FINAL REPORT

State: Oklahoma

Grant Number: W-146-R
Project Number: 1

Grant Title: Prairie Chicken Investigations

Grant Period: July 1, 2000 - June 30, 2003

Project Title: Factors Affecting Nesting Success and Mortality of Lesser Prairie-Chickens in Oklahoma

Project Objectives:

The objectives of this study are to address potential causes of declines in the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) through examination of habitat use, nesting success, and mortality rates via capture and radio-tracking of marked wild birds in western Oklahoma. Included is a comparison of these factors among dry-land cultivated, irrigated cultivated, native rangeland, introduced grass non-CRP pasture, native-mix CRP pasture, and Old World Bluestem CRP pasture, and across seasons for three years beginning July 2000.

1. Trap and radio-tag up to 100 Lesser Prairie-Chickens annually.
2. Locate the radio-tagged birds on a weekly basis (daily when possible) through the year.
3. Identify land use types in areas where the radio-tagged birds are located. Compare with the availability of those land use types in the entire study area.
4. Characterize the vegetation of the habitat on those areas.
5. Compare nest success of radio-tagged hens among the various land use types.
6. Compare mortality rates for radio-tagged adults among the various land use types.
7. Evaluate mortality rates of radio-tagged chicks from hatching (May-June) through the brood period (June-August) to adulthood. (Note - Project statement was amended in 2001 to include this objective, which was to be carried out by a graduate student at the Univ. of Oklahoma. Circumstances beyond our control prohibited this from happening. In 2002, we selected a graduate student at Okla. State. Univ. to conduct this aspect, but it was carried out at our New Mexico study site due to concerns over radio-tagging chicks by some cooperators in Oklahoma).

Abstract: In 1999, G. M. Sutton Avian Research Center (GMSARC) began a five-year study on factors affecting nesting success and mortality of Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*) in Beaver, Ellis, and Harper Counties, northwest Oklahoma. Although this research was designed as a stand-alone study, it was conducted simultaneously with a nearly identical study being conducted by GMSARC in Roosevelt County, New Mexico. Findings from these studies, when combined, allow for a better understanding of Lesser Prairie-Chicken life history and ecology over a significant portion of the species' current range.

Since March 1999, we captured 271 Lesser Prairie-Chickens in northwestern Oklahoma. All hen prairie-chickens, and most males were equipped with bib-mounted, tuned-loop radio transmitters. All radio-tagged birds were tracked as often as time permitted, generally twice a week for each bird. Sixty-seven nests from radioed hens were located and monitored. Vegetation sampling was done each time a bird was tracked, as well as at 60-90 random points each month. More extensive vegetation sampling was conducted at each nest site immediately after the nest failed or fledged.

Two major manuscripts have been published to date on our findings, two others have recently been submitted and are currently under review, several more manuscripts are expected to be completed and published in the next few months, and our findings contributed greatly to a recent Lesser Prairie-Chicken management guide (Bidwell et al. 2002).

REPORT CONTENT:

The following report contains the following sections: (1) Introduction - explains reasons for this research; (2) Approach – details methods used in capturing, radio-tracking, and vegetation sampling; (3) Findings – includes results and analysis of our research under the following sub-headings: Nest Success, Nesting Habitat, Movement Patterns, Habitat Usage, Disease and Genetics Surveys, Survivorship, and Mortality Causes; (4) Significant Deviations; (5) Recommendations; (6) Manuscripts published or in preparation; (7) Literature Cited.

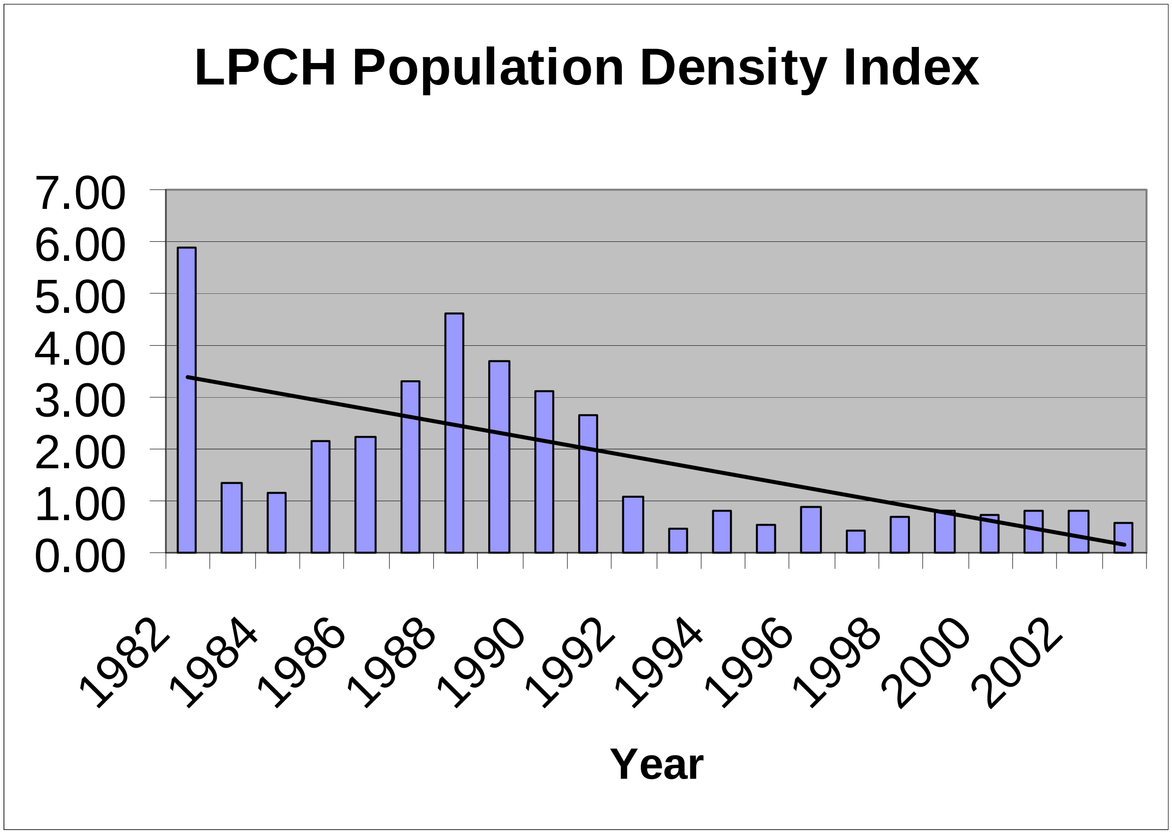
INTRODUCTION:

Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*) were once a common upland game bird across much of the Southern High Plains. Lesser Prairie-Chickens are closely related to the more eastern and more widespread Greater Prairie-Chicken (*T. cupido*) of the tallgrass and mixed grass prairies. Both species have experienced considerable declines in recent years. Due to its considerably smaller population size and limited geographical range, more concern over the reduction of occupied range and numbers of the Lesser Prairie-Chicken has been expressed than for the Greater Prairie-Chicken. In 1995, the U.S. Fish and Wildlife Service (USFWS) received petitions from the Biodiversity Legal Foundation and Marie Morrissey, requesting consideration of listing Lesser Prairie-Chickens as a threatened species under the endangered species act. In 1998, the USFWS ruled that listing the species was “warranted, but precluded by higher priority species.” The USFWS has since re-evaluated the status annually, but has not increased the priority rating. In July 2003, a Notice of Intent to Sue was issued to the USFWS by Forest Guardians and others, due to a concern that the USFWS has not taken further action towards listing the species, in spite of stable to declining populations. A multi-agency Lesser Prairie-Chicken Interstate Working Group was established in 1997, which produced an assessment and conservation strategy in 1999 (Mote et al. 1999), and has continued annual meetings to facilitate the dissemination of research findings and to coordinate efforts among states and agencies.

