EFFECT ON LESSER PRAIRIE CHICKENS OF BRUSH CONTROL IN WESTERN OKLAHOMA

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CHAPTER I

INTRODUCTION

Extensive areas of the Southern Great Plains are carpeted with brushy grasslands. The degree of dominance of the brush species varies considerably. Historically, the grasslands were probably kept open by fire (Box, 1967). In recent times, however, brush species have invaded or have increased in abundance in many areas that were formerly grassland.

Brush encroachment significantly reduces the carrying capacity of rangelands for livestock. With increased demands for livestock range and agricultural products brush control has become economically feasible. There has been a great increase in the development of methods for manipulating range resources to enhance those of greater commercial value (Goodrum and Reid, 1956).

Recent advances in brush control methodology have increased the capacity of certain areas to produce livestock, resulting in substantially increased net profit to the operator (McIlvain and Shoop, 1965). The practice of controlling brush for pasture improvement will probably continue indefinitely. Complete eradication of brush species is seldom undertaken. The current emphasis is placed on brush management rather than eradication (McIlvain, personal communication). Some species of brushy plants are valuable for winter and for drought forage; they aid in the control of wind erosion, protect some grasses

from grazing so that they will set seed, shade cool-season grasses, and aid in the recirculation of deeply leached soil minerals. Brush species are therefore considered "conservation devices" in some areas (McIlvain and Shoop, 1965).

Shinnery oak (Quercus havardi) and sand-sagebrush (Artemisia filifolia) are two brush species occupying rather large areas of deep, sandy soils in the Southern Great Plains. Western Oklahoma contains approximately 1,000,000 acres of shinnery oak and 600,000 acres of sand-sagebrush (Allred, 1948). For more than a decade shinnery oak and sand-sagebrush have been subjected to eradication or suppressive measures. These two range plants, in their respective areas of distribution, are presently considered to be vital to the welfare of lesser prairie chickens [Tympanuchus pallidicinctus (Ridgway)]; (Hamerstrom and Hamerstrom, 1961; Copelin, 1963; Jackson and DeArment, 1963; and Jones, 1963). It is important, therefore, to determine the effect of brush suppression on the welfare of the lesser prairie chicken. If brush control affects prairie chickens adversely and this harm can be identified and measured, corrective measures may then become possible. Ultimately the perpetuation of this grouse species must be assured.

The purpose of this study was to analyze the response of the lesser prairie chicken to brush control operations in western Oklahoma. More specifically the objectives were to: (i) determine whether lesser prairie chickens are present or absent in selected areas of treated and untreated shinnery oak and sand-sagebrush; (ii) measure the effects of brush control on the characteristics and composition of representative vegetational associations; and (iii) determine if brush control practices have affected the distribution and numbers of lesser prairie

chickens in the treated areas.

The lesser prairie chicken has been confined to a relatively small range since the beginning of the historical period (Bent, 1932; and Aldrich and Duvall, 1955). More recently, however, its populations appear to have become even more localized, suggesting a reduced species survival potential. Populations fluctuate markedly (Davison, 1940; and Copelin, 1956, 1963). The birds reportedly were very numerous in the early 1900's during which time they occasionally damaged some crops (Judd, 1905). They were subject to some market hunting during peak population periods in early times (Judd, 1905; and Jackson and DeArment, 1963). Very low populations were noted during the great drouths of the 1930's and early 1950's. Although lesser prairie chickens are currently maintaining sizeable populations, their range and total numbers are much reduced from earlier periods (Hamerstrom and Hamerstrom, 1961). Currently the lesser prairie chicken is considered an endangered species (USFWS, 1966; Greenway, 1967).

The basic approach of this study was to evaluate the quality of the habitat in representative treated and non-treated shinnery oak and sand-sagebrush grasslands. Habitat is considered here to be the place where a population of a species carries out all of its life activities (Stebler, 1957). The habitat must include components to satisfy the species' need for food, shelter, and reproduction. The use to which a habitat component is put, e.g., courtship grounds or nesting areas, may also be a subdivision of the habitat. The summation of the components an animal uses to satisfy its life activities constitutes its habitat.

Habitats have been defined classically either in very general or

very specific terms. The latter approach is usually based on a detailed analysis of the plant species present in a given area. More recently, however, the description and analysis of habitat has focused on an attempt to discern the actual operative and recognizable elements involved (Yapp, 1922; Lack, 1933; Pitelka, 1941; Peterson, 1942; Svardson, 1949; Elton and Miller, 1954; Stebler and Schemnitz, 1955; Emlen, 1956; Jones, 1959; Schemnitz, 1961; and Klopfer and Hailman, 1962). Grinnell (1928), Seton (1929), and Miller (1942) have shown that animals do not roam about at random. Murie and Murie (1931) and Stickel (1949) demonstrated a positive orientation or attraction on the part of animals to a particular area. Lack (1933) states that the distribution of birds is always irregular. Habitat selection implies recognition. One would, therefore, expect a correlation between recognition and conspicuous features of the habitat. Lack (1933) found that stonechats and whinchats were equally common in vegetation of similar height whether bracken fern or young pines. Miller (1942) found olive-sided flycatchers in conifers and in introduced eucalyptus, tree species having similar height. Miller adds, however, that the spacing of the trees was also a prime factor in habitat selection. Clearly, height of the vegetation is not the only feature of the environment correlated with habitat selection. There is a dependence on other features. However, the influence of height can be isolated from other features, hence its prominence in this discussion.

A consistent relationship between birds and plant life-form was found by Pitelka (1944). The life-form of vegetation provides recognizable features of a habitat (Elton and Miller, 1954). Plant life-form appears to be a reliable criterion with which to discern subtle

habitat differences. Vegetation used as cover is the main single point of the habitat that will be most seriously affected by spraying. This variable will be investigated here to learn how it is influenced by spraying and how this in turn may affect lesser prairie chickens.

According to DuRietz (1931), life-form classification is based upon "the general physiognomy of the plants during the height of their annual vegetation period, without regard to any details in their morphological structure or to their way of perduring the unfavorable season." Principle categories of this system are woody plants, half-shrubs, and herbs. Further subdivision can be based on height (Kuchler, 1949).

This study was developed by combining the methods of the plant and animal ecologist. It is obviously important to integrate flora and fauna in wildlife ecology. The use of such methods as the point-centered quarter technique and plant life-form classification enable researchers to concentrate on intensive rather than extensive investigation. With such an approach one immediately becomes aware of the diversity rather than the uniformity of life conditions within the range (potential or occupied) of a species. Once the preferred habitat of a species is known it becomes possible to assess directly the quality of the habitat throughout its range.

This report is based on approximately two years of field research. The summer of 1965 was devoted to delineating specific study areas and developing techniques. Intensive field work was initiated in February 1966 and terminated in the summer of 1967.

CHAPTER II

DESCRIPTION OF THE STUDY AREAS

Regional Environment

Western Oklahoma has a continental climate characterized by hot summers, mild autumns, moderately cold winters, and moist, windy springs. The growing season averages about 200 days in the northwestern sections, with an average annual precipitation of about 23 inches. Wind velocities and evaporation are high. Specific climatological phenomena of the region have been described by Wahlgren (1941) and the U.S. Weather Bureau (1950).

The physiography of the region has been described by Fenneman (1931). In general, the region lies within the Great Plains Province characterized by a "broad belt of highland which slopes gradually eastward from the Rocky Mountains to the central lowland" (Fenneman, 1931). Specific local physiographic conditions have been described by the Soil Conservation Service, USDA.

The vegetation of western Oklahoma has been described by Bruner (1931), Blair and Hubbell (1938), and Webb (1950). These studies are in general agreement with the work of Duck and Fletcher (1943 and ca. 1944). The ecologic regions or game types recognized in western Oklahoma are sand-sagebrush grassland, shinnery oak grassland, stabilized dunes, mixed-grass eroded plains, short-grass highlands, and

tall-grass prairie (Duck and Fletcher, 1943 and ca. 1944). Eight study areas representing two of the above game types (sand-sagebrush grassland and shinnery oak grassland) were selected for investigation.

The specific study areas were representative of treated and untreated plots in the shinnery oak and sand-sagebrush habitat types. Two untreated areas each in the shinnery oak and sand-sagebrush habitat types were selected as control areas for comparison with two treated areas in each habitat type. These were located in Harper, Woodward, and Ellis Counties (Fig. 1); their geographical positions are listed in Table I.

TABLE I

SPECIFIC LOCATIONS AND SIZES OF THE STUDY AREAS

Name of Area	Habitat Type and Treatment	Location	Size
Smith	untreated Qha*	N½ - S 8 - T 20 N - R 22 W	320 acres
East House	untreated Qha	S 18 & 19 - T 18 N - R 23 W	1280 acres
Willcoxin	treated Qha	N½ - S 6 - T 20 N - R 22 W	320 acres
Twin Tanks	treated Qha	S 30 & 31 - T 18 N - R 23 W	1280 acres
Randall	untreated Afi**	S 18 - T 25 N - R 22 W	640 acres
Range	untreated Afi	portions of S 21 & 28 - T 25 N - R 22 W	640 acres
Coop. No.	treated Afi	N½ - S 25 - T 25 N - R 22 W & N½ - S 30 - T 25 N - R 21 W	640 acres
Coop. So.	treated Afi	S 36 - T 24 N - 22 W	640 acres

* Qha refers to Quercus havardi (Shinnery oak)
** Afi refers to Artemisia filifolia (Sand-sagebrush)

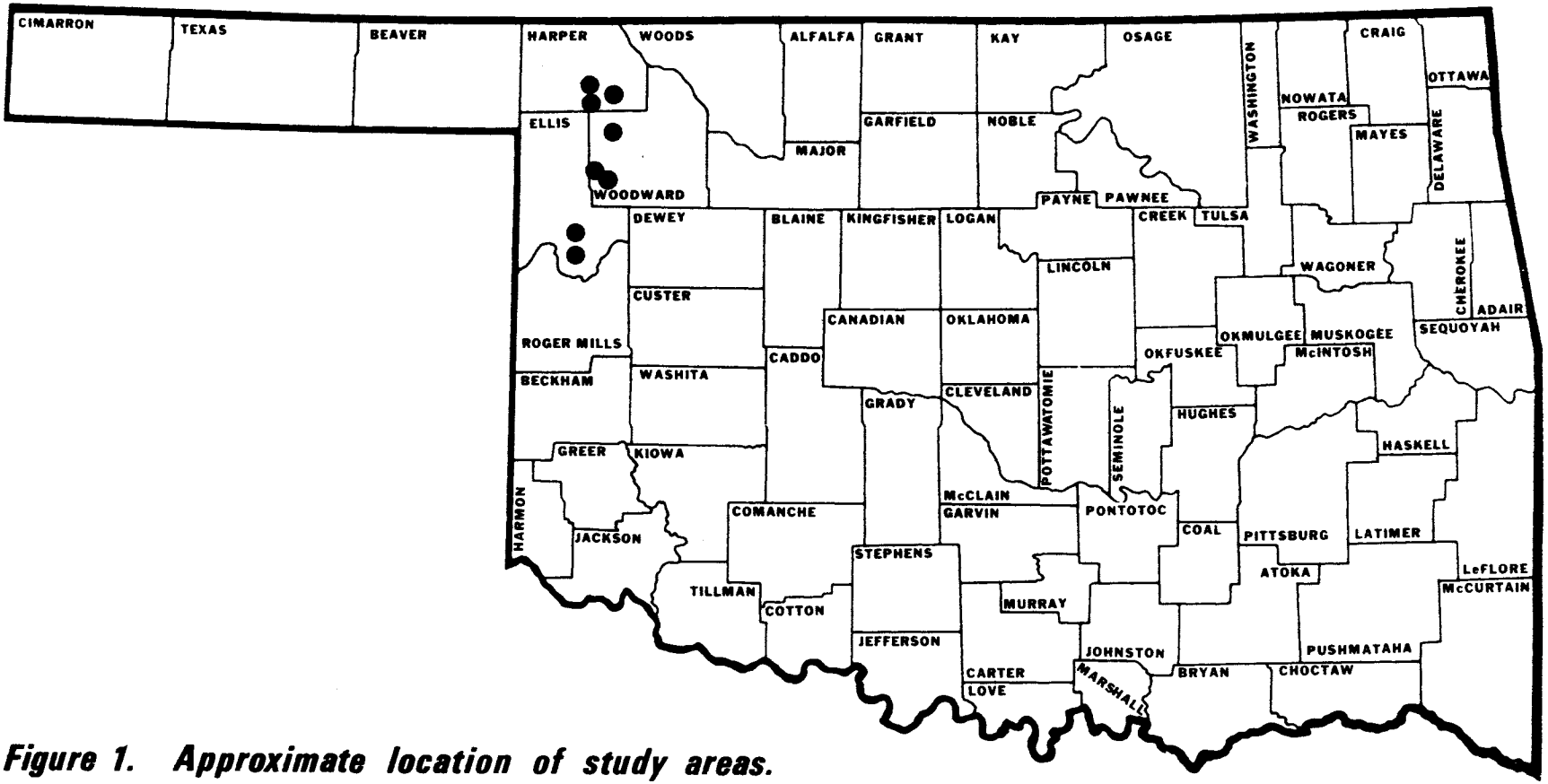

Figure 1. Approximate location of study areas.

