VEGETATION AND OCCURRENCE OF GREATER PRAIRIE CHICKENS (*TYMPANUCHUS CUPIDO PINNATUS*) ON THREE RANGE SITES IN GEARY COUNTY, KANSAS

by

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INTRODUCTION

Leopold (1933:306) believed a species of wildlife must have a habitable range containing places to perform all life functions including feeding, resting, and raising young. For the greater prairie chicken (*Tympanuchus cupido pinnatus*), a habitable range is almost invariably defined by extensive grassland habitat.

The prairie chicken was once abundant throughout the vast grassland regions of central United States, but its range has experienced a great reduction in recent years (Aldrich, 1963:537). Grassland is so important to prairie chickens that, as man changed the northern prairie regions from marshland to synthetic grassland, prairie chickens increased in number (Hamerstrom, 1939:105). As this synthetic grassland was destroyed, the prairie chicken population was seriously reduced. Ammann (1957:54) stressed ground cover as the dominant feature of both prairie chicken and sharptail (*Pediocetes phasianellus*) habitat and pointed out that neither species could survive without sufficient ground cover.

It was the purpose of this study to conduct a detailed investigation of the habitat of the greater prairie chicken in eastern Kansas and examine the influence of the habitat on the movements of this prairie grouse.

REVIEW OF LITERATURE

Observation and description techniques of the early days of plant ecology are being replaced by readily repeatable quantitative techniques (Oosting, 1958:31). Use of sampling quadrats was begun in 1898 and marked the beginning of the transition from descriptive to more quantitative vegetational study methods (Ursic and McClurkin, 1959:70). Since 1898 many new quantitative techniques have been developed, although, as pointed out by Daubenmire (1959:43), standardization was lacking.

Extensive surveys of vegetation cannot feasibly be made by investigating each individual plant. Because of this, Brown (1954:6) stressed the necessity of a good sampling system.

Daubenmire (1959) gave a detailed discussion of sample size and believed that a more representative sample could be gained from a large series of small plots rather than a single large one. A major advantage of sampling with small plots is the reduction in the observer's error by narrowing his sphere of attention. Cain (1937:349) found that an extremely small sample was sufficient to define the characteristic species in a natural grassland area. It was found by Rice (1952) that grass species were encountered equally well by 20 plots measuring one meter square as by 40 plots of the same size. Poulton (1948:110) indicated that since grassland areas are so homogeneous, relatively few clipping samples are needed to determine forage production.

In vegetational analysis there is a greater probability of encountering small isolated groups of species if an elongate plot is used in preference to an isodiametric plot (Daubenmire, 1959:45). Bormann (1953:485) and Hasel, (1938:730) have found that vegetation sampling procedures can be facilitated, without a loss in sampling efficiency, by systematically omitting short segments of a long narrow sampling plot.

Oosting (1959:39) discussed in detail the location of sampling plots. He pointed out that all statistical treatments were designed to handle data free from intrinsic and personal bias. Sampling should therefore be as random as possible. He warned, however, that statistical analysis could not be an effective substitute for good judgement in community selection and data interpretation.

It was expressed by Braun-Blanquet (1932:27) and Daubenmire (1959:45) that plots used to sample single stands of vegetation should be located on areas of great uniformity. This is to remove the effect of site variability and reflect the floristic variation within the area being studied. Such factors as grazing intensity, soil type and topography can be used to restrict the placement of plots.

An important part of grassland analysis is an accurate determination of the species composition. Plant species composition is the total number of species present in a given population (Holscher, 1958:39).

For some purposes a simple listing of the species present is sufficient to describe a community (Holscher, 1958:39). To reveal more meaningful information about a community, however, other techniques must be used. Weaver (1929:21) believed the line transect was the best method to determine local differences in the composition of grassland vegetation. The species composition of a grassland was analyzed by Anderson (1942) using two different methods. He concluded that line transects are more effective than large fixed plots in revealing species over scattered areas. The trend to reduce plot size has also given rise to the point method as described by Brown (1954:71). Brown indicated that if a sufficient number of points were used, the vegetation could be accurately analyzed by the point method.

Lindsey (1956) suggested that, in sampling, a 2-dimensional plot showed more meaningful vegetative relationships and enabled the investigator to detect more species at each sampling location. Daubenmire (1959) has combined the 2-dimensional plot concept with the line transect and developed a method capable of showing the community importance of vegetative species based on their canopy coverage. The method involved estimating the canopy coverages within a small plot frame that was placed along a line transect at regular intervals.

Species composition alone cannot provide all information needed to evaluate the habitat potential a grassland area holds for wildlife. Emlen (1956:568) listed the vegetation screening efficiency or density as an important consideration in describing avian habitats. When used in conjunction with other aspects such as species composition, density is a valuable indicator of community structure (Holscher, 1958:99).

The term vegetation density has two different interpretations. A number of investigators express density as the number of individuals per unit area (Brown, 1953:24; Kobriger, 1965; Tomanek and Albertson 1953; Wight, 1938:104). Emlen (1956), on the other hand, referred to density as the screening efficiency of the vegetation. Mosby (1963:55) considered both interpretations and proposed a number of different methods to measure vegetative density.

The most direct method of obtaining density data which can be expressed on a number per unit area basis is to simply count the number of individuals present in a sample unit (Brown, 1954:24; Mosby, 1963:57; Tomanek and Albertson, 1953; Wight, 1938:104). This is a relatively simple technique and data are easily converted to standard density figures, but, as pointed out by Mosby (1963:57), it is time consuming.

Methods whereby the screening properties of vegetation can be expressed as an index to density include: (1) comparative light penetration measurements such as reported by Mossman (1955:565) where light meter readings were taken both within and outside of the vegetation being studied, (2) photographic evaluation which is useful in showing seasonal and annual changes in the vegetation density (Mosby, 1963:58), and (3) measurement of the obstruction to vision imparted to an observer by the vegetation. The third method was discussed by Wight (1938:106) who described the use of a "density board" which was marked in feet and viewed through forest vegetation under standard conditions. This principle was also used in another system where a 15 inch ruler was placed on the ground and the density expressed by the degree of visual obstruction (Webb, 1942:40). In a study of prairie chicken habitat by the Kansas Forestry, Fish and Game Commission, a square board was marked with 100 squares and viewed from a standard distance. The number of squares visible through the vegetation gave an index to density (Horak, Personal communication).

An important factor in a determination of the screening properties of vegetation density is plant height. Emlen (1956) believed that both density and vegetation height measurements should be combined when evaluating the vegetation of avian habitats.

A popular method in vegetational analysis is the use of oven dried samples of clipped vegetation. This technique is used primarily in studying forage production (Brown, 1954:79; Daubenmire, 1959:56). Daubenmire found it impossible to express results from his canopy coverage method in terms of the weight of vegetation clipped from his study area; however, Hanson (1934:842) and Arny and Schmid (1942:247) were successful in correlating weight of clipped vegetation with other vegetative measurements.

The importance of the study of vegetation to the wildlife manager was emphasized by Webb (1942) who believed that in most cases proper wildlife management was dependent on a control of the floristic environment based on an accurate knowledge of plant distribution and abundance. Jones (1963:763) made a detailed analysis of prairie chicken habitat in Oklahoma, concluding:

> It is not enough...to recognize that prairie chickens need grassland. We must be able to state that prairie chickens need grass of a certain density, height and character for their vital activity.

Hamerstrom et al. (1957:20) showed that Wisconsin prairie chickens were best adapted to regions where the land was at least one third grassland and chickens were abundant only in areas having greater than 35 percent permanent grassland. Baker (1953:16) and Schwartz (1945:23) likewise found that between 30 and 60 percent of the land must be permanent grassland to support stable populations of prairie chickens in Kansas and Missouri, respectively.