Lesser Prairie-Chickens are found in eastern New Mexico, southeastern Colorado, southwestern Kansas, northwestern Oklahoma, and western Texas. It is thought that the species historically ranged as far north as southwestern Nebraska (Giesen 1998). Since European settlement of the Great Plains, the Lesser Prairie-Chicken's range and population size have each declined by over 90% (Cannon and Knopf 1980, Taylor and Guthery 1980).

In Oklahoma, Lesser Prairie-Chickens can now be found in only eight of the 22 counties in which they were historically found (Horton 2000). The core Lesser Prairie-Chicken population in the state is found in Beaver, Ellis, and Harper Counties. The graph below indicates the population trend in Oklahoma for Lesser Prairie-Chickens. These data were collected by the Oklahoma Department of Wildlife Conservation (ODWC), and were derived by multiplying the number of gobbling grounds per square mile by the number of cocks per gobbling ground (Horton 2003).

Figure 1: Lesser Prairie-Chicken population trend in Oklahoma:



APPROACH:

Trapping:

In March 1999, we began trapping and radioing Lesser Prairie-Chickens in Beaver, Ellis, and Harper Counties. Since that time, we captured 271 birds. This number includes 49 birds captured on gobbling grounds in spring 1999, one bird captured at night in July 1999, eight birds captured on gobbling grounds in fall 1999, 60 birds captured on gobbling grounds in spring 2000, four poults captured and banded in summer 2000, 60 birds captured on gobbling grounds in spring 2001, one poult captured in summer 2001, three new birds captured on gobbling grounds in fall 2001, 39 new birds captured on gobbling grounds in spring 2002, and 46 new birds captured on gobbling grounds in spring 2003. Most birds were fitted with a bib-mount radio transmitter (Amstrup 1980) weighing ≤ 15 grams (<2% body weight) with a tuned loop antenna (the more commonly used whip antennas are known to cause higher mortality due to flight feather abrasion). Six cocks captured in 2002 and nine cocks captured in 2003 were banded but not radioed; additionally, four poults captured in summer 2000, and one poult captured in summer 2001 were banded but not radioed. Trapping on gobbling grounds was accomplished by using a series of walk-in funnel traps and 8-meter lengths of drift fence, in a W configuration (Schroeder and Braun 1991, Toepfer 1988). From each bird captured, about one cc of blood was taken for genetic analysis and for examination for retroviruses (the latter are known to occur in wild populations of Greater and Attwater's Prairie-Chickens, and are known to cause mortality in captive birds). All birds were also fitted with a 7/16 inch diameter, serially numbered aluminum band to allow for positive identification when recaptured or recovered. Age of captured birds was determined by calamus ratio (J. Toepfer, pers. comm.), scapular feather coloration (Copelin 1963), and by primary feather shape (Ammann 1944, Petrides 1942).

Tracking:

Prairie-chickens were tracked as often as time allowed, generally at least twice a week. Nests were located by radio tracking of hens, and were monitored twice weekly until completion. Extensive vegetation sampling was conducted at each nest site immediately after the nest failed or fledged. Vegetation sampling was also conducted each time a bird was tracked, as well as at 60-90 random points each month. For those birds that were found dead, carcasses were photographed and salvaged, and we attempted to determine cause of mortality.

We considered birds "missing" if they had not been located for 3 months. Our search effort for a missing bird, however, was expanded if the individual has not been located in 2-3 weeks. We searched for missing birds from the air every two to three weeks during nesting season, and about every eight weeks the rest of the year, following methodologies and recommendations by Gilmer et al. (1981). Using loop antenna transmitters (as opposed to whip antennas) and attempting to keep transmitter weight at or below 2% body weight (lower signal strength due to small batteries) generally allows a detection range of about one mile or less. This constraint, combined with the paucity of accessible roads, made it difficult to immediately relocate birds that had moved several miles. Lack of land access permission in some locales also contributed to this difficulty. Through July 2003, we recorded over 14500 bird locations (Table 1).

Table 1: Tracking totals by month.

	1999	**2000**	**2001**	**2002**	**2003**
January		148	90	217	252
February		196	206	190	147
March	35	502	606	540	267
April	174	576	723	646	682
May	386	527	273	485	767
June	343	238	203	275	523
July	362	122	123	191	424
August	159	32	214	256	
September	223	73	297	183	
October	89	26	317	112	
November	164	64	129	152	
December	106	97	211	194	
Total	**2041**	**2601**	**3392**	**3441**	**3062**
Average	204	217	283	287	437

Vegetation Sampling:

We collected vegetation data at each nest site immediately after the nest hatched or failed. From December 2000 through May 2003, vegetation data were also collected each time a bird was tracked, except when they were located from triangulation or were on gobbling grounds (gobbling ground vegetation data were recorded monthly in spring). In addition, vegetation data were collected monthly throughout the year at 60-90 random points for comparison to bird locations and nest sites. Vegetation sampling protocol was developed, based on Heady et al. (1959) to allow comparison to previous research (Davis et al. 1981), as well as to our other prairie-chicken research sites (Wiedenfeld et al. 2001, 2003). Vegetation data collected included: amount and type of basal cover, amount and type of canopy cover, amount and type of woody stems, and height and density measurements. In the fall of 2000, we changed our protocol (smaller but more vegetation sampling points) to allow for more representative coverage of the study area and actual bird locations. We completed a manuscript exploring the relationship between survivorship and these vegetation and microclimate data. Following completion of this manuscript, we again changed the vegetation sampling protocol (in June 2003), largely because w e had a sufficient amount of data from which to draw conclusions about habitat selection. We then began gathering vegetation data in a way that we can calculate the cone of vulnerability

(Kopp et al. 1998), essentially a measure of volume of open space over a bird's location, at occupied and random points. The type and amount of vegetation data collected at nest sites remained the same as in previous years. Vegetation data was collected from over 7500 points since spring 1999. Table 2 shows the number of the vegetation points completed by month through July 2003.

Table 2: Vegetation sampling totals by month.

