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Source: *The Journal of Wildlife Management*, Vol. 40, No. 1 (Jan., 1976), pp. 96-104
Published by: Allen Press
Stable URL: http://www.jstor.org/stable/3800160
Accessed: 13/01/2011 12:01

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EFFECTS OF LAND USE ON LESSER PRAIRIE CHICKENS IN TEXAS[1]

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Abstract: The impact of land use on lesser prairie chicken (*Tympanuchus pallidicinctus*) populations in west Texas was studied from October 1971 to February 1974. Habitat factors considered were soil type, range condition, grazing intensity, amount and type of cultivation, amount of minimum tillage farming, and plant cover as measured by life-form criteria. Lesser prairie chicken populations were estimated from spring and fall lek censuses. Results indicated that extensive areas of native rangeland interspersed with cropland are required to sustain the population. Lek counts averaged 24 males in the spring and 36 birds in the fall where 5–37 percent of the land was used for grain sorghum production and the remainder composed of native shinnery oak (*Quercus havardii*) rangeland. Lek populations on areas with 100 percent rangeland averaged 12 males in spring and 26 birds in fall. Under existing methods of land use, areas with less than 63 percent rangeland appear incapable of supporting stable populations of lesser prairie chickens. Minimum-tillage farming enhances food availability, but the greatest potential threat to the remaining lesser prairie chicken populations in west Texas is the additional loss of native rangeland to cultivation.

J. WILDL. MANAGE. 40(1):96–104

The former range of the lesser prairie chicken included portions of New Mexico, Oklahoma, Texas, Kansas, Colorado, and, possibly, southwestern Nebraska (Sharpe 1968:46–51). The species, perhaps never abundant within historical times, has steadily been confined to ever-smaller ranges (Greenway 1958:190). Jackson and DeArment (1963) believed that the birds peaked in Texas about 1900, an increase attributed to patchwork-type farming and the fall and winter food it provided. Overgrazing and extensive cultivation were blamed for the decline in population in the early twentieth century (Bent 1932:280), and with the drought of the 1930's the lesser prairie chickens apparently were nearing extinction (Lee 1950, U.S. Fish and Wildlife Service 1966). However, Davison (1940) found the birds in good body condition despite the drought and attributed the decline to overhunting. In Texas, lek censuses indicated a decrease of 50 percent between 1942 and 1953 despite the protection from hunting given the birds since 1937; habitat destruction and drought again were blamed for the reduced population (Jackson and DeArment 1963). The hunting season in Texas remained closed on lesser prairie chickens until the late 1960's.

The lesser prairie chicken population fluctuates widely, this instability perhaps resulting from the birds' dependence on mid- and tall grasses occurring in regions of low rainfall (Hamerstrom and Hamerstrom 1961). Serious population reductions occur in years of drought and overgrazing.

Nonetheless, lesser prairie chickens also rely on shinnery oak and sand sagebrush (*Artemisia filifolia*) for resting and escape cover. Jackson and DeArment (1963) believed the removal of these shrubs with herbicides to be one of the major factors affecting lesser prairie chicken populations. They noted that treatment with 2,4-D and 2,4,5-T ruined the habitat, and only after the brush reinvaded the area did any birds return; also, acorn production was pre-

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vented for 2 years, thus removing this key winter food and reducing the lesser prairie chicken population. Furthermore, Jackson and DeArment contended that brush removal concurrent with, or followed by, overgrazing can result in habitat changes which the birds cannot tolerate.

Contrariwise, Donaldson (1969) found that lesser prairie chickens favored sites in Oklahoma where shinnery oak was treated with 2,4,5-T and sand sagebrush with 2,4-D. The sites were sprayed at least twice and a satisfactory kill was achieved, yet more display grounds and relatively large numbers of birds occurred on the treated sites when these were compared with untreated areas.

The habitat limitations imposed on lesser prairie chickens by modern farming and ranching practices are little known. Moreover, this species is considered a rare and vanishing species (Greenway 1958:190, U.S. Fish and Wildlife Service 1968), yet the population in west Texas has been subject to limited hunting in recent years. Accordingly, this study was designed to determine the effects of contemporary land use on the lesser prairie chicken population in a farming and ranching area where hunting is permitted.