Treated areas were subjected to aerial herbicide applications. The shinnery oak study areas were sprayed with 2,4,5 T, and 2,4 D was used on the sand-sagebrush study areas. The herbicides were applied at a rate of 0.5 pounds per acre. The carrier for the herbicides was an emulsion of diesel oil in water. No direct toxic effects of these herbicides on animals have been reported (Hall, 1952; Rudd, 1954). Spraying was done when the plants were mostly in full leaf and growing rapidly. This period was usually between May 15 and July 14 (Armstrong and McIlvain, 1963).

All treated areas were sprayed at least twice by private applicators prior to the initiation of this study. The brush kill was considered to be satisfactory in the sprayed pastures. Generally, after an acceptable kill is attained, it is not necessary to treat the area again for ten to fifteen years (McIlvain and Armstrong, 1959). This interval, however, depends on the cattle stocking rate. The Twin Tanks study area was burned in 1965.

No pre-spray information was available. It was assumed that the vegetation was similar in sprayed and unsprayed areas before spraying.

CHAPTER III

METHODS

Vegetational Analysis

The point-centered quarter method of vegetation sampling developed by Cottam and Curtis (1956) and modified for use in grassland by Dix (1958, 1961) was employed for sampling the vegetation of each study area. This method belongs to the family of plotless or distance-measurement methods (Phillips, 1959; Dix, 1961). Each sampling point is the center of four quarters; the plant closest to the center in each of the quarters is chosen and its distance from the center recorded to the nearest centimeter. This method provides a means of taking rapid quantitative samples which are free from subjective estimates and which yield reliable data on frequency and density of grassland vegetation (Dix, 1961; Penfound, 1963).

All study areas were sampled in the spring of 1966 and again in the summer of 1966 to ascertain the structure and composition of the vegetation available to prairie chickens during the height of the growing season. At each point, the plant life-form was noted for each plant species encountered. Each stand was sampled by 50 points (200 measurements) placed at 5-meter intervals. According to Cottam and Curtis (1956) approximately 30 individuals of a particular species must be encountered in the total sample before reasonable accuracy is

obtained for that species. Since 30 individuals of several species were encountered in each stand, the sampling intensity used here was assumed to be adequate.

The life-form classification used in this study closely follows that proposed by DuRietz (1931). There were, however, some minor modifications. Height criteria proposed by Kuchler (1949) were used and the life-form of some species was noted in terms of the amount of growth attained by the time of sampling. The latter modification was made to obtain data on the phenology of vegetational structure.

In agreement with DuReitz's original classification, all plants were first categorized as woody plants, half-shrubs, or herbs. Woody plants were subdivided into trees, shrubs, or dwarf shrubs. The life-forms used in this study are summarized in Table II.

In addition to the parameters directly obtainable from original vegetal data, some refinements were made. Importance values were calculated by summing relative frequency and relative density values. Since relative frequencies and densities are calculated from the number of points of occurrence (each point is considered a quadrat), the importance value is independent of distances or absolute densities per unit area (Cottam and Curtis, 1956; Dix, 1961). Its magnitude suggests the vegetational importance of a species within a stand (Curtis and McIntosh, 1951). Dix (1961) pointed out that these values may be highly desirable when some method which will permit direct comparisons between various synusia is wanted. Finally, the similarities of life-form in each of the eight study areas were objectively measured by employing Sorenson's Index of Similarity (Sorenson, 1948 in Dix, 1958).

TABLE II

DESCRIPTION OF LIFE-FORMS (DuRIETZ, 1931)

HERBACEOUS PLANTS	
Grasses	
(S.G.) Short grass:	< 25 cm
(M.G.) Mid-grass:	25 cm - 80 cm
(T.G.) Tall grass:	> 80 cm
Forbs	
(S.F.) Short forb:	< 25 cm
(M.F.) Mid-forb:	25 cm - 80 cm
(T.F.) Tall forb:	> 80 cm
WOODY PLANTS	
(T) Tree:	Distinct main trunk remaining unbranched in its lower parts.
(S) Shrub:	Stem branched from its basal parts. Above or below the ground. > 80 cm.
(D.S.) Dwarf shrub:	Conforming to shrub description but < 80 cm.
(H.S.) Half-shrub:	Only the lower parts of the stem lignified and perennial; the upper parts are annual and herbaceous. > 80 cm.
(D.H.S.) Dwarf half-shrub:	Conforming to half-shrub description but < 80 cm.

Habitat Use Analysis

Data on habitat use were gathered by observing lesser prairie chickens under field conditions. The amount of time spent on each study area was directly proportional to the size of the area and 2,000 miles of prairie chicken habitat were traversed. When birds were flushed from a covert, which could be verified by the presence of droppings, the point-centered quarter implement was placed at the flush point and readings were taken. In some cases the birds flushed wildly and the exact point from which they fled was impossible to locate. In such cases, an estimation was made of the immediate area. The

estimations were made of the same parameters as those measured by the point-centered quarter implement. The life activity in which each bird was engaged was noted at every sighting. Additional information taken at the sightings included the height of the vegetation, life-form, dispersion of the various plant components, and approximate aerial plant coverage. Miscellaneous notes were taken on other aspects of lesser prairie chicken ecology. These data were recorded on specially designed key-sort marginal punch cards.

The term "bird quadrat frequency" was used to express the frequencies of plant species and life-forms encountered at the flush sites.

Booming Ground Surveys

All booming grounds on or near the various study areas were located and the number of males using each ground was noted. Counts were made from either an automobile or from a portable blind placed near the booming ground. Those from automobiles or portable blinds were also found to be the most satisfactory by other workers (Davison, 1940; Jones, 1963). Occasionally, the birds would flush from the display ground when a vehicle approached, but they would return in a few minutes. Three to five booming grounds were censused each morning. The birds would flush wildly if display areas were approached on foot or horseback resulting in less reliable counts. A census of all booming grounds was made in the spring and fall of 1966 and spring of 1967. Each booming ground was surveyed at least 12 times during each courtship season.

CHAPTER IV

RESULTS

Vegetation Analysis - Spring 1966

Noticeable differences occurred between total plant density values of all species in the various study areas (Fig. 2). The Range study area, located in non-treated sand-sagebrush grassland, had the greatest total density of plants. Conversely, the Cooper North study area in the same grassland type had the lowest total density value. The latter area had been subjected to brush control operations. Total density values in the study areas of the sand-sagebrush grasslands were much more variable than those situated in the shinnery oak grasslands. Non-treated shinnery oak study plots were characterized by lower total plant densities than non-treated sand-sagebrush plots.

The relative densities of species in woody, forb, and grass life-forms on all study plots are shown in Figures 3, 4, and 5 respectively. As would be expected, woody species were most prevalent in non-treated areas. All treated areas show a marked suppression of woody species. Forbs occurred more densely in the sand-sagebrush than in the shinnery oak areas. Sand-sagebrush areas also had the greatest disparities in forb densities. Grasses were considerably more dense in treated as opposed to non-treated shinnery oak plots. Grass densities varied greatly in sand-sagebrush study plots, and no order was evident between treated and non-treated areas.

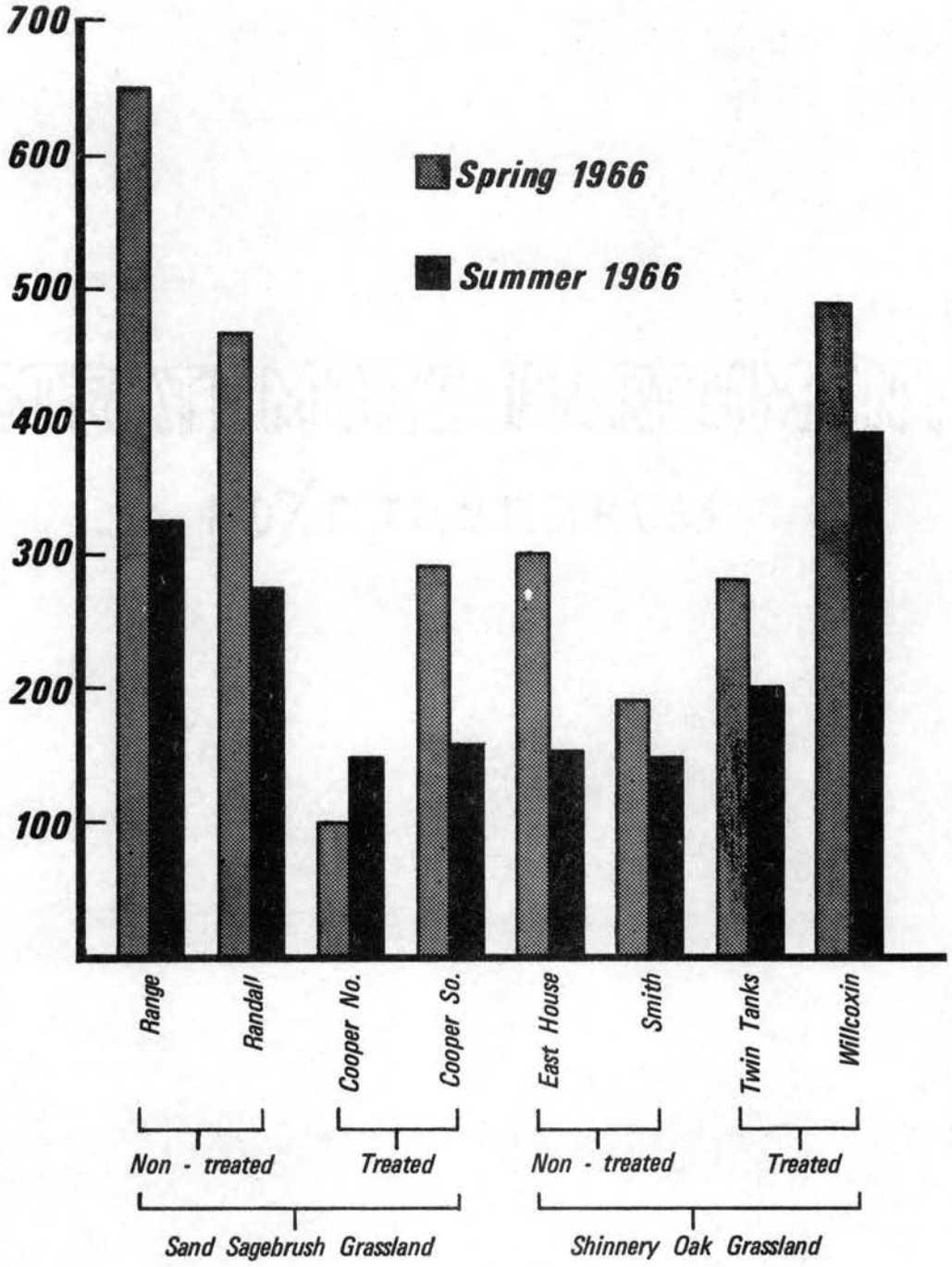

Figure 2. Total plant density.

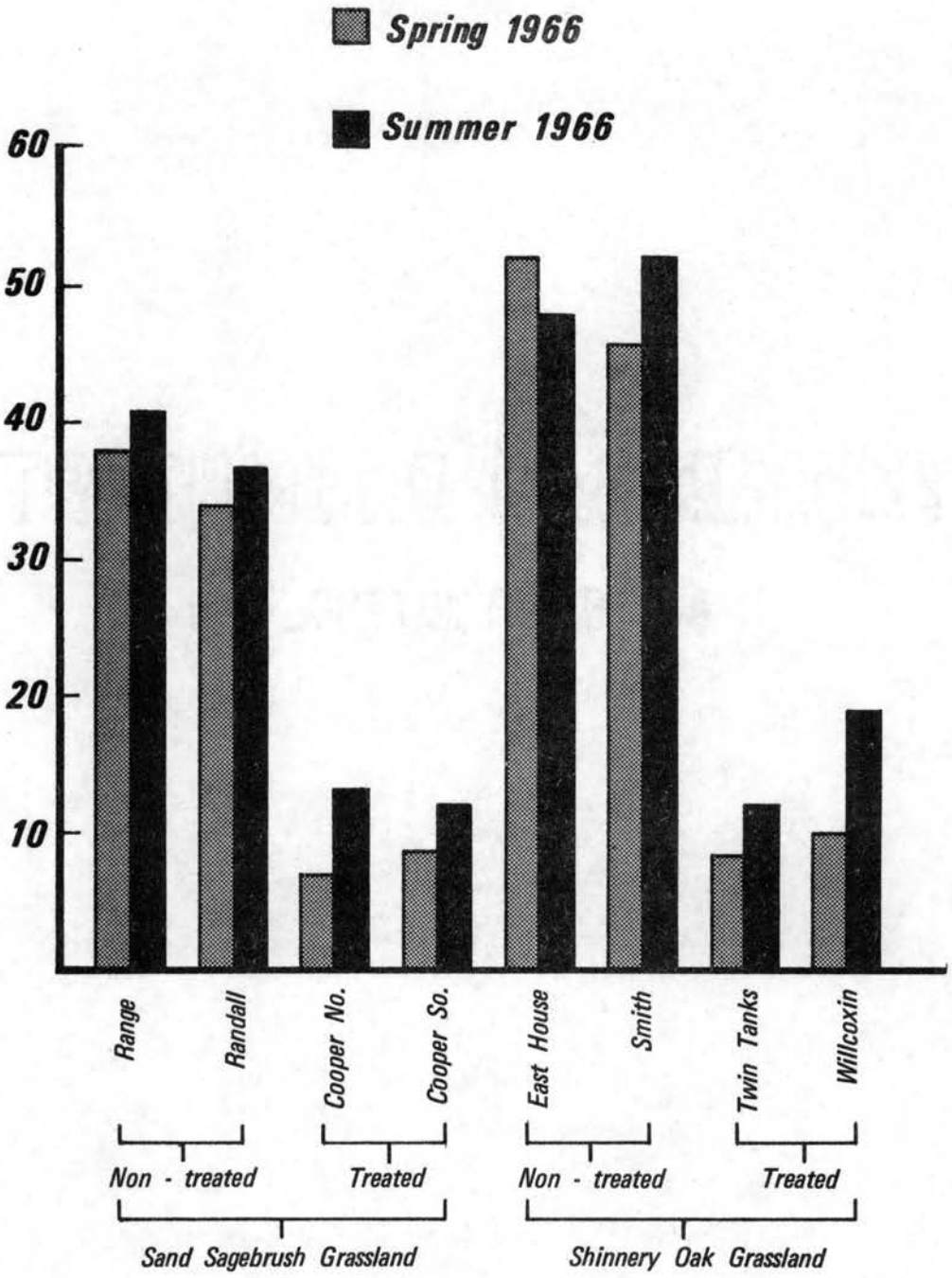

Figure 3. Relative density of woody species.

