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HABITAT USE AND NEST SITE SELECTION BY NESTING LESSER PRAIRIE-CHICKENS IN SOUTHEASTERN NEW MEXICO

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ABSTRACT—Lesser prairie-chickens (*Tympanuchus pallidicinctus*) occur in shinnery oak (*Quercus havardii*) and sand sagebrush (*Artemisia filifolia*) grassland habitats in New Mexico, Texas, Oklahoma, Kansas, and Colorado. Range-wide population reductions since the 1800s have been attributed to habitat loss, especially of nesting habitat. Using radio-telemetry and a vegetation map of the study area, we investigated habitat use by lesser prairie-chicken hens during the nesting season in herbicide-treated and untreated pastures (each about 1,000 ha in size). Herbicide treatment was effective in reducing shinnery oak cover. The most common vegetation types in hen home ranges were those dominated by shinnery oak. Hens were detected more often than randomly in or near untreated pastures. Although hens were detected in both treated and untreated habitats, 13 of 14 nests were located in untreated pastures, and all nests were located in areas dominated by shinnery oak. Areas immediately surrounding nests had higher shrub composition than the surrounding pastures. This study suggests that herbicide treatment to control shinnery oak might adversely impact nesting lesser prairie-chickens.

RESUMEN—La gallinita de praderas (*Tympanuchus pallidicinctus*) se encuentra en hábitats como pastizales de encino blanco (*Quercus havardii*) y artemisia (*Artemisia filifolia*) en los estados de Nuevo México, Texas, Oklahoma, Kansas y Colorado. Reducciones de poblaciones en todo su rango desde 1800 han sido atribuidas a la pérdida de hábitat, especialmente hábitat para anidación. Usando radio-telemetría y un mapa de vegetación del área de estudio, investigamos el uso de hábitat por hembras de la gallinita de praderas durante el periodo de anidación en campos tratados con herbicidas y en campos no tratados (cada campo de cerca de 1000 ha). El tratamiento con herbicida fue exitoso en reducir la cubierta de *Q. havardii.* Los tipos de vegetación más comunes en las áreas de hogar de las gallinitas fueron los dominados por *Q. havardii.* Se detectaron gallinitas más frecuentemente que al azar en o cerca de campos no tratados. Aunque las hembras usaron tanto hábitats tratados con herbicida como no tratados, 13 de 14 nidos se hallaron en campos no tratados y todos los nidos fueron localizados en áreas dominadas por *Q. havardii.* Areas cerca de nidos fueron cubiertas con más arbustos que los parches circundantes. Este estudio sugiere que el tratamiento con herbicida para reducir *Q. havardii* puede empeorar el hábitat de anidación de la gallinita de praderas.

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) has the second-most restricted distribution and second-smallest population size of any native North American grouse species, next to Gunnison's sage grouse (*Centrocercus minimus*) (Giesen, 1998; Young et al., 2000). Significant reductions in population and distribution since the 1800s have been attributed to drought, excessive grazing of rangelands, conversion of native rangelands to croplands, and chemical control of sand sagebrush (*Artemisia filifolia*) and shinnery oak (*Quercus havardii*). As a consequence, the species is a candidate for listing as threatened under the Endangered Species Act (Giesen, 1998).

The lesser prairie-chicken occurs primarily in shinnery oak or sand sagebrush grasslands in 5 states within the Southern Shortgrass Ecoregion (Bailey et al., 1994). In New Mexico, Texas, and Oklahoma, the lesser prairie-chicken occurs in shinnery oak-bluestem habitats dominated by sand bluestem (*Andropogon hallii*), little bluestem (*Schizachyrium scoparium*), sand dropseed (*Sporobolus cryptandrus*), three-awn (*Aristida*), and blue grama grasses (*Bouteloua gracilis*) (Giesen, 1998).

Lesser prairie-chickens nest on the ground under sand sagebrush or shinnery oak shrubs, or in tall bunchgrasses (e.g., *Aristida, Schizachyrium, Andropogon*) (Riley et al., 1992; Giesen, 1994). Predation is the primary cause of nest failure, and nest depredation and abandonment rates are lower when vegetation height and tallgrass cover near nests are higher (Riley et al., 1992). Although tallgrass apparently is important for nesting cover, lesser prairie-chicken hens nest disproportionately in areas containing a mixture of grass and shinnery oak, compared to areas in which shrubs have been eliminated (Haukos and Smith, 1989).

Lesser prairie-chicken habitat is impacted by several agricultural practices. Conversion of native rangeland to croplands destroys and fragments shinnery oak dune breeding and wintering habitats (Taylor and Guthery, 1980). Overgrazing reduces cover of tall bunchgrasses, which in turn increases levels of predation (Merchant, 1982; Riley et al., 1992). Shrub eradication, a common range management practice, degrades and fragments nesting, brood-rearing, and wintering habitat (Peterson and Boyd, 1998). In a landscape-level analysis, loss of shrub-dominated habitats was associated with a tendency for a lesser prairie-chicken population to be classified as declining (Woodward et al., 2001).

