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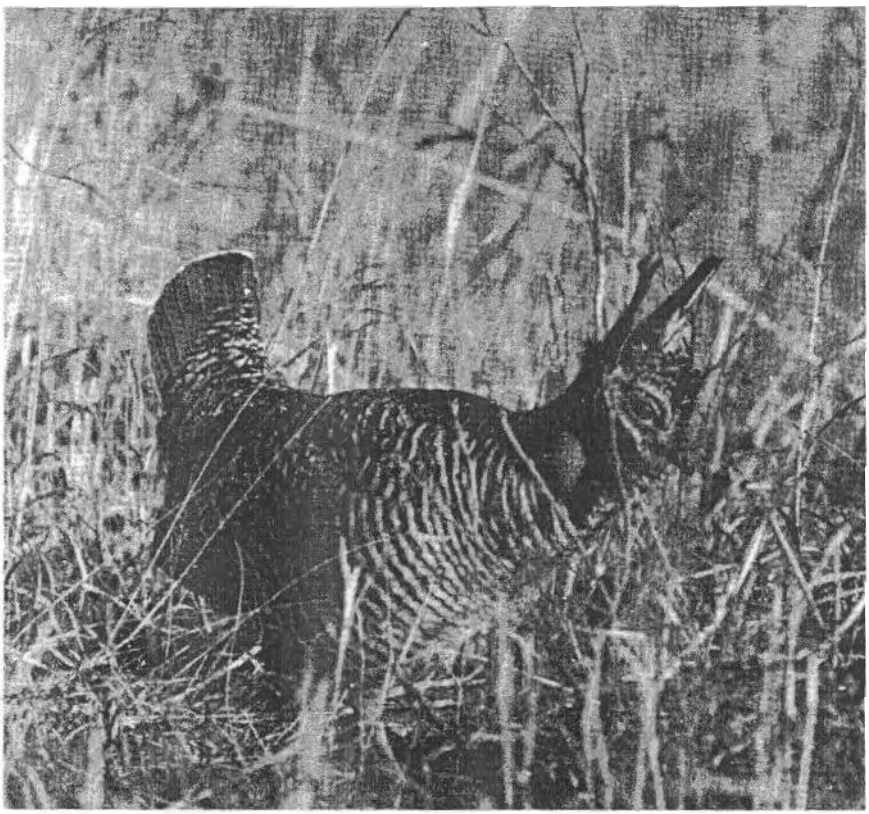


The Lesser Prairie Chicken in Oklahoma

FARRELL F. COPELIN

October 3, 1997

To the Library of the G.M. Sutton ARC

I'm pleased to donate my next-to-last copy of this publication on the date of my 64th Birth Day.

It is a source of great joy & encouragement that the Avian Research Center proposes an expansion of its studies, which will include the lesser prairie chicken.

You have my heart felt support for efforts to perpetuate this species for future generations

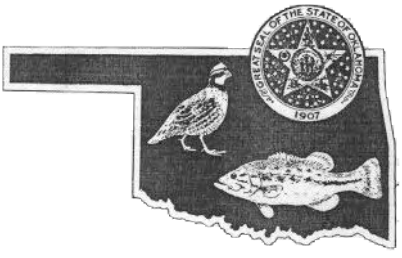
Farrell Copeland

THE LESSER PRAIRIE CHICKEN IN OKLAHOMA

by

FARRELL F. COPELIN

Game Biologist



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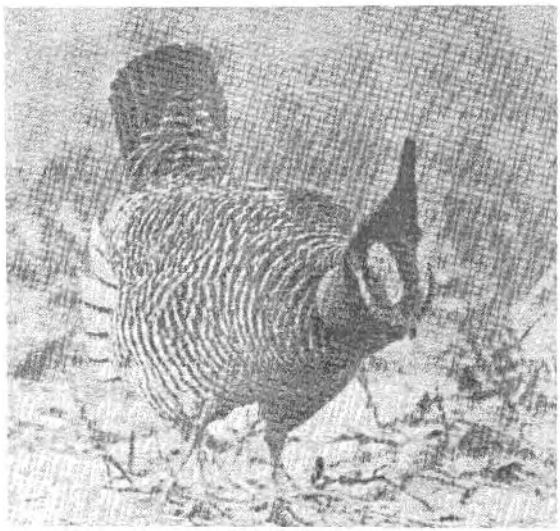

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DEDICATION

This publication is dedicated to the late H. Ford Mercer who encouraged and inspired me greatly during this investigation.

INTRODUCTION

Management of the lesser prairie chicken in Oklahoma has been hampered by inadequate knowledge of distribution, numbers and ecology. Some conservationists have expressed belief that the species was nearing extinction. Therefore, I tried to determine its status and suggest needed management.

I studied ecology of the lesser prairie chicken in one area, and inventoried male lesser prairie chickens in three others (Figure1). In addition, the distribution of the species was mapped by a farm-to-farm survey in western Oklahoma.

The six-year study was begun in September 1955 and concluded in May 1961. The first two years were part-time graduate research. Full time was spent in the field from June 1957 to December 1959. Only minor part-time effort was expended in 1960 and 1961.

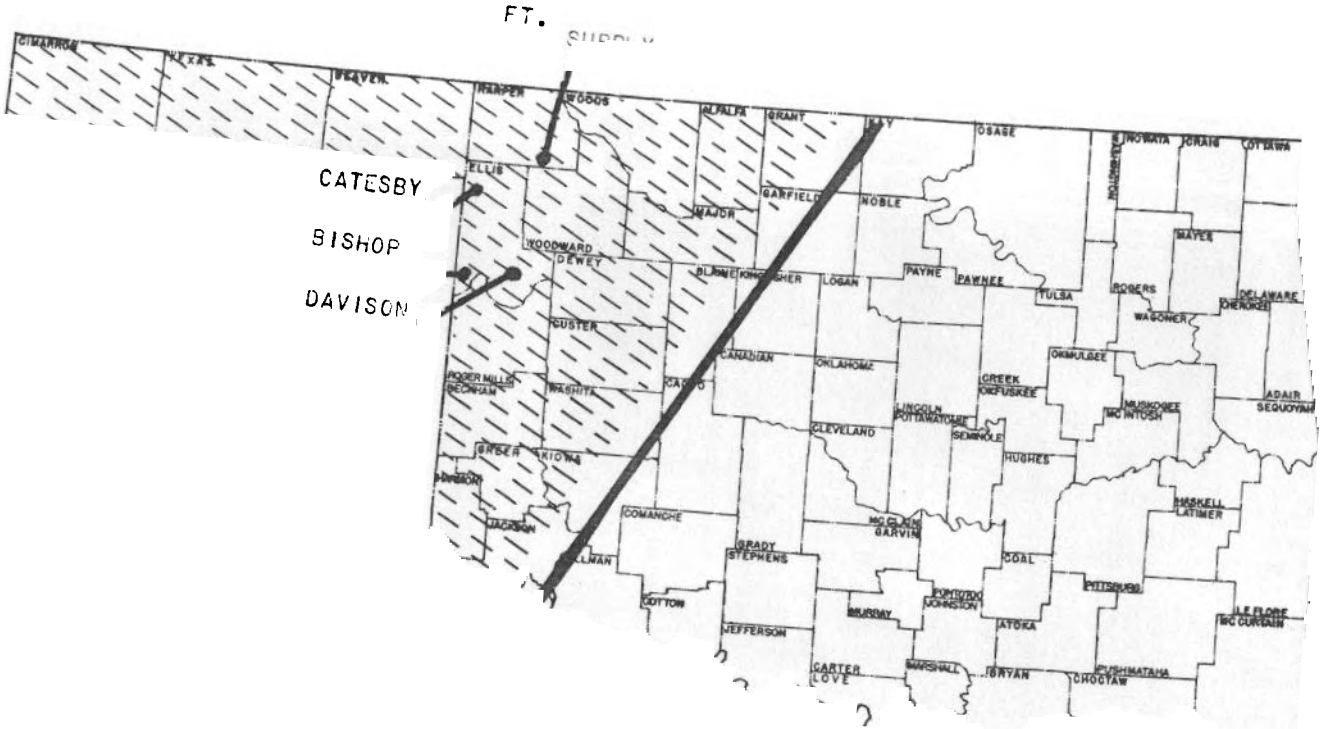


FIGURE 1. WESTERN OKLAHOMA STUDY AREA.

