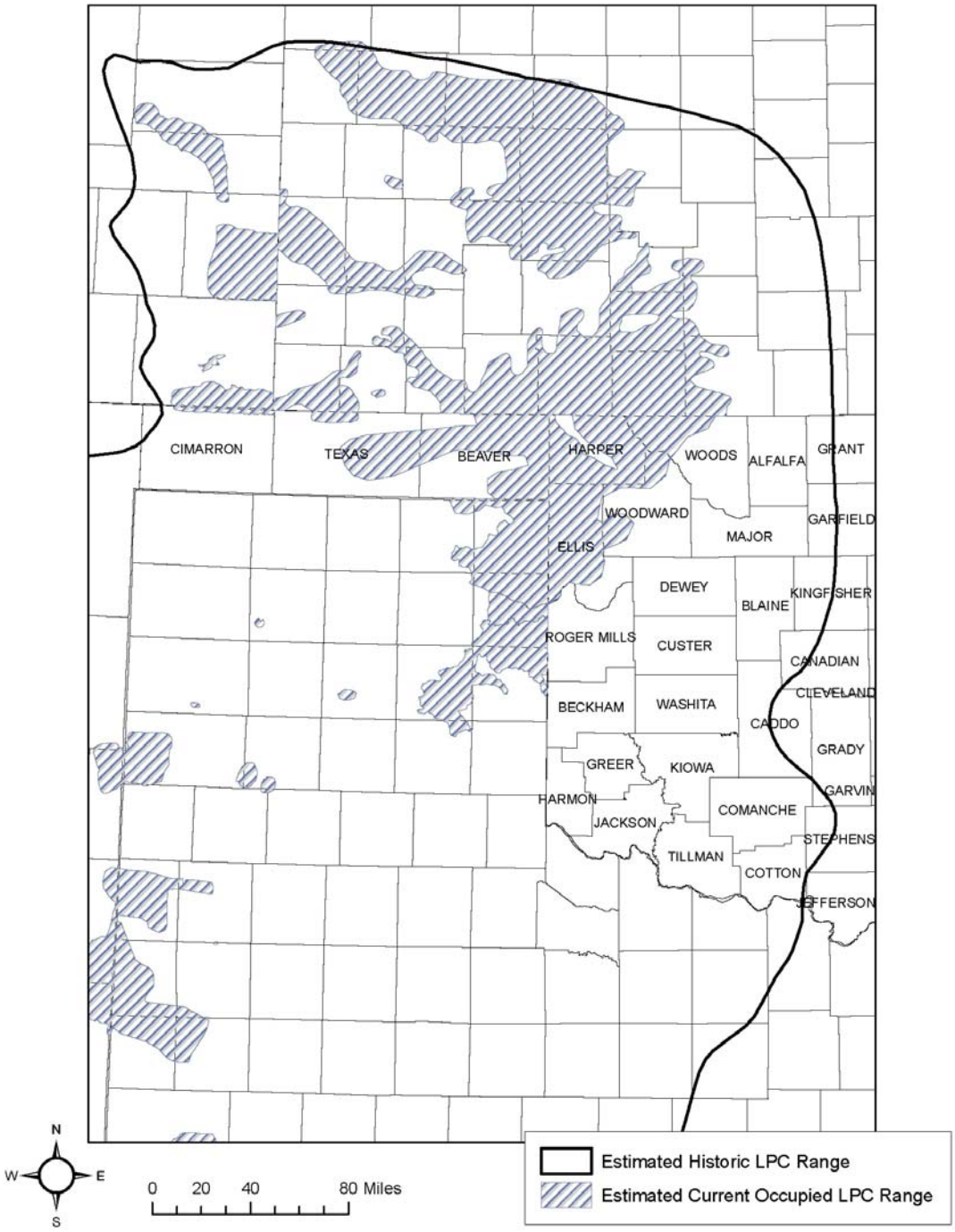
State maps of current and historical distribution