The purposes of this study were to: 1) determine which vegetation types were used by lesser prairie-chicken hens and 2) test the hypothesis that nesting lesser prairie-chicken hens use treated and untreated habitats equally. We investigated habitat use by lesser prairie-chicken hens during the nesting season in an area in which shrubs had been chemically removed in pasture-sized patches. This pattern allowed an experiment-like approach to test the hypothesis.

METHODS—*Study Area*—The study was conducted on the Caprock Wildlife Habitat Management Area, approximately 60 km east of Roswell, Chavez County, New Mexico. The management area is administered by the Bureau of Land Management (BLM), Roswell, New Mexico Field Office. Vegetation on the study area consisted primarily of shinnery oak shrublands and various grasslands (Fig. 1, Table 1).

Patches of the study area had been previously treated with herbicide to kill shinnery oak and increase relative grass cover for livestock (Fig. 1). Between 1986 and 1992, BLM applied a single treatment of one-half pound per acre active ingredient of tebuthiuron to each treated pasture to kill oak and encourage grass for livestock. This treatment resulted in a patchwork of treated and untreated pastures within the home ranges of the study animals. Pastures averaged 983 ha in area (5 treated pastures, mean = 1,054 ha, range = 648 to 1,991 ha, *SD* = 550 ha; 5 untreated pastures, mean = 912 ha, range = 697 to 1,246 ha, *SD* = 211 ha).

All 3 leks where hens were captured were located less than 600 m from blocks of both treated and untreated habitat (Fig. 1); thus, all hens had access to both treatment types (lesser prairie-chicken hens typically nest within 3.2 km of the lek of capture; Giesen, 1998).

The entire study area was grazed during the study. Permits for pastures were for either year-round grazing on a rest-rotation system (4 untreated, 3 treated), year-round grazing on a light rest-rotation system (1 untreated), or seasonal grazing on a yearlong rotation system (2 treated). Two focal leks were located in year-round, rest-rotation pastures, and 1 was located in a seasonal grazing, yearlong rotation pasture.

Vegetation Map—We used a vegetation map developed for management of the lesser prairie-chicken and other target species in the area. The vegetation map contained 15 vegetation mapping units (MUs, Table 1) and was 88% accurate. Details of the mapping process are reported elsewhere (Johnson et al., 2001) and are available from the corresponding author.

Topography in Treated versus Untreated Pastures—If flat areas were selectively treated with herbicide, apparent hen avoidance of treated areas could actually be a result of hens avoiding flat areas, irrespective of treatment history. Using ArcView (Environmental Systems Research Institute, Redlands, California), we overlaid digital raster graphics (DRGs) with treatment polygons to determine if treated areas contained dunes.

Vegetation Data—We collected vegetation data at each nest site, after all nests were empty, during mid June of all 3 years. We employed a vegetation sampling method similar to that used by BLM personnel to allow us to combine our data with existing vegetation data for treated and untreated areas. X-shaped, line-point transects were centered at each nest, with arms in the 4 cardinal directions from the nest (R. French, pers. comm.). Each arm consisted of 100 steps, with a point taken at the right toe every