THE LESSER PRAIRIE CHICKEN

TAXONOMY

Prairie chickens are members of the grouse family, Tetraonidae. In the southwestern United States the pinnated grouse — greater, lesser, and Attwater's prairie chickens — are commonly known as prairie chickens.

The lesser prairie chicken, **Tympanuchus pallidicinctus** (Ridgway), has been considered a species distinct from the greater prairie chicken, (**T. cupido pinnatus**), Attwater's prairie chicken (**T. c. attwateri**), and the heath hen (**T. c. cupido**) (A. O. U. Checklist, 1957).

Recently there has been speculation about the taxonomy of the lesser prairie chicken. Is it a singular species, or a subspecies of **Tympanuchus cupido** (Aldrich and Duvall, 1955)? Classification of the lesser prairie chicken as a singular species is supported by the following evidence.

Habitat

Habitat of the lesser prairie chicken is intermediate between the brushless prairie grassland that supports greater prairie chickens and low density forest used by sharptail grouse (**Pedioecetes phasianellus**). Of course there are many intermediate types of grassland-forest ecotone that support greater chickens and sharptails. But lesser chickens occur neither in prairie grassland without brush nor in low density forests. Their's is a land of low to high density shrub savannah where most shrubs are three feet tall or less.

Coloration

Bars on the feathers of the back of the lesser prairie chicken are treble: a broad brown bar enclosed by two narrow black ones. But all subspecies of **T. cupido** have single, broad, solid black bars. A single lesser prairie chicken can be identified by this characteristic, whereas subspecies of **T. cupido** must be compared with one another. During spring courtship displays, the air sac of the lesser prairie chicken is rosy colored, much in contrast to, and perhaps intermediate in color, between the purplish (Ammann, 1957) air sac of the sharptail and the orange air sac of the greater prairie chicken.

Voice

Perhaps the most startling difference in characteristics of greater and lesser prairie chickens is in the voice, which is a prominent part of the courtship performance. Unlike the low-pitched "booming" of the greater prairie chicken, the voice of the lesser chicken resembles a turkey call with a two or three syllable gobble. Or, at times, like air bubbles emerging from water.

The gobble usually is given but a single time when the bird is alone. But when two cocks face each other in courtship displays on the imaginary territory boundary, they frequently gobble several times in perfect cadence, alternating the sound from bird to bird but sounding very much like one with

a rapid gobble. This dueting is very intense just after the cocks arrive at daybreak on display grounds in spring, and is continued intensively until sunrise.

The two syllable gobble is loud, and sometimes ends in a clear, ringing, rising note. When several birds gobble in alternating cadence, they sometimes resemble the yelp of a coyote when heard from a distance. On a clear morning the sound can be heard more than a mile away.

The three syllable, low intensity gobble is usually emitted by individuals without obvious regard for actions of other cocks.

The cackle, perhaps an alarm note, is rarely heard during intensive courtship displays. It may be emitted, however, when birds are disturbed on the display ground, or when they flush from the display ground, water hole, or grassland.

Davison (1935 and 1940) mentioned the small areas on which cock birds "strut," "gobble," or "drum," which he called gobbling grounds.

Dr. Fred Hamerstrom remarked, after viewing sound movies of the lesser prairie chicken, that the lesser chicken sounds more like a sharptail than a greater chicken.

Since lesser prairie chickens do not "boom," the term gobbling ground or display ground, rather than booming ground, will be used in this publication.

Morphology

After studying skeletons of several grouse, H. G. Lumsden (correspondence) concluded that the lesser prairie chicken was intermediate between sharptails and **T. cupido.**

DISTRIBUTION

The lesser prairie chicken is an inhabitant of southeastern Colorado, southwestern Kansas, western Oklahoma, northern Texas, and eastern New Mexico (Figure2). The range was delineated in New Mexico by Frary (1957), in Texas by De Arment (1963), in Kansas, Oklahoma and Colorado by my work.

Historical reports indicate the lesser prairie chicken was widely distributed in western Oklahoma before the prairie sod was tilled. The occupied range was greatly reduced by cultivation of most of the land, which began with settlement in 1890. Remnants of the range in 1940 were delineated by Duck and Fletcher (ca. 1944).

Present distribution of lesser prairie chickens in Oklahoma was determined by interviewing residents of western Oklahoma. State game rangers, county agricultural agents, and sportsmen knew the general location of grasslands supporting prairie chicken. The grassland tracts were located and delineated with the aid of aerial photographs scaled one inch to the mile. Then exact locations of prairie chicken flocks were recorded after interviewing farmers and ranchers. Only a small portion of the birds (273

flocks) in western Oklahoma were found (Figure 3). The precise locations of these flocks were recorded earlier on county maps (Copelin, 1958).

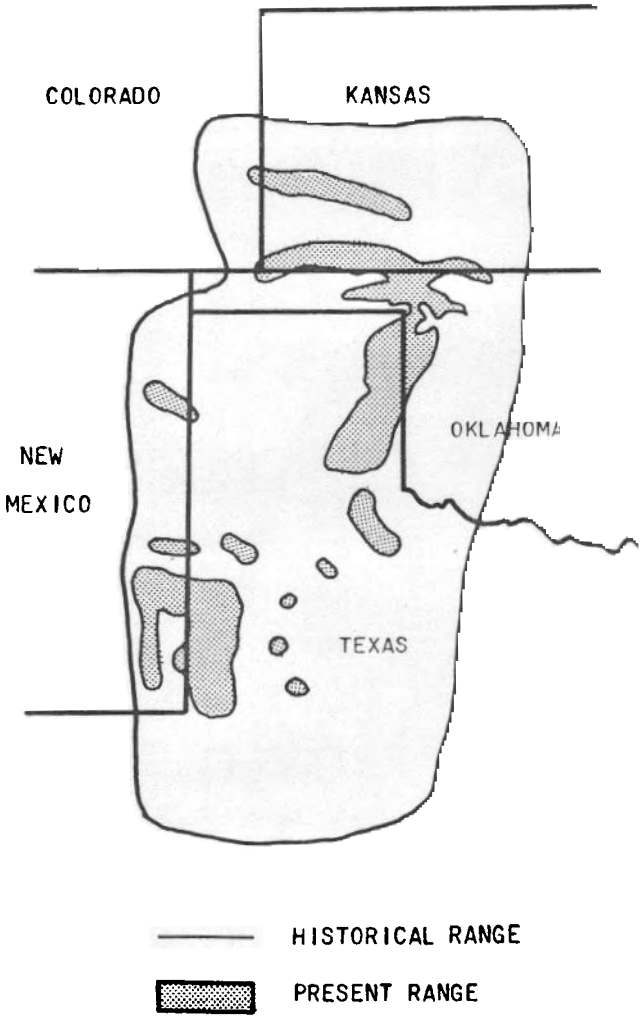


FIGURE 2. GEOGRAPHICAL RANGE OF THE LESSER PRAIRIE CHICKEN.