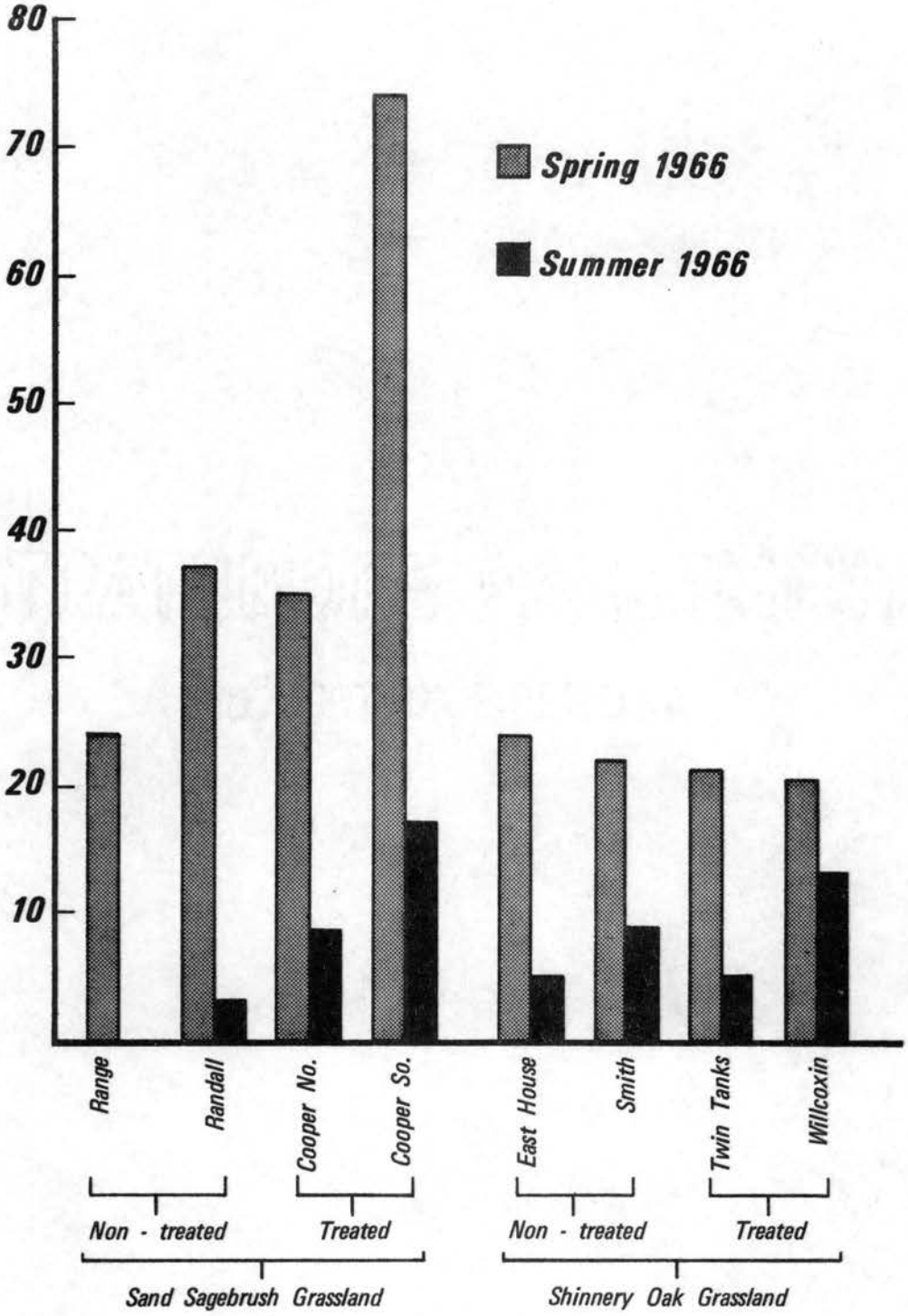

Figure 4. Relative density of forb species.

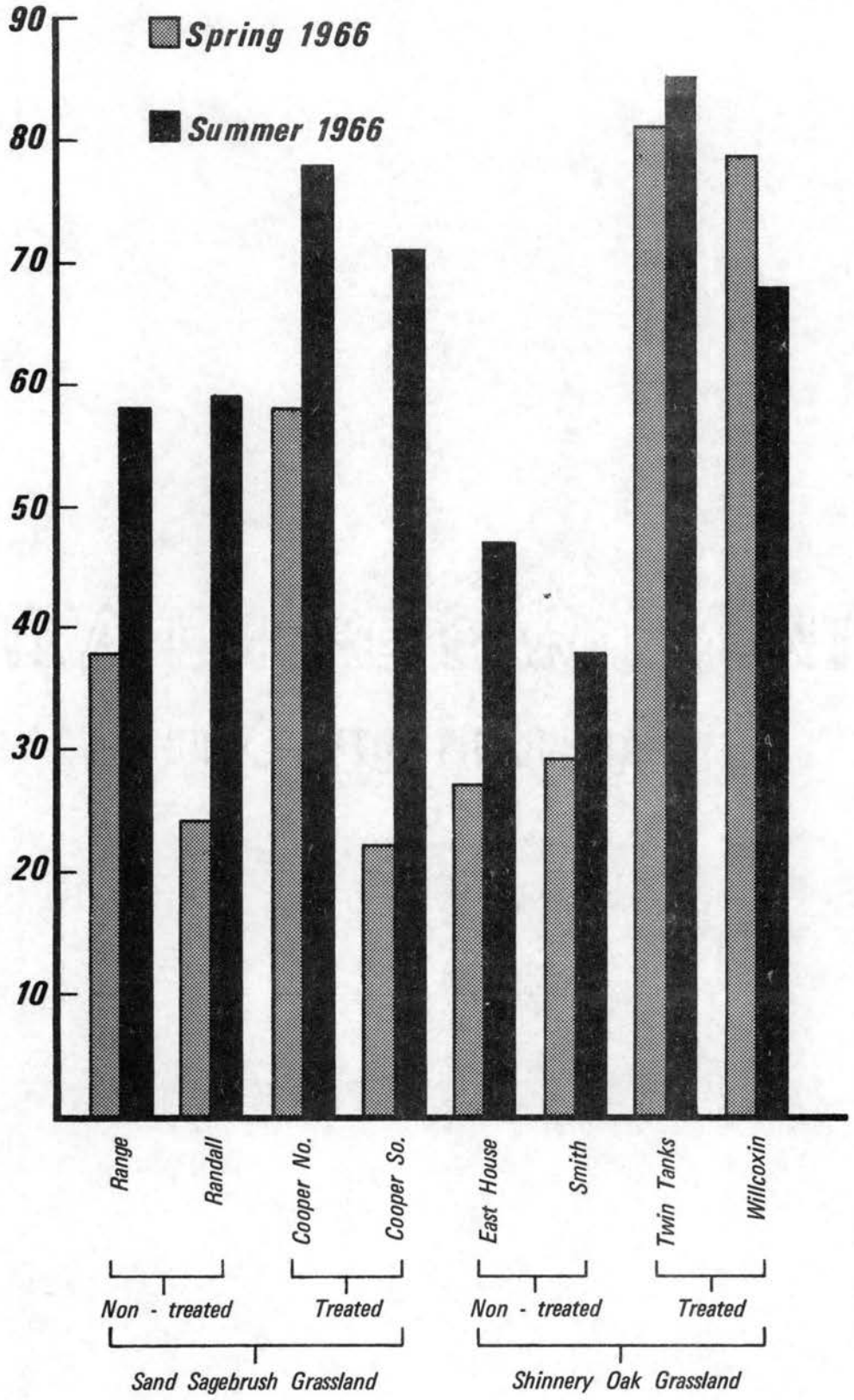

Figure 5. Relative density of grass species.

Importance values for all life-forms and for the five most important species in each stand are tabulated in Table III. Short grasses, short forbs, and dwarf half-shrubs were the most important life-forms in non-treated sand-sagebrush areas. Dwarf half-shrubs were less important in treated plots. Sand-sagebrush was responsible for nearly all the dwarf half-shrub values. The short grass life-form was comprised chiefly of blue grama (Bouteloua gracilis) and secondarily by Texas bluegrass (Poa arachnifera). By far the most important forb was wooly plantago (Plantago purshii) followed by western ragweed (Ambrosia psilostachya) and johnny jumpup (Viola rafinesquii). Annual buckwheat (Eriogonum annuum), camphorweed (Heterotheca subaxillaris), and Missouri goldenrod (Solidago missouriensis) were less important forbs.

Short grasses and short forbs were consistantly important on the shinnery oak study areas. Dwarf shrubs were more important on non-treated plots. Shinnery oak was the primary representative of the dwarf shrub life-form. Little bluestem (Andropogon scoparius) was an important grass in all shinnery oak areas. Less important grasses included sideoats grama (Bouteloua curtipendula), sand paspalum (Paspalum stramineum), sand dropseed (Sporobolus cryptandrus), switch grass (Panicum virgatum), and hidden dropseed (Sporobolus clandestinus). Important forbs were western ragweed (A. psilostachya) and camphorweed (H. subaxillaris).

Frequency index values for all vegetational life-forms encountered on the study plots are presented in Table IV. Data presented in Table IV were used to calculate similarity indices (Table V). Indices of stand similarity were based on the vegetal life-forms. The most

TABLE III

IMPORTANCE VALUES FOR ALL LIFE-FORMS ENCOUNTERED AND OF THE FIVE MOST IMPORTANT SPECIES IN EACH STAND

Sand Sagebrush Grassland

Range (Non-treated)		Randall (Non-treated)		Coop. N. (Treated)		Coop. S. (Treated)	
Short grass	(77.16)	Short forb	(83.89)	Short grass	(110.08)	Short forb	(132.51)
Dwarf Half shrub	(72.76)	Dwarf Half shrub	(60.67)	Short forb	(81.95)	Short grass	(55.63)
Short forb	(47.74)	Short grass	(55.49)	Dwarf Half shrub	(7.98)	Dwarf Half shrub	(11.88)
Mid shrub	(2.35)						
Artemisia filifolia	(69.86)	*Artemisia filifolia*	(57.49)	*Bouteloua gracilis*	(91.76)	*Plantago purshii*	(74.58)
Bouteloua gracilia	(62.65)	*Plantago purshii*	(44.39)	*Plantago purshii*	(56.63)	*Ambrosia psilostachya*	(42.46)
Plantago purshii	(32.55)	*Bouteloua gracilis*	(43.04)	*Heterotheca subaxillaris*	(12.59)	*Bouteloua gracilis*	(13.71)
Poa arachnifera	(12.69)	*Viola rafinesquii*	(33.58)	*Poa arachnifera*	(12.56)	*Solidago missouriensis*	(12.07)
Eriogenus annuus	(6.50)	*Ambrosia psilostachya*	(10.79)	*Artemisia filifolia*	(7.55)	*Artemisia filifolia*	(9.67)

Shinnery Oak Grassland

East House (Non-treated)		Smith (Non-treated)		Willcoxin (Treated)		Twin Tanks (Treated)	
Short grass	(62.50)	Dwarf shrub	(73.27)	Short grass	(140.63)	Short grass	(143.49)
Dwarf shrub	(61.88)	Short grass	(67.77)	Short forb	(35.01)	Short forb	(41.47)
Short forb	(40.00)	Short forb	(33.49)	Dwarf shrub	(22.19)	Dwarf shrub	(15.15)
Shrub	(21.25)	Shrub	(20.03)	Dwarf Half shrub	(2.19)		
Tree	(11.25)	Dwarf Half shrub	(5.45)				
Dwarf Half shrub	(3.13)						
				Bouteloua curtipendula	(34.80)	*Paspalum stramineum*	(55.27)
				Sporobolus cryptandrus	(33.67)	*Andropogon scoparius*	(26.26)
Quercus havardi	(76.74)	*Quercus havardi*	(64.73)	*Andropogon scoparius*	(30.60)	*Cyperus schweinitzii*	(17.04)
Andropogon scoparius	(19.52)	*Andropogon scoparius*	(23.58)	*Quercus havardi*	(18.84)	*Sporobolus clandestinus*	(12.92)
Paspalum stramineum	(12.30)	*Panicum virgatum*	(17.26)	*Panicum virgatum*	(15.27)	*Quercus havardi*	(11.57)
Ambrosia psilostachya	(10.42)	*Prunus gracilis*	(17.26)				
Heterotheca subaxillaris	(9.31)	*Ambrosia psilostachya*	(10.42)				

similar stands were those in the same vegetational type (sand-sagebrush or shinnery oak grasslands) whether treated or not. Similarity coefficients were much less between treated and non-treated stands in the different vegetational types.

