Lesser prairie-chicken densities on tebuthiuron-treated and untreated sand shinnery oak rangelands

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Abstract

Line transect procedures were used to estimate density of lesser prairie-chicken *(Tympanuchus pallidicinctus)* in tebuthiuron-treated and untreated sand shinnery oak (*Quercus havardii* Rydb.) rangelands. Forb and grass composition was greater ($P \leq 0.014$, $P < 0.001$, respectively) in treated areas than in untreated areas, while shrub composition was greater ($P < 0.001$) in untreated sites. Densities of lesser prairie-chicken were similar ($P \leq 0.298$) between treatments. Summer densities were 0.26 birds/ha in treated areas and 0.20 birds/ha in untreated areas, while winter densities were 0.53 and 0.34 birds/ha, respectively. Because shinnery oak provides an important source of shade and food for lesser prairie-chicken, and may be important for cover maintenance by preventing entire areas from being overgrazed in dry years, preservation of some untreated areas is recommended.

Key Words: density, population, *Quercus havardii,* tebuthiuron, *Tympanuchus pallidicinctus*

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The distribution of lesser prairie-chicken has declined >90% since the 1800's (Taylor and Guthery 1980). In west Texas and eastern New Mexico, lesser prairie-chicken are restricted to range sites currently or previously dominated by sand shinnery oak. Shinnery oak is poisonous to livestock during spring and competes with grasses for moisture. Landowners in west Texas and eastern New Mexico have used the herbicide tebuthiuron (N-[5-(1,-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N′-dimethylurea) to control oak. With oak removal, grass production may increase 3–9 times within 2 years of treatment (Pettit 1979).

Rapid conversion from a shrub-dominated to a grass-dominated community could impact lesser prairie-chicken populations. The effects of tebuthiuron on shinnery oak communities have been investigated (Pettit 1979, Jones 1982, Doerr and Guthery 1983), but the actual effects of these treatments, and resulting habitat changes, upon lesser prairie-chicken densities have not been studied. Our objective was to estimate and compare the density of lesser prairie-chicken in tebuthiuron-treated and untreated sand shinnery oak rangelands.

Methods

Field work was conducted in Cochran and Yoakum counties, Texas, and Lea and Roosevelt counties, New Mexico. Areas studied were at the southern portion of the Southern High Plains or Llano Estacado (Dittemore and Hyde 1960, Turner et al. 1974).

Mean annual precipitation was 41 cm and >80% of the moisture occurred between May and October during thunderstorms (Newman 1960, Turner et al. 1974). Range cattle production was the major land use (Newman 1960).

The area was characterized by the Brownfield-Tivoli fine sand soil association, which produced a gently undulating and duned landscape (Dittemore and Hyde 1960). Shinnery oak dominated the area, with less frequent occurrences of sand sagebrush (*Artemisia filifolia* Torr.), sand dropseed (*Sporobolus cryptandrus* Torr.), purple threeawn (*Aristida purpurea* Nutt.), little bluestem (*Schizachyrium scoparium* Michx.), and broom snakeweed (*Xanthocephalum sarothrae* Pursh.) (Pettit 1979). Plant nomenclature follows Correll and Johnston (1979).

Areas previously treated with tebuthiuron were compared with untreated areas. Tebuthiuron-treated pastures were treated between 1979 and 1983 at a rate of 0.56 active ingredient (a.i.) kg/ha. To compare composition of vegetation in treated (N = 5) and untreated (N = 5) pastures, 10 randomly placed 100 point step-point transects (Evans and Love 1957, Strauss and Neal 1983) were conducted within each treatment type during 26 September–26 October 1985 (fall), and 5 March–10 April 1986 (spring). If a point encountered bare soil, the nearest plant was recorded. The nearest plant was chosen from a 180° arc in front of the point (Evans and Love 1957, Strauss and Neal 1983). Kruskal-Wallis K-sample tests ($P<0.05$) were used to compare mean basal composition of taxa between treatment types by season.