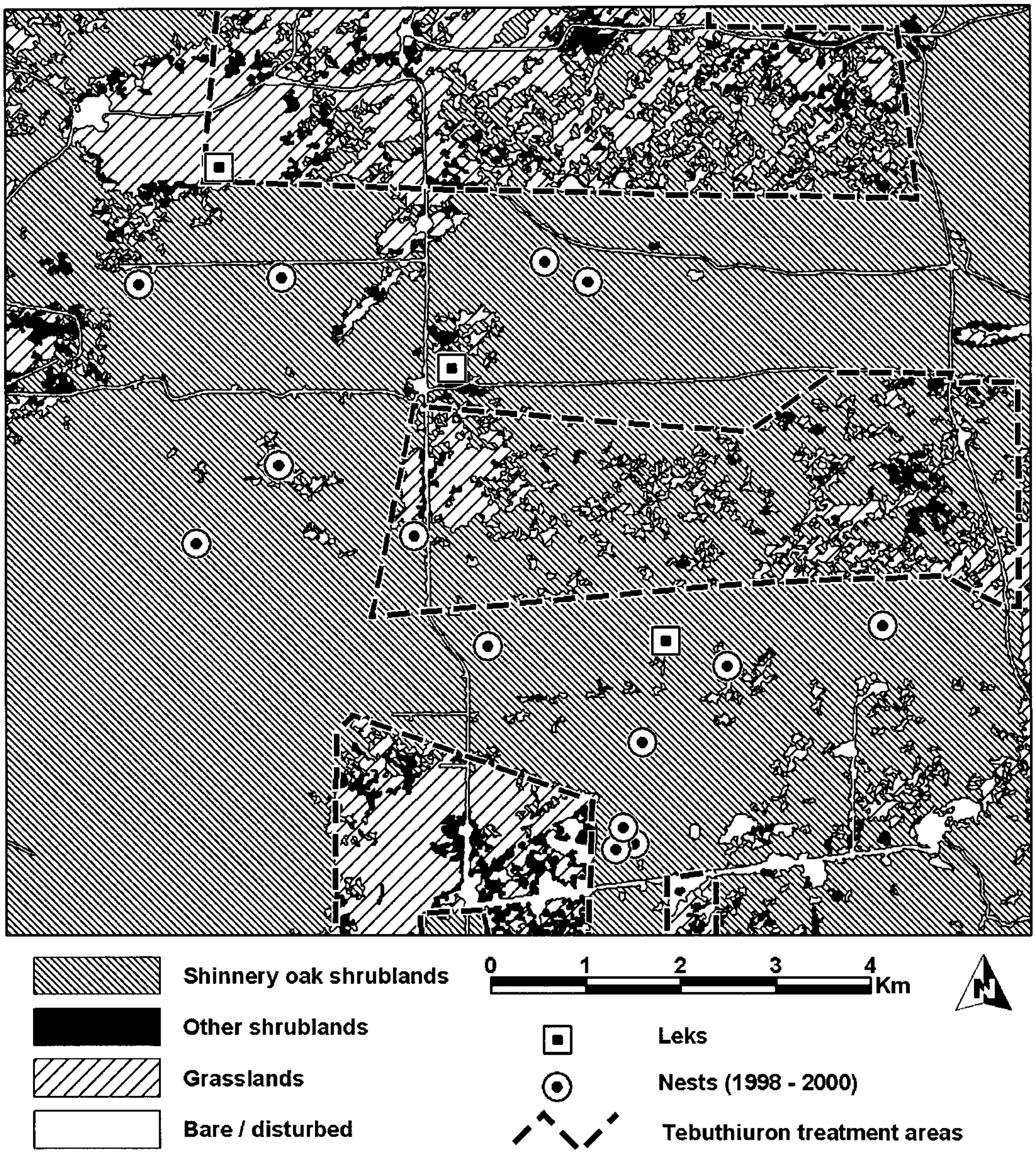

FIG. 1—Simplified vegetation map of lesser prairie-chicken habitats, showing major vegetation types on the study area in eastern New Mexico. To allow depiction without color, vegetation classes have been lumped into shinnery oak (mapping units [MUs] 1 through 6), non-shinnery oak shrubland (MUs 7 through 9), grassland (MUs 10 through 14), and barren-disturbed (MU 15). Polygons show areas treated with herbicide.

other step, such that each arm contributed 50 points and each transect 200. At each point, bare ground, litter, or plant species touched by or nearest to the toe was recorded. We computed the percent of groundcover types around each nest and species composition from the nearest plant data.

BLM provided 1999 and 2000 summary vegetation data from pastures previously treated or not treated with tebuthiuron. One treated and 13 untreated transects were unique and non-overlapping with the BLM transects. Most were approximately 1 km from the nearest BLM transect, and none was closer than 350 m to the nearest BLM transect.

To characterize the area within 3 m of the nest site, we used 3-m transects extending from the nest in each of the 8 directions. Data points were taken

TABLE 1—Vegetation map units (MU) in lesser prairie-chicken habitat, Caprock Wildlife Habitat Management Area, New Mexico, 2000. Area (ha) calculated using ERDAS Imagine (Leica Geosystems GIS and Mapping, Atlanta, Georgia). MU 9 occurred on the area mapped for vegetation but not on our study area. Percentages of each MU found in treated versus untreated pastures were computed over a subset of the mapped area containing treated areas and including adjacent untreated areas.