	1999	2000	2001	2002	2003
January		7	129	249	301
February		18	144	208	169
March		3	189	502	214
April	1	17	175	536	120
May	16	19	127	200	309
June	4	20	110	282	429
July	18	4	133	243	415
August	0	3	224	274	
September	0	2	320	186	
October	9	11	252	132	
November	19	41	133	158	
December	7	89	230	172	
Total	**74**	**234**	**2166**	**3142**	**1957**
Average	8	20	181	262	280

FINDINGS:

Nest Success:

One nest from a radioed hen was located in 1999, but it was depredated. Seven (50%) of 14 nests found in 2000 were successful. Six (35%) of 17 nests found in 2001 were successful. Six (35%) of 17 nests found in 2002 were successful. Nine (50%) of 18 nests found in 2003 were successful. Additionally, two nests in 2001 and one nest in 2002 from unradioed birds were located after they had been depredated, and an active nest from an unknown bird, found in 2003, later failed. Since 1999, 67 nests were found from radioed birds: 28 (41.8%) of those were successful. Average clutch size in a given year ranged from 9.9 to 11.7 (Table 3). Brood size (at fledging) in a given year ranged from 9.0 to 10.3. Interestingly, the year (2002) that the average clutch size was the largest, brood size was among the smallest. Also interesting is that the years of highest nest success also had the greatest number of fledglings per nest, suggesting years of optimal nesting conditions or high hen condition those years (Table 3).

Considering that nearly 30% of the hens, on average, re-nested in the same year, a given hen's seasonal breeding success was actually much higher than raw nest success. In other words, 28 nests were successful out of 52 annual breeding efforts, resulting in an average breeding success of 53.8%.

Adult hens had higher nesting success (47.6%) than did yearling hens (30.0%). There was no difference in re-nesting effort between adult and juvenile hens (Table 4). There also was no difference in clutch size between adults and yearlings. Second nesting attempts were slightly more successful than first attempts, but the clutch sizes on second or third attempts was reduced by three eggs on average (Table 5).

Table 3: Nest success by year.

Year	**Nests**	**Successful Nests**	**% Successful**	**2nd or 3rd Attempts**	**% Hens Renesting**	**Clutch Size**	**Brood Size**
1999	1	0	0.0%	0	0.0%	NA	NA
2000	14	7	50.0%	1	7.7%	10.80	10.25
2001	17	6	35.3%	4	30.8%	9.89	9.00
2002	17	6	35.3%	4	30.8%	11.67	9.00
2003	18	9	50.0%	6	50.0%	11.25	10.25
1999-2003	67	28	41.8%	15	28.8%	10.85	9.59

Table 4: Nest success by hen's age.

Hen Age	**Nests**	**Successful nests**	**% Successful**	**2nd or 3rd Attempts**	**% Hens Renesting**	**Clutch Size**
Adult	42	20	47.6%	9	27.3%	10.89
Yearling	20	6	30.0%	5	33.3%	10.84
Unknown	5	2	40.0%	1	25.0%	10.00

Table 5: Nest success by attempt.

Attempt Number	**Nests**	**Successful Nests**	**% Successful**	**Clutch Size**
1	52	21	40.4%	11.33
2	14	7	50.0%	8.40
3	1	0	0.0	NA

Nesting Habitat:

Habitat parameters were available for 65 of the 67 nests. Of these 65 nests, 28 (43.1%) were successful. One nest, located in an alfalfa field, failed. No other use of current agricultural fields for nesting was observed. Twenty-five nests were found in Conservation Reserve Program (CRP) fields, of which 12 (48.0%) were successful. Nine nests were found in fallow fields, of which 3 (33.3%) were successful. Thirty (30) nests were found in native rangeland, of which 13 (43.3%) were successful. The presence or absence of grazing was recorded for 60 nests. Twenty-five (41.7%) nests were found where cattle were grazing, of which 11 (44.0%) were successful. Thirty-five (58.3%) nests were found where there was no grazing, of which 14 (40.0%) were successful. Thus, there appears to be no difference, in general, in nest success between native and CRP/fallow fields, nor between grazed and ungrazed areas (Table 6).

Lesser Prairie-Chickens showed some preference for nest site selection. Natural Resources and Conservation Services (NRCS) data showed that 20.7% of our study area was enrolled in CRP, while 25 (38.5%) of the nests were in CRP. And, while 57.6% of the study area is listed as native by the NRCS, only 30 (46.2%) of the nests were found in native rangeland. The NRCS data shows that 19.3% of the study area was in agricultural production, but that figure likely also includes some fallow fields (many older fields taken out of production years ago may not have been included in NRCS data). One nest (1.5%) was found in an alfalfa field, and nine (13.8%) were found in fallow fields. Our random vegetation sampling data shows that current agricultural fields made up 12.8% of the study area, and fallow fields made up 10.4% of the study area. There appears to be a slight preference for nesting in ungrazed areas, but this is likely an artifact of the use of CRP and fallow fields for nesting.

On our random and bird location vegetation sampling points, we differentiated Old World bluestem CRP fields from native-mix CRP fields. While native-mix CRP occurs on only about 6.9% of our study area, 14 (21.5%) nests were located on these CRP fields. Also, nest success (50%) was slightly higher in native-mix CRP fields than any other habitat. Only 11 (16.9%) nests were found in Old World bluestem CRP fields, which made up 12.7% of our study area. Whereas there was nearly twice the amount of Old World bluestem CRP as native mix CRP, it was used less often for nesting, although still selected over native rangeland.

Vegetation at nests was about five times higher than at random vegetation points, and three to five times as dense as at random points. No difference, however, was observed between successful and failed nests (Table 7).

Table 6: Nesting habitat.

Habitat Type	Nests	Succ. Nests	% Succ.	% Nests in that habitat	% Habitat Avail. (From Random Veg.)	% Habitat Avail. (from NRCS data)
Native Rangeland	30	13	43.3%	46.2%	51.8%	58.6%
Old World Bluestem CRP	11	5	45.5%	16.9%	12.7%	NA
Native Mix CRP	14	7	50.0%	21.5%	6.9%	NA
All CRP	25	12	48.0%	38.5%	20.1%	20.7%
Fallow	9	3	33.3%	13.8%	10.4%	NA
Agricultural	1	0	0.0%	1.5%	13.4%	NA
Ag & Fallow	10	3	30.0%	15.4%	23.8%	19.3%
All Non-Native	35	15	42.9%	53.8%	43.9%	40.0%
Cattle Grazed	25	11	44.0%	41.7%	52.7%	NA
Ungrazed	35	14	40.0%	58.3%	47.3%	NA

Table 7: Nest vegetation characteristics.

	Random Veg. Points	Successful nests	Failed nests
Plant Height	11.1cm	53.5cm	47.0cm
Density <10cm	1.80	4.19	5.49
Density 10-50cm	0.92	4.55	6.37
Density >50cm	0.06	0.16	0.20
Concealment Rating	NA	2.84	2.71

Movement Patterns:

Hens nested from 352 meters (0.22 miles) to 21.9 km (13.7 miles) from the gobbling ground on which they were captured; average distance was 3715 meters (2.31 miles). However, over 50% of the nests were located within 2 km (1.24 miles) of the gobbling ground on which the hen was captured. In general, nest success increased with distance from the gobbling ground (often, nests were located near other gobbling grounds). For nests that were successful, hens moved an average of 4228 meters (2.63 miles) from the gobbling ground on which they were captured (range 352 meters to 21.9 km), while for nests that failed, hens moved an average of 3346 meters (2.08 miles, range 421 meters to 20.7 km) from the gobbling ground on which they were captured. It is commonly accepted that hens disperse between becoming inseminated and initiating nesting to reduce competition between related offspring. Bergerud (1988) and

Bergerud and Gratson (1988) also suggested that for many grouse species, nest success increases with distance from the lek, because the presence of males might attract predators and/or increase conspicuousness of the nest. We observed two cases of hens nesting more than 20 km from the lek of capture, and an additional three hens that moved over 10 km from the lek of capture. For all five of these cases, the hens moved west or west-southwest. We suspect that there were other gobbling grounds in close proximity to these nests, but thorough lek surveys were not conducted in these areas since they were a considerable distance from our normal study area.