A great deal has been written about the incompatibility of the prairie chicken and the agriculturalization of the prairies. Schwartz (1945:90) listed the land use practices that were unfavorable to Missouri prairie chickens as: (1) overgrazing, (2) promiscuous burning and (3) late season mowing. Mohler (1952:9) showed concern over the decline of Nebraska's prairie chicken population following the habitat-reducing processes of plowing, grazing and drought. Even lesser prairie chickens (*Tympanuchus pallidicinctus*) have been known to suffer from the invasion of agriculture. Hoffman (1963:27) pointed out that the lesser prairie chicken in Colorado was best adapted to the primeval tall-grass prairie that existed on the eastern plains until heavy grazing and the drought of the 1930's reduced this region to a short grass disclimax.

A few writers have indicated that man has not existed entirely to the demise of the prairie chicken. When row crops were introduced into Iowa, the prairie chickens utilized them and even increased their numbers until the crops replaced most of the prairie that the birds needed for nesting (Stemple and Rogers, 1961). Mohler (1963:738) found the best winter habitat for prairie chickens in Nebraska to be small cornfields located near extensive grasslands. Korschgen (1962:316), in a study of prairie chicken food habits, found native plants to be less important than agricultural crops. He pointed out, however, that this preference could be due to the greater availability of the crops.

Prairie chickens benefit from moderate grazing (Baker, 1953:63). Activities of cattle cause the formation of paths through the vegetation and these paths could be of benefit to brood movements and facilitate sunning activities after a rain. Ammann (1957:54) concurred with the belief that breaks in the continuous cover were beneficial to prairie chickens. He stated that grazing by livestock and wildlife produced these openings where they did not already exist.

Prairie chicken populations are dependent not only on grassland but also on proper grassland management. "Prairie chicken management is primarily range management" (Hamerstrom and Hamerstrom, 1961:289).

STUDY AREA

The study was conducted on a grassland area located approximately 9 miles east-southeast of Junction City in Geary County, Kansas. This area covered approximately 6000 acres in sections 14 through 27, T12S, R7E and included all of the Simpson Ranch and a small portion of the area south and east of the ranch.

The topography of the study area was typical of the western edge of the Flint Hills bluestem prairie which extends through eastern Kansas from the Nebraska border to Okalahoma. The topography was dominated by a series of gently sloping, rounded hills separated by wooded draws with intermittent streams and small drainages. The hills were drawn into long ridges with limestone outcropings below the crests. The Permian outcrops are classified as Florence Limestone of the Barnston Formation, Chase Group (Bidwell, 1960:29). Averaging about 35 feet in thickness, the outcrops had considerable soil mixed with the rocks. The soils were derived from eolian, colluvial, alluvial, and residual material. The highest elevation on the study area was about 1400 feet and the lowest was 1180 feet.[1]

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[1]United States Dept. of Int. Geol. Survey Contour Map, 1955.

The rocky and hilly nature of the Flint Hills has discouraged plowing and cultivation, thereby making the primary enterprise commercial livestock grazing. Several of the ridge tops on the study area have been previously cultivated but this practice was abandoned during the 1930's (Owensby and Anderson, 1965). Two 160-acre cultivated fields were on the study area each comprising about 2 percent of the area. One was planted to wheat and one to milo. The area had not been burned for several years but a portion of one pasture was cut and baled for prairie hay during the summer of 1966. The remainder of the ranch was used for year-around cattle grazing. The ranch management emphasized moderate stocking rates and pasture rotation, but certain pastures, especially a 40-acre old field at the north end of the ranch, experienced heavy usage during the extremely dry fall and winter of 1966-67.

The average precipitation is about 30 inches per year, with about 75 percent of the rainfall occurring during the 170- to 190-day frost-free season (Bark, 1961:3; Anderson and Fly, 1955:164).

The vegetation on the study area consisted of the following grasses: little bluestem (Andropogon scoparius),[1] big bluestem (Andropogon geradi), indiangrass (Sorghastrum nutans), switchgrass (Panicum virgatum), tall dropseed (Sporobolus asper), sideoats grama (Bouteloua curtipendula), blue grama

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[1]Common and scientific names follow Anderson (1961).

(Bouteloua gracilis), buffalograss (Buchloe dactyloides), western wheatgrass (Agropyron smithii) and Japanese brome (Bromus japonicus). Several forbs were also abundant. They included: slimflower scurfpea (Psoralea tenuflora), western ragweed (Ambrosia psilostachya), western yarrow (Achillea millefolium), green milkweed (Asclepias viridiflora), broomweed (Gutierrezia dracunculoides), purple prairieclover (Petalostemum purpureum), and Louisiana sagewort (Artemesia ludoviciana) (Robel, 1964:703; Cebula, 1966:6; Viers, 1967:9).

There were three major range sites on the study area; the limestone breaks, the shallow, and the claypan (Bidwell, 1960:10). The limestone breaks range site constituted approximately 55 percent of the study area, extending from the top of the limestone outcrops to the draws between the hills (Plate I). The surface soil in this range site is clay loam or silty clay loam intermixed with large stones. Water holding capacity of the soil in the limestone breaks is good. Climax vegetation of the limestone breaks is a mixture of true prairie tall- and mid-grasses, including little bluestem, big bluestem, indiangrass and sideoats grama. Under conditions of grazing, the sideoats grama and tall dropseed increase. Annual forbs and short grasses are invaders under conditions of extremely heavy grazing. Woody plants such as sumac (Rhus glabra), buckbrush (Symphoricarpos orbiculatus) and dogwood (Cornus sp.) also invade the limestone breaks range site under heavy grazing.

The shallow range site covered the smallest area of the

EXPLANATION OF PLATE I

Fig. 1. A view of the study area showing the three major range sites; claypan site (1), shallow site (2), and limestone breaks site (3).

PLATE I

three major range sites, about 20 percent of the total study area. This site occurred above the limestone breaks on the ridge crests on gently sloping or nearly level ground. The shallow soil is Sogn Rocky Clay Loam, a dark loam 10 inches thick, generally lying over bedrock and supports chiefly mid-grasses in climax vegetation. Little bluestem was the dominant grass species but under grazing conditions prairie dropseed, sideoats grama and other species increase. Short grasses and forbs are more common here than in the deeper sites and under heavy grazing these species increase greatly.

The claypan range site covered about 20 percent of the study area, existing on the ridge tops. This range site was untenable for tall grass species because of shallow soil and poor water holding capacity. Little bluestem, tall dropseed, and sideoats grama thrived on claypan soils when ungrazed, but under moderate grazing, short grasses and forbs increased. Under heavy grazing, buffalograss was often the only species capable of thriving on this site.

One area on the claypan site was designated as a reseed plot, an area cultivated prior to the 1930's then allowed to "go back" to native grassland until 1963 when the area was plowed and a portion reseeded to native grass (Owensby and Anderson, 1965).

MATERIALS AND METHODS

Sampling Procedure

Twenty 20-meter line transects were established on the study area. All vegetational analyses were performed along these transects, the locations of which were determined subjectively to obtain a representative sample of the study area. Nine transects were located on the limestone breaks range site and five transects each were located on the shallow and claypan sites. One transect was placed on an unseeded portion of the reseed plot.

The location of each transect was recorded by azimuth bearings to prominent landmarks. The southern end of each transect was marked with a pile of stones about 2-decimeters high. A steel spike was driven into the ground just north of each pile of stones. From this spike a 20-meter steel tape was stretched due north (magnetic north) and affixed with coil springs and surveyor's pins. Ten plots were established along the transect immediately to the west side, the first plot located at the zero meter mark at the south end of the tape and subsequent plots at 2-meter intervals thereafter.