MU	MU description	Mapped area (ha)	Study area	
			% treated	% untreated
1	Shinnery Oak/Mixed Mid-Grass & Tall-Grass Duneland	31,596	13.16	86.84
2	Shinnery Oak/Sparse Duneland	9,816	13.97	86.03
3	Shinnery Oak/Mixed Mid-Grass & Tall-Grass Shrubland	14,358	29.75	70.25
4	Shinnery Oak/Mid-Grass Shrubland	6,095	2.90	97.10
5	Shinnery Oak/Mixed Short-Grass & Mid-Grass Shrubland	22,949	38.28	61.72
6	Shinnery Oak/Sparse Shrubland	4,443	40.41	59.59
	Total shinnery oak habitat	89,257		
7	Sand Sagebrush Shrubland	16,288	88.82	11.18
8	Honey Mesquite Shrubland	12,540	58.63	41.37
9	Escarpment Shrubland	237	0	0
	Total non-shinnery oak shrubland	29,065		
10	Mixed Mid-Grass & Tall-Grass/Shinnery Oak Grassland	2,944	66.83	33.17
11	Tall-Grass Grassland	13,535	73.79	26.21
12	Short-Grass Grassland	14,021	34.66	65.34
13	Mid-Grass Grassland	10,658	83.09	16.91
14	Short-Grass/Honey Mesquite Grassland	9,906	52.31	47.69
	Total grassland	51,064		
15	Barren-Sparsely Vegetated/Manmade Disturbance	10,292	51.07	48.93
	Map Total	179,678		

at 0.3-m intervals, such that each arm provided 10 points, for 80 points per nest. As on the large transects, litter, bare ground, and plant species were recorded.

Radiotelemetry—We trapped lesser prairie-chickens (methods in Schroeder and Braun, 1991) at 3 traditional lek sites during the peak lek attendance period, late March until early May, 1998 through 2000 (201 lek trapping days over the 3 years).

Twenty-eight females were fitted with radio transmitters. We used a combination of loop necklace and whip antenna, battery-operated transmitters from AVM (Colfax, California) and Telemetry Solutions (Walnut Creek, California). Transmitters weighed from 13 to 15 g (1.5 to 2% of the body weight of the bird). All birds were released unharmed after approximately 30 min handling time. The animal welfare protocol was approved by the University of New Mexico Main Campus Animal Care and Use Committee (#A4023-01).

We attempted to locate each female daily after transmitters were attached. We checked nesting hen locations each day to ascertain if hens were still present. In 1999 and 2000, we took several bearings on each hen daily, using a model 2100 receiver from Advanced Telemetry Systems (Isanti, Minnesota). We triangulated these bearings, plotted hen locations on a 7.5′ quadrangle map, and digitized them into an ArcView coverage (version 3.2a, Environmental Systems Research Institute, Redlands, California) in 1999 or recorded UTM coordinates from the map in 2000. We generated 95% fixed kernel estimates from these point coverages using the Animal Movement ArcView extension (version 2.04, United States Geological Survey, Biological Resources Division). We used fixed kernel home range estimates, because they compare well to other home range estimators on such criteria as sample size, sensitivity to outliers, etc. (Kernohan et al., 2001). We performed statistical analyses using Minitab 13 (Minitab, State College, Pennsylvania) and SAS for Windows (SAS Institute, Cary, North Carolina).

Hen Use of Treated versus Untreated Pastures—We used Euclidean distances to assess nonrandom use of treated and untreated pastures (Connor and Plowman, 2001). By using ratios of distances to each pasture type from random versus actual detection points, this method automatically controls for variation among individuals in home range size, as well as the availability of the 2 treatment types. The animal is used as the sampling unit; thus, unequal sampling does not affect the overall analysis. This approach requires no explicit error modeling, and summary statistics are readily interpreted (Connor and Plowman, 2001).

Using ArcView, we simulated 200 locations from a uniform random distribution within the 95% fixed kernel home range of each animal. Using the Nearest Feature ArcView extension (Jenness, 2001), we calculated the distance from each random point and each detection point to both (treated and untreated) habitat types and averaged the random and actual distances for each animal. We created a vector of observed to expected ratios for each habitat type for each hen and tested the ratios for deviation from 1.0 using a single-sample Wilcoxon test. We also compared treated and untreated ratios using a Wilcoxon signed rank test.

RESULTS—*Topography and Grazing in Treated versus Untreated Pastures*—Examination of DRGs overlaid with treatment polygons revealed that all treatment blocks were crossed by continuous dune complexes that dissect the study area. Thus, physical features favored by hens for nest placement, such as slope and aspect, were abundant in both treated and untreated areas. Eleven nests were located in pastures under year-round grazing on a rest-rotation system. Three nests were located in a pasture on a year-round, light rest-rotation system.

Vegetation in Treated versus Untreated Pastures—Analysis of data from 1999 and 2000 BLM vegetation monitoring transects on the study area showed that percent shrub cover was significantly higher in untreated, as opposed to treated, pastures (Mann-Whitney test: median treated = 5%, untreated = 37%; $n = 7, 5$; $W = 28$; $P = 0.006$; Fig. 1). Results were similar when our vegetation data from pastures containing nests (1998 through 2000) were included in the analysis (Mann-Whitney test: median treated = 5%, untreated = 46%; $n = 8, 18$; $W = 41$; $P < 0.001$). Basal vegetation cover was apparently lower in treated than untreated pastures, but the difference was not significant (Mann-Whitney test, median treated = 16%, untreated = 23%; $n = 26$, $W = 75$, $P = 0.071$).