Line transect procedures (Burnham et al. 1980) were used to estimate density of lesser prairie-chicken. Density estimation using line transects requires that 5 assumptions be satisfied: (1) objects on the line will always be seen, (2) objects do not move prior to detection and are only counted once, (3) distances and angles are measured exactly, (4) sightings are independent events, and (5) group size does not affect probability of detection (Burnham et al. 1980:14-20). Transects were established systematically and marked with 3-m stakes. All transects were ≥0.8 km apart to minimize the possibility of recounting groups, and at least 0.2 km from any other treatment type to reduce edge effects.

Treated (14,728 ha) and untreated (17,383 ha) areas were sampled over 2 time periods: (1) 16 July–16 September 1985, and (2) 6 January–23 February 1986. One density estimate was obtained each for treated (all treated pooled) and for untreated (all control pooled) pastures in each summer and winter to obtain a group sample size of 40 (Burnham et al. 1980) for each estimate. Thirty-six treated and 21 control pastures were used in summer. In winter 22 treated and 40 control pastures were used. Transects were surveyed only once during each sampling period. During summer, 25 line transects were sampled in untreated oak rangeland, resulting in a total line length of 141.6 km compared with 47 line transects totaling 204.8 km in treated areas. During winter, 50 transects were sampled for a total length of 289.4 km in untreated areas, while 31 line transects were sampled for a total length of 144.2 km in treated pastures.

Transects were surveyed by a 2-person team using a four-wheel-drive vehicle. Use of a dashboard compass and a hand-held compass facilitated our ability to travel in a straight line. Data recorded for all transects were: (1) total length and number of lines surveyed, (2) number of sightings, (3) number of birds in each observation, and (4) perpendicular distances from the transect line to the observed sighting point. Perpendicular distances were recorded using a measuring tape.

Computer program TRANSECT (Laake et al. 1979) was used to estimate lesser prairie-chicken density in treated and untreated

Table 1. Composition (%) of vegetation in treated and untreated sand shinney oak rangelands in west Texas and eastern New Mexico.

	Fall 1985			Spring 1986		
Species	Treated	Untreated	P*	Treated	Untreated	P*
Grasses						
Purple threeawn	21.5	8.6	0.049	30.0	7.1	0.001
Little bluestem	17.2	7.9	0.069	19.9	17.7	0.704
Thin paspalum (*Paspalum setaceum* Nutt.)	9.1	3.6	0.023	4.0	0.1	0.000
Sand dropseed	9.0	3.7	0.053	7.4	2.5	0.043
Hairy grama (*Bouteloua hirsuta* Lag.)	7.0	2.6	0.124	8.2	3.6	0.079
False buffalograss (*Munroa squarrosa* Nutt.)	3.3	0.0	0.013	0.0	0.0	----
Red threeawn (*Aristida longiseta* Steud.)	0.0	2.7	0.005	0.0	0.0	----
Other grasses[1]	11.7(4)	6.4(4)		2.7(2)	1.8(2)	
All grasses	78.8	35.5	0.000	72.2	32.8	0.001
Cyperus spp.[1]	2.5(1)	4.8(2)	0.180	0.2(1)	0.0	0.317
Forbs						
Annual wildbuckwheat	4.7	0.4	0.031	0.2	0.1	0.942
Camphorweed (*Heterotheca latifolia* Buckl.)	3.9	0.1	0.040	0.0	0.0	----
False-nightshade	0.0	0.0	----	8.8	0.0	0.002
Narrowleaf gromwell (*Lithospermum incisum* Lehm.)	0.0	0.0	----	4.6	0.2	0.010
Other species[1]	8.3(16)	8.5(13)		10.1(8)	1.6(7)	
All forbs	16.9	9.0	0.014	23.7	1.9	0.000
Shrubs						
Sand shinnery oak	0.7	47.6	0.000	1.6	63.9	0.000
Sand sagebrush	0.1	1.8	0.036	1.0	0.9	0.722
Other shrubs[1]	1.0(3)	1.3(2)		1.3(2)	0.5(2)	
All shrubs	1.8	50.7	0.000	3.9	65.3	0.000

*Test between treatments within seasons.
[1]Species which individually make up less than 5.0% of the total composition in all treatment-season combinations, and do not differ ($P>0.05$). Number of species in parentheses.

areas. Number of groups/unit area (D_c) was estimated using the formula (Burnham et al. 1980:56):

$$Dc = \frac{nf(0)}{2L},$$

where n is the number of observations (groups), $f(0)$ is the probability density at the transect line, and L is the combined length (km) of the line transects. The value $f(0)$ was estimated by fitting the Fourier series estimator model to the perpendicular distance data from each treatment type for each season transects were surveyed (Burnham et al. 1980). Because perpendicular distance data were collected without a defined width, all data were used for the initial analysis. We truncated 7.5–2.5% of the data from 3 of the 4 surveys to obtain an acceptable fit as determined by chi-square tests. For the summer data 1 term was specified in the Fourier series models.