TAOS
COLFAX
UNION
RIO ARRIBA
MORA
LOS ALAMOS
LOS ALAMOS
HARDING
SANTA FE
SAN MIGUEL
QUAY
BERNALILLO
GUADALUPE
TORRANCE
CURRY
DE BACA
SOCORRO
ROOSEVELT
LINCOLN
CHAVES
LEA
OTERO
EDDY
N
W
E
S
0 20 40 80 Miles
Estimated Historic LPC Range
Estimated Current Occupied LPC Range

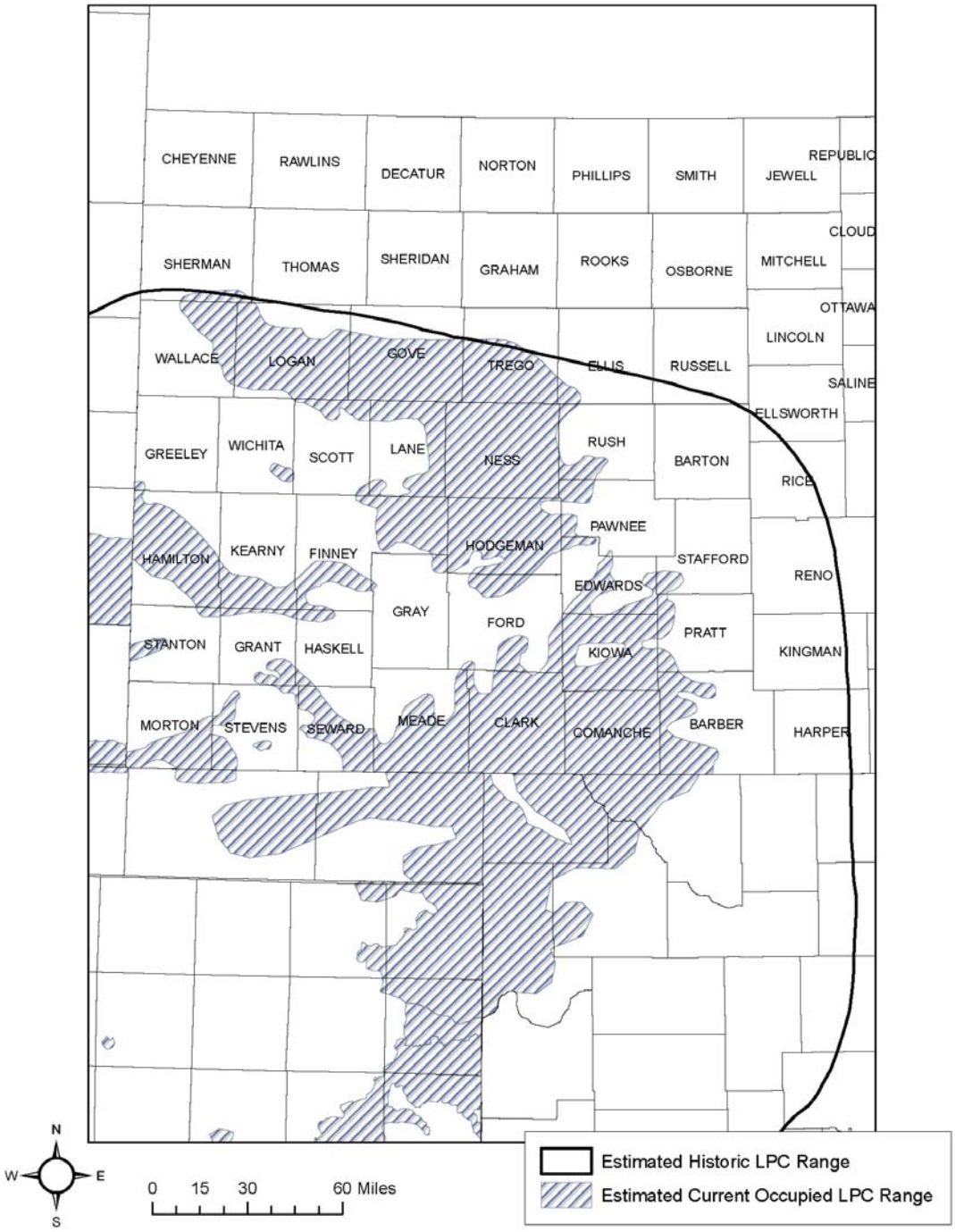
New Mexico


DALLAM
SHERMAN
HANSFORD
OCHILTREE
LIPSCOMB
HARTLEY
MOORE
HUTCHINSON
ROBERTS
HEMPHILL
OLDHAM
POTTER
CARSON
GRAY
WHEELER
DEAF SMITH
RANDALL
ARMSTRONG
DONLEY
COLLINGSWORTH
PARMER
CASTRO
SWISHER
BRISCOE
HALL
CHILDRESS
HARDEMAN
BAILEY
LAMB
HALE
FLOYD
MOTLEY
COTTLE
WILBARGER
FOARD
COCHRAN
HOCKLEY
LUBBOCK
CROSBY
DICKENS
KING
KNOX
BAYLOR
ARCHER
YOAKUM
TERRY
LYNN
GARZA
KENT
STONEWALL
HASKELL
THROCKMORTON
YOUNG
GAINES
DAWSON
BORDEN
SCURRY
FISHER
JONES
SHACKELFORD
STEPHENS
ANDREWS
MARTIN
HOWARD
MITCHELL
NOLAN
TAYLOR
CALLAHAN
EASTLAND
LOVING
WINKLER
ECTOR
MIDLAND
GLASSCOCK
STERLING
COKE
RUNNELS
COLEMAN
BROWN
COMANCHE
WARD
CRANE
UPTON
REAGAN
IRION
TOM GREEN
CONCHO
MILLS
REEVES
MC CULLOCH
SAN SABA
PECOS
SCHLEICHER
MENARD
JEFF DAVIS
CROCKETT
MASON
LLANO
SUTTON
KIMBLE
TERRELL
BREWSTER
GILLESPIE
VAL VERDE
EDWARDS
KERR
N
W
E
S
0 20 40 80 Miles
Estimated Historic LPC Range
Estimated Current Occupied LPC Range