Similarity indices were more consistent between treated and non-treated study plots in the shinnery oak than those in sand-sagebrush areas. The comparatively high relative density of forb life-forms and the rather low relative density of grasses on the Randall study area accounted for the close similarity between this non-treated area and the treated areas of the sand-sagebrush vegetational type.

Vegetation Analysis - Summer 1966

The total density values in the various study areas are presented graphically in Figure 2. Non-treated stands in the sand-sagebrush grassland and treated stands in the shinnery oak grassland had the greatest total densities. Treated stands in the sand-sagebrush grassland and non-treated stands in the shinnery oak grassland had nearly uniform total density values. The greatest disparity in total density values was between the two treated stands in the shinnery oak grassland. The marked variability in the spring total density values is not so apparent in the summer values.

The relative density of woody, forb, and grass life-forms on all study areas are shown in Figures 3, 4, and 5 respectively. As was the case in the spring, woody life-forms were most prevalent in non-treated areas. All treated areas showed a marked suppression of woody species. Forb life-forms were most densely distributed in two study plots, one each in both treated sand-sagebrush and shinnery oak. Forb densities

TABLE IV

FREQUENCY INDEX VALUES FOR VEGETATION LIFE-FORMS

Life-form	Study Areas: Sand-Sagebrush Grassland, Non-treated: Range	Randall	Sand-Sagebrush Grassland, Treated: Coop. N.	Coop. S.	Shinnery Oak Grassland, Treated: Willcoxin	Twin Tanks	Shinnery Oak Grassland, Non-treated: East House	Smith	Sums of Life-form Frequencies
Tree	-	-	-	-	-	-	7.5	-	7.5
Shrub	-	-	-	-	-	-	22.5	25.0	47.5
Dwarf Shrub	-	-	-	-	22.5	15.0	62.5	72.5	172.5
Half-Shrub	2.5	-	-	-	-	-	-	-	2.5
Dwarf Half Shrub	47.5	47.5	7.5	10.0	2.5	-	2.5	7.5	125.0
Tall Grass	-	-	-	-	-	-	-	-	0.0
Mid-Grass	-	-	-	-	-	-	-	-	0.0
Short Grass	57.5	52.5	90.0	55.0	100.0	100.0	62.5	67.5	585.0
Tall Forb	-	-	-	-	-	-	-	-	0.0
Mid-Forb	-	-	-	-	-	-	-	-	0.0
Short Forb	37.5	72.5	80.0	95.0	35.0	42.5	42.5	37.5	442.5
Total Number of Life-forms	4	3	3	3	4	3	6	5	
Sums of Stand Frequencies	145.0	172.5	177.5	160.0	160.0	157.5	200.0	210.0	

TABLE V

INDICIES OF STAND SIMILARITY BASED ON COMPOSITE LIFE-FORMS*

			Study Areas							
			Range	Randall	Coop. N.	Coop. S.	Willcoxin	Twin Tanks	East House	Smith
Sand-Sagebrush Grassland	Non-treated	Range								
		Randall	86.6							
	Treated	Coop. N.	63.6	75.7						
		Coop. S.	67.2	81.2	84.4					
Shinnery Oak Grassland	Treated	Willcoxin	62.3	54.1	75.6	57.8				
		Twin Tanks	62.8	57.6	79.1	61.4	94.5			
	Non-treated	East House	56.5	52.3	57.0	55.6	68.1	67.1		
		Smith	57.7	51.0	58.1	54.1	68.9	65.3	91.5	

*Numbers are in per cent. A value of 100 would mean that two stands were identical, i.e., the stands are 100% alike.

were consistently greater in treated than non-treated sand-sagebrush areas. Shinnery oak areas were characterized by variability in forb density between treated and non-treated plots. Forbs were noticeably less dense in summer than in the spring. In all cases, grasses were more dense in treated rather than non-treated areas. Grasses were generally more densely distributed in all study areas at this time than in the spring. With the exception of forbs, the relative densities of the other life-forms were much less variable than in the spring.

Importance values for all the plant life-forms encountered, and for the five most important species in each stand are tabulated in Table VI. Short grasses, dwarf half-shrubs and half-shrubs were the most important life-forms in non-treated sand-sagebrush areas. The short grass life-form was composed chiefly of blue grama and sand dropseed. Sand-sagebrush was responsible for nearly all of the dwarf half-shrub and half-shrub values. Sand lovegrass (Eragrostis trichodes), little bluestem, and windmill grass (Chloris verticillata) also appeared in the grass life-form in the non-treated sand-sagebrush areas. Western ragweed had lesser importance in one study plot. More different life-forms were encountered in treated plots of the sand-sagebrush grassland. Short and mid-grasses, short forbs and dwarf half-shrubs predominated in these areas. Sand dropseed and blue grama were the most important grass species followed by sand paspalum, hairy grama (Bouteloua hirsuta), sand bluestem (Andropogon hallii), and fall witchgrass (Leptoloma cognatum). Western ragweed was the most important forb species. Sand sagebrush was the primary member of the half-shrub life-forms.

Short and mid-grasses and dwarf shrubs were the most important

TABLE VI

IMPORTANCE VALUES FOR ALL LIFE-FORMS ENCOUNTERED AND OF THE FIVE MOST IMPORTANT SPECIES IN EACH STAND

Sand-Sagebrush Grassland			
Range (Non-treated)		Randall (Non-treated)	
Short Grass	(116.6)	Short Grass	(110.4)
Dwarf Half Shrub	(71.5)	Dwarf Half Shrub	(59.4)
Half Shrub	(11.8)	Half Shrub	(21.6)
		Short Forb	(8.6)
Artemisia filifolia	(71.0)	*Artemisia filifolia*	(70.5)
Bouteloua gracilis	(66.2)	*Bouteloua gracilis*	(65.4)
Sporobolus cryptandrus	(41.2)	*Sporobolus cryptandrus*	(37.7)
Eragrostis trichodes	(5.2)	*Chloris verticillata*	(9.0)
Andropogon scoparius	(3.9)	*Ambrosia psilostachya*	(3.9)
Shinnery Oak Grassland			
East House (Non-treated)		Smith (Non-treated)	
Short Grass	(65.3)	Dwarf Shrub	(63.7)
Dwarf Shrub	(63.5)	Short Grass	(50.0)
Mid-Grass	(32.2)	Mid-Grass	(33.2)
Tree	(18.9)	Shrub	(18.0)
Short Forb	(9.7)	Short Forb	(13.5)
Shrub	(5.3)	Mid-Forb	(7.4)
Mid-Forb	(3.3)	Dwarf Half Shrub	(7.2)
Tall Grass	(1.6)	Tree	(7.0)
Quercus havardi	(74.6)	*Quercus havardi*	(74.3)
Andropogon scoparius	(29.1)	*Andropogon scoparius*	(18.9)
Paspalum stramineum	(26.1)	*Panicum virgatum*	(17.2)
Sporobolus clandestinus	(16.2)	*Ambrosia psilostachya*	(16.1)
Andropogon hallii	(10.8)	*Bouteloua curtipendula*	(15.8)

TABLE VI (continued)

Sand-Sagebrush Grassland			
Coop. N. (Treated)		Coop. S. (Treated)	
Short Grass	(113.0)	Short Grass	(79.7)
Mid-Grass	(37.6)	Mid-Grass	(61.1)
Dwarf Half Shrub	(25.6)	Short Forb	(32.3)
Short Forb	(15.5)	Dwarf Half Shrub	(16.3)
Mid-Forb	(4.9)	Half Shrub	(5.8)
Half Shrub	(1.7)	Mid-Forb	(4.8)
Dwarf Shrub	(1.7)		
Bouteloua gracilis	(62.4)	*Sporobolus cryptandrus*	(42.4)
Sporobolus cryptandrus	(35.4)	*Ambrosia psilostachya*	(28.9)
Artemisia filifolia	(22.9)	*Paspalum stramineum*	(28.9)
Andropogon hallii	(10.9)	*Bouteloua gracilis*	(28.1)
Leptoloma cognatum	(10.4)	*Bouteloua hirsuta*	(13.2)
Shinnery Oak Grassland			
Willcoxin (Treated)		Twin Tanks (Treated)	
Short Grass	(108.0)	Short Grass	(88.7)
Dwarf Shrub	(36.8)	Mid-Grass	(72.0)
Mid-Grass	(19.9)	Dwarf Shrub	(22.0)
Short Forb	(18.4)	Short Forb	(8.1)
Mid-Forb	(15.4)	Tall Grass	(4.8)
Dwarf Half Shrub	(1.5)	Mid-Forb	(2.9)
		Dwarf Half Shrub	(1.4)
Quercus havardi	(74.3)	*Paspalum stramineum*	(35.2)
Bouteloua curtipendula	(26.5)	*Andropogon scoparius*	(33.6)
Paspalum stramineum	(23.1)	*Sporobolus clandestinus*	(21.8)
Eriogenum annuum	(19.5)	*Andropogon hallii*	(20.6)
Andropogon scoparius	(17.3)	*Quercus havardi*	(20.3)

life-forms in all shinnery oak areas, treated and non-treated alike. Little bluestem, sand paspalum, sideoats grama, and hidden dropseed were the main components of the grass life-forms. Less important grass species included sand bluestem and switch grass. Forbs included western ragweed and annual buckwheat. Shinnery oak was the predominant woody species.

Frequency index values and indicies of stand similarity for all life-forms encountered on the study plots are presented in Tables VII and VIII. Non-treated stands within the sand-sagebrush and shinnery oak grasslands, respectively were the most nearly similar. In contrast, non-treated stands between the two grassland types had the lowest similarity coefficients. Treated and non-treated stands in the shinnery oak grassland were more nearly similar than those in the sand-sagebrush grasslands. The two treated study plots in the sand-sagebrush were more similar than those in the shinnery oak. This relationship is in contrast to the spring situation. Of the four vegetational comparisons between study plots (treated and non-treated shinnery oak vs. treated and non-treated sand-sagebrush), treated stands in the two habitat types were the most nearly similar.

Habitat Use Analysis

General

A total of 1,593 lesser prairie chickens was encountered during the study (Table IX). Of this total, 477 birds were on specific study areas. The remaining 1,116 birds were located in scattered areas throughout northwestern Oklahoma. Most birds in the latter areas were observed flocking into fields of shocked sorghum during the fall and

TABLE VII

FREQUENCY INDEX VALUES FOR VEGETATION LIFE-FORMS

Life-form	Study Areas: Sand-Sagebrush Grassland, Non-treated: Range	Non-treated: Randall	Treated: Coop. N.	Treated: Coop. S.	Shinnery Oak Grassland, Treated: Willcoxin	Treated: Twin Tanks	Non-treated: East House	Non-treated: Smith	Sums of Life-form Frequencies
Tall Grass	-	-	-	-	-	6.0	2.0	-	8.0
Mid-Grass	-	-	38.0	70.0	26.0	80.0	30.0	40.0	284.0
Short Grass	72.0	74.0	84.0	80.0	96.0	88.0	58.0	60.0	612.0
Tall Forb	-	-	-	-	-	-	-	-	0.0
Mid-Forb	-	-	4.0	6.0	20.0	4.0	4.0	10.0	48.0
Short Forb	-	8.0	16.0	40.0	22.0	10.0	10.0	18.0	124.0
Tree	-	-	-	-	-	-	12.0	8.0	20.0
Shrub	-	-	-	-	-	-	4.0	18.0	22.0
Dwarf Shrub	-	-	2.0	-	36.0	26.0	54.0	66.0	184.0
Half-Shrub	8.0	16.0	2.0	6.0	-	-	-	-	32.0
Dwarf Half Shrub	46.0	46.0	22.0	16.0	2.0	2.0	-	6.0	140.0
Total Number of Life-forms	3	4	7	6	6	7	8	8	
Sums of Stand Frequencies	126.0	144.0	168.0	218.0	202.0	216.0	174.0	226.0	

TABLE VIII

INDICES OF STAND SIMILARITY BASED ON COMPOSITE LIFE-FORMS

			Study Areas							
			Range	Randall	Coop. N.	Coop. S.	Willcoxin	Twin Tanks	East House	Smith
Sand-Sagebrush Grassland	Non-treated	Range								
		Randall	93.3							
	Treated	Coop. N.	65.3	67.9						
		Coop. S.	54.7	57.5	80.8					
Shinnery Oak Grassland	Treated	Willcoxin	45.1	48.6	72.4	64.8				
		Twin Tanks	43.3	46.7	72.9	76.5	74.6			
	Non-treated	East House	38.7	41.5	60.8	52.0	71.3	66.7		
		Smith	37.5	40.0	64.0	58.6	71.0	64.3		84.0

winter seasons. When considering only the specific study areas, the number of birds differed greatly between treated and non-treated areas as well as between the grassland types. More birds were encountered on treated areas. The shinnery oak grassland supported more birds than the sand-sagebrush grassland. The apparent preference for treated areas, especially in the shinnery oak grasslands, shown by adult birds also holds for the young.