Species Composition

Between 10 July and 30 August 1966, species composition was recorded along each of the 20-meter transects.[1]

The canopy coverage method of vegetational analysis, described by Daubenmire (1959) was used in this study. A 1/10-square meter rectangular plot frame measuring 50 cm by 20 cm was constructed from standard welding rods. This frame was marked with yellow paint (Plate II, Fig. 1) to facilitate estimating canopy coverage in percentage categories, i.e., 5, 25, 50, 75, 95 and 100 percent. Each percentage class was number-coded to facilitate canopy coverage calculations, i.e., 1 = 0-5 percent, 2 = 5-25 percent, 5 = 75-95 percent, 6 = 95-100 percent. The plot frame was placed in the vegetation at the 10 plot locations along the tape and canopy coverages were estimated for each plot. The frame was oriented lengthwise along the tape with the southeast corner touching the even meter mark on the west side of the tape. The canopy coverage (percent of the 1/10-square meter covered by the aerial portions of each species) was estimated by placing each species encountered in one of the six percentage classes. The species canopy coverage for each transect was the average canopy coverage for the species in the ten plots. Since the aerial parts of different species can

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[1]Plant species were identified with the aid of a reference collection, verified by the Kansas State University Herbarium and Dr. L. C. Hulbert.

occupy different heights and overlap at the same height, a total canopy coverage of greater than 100 percent is possible for each plot.

Vegetation Density

Vegetation density was sampled at each of the 20 transects during the summer (10 July through 30 August), fall (6-11 November), winter (10-20 March), and spring (25-27 May). The capacity of the grassland vegetation to obstruct vision was measured in a manner similar to that described by Wight (1938:106) for sampling forest density.

A round stake, 3 by 150 cm, was painted light brown and white, alternating decimeters (Plate II, Fig. 2). The midpoint of each decimeter was marked with a narrow black stripe, making it possible for an observer to distinguish half-decimeters on the pole.

At the zero-meter plot of each transect, the pole was placed vertically in the vegetation exactly 10 cm to the west of the tape. The pole was placed in precisely the same location as the northern edge of the canopy coverage plot frame, at the 50 cm mark on the tape. The observer, positioned exactly 4 meters due south of the pole, viewed the density pole from heights of 0.5, 0.8 and 1 meter (Fig. 1). The lowest half-decimeter visible on the pole was recorded for each of the three respective heights of observation. The observer then moved to a distance of 3 meters from the pole and repeated the three height

EXPLANATION OF PLATE II

Fig. 1. The tape transect and rectangular plot frame. Note that frame has 5 percent markings in lower right corner and is marked in quarters.

Fig. 2. Use of the "density pole". Observer is facing north and viewing vegetation from 0.8 meter height.

PLATE II

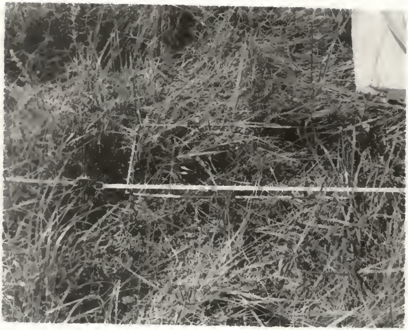

Fig. 1

Fig. 2

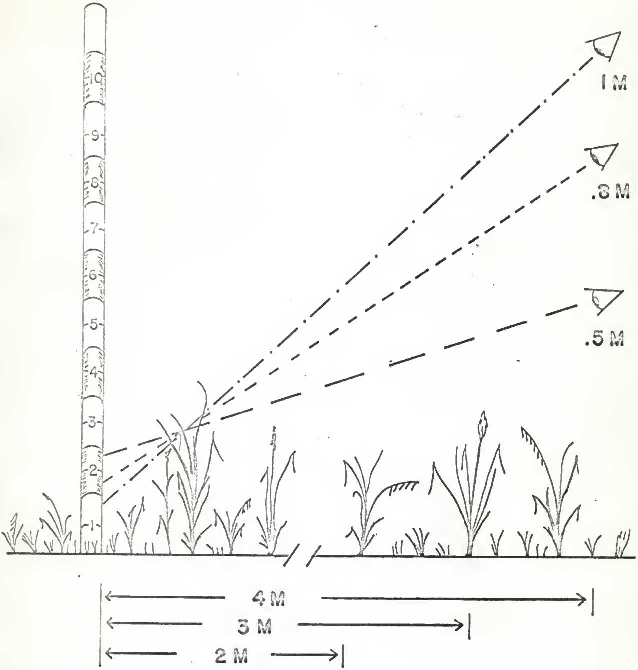

Figure 1. Density pole showing heights from which readings were taken. Each series of three readings was repeated at 2, 3, and 4 meters from the pole.

observations. This was done again at a distance of 2 meters south of the pole. The density pole was then moved to each subsequent plot (alternate meters) along the 20 meter tape and the series of observations repeated for a total of 90 density readings per transect. These 90 readings were totaled and their average used as the density index for the transect.

Habitat Relations of Prairie Chickens

Prairie chicken movement data collected by Silvy (1968) during the 16 June 1966 to 15 June 1967 period were analyzed with reference to vegetative composition and density data gathered by the author during the same period. Bird location data as determined by radio-telemetry were coded and placed on IBM punch cards for each of 1155 prairie chicken locations. Coded data included: sex and age of bird, range site, direction of slope, date, time of day, daily temperature ranges, and daily precipitation. In addition to these factors the adult females were classified as incubating, laying, or not nesting and whether or not they were accompanied by a brood.

Prairie chicken nest locations for this study were located on the basis of range site.

RESULTS

Species Composition

The summer vegetation analysis showed that the limestone breaks range site was dominated by tall grass species (Table 1). Little bluestem[1] showed the greatest canopy coverage and frequency of occurrence with values of 46.2 and 83.3 percent, respectively. Big bluestem was next in abundance with a canopy coverage of 21.9 percent and frequency of 72.2 percent. Sideoats grama was the third major species in this site with values of 18.4 percent for canopy coverage and 74.4 percent for frequency. Tall dropseed and indiangrass had canopy coverages of 16.7 and 13.7 percent, respectively, with respective frequencies of 44.4 and 50.0 percent. Species with canopy coverages less than 10.0 percent and frequencies less than 30.0 percent included hairy grama, switchgrass, buffalograss, scribner panicum, tumblegrass, prairie threeawn and all forbs.

The dominant species on the shallow site was tall dropseed with a canopy coverage of 35.9 percent and an 82.0 percent frequency. The second and third important species in the shallow site were little bluestem (canopy coverage 13.2 percent and frequency 52.0 percent) and big bluestem (canopy coverage 12.3 percent and frequency 68.0 percent). Sideoats grama had a 9.5 percent canopy coverage and 46.0 percent frequency.

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[1]Common and scientific names are listed in Table 5.

Table 1. Results of vegetation analysis conducted during summer of 1966. Canopy coverage and frequency of occurrence are averaged for all transects in each range site.

Species	Range Site					
	Claypan		Shallow		Limestone Breaks	
	Canopy[1] Coverage	Frequency[2]	Canopy Coverage	Frequency	Canopy Coverage	Frequency
Perennial Grass Decreasers						
Little bluestem	3.3	4.0	13.2	52.0	46.2	83.3
Big bluestem	8.5	18.0	12.3	68.0	21.9	72.2
Indiangrass	0.0	0.0	7.8	32.0	13.7	50.0
Switchgrass	2.0	6.0	3.4	20.0	2.6	20.0
Perennial Mid- and Short Grass Increasers						
Tall dropseed	31.7	54.0	35.9	82.0	16.7	44.4
Sideoats grama	2.3	6.0	9.5	46.0	18.4	74.4
Blue grama	0.1	2.0	5.4	8.0	1.2	5.5
Hairy grama	1.6	6.0	0.5	8.0	6.9	17.7
Buffalograss	6.5	12.0	5.9	14.0	0.0	0.0
Scribner panicum	2.5	26.0	5.4	48.0	0.2	1.1
Tumblegrass	6.6	40.0	0.1	4.0	0.1	5.5
Prairie threeawn	32.2	60.0	0.7	6.0	0.6	1.1
Forbs						
Slimflower scurfpea ...	4.5	14.0	5.7	16.0	1.1	5.5
Louisiana sagewort	4.6	36.0	2.6	28.0	0.1	1.1
Heath aster	3.6	30.0	2.7	38.0	1.8	21.1
Pitcher sage	1.1	16.0	2.3	12.0	2.1	28.8
Western yarrow	2.2	24.0	3.6	36.0	0.1	2.2
Western ragweed	0.9	30.0	2.8	54.0	2.1	41.1

[1]Expressed in average percent aerial coverage of 0.1-square meter plots.