The vegetation map also indicated differences between treated and untreated pastures in relative shrub and grass composition (Fig. 1). Mapping units 1 through 6, dominated by shinnery oak, were much more common in untreated than in treated pastures (Table 1). Three grassland MUs, 10, 11, and 13, were much more common in treated pastures. MU 12, shortgrass grassland, was more common in untreated than in treated areas, but MU 12 was dominated by black grama, which typically would not be naturally associated with shinnery oak and therefore would not have been treated. The remaining grassland MU contained honey mesquite (*Prosopis glandulosa*), which would not be left after shrub eradication and so would not be expected to occur in treated areas.

In summary, BLM transect data from treated versus untreated pastures, our transect data in nest pastures combined with BLM transect data, and the vegetation map and classification indicated that herbicide treatment was effective in reducing shrub cover. Vegetation cover also tended to be lower in treated than untreated pastures, although not significantly.

Fate of Hens—Of the 28 radio-collared hens, 6 were found dead before their nests were found. We followed another 6 (all in 2000) for 2 months without finding a nest. These hens never settled in 1 spot, which suggests that they either did not nest or their nests were depredated before hens began incubating and before we found their nests. We lost track of 6 hens, of which 3 were recaptured or re-sighted the next year, which suggested that at least half were lost due to transmitter failure. We found 1 nest each for 12 of the remaining 13 hens and 2 nests for one 1999 hen, giving a total of 14 nests. We have telemetry data for 19 hens, the 13 that nested and the 6 that did not incubate a nest.

Hen Use of Treated versus Untreated Pastures: Home Ranges—The mean area of the 95% fixed kernel for 19 hens was 1,790 ha (SE = 508 ha). All hens had access to both treated and untreated pastures, and 18 of 19 hens (1999 and 2000) used both treatment types (Fig. 2). One hen was detected only in untreated habitat.

The Euclidean distance analysis revealed that ratios of observed to random distances to untreated patches were significantly less than 1.0 ($n = 19$, $S = -54.5$, $P = 0.016$), meaning that hens were detected more often than randomly in or near untreated pastures. A similar test of the treated distance ratios was not significant ($n = 19$, $S = -2$, $P = 0.95$). Examination of hen detection points suggested that this occurred because, when hens were detected in treated patches, they were on the edges of treated areas, near untreated pastures. Ratios of observed to random distances were greater for treated than for untreated habitat patches (signed rank test, $n = 19$, $S = 50$, $P = 0.045$), which also showed that females were detected more often in or near untreated patches. Ratios of observed to random distances did not differ between hens that nested and those for which we did not find nests (distance to untreated: $U = 99$, $P = 0.49$, $n = 9{,}19$; distance to treated: $U = 77$, $P = 0.31$, $n = 9{,}10$).

Hen Use of Treated versus Untreated Pastures: Nest Sites—Although hens were detected in both treated and untreated pastures, 13 of 14 nests (93%) were in untreated pastures, a significant bias against treated pastures ($\chi^2 = 6.99$, $P < 0.01$, $df = 1$). The 1 hen that nested on the edge of a treated pasture was in an area covered in 40.5% shrubs. This area apparently was missed during herbicide treatment. Thus, no nest was placed in any vegetation type dominated by grasses and without a substantial shrub component.

Vegetation Types in Hen Home Ranges—For 17 of 19 hens, the MU that covered the largest or second-largest proportion of their 95% fixed kernel was MU 1, Shinnery Oak/Mixed Mid-Grass and Tall-Grass Duneland. Thirteen of 19 hens had the highest or second-highest percentages of their 95% fixed kernel in MU 5, Shinnery Oak/Mixed Short-Grass and Mid-Grass Shrubland. Thus, hen home ranges were covered primarily in shinnery oak-dominated vegetation types.

Vegetation at Nests—The percent shrub composition in pastures where nests were located varied from 35 to 58%, and percent shrubs within 3 m of nests varied from 36 to 69%. Thus, all hens chose to nest in habitat containing at least 35% shrubs. Areas within 3 m of nests had higher shrub composition than within 100 m of nests (Wilcoxon Signed Rank Test: pasture mean = 47.84, SD = 7.75; nest mean = 54.96, SD = 10.59, $n = 14$; $W = 14.5$, $P = 0.019$). Thus, hens appeared to nest in areas of habitat with higher shrub composition within untreated pastures.

GIS analysis of vegetation communities revealed that vegetation classes 1 through 5, all of which were dominated by shinnery oak, were most prevalent at nest sites. For all nests combined, the most common MUs chosen for nest sites were shinnery oak-dominated habitats (Table 2).