TABLE IX

TOTAL NUMBER OF BIRDS ENCOUNTERED DURING THE STUDY

	Treated Qha		Non-treated Qha		Treated Afi		Non-treated Afi	
	est.	obs.	est.	obs.	est.	obs.	est.	obs.
Adults	152	81	7	15	61	41	9	2
Young	42	26	10	-	22	-	9	-
Subtotal	194	107	17	15	83	41	18	2
Total (type, treatment)	301		32		124		20	
Total (type)	333				144			

The number of adult birds observed on study areas in each season is summarized in Table X. On a year long basis, more birds were consistently observed in treated areas. In the fall months many birds would move to peripheral areas which were close to cultivated fields.

Plant life-forms used by prairie chickens throughout the duration of the study, without regard to the grassland type or treatment, are presented in Table XI. Nearly all life-forms were used for the day resting activity. Low vegetation was consistently used for feeding. Night roosts were characterized by mid life-forms. Mid to tall life-forms were most frequently used for escape cover. In general, there is a rather close agreement between the estimated and observed data.

TABLE X

NUMBER OF ADULT BIRDS ON STUDY AREAS IN EACH SEASON

Treated Shinnery Oak				Non-treated Shinnery Oak			
Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
83	11	96	43	6	2	14	0
Total	233				22		
Treated Sand-Sagebrush				Non-treated Sand-Sagebrush			
Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
25	14	59	4	2	3	6	0
Total	102				11		

TABLE XI

YEAR LONG LIFE-FORM USE REGARDLESS OF GRASS TYPE OR TREATMENT
ALL VALUES RELATE TO BIRD QUADRAT FREQUENCY

Life-form	Day Resting		Feeding		Night Roost		Escape	
	est.	obs.	est.	obs.	est.	obs.	est.	obs.
Tall grass	—	45	—	—	—	—	2	—
Mid-grass	155	111	22	2	—	35	21	10
Short grass	130	43	4276	18	—	12	3	—
Tall forb	—	—	—	—	—	—	—	—
Mid-forb	93	35	6	—	—	3	7	3
Short forb	34	45	25	22	—	6	—	1
Tree	64	23	—	—	—	—	28	—
Shrub	10	7	—	—	—	1	—	1
Dwarf shrub	97	112	7	2	—	13	4	4
Half shrub	—	—	—	—	—	—	—	4
Dwarf half shrub	9	11	—	—	—	6	17	1

The life-forms in Table XI were composed of the plant species presented in Table XII. Again, there is general agreement between the estimated and observed values in each category. Little bluestem, shinnery oak, and sand dropseed were the most consistently used plant species. The data show that day-resting birds prefer areas carpeted by

shinnery oak, little bluestem, western ragweed, and sand dropseed. Other species were used to a lesser extent. Grain sorghum appeared to be highly preferred by feeding birds during fall and winter. Other species such as wheat, western ragweed, and blue grama were characteristic of areas used for feeding. On occasion, birds were observed on areas of bare ground. In such cases the birds were presumably obtaining grit. Sand dropseed, shinnery oak, and little bluestem were most frequently used as night roosting sites. Escape cover was primarily composed of shinnery oak, little bluestem, and sand-sagebrush. A certain amount of specificity between life activity and plant species was evident.

Seasonal Habitat Use

There was a general similarity in the life-forms used on a seasonal basis (Table XIII). Mid-grasses and dwarf shrubs were consistently used for day resting sites. Sites selected for day resting in the summer were characterized by a greater frequency of dwarf shrubs, tall grasses, and trees. The use of the tree life-form continued into the fall. Feeding locations were rather uniformly composed of short-grasses with some diversification in the summer. Vegetation of mid-stature characterized night roosting sites. Escape cover was primarily composed of the taller plant life-forms.

Both the number of species and the frequency of use per species varied considerably through the seasons (Table XIV). This variability was also evident in comparing the habitat components used for different activities. Little bluestem, shinnery oak, and western ragweed were used throughout the year for day resting. The high frequency values

TABLE XII

PLANT SPECIES USED CONSISTENTLY ON A YEAR LONG BASIS
REGARDLESS OF GRASS TYPE OR TREATMENT

Species	Day Resting		Feeding		Night Roost		Escape	
	est	obs	est	obs	est	obs	est	obs
Ambrosia psilostachya	53	48	38	-	-	9	7	3
Andropogon saccharoides	-	6	-	-	-	6	-	-
Andropogon scoparius	98	108	15	1	-	12	19	4
Artemisia filifolia	5	5	-	-	-	5	11	5
Boutelous curtipendula	35	6	4	-	-	2	-	2
Bouteloua gracilis	15	4	26	-	-	2	-	-
Bouteloua hirsuta	-	2	10	7	-	-	-	-
Buchloe dactyloides	-	2	16	8	-	-	-	-
Chrysopsis pilosa	-	5	-	14	-	-	-	-
Eriogonum annuum	43	11	1	2	-	-	-	1
Panicum virgatum	2	12	-	-	-	-	-	1
Paspalum stramineum	52	6	8	-	-	1	2	-
Quercus havardi	171	141	7	2	-	14	32	5
Sporobolus clandestinus	24	1	-	1	-	2	-	-
Sporobolus cryptandrus	17	35	13	2	-	18	4	3
Sorghum vulgare	-	-	4152	-	-	-	-	-
Triticum aestivum	-	-	44	-	-	-	-	-
Yucca glauca	-	-	-	-	-	-	6	-
Bare ground	-	-	26	-	-	-	-	-

TABLE XIII

SEASONAL USE OF LIFE-FORMS REGARDLESS OF GRASS TYPE OR TREATMENT

	Day Resting				Feeding			
Life-Form	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
Tall Grass	8	2	30	5	-	-	-	-
Mid-Grass	123	6	79	58	-	-	22	2
Short Grass	73	28	60	12	3556	-	74	664
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	43	-	44	41	-	-	6	-
Short Forb	20	16	36	7	-	-	47	-
Tree	1	4	30	52	-	-	-	-
Shrub	1	-	16	-	-	-	-	-
Dwarf Shrub	53	12	103	41	-	-	7	2
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	10	-	10	-	-	-	-	-

	Night Roosting				Escape			
Life-Form	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
Tall Grass	-	-	-	-	-	-	6	-
Mid-Grass	22	-	9	4	9	2	20	-
Short Grass	6	-	6	-	-	2	1	-
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	-	-	3	-	6	-	4	-
Short Forb	5	-	1	-	1	-	-	-
Tree	-	-	-	-	-	-	28	-
Shrub	1	-	-	-	-	-	1	-
Dwarf Shrub	4	-	9	-	-	-	12	-
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	2	-	4	-	-	-	6	-

for shinnery oak and little bluestem in the summer correspond nicely to the high values for tall grasses, dwarf shrubs, and trees during the same season (Table XIII). Plant species present at feeding locations differed tremendously through the seasons. The most marked difference being winter and fall at which time grain sorghum and wheat were the outstanding species. Summer feeding locations were usually carpeted by grasses and forbs which were characteristically short in stature. Night roosting areas were chiefly composed of sand dropseed, shinnery oak, and little bluestem. Shinnery oak, little bluestem, and sand-sagebrush were most commonly present at escape sites.

The size of the specific vegetal fasciation used by lesser prairie chickens for various life activities differed through the seasons (Table XV). Cover units used for the day resting activity were generally distributed over large areas. In the summer, however, restricted areas were sought out. Such areas were usually shinnery oak motts, where the shinnery oak had grown rather tall and dense. In sand-sagebrush grasslands, a restricted area would be a plum (Prunus sp.) thicket or an island of dense sand-sagebrush. The high frequency values for large and extensive feeding locations was attributable primarily to the use of wheat and sorghum fields in the winter and fall. In the summer, sites selected for feeding were much smaller in extent. Night roosting sites were commonly in areas of restricted or large blocks of rather homogeneous cover. The preponderance of restricted and large areas sought out for cover to meet various needs suggests the importance of edge in lesser prairie chicken habitat.

TABLE XIV

SEASONAL USE OF PLANT SPECIES REGARDLESS OF GRASS TYPE OR TREATMENT

Species	Day Resting Winter	Spring	Summer	Fall	Species	Feeding Winter	Spring	Summer	Fall
Ambrosia psilostachya	36	-	45	20	Ambrosia psilostachya	-	-	24	14
Andropogon scoparius	73	8	78	47	Andropogon scoparius	6	-	9	1
Artemisia filifolia	1	-	9	-	Bouteloua gracilis	-	-	26	1
Bouteloua curtipendula	37	3	1	-	Bouteloua hirsuta	-	-	17	-
Bouteloua gracilis	2	3	3	11	Buchloe dactyloides	-	-	24	-
Erigonum annuum	25	-	1	28	Chrysopsis pilosa	-	-	14	-
Paspalum stramineum	29	3	14	12	Sorghum vulgare	3488	-	-	664
Quercus havardi	55	16	148	93	Wheat	44	-	-	-
Sporobolus clandestinus	8	-	17	-	Yucca glauca	12	-	-	-
Sporobolus cryptandrus	33	3	16	-	Bare ground	-	-	-	14
Other species	28	-	52	5	Other species	18	-	17	3
Total number of species	17	6	31	9	Total Number of species	7	-	18	6

Species	Night Roosting Winter	Spring	Summer	Fall	Species	Escape Winter	Spring	Summer	Fall
Ambrosia psilostachya	5	-	4	1	Ambrosia psilostachya	6	-	4	-
Andropogon saccharoides	-	-	3	3	Andropogon scoparius	9	2	12	-
Andropogon scoparius	9	-	3	-	Artemisia filifolia	6	-	10	-
Artemisia filifolia	2	-	3	-	Quercus havardi	4	-	37	-
Quercus havardi	5	-	9	1	Sporobolus cryptandrus	-	-	7	-
Sporobolus cryptandrus	13	-	4	1	Yucca glauca	6	-	-	-
Other species	6	-	6	-	Other species	2	2	5	-
Total number of species	10	-	11	2	Total number of species	6	3	7	-

TABLE XV

ESTIMATED EXTENT OF FASCIATIONS USED BY LESSER PRAIRIE CHICKENS

Size*	Day Resting	Feeding	Night Roost
Restricted	372	128	16
Large	520	4256	52
Extensive	164	40	8

Year long, regardless of season, grasstype and treatment.

	Day Resting				Feeding			
Size	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
Restricted	28	52	240	52	36	-	64	4
Large	268	4	84	164	3536	-	52	28
Extensive	36	12	116	-	-	-	40	668

	Night Roost			
Size	Winter	Spring	Summer	Fall
Restricted	-	-	16	-
Large	36	-	16	-
Extensive	4	-	-	4

*Restricted - less than 500 sq. ft.
Large - less than 5 acres
Extensive - over 5 acres

Treatment and Habitat Use

Habitat use in treated and non-treated areas regardless of grassland type is summarized in Tables XVI and XVII. In general, the same life-forms and species were used in both treated and non-treated areas. The target species of brush control operations were used, moreover, to a greater extent in treated rather than in non-treated areas. The paucity of data from non-treated areas was attributable to the small number of birds in such areas. The overriding indication was that even though certain components were available in both treated and non-treated areas, such components as mid-grasses and woody plants were more

attractive in treated areas.

Comparison of Treated and Non-treated Study Areas

Life-forms and plant species used for the day resting activity on all study areas are presented in Tables XVIII and XIX. Again, owing to the paucity of information from non-treated areas, it is difficult to compare in detail the habitat components used in such areas. The life-forms used in the treated and non-treated grassland types were nearly identical. The main difference was that fewer life-forms were used in the non-treated areas. Life-forms and plant species used in the non-treated areas were frequently those which would increase after treatment.

Nesting

Owing presumably to the extreme concealment of the nests of lesser prairie chickens, only one nest was located. Other investigators have remarked about the difficulty encountered in locating nests of this species (Coats, 1955; Copelin, 1963; Jones, 1963; Sutton, 1964, 1967).