Those hens that re-nested after a nesting failure moved an average of 2972 meters (1.85 miles, range 254 meters to 20.7 km) before re-nesting. The distance between first and second nesting attempts did not apparently affect success of second attempts, although successful re-nesting attempts averaged a slightly shorter distance from the first attempt than did re-nesting attempts that failed (2677 meters and 3563 meters, respectively).

Ten hens nested in consecutive years. Those hens that were successful the first year showed some nest area fidelity, nesting an average of 513 meters (range 48 to 1677 meters) from the previous year's nest, while those that failed the first year showed less fidelity, nesting an average of 991 meters (range 89 to 2057 meters) from the previous year's nest.

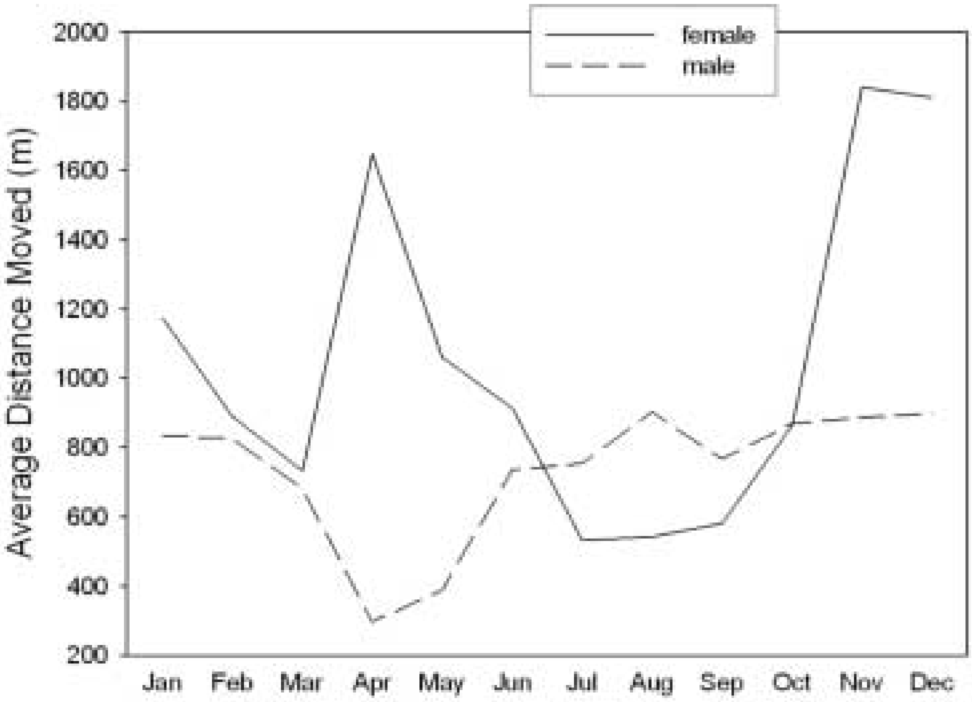
On average, gobbling grounds were located 3.77 km (2.34 miles) from the next nearest gobbling ground. This distance is nearly identical to the average distance traveled from gobbling grounds to nests (3.71 km) (Table 8). At our New Mexico study site, gobbling grounds averaged only 1.51 km (0.94 mile) apart. Similarly, the distance from lek of capture to nest in New Mexico was also shorter, averaging 1.31 km (0.81 mile) (GMSARC unpublished data).

Table 8: Gobbling Ground Relationships (satellite gobbling grounds and those that shifted were lumped).

Gobbling Ground	**B2**	**B3**	**B4**	**C1**	**E1**	**E2**	**E3**	**E4**	**H1**	**H2**
B2 (km)	-	3.2	2.7	14.3	25.0	16.0	6.5	8.8	5.5	11.3
B3 (km)		-	2.5	15.6	26.5	17.9	9.5	11.7	8.7	14.3
B4 (km)			-	13.1	24.0	15.4	7.6	9.7	7.8	13.7
C1 (km)				-	11.0	4.2	10.7	9.7	14.3	18.6
E1 (km)					-	9.3	20.2	18.4	23.9	26.6
E2 (km)						-	10.9	9.1	14.5	17.6
E3 (km)							-	2.4	3.7	8.4
E4 (km)								-	5.6	9.0
H1 (km)									-	6.0
H2 (km)										-
Nearest Lek (km)	**2.7**	**2.5**	**2.5**	**4.2**	**9.3**	**4.2**	**2.4**	**2.4**	**3.7**	**6.0**
Nests	**10**	**10**	**0**	**8**	**8**	**1**	**17**	**4**	**8**	**0**
Mean Distance to Nest (km)	**3.6**	**1.3**	**-**	**2.4**	**3.6**	**21.9**	**5.0**	**2.3**	**4.2**	**-**

When looking at the average distance birds moved between tracking events, female movements averaged about 50% greater than for males (985 meters for females, 648 meters for males). There was also quite some difference in movement patterns between genders throughout the year. Females moved much more than males in April and May, presumably movements between leks and nesting areas, but moved little from June through October, probably as a result of brood rearing. Females also moved a lot more in November and December, for reasons as yet undetermined (Figure 2), although this phenomena has been noted for both Greater and Lesser Prairie-Chickens by other researchers (Copelin 1963, Grange 1948).

Figure 2: Movement patterns for male and female Lesser Prairie-Chickens.



Habitat Usage:

Use of habitat types by non-nesting prairie-chickens occurred in nearly the same proportions as availability based both on our random vegetation sampling and data provided by the NRCS (see table 9). Occasionally, however, birds were tracked outside of our arbitrarily designated study area, including the northeast corner of Lipscomb County, TX. In these cases, bird location vegetation data was collected, but no random vegetation sampling was done. We also did not receive NRCS land use data from Lipscomb County, TX, but the land use and habitat appeared to be the same as that found in adjacent areas of Beaver and Ellis Counties, OK.

There were minor differences in the use of certain agricultural fields. For example, while only 0.3% of our random vegetation points were located in alfalfa fields, 4.2% of the bird locations were in alfalfa fields. A similar, although smaller, trend occurred with sorghum (including both forage sorghum and milo) fields, while most other agricultural fields were selected less than their availability.

On a smaller scale than habitat type, birds generally selected for areas of greater vegetation height, more brush and grass cover, and greater vegetation density. Brush cover for bird locations averaged more than twice that of random locations, and sand sagebrush cover was three times as great at bird locations than at random locations (Table 10). We also found that adult survivorship was significantly correlated with brush cover. A manuscript recently submitted to the *Journal of Wildlife Management* describes this in much greater detail (Patten et al.).

In June 2002, we also began collecting microclimate information on bird use areas as well as at random vegetation points. In general, birds selected for areas slightly cooler, more humid, and with less wind speed than was found at random sites (Table 11).