Group densities were multiplied by average group size ($\overline{C}$) to estimate density of birds/ha (D) where:

$$D = D_c \overline{C} = \frac{nf(0)\ \overline{C}}{2L}$$

Standard error for bird density was calculated (Burnham et al. 1981) as:

$$se(d) = D[(cv^2(\overline{C}) + cv^2(D_c)]^{1/2} \bullet$$

Differences in density estimates between treated and untreated areas were tested using a Z test (Johnson 1976:355) on a seasonal basis. Within a season, mean group sizes were compared between treatments using a Wilcoxon 2- sample test (Hollander and Wolfe 1973:68).

Results

Vegetation composition differed between treatments for both seasons (Table 1). Shrub composition was greater ($P<0.001$) in untreated pastures during both seasons; shinnery oak comprised the greatest percentage of live plants encountered. In contrast, forbs occurred more ($P\leq0.014$) frequently in treated than in untreated pastures. However, forbs present varied between seasons. Annual wild buckwheat (*Eriogonum annuum* Nutt.) composition was greater ($P = 0.031$) in treated than in untreated areas during fall, but was similar ($P = 0.942$) between treatments during spring. Conversely, false-nightshade (*Chamaesaracha* sp. Gray) was not encountered in fall, but occurred in tebuthiuron-treated areas in spring. Frequency of grasses was greater ($P<0.001$) in treated areas than in untreated areas during both seasons (Table 1). Among grass species, purple threeawn occurred most frequently.

Densities of lesser prairie-chicken were similar ($P = 0.535$) in tebuthiuron-treated and untreated areas during summer (Table 2). Group sizes were also similar ($P = 0.712$) between the 2 treatment types. During winter estimated density was 55.7% higher in treated than in untreated areas, but this difference was not statistically significant ($P = 0.298$). Density of groups was higher during winter ($P\leq0.010$) in tebuthiuron-treated than in untreated areas. Group sizes did not differ ($P = 0.411$) between treated and untreated areas at this time.

Distributions of perpendicular distances from the transect line to the detection point varied between treatments. Most sightings of prairie-chicken occurred closer to the transect line in tebuthiuron-treated than in untreated areas, particularly during winter (Fig. 1). During winter, 70% of the groups in tebuthiuron-treated areas were ≤15 m of the line; 2.5% of the groups were ≥48 m. In contrast, 52.5% of prairie-chicken groups in untreated areas were ≤15 m from the line and 22.5% of perpendicular distances were ≥ 48 m from the line.

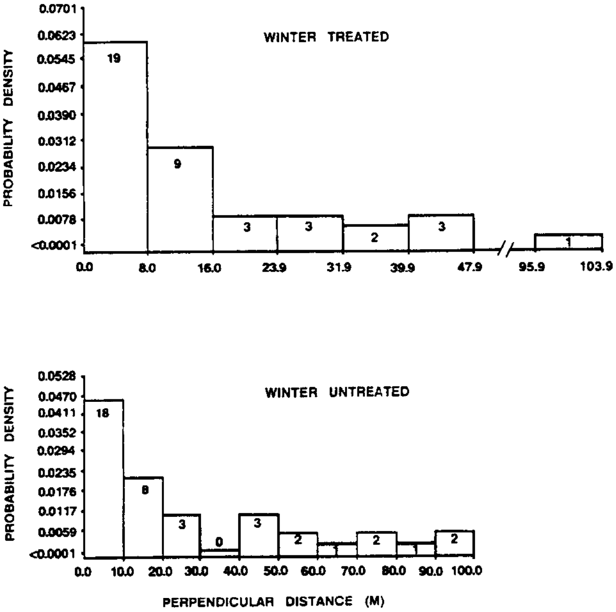

Fig. 1. Distribution of perpendicular distances for lesser prairie-chicken in tebuthiuron-treated (top) and untreated (bottom) sand shinnery oak rangelands in west Texas and eastern New Mexico, January–February 1986. Values within histogram bars represent the number of groups observed in each distance interval.