METHODS

Study Area and Site Selection

Yoakum County, Texas, was selected as the study area because of the relatively large lesser prairie chicken population found there. The county is in the extreme southern part of the High Plains (or Llano Estacado). Portions of some study sites extended into Cochran and Terry counties, Texas, and Lea County, New Mexico. This region is semiarid with an average annual precipitation of 39.6 cm (U.S. Dept. Agric. records). Sandy or sandy loam soils are typical, and nearly 60 percent of the 214,896 ha in Yoakum County is under cultivation. Grain sorghum is the most common crop, but cotton and alfalfa also are cultivated in the area. The remainder of the land is used primarily for cattle grazing. Petroleum production is also important throughout the county.

Specific study sites were located in March 1972 by driving rural roadways each morning from dawn until 4 hours after sunrise and again in the evening from 4 hours before sunset to dusk; stops were made every 0.8 km to listen for vocalizations indicating an active lek site. Approximately 200 potential sites were checked in this manner, and 7 active leks were selected for study.

After a lek was located and selected for study, the proportions of rangeland and cultivation for the immediate section of land and the eight surrounding sections were determined. Blocks of 9 sections (2,331 ha) were recommended to us by R. E. Jones (Personal communication) because most of the birds' essential activities (i.e., mating and nesting) take place within 0.8 km of the lek. One additional nine-section block consisting entirely of cultivated land was chosen as a control site.

Census Techniques

A lek census (Hoffman 1963) was used to determine the relative population size of each study site. Each lek was censused three times from the last week of March until the third week of May in the springs of 1972 and 1973. Two fall counts were made in 1972 and 1973 between the third week of September and the second week of October. The distance between each lek and the next nearest lek was measured to determine lek density. A randomized block design with sample dates as blocks and analysis of variance test were used to determine if significant differences existed among the study sites.

Duncan's new multiple-range test (Le Clerg 1957) was used to compare the populations between study sites. All population data were transformed for parametric analysis by the equation $N = \sqrt{x} + \sqrt{x+1}$ (Snedecor and Cochran 1967:325–327). Spring and fall populations were compared with Friedman's chi-square R test (Woolf 1968:314–315).

During spring counts, the number of cocks on the lek was recorded during 20-minute sampling periods. In the fall, only the total number of birds on each lek was noted, because many birds remained in cover at this time of year and could not be seen until flushed. Also, juvenile birds were present near the leks in fall but were not sexed.

Land Use

Information regarding specific types of land use for each study area was obtained from the Soil Conservation Service (S.C.S.), Plains, Texas. Data on soils, range condition, grazing intensity, amount and types of brush control, and amount and types of cultivation were determined for the major study sites in 1972.

The percentage of each range site classification (e.g., deep sand, sandy loam, and sandy land) and the range site description for each major study area also were obtained with S.C.S. materials (Dittemore and Hyde 1960) as were range condition and grazing data.

Landowners and S.C.S. records provided data on the extent and nature of chemical brush control applications in the area; aerial applications of 2,4,5-T at 0.56 kg/ha were used throughout. Sites once in cultivation but subsequently abandoned and reverting to rangeland also were treated as brush controlled rangelands. The percentage of plowed land and the year of abandonment were recorded for each site.

Field observations and S.C.S. records were used to determine cultivation data. The percentage of land in grain sorghum and the acreages farmed with minimum tillage techniques were of primary interest. Minimum tillage leaves the grain stubble intact until the land is broken again in the spring. The practice uses specialized equipment which eliminates traditional plowing.

Vegetational Analysis

The rangeland component of all study areas was categorized into range-use types. Areas consisting of the same range site, condition, grazing intensity, and type of brush control were considered to be one type. From combinations of these factors, 23 distinct range-use types were identified on the 7 study areas containing rangeland.

De Rietz's life-form classification as applied by Jones (1963:12) was used to categorize shrubs, forbs, and grasses. Ten random 30.5-m line transects were used to determine crown cover of shrubs and forbs. Along each transect, five 0.45-m^2 quadrats were examined to estimate basal cover of grasses.