[2]Expressed as percent occurrence of species in total number of plots examined.

Indiangrass had a canopy coverage of 7.8 percent and frequency of 32.0 percent. Species having canopy coverages with values between 5.0 and 6.0 percent included buffalograss (14.0 percent frequency), slimflower scurfpea (16.0 percent frequency), scribner panicum (48.0 percent frequency) and blue grama (8.0 percent frequency). Those species in the shallow site having canopy coverages less than 5 percent included the remaining forbs (frequencies ranging from 12.0 to 54.0 percent), switchgrass, tumblegrass, prairie threeawn, and hairy grama (frequencies less than 20 percent).

The claypan range site was dominated by two species; prairie threeawn and tall dropseed, with canopy coverage values of 32.2 and 31.7 percent respectively and respective frequencies of 60.0 and 54.0 percent. The next highest canopy coverage was exhibited by big bluestem with an 8.5 percent canopy coverage and 18.0 percent frequency. Tumblegrass had a 6.6 percent canopy coverage and 40.0 percent frequency and buffalograss had a 6.5 percent canopy coverage but a 12.0 percent frequency. All other species had canopy coverages less than 5 percent and frequencies less than 37.0 percent on the claypan range site.

The species composition during the summer on the unseeded portion of reseed plot was generally similar to the other claypan areas except that short grasses showed even greater dominance. The most abundant species was prairie threeawn with a canopy coverage of 96.3 percent and 100.0 percent frequency of occurrence. Tumblegrass was the second important species, also with a frequency of 100.0 percent but a canopy coverage of only 26.3 percent. Little bluestem and western wheatgrass both had canopy coverages of 8.5 percent and frequencies of 10.0 percent. Having a canopy coverage of 4.8 percent was witchgrass (frequency 40.0 percent) while big bluestem showed a 4.3 percent canopy coverage (30.0 percent frequency). Catclaw sensitive briar and horseweed also had 4.0 percent canopy coverages with respective frequencies of 20.0 and 10.0 percent. Western ragweed showed a canopy coverage of 3.0 percent (70.0 percent frequency) while slimflower scurfpea, western yarrow and hairy grama all had canopy coverages of less than 2.0 percent (frequencies of 20.0, 10.0, and 10.0 percent, respectively).

Several additional plants were encountered by the transects but their canopy coverages and frequencies of occurrence were so low that they were not included in the above totals. The additional grasses included Japanese brome, Kentucky bluegrass, prairie dropseed, sand dropseed, and Virginia wild rye. Sedges and rushes were also encountered. The additional forbs included alfalfa, aromatic aster, blue wildindigo, broomweed, buckbrush, dotted gayfeather, green milkweed, ironweed, leadplant, lespedeza, peppergrass, prairie coneflower and purple prairieclover (Table 5).

Vegetation Density

The density indices were averaged over each range site and showed site and seasonal variations. During all four seasons, vegetation on the limestone breaks site had a higher density index than did the vegetation on claypan or shallow sites (Fig. 2). The claypan site consistently exhibited the lowest density index while the vegetation on the shallow site was always intermediate in density. The highest density indices were encountered during the summer and the lowest values during the winter, with the fall and spring indices roughly equal and always intermediate. The summer density index value for the limestone breaks was 1.73, the fall value 1.22, winter 0.90 and spring 1.30. The summer index for the shallow site was 1.05, followed in the fall by 0.78, a winter index of 0.70, and a spring index of 0.90. The same pattern of index relationships was observed on the claypan site; a summer high of 0.96, a fall value of 0.68 and a winter low of 0.65 followed by a spring increase to 0.74.

The reseed plot experienced its highest density during the summer, a value of 1.52. The fall and winter seasons had vegetative density values of 1.27 and 1.26, respectively. The lowest density on the reseed plot was during the spring, a value of 1.18.

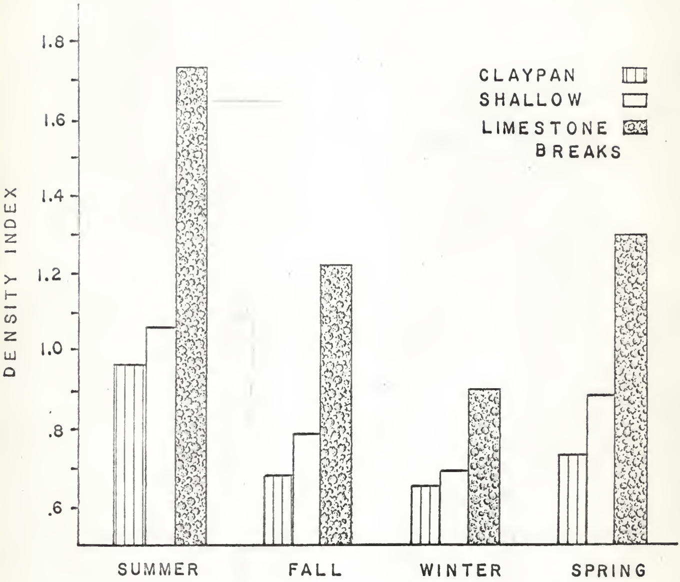

Figure 2. Seasonal variation in vegetative density on the three range sites of the study area during 1966-67.

Prairie Chicken Habitat Relationships

Twenty-six individual prairie chickens were radio-tracked from 16 June 1966 through 15 June 1967, providing a total of 1155 locations which were analyzed with reference to vegetational data (Table 2). Eleven adult male prairie chickens provided 420 bits of location data while four juvenile males provided 301 bits. A total of 341 locations were obtained from the 10 adult females tracked in this study, 76 of which were taken while the females were accompanied by broods. One juvenile female was tracked for a total of 93 locations.

Fifty percent of the 1155 prairie chicken locations were recorded on the shallow range site; 21 percent on the limestone breaks site, and 4 percent on the claypan site. Locations of the birds on the booming grounds accounted for 11 percent of the total number while the wheat and milo fields accounted for 8 and 7 percent of the total locations, respectively.

The adult male prairie chickens used the shallow range site and booming ground extensively during the spring (March, April, and May) with each area accounting for 40 percent of the 92 adult male locations taken during this season (Fig. 3). Nine and 10 percent of the 92 locations of adult males during the spring occurred on the limestone breaks and milo field, respectively; while only 1 percent of the locations occurred on the claypan range site. Wheat field use by adult males was not detected during this study for the spring season. Of the 108

Table 2. Summary of prairie chicken location data gathered from 16 June 1966 through 15 June 1967. Number of locations within each range site is presented along with the percent each number constitutes of the total number of locations for each group of birds.

	Range Site												
	Limestone Breaks (55)[1]		Shallow (20)		Claypan (20)		Booming Ground (1)		Wheat Field (2)		Milo Field (2)		Total
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	
Males													
Adult	71	16.7	200	47.6	12	2.8	49	11.6	56	13.3	32	7.6	420
Juvenile	42	13.9	138	45.8	5	1.6	66	21.9	9	2.9	41	13.6	301
Total Males	113	15.6	338	46.8	17	2.3	115	15.9	65	9.0	73	10.1	721
Females													
Adult	64	24.1	144	54.3	28	10.6	10	3.8	16	6.0	3	1.1	265
With Brood	34	44.7	39	51.3	3	3.9	0	0	0	0	0	0	76
Juvenile	31	33.3	51	54.8	1	1.1	0	0	8	8.6	2	2.1	93
Total Female	129	29.7	234	53.9	32	7.3	10	2.3	24	55.3	5	1.1	434
All Birds	242	20.9	572	49.5	49	4.2	125	10.8	89	7.7	78	6.7	1155

[1]Parenthetical figures represent percent of study area.