Table 2. Density (birds/ha) of lesser prairie-chicken in tebuthiuron-treated and untreated sand shinnery oak rangelands during summer (July–September) 1985 and winter (January–February) 1986, Southern High Plains of Texas and New Mexico.

Survey	N (groups)	w[1]	L[2]	$f(0)$[3]	SE	D_c[4]	SE	$\bar{c}$[5]	SE	D[6]	SE
Summer											
Treated	37	25.6	204.8	0.084	0.007	0.075[a]	0.013	3.375	0.521	0.254[c]	0.059
Untreated	38	44.8	141.6	0.044	0.005	0.058	0.016	3.425	0.572	0.200	0.063
Winter											
Treated	39	47.9	144.2	0.064	0.011	0.086[b]	0.020	6.175	1.033	0.531[d]	0.149
Untreated	40	99.7	289.4	0.046	0.008	0.032	0.008	10.675	2.080	0.341	0.106

[a] = 0.407 between treatments within seasons; [b] $P = 0.010$; [c] $P = 0.535$; [d] $P = 0.298$.
[1]Largest perpendicular (m) distance after truncation.
[2]Total line length (km)
[3]Inversely proportional to the probability of detecting a group.
[4]Groups/ha.
[5]Average group size.
[6]Birds/ha.

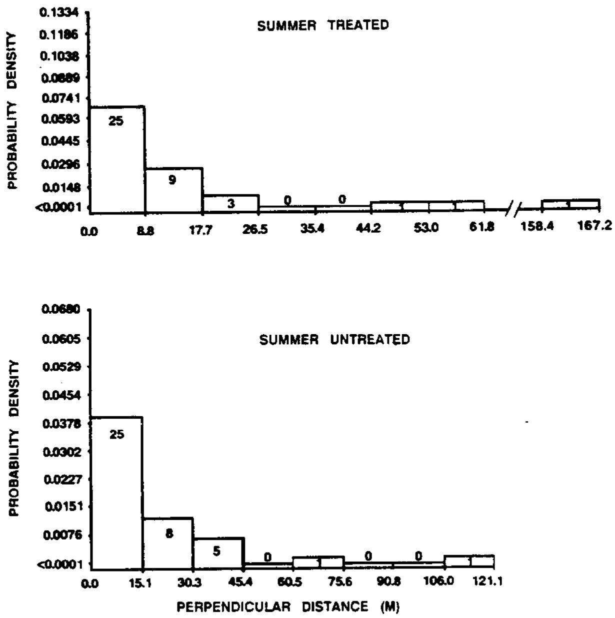

Fig. 2. Distribution of perpendicular distances for lesser prairie-chicken in tebuthiuron-treated (top) and untreated (bottom) sand shinnery oak rangelands in west Texas and eastern New Mexico, July-September 1985. Values within histogram bars represent the number of groups observed in each distance interval.

Perpendicular distance distributions in summer also differed between treatments as 52.5% of the groups recorded in treated areas were ≤5 m from the line (Fig. 2). In contrast, only 35% of the groups were ≤5 m from the line in untreated oak.

Discussion

Our data indicated that composition of forbs was greater in areas previously treated with 0.56 a.i. kg/ha of tebuthiuron than in untreated areas within 3–6 years after treatments. Jones (1982) noted forbs and grasses were adversely affected by rates ≥0.4 kg/ha, but recovered within 2 years of treatment.

Prior investigations of tebuthiuron treatments in a portion of our study area (Cochran County) (Jones 1982) indicated that while total grass density increased with treatments, purple threeawn was the only perennial grass to increase in density. Increased canopy cover by perennial grasses was generally due to an increase in plant size and not plant density (Jones 1982). Davis et al. (1979) suggested that sand bluestem (*Andropogon hallii* Hack.) provided critical cover for lesser prairie-chicken. Although we rarely encountered sand bluestem on step-point transects, Jones (1982) found that densities of plant species following treatment were highly dependent upon pretreatment densities. Therefore, lack of sand bluestem prior to treatment may have affected sand bluestem frequencies on step-point transects.