Discussion—In this breeding-season study, the spatial distribution of treated and untreated pastures relative to traditional lek sites (Fig. 1) allowed an experiment-like investigation of hen habitat use. Lesser prairie-chicken hens

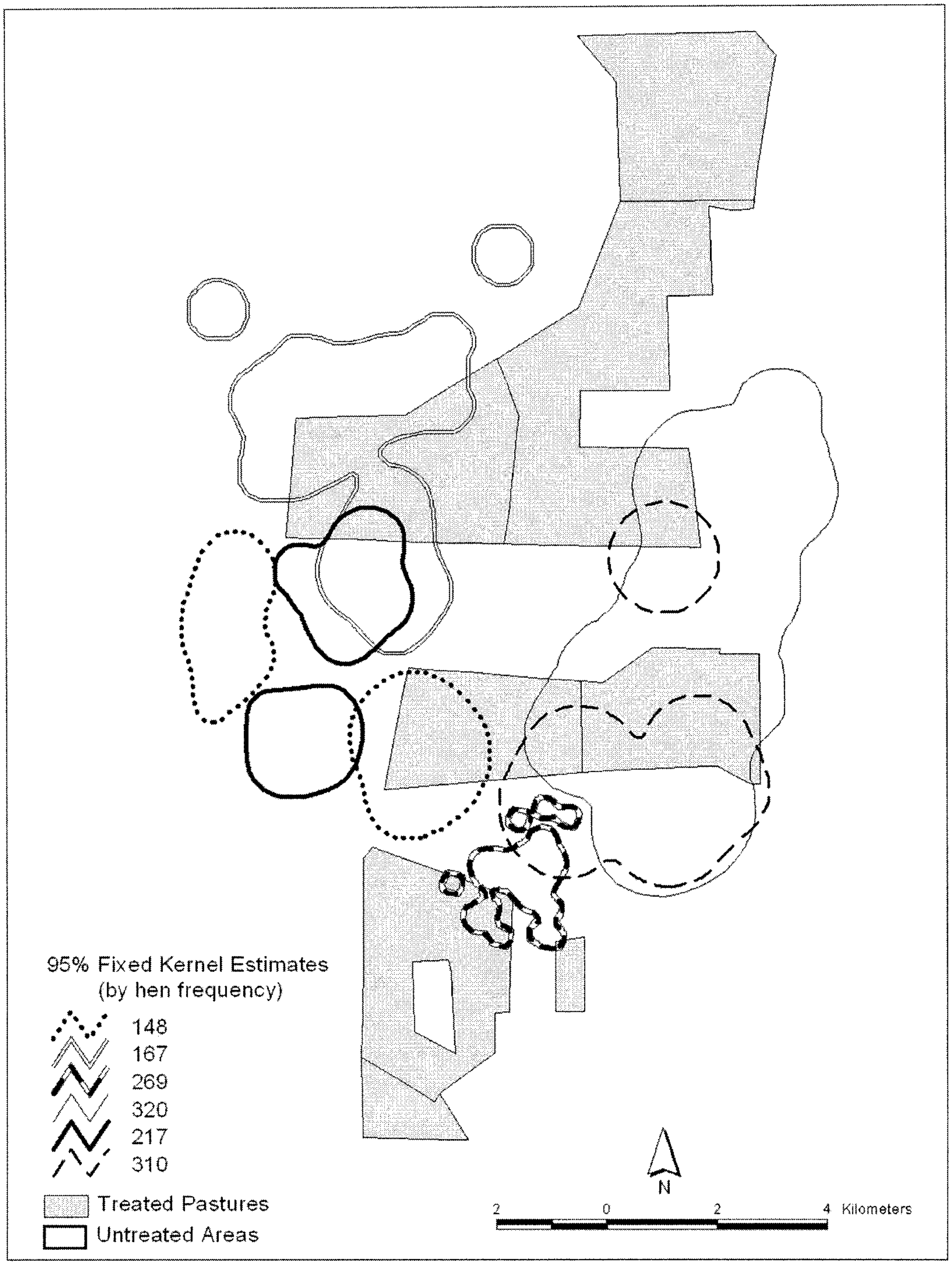

FIG. 2—The 95% fixed kernel estimates of 6 representative lesser prairie-chicken hens, showing typical overlap of hen home ranges with treated and untreated pastures in eastern New Mexico.

TABLE 2—Proportion of 20-m lesser prairie-chicken nest buffer covered in each vegetation class (MU = mapping unit) at Caprock Wildlife Habitat Management Area, New Mexico, 1998 through 2000.