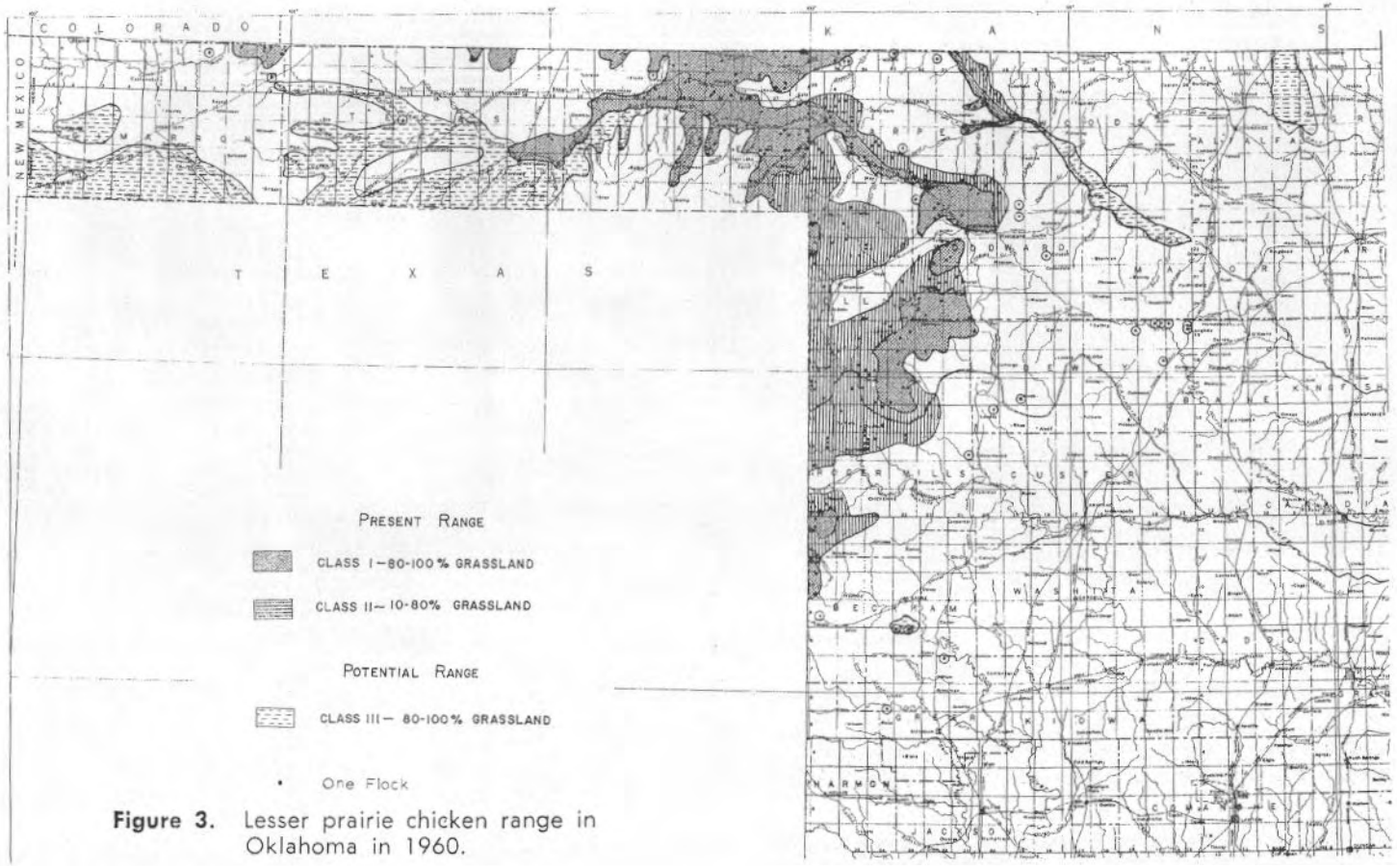


Figure 3. Lesser prairie chicken range in Oklahoma in 1960.

There has been virtually no change in the occupied range in Oklahoma since 1940. The birds now occur in 12 counties. They are common in Beaver, Harper, Woodward, Ellis and Roger Mills; occupy limited range in Beckham, Cimarron, Texas and Woods; and are very rare in Blaine, Dewey and Greer counties.

As the survey progressed from 1957 to 1960 it was apparent that the breadth of each occupied area expanded at the same time that density increased in study areas. During the winter of 1959-1960 prairie chickens reportedly occurred in the following places for the first time in five years or more: one and one-half miles southwest of Vici in Dewey County; along Buffalo Creek in Harper County, east of Buffalo; and southeast of Freedom on the east side of the Cimarron River in Woods County.

Lesser prairie chicken range was divided into two classes. Class I range was about 80% grassland. Class II range was 10-80% grassland, the remainder being cultivated land. There were about 1,305 square miles of Class I and 1,086 square miles of Class II range (Table 1), for a total of 2,391 square miles of occupied breeding range.

TABLE 1

Area of present and potential lesser prairie chicken range in Oklahoma

County	Approximate number of square miles		
	CLASS I	CLASS II	CLASS III
Alfalfa			75
Beaver	585		75
Beckham	13	3	14
Blaine		__*	
Cimarron	33		426
Dewey		__*	
Ellis	281	556	
Grant			33
Greer		__*	
Harper	91	51	
Roger Mills	38	331	
Texas	30		694
Woods	33	63	122
Woodward	201	82	
Total	**1305**	**1086**	**1439**

* Less than four square miles.

Potential range was mapped. About 1,439 square miles, composed of 80-90% grassland, is considered potential lesser prairie chicken range, capable of supporting low density populations. Wintering prairie chickens were reported in some potential range (Figure 3).

Some cultivated land in western Oklahoma is being returned to grassland. According to the Soil Conservation Service, USDA (Rowley, 1960) a 16 percent increase in grassland is expected from 1960 to 1975 in the five counties where prairie chickens are most abundant (Table 2). This should have a favorable affect upon prairie chicken distribution, but may reduce winter food.

TABLE 2

Acreage in rangeland in 1960 and expected acreage in 1975 in five western Oklahoma Counties

County	Acres – 1960	Expected Acres 1975
Beaver	538,804	605,746
Harper	380,735	443,216
Woodward	481,595	532,061
Ellis	395,083	496,839
Roger Mills	451,810	524,700
Totals	2,248,027	2,602,562

SEPARATION OF SEXES

Coloration of the tail feathers is a dependable characteristic for determining the sex of lesser prairie chickens. Tail feathers of hens are partially or entirely barred, whereas tail feathers of cocks are black, except for occasional light coloration of central feathers (Figure 4).

Cocks have brilliant yellow eyebrows in spring during courtship. They also strut and gobble, in contrast to the plain, less active hens.

In the hand cocks are readily distinguished from hens by their black under-tail-coverts, which have a round, white spot on the end (Figure 4). In contract, the under-tail-coverts of hens are barred, with some brown coloration. The sex of birds can be determined by under-tail-coverts when birds are only 12 weeks old, much earlier than by other criteria.

Usually, only male birds strut, gobble, and present characteristic body motions and postures of the courtship display. But one hen on a display ground became pugnacious, strutted and chased other hens, erected her stubby pinnae, and gobbled. The sound was muffled, similar to that of a young cock in fall, just learning to gobble.

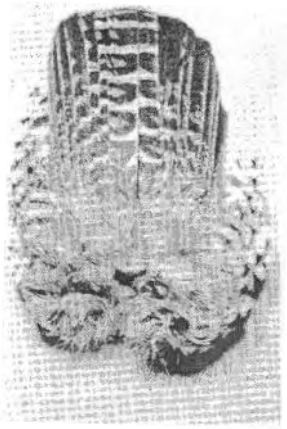
AGE DETERMINATION

Young birds frequently can be distinguished from adult birds in fall and winter by using a combination of methods.

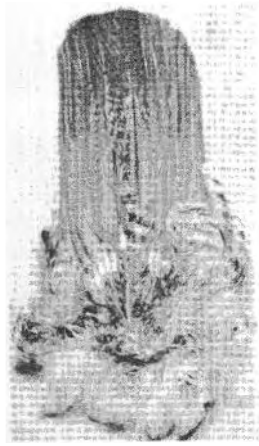
The two outer primary wing feathers of young birds have worn and frayed trailing edges, but the inner primary feathers are less frayed. On older birds the amount of wear on all primaries is about equal, and comparable to the inner primaries of young birds. Also, on the fore-edge of

Top view of tail feathers

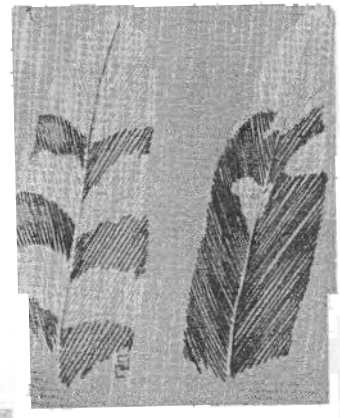
Hen



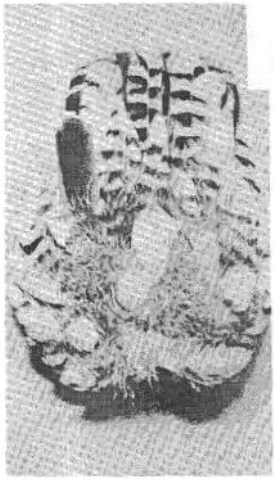
Cock



Hen



Cock



Under-tail-coverts

Figure 4

Sex of lesser prairie chicken is readily determined by tail feathers

the outer primary of young birds, white spots appear at intervals to the tip of the feather, whereas on older birds the spots are not present within an inch or inch and a half of the tip of the feather (Petrides, 1942; Ammann, 1944).