The average amount of cover for each life-form on a specific range-use type was multiplied by the percentage of that type on each major study site. Thus, average percentages of cover of the various life-form categories for each study site were obtained.

The land-use and vegetative factors were compared to lek populations in the spring and fall of 1972 and 1973 with multiple regression techniques (Snedecor and Cochran 1967:381–418). The program used was

Table 1. Description of habitat and land-use factors on west Texas lesser prairie chicken study sites, 1973. All values are percentages except those for average range condition and average grazing intensity.

	Site number							
Parameter	1	2	3	4	5	6	7	8
Deep sand	74	56	94	61	97	36	8	2
Sandy land	6	44	6	36	3	50	86	86
Sandy loam	20			3		14	6	12
Rangeland	100	100	95	87	70	63	11	
Av range condition[a]	2.7	2.4	2.4	2.7	1.4	2.2	3.0	
Av grazing intensity[b]	2.0	1.8	1.2	1.7	3.8	1.5	3.0	
Sprayed twice 1959–63[c]	92	90	6					
Sprayed once 1968[c]						24		
Total plowed			12		67			
Dwarf half shrubs	2	3				1	3	
Dwarf shrubs	25	21	41	33	18	27	29	
Shrubs				1			3	
Shrub cover	27	23	41	33	18	29	33	
Short forbs	1	3	2	3	4	8	2	
Mid-forbs		1	1	1	2	1	2	
Total forb cover	2	3	3	4	6	9	4	
Short grass	19	24	10	23	4	29	14	
Mid-grass	8	5	4	3	6	2	9	
Tall grass					1			
Total grass cover	28	29	15	26	12	32	23	
Cultivation			5	13	30	37	89	100
Minimum tillage of grain sorghum				60	36	40	8	

[a] Range condition classes were assigned the following values: Excellent = 4, Good = 3, Fair = 2, Poor = 1. Average range condition was obtained by multiplying the percentage of each condition for every site by the value of the condition class and summing the resulting values.
[b] Levels of grazing intensity were assigned the following values: Ungrazed = 4, Light = 3, Moderate = 2, Heavy = 1. Average grazing intensity was obtained by multiplying the percentage of each grazing level for every study site by the assigned value for that level and summing the resulting values.
[c] Chemical brush control consisted of 2,4,5-T applied at the rate of 0.56 kg/ha.

a step-wise, multiple regression analysis which selected the set of variables, up to a maximum of five, which best accounted for the variation in population data. Two multiple regression analyses were necessary for each sampling period because certain land-use and vegetation factors did not apply to all study sites. One site contained no rangeland and, thus, measurements pertaining to rangeland were not applicable. Two others contained no cultivation. Therefore, one analysis dealt with cultivation factors on all areas having cultivation and the other analysis dealt with rangeland factors on all areas containing rangeland. Separate analyses were made for each sampling period to determine the constancy of factors affecting the population during different years and seasons. Those factors which recurred in the regression formulae for each census period and had high simple correlations were treated as most important in terms of affecting lesser prairie chicken populations.

RESULTS

Description of Study Sites

The 8 study sites contained 0 to 100 percent rangeland. Two sites were 100 percent rangeland, and 4 contained only limited cultivation (5 to 37 percent). Another site was composed of a single section (259 ha) of rangeland surrounded by cultivation. Three sections (777 ha) of land adjoining this site were plowed the year our work

Table 2. Average number of lesser prairie chickens on leks and lek density as determined by the next closest lek to each study site in west Texas, 1972–73.

	1972		1973		Distance to closest
Site	Spring[a]	Fall[b]	Spring	Fall	lek (km)
1	9.3	5.0	14.3	78.0	3.2
2	11.0	4.5	13.0	15.0	3.2
3	20.0	28.5	24.7	17.0	2.4
4	23.3	38.0	24.3	37.0	2.4
5	25.7	38.0	31.3	28.0	1.6
6	17.3	48.0	25.3	53.0	2.9
7	7.3	15.5	3.3	2.0	4.3
8					5.5

[a] Spring counts represent the number of cocks only.
[b] Fall counts include hens and cocks.