Table 9: Habitat use by Lesser Prairie-Chickens.

Habitat Type	**% Bird Use in that habitat**	**% Habitat Avail. (From Random Veg.)**	**% Habitat Avail. (From NRCS data)**
Native Rangeland	57.6%	51.8%	58.6%
Old World Bluestem CRP	11.7%	12.7%	NA
Native Mix CRP	7.9%	6.9%	NA
All CRP	20.7%	20.1%	20.7%
Fallow	11.4%	10.4%	NA
Agricultural	9.9%	13.4%	NA
Ag & Fallow	21.3%	23.8%	19.3%
All Non-Native	42.0%	43.9%	40.0%
Cattle Grazed	52.7%	52.7%	NA
Ungrazed	47.3%	47.3%	NA

Table 10: Vegetation characteristics of bird occupied areas.

	Occupied bird sites	**Random points**	**Difference between occupied and random sites**
Tallgrass Cover	17.0%	14.4%	+2.6%
Shortgrass cover	1.1%	0.9%	+0.2%
All grasses cover	17.8%	15.3%	+2.5%
Shinnery oak cover	<0.1%	0.0%	+0.0%
Sand sagebrush cover	3.6%	1.2%	+2.4%
Sand plum cover	0.4%	0.2%	+0.2%
Other shrub cover	5.9%	2.9%	+3.0%
All shrub cover	9.7%	4.3%	+5.4%
Total canopy cover	27.5%	19.6%	+7.9%
Mean height	14.2cm	11.1cm	+3.1cm
Density <10cm	1.80	1.80	0.0
Density 10-50cm	1.32	0.92	+0.4
Density >50cm	0.10	0.06	+0.04

Table 11: Bird Location Microclimate.

	Occupied Mean	**Random Mean**	**Significant?**
Temperature (ºC)	18.9	20.0	Nearly (0.05<P<0.10)
Relative Humidity (%)	38.3	34.3	Yes (P<0.05)
Wind Speed (km/hr)	1.89	2.37	Yes (P<0.05)

Disease and Genetics Surveys:

From each bird captured, blood was collected for genetic analyses and to search for the presence of retroviruses. Blood samples from all birds captured in 1999 and 2000 were tested for reticuloendotheliosis viruses, but all tested negative. The results from the first two years of these surveys have been included in the following two publications:

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.

Wiedenfeld, D. A., D. H. Wolfe, J. E. Toepfer, L. M. Mechlin, R. D. Applegate, and S. K. Sherrod. 2002. Survey for reticuloendotheliosis viruses in wild populations of Greater and Lesser Prairie-Chickens. Wilson Bull. 114:142-144.

Four birds (3 in 2002 and one in 2003) that died (from apparent respiratory failure) during processing were necropsied at the Oklahoma Animal Disease Diagnostic Laboratory in Stillwater, OK. The one bird in 2003 had a mycoplasma infection, as did a pooled sample of two birds in 2002. In all cases, these infections were considered to be at non-lethal levels. Two birds in 2002 contained a small number of cecal worms (*Heterakis* sp.). The one bird in 2003 also had a proventriculous nematode (likely *Tetrameres* sp.). For all four birds necropsied the cause of death was undetermined, but thought to be a result of stress during capture and handling (S. Vanhoosier, pers. comm.). We plan to examine salvaged carcasses and collected fecal samples for parasites in the future.

Peterson et al. (2002) reported Infectious Bronchitis Virus (IBV) infections in Lesser Prairie-Chickens sampled in Hemphill County, TX. One bird from our study was tested for IBV and was found to be negative. West Nile Virus (WNV) infections of Attwater's Prairie-Chickens (M. Peterson pers. comm.), and deaths of Greater Prairie-Chickens (T. Lief pers. comm.) due to WNV have recently been documented. Crawford (1980) emphasized the need for a better understanding of limiting factors such as diseases and parasites in Lesser Prairie-Chickens. Considering that numerous captive Attwater's Prairie-Chickens succumbed to REV in the 1990s (Drew at al. 1998), and that five cases of REV occurred this spring (2003) in captive Attwater's Prairie-Chickens (B. Wilson pers. comm.), continued surveillance for this disease is warranted.

The genetics survey carried out in 1999 and 2000 revealed that ample genetic diversity remains in the Oklahoma Lesser Prairie-Chicken population. However, with increasing fragmentation and isolation of populations, further research and monitoring is warranted. Reduction in genetic diversity has been observed in isolated populations of Greater Prairie-Chickens in both Illinois and Wisconsin in recent years (Bellinger et al. 2003, Bouzat et al. 1998, Toepfer and Septon 2003), and our research shows some loss of genetic diversity in New Mexico Lesser Prairie-Chickens (Van Den Bussche et al. 2003).

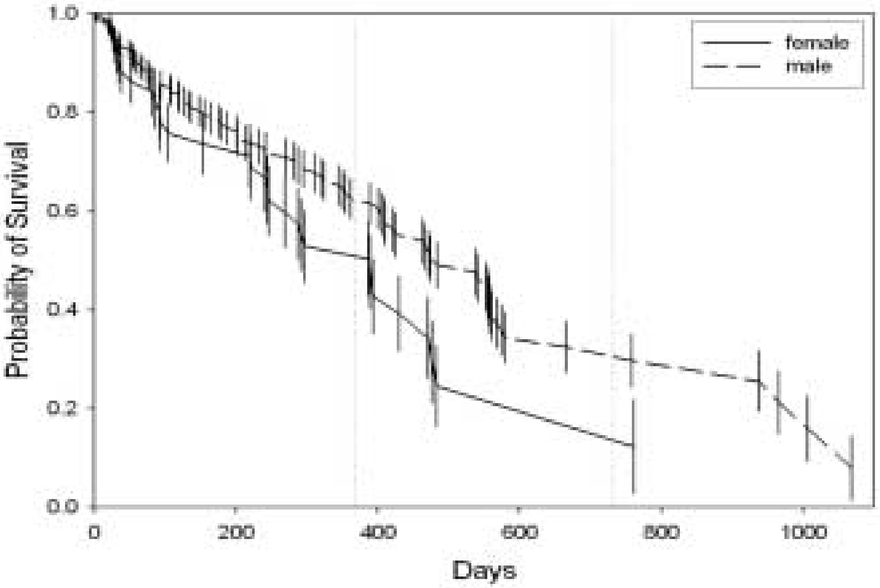
Survivorship:

Kaplan-Meier estimate of survivorship for males was 0.622 through the first year following capture, and 0.310 through two years. Females, however, had a considerably lower survivorship estimate, at 0.506 for one year and 0.138 for two years following capture (Table 12, Figure 3). For either gender, it appears that survivorship rates decrease with time. If one were to predict a linear, non-age dependant survivorship rate, then the survivorship the second year should be equal to the square of the first year's estimate: the survivorship estimates we observed, however, did not reflect this. Thus, survivorship may be more age dependent than was previously thought. This also implies that survivorship estimates based on data collected from only the first year may not be totally representative of actual survivorship. Interestingly, two-year survivorship estimates from New Mexico are very similar to what would be predicted from one-year estimates. When compared to our data from New Mexico, male survivorship is the same in Oklahoma, but female survivorship is lower in Oklahoma. Jamison (2000), calculated annual survivorship for male Lesser Prairie-Chickens in Kansas from 1997 through 1999 by three methods, and derived estimates ranging from 0.23 to 0.57. Campbell (1972) estimated annual survivorship in New Mexico from 1962 to 1970 to be around 35%, but his estimate was based on capture-recapture data, and he conceded that biases inherent in recapturing birds may have underestimated actual survivorship by 5 to 10%. Campbell's estimates were also from a period when prairie-chickens were still hunted in New Mexico, and 23 (7.3%) of his 317 banded birds were known to have been taken by hunters. If it is assumed that hunting is completely additive to all other mortality causes, and assuming a 5 to 10% underestimate, then actual annual survivorship may have been close to 50%.