The nest that was found had recently been destroyed as evidenced by the freshness of the debris. Measurements of the vegetation were made at two levels, one at the base of the nest and the other at 25 cm above the nest. Species encountered at the level of the depressed area on the sand included little bluestem and scribner's panicum (Panicum oligosanthes). Species encountered at the 25 cm level were little bluestem and shinnery oak. Heights ranged from 32 to 52 cm with life-form classification of mid-grass and dwarf shrub. Coverage in the four 1 meter quadrats about the center of the nest was 30, 45, 55, and

TABLE XVI

USE OF LIFE-FORMS IN TREATED AND NON-TREATED AREAS
REGARDLESS OF SEASON OR GRASS TYPE

	Estimations							
	Day Resting		Feeding		Night Roost		Escape	
Life-Form	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt
Tall Grass	-	-	-	-	-	-	2	-
Mid-Grass	146	9	22	-	-	-	21	-
Short Grass	101	29	77	3	-	-	3	-
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	86	7	6	-	-	-	7	-
Short Forb	27	7	21	4	-	-	-	-
Tree	64	-	-	-	-	-	28	-
Shrub	10	-	-	-	-	-	-	-
Dwarf Shrub	93	4	6	1	-	-	4	-
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	9	-	-	-	-	-	17	-

	Observations							
	Day Resting		Feeding		Night Roost		Escape	
Life-Form	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt
Tall Grass	43	2	-	-	-	-	-	-
Mid-Grass	106	5	2	-	28	7	7	3
Short Grass	42	1	18	-	10	2	-	-
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	31	4	-	-	-	3	3	-
Short Forb	38	7	22	-	2	4	-	1
Tree	19	4	-	-	-	-	-	-
Shrub	7	-	-	-	-	1	1	-
Dwarf Shrub	104	8	2	-	1	12	8	-
Half Shrub	-	-	-	-	-	-	4	-
Dwarf Half Shrub	10	1	-	-	3	3	1	-

TABLE XVII

USE OF PLANT SPECIES WITH A FREQUENCY VALUE OF TEN OR ABOVE ON TREATED AND NON-TREATED AREAS REGARDLESS OF SEASON OR GRASS TYPE

	Estimations							
	Day Resting		Feeding		Night Roost		Escape	
Species	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt
Ambrosia psilostachya	52	1	36	2	-	-	6	-
Andropogon scoparius	93	5	15	-	-	-	19	-
Artemisia filifolia	5	-	-	-	-	-	11	-
Bouteloua curtipendula	32	3	4	-	-	-	-	-
Bouteloua gracilis	12	3	24	2	-	-	-	-
Bouteloua hirsuta	-	-	10	-	-	-	-	-
Buchloe dactyloides	-	-	15	1	-	-	-	-
Erigonum annuum	43	-	1	-	-	-	-	-
Paspalum stramineum	44	8	8	-	-	-	2	-
Quercus havardi	167	4	6	1	-	-	32	-
Sporobolus clandestinus	20	4	-	-	-	-	-	-
Sporobolus cryptandrus	14	3	13	-	-	-	4	-
Bare Ground	-	-	26	-	-	-	-	-

	Observations							
	Day Resting		Feeding		Night Roost		Escape	
Species	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt	Trt	Non-trt
Ambrosia psilostachya	41	7	-	-	2	7	3	-
Andropogon saccharoides	6	-	-	-	6	-	-	-
Andropogon scoparius	104	4	1	-	9	3	1	3
Artemisia filifolia	5	-	-	-	3	2	5	-
Buchloe dactyloides	2	-	8	-	-	-	-	-
Chrysopsis pilosa	5	-	14	-	-	-	-	-
Erigonum annuum	11	-	2	-	-	-	-	-
Panicum virgatum	11	1	-	-	-	-	1	-
Quercus havardi	129	12	2	-	1	13	5	-
Sporobolus cryptandrus	35	-	2	-	18	-	3	-

TABLE XVIII

LIFE-FORMS USED FOR THE DAY RESTING ACTIVITY
ON TREATED AND NON-TREATED STUDY AREAS

	Treated Qha							
	Winter		Spring		Summer		Fall	
Life-Form	est	obs	est	obs	est	obs	est	obs
Tall Grass	-	3	-	2	-	2	-	5
Mid-Grass	50	28	4	2	40	12	40	18
Short Grass	62	2	-	-	5	15	11	1
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	25	15	-	-	18	14	39	2
Short Forb	-	15	-	-	-	12	6	1
Tree	-	1	1	1	12	18	52	-
Shrub	-	1	-	-	10	6	-	-
Dwarf Shrub	34	10	4	8	39	60	16	25
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	5	5	-	-	-	1	-	-

	Non-treated Qha							
	Winter		Spring		Summer		Fall	
Life-Form	est	obs	est	obs	est	obs	est	obs
Tall Grass	-	-	-	-	-	2	-	-
Mid-Grass	8	-	-	-	1	5	-	-
Short Grass	4	-	-	-	1	1	-	-
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	-	3	-	-	1	1	-	-
Short Forb	-	-	-	-	1	7	-	-
Tree	-	-	-	4	-	-	-	-
Shrub	-	-	-	-	-	-	-	-
Dwarf Shrub	4	5	-	-	-	3	-	-
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	-	-	-	-	-	1	-	-

TABLE XVIII (continued)

Life-Form	Winter est	Winter obs	Spring est	Spring obs	Summer est	Summer obs	Fall est	Fall obs
			Treated Afi					
Tall Grass	-	5	-	-	-	26	-	-
Mid-Grass	8	29	-	-	4	17	-	-
Short Grass	4	1	16	-	3	23	-	-
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	-	-	-	-	4	-	-	-
Short Forb	4	1	16	-	1	9	-	-
Tree	-	-	-	-	-	-	-	-
Shrub	-	-	-	-	-	-	-	-
Dwarf Shrub	-	-	-	-	-	1	-	-
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	-	-	-	-	4	4	-	-
			Non-treated Afi					
Life-Form	Winter est	Winter obs	Spring est	Spring obs	Summer est	Summer obs	Fall est	Fall obs
Tall Grass	-	-	-	-	-	-	-	-
Mid-Grass	-	-	-	-	-	-	-	-
Short Grass	-	-	12	-	12	-	-	-
Tall Forb	-	-	-	-	-	-	-	-
Mid-Forb	-	-	-	-	6	-	-	-
Short Forb	-	-	-	-	6	-	-	-
Tree	-	-	-	-	-	-	-	-
Shrub	-	-	-	-	-	-	-	-
Dwarf Shrub	-	-	-	-	-	-	-	-
Half Shrub	-	-	-	-	-	-	-	-
Dwarf Half Shrub	-	-	-	-	-	-	-	-

TABLE XIX

PLANT SPECIES WITH A FREQUENCY VALUE OF FIVE OR ABOVE USED FOR THE DAY RESTING ACTIVITY ON TREATED AND NON-TREATED STUDY AREAS

	Treated Qha							
	Winter		Spring		Summer		Fall	
Species	est	obs	est	obs	est	obs	est	obs
Ambrosia psilostachya	10	18	-	-	18	19	17	3
Andropogon scoparius	34	13	4	4	21	14	28	19
Bouteloua curtipendula	28	-	-	-	-	-	-	-
Bouteloua gracilis	-	-	-	-	-	2	11	-
Erigonum annuum	15	10	-	-	-	1	28	-
Paspalum stramineum	25	-	-	-	6	-	11	1
Quercus havardi	34	12	4	8	61	84	68	25
Sporobolus clandestinus	4	-	-	-	16	-	-	-
Sporobolus cryptandrus	10	20	-	-	2	7	-	-

	Non-treated Qha							
	Winter		Spring		Summer		Fall	
Species	est	obs	est	obs	est	obs	est	obs
Ambrosia psilostachya	-	3	-	-	1	4	-	-
Andropogon scoparius	4	-	-	-	1	4	-	-
Paspalum stramineum	4	-	-	-	1	-	-	-
Quercus havardi	4	5	-	4	-	3	-	-

	Treated Afi							
	Winter		Spring		Summer		Fall	
Species	est	obs	est	obs	est	obs	est	obs
Ambrosia psilostachya	4	1	-	-	3	-	-	-
Andropogon saccharoides	-	-	-	-	-	6	-	-
Andropogon scoparius	4	18	-	-	2	36	-	-
Artemisia filifolia	-	-	-	-	4	4	-	-
Bouteloua curtipendula	4	5	-	-	-	-	-	-
Chrysopsis pilosa	-	-	-	-	-	5	-	-
Paspalum stramineum	-	-	-	-	2	5	-	-
Panicum virgatum	-	5	-	-	-	4	-	-
Sporobolus cryptandrus	-	3	-	-	-	5	-	-

Non-treated Afi

All species less than five

60 percent. A ranked sampling to the nearest woody vegetation yielded the following information: shinnery oak at 19 cm, 4 cm, and 8 cm; and sand plum at 16 cm. The nest proper was totally obscured from top view.

The nest itself occupied an area scooped out in the sand to a depth of 5 cm. Its diameter was 18 cm. Dead shinnery oak leaves and grass served as a lining. The approach was through a west-facing tunnel under overhanging little bluestem. The nest was situated in a general area of life-form diversity with short and mid-grasses, short forbs, dwarf shrubs, and trees nearby. A booming ground was located about one-quarter of a mile away. The number of eggs was estimated at six to seven based upon the scattered shell fragments.

Brood Habitat Use

A total of twelve broods was located during the summer months, with an average of 8.5 young per brood. Of the twelve broods, eight were located in the shinnery oak and two in the sand-sagebrush grassland types. The remaining two broods were observed in roadways. Six brood sightings were made in treated shinnery oak, two in non-treated shinnery oak and one each in both treated and non-treated sand-sagebrush.

Prairie chicken broods were observed in such life activities as feeding, day resting, and escape (Tables XX, XXI, and XXII). Vegetation that was low in stature and of a rather open aspect was used in the feeding activity. Plant species most frequently encountered were shinnery oak, little bluestem, western ragweed, blue grama, sand dropseed, sand lovegrass, and sand paspalum. Vegetational associations of plants moderate to tall in height with greater ground coverage were

Summer

sought out for the day resting activity. The height of the vegetation used by broods averaged higher on hot days (90°F plus) than on cooler days (less than 90°F). The higher value for vegetal height used on hot days was attributable to the use of shinnery oak motts. Shinnery oak, little bluestem, and sand bluestem were used most extensively in this activity. On three occasions, the cover used by broods for escape was found. Dwarf shrub and mid-grass associations were used with oak motts sought out on hot days. The terrain of the area was usually more broken than where originally flushed. Generally, broods were in rather tight groups and were in areas characterized by a diversity of plant life-forms (Table XXIII).

In sum, lesser prairie chicken broods used sites typified by a plant life-form heterogeneity within a restricted area so that cover of the desired nature for the various life activities was generally close by. The structure of the vegetation used in the day resting activity appeared to be highly dependent on the weather. Distinct differences in vegetal heights within areas used for specific activities suggests that the birds actively seek out vegetation of particular heights and plant life-forms to satisfy various needs.

Display Activity

A total of twenty display grounds was located and surveyed for the number of males using each. All study areas had either a display ground within their boundaries or one located very near. Of the two study areas which did not have a display ground situated within their boundaries, neither had been subjected to brush control operations and the vegetation was rather uniformly rank.

TABLE XX

LIFE-FORMS USED BY BROODS REGARDLESS OF GRASS TYPE OR TREATMENT

Life-form	Day Resting		Feeding	
	est	obs	est	obs
Tall grass	-	1	-	-
Mid grass	16	23	28	1
Short grass	4	5	61	3
Tall forb	-	-	-	-
Mid forb	-	1	29	6
Short forb	8	1	27	2
Tree	32	4	-	-
Shrub	-	-	-	-
Dwarf shrub	12	57	27	-
Half shrub	-	-	-	-
Dwarf half shrub	8	-	-	-

Species	Day Resting		Feeding	
	est	obs	est	obs
Ambrosia psilostachya	8	1	34	1
Andropogon hallii	4	7	-	7
Artemisia filifolia	8	-	-	-
Andropogon scoparius	4	15	27	15
Bouteloua gracilis	-	-	18	-
Chrysopsis villosa	-	-	9	-
Cyperus schweinitzii	-	2	13	2
Erigonum annuum	-	-	16	-
Prunus gracilis	-	4	-	4
Paspalum stramineum	4	1	16	1
Quercus havardi	36	57	27	57
Rhus aromatica	8	-	-	-
Sporobolus cryptandrus	8	-	9	-

TABLE XXI

LIFE-FORMS USED BY BROODS FOR THE DAY RESTING ACTIVITY ON TREATED AND NON-TREATED STUDY AREAS

Life-form	T Qha est	T Qha obs	Nt Qha est	Nt Qha obs	T Afi est	T Afi obs	Nt Afi est	Nt Afi obs	Total
Tall grass	-	-	-	-	-	-	-	-	-
Mid grass	8	23	-	-	8	-	-	-	39
Short grass	4	5	-	-	-	-	-	-	9
Tall forb	-	-	-	-	-	-	-	-	-
Mid forb	-	1	-	-	-	-	-	-	1
Short forb	-	1	-	-	8	-	-	-	9
Tree	28	4	4	-	-	-	-	-	36
Shrub	-	-	-	-	-	-	-	-	-
Dwarf shrub	4	57	-	-	8	-	-	-	69
Half shrub	-	-	-	-	-	-	-	-	-
Dwarf half shrub	-	-	-	-	8	-	-	-	8