Table 3. Significant differences and similarities among lek populations on study sites in west Texas, 1972–73, according to Duncan's new multiple-range tests.[a]

Sampling period	Study site no.							
Spring 1972	8[b]	7	1	2	6	3	4	5
Fall 1972	8	2	1	7	3	4	5	6
Spring 1973	8	7	2	1	4	3	6	5
Fall 1973	8	7	2	3	5	4	6	1

[a] Lines under sites indicate those which are not statistically different from one another ($P > 0.05$).
[b] Sites with the least number of birds appear on the left hand side and progress, in order, to the largest population on the right.

began. Another site consisted of 100 percent cultivation. Habitat descriptions and land-use factors for each study area are given in Table 1.

In deep sand areas shinnery oak was the most common shrub. Sand dropseed (*Sporobolus cryptandrus*), purple threeawn (*Aristida purpurea*), sand bluestem (*Andropogon hallii*), and little bluestem (*Schizachyrium scoparium*) were common grasses. In sandy land areas, blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*), interspersed with mesquite (*Prosopis glandulosa*) and catclaw mimosa (*Mimosa biuncifera*), were the most common plants.

Lek Populations

The average number of cocks on each lek in spring during the 2 years of the study and the average number of birds on the lek each fall are given in Table 2. Analysis of variance tests indicated significant population differences ($P < 0.05$) between the study sites for each period but no significant differences between the sampling dates (i.e., "blocks") within any spring or fall period. Statistical ranking of the mean lek densities for each sampling period appears in Table 3.

The average distance between leks on sites having limited cultivation was 2.4 km (Table 2). Sites with 100 percent rangeland averaged 3.2 km between leks, but where extensive cultivation occurred the average distance increased to 5.0 km.

The average spring lek size, on those areas having active leks, was 14.0 cocks in 1972 and 17.0 cocks in 1973; the increase (22 percent) was significant ($P < 0.10$). No birds were present during any census on site 8. The population at site 7 decreased 55 percent between spring 1972 and spring 1973. Populations at all other study sites increased or remained stable.

The average fall lek population, on areas with active leks, was 22.2 birds in 1972 and 28.8 birds in 1973. Although this was an increase of 30 percent, the difference was not significant ($P > 0.99$). Fall populations also increased at sites 1, 2, and 6 between 1972 to 1973 but decreased in size or were stable in other areas. The average number of birds on leks increased 50 percent from spring to fall of 1972 and 66 percent from spring to fall of 1973. These

Table 4. Simple correlation coefficients between critical habitats (Table 1) and lesser prairie chicken populations.

	Sampling period			
	Spring 1972	Fall 1972	Spring 1973	Fall 1973
Rangeland (%)	0.905	0.795	0.928	0.801
Minimum tillage (%)	0.647	0.703	0.633	0.771
Deep sand (%)	0.835	0.093	0.856	0.592

figures may indicate partially the relative reproductive success for the 2 years of the study, for the fall populations included juvenile birds. Sites with limited cultivation averaged 24.0 males in spring and 35.9 birds in the fall, whereas sites with 100 percent rangeland averaged 11.9 males and 25.7 birds for spring and fall, respectively. Where extensive cultivation occurred, there was an average of 2.7 males in spring and 4.4 birds in the fall.

Land-Use and Habitat Factors

The simple correlations of population size with those factors which the multiple regression analysis demonstrated to be of greatest importance are shown in Table 4. These results demonstrated the importance of the amount of rangeland in maintaining high lesser prairie chicken populations. Where cultivation existed, minimum tillage was found to be influential on populations. Also, the population data were correlated with the amount of deep sand. In addition to the above 3 variables, 14 other variables were contained in the regression formulae but they did not recur during each sampling period and did not normally possess high simple correlations.