Hen ID	Year	MU 1[a]	MU 2[b]	MU 3[c]	MU 4[d]	MU 5[e]	MU 10[f]	MU 11[g]
130	1998	0.25	0.00	0.68	0.00	0.00	0.07	0.00
190	1998	0.89	0.11	0.00	0.00	0.00	0.00	0.00
460	1998	0.13	0.00	0.00	0.87	0.00	0.00	0.00
500	1998	0.40	0.00	0.51	0.00	0.04	0.00	0.05
122	1999	1.00	0.00	0.00	0.00	0.00	0.00	0.00
197	1999	0.00	1.00	0.00	0.00	0.00	0.00	0.00
269	1999	0.62	0.00	0.38	0.00	0.00	0.00	0.00
327	1999	0.00	1.00	0.00	0.00	0.00	0.00	0.00
2171	1999	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2172	1999	0.00	0.00	1.00	0.00	0.00	0.00	0.00
148	2000	0.00	0.00	0.25	0.00	0.70	0.00	0.05
213	2000	0.96	0.00	0.00	0.00	0.04	0.00	0.00
228	2000	0.94	0.00	0.06	0.00	0.00	0.00	0.00
297	2000	0.07	0.00	0.00	0.00	0.93	0.00	0.00

[a] Shinnery Oak/Mixed Mid-Grass and Tall-Grass Duneland.
[b] Shinnery Oak/Sparse Duneland.
[c] Shinnery Oak/Mixed Mid-Grass and Tall-Grass Shrubland.
[d] Shinnery Oak/Mid-Grass Shrubland.
[e] Shinnery Oak/Mixed Short-Grass and Mid-Grass Shrubland.
[f] Mixed Mid-Grass and Tall-Grass Shinnery Oak Grassland.
[g] Tall-Grass Grassland.

typically nest within 3.2 km of the lek at which they are captured (Giesen, 1998). In this study, because leks of capture were less than 600 m from both treated and untreated pastures, all hens had the option of spending time and nesting either in habitats dominated by shinnery oak or habitats in which shinnery oak had been eliminated and replaced by grasses and forbs.

The hypothesis that nesting hens use treated and untreated habitats equally was rejected. None of the 14 nests was placed in treated habitat, even though hen home ranges overlapped both treated and untreated areas.

Vegetation data and the vegetation map demonstrated that herbicide treatment was effective in significantly reducing shrub cover in treated areas (see also Doerr and Guthery, 1983, for similar results). Home ranges of the majority of hens were covered primarily in only 3 vegetation classes, all dominated by shinnery oak: Shinnery Oak/Mixed Mid-Grass and Tall-Grass Duneland, Shinnery Oak/Mixed Mid-Grass and Tall-Grass Shrubland, and Shinnery Oak/Mixed Short-Grass and Mid-Grass Shrubland. Analysis of telemetry data suggested that within their home ranges, hens spent more time in or near untreated habitat than treated habitat. Together, both types of data indicated that our study hens selected habitats dominated by shinnery oak and avoided treated areas. Even given the importance of bunchgrasses for lesser prairie-chicken nesting cover, hens in this study did not choose grass-dominated habitats over oak-dominated ones. Although hens spent most of their time in shinnery oak-dominated habitat during the nesting season, this result might be driven by the strong tendency for hens to place nests in untreated pastures, with the result that breeding-season activity was also naturally centered in shinnery oak-habitat.

Cattle eat more grass than shrubs. Even though all pastures in the study were grazed and all nests were located in pastures that were grazed year-round, there was relatively less grass available for grazing in pastures with a substantial shrub component. We therefore considered the possibility that grass-dominated pastures also contained lower vegetative cover than shrub-dominated pastures. Heavily grazed areas might have been avoided by lesser prairie-chicken as much because they lacked cover as because they lacked shrubs. Although basal cover in treated versus untreated areas was not statistically different, it might nonetheless differ enough to be biologically meaningful. Vegetative cover varies spatially and temporally, according to livestock use, topography, and rainfall. Further analysis that controlled for this variation would be required before the cover hypothesis could be adequately tested.

If flat areas were selectively treated with herbicide, apparent hen avoidance of treated areas could actually be a result of hens avoiding flat areas, irrespective of treatment history. However, GIS examination of topography (DRGs) overlaid with treatment polygons revealed that all treatment blocks were crossed by continuous dune complexes that dissect the study area. Given the abundance of dunes in both treated and untreated areas, avoidance of treated areas apparently was not due to topography.

Few other studies exist on the impact of herbicide on lesser prairie-chickens and their habitats. A study in shinnery oak habitat in Texas found significantly more lesser prairie-chicken nests on untreated than on tebuthiuron-treated lands (Haukos and Smith, 1989). In another study, lesser prairie-chickens collected from treated pastures had lower lipid levels, suggesting that they were in poorer condition than birds from untreated sites (Olawsky, 1987). Martin (1990) found 86% fewer lesser prairie-chicken in treated areas than in untreated areas, but visibility was lower in grass, which would be relatively more abundant in treated areas. In an ongoing experimental study in eastern New Mexico, lesser prairie-chicken hens have avoided nesting in tebuthiuron-treated plots and also nested preferentially in ungrazed areas (George M. Sutton Avian Research Center, unpublished data from 2001 and 2002 annual reports). These studies accord with our finding that lesser prairie-chickens nest in habitats dominated by shinnery oak and avoid nesting in areas treated to destroy shinnery oak.