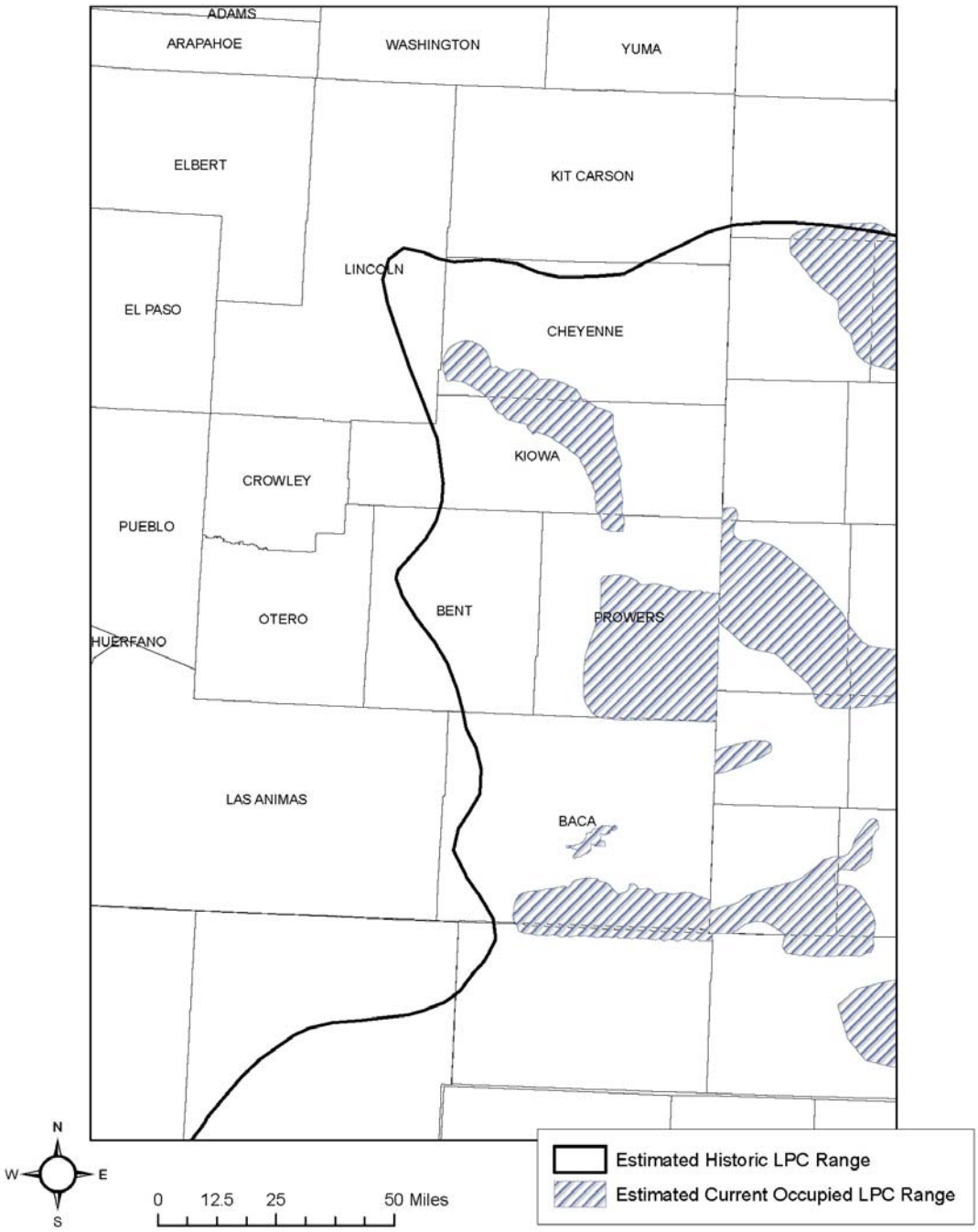
Texas


CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
WOODWARD
GARFIELD
MAJOR
ELLIS
DEWEY
BLAINE
KINGFISHER
ROGER MILLS
CUSTER
CANADIAN
CLEVELAND
BECKHAM
WASHITA
CADDO
GRADY
GREER
KIOWA
GARVIN
HARMON
COMANCHE
JACKSON
STEPHENS
TILLMAN
COTTON
JEFFERSON
N
W
E
S
0 20 40 80 Miles
Estimated Historic LPC Range
Estimated Current Occupied LPC Range

Oklahoma


CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
REPUBLIC
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
CLOUD
OTTAWA
LINCOLN
WALLACE
LOGAN
GOVE
TREGO
ELLIS
RUSSELL
SALINE
ELLSWORTH
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
RICE
PAWNEE
HAMILTON
KEARNY
FINNEY
HODGEMAN
STAFFORD
RENO
EDWARDS
GRAY
FORD
PRATT
STANTON
GRANT
HASKELL
KIOWA
KINGMAN
MORTON
STEVENS
SEWARD
MEADE
CLARK
COMANCHE
BARBER
HARPER
N
W
E
S
0 15 30 60 Miles
Estimated Historic LPC Range
Estimated Current Occupied LPC Range

Kansas


ADAMS
ARAPAHOE
WASHINGTON
YUMA
ELBERT
KIT CARSON
LINCOLN
EL PASO
CHEYENNE
KIOWA
CROWLEY
PUEBLO
OTERO
BENT
PROWERS
HUERFANO
LAS ANIMAS
BACA
N
W
E
S
0 12.5 25 50 Miles
Estimated Historic LPC Range
Estimated Current Occupied LPC Range

Colorado