Another very useful criterion for distinguishing age in late winter, one not described before, is coloration of the covert over the outer primary wing feather. In 98 of 100 birds examined there was white in the distal portion of the shaft in coverts of young birds but no white in the shaft of older birds (Figure 5).

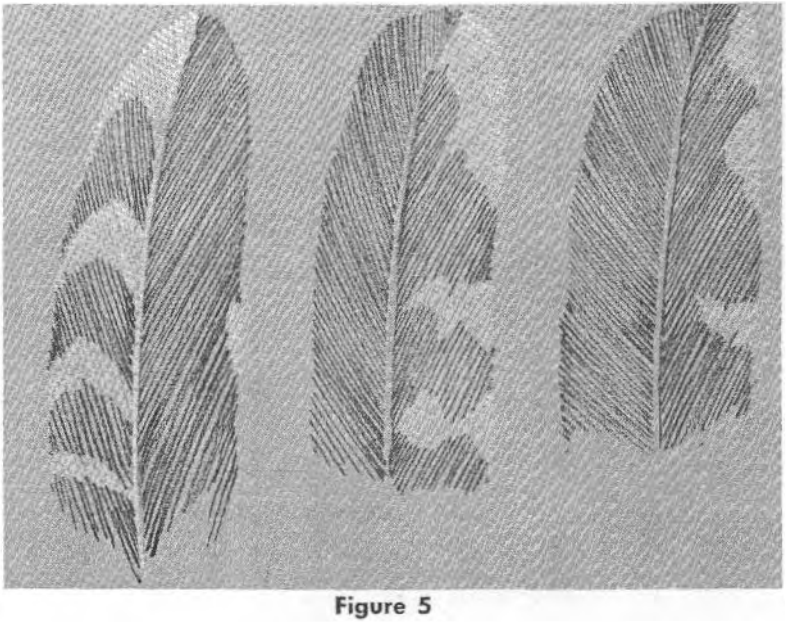


Figure 5

The covert over the outer primary wing feather is an indicator of age. On the left is shown a feather from a young-of-year bird. It has white in the distal end of the shaft, whereas feathers on the right from old birds have dark shafts.

Age of juvenile birds was determined from molt of primary wing feathers. I assumed the first primary wing feather was shed at four weeks of age, and other primaries were shed weekly thereafter, except for slight slowing of the molting rate after several weeks (Baker, 1953). Examination of wild birds trapped at weekly intervals (apparently five to six, and six to seven weeks of age) substantiated the belief that about seven days were required from time of shedding of second, to third, and from third to fourth primaries.

LIFE HISTORY

STUDY AREAS

Lesser prairie chickens occupy three slightly different types of vegetation in Oklahoma as described by Duck and Fletcher (ca. 1944). All three are prairie grassland types, with some sandy soils and brushy plants. Male lesser prairie chickens were inventoried in all three types, and prairie chicken ecology was studied in one.

Davison Ranch Study Area

This study area was in the shin oak type of vegetation. The study was begun on a small four-section tract and later moved to an adjoining 16-section tract. The small tract was used from 1955 to 1957, and the larger one from 1958 to 1961 (Figure 6).

The terrain was gently rolling, composed of deep, sandy soils, vegetated by shin oak (**Quercus havardi,** Rydb.) and tall grass (Figure 7). Shin oak (shinnery) is a low growing shrub oak, about twelve inches tall, with an extensive system of roots. Intermixed with shin oak were taller forms of the same oak, four to twenty feet tall, in clumps or "motts" of five to one hundred or more feet in diameter. Predominant grasses were little bluestem (**Andropogon scoparius**), sand dropseed (**Sporobolus cryptandrus**), sand bluestem (**A. halli**), and hairy grama (**Bouteloua hirsuta**). Many other grasses, a great variety of forbs and a minor amount of sand sagebrush were present.

Bishop and Ft. Supply Study Areas

Two study areas were used in the sand sagebrush type. The first plot, enclosing a rural school house, the Bishop School, was in southwestern Ellis County in sections 26, 27, 34, and 35, T 18 N, R 26 W, Indian Meridian. After prairie chickens disappeared from this area, the Ft. Supply study area was chosen in Harper County.

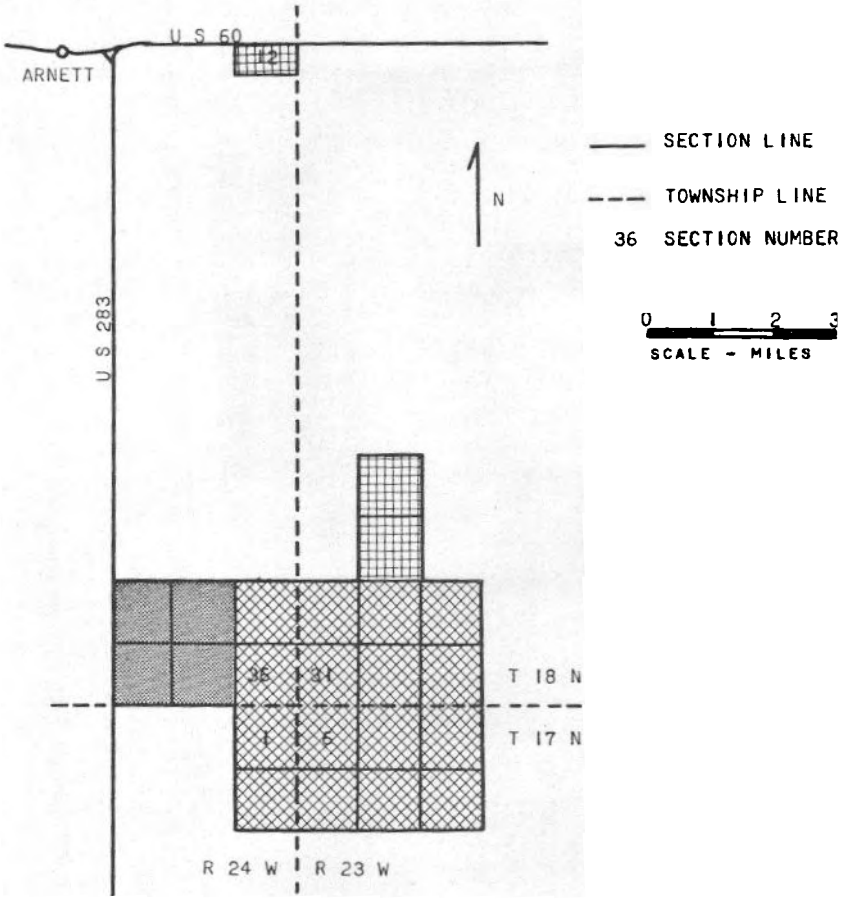
The Ft. Supply area, which enclosed the experimental range of the Southern Great Plains Field Station, Woodward, was composed of 15 sections (Figure 8).

Both areas in the sand sagebrush type had gently rolling to rolling terrain, deep, coarse sandy soils, dense stands of sand sagebrush (**Artemisia filifolia**) and moderate stands of grasses and forbs (Figure 9). Predominant grass species were hairy grama, sideoats grama (**Bouteloua curtipendula**), sand dropseed, and little bluestem. Several species of forbs were common.

Catesby Study Area

The Catesby study area, in the mixed-grass prairie type of vegetation, was two miles south of Catesby, Oklahoma in northwestern Ellis County (Figure 10).

This rolling prairie type has short-grass vegetation on ridges, and short and mid-grasses in the valleys (Figure 11). There was a sparse covering of



MAIN STUDY AREA: 1955, 1956, AND 1957

MAIN STUDY AREA: 1958, 1959, AND 1960 AND 1961

BIRDS BANDED IN THESE AREAS ALSO: 1958 AND 1959

Figure 6. The Davison study area in Ellis County.