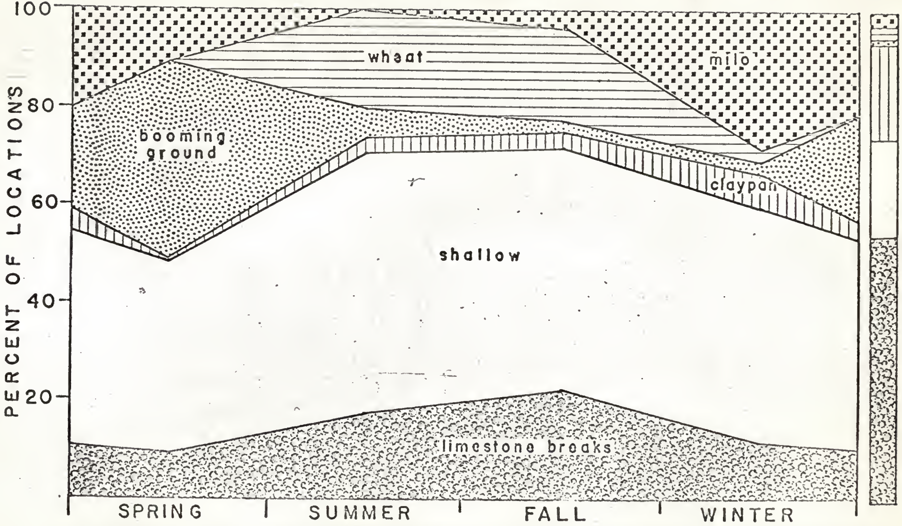

Figure 3. Seasonal distribution of 420 adult male prairie chicken locations by habitat unit.

locations of adult males recorded in the summer (June, July, and August), 53 percent occurred on shallow range sites and 6 percent on booming grounds. Eighteen percent of the 108 adult male locations were on the limestone breaks range site while the proportion of locations on the wheat field was 20 percent. During the summer 3 percent of 108 locations were on the claypan range site and zero in the milo field. During the fall (September, October, and November), 49 percent of the 160 locations of adult male prairie chickens occurred on the shallow range site, 23 percent on the limestone breaks, and 20 percent on the wheat field. The milo field and claypan sites had 4 and 3 percent respectively, of the 160 adult male fall locations while the booming ground accounted for 2 percent of the locations. The shallow range site contained the greatest number of winter (December, January, and February) locations of the adult males (48 percent of 60 locations) and the booming ground received 2 percent of 60 locations. Areas receiving intermediate numbers of locations included the milo field (28 percent of 60 locations), limestone breaks site (12 percent of 60 locations), claypan site (7 percent of 60 locations) and the wheat field (3 percent of 60 locations).

Adult female prairie chicken movement data were insufficient to detect the fall and winter habitat relationships, however, 150 locations were obtained during the spring and 115 during the summer. The adult females used the shallow range site heavily during the spring (57 percent of the locations) and summer (59 percent of the locations). The booming ground areas on which 7 percent of 150 spring locations occurred, had no adult females located on them during the summer. The wheat field was not used during the spring but 6 percent of the 115 summer locations occurred on the wheat field. The limestone breaks site was used moderately by the adult females in the spring (23 percent of 150 locations) and summer (27 percent of 115 locations). Only 1 percent of the prairie chicken locations occurred on the milo field during the spring and summer periods.

The seasonal habitat relationships of juvenile male and female prairie chickens were similar to those of the adult males (Fig. 4). During the spring, 36 percent of 120 locations occurred on the shallow site while 46 percent of the locations occurred on the booming ground. Eleven percent of the spring locations of juvenile birds were recorded on the milo field while 3 and 4 percent of the 120 locations occurred on the claypan and limestone breaks sites, respectively. No locations were detected in the wheat field for juveniles during the spring. The majority of the 39 locations taken for juveniles during the summer occurred on the shallow range site (62 percent) with the remainder occurring on the limestone breaks and wheat field. The shallow range site contained 50 percent of the 150 juvenile prairie chicken locations taken during the fall season. The limestone breaks accounted for 35 percent of the fall locations for juveniles and the wheat and milo fields contained the remaining 15 percent. During the winter, 46 and

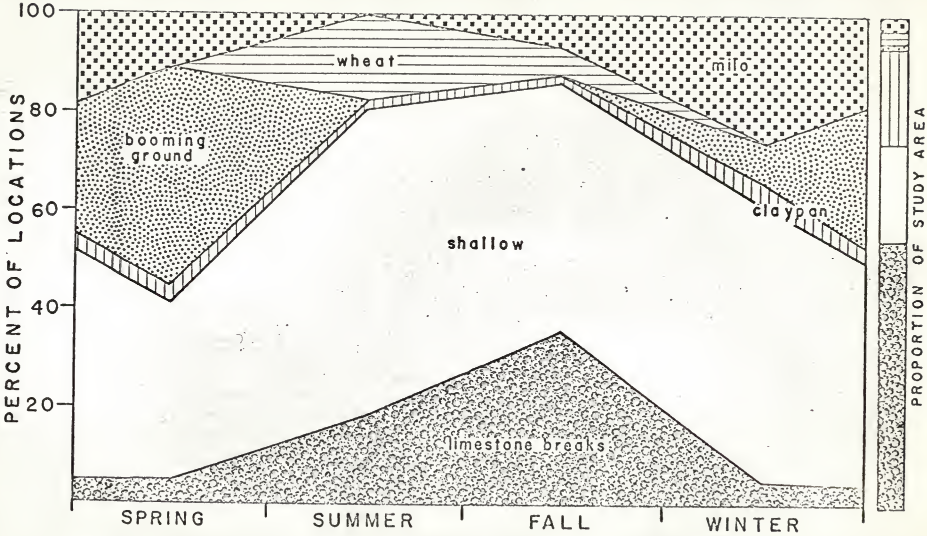

Figure 4. Seasonal distribution of 394 juvenile prairie chicken locations by habitat unit.

20 percent of 75 locations of juveniles occurred on the shallow site and the milo field, respectively, while the booming ground received 30 percent of the locations.

A total of 362 prairie chicken locations (adults and juveniles) were taken during the spring. Ninety-eight percent of the 55 locations taken before sunrise during the spring were on the booming ground (Fig. 5). During the first 20 percent of the day (measured from sunrise to sunset) the booming ground received only 20 percent of 131 locations while the shallow site received 53 percent and the limestone breaks received 10 percent of the locations. The majority of the 79 locations taken during the middle portion of the day (21-80 percent of the daylight period) were found on the shallow range site (60 percent of the locations). The limestone breaks and booming ground accounted for most of the remainder of the locations. During the afternoon (81-100 percent of the day) period, the milo field, booming ground, and claypan site each accounted for about 10 percent of 90 locations while the shallow and limestone breaks sites contained approximately 45 and 20 percent of the locations, respectively. After sunset during the spring the shallow range site contained 55 percent of 7 locations and the limestone breaks contained 30 percent. Some of the locations taken after sunset were on the booming ground.