Table 12. Kaplan-Meier survivorship estimates:

	Oklahoma		**New Mexico**	
	Males	**Females**	**Males**	**Females**
One Year Survivorship	0.622	0.506	0.539	0.663
Two Years Survivorship	0.310	0.138	0.313	0.416
Predicted Two Year Survivorship (based on first year's estimate)	0.387	0.256	0.291	0.440

Figure 3. Kaplan-Meier survivorship estimates for Oklahoma Lesser Prairie-Chickens:



Mortality Causes:

A total of 122 carcasses from radio-tagged prairie-chickens has been recovered. We also recovered carcasses from seven unbanded birds. Of those, we were able to surmise the cause of death for 100 radioed birds. Thirty-three (33%) of those were attributed to raptor predation, 32 (32%) were attributed to fence collisions, 25 (25%) were attributed to mammalian predation, six (6%) were attributed to powerline collisions, and four (4%) were attributed to automobile collisions. All collisions with structures and vehicles accounted for 42% of the over all mortalities. When looking only at predation events, 33 (56.9%) were attributed to raptors, and 25 (43.1%) were attributed to mammals. The predation rates on adult birds mirrored our findings in New Mexico during the same time period (57.1% raptor, 42.9% mammalian), suggesting that predation pressures for Lesser Prairie-Chickens are nearly equal across the entire Lesser Prairie-Chicken occupied range. Our findings also suggest that collisions with man-made structures may be additive to other mortality factors, and recruitment in years of poor reproduction may not be adequate to offset low survivorship. Since scavenging, especially by mammals, can occur at over 50% of carcasses within days (Bumann and Stauffer 2002), it is likely that collisions with fences or powerlines are occurring at a rate even higher than we are reporting. Elsewhere, collisions with fences and powerlines have been estimated to be one the greatest mortality factors for grouse in Scotland and Norway (Baines and Andrew 2003, Baines and Summers 1997, Bevanger 1995). Over 50 years ago, Ligon (1951) documented large numbers of Lesser Prairie-Chickens dying as a result of collisions with powerlines in New Mexico and cited reports of railroad workers essentially surviving on prairie-chickens collected from under telegraph wires in Kansas and Nebraska. Copelin (1963) also named powerline collisions as a threat for Lesser Prairie-Chickens in Oklahoma, and pointed out that this should be a consideration when initiating food plots. A nearly identically sized dataset from our research in New Mexico shows that fence and powerline collisions account for only 14% of the mortality in Roosevelt County, New Mexico (GMSARC unpublished data).

Over much of Beaver, Ellis, and Harper Counties, county roads are laid out along section lines, and most pastures are fenced in ¼ sections (160 acres or 65 hectares). This results in six linear miles of fences for every square mile. A bird flying through this landscape would encounter a fence, on average, every ½ mile, or twice as often as would be the case if pastures were fenced in full sections (640 acres or 259 hectares). Unnecessary fences surrounding CRP fields should be removed, and the probability of fence collisions should be taken under consideration before advocating any further cross fencing of pastures.

Of the 129 mortalities from 1999 through July 2003, 29 (22%) occurred in May, while 12 (36%) of the 33 hen mortalities during the same time period occurred in May. The number of birds found dead in other months ranged from four (3%) to 13 (10%). The high mortality experienced by hens in May is probably due in part to the vulnerability of incubating hens to predators, but may also be a result of movements necessary to locate suitable nesting habitat. Male mortality peaks during the months when gobbling activity is at its peak. Data from our New Mexico site shows a virtually identical mortality trend for females, but peak male mortality is about a month ahead of what we have observed at our Oklahoma site. Combined with data from our New Mexico study site, 12%, 16%, and 15% of all male mortalities have occurred in March, April, and May, respectively.

There is also an apparent difference in mortality causes for hens and cocks. Of 69 male carcass recoveries for which we could determine mortality causes, 26 (37.7%) were the result of raptor predation, 18 (26.1%) were the result of mammalian predation, 21 (30.4%) were the result of fence collisions, two (2.9%) were the result of powerline collisions, and two (2.9%) were the result of automobile collisions. Of 24 female carcass recoveries of known mortality causes, six (25.0%) were the result of raptor predation, seven (29.2%) were the result of mammalian predation, nine (37.5%) were the result of fence collisions, and two (8.3%) were the result of powerline collisions. An alarming 45.8% of all female mortalities were the result of collisions with either fences or powerlines. Most of this is occurring in May, and we attribute it to movements from gobbling grounds to nesting areas, and movements between nesting and foraging areas. The additive nature of collisions likely explains the differences in survivorship estimates seen between males and females (Table 12, Figure 3). Additional details are available in a manuscript recently submitted to *Nature* (Patten at al.), and will be further detailed in a manuscript currently in preparation for submission to the *Journal of Wildlife Management* (Wolfe et al.).

SIGNIFICANT DEVIATIONS:

For objective 7 above - The project statement was amended in 2001 to include this objective, which was to be carried out by a graduate student at the University of Oklahoma. Circumstances beyond our control prohibited this from happening. In 2002, we selected a graduate student at Oklahoma State University to conduct this aspect of our research, but it was carried out at our New Mexico study site due to concerns over radio-tagging chicks by some cooperators in Oklahoma. No Federal Aid in Wildlife Restoration Funds were spent on this objective.

MANAGEMENT RECOMMENDATIONS:

Old World bluestem CRP fields were chosen (compared to their availability) over native rangelands, quite possibly due to the lack of grazing, but native-mix CRP fields were chosen considerably more often than Old World bluestem CRP fields, and also had the highest nest success. For any agricultural fields entering CRP contracts, native-mix seedings should be stipulated.

Cattle grazing did not affect nest success, but there is a possibility that the presence of cattle or the effect of grazing may affect nest site selection. Thus, we recommend that the use of supplemental feed, mineral licks, and/or water sources be used to control grazing if necessary. Low-density continuous grazing systems may help to create and maintain a mosaic that includes areas of high grass and brush cover for suitable nesting habitat. The use of patch burning may even further enhance the necessary mosaic. The use of cross-fencing to control grazing pressure should be avoided if at all possible.