Lesser prairie-chicken densities were evaluated based upon the major assumptions of line transect theory (Burnham et al. 1980). (1) When conducting line transects, 1 of the 2 observers stood in the back of the vehicle, resulting in an elevated position. The elevated position allowed good visibility of birds on or near the transect line. Wywialoski and Stoddart (1988) found that density estimates were more accurate with elevated observers relative to observers on foot. (2) Histograms of the perpendicular distances gave no indication that birds moved appreciably before detection (Figs. 1, 2). Although inferences about the lack of lateral movement cannot be based solely on histogram appearance (Burnham et al. 1980:130), field observations do not suggest that Assumption 2 was seriously violated. (3) Measuring tapes were used to record distances and care was taken not to round measurements so distances were measured exactly. (4) Of 160 observations during the 4 surveys, only in 2 instances were 2 groups observed <5 minutes apart. Thus, sightings were independent. (5) Because lesser prairie-chicken may congregate in large groups, group size may affect flushing behavior. During summer, effects of group size on perpendicular distances were not significant for treated ($R^2 = 0.023$, $P = 0.354$) or untreated ($R^2 = 0.001$, $P = 0.868$) areas. Analysis of winter data also indicated no correlation between group size and perpendicular distance for treated ($R^2 = 0.002$, $P = 0.769$) or untreated ($R^2 = 0.017$, $P = 0.424$) areas. Although these results do not eliminate the possibility of dependence between group size and detectability, they do suggest that Assumption 5 was not seriously violated.

Lesser prairie-chicken densities were not different between treatments. Davis et al. (1979) noted that concealing plant cover may be better in areas with more tall grass and fewer shrubs, especially during winter. Similarly, Doerr and Guthery (1983) found bunchgrasses in tebuthiuron-treated plots provided greater vertical screening than vegetation in untreated plots during December. Differences between treatments in the distribution of perpendicular distances indicated that lesser prairie-chicken were more difficult to detect in treated than in untreated areas. Likewise $f(0)$ values indicated that detectability was greatest in untreated pastures (Table 2). This suggests that cover in tebuthiuron-treated pastures provided better concealment than in untreated pastures, particularly during winter, after oak leaves had dropped. While shinnery oak is bare in winter, tall grasses continue to provide cover for birds, and may be preferred areas for loafing and roosting during cool seasons (Taylor and Guthery 1980). Cannon and Knopf (1981) also noted a positive correlation between density of displaying males and percent grass cover in shinnery oak rangelands.

Copelin (1963) suggested that lesser prairie-chicken required brushy vegetation for shade during summer. He also suggested this requirement was critical during drought or when temperatures neared or reached 37.8° C. Average temperatures during the 3 months of summer transects (July–September 1985) were within 1° C of the 30-year average. The average maximum temperatures were 33.6, 34.5, and 29.0° C for July, August, and September, respectively. Daily high temperatures reached or exceeded 35° C during 21 days (33%) when summer line transects were conducted. Thirteen of the 21 days occurred in August. Precipitation was also slightly above the 30-year mean for the time when line transects were surveyed. During a warmer and/or drier summer, shade provided by oak may be more critical to prairie-chicken, and may cause birds to move into areas of untreated oak. Oak may also help maintain prairie-chicken cover by preventing entire areas from being overgrazed in dry years.

Tebuthiuron applications on shinnery oak rangelands resulted in increases in grass composition as shrub composition decreased. Forb composition increased within 3-6 years after chemical treatment. Changes in vegetation composition as a result of tebuthiuron treatments appeared to have little effect on lesser prairie-chicken densities, especially during summer. Increased production of tall grasses in treated pastures may provide concealing cover superior to that in untreated areas. However, in shinnery oak rangelands, lesser prairie-chicken may require oak for food (Crawford and Bolen 1976, Olawsky 1987) or for shade during summer. Lesser prairie-chicken may benefit by preservation of scattered sites of untreated sand shinnery oak. A mosaic of the 2 treatment types should produce favorable conditions by making areas of both untreated oak and tall grasses available to lesser prairie-chicken.

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