A total of 262 prairie chicken locations was taken during the summer. Sixty percent of the 8 locations taken before sunrise were on the booming ground while the remainder were on

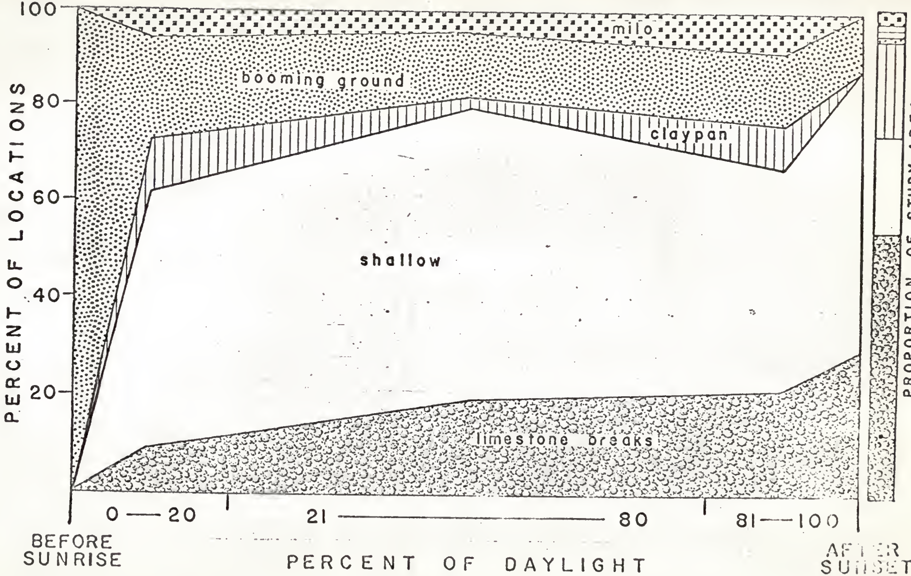

Figure 5. Time-wise distribution of 362 prairie chicken locations during the spring period.

the claypan and limestone breaks sites (Fig. 6). Seventy percent of the 17 readings taken during the morning period of the summer were on the shallow range site. This figure decreased to 50 percent of the 129 readings taken during the middle portion of the day. The limestone breaks range site received only 12 percent of the 17 locations taken during the morning but increased to 30 percent of the 129 locations during the middle portion of the day. Sixty-eight percent of 32 locations taken in the late afternoon were on the shallow site with the wheat field making up the majority of the remainder. After sunset, 56 and 25 percent of 76 locations were taken on the shallow site and wheat field, respectively, during the summer.

Three hundred twenty locations were taken during the fall period. Only 3 locations were taken before sunrise during the fall, so no conclusions involving habitat relationships were made for this time period. Fifty five and 25 percent of 34 locations taken during the morning were on the shallow and limestone breaks range sites, respectively, during the fall (Fig. 7). The shallow site contained 60 percent of 67 middle-day locations while the limestone breaks contained 25 percent. Of 88 afternoon prairie chicken locations, the limestone breaks range site contained 38 percent while the shallow contained 30 percent. The shallow range site received 52 percent of 128 locations taken after sunset during the fall. Twenty-five percent of this number were on the limestone breaks site while

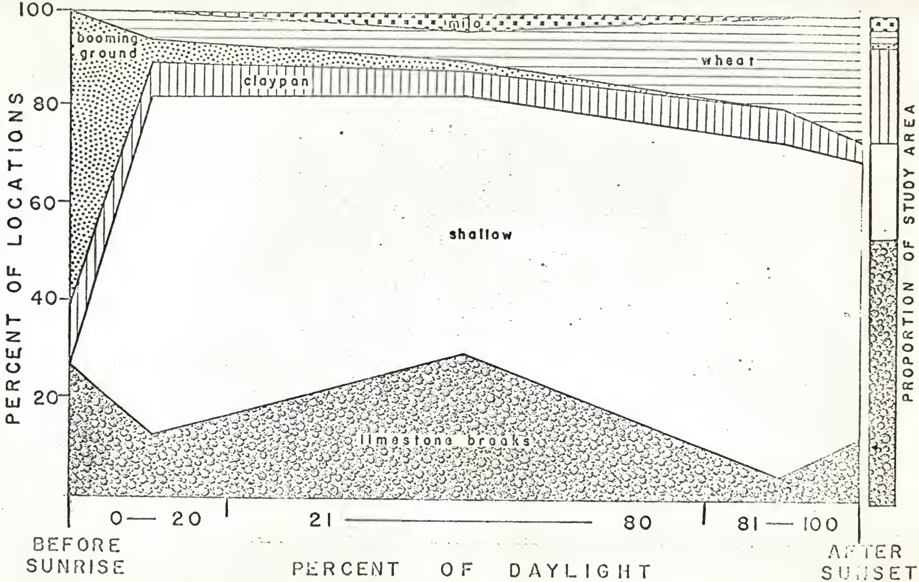

Figure 6. Time-wise distribution of 252 prairie chicken locations during the summer period.

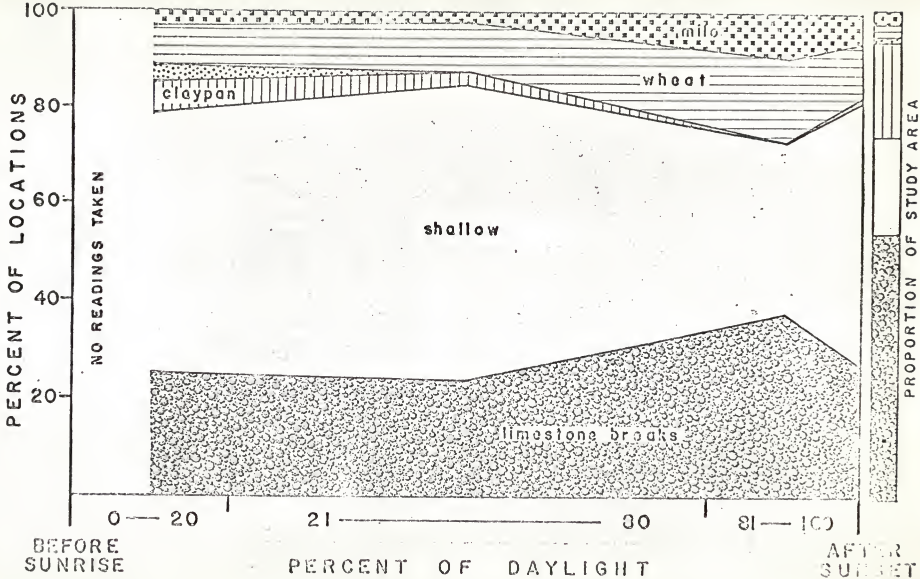

Figure 7. Time-wise distribution of 320 prairie chicken locations during the fall period.

the cultivated fields contained 20 percent of the locations.

A total of 135 prairie chicken locations was determined during the winter, although only 2 were taken before dawn. Fifty percent of 50 locations were on the shallow site, 20 percent on the booming ground and 20 percent on the milo field during the morning in winter (Fig. 8). The majority of the middle-day locations were on the shallow site (68 percent of 28 locations). The shallow site also received the greatest proportion of afternoon locations (45 percent of 39 locations) and the milo field contained 35 percent of these locations. Sixty percent of 16 locations determined after sunset were on the shallow site and 25 percent were in the milo field.

While accompanied by broods, the adult female prairie chickens provided a total of 76 locations. Forty-five percent of these locations occurred on the limestone breaks range site and 51 percent were on the claypan site. Thus, 96 percent of the locations of females with broods occurred on sites which comprised 75 percent of the study area (Table 3).

A total of nine nests were located during the 16 June 1966 through 15 June 1967 period. Seven of the nests were located on the shallow range site and two were on the limestone breaks site.