DISCUSSION

Lek Populations

Significant differences in lek populations existed between study sites for each sampling period. The highest populations usually were found on those sites with limited cultivation. One exception occurred in fall 1973 when site 1 supported a very high population (78 birds). However, the lek at site 1 was within 274 m of a man-made water impoundment, whereas at all other sites the nearest water source was more than 805 m from the lek. Jones (1964) and Copelin (1963) noted use of stock ponds for drinking in late summer and fall (cf. Crawford and Bolen 1973). Precipitation records (U.S. Department of Commerce 1972, 1973) indicated that total precipitation for September and October 1972 amounted to 18.0 cm but for the same period in 1973 the total precipitation was only 3.1 cm. Because of drought conditions in fall 1973, the birds may have concentrated unusually near the available water source at site 1.

The populations on sites 1 and 2 were not statistically different except during the fall 1973 sampling period. The lesser prairie chicken population associated with the 100 percent rangeland site ranked second in numbers to those sites with limited cultivation. Sites 5 and 6 tended to have the highest populations. Sites 3 and 4 likewise had high populations. However, among these four areas, none consistently held the highest population.

The population on site 7 apparently was not maintaining itself. The 1972 fall count was approximately double the spring count for that year. However, the 1973 spring count was about one-half of the previous spring and the 1973 fall count was lower than the spring of that year. It appears that little or no production occurred on that area in 1973. No lek activity was observed on site 8 during any sampling period.

The estimates of lek density showed that areas with limited cultivation possessed the highest lek density. Areas with 100 percent rangeland ranked second, and areas with extensive cultivation had the lowest lek density.

The population size and density data indicated maximum bird populations occurred on sites with 63 to 95 percent native rangeland and the remainder in grain sorghum cultivation.

Areas with 100 percent rangeland were capable of maintaining a population, perhaps similar to pristine conditions, but the numbers of birds were less than where limited cultivation existed. Birds usually were not found on leks in areas of more than 37 percent cultivation. Site 7 consisted of 89 percent cultivation and apparently was not capable of sustaining a population.

Areas of 63 to 95 percent native rangeland may be considered Class I habitat for the lesser prairie chickens in west Texas. Class II has 100 percent rangeland, and areas with less than 63 percent rangeland are unsuitable for this species. This ranking is in contrast to that used by Copelin (1963: 11). In his study, Class I lesser prairie chicken habitat consisted of 80 to 100 percent rangeland and Class II consisted of 10 to 80 percent rangeland. However, no population data relating to different percentages of the rangeland component were presented, and thus no direct comparison can be made. It is possible that the production of acorns and other seeds was greater on areas studied by Copelin and that the west Texas population is more dependent on cultivated crops to maintain high populations.

Land-Use Effects

Copelin (1963) believed that lesser prairie chicken population density was influenced less by vegetation type alone than by the combined influence of soils, vegetation, and land-use. The results of the regression analyses in our study support this idea and quantify important factors. These factors will be discussed according to consistency during the sampling periods and the magnitude of the correlation coefficients (Table 4).

There were only three common factors in all sampling periods. The percentage of rangeland, percentage of minimum tillage, and percentage of deep sand were part of the multiple regression formulae during each period and also normally possessed high simple correlation coefficients. The positive correlations ($r = 0.91$, 0.80, 0.93, and 0.80 for the respective sampling periods) with the percentage of rangeland appear of prime importance. Areas of less than 63 percent rangeland did not support high, stable populations of lesser prairie chickens. However, areas consisting entirely of rangeland do not support as many birds as those with limited cultivation. If the lesser prairie chicken is to thrive, relatively large tracts of native rangeland must be maintained.

The results of the land-use analyses also indicate a positive correlation ($r = 0.65$, 0.70, 0.63, and 0.77 for the respective sampling periods) between the amount of minimum tillage of grain sorghum on sites with cultivation and the population size during each sampling period (Fig. 1). The fall diet of lesser prairie chickens in this region demonstrated heavy reliance upon sorghum for food, and feeding observations indicated the importance of minimum tillage areas as feeding habitats (Crawford and Bolen 1976).