Species	T Qha est	T Qha obs	Nt Qha est	Nt Qha obs	T Afi est	T Afi obs	Nt Afi est	Nt Afi obs	Total
Ambrosia psilostachys	-	-	-	-	8	-	-	-	8
Andropogon hallii	4	-	-	-	-	-	-	-	4
Artemisia filifolia	-	-	-	-	-	-	-	-	8
Andropogon scoparius	4	-	-	-	-	-	-	-	4
Paspalum stramineum	4	-	-	-	-	-	-	-	4
Quercus havardi	32	-	4	-	-	-	-	-	36
Rhus aromatica	-	-	-	-	8	-	-	-	8
Sporobolus cryptandrus	-	-	-	-	8	-	-	-	8

TABLE XXII

LIFE-FORMS USED BY BROODS FOR THE FEEDING ACTIVITY ON TREATED AND NON-TREATED STUDY AREAS

Life-form	T Qha est	T Qha obs	Nt Qha est	Nt Qha obs	T Afi est	T Afi obs	Nt Afi est	Nt Afi obs	Total
Tall grass	-	-	-	-	-	-	-	-	-
Mid grass	19	1	9	-	-	-	-	-	29
Short grass	25	3	9	-	9	-	18	-	64
Tall forb	-	-	-	-	-	-	-	-	-
Mid forb	26	6	-	-	3	-	-	-	35
Short forb	-	2	9	-	-	-	18	-	29
Tree	-	-	-	-	-	-	-	-	-
Shrub	-	-	-	-	-	-	-	-	-
Dwarf shrub	18	-	9	-	-	-	-	-	27
Half shrub	-	-	-	-	-	-	-	-	-
Dwarf half shrub	-	-	-	-	-	-	-	-	-

Species	T Qha est	T Qha obs	Nt Qha est	Nt Qha obs	T Afi est	T Afi obs	Nt Afi est	Nt Afi obs	Total
Ambrosia psilostachya	13	3	9	-	3	-	9	-	37
Andropogon scoparius	18	-	9	-	-	-	-	-	27
Bouteloua curtipendula	-	1	-	-	-	-	-	-	1
Bouteloua gracilis	-	-	9	-	-	-	9	-	18
Cyperus schweinitzii	13	-	-	-	-	-	-	-	13
Chrysopsis villosa	-	-	-	-	-	-	9	-	9
Chenchrus sp.	-	-	-	-	3	-	-	-	3
Erigonum annuum	13	5	-	-	3	-	-	-	21
Paspalum stramineum	13	3	-	-	3	-	-	-	19
Quercus havardi	18	-	9	-	-	-	-	-	27
Sporobolus cryptandrus	-	-	-	-	-	-	9	-	9

TABLE XXIII

ESTIMATED EXTENT OF FASCIATIONS USED BY LESSER PRAIRIE CHICKEN BROODS

Size	Day Resting	Feeding	
Restricted	100	100	Regardless of season, grass-type and treatment.
Large	-	92	
Extensive	72	36	

Size	T Qha		NT Qha		T Afi		NT Afi	
	DR	F	DR	F	DR	F	DR	F
Restricted	64	64	4	36	32	-	-	-
Large	16	36	-	-	-	56	-	36
Extensive	56	-	-	-	-	-	-	-

All display grounds were located in areas of a low physiognomic level. Most were on ridges; some, however, were located in large swales. All areas used as display grounds had rather unrestricted visibility for a considerable distance in all directions. Plants of medium stature appeared occasionally over the areas. Such plants frequently appeared to be markers of individual territories. Some booming grounds located in areas in which the vegetation grew rapidly as the season progressed were abandoned earlier than those on which growth was less rapid. Species composition was variable. Where potentially mid and tall vegetation was present, it had been mowed or used as a winter feeding location for cattle in the winter months.

The greatest number of males using the various display grounds was observed in April and the first part of May. Hens were present on the display grounds from March to May. They were infrequent visitors at all times, but were most common in April. Counts of males using the display areas were most uniform in April. The number of males using the grounds both early and late in the season varied considerably.

More birds consistently were on the areas in the morning than in the evening hours. Booming intensity of the cocks was greatest in March and throughout April. Booming intensity as the season progressed was largely associated with the presence of hens. Earlier high intensity booming was probably a result of territorial disputes. During very intense booming activity, the birds would continue booming on nearby areas when flushed from the display ground and would promptly return. As the season progressed (late May and June), booming activities of the cocks were more passive.

Birds began to visit some of the display grounds again in August. These visits appeared, however, to be only of a passive nature. Fall display ground counts were initiated in September. With one exception, all grounds surveyed had fewer than the maximum number of males counted in the spring counts (Table XXIV). The one exception was located in a treated shinnery oak study area. Twenty-four birds were counted on this ground compared to a maximum spring count of nineteen. Feeding and resting were frequently observed on and near the display areas. On several occasions, booming activity approached the intensity observed in the spring season. These outbursts, however, were of short duration. Display areas on which the vegetation had developed a rank growth were used infrequently and no active display behavior was observed on such areas. When flushed from the display grounds, the birds flew to areas of rough terrain covered with vegetation of mid-stature. Birds failed to return to the display grounds after being flushed, suggesting a less intensive drive to perform the display ritual at this time of the year.

TABLE XXIV

MAXIMUM NUMBER OF MALES OCCUPYING DISPLAY GROUNDS

	Spring '66	Fall '66	Spring '67
Shinnery Oak (Qha)			
Treated:			
Willcoxin	19	22	24
Twin Tanks			
A	7	0	9
B	18	NC**	21
C	12	NC	14
*West House	20	NC	22
*S. Carlton			
A	19	4	18
B	40	13	34
*Lease			
A	23	NC	NC
B	16	NC	NC
$\bar{X}$	19.3	9.77	20.3
Non-treated:			
Smith	3	0	0
East House			
A	4	0	7
B	5	NC	6
C	4	NC	0
D	3	NC	0
$\bar{X}$	3.8	0	2.6
Sand-Sagebrush (Afi)			
Treated:			
Coop. So.			
A	20	4	12
B	26	29	18
C	-	-	13
D	-	-	19
Coop. No.	19	3	18
$\bar{X}$	21.7	12	16.0
Non-treated:			
*Range	15	14	10
$\bar{X}$ all treated Qha and Afi	19.9	9.7	17.0
$\bar{X}$ all non-treated Qha and Afi	3.8	0.0	2.6

*Indicates display grounds not located within boundaries of study area.

**Indicates no count was made in the fall census.

The following field notes indicate the nature of the booming activity for this season:

> 12 Sept. '66, Coop. No. B.G.; Temp. low 70's; wind SE at 10 mph, gusts to ca. 20 mph; cloud cover 0.0; arrive 1820 hrs; 11 birds present. Booming clearly audible and territorial disputes not infrequent. Booming call not as guttural as in the spring. Pinnae not fully erected. Air sacs brilliant orange but not fully inflated. Territories seem ill-defined. Considerable movement by all birds. Some dispute with blackbirds and meadow larks, especially the latter. All the various display postures observed as in the spring but with decidedly less vigor. Birds would boom and fight, then would feed together over a rather large area of the booming ground proper. Observed birds chasing and feeding on grasshoppers.

In the spring surveys, display areas were occupied by more birds in treated as opposed to non-treated areas (Table XXIV). No booming grounds were situated in the non-treated sand-sagebrush grassland type, and booming grounds in the non-treated shinnery oak grassland type were very small. The average number of males per display area in the combined treated areas was 19.9 (1966) and 17.0 (1967) while the non-treated areas had an average of 3.8 (1966) and 2.6 (1967). A characteristic of the display grounds located in non-treated areas was that they seldom had the same number of birds occupying them through a single season. The preponderance of display grounds as well as the relatively large number of birds using them in treated plots suggests a preference for such areas.

Birds on thirteen booming grounds were counted in the spring of both years. The values were tested statistically by using a modified Doolittle to perform an analysis of variance (Ostle, 1963). An F value of 5.56 (2,20 df) was obtained suggesting a stable population ($P < 0.05$) for the two year period.

CHAPTER V

DISCUSSION

Vegetational Relations

Measurement of vegetational parameters on all study areas showed that there were distinct differences in the response of the shinnery oak and sand-sagebrush grasslands to brush control operations. The marked variability in the total of spring density values was not so apparent during the height of the growing season indicating a more homogeneous condition of the vegetation in the various study areas as the season progressed (Fig. 2). The contrasts in the total densities of the treated stands may be attributable to differences in plant kill resulting from brush control operations and the following vegetational response. A point to emphasize, however, is that woody species were not eradicated but merely suppressed. Woody life-forms were available, therefore, to lesser prairie chickens after treatment.

The general decrease in the relative densities of the woody and forb life-forms, and the increase of grasses as the season progressed points out phenological dynamics (Figs. 3, 4, and 5). Changes in the importance values between the two sampling periods also indicate the magnitude of the phenological relations between the stands (Tables III and VI). The phenology of plants has been found to be associated with the use of associations by lesser prairie chickens (Jones, 1964). It

is important to note that, in the course of a year, coverts change with respect to relative availability.

The effects of brush control on the vegetational associations of the shinnery oak and sand-sagebrush grasslands were both pronounced and variable. Treated areas in the shinnery oak grasslands appeared to be affected to a lesser extent than treated areas in the sand-sagebrush grasslands. Moreover, treated areas of the different grassland types appeared to be more similar than non-treated areas (Table VIII). This implies that the habitat components available to lesser prairie chickens were more comparable in treated areas of the respective grassland types. The very low similarities between non-treated areas of both grassland types is primarily attributable to the different woody life-forms in each, i.e., shinnery oak may be a dwarf shrub, shrub, or tree; while sand-sagebrush may be either a dwarf half shrub, or half shrub. In sum, treatment of shinnery oak and snad-sagebrush grasslands introduced a greater uniformity for the respective types.

The successional relationships between the different study areas were not clear. It has been suggested that more favorable moisture conditions tend to favor a greater variety of dominants and an increase in total density (Dix, 1958). Clements (1916) felt that communities became stabilized when the most mesophytic conditions were attained. It follows that areas within the same grassland type which exhibited the greatest variety of dominants and greatest total density would be indicative of stabilization. If total density values are truly indicative of climax conditions, then treated shinnery oak areas and non-treated sand-sagebrush areas approximate the climax condition (Fig. 2). If, on the other hand, varieties of dominants are used as

successional criteria, treated shinnery oak and sand-sagebursh grasslands would approach the climax (Table VI). The above is based on the conformity of the importance values of the most important species in each stand. Vegetational life-form also has been advanced as exerting a controlling influence on stabilization (Clements, 1916). Using life-form as a stabilization criterion, one would expect a climax situation to be characterized by fewer life-forms than might be present in earlier seral stages. If this is valid then non-treated sand-sagebrush and treated shinnery oak would approach climax (Table VI). Climax is considered to be permanent because of its harmony with a stable habitat. It should also persist as long as the climate remains unchanged. Using all the above criteria, treated shinnery oak areas consistantly indicated climax, while non-treated sand-sagebrush areas were most frequently indicative of climax.

The concept of climax as proposed by Clements has several inherent weaknesses. These weaknesses are generally centered around the idea of premanency, climate, site, and amount of geographic inclusion. Whittaker (1953) has reconsidered the climax theory proposing that the climax is a population pattern. It is difficult to distinguish between a seral stage and a climax. Furthermore, there seems to be no reason why the usual successional direction should not be reversed. Since so many factors are involved in successional phenomena, it is convenient to determine climax status by the populations that replace other populations and then maintain themselves (Whittaker, 1953). This pattern or mosaic is determined by local conditions.

The variability in the plant species and life-forms between

treated and non-treated areas of shinnery oak and sand-sagebrush grasslands is indicative of patterning. Herbicide application is admittedly largely responsible for this patterning; natural factors such as fire, however, would have a similar effect. In the final analysis, it appears that the herbicidal treatment of brushy grasslands is creating a pattern which approaches a climax mosaic.

Habitat Relations

One of the objectives of this study was to determine whether lesser prairie chickens were present or absent in selected areas of treated and non-treated shinnery oak and sand-sagebrush grasslands. Treated areas of both grassland types consistantly supported more prairie chickens (Table IX). The apparent preference for treated plots, especially in the shinnery oak grasslands, suggests that treatment created a more favorable habitat for the birds.

It is possible that undue concern has been directed toward brush control operations in so far as lesser prairie chickens are concerned. Jackson and DeArment (1963) felt that the accelerating program of brush control was decidedly adverse to the future of the species. To be sure, as shown in this study, woody species are an important habitat element to lesser prairie chickens; however, a matter of degree is involved. The results of this study show the degree of brush removal in selected areas of western Oklahoma, at this time, to be decidedly beneficial to the species.

Two other points projected by Jackson and DeArment (1963) to be deleterious to lesser prairie chickens were overgrazing and a change-over to the combine-harvesting rather than the shocking system of

harvesting grain sorghums in the field. The rangelands inhabited by lesser prairie chickens are in a rather low rainfall region which makes the habitat very sensitive to overgrazing. Hard lessons were learned in previous drought periods and many ranchers currently stock their ranges at a safe rate, rendering such areas as good prairie chicken habitat. Penfound (1964) found that the vegetation remained fairly constant with some grazing as opposed to complete protection. The practice of combine-harvesting grain sorghums is, however, another case. Birds made tremendous use of shocked sorghum fields in the fall and winter. The practice of combine-harvesting may come to affect lesser prairie chicken numbers adversely.