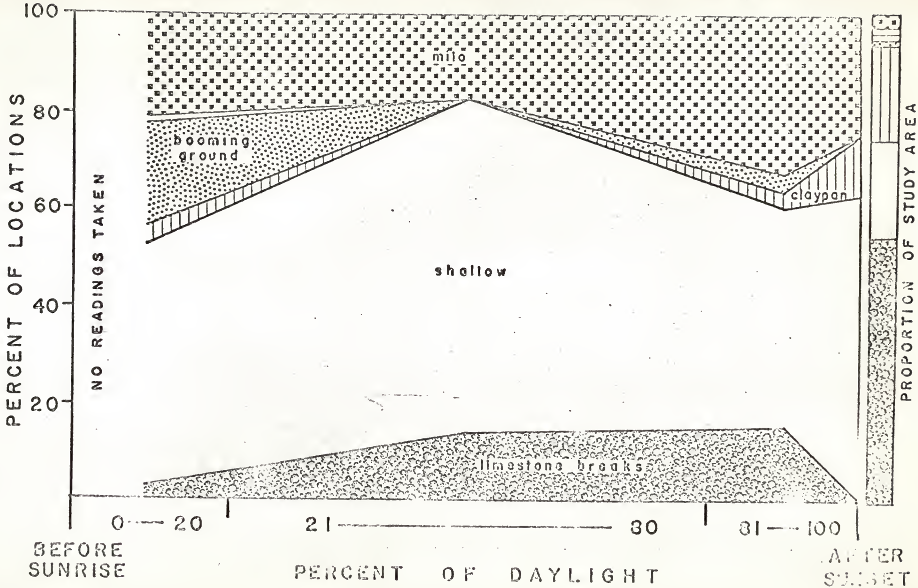

Figure 8. Time-wise distribution of 135 prairie chicken locations during the winter period.

Table 3. Summary of brood locations for June and July showing range sites for indicated time of day. Number in parentheses represents percent of total study area.

		Range Site		
		Limestone Breaks (55)	Shallow (20)	Claypan (20)
Before sunrise			1	
Percent of Sunrise to Sunset Period	0- 9	1	1	
	10-19		3	
	20-29		2	
	30-39	6	2	
	40-49	5	5	1
	50-59	2	5	
	60-69	4	3	1
	70-79	3	6	
	80-89	7	6	1
	90-99	6	2	
After sunset			3	
	Total	34	39	3
Percent of total		45	51	4

DISCUSSION

Species Composition

The 2-dimensional canopy coverage method of Daubenmire (1959) showed not only which species were present but also the degree of conspicuousness of each species in the area. This idea was expressed by Lindsey (1956) who believed that the 2-dimensional plot method showed more meaningful vegetative relationships than the more conventional single dimensional techniques. By calculating frequency of occurrence the degree of dispersion of each species was ascertained. In the limestone breaks site, tall dropseed had a canopy coverage of 17 percent and a frequency of 44 percent while sideoats grama had a similar canopy coverage value of 18 percent but a frequency of 74 percent. Thus, while both species had similar canopy coverages in the limestone breaks site, sideoats grama was much more widespread over the site as indicated by the much higher frequency.

A comparison was made of the major species determined by canopy coverage and frequency in this study with the findings of Anderson and Fly (1955:67) and Bidwell (1960:12). Anderson and Fly's study was conducted in the Flint Hills about 30 miles north of the study area while Bidwell's data refer to Geary County in general. While some differences do exist (Table 4), the three studies have encountered about the same dominant species for each range site.

Table 4. Major plant species in each range site as disclosed by three studies in the Flint Hills of Kansas.

Study	Range Site		
	Limestone breaks	Shallow	Claypan
Anderson and Fly (1955)	Little bluestem Big bluestem Sideoats grama Indiangrass	Blue grama Little bluestem Big bluestem Hairy grama Sideoats grama	Buffalograss Kentucky bluegrass Big bluestem Little bluestem
Bidwell (1960)	Big bluestem Little bluestem Indiangrass Sideoats grama	Little bluestem Prairie dropseed Sideoats grama	Little bluestem Sideoats grama Tall dropseed Short grasses
This Study	Little bluestem Big bluestem Sideoats grama Tall dropseed Indiangrass	Tall dropseed Little bluestem Big bluestem Sideoats grama	Prairie threeawn Tall dropseed Big bluestem Tumblegrass Buffalograss

While the vegetation analysis of this study was conducted during an extremely dry summer following a dry spring, the occurrence of short, drought-resistant grasses did not appear greater than Bidwell (1960) and Anderson and Fly (1955) found for the same range sites following more moist periods.

Vegetation Density

The obstruction of vision method of density determination appeared to be an excellent measure of actual density (thickness) of vegetation in addition to height. It allowed comparative measurements to be made at exactly the same locations during consecutive seasons. Such would not have been possible if the vegetation had been clipped.

Density at all sites was characterized by an increase from spring to summer followed by a steady decrease through the winter. The decrease was probably due to the natural compacting of the vegetation plus the effect of continued grazing of all pastures after the cessation of the growing season.

The range site density pattern of the vegetation--high density in limestone breaks, lower on shallow, and lowest on claypan--probably reflects the water holding qualities of the soils in each site. The soil of the limestone breaks was listed by Anderson and Fly (1955:167) as capable of holding sufficient moisture to produce a luxuriant growth of vegetation. They listed the shallow and claypan soils as being much more droughty.

Prairie Chicken Habitat Relationships

The three booming grounds, comprising less than 1 percent of the total study area, were located on hilltops on claypan range sites and were consequently vegetated by mid- and short-grass species with low height and density. Schwartz (1945:39) likewise found booming grounds located on ridgetops with uniformly low and sparse cover. Hamerstrom _et al_. (1957:13), however, found no indication that Wisconsin prairie chicken booming grounds were located on knolls, but rather they found them on low, dry areas. Hamerstrom _et al_. (1957:13) and Jones (1963:771) found the cover on booming grounds to be predominantly short grass.

The two cultivated fields comprised a total of 4 percent of the study area, and each had a low overall utilization by prairie chickens (8 percent for wheat and 7 percent for milo). A closer examination, however, reveals that at certain times the cultivated fields experienced intensive use by prairie chickens. The wheat field was frequented intensively by prairie chickens during the summer and fall when waste grain was available. Wheat fields were frequented by the prairie chickens to a lesser extent during the winter and spring when green wheat was present. Twenty-four percent of the early morning locations of prairie chickens occurred in the milo field during the winter, decreasing to 18 percent during the day, and increasing to 34 percent by late afternoon. Baker (1953:50) similarly found the major winter use of cultivated fields to be in the early morning and late evening for Kansas prairie chickens.

Several additional authors have expressed the belief that cultivated crops are very important to prairie chickens as food (Hamerstrom et al., 1957:17; Mohler, 1963:738; Schwartz, 1945:76; Yeatter, 1963:738), but it was found by this study that cultivated fields also were used by prairie chickens for night roosting areas. Twenty-five percent of both the summer and winter roosting (after sunset) locations of prairie chickens were in cultivated fields while 18 percent of the fall roosting locations were in these areas. No roosting locations were recorded in cultivated fields during the spring period.

Even though the claypan range site comprised 25 percent of the study area, only 4 percent of the total prairie chicken locations were recorded on this site. An examination of the seasonal use pattern of this site offered no clues to the reason for such low usage. The vegetation analysis, however, showed the claypan to be dominated by mid- and short-grass species with low density. This site might well be lacking sufficient cover to attract and sustain large numbers of prairie chickens.

The limestone breaks range site covered 55 percent of the total study area yet only 21 percent of the total prairie chicken locations occurred on this site. The shallow site covered only 20 percent of the area and contained 50 percent of the prairie chicken locations. Possible reasons for the large differential in the area-use ratio of these sites can be found by examining differences in the vegetation and topography of the two sites.

The vegetation on the limestone breaks site was typified by taller grass species than the shallow site and the density index was consistently higher on the limestone breaks than the shallow site. Thus, the shallow site offered less potential cover to prairie chickens than the limestone breaks offered. Since the smaller shallow site acreage was frequented to a far greater extent by prairie chickens than the greater acreage of the limestone breaks suggests that the shallow site (with its lesser amount of cover) more closely approximates the optimum cover requirements of the greater prairie chicken than the limestone breaks site. Lehmann (1941:30) indicated that light to medium cover was used for roosting by Attwater's prairie chickens (Tympanuchus cupido attwateri) and Jones (1963:778) found that greater prairie chickens roosted in areas with short grass pockets among taller grasses but used short grass cover for feeding. Yeatter (1943:388) showed that prairie chickens in Illinois, deprived of native grass cover, adapted to cultivated redtop (Agrostis alba) fields. Schwartz (1945:69) indicated that prairie chickens roosted in tall grass cover.