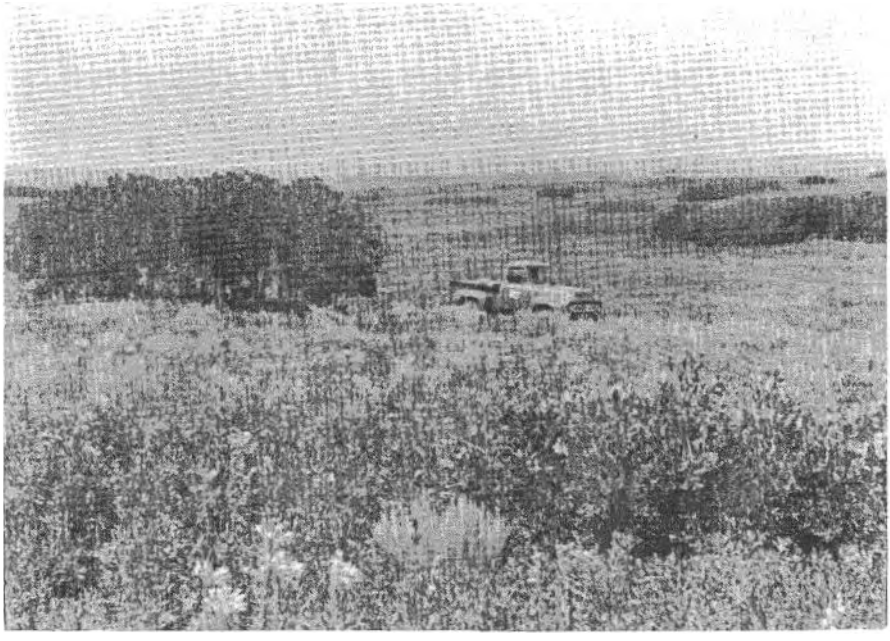


Figure 7. Shin oak vegetation

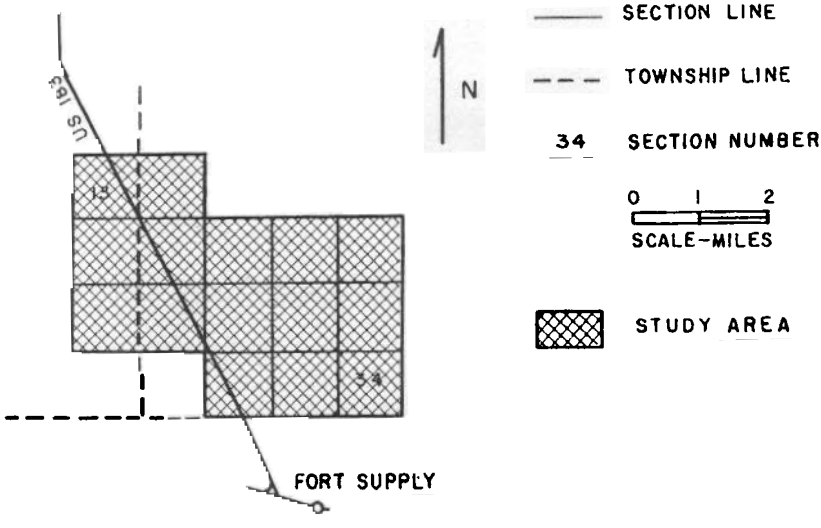


Figure 8. The Ft. Supply study area in Harper County.

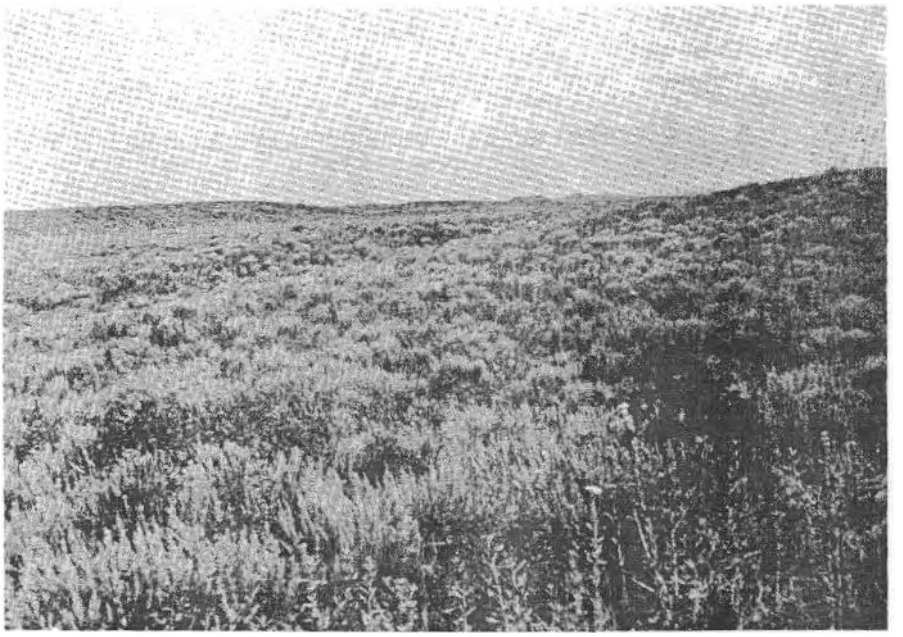


Figure 9. Sand Sagebrush vegetation

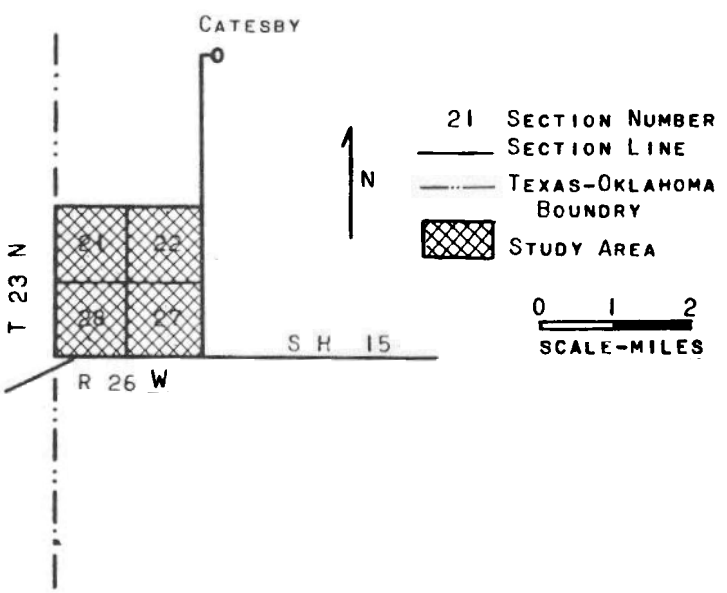


FIGURE 10. THE CATESBY STUDY AREA IN ELLIS COUNTY.

sand sagebrush in the valleys, and to a lesser extent on the slopes. Two other woody plants, skunkbrush **(Rhus trilobata)** and plum **(Prunus sp.)** were present. All of these shrubs were about three feet high at maturity. Predominant grasses were little bluestem, sand bluestem, hairy grama, sideoats grama, blue grama **(Bouteloua gracilis)** and needle grass **(Aristida sp.)**.

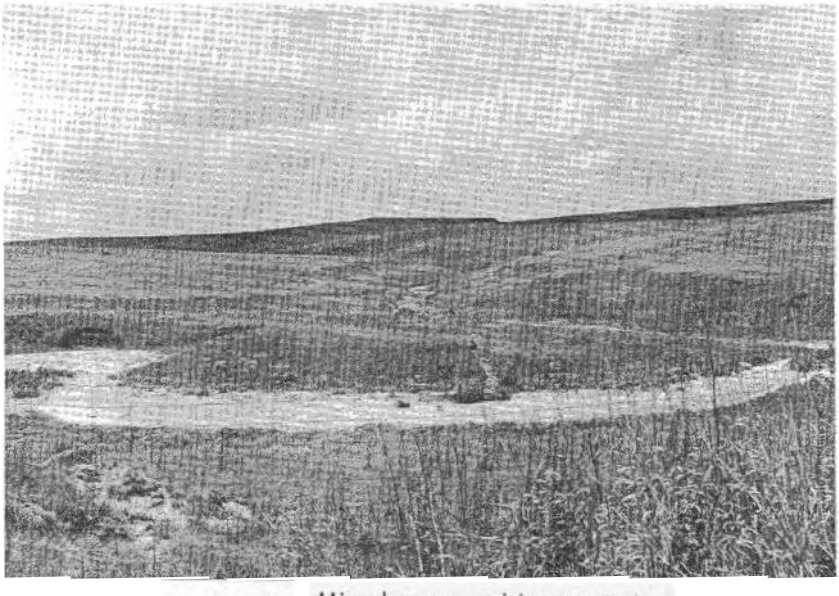


Figure 11. Mixed-grass prairie vegetation

TRAPPING

Lesser prairie chickens were caught in summer with the Davison drive net, and in other seasons with a drop net.