New Mexico BLM abandoned herbicidal shrub control in the early 1990s. Herbicides are still being used to control shinnery oak in lesser prairie-chicken habitat on private lands, but the extent of treatment is unknown. Despite a lack of data on the topic, the belief persists among some land managers that in some areas shinnery oak has become denser than is optimal for lesser prairie-chicken survival and reproduction. This study suggests that if herbicides are applied in doses high enough to destroy most or all of the shinnery oak cover, the habitat will not be used by hens for nesting. Until experimental studies of moderately-treated areas suggest otherwise, we caution that moderate doses of herbicide, designed to thin, but not eradicate, shinnery oak, might also degrade habitat for lesser prairie-chickens.

Management for lesser prairie-chickens should take into account the herbicide treatment and grazing that have impacted much of the lesser prairie-chicken range in New Mexico and other states. Treated areas should not be considered good nesting habitat, especially where grazing has also reduced cover in treated pastures.

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Literature Cited

Bailey, R. G., P. E. Avers, T. King, W. H. McNab, and W. Henry, editors. 1994. Ecoregions and subregions of the United States. Map, scale 1: 7,500,000, colored. Accompanied by a supplementary table of MU descriptions, compiled and edited by W. H. McNab, W. Henry, and R. G. Bailey. United States Department of Agriculture, Forest Service, and United States Geological Survey, Washington, D.C.

Connor, L. M., and B. W. Plowman. 2001. Using Euclidean distances to assess nonrandom habitat use. In: Millspaugh, J. J., and J. M. Marzluff, editors. Radio tracking and animal populations. Academic Press, San Diego, California. Pp. 275–290.

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.

Giesen, K. M. 1994. Movements and nesting habitat of lesser prairie-chicken hens in Colorado. Southwestern Naturalist 39:96–98.

Giesen, K. M. 1998. The lesser prairie-chicken. In:

Poole, A., and G. Gill, editors. The Birds of North America, number 364. Birds of North America, Philadelphia, Pennsylvania.

HAUKOS, D. A., AND L. M. SMITH. 1989. Lesser prairie chicken nest site selection and vegetation characteristics in tebuthiuron-treated and untreated sand shinnery oak in Texas. Great Basin Naturalist 49:624–626.

JENNESS, J. 2001. Nearest Features Arcview extension, version 3.5. United States Forest Service, Rocky Mountain Research Station, Flagstaff, Arizona.

JOHNSON, K., T. NEVILLE, P. TONNE, P. NEVILLE, AND E. CLARY. 2001. Vegetation map of lesser prairie-chicken habitat on the Caprock Wildlife Habitat Management Area, New Mexico. Technical Report U01JOH02NMUS, Natural Heritage New Mexico, Albuquerque.

KERNOHAN, B. J., R. A. GITZEN, AND J. J. MILLSPAUGH. 2001. Analysis of animal space use and movements. In: Millspaugh, J. J., and J. M. Marzluff, editors. Radio tracking and animal populations. Academic Press, San Diego, California. Pp. 125–166.

MARTIN, B. H. 1990. Avian and vegetation research in the shinnery oak ecosystem of southeastern New Mexico. Unpublished M.S. thesis, New Mexico State University, Las Cruces.

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

OLAWSKY, C. D. 1987. Effects of shinnery oak control with tebuthiuron on lesser prairie-chicken populations. Unpublished M.S. thesis, Texas Tech University, Lubbock.

PETERSON, R., AND C. S. BOYD. 1998. Ecology and management of sand shinnery communities: a literature review. General Technical Report RMRS-GTR-16, United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

RILEY, T. Z., 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.

SCHROEDER, M. A., AND C. E. BRAUN. 1991. Walk-in traps for capturing greater prairie-chickens on leks. Journal of Field Ornithology 62:378–385.

TAYLOR, M. A., AND F. S. GUTHERY. 1980. Status, ecology, and management of the lesser prairie chicken. GTR RM-77, United States Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experimental Station, Fort Collins, Colorado.

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.

YOUNG, J. R., C. E. BRAUN, S. J. OYLER-MCCANCE, J. W. HUPP, AND T. W. QUINN. 2000. A new species of sage grouse (Phasianidae: *Centrocercus*) from southwestern Colorado, USA. Wilson Bulletin 112:445–453.

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