Another possible explanation of the greater use of the shallow site is the fact that this region almost invariably was located on gently sloping ground near the crest of a hill or ridgetop, essentially a narrow ribbon sandwiched between the limestone breaks on the side of the hill and the claypan on the top. It is possible that the location on the side of the hills near the top is the attractive force for prairie chickens. An investigation of microclimate and predation may be helpful in determining the importance of the location of this range site.

During the summer, a sharp increase in the occurrence of prairie chickens on the limestone breaks range site was noted during the mid-day period. Lehmann (1941:30) noted that heavy cover was used for shade by Attwater's prairie chickens during the summer, Copelin (1963:37) found similar behavior with lesser prairie chickens, and Baker (1953:17) found that in summer, male Kansas prairie chickens used loafing cover in the shade of shrubs and tall grass. Thus, the increased occurrence of prairie chickens in the limestone breaks area (with its more shade producing luxuriant vegetation) as found in this study may well support the observations of Lehmann (1941:30), Copelin (1963:37), and Baker (1953:17).

The majority of the nests found during this study were located on the shallow range site, the site with moderately dense vegetation. This is somewhat in agreement with the findings of Yeatter (1943:389) which indicated that nesting was more common in short grass cover with scattered forbs. Lehmann (1941:30) reported Attwater's prairie chickens nested in medium heavy to heavy cover and Jones (1963:772) found nesting of greater prairie chickens to occur most commonly in extremely heavy cover.

About half of the brood movements occurred in limestone breaks vegetation and half on shallow vegetation. This indicates, perhaps, that broods require moderate to heavy cover (based on the vegetation on this study area). Lehmann (1941:30) found, however, that young broods were found in light to medium cover while Jones (1963:772) found brood movements to occur in areas with high percentages of forbs as well as cultivated pastures.

In comparing the results of this study of prairie chicken habitat with the results of other investigators, one major problem has become evident--a need for standardized measurements. What an observer in Oklahoma reports as heavy cover or dense grassland may mean one thing to an investigator in Wisconsin and something entirely different to an investigator in Missouri. In this study an attempt has been made to add quantitative measurements to the evaluation of vegetational aspects of prairie chicken habitat in order that other investigators may be better able to interpret the results of this and other studies.

SUMMARY

During the period of 16 June 1966 through 15 June 1967, an intensive study of the habitat of the greater prairie chicken was conducted in the Flint Hills of eastern Kansas. Vegetation analyses were conducted on the 6000-acre Simpson Ranch in Geary County. Analyses were based on the vegetative differences between range sites.

Species composition was determined by the canopy coverage method of vegetational analysis. Density was determined by the obstruction of vision, measured by viewing a "density pole" under standard conditions. Prairie chicken movement data were collected by radio-telemetry and recorded on the basis of range site.

The limestone breaks range site, which covered 55 percent of the area, had the highest vegetative density and was dominated by little bluestem, big bluestem, and sideoats grama. The shallow site, comprising 20 percent of the area, was dominated by tall dropseed and had intermediate vegetative density. The claypan range site covered 20 percent of the study area, had the lowest vegetative density, and was dominated by prairie threeawn and tall dropseed. Cultivated land comprised 4 percent of this 6000-acre Simpson Ranch.

A total of 1155 prairie chicken locations was determined. Fifty percent of these locations occurred on the shallow range site, 20 percent on the limestone breaks, and 5 percent on the claypan. Ten percent of the locations were on the booming ground while 13 percent of the locations were in wheat and milo fields. Booming grounds were frequented heavily during the spring, the wheat field during the summer and fall, and the milo field during the winter and spring. The majority of locations on the limestone breaks came during the fall and the shallow site was frequented to a relatively constant degree during the whole year.

Year-around night roosting by prairie chickens was done predominantly on the shallow range site but also on the limestone breaks and, during the summer, fall and winter, in cultivated fields. The booming ground was frequented to the greatest extent at the time of sunrise. Cultivated fields were most frequented in the afternoon.

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APPENDIX

Table 5. List of plant species[1] which were recorded during August 1966 on 20-meter transects located on the Simpson Ranch, Geary County, Kansas.

Grasses	
Big bluestem	Andropogon gerardi
Blue grama	Bouteloua gracilis
Buffalograss	Buchloe dactyloides
Hairy grama	Bouteloua hirsuta
Indiangrass	Sorghastrum nutans
Japanese brome	Bromus japonicus
Kentucky bluegrass	Poa pratensis
Prairie dropseed	Sporobolus heterolepus
Prairie threeawn	Aristida oligantha
Sand dropseed	Sporobolus cryptandrus
Scribner panicum	Panicum scribnerianum
Sideoats grama	Bouteloua curtipendula
Switchgrass	Panicum virgatum
Tall dropseed	Sporobolus asper
Tumblegrass	Schedonnardus paniculatus
Virginia wild rye	Elymus virginicus
Western wheatgrass	Agropyron smithii
Windmillgrass	Chloris verticillata
Witchgrass	Panicum capillare
Sedges and rushes	
Sedge	Carex spp.
Rush	Juncus spp.
Forbs legumes and woody plants	
Alfalfa	Medicago spp.
Aromatic aster	Aster oblongifolius
Blue wildindigo	Baptisia minor
Broomweed	Gutierrezia dracunculoides
Buckbrush	Symphoricarpos orbiculatus
Catclaw sensitivebriar	Schrankia uncianata
Dotted gayfeather	Liatris punctata
Green milkweed	Asclepias viridiflora
Heath aster	Aster ericoides
Horseweed	Conyza canadensis
Ironweed	Vernonia baldwinii
Leadplant	Amorpha canescens
Louisiana sagewort	Artemisia ludoviciana
Lespedeza	Lespedeza spp.
Peppergrass	Oxalis stricta
Prairie coneflower	Ratibida spp.
Pitcher sage	Salvia azurea
Purple prairieclover	Petalostemum purpureum
Slimflower scurfpea	Psoralea tenuflora
Western ragweed	Ambrosia psilostachya
Western yarrow	Achillea millefoleum

[1]Common and scientific names follow Anderson (1961).

VEGETATION AND OCCURRENCE OF GREATER PRAIRIE CHICKENS (TYMPANUCHUS CUPIDO PINNATUS) ON THREE RANGE SITES IN GEARY COUNTY, KANSAS

by

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During the period of 16 June 1966 through 15 June 1967 an intensive study of the habitat of the greater prairie chicken (Tympanuchus cupido pinnatus) was conducted on a 6000-acre ranch in Geary County, Kansas. Vegetational analyses, based on the differences between three range sites were conducted to determine species composition (by canopy coverage) and vegetative density (by obstruction of vision). The major grass species on the limestone breaks range site were little bluestem (Andropogon scoparious), big bluestem (Andropogon gerardi), and sideoats grama (Bouteloua curtipendula). The major species on the shallow range site were tall dropseed (Sporobolus asper), little bluestem, and big bluestem. The claypan range site was vegetated primarily by two species, tall dropseed and prairie threeawn (Aristida oligantha).

Individual prairie chicken locations were determined by radio-telemetry and stratified according to season of year, time of day, and range site.

The limestone breaks range site, comprising 55 percent of the study area, had the highest vegetative density and contained 20 percent of the 1155 prairie chicken locations. The shallow range site, comprising 20 percent of the study area, had intermediate vegetative density and contained 50 percent of the prairie chicken locations. The claypan range site, comprising 20 percent of the study area had the lowest vegetative density and contained 5 percent of the 1155 prairie chicken locations. Cultivated land (wheat and milo), comprising 4 percent of the study area, contained 13 percent of the prairie chicken locations.

Booming grounds were frequented heavily during the spring, primarily at sunrise. Year-around night roosting by prairie chickens was done predominantly on the shallow and limestone breaks range sites, but during the summer, fall, and winter cultivated fields were occasionally frequented by prairie chickens for night roosting.