While it has been common practice to manage for nesting habitat within one mile (1.6 km) of a gobbling ground, we suggest attempting to manage a much larger area. On average, hens nested 2.3 miles (3.7 km) from the lek on which they were captured, while successful nests averaged 2.6 (4.2 km) from the lek on which the hen was captured. Gobbling ground spacing is likely correlated with this, as the average gobbling ground spacing we observed was 2.3 miles. Our research in New Mexico showed that gobbling grounds in that area are spaced less than half the distance they are in northwestern Oklahoma, while the distance from gobbling ground to nest was one-third of what we observed in Oklahoma. Traversing many miles to find suitable nesting habitat or for dispersal to other gobbling grounds undoubtedly comes at a cost. This cost may be in energy expenditure, increased vulnerability to predators in unfamiliar areas, and/or increased likelihood of colliding with fences and powerlines. Management efforts should be on a large enough scale to allow for establishment of new gobbling grounds with spacing of approximately one mile between them.

Our findings indicate that collisions with fences are a major mortality factor, kill more hens than cocks, and appear to have the greatest impact during nesting season. Therefore, we recommend that all unnecessary fencing be removed, and that fences near suitable nesting habitat (CRP fields or pastures with high grass and brush cover) be marked with 12 inch strips of safety fences attached from the top strand to the second strand of fences. This technique has been shown to reduce grouse collisions by 50% to 90% in Scotland (Baines and Andrew 2003). This would be a very costly undertaking, ranging from $300 to $1300 per linear mile, and would likely be beyond what most landowners could do without subsidies. State and federal agencies should give serious consideration to subsidizing those landowners willing to help by marking fences. Other high priority areas where fences should be marked might include food plots, alfalfa fields, and sorghum fields.

We also discourage cross fencing, especially cell-type grazing systems, in occupied Lesser Prairie-Chicken range. A single-section (640 acre, 259 hectare) pasture includes 4 linear miles of fences; prairie-chickens would encounter a fence once every mile, on average. In an 8-pasture cell system of the same size, the amount of fences would increase to 8.8 linear miles, essentially quadrupling the encounter rate (a prairie-chicken would encounter a fence every ¼ mile). Our research suggests that fragmentation due to roads, fences, and powerlines, which are not necessarily detected in traditional landscape fragmentation studies (Fuhlendorf et al. 2002, Leslie et al. 1999, Woodward et al. 2001), may be a greater factor than what has previously been thought.

Further genetic testing of Lesser Prairie-Chicken populations in Oklahoma and other states should be conducted, especially those Oklahoma populations thought to be disjunct from the core population(s). Additionally, management efforts should concentrate on increasing the connectivity of populations within Oklahoma, as well as with populations in Kansas, New

Mexico, and Texas.

Further research into microclimate parameters of adult bird and brood use areas is recommended to aid in explaining the preference of certain habitats over others. Research on brood microclimate and survivorship currently being conducted at our New Mexico study site will further our understanding, but much of it may not be directly applicable to Oklahoma.

Further investigation into stochastic events, including weather patterns, and how they affect populations should also continue. Flanders (2002) demonstrated that rainfall patterns can drive populations of Greater Prairie-Chickens and Sharp-tailed Grouse (*T. phasianellus*).

MANUSCRIPTS PUBLISHED OR IN PREPARATION:

Bidwell, T., S. Fuhlendorf, B. Gillen, S. Harmon, R. Horton, R. Rodgers, S. Sherrod, D. Wiedenfeld, and D. Wolfe. 2002. Ecology and management of the Lesser Prairie-Chicken in Oklahoma. OSU Extension Circular E-970. 15pp.

Patten, M. A., D. H. Wolfe, E. Shochat, and S. K. Sherrod. Submitted. The consequences of habitat selection on survivorship of the Lesser Prairie-Chicken. J. Wildl. Manage. Draft Only.

Patten, M. A., D. H. Wolfe, E. Shochat, and S. K. Sherrod. Submitted. Habitat fragmentation, rapid evolution, and population persistance. Nature. Draft Only.

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.

Wiedenfeld, D. A., D. H. Wolfe, J. E. Toepfer, L. M. Mechlin, R. D. Applegate, and S. K. Sherrod. 2002. Survey for reticuloendotheliosis viruses in wild populations of Greater and Lesser Prairie-Chickens. Wilson Bull. 114:142-144.

Wolfe, D. H., M. A. Patten, E. Shochat, and S. K. Sherrod. In Prep. Causes and patterns of mortality in Lesser Prairie-Chickens and implications for management.

LITERATURE CITED:

Ammann, G. A. 1944. Determining age of Pinnated and Sharp-tailed Grouses. J. Wildl. Manage. 8:170-171.

Amstrup, S. C. 1980. A radio-collar for game birds. J. Wildl. Manag. 44:214-217.

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

Baines, D., and R. W. Summers. 1997. Assessment of bird collisions with deer fences in Scottish forests. J. Applied Ecology 34:941-948.

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.

Bergerud, A. T. 1988. Mating systems in grouse. Pp. 439-472 *in* Adaptive strategies and population ecology of northern grouse (A. T. Bergerud and M. W. Gratson, eds). Univ. Minnesota Press, Minneapolis.

Bergerud, A. T., and M. W. Gratson. 1988. Survival and breeding strategies of grouse. Pp. 473-577 *in* Adaptive strategies and population ecology of northern grouse (A. T. Bergerud and M. W. Gratson, eds). Univ. Minnesota Press, Minneapolis.

Bevanger, K. 1995. Estimates and population consequences of tetraonid mortality caused by collisions with high tension power lines in Norway. J. Applied Ecology. 32:745-753.

Bidwell, T., S. Fuhlendorf, B. Gillen, S. Harmon, R. Horton, R. Rodgers, S. Sherrod, D. Wiedenfeld, and D. Wolfe. 2002. Ecology and management of the Lesser Prairie-Chicken in Oklahoma. OSU Extension Circular E-970. 15pp.

Bouzat, J. L., H. H. Cheng, H. A. Lewin, R. L. Westemeier, J. D. Brawn, and K. N. Paige. 1998. Genetic evaluation of a demographic bottleneck in the Greater Prairie Chicken. Conservation Biol. 12:836-843.

Bumann, G. B., and D. F. Stauffer. 2002. Scavenging of ruffed grouse in the Appalachians: influences and implications. Wildl.Soc. Bull. 30:853-860.

Campbell, H. 1972. A population study of Lesser Prairie Chickens in New Mexico. J. Wildl. Manage. 36:689-699.

Cannon, R. W., and F. L. Knopf. 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.). OSU, Stillwater.

Copelin, F. F. 1963. The Lesser Prairie Chicken in Oklahoma. ODWC Tech. Bull. No. 6. 58pp.

Crawford, J. A. 1980. Status, problems, and research needs of the Lesser Prairie Chicken. Pp. 1-7 *in* Proceedings Prairie Grouse Symposium (P.A. Vohs, and F.L. Knopf, eds.). OSU, Stillwater.

Davis, C. A., G. G. Ahlborn, S. S. Merchant, D. L. Wilson. 1981. Evaluation of lesser prairie chicken habitat in Roosevelt County, New Mexico. Final Report to NM Dep. Fish and Game. Contract 516-67-05. Las Cruces: NM State Univ. 130pp.

Drew, M. L., W. L. Wigle, D. L. Graham, C. P. Griffon, N. J. Silvy, A. M. Fadly, and R. L. Witter. 1998. Reticuloendotheliosis in captive Greater and Attwater's Prairie Chickens. Jnl. Wildl. Diseases. 34:783-791.