The Davison method (Davison, 1935) was used (1) when lesser prairie chickens were in the shade of oak motts, (2) when the temperature was 90°F. or higher, and (3) when soil moisture was low. Birds were found by driving from mott to mott. When found, they were driven away slowly from their dusting forms at the edge of the mott by racing the engine and driving back and forth close to the birds. They usually walked to the opposite side of the mott, if it was large, or into the shinnery-grassland if it was small.

As soon as the birds were out of sight the trap was set as quickly as possible. It was a one-inch mesh net, fifteen feet wide and eighty feet long (Figure 12). The bottom of the net was weighted with lead cylinders on 3/8 inch rope to keep it snugly against the ground. At the bottom an eight-foot cone of netting with hoops was attached midway in the long net. The cone was 30 inches in diameter at its juncture with the large net, and was graduated to twelve inches at the other end. The small end was closed with a drawstring.

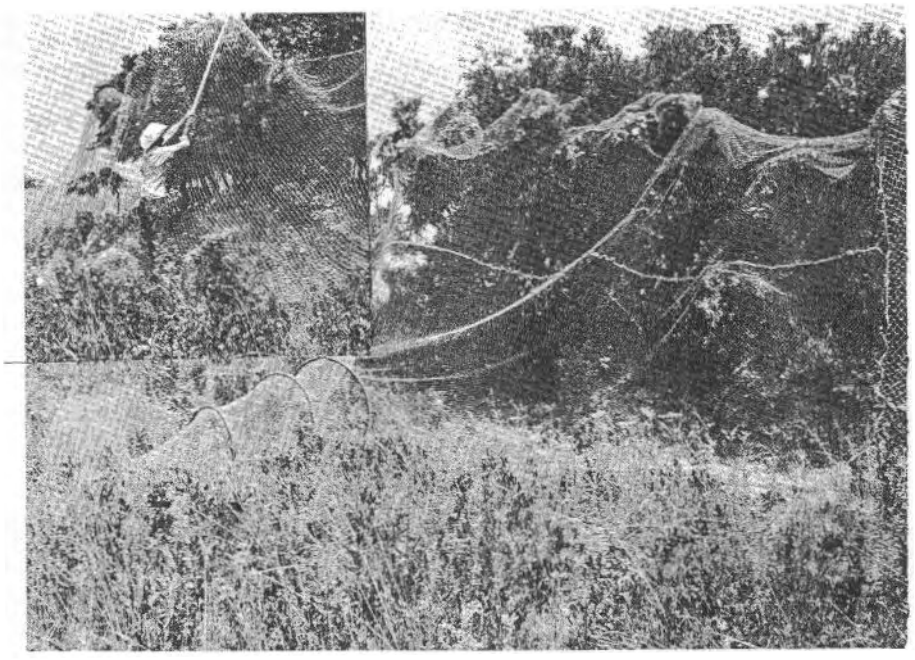


Figure 12. The Davison drive net

The top of the net was hung over the peripheral trees of the mott, preferably over the dusting forms the birds used. The closed end of the net barrel was then pulled as far away from the mott as possible without pulling the large net from the mott. This fashioned the large net into a V-shape with the mouth of the barrel in the angle of the net. Also, the large net sloped inward, from bottom to top, toward the mott.

Two experienced men set the net in two or three minutes. The men then re-entered the truck and drove to the opposite side of the mott, around the birds. The chickens, anxious to return to the shade, were then driven back into the mott by the same method employed to remove them. The truck was parked beside the mott with the motor running. One man then walked slowly, but steadily, along each wing of the trap.

As soon as the birds were in the barrel it was detached from the main body of the net and placed in the shade. Sometimes, when prairie chickens would not enter the barrel, it was necessary to pull the large net down upon them.

The drop net was used in fall, winter, and spring. This trap consisted essentially of a net held out-stretched above the ground by a group of posts (Jacobs, 1959). A 29′ x 29′ and a 29′ x 58′ net were used at ponds during fall, winter and spring, at bait stations during fall and winter, and on display grounds in spring (Figure 13).

Figure 13. The drop net

During winter best results were obtained at ponds. Trapping was possible from October through March when the birds drank daily, and usually twice daily, except when it was raining, snowing or when snow covered the ground. In order to force birds to congregate on one side of a pond, a fence of small mesh wire was built around it, except in the area to be covered by the drop net.

A combination of water and feed was tried at ponds. It seemed to be better than water alone. However, water in a tub at a feeding station was not used by birds.

Prairie chickens usually fed or watered in small groups, and several groups usually visited the trap site during early morning or late afternoon. Therefore, more birds were captured by trapping a few (5-15), resetting the net quickly, and trapping again. Birds usually fed and watered in less than 25 minutes.

Sorghum grain was the best bait. When trapping was first tried in winter, bait was placed in cultivated grain fields where birds fed daily. This method was satisfactory, but the percentage of birds trapped from a flock was low. Waste grain kept many birds from the bait.

Finally, grain bait stations were established in grass pastures, where there were no concentrations of food. Trapping success greatly improved, particularly where bait stations were near display grounds. Large groups of birds, especially males, spent a great deal of time near these grounds.

From August 1956 until November 1959, a total of 454 lesser prairie chickens were trapped; 437 were banded and released for study. The remaining 17 (3.7 percent) were injured in trapping. Of the 437 birds that were released, 114 (26 percent) were later identified in the field or recaptured. Birds were trapped in two areas: (1) a cultivated grain field three miles east of Arnett, and (2) a large grassland pasture about eight miles southeast of Arnett (Figure 6). Only 27 were captured in the grain field, all in winter, whereas 427 were trapped in the pasture during all seasons.

BANDING

Captured lesser prairie chickens were marked so they could be individually identified in the field (Figure 14). Aluminum, serially numbered leg bands were placed on all trapped birds. Colored celluloid leg bands, plain and numbered (Figure 15), plastic collars (Craighead and Stockstad, 1956), bowties (Wint, 1951), and/or wing tags were placed on most birds. Feathers on some banded birds were dyed to facilitate recognition.

Figure 14

Banded birds were identified, individually, on display grounds, at watering places, in grain fields and at other places where they could be approached closely enough to read the number on the celluloid leg band with the aid of a telescope.

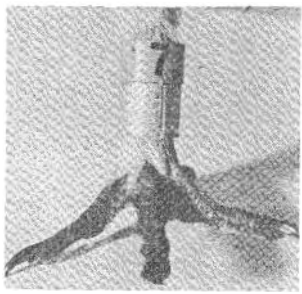


Figure 15

All birds were sexed, aged, and banded before being released. Numbered aluminum and colored celluloid leg band were placed on this bird.

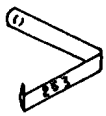


Figure 16. Numbered wing tag.

The wing tag is a new device. It was composed of an aluminum wing band and numbered tag of duran plastic with nylon cloth backing. The most suitable size of plastic bag was 1½" x 2" when completed. It was formed by cutting a piece of plastic 1½" x 4" and folding it in the midde. The front and back were sewed together (Figure 16). Either the rivet type or clamp type (jiffy) wing band was inserted through holes punched in the top of the tag.

The wing tag was better than other large markers because it was high on the body and easy to read, and it was at least as durable as other types. Only the aluminum leg band was considered to be near-permanent.