The benefits of minimum tillage farming are not restricted to the lesser prairie chicken. The S.C.S. reported that acreage suffering wind erosion in the Great Plains more than tripled from November and December 1972 to the same period of 1973 (Willson 1974). In the High Plains region

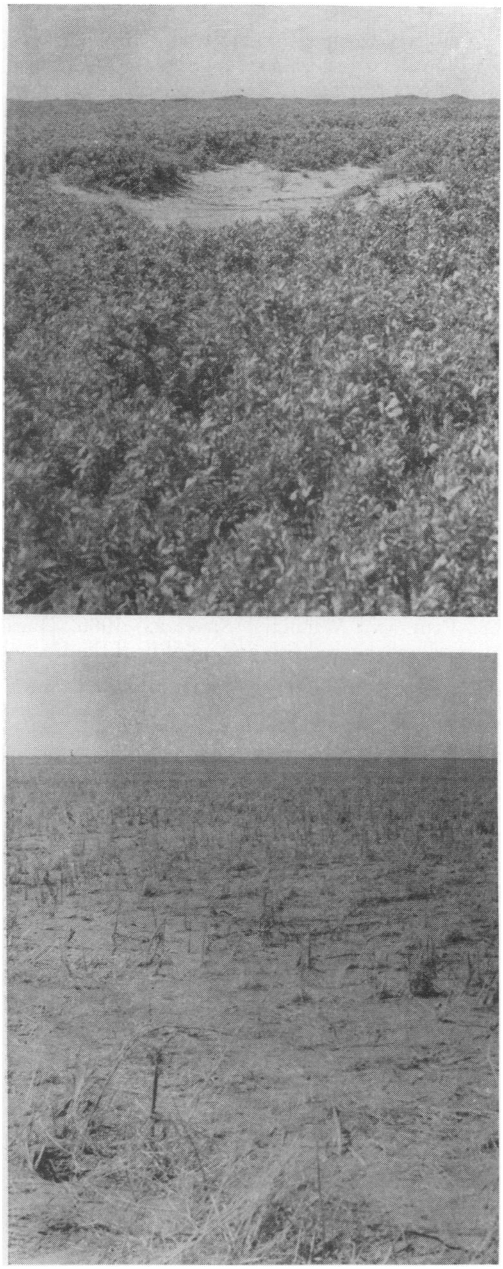

Fig. 1. Shinnery oak sandhills (upper) necessary for lesser prairie chickens in west Texas, and minimum tillage farming (lower) showing grain sorghum stubble, accessible food, and some cover value for lesser prairie chickens. Mixture of oak and cultivation can prove optimal for lesser prairie chickens but clean farming (i.e., traditional plowing) provides virtually no wildlife habitat value.

of Texas the number of hectares damaged increased nearly 8-fold, from 50,183 in late 1972 to 38,251 in late 1973. This damage resulted from inadequate cover, insufficient moisture, and the unwise use of land for row crops. Concurrent with this problem are material shortages and an increase in farming costs. Minimum tillage offers a partial solution to these important farming problems. Labor, machinery, and fuel costs are cut with minimum tillage practices by reducing the amount of work required to obtain a crop. Soil moisture is conserved and, thus, less irrigation water is necessary. Wind and water erosion are reduced, which benefits everyone by diminishing air and water pollution. Furthermore, the stalks, leaves, and seeds undoubtedly benefit pheasants (*Phasianus colchicus*), quail (*Colinus virginianus* and *Callipepla squamata*), doves (*Zenaida macroura*), and turkeys (*Meleagris gallopavo*) in many areas of their ranges as well as the lesser prairie chicken.

Soil factors were also important to lesser prairie chicken populations. During the spring there was a particularly high, positive correlation (1972, $r = 0.84$; 1973, $r = 0.86$) between percentage deep sand and lesser prairie chicken populations, which indirectly emphasizes the reliance of this bird on shinnery oak-bluestem sandhills. Such areas are especially important for nesting.

A number of land-use factors occurred in the multiple regression formulae, but the three factors discussed above recurred in the formulae for each sampling period; moreover, they also possessed high simple correlations with lesser prairie chicken populations, and are thus considered of critical importance to the survival of the species. It must be recognized that continued breaking of the land will create a habitat in which the bird cannot exist.

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Accepted 6 August 1975.