Flanders, B. L. 2002. Prairie grouse production on Valentine National Wildlife Refuge: The effects of weather and grassland management. MS Thesis. CO State Univ., Fort Collins. 116pp.

Fuhlendorf, S. D., A. J. W. Woodward, M. D. Leslie, and J. S. Shackford. 2002. Multi-scale effects of habitat loss and fragmentation on Lesser Prairie-Chicken populations of the US Southern Great Plains. Landscape Ecology 17:617-628.

Giesen, K. M. 1998. The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*). *In* The

Birds of North America, No. 364 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U.S.F.W.S. Resource Publ. 140, Washington, DC. 19pp.

Grange, W. B. 1948. Wisconsin grouse problems. Wisc. Conserv. Dep. Publ. No. 328. Madison. 318pp.

Hagen, C. A., S. C. Crupper, R. D. Applegate, and R. J. Robel. 2002. Prevalence of Mycoplasma antibodies in Lesser Prairie-Chickens. Avian Diseases 46:708-712.

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

Heady, H. F., R. P. Gibbens, and R. W. Powell. 1959. A comparison of the charting, line intercept, and line point methods of sampling shrub types of vegetation. J. Range Manage. 12:180-188.

Horton, R. E. 2000. Distribution and abundance of Lesser Prairie-Chicken in Oklahoma. Prairie Naturalist 32: 189-195.

Horton, R. E. 2003. Monitoring Prairie Chicken Populations. OK Dept. Wildl. Cons. Fed. Aid in Wildl. Restor. Proj. W-82-R, Job 001, Oklahoma City, 9pp.

Jamison, B. E. 2000. Lesser Prairie-Chicken chick survival, adult survival, and habitat selection and movements of males in fragmented rangelands of southwestern Kansas. M.S. Thesis. KS State Univ., Manhattan, KS. 197pp.

Kopp, S.D., F. S. Guthery, N. D. Forrester, and W. E. Cohen. 1998. Habitat selection modeling for Northern Bobwhites on subtropical rangeland. J. Wildl. Manage. 62:884-895

Leslie, D. M., J. S. Shackford, A. Woodward, S. Fuhlendorf, and C. B. Greene. 1999. Landscape-level evaluation of the decline of the Lesser Prairie-Chicken in Oklahoma, Texas, and New Mexico. ODWC Final Report, grant no. AP-96-201W. 63pp.

Ligon, J. S. 1951. Prairie chickens, highways, and powerlines. New Mexico Magazine 29(5):29.

Mote, K. D., R. D. Applegate, J. A. Bailey, K. E. Giesen, R. Horton, and J. L. Sheppard. 1999. Assessment and conservation strategy for the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*).

Patten, M. A., D. H. Wolfe, E. Shochat, and S. K. Sherrod. Submitted. The consequences of habitat selection on survivorship of the Lesser Prairie-Chicken. J. Wildl. Manage. Draft Only.

Patten, M. A., D. H. Wolfe, E. Shochat, and S. K. Sherrod. Submitted. Habitat fragmentation, rapid evolution, and population persistance Nature. Draft Only.

Peterson, M. J., P. F. Ferro, M. N. Peterson, R. M. Sullivan, B. E. Toole, and N. J. Silvy. 2002. Infectious disease survey of Lesser Prairie Chickens in north Texas. J. Wildl. Diseases 38:834-839.

Petrides, G. A. 1942. Age determination in American gallinaceous game birds. Trans. 7th. N. Am. Wildl. Conf. 7:308-328.

Schroeder, M. A., and C. E. Braun. 1991. Walk-in traps for capturing Greater Prairie-chickens on leks. J. Field Ornithol. 62:378-385.

Taylor, M. A., and F. S. Guthery. 1980. Status, ecology, and management of the Lesser Prairie-Chicken. U.S. For. Serv. Gen. Tech. Rep. RM-77. Rocky Mt. Forest and Range Exper. Sta., Fort Collins, CO.

Toepfer, J. E. 1988. Ecology of the Greater Prairie-chicken as related to reintroduction. PhD dissertation. MT State Univ., Bozeman, MT.

Toepfer, J. E., and G. Septon. 2003. Prairie Chickens and grasslands: 2000 and beyond. A report to the Council of Chiefs. Society of Tympanuchus Cupido Pinnatus, Ltd. 69pp.

USFWS. 1998. Twelve-month administrative finding on petition to list the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) as threatened. Tulsa Ecol. Services, USFWS, Tulsa, OK. 65pp.

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.

Wiedenfeld, D. A., D. H. Wolfe, J. E. Toepfer, L. M. Mechlin, R. D. Applegate, and S. K. Sherrod. 2002. Survey for reticuloendotheliosis viruses in wild populations of Greater and Lesser Prairie-Chickens. Wilson Bull. 114:142-144.

Wiedenfeld, D. A., D. H. Wolfe, and S. K. Sherrod. 2001. New Mexico Lesser Prairie-Chicken Project 2001. Effects of shrub control and grazing on Lesser Prairie-Chicken reproductive success, year 1. Final Report.

Wiedenfeld, D. A., D. H. Wolfe, and S. K. Sherrod. 2002. A study of factors affecting nesting success and mortality of Greater Prairie-Chickens in northeastern Oklahoma 1997-2000. Final Report.

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. Am. Midland Naturalist 145: 261-274.

ACKNOWLEDGEMENTS:

Financial support for this publication was also provided by the University of Oklahoma. Additional financial support for our research was provided by U.S. Fish and Wildlife Service, National Fish and Wildlife Foundation, Western Governor’s Association, High Plains R. C. & D., Wolf Creek Charitable Foundation, K. S. Adams Foundation, World Publishing Company, ConocoPhillips, Bank of Oklahoma, Riggs-Abney Attorneys at Law, American Electric Power, Arrow Trucking, and many other private contributors including John Brock, Sam Daniel, Carol McGraw, Judge Joe Morris, Harold and Sandy Price, George Records, and Joseph H. Williams. Far too many landowners to be named allowed us access to their lands in Oklahoma and Texas. Dan and Helen O’Hair deserve special recognition for not only allowing access to their land, but for also providing much needed logistical support (and many great meals). John Shackford located many of the gobbling grounds and contacted many landowners in the beginning stages of this research. NRCS personnel David Hungerford, Jim Shaffer, and Christine Henry offered much assistance and guidance on land uses and plant identification. Finally, this research would not have been possible without the efforts of field technicians Fred Allen, Luke Bell, Mike Blondin, Jessica Bolis, David Bostock, Colleen Burgess, Matt DiBona, Heather Hart, Tyler Hinkle, Even Holmboe, Quresh Latif, Stephanie Lee, Celeste McKnight, Jonee' Miller, Steve Page, Nicole Rein, David Riley, Lawry Sager, Geraldine Saw, Josh Scheiring, Cassie Schermer, Melissa Thompson, Ray Thompson, Tom Thompson, Shelly Tovell, Adam Wargon, and especially the long-term commitment and dedication of Barry Leach and Fumiko Sakoda.

Prepared by: Donald H. Wolfe, Michael A. Patten, and Steve K. Sherrod

Date: October 16, 2003

Approved by: ____________________________________
Harold E. Namminga
Federal Aid/Research Coordinator