POPULATION DENSITY AND TREND

Population density from 1956 to 1961 was reflected by the number of males on display grounds (Davison, 1940), determined by two or more counts per ground. In order to study behavior and identify banded birds while counting cocks, portable canvas blinds were placed on the grounds daily before birds arrived or left at the site all season. Beginning in 1958 vegetation on major display grounds was mowed to permit an unobstructed view of birds. After three years it was not necessary to mow the vegetation. Cattle grazed new sprouts as they appeared, and prevented revegetation of bunch grass by effective **over-grazing.**

In the Davison and Catesby study areas male prairie chicken density was very low in the spring of 1956, and it declined even lower the next year, then increased sharply (Table 3) (Figure 17). The greatest magnitude of change was in the Davison area where density increased from 3.5 cocks per square mile in 1957 to 18.31 per square mile in 1960, an increase of 423 percent. Density then decreased 12 percent by 1961, when there were 16.13 cocks per square mile.

TABLE 3

Density of male lesser prairie chickens on display grounds in study areas, 1956-1961

Study Area	Density of Cocks per Square Miles					
	1956 No.	1957 No.	1958 No.	1959 No.	1960 No.	1961 No.
Davison Ranch	4.00	3.50	9.00	17.30	18.31	16.13
Bishop	1.75	1.50	—	—	—	—
Ft. Supply	—	—	3.00	2.87	2.33	—
Catesby	6.50	5.00	5.75	10.25	11.25	—

In the sand sagebrush type density was low throughout the study period. There, the population trend was the same as in other areas until 1958, when numbers decreased. The difference in population density in the three study areas probably was not influenced as much by vegetation type, as by the combined influence of soils, vegetation, and land use.

The need for large census tracts became apparent. Although density increased 5.8 percent in the Davison census area from 1959 to 1960, there were great inconsistencies in portions of the large census area. In four

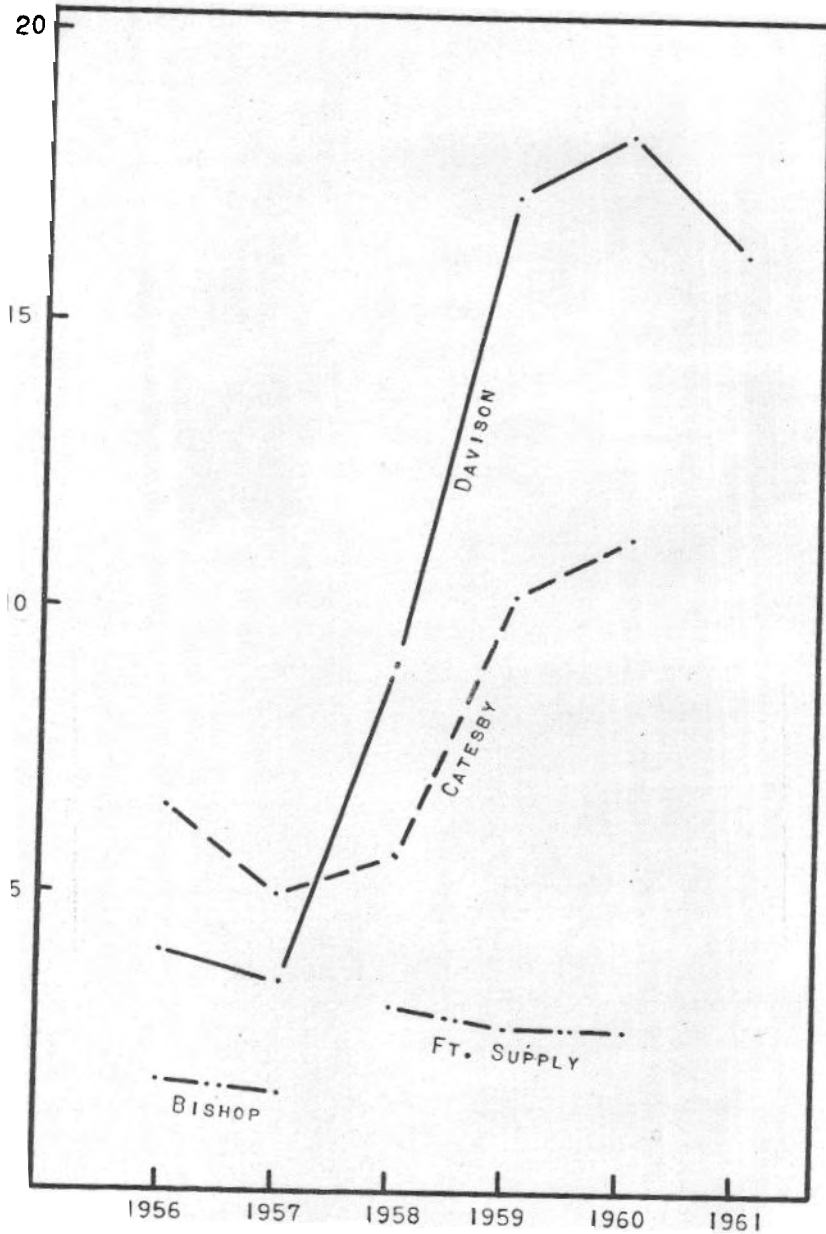


FIGURE 17. DENSITY OF MALE LESSER PRAIRIE CHICKENS IN STUDY AREAS.

sections in the northwest corner of the 16 square mile census plot the number of cocks increased from 75 to 103, while those in the northeast four sections decreased from 80 to 65 cocks. This was an **increase** of 37.3 percent in the northwest quarter and an 18.8 percent **decrease** in the northeast quarter.

During 1960, the peak male lesser prairie chicken density in the Davison study area was 52 percent lower than it was in this same area at its peak in the 1930's (Figure 18). Verne E. Davison (1940) censused this identical four-mile square area (16 sections) from 1932 to 1939, excepting 1937. A census was repeated on the same area in 1940 by L. G. Duck (1942) and in 1946 by Oklahoma Game and Fish Department personnel (Anon. 1946). In 1947 ten sections of land were surveyed, most of which were in the above mentioned area (Jones, 1947).

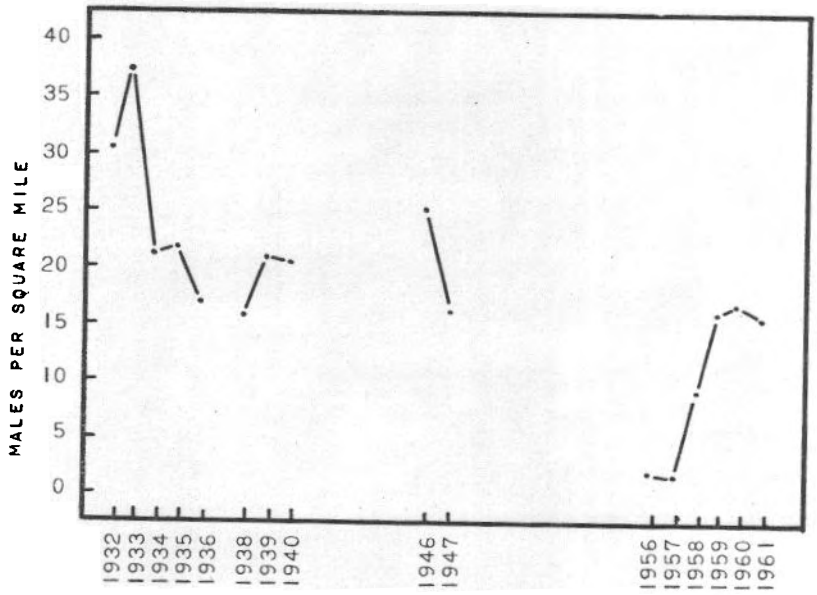


FIGURE 18. DENSITY OF MALES IN THE DAVISON STUDY AREA, 1932 TO 1961.