Brood Size

Average brood size recorded in this study was larger than counts made by Copelin (1963) and Davison (1940). It is possible that a more favorable habitat was created by change in management of native vegetation through the use of herbicides. It is also possible that dry weather during the incubation period favored chick survival. Lehmann (1941), Marcstrom (1960), and Halloran (1964) have reported on chick survival relative to rainfall patterns for the Attwater prairie chicken, capercaillie, and Rio Grande turkey, respectively.

Display

The presence of larger display grounds in treated areas not only suggests that more favorable sites were available but that other habitat components were near-by. For example, nesting sites are frequently located near booming grounds (Copelin, 1963; Davison, 1940;

Jones, 1963). It has been shown that brush control operations result in an increase of grass species. Areas of rather dense grass coverage are preferred resting sites. Therefore, one would expect larger display grounds in treated areas. In general, the largest booming grounds were located within or near relatively large tracts of preferred habitat. Hamerstrom, Hopkins, and Rinzel (1941) found that greater prairie chicken booming grounds were larger and occupied by more birds in areas of good habitat.

Territorial behavior displayed at leks is thought to be a factor in the natural regulation of tetranoid populations (Tinbergen, 1957; Wynne-Edwards, 1962; Jenkins, 1967). Robel (1967) felt that booming grounds are instrumental in maintaining maximum productivity for greater prairie chickens. He suggested that the roles of booming grounds are a rigorous selection of the male mating stock and attraction and sexual stimulation of the visiting females. Lumsden (1965) stated that the territorial mating system and dominance hierarchy restricts matings to relatively few cocks in sharptail grouse. In this study, hens were most frequently observed on the larger booming grounds suggesting perhaps that greater volume of sound attracted the hens. Robel (1967) found sound volume to be of significance in the attraction of hens for the greater prairie chicken.

The preponderance of display grounds as well as the relatively large number of birds using them in treated plots suggests a preference for such areas. Conversely the sporadic occupancy of display grounds in non-treated plots suggests unfavorable conditions for this particular activity. It is possible that the presence of birds on the less preferred display grounds may indicate a lack of space on the more

preferred areas and thus point to a population overflow or to a degradation of suitable display areas.

Habitat Selection

Up to a certain limit, the greater prairie chicken has historically increased its range with human settlement and cultivation (Leopold, 1933; Hamerstrom, Mattson, and Hamerstrom, 1957; Lumsden, 1965). The lesser prairie chicken responded to settlement largely by increased numbers rather than increased range. In recent times, however, both species have not only been reduced in numbers but have also witnessed severe constriction in their range. The primary factor involved is evidently habitat deterioration. In the case of the lesser prairie chicken, there actually has been a segmentation of the former continuous range. The general significance of habitat selection lies in the fact that it may constitute the first barrier to distribution which brings about incipient isolation. A negative way in which habitat selection functions is through unduly limiting the exploration of new areas or slightly different habitats by a species (Miller, 1942). If restriction of geographic range is extreme, a single unfavorable season could almost exterminate a population (Taylor, 1934). The contemporary problem is how to perpetuate the survival of species which have undergone severe contraction of range. The solution to this situation may rest in understanding specific habitat requirements.

This study was conceived to determine the effect of herbicide treatment on habitat of the lesser prairie chicken. The range of this bird spans two distinctly different grassland types. Both of the grassland types are essentially brush-prairie savannas and the presence

of the brushy elements seemingly is important for the welfare of the species. Artificial reduction of brushy canopy in recent times has caused much consternation about the perpetuation of this bird species. It has been demonstrated in this study that the suppression of brush species over much of the range of the lesser prairie chicken has resulted in a general increase in numbers.

The results of this study clearly indicate that rather specific vegetal heights are sought out by lesser prairie chickens for the various life activities (Table XI). Components of the environment actually used by prairie chickens appear to define their habitat effectively. This perceived environment probably represents the birds' Umwelt.

At this point, one might ask the question: What are the common elements in shinnery oak and sand-sagebrush grasslands which enable the lesser prairie chicken to occupy both? As mentioned earlier, treated areas of the respective grassland types are structurally the most similar. Since treatment affects vegetal structure by reducing the amount of overhead cover, one may tentatively conclude that areas characterized by an open aspect tend to favor lesser prairie chickens. To be sure, a certain amount of brushy canopy is needed. Proper interspersion of open and partially closed canopy appears to be the common denominator of good quality prairie chicken habitat. Prairie chickens need sufficient room to spread their wings for landing and take-off. Since this bird relies heavily on its strong powers of flight for escaping predators, one might conclude that this species is preeminently a bird of open lands. From the above discussion it is evident that the quality of lesser prairie chicken habitat hinges on essential place

components, the kinds of place being structural and spatial (Table XIII). These place components can be considered a common denominator transcending two grassland associational types.

Habitat Manipulation

Certain kinds of vegetational management have been shown to benefit many game species (Goodrum and Reid, 1956; Hartman, 1956; Sharp, 1963; Trumbo, 1963). In general, brush control operations change wildlife habitat by altering the composition, height and diversity of plant cover and by changing the relative availability of food plants (Box, 1964). The emphasis of brush control has shifted from eradication to suppression or management of woody species. A methodology is now emerging for incorporating brush control practices with game management objectives (Lehmann, 1960; Trumbo, 1963).

It has been shown that seemingly homogeneous brushy grasslands inhabited by lesser prairie chickens represent a complex mosaic, with discrete boundaries separating adjacent portions. Brush control can be used to create and maintain an interspersion of structural elements favorable to lesser prairie chickens. Brush control may, therefore, be considered as a feasible tool for habitat manipulation, favoring both the rancher and the lesser prairie chicken. The practice appears to be sound economically and ecologically. The future of the lesser prairie chicken in the light of the current findings appears to be reasonably secure.

Management Suggestions

The lesser prairie chicken is a bird of the prairie. The kind of grassland, however, is of vital importance to this species. A brush-prairie savanna is preferred. Management proposals suggested herein are related to the management of the habitat.

Grasses are considerably important. Moderate grazing should be encouraged. Areas of rather dense grass cover with the grasses mid in stature should be encouraged in the vicinity of booming grounds. Such areas would afford good nesting cover.

Woody species should be reduced in abundance where they form large blocks of a closed canopy. Scattered shinnery oak motts should, however, be encouraged. Oak motts are extensively used for shade in the hot summer months. Woody species can be controlled by herbicide treatment, mechanical means, or fire. Fire should be used previous to the nesting season.

Brush control practices, while favoring an increase in grass cover, reduce some of the native winter food. This is particularly true for the mast crop produced in the shinnery oak grasslands. Supplemental food plots of adequate size to last through the winter should be developed. Hamerstrom, Mattson, and Hamerstrom (1957) suggested that food plots be placed not less than four miles apart in greater prairie chicken range. Their suggestion seems reasonable for lesser prairie chicken range. Such a spacing would spread out the large concentrations of birds currently utilizing the few food plots now available, and reduce the chances of spreading diseases and parasites.

Areas used for display grounds are abandoned if the vegetation is

allowed to develop into a rank growth. The use of such areas for winter cattle feeding locations would insure their use. Hamerstrom, Hopkins, and Rinzel (1941) have shown that, up to a limit (11-15), the more cocks per display ground, the more successful copulations. If this holds for the lesser prairie chicken, it would be advantageous to create new display grounds by reducing the height of the vegetal cover on knolls, ridges, or large swales.

A mosaic composed of different vegetal structural elements has been shown to be preferred by the lesser prairie chicken. This mosaic arrangement has been called "ecological patterning" by Hamerstrom et al. (1957). This condition can be created and maintained by herbicide treatment, mechanical means, or fire. Large blocks of uniform aspect should be made heterogenous.

Management should be directed not only to quality, but also to quantity and distribution.

CHAPTER VI

SUMMARY

Shinnery oak and sand-sagebrush occupy large areas of the Southern Great Plains. Both species have been subjected to eradication or suppressive measures. These two range plants, in their respective areas of distribution, are considered to be vital to the welfare of lesser prairie chickens.

The objectives of this study were to: (i) determine whether lesser prairie chickens are present or absent in selected areas of treated and untreated shinnery oak and sand-sagebrush grasslands; (ii) measure the effects of brush control on the characteristics and composition of the representative vegetational associations; and (iii) determine if brush control practices have affected the distribution and numbers of lesser prairie chickens.

The vegetation in selected areas of treated and untreated shinnery oak and sand-sagebursh grasslands was sampled by the point-centered quarter method. Importance values and indicies of stand similarity were calculated.

The basic approach of this study was to evaluate the quality of the habitat in representative treated and untreated study plots. Habitat quality was based on the actual use of environmental elements by lesser prairie chickens.

Habitat was analyzed primarily on the basis of structure or plant

life-form. Plant species were also considered.

Display grounds were censused in the spring and fall of 1966 and the spring of 1967.

Distinct differences were evident in the response of shinnery oak and sand-sagebrush grasslands to brush control operations. Woody species were not eradicated but merely suppressed in treated plots.

Treated areas in the shinnery oak grasslands appeared to be affected to a lesser extent than treated areas in the sand-sagebrush grasslands. Treated areas of both grassland types consistently supported more prairie chickens suggesting that treatment created a more favorable habitat for the birds.

It was concluded that brush control may be considered as a feasible tool for habitat manipulation, favoring both the rancher and the lesser prairie chicken. The practice appears to be sound economically and ecologically.

Future investigations along the lines of tolerable and optimum degrees of brush management should prove rewarding.

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APPENDIX

APPENDIX

A LIST OF SCIENTIFIC AND COMMON PLANT NAMES ENCOUNTERED IN THIS STUDY*

Scientific Name	Common Name
Agropyron smithii Rydb.	Western Wheatgrass
Ambrosia psilostachya DC.	Western Ragweed
Amorpha canescens Pursh	Leadplant
Andropogon hallii Hack	Sand Bluestem
Andropogon saccharoides SW.	Silver Bluestem
Andropogon scoparius Michx.	Little Bluestem
Aristida purpurascens Poir.	Arrowfeather Threeawn
Artemisia filifolia Torr.	Sand-sagebrush
Aster ericoides L.	Heath Aster
Aster oblongifolius Nutt.	Aromatic Aster
Bouteloua curtipendula (Michx.) Torr.	Sideoats Grama
Bouteloua gracilis (Willd.) Lag.	Blue Grama
Bouteloua hirsuta Lag.	Hairy Grama
Buchloe dactyloides (Nutt.) Engelm.	Buffalo Grass
Cassia fasciculata Michx.	Partridge Pea
Chenchrus sp.	Sandbur
Chenopodium sp.	Goosefoot (Lanb's-quarters)
Chloris verticillata Nutt.	Windmill Grass
Chrysopsis pilosa Nutt.	Goldaster
Chrysopsis villosa (Pursh) Nutt.	Hairy Goldaster
Cyperus schweinitzii Torr.	Flatsedge

*Scientific names were taken from Waterfall (1962) and Rydberg (1932). Common names were taken from Anderson (1961).

Scientific Name	Common Name
Eragrostis curvula (Schrad.) Nees	Weeping Lovegrass
Eragrostis trichodes (Nutt.) Nash	Sand Lovegrass
Erigonum annuum Nutt.	Annual Erigonum
Heterotheca subaxillaris (Lam.) Britt. and Rusby	Camphorweed
Leptoloma cognatum (Schultes) Chase	Fall Witchgrass
Lithospermum sp.	Gromwell (Stoneseed)
Oenothera serrulata Nutt.	Serrateleaf Evening Primrose
Panicum oligosanthes var. scribnerianum (Nash) Fern.	Scribner Panicum
Panicum virgatum L.	Switchgrass
Paronychea jamesii T. &. G.	James Nailwort
Paspalum stramineum Nash	Sand Paspalum
Poa arachnifera Torr.	Texas Bluegrass
Plantago purshii R. &. S.	Woolly Plantago
Prunus angustifolia Marsh	Chickasaw (Sand) Plumb
Prunus gracillis Engelm. & Gray	Oklahoma Plumb
Quercus havardi Rydb.	Shinnery Oak
Rhus aromatica Ait.	Aromatic Sumac (Skunkbush)
Ruellia humilis Nutt.	Fringeleaf Ruellia
Solidago missouriensis Nutt.	Missouri Goldenrod
Sorghastrum mutans (L.) Nash	Indian Grass
Sorghum vulgare Pers.	Sorghum
Sporobolus clandestinus (Bieler) Hitchc.	Hidden Dropseed
Sporbolus cryptandrus (Torr.) A. Gray	Sand Dropseed
Strophostyles leiosperma (T. & G.) Piper	Smoothseed Wildbean
Tephrosia virginiana (L.) Pers.	Virginia Tephrosia
Triticum aestivum L.	Common Wheat
Viola kitaibeliana var. rafinesquii (Greene) Fern	Johnnyjumpup
Yucca glauca Nutt.	Small Soapweed

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