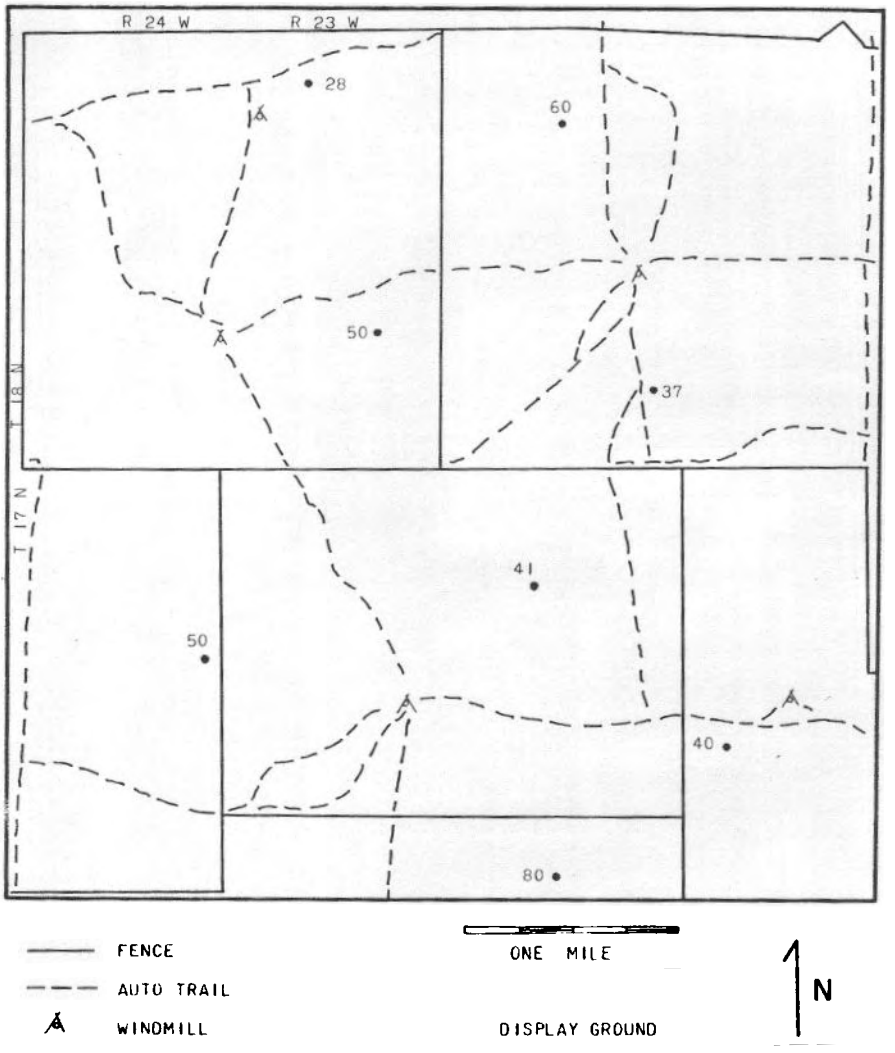


FIGURE 19. LESSER PRAIRIE CHICKENS ON DISPLAY GROUNDS OCTOBER 6-17, 1958, DAVISON STUDY AREA.

Fall display ground surveys in 1958 revealed a 161 percent increase in birds on display grounds from the spring cock population. From October 6, to 17, 1958 a total of 386 birds, nearly all cocks, were found in the Davison area (Figure 19). That is, 242 more birds than the 144 birds found the preceding spring. The following spring only 227 cocks were present, a decrease of 109 birds during the winter. Since there was not enough personnel to thoroughly study this phase of population inventory, no interpretation of reproductive success will be attempted.

SPRING DISPLAY GROUND ACTIVITIES

About the last week in February, when the weather was clear and mild, a few prairie chicken cocks began displaying on traditional grounds.

In the beginning only a few grounds were occupied, and by a large number of birds. As spring approached and morning weather became milder, birds began using additional grounds, and large concentrations dwindled. Daily visits were continued until mid-May.

Territorial disputes of individual cocks on display grounds were greatest during March and early April. However, territories were best delineated, and copulations were most frequent, during the last ten days of April and the first week of May. Display grounds were easiest to find when territorial disputes were most intense. Inventory of cocks was most certain, however, after territorial disputes were settled. Therefore, during late March and early April, display grounds were hunted, and cocks were counted after April 15 all within the shortest period of time possible. At least two, and usually three counts were made on each ground.

Daily, early morning displays prevailed usually until early May, but cocks did abandon one ground April 20.

Cocks usually displayed on the ground, but sometimes they stood on short oak bushes. On five occasions one cock fluttered to the top of my stationary blind. On placing my head against the top of the canvas blind and raising the roof to an apex, the cock walked to the high point and strutted and gobbled on my covered head. This novel treat was experienced also by four other persons.

Flutter jumps of cocks on display grounds were frequent when other grouse flew into sight. Courtship displays were most intense at sunrise. Nuptial bows of cocks were similar to those described for greater prairie chickens (Schwartz, 1945). A receptive hen drooped her primary wing feathers nearly to the ground, with the wings separated a short distance from her body, and squatted. If the actions elicited the interest of a cock, copulation followed.

Hens visited display grounds the last half of March, throughout April, and the first week of May. Hens were common on display grounds throughout April, but only a few were seen at one time. In 1959, a hen was first seen on a display ground March 23. The last one seen on the grounds was observed May 6, 1959 (Table 4), when daily observations were discontinued.

Copulations on display grounds were seen April 24 (1 time), April 25 (3 times), April 26 (4 times) and May 6 (1 time), 1959.

Birds always chose relatively short-grass areas for their display grounds. Most grounds were on ridges or similar elevations. In the sand sagebrush type, display grounds were found in valleys on the short-grass meadows if sagebrush was tall and dense on nearby ridges.

Only one of 44 observed display grounds was located on plowed ground. This was on a cultivated field on the Southern Great Plains Experimental Range in the Ft. Supply area.

TABLE 4

Number of hens observed on display grounds
in the Davison study area, spring 1959

Date	Number of hens on gobbling grounds
March 23	1
April 2	13
April 3	1
April 4	5
April 5	6
April 9	5
April 17	5
April 20	8
April 22	9
April 23	6
April 26	5
April 27	2
April 29	2
April 30	1
May 1	1
May 6	1

FALL COURTSHIP ACTIVITIES

Fall bird courtship ground displays were almost as common as spring activities in the Davison study area, although birds appeared on fewer display grounds. But in the other areas, fall displays rarely occurred.

Early morning displays of a few cocks began in late August. In August and early September cocks engaged in minor fighting and low intensity gobbling. It was late September, however, before they strutted. In September young birds joined the adults, and in October hens also appeared. Cocks courted the hens, even to the extent of bowing demonstrations during late November, but no copulations were observed in fall. In 1958, when the sex and number of birds on one ground were closely observed, young-of-year first appeared September 10, and old hens were seen November 18. But on another ground a hen was seen October 15.

Young birds and old hens were difficult to differentiate in the fall as a result of molt. Even old cocks were not always easily distinguished in fall.

Old cocks usually began arriving on display grounds each morning one-half hour before sunrise. They were followed a few minutes later by young birds. Occasionally, flocks of ten to 15 birds, apparently young of the year, visited display grounds briefly, and intermingled with regular displaying birds. This made inventories difficult, because the highest number of birds on a ground occurred anytime from 20 minutes before sunrise to one hour after sunrise (Table 5).

TABLE 5

Occurrence of peak numbers of prairie chickens on display grounds in fall in relation to time of sunrise, 1959

Date	Display Ground	Highest Number of Cocks
9-8-59	Woods	At sunrise
9-10-59	Twin Tanks	20 minutes after sunrise
9-11-59	Davison	10 minutes before sunrise and 25 minutes after sunrise
9-18-59	Cross	1 hour after sunrise
9-23-59	South Carlton	15 minutes after sunrise
9-28-59	Davison	10 minutes before sunrise
10-7-59	Twin Tanks	10 minutes after sunrise

This contrasted to spring when nearly all cocks arrived 50 to 60 minutes before sunrise. The following example of the extreme variation in behavior is cited from field notes of September 18, 1958, in the Davison study area:

5:45 AM — entered blind on display ground
6:10 AM — 1 lesser prairie chicken present
6:20 AM — 3 birds present
6:27 AM — sunrise
6:30 AM — 9 birds present
6:45 AM — 6 flew, 3 remained
7:10 AM — 10 birds present
7:15 AM — 13 birds present
7:30 AM — 14 birds present

As the fall season waned, and the weather grew colder, the number of birds in small flocks increased. Concurrently, the birds used fewer display grounds. A near maximum 150 birds used some of the grounds in late autumn. Regular daily visits by the birds to the display grounds ceased abruptly during late autumn correlated with the first severe cold spell accompanied by snow or heavy clouds.

The lesser and greater prairie chickens, when observed during autumn in western Oklahoma and Missouri (Schwartz, 1945) were similar in the following respects. Old cocks began regular early morning display sessions on historical grounds in August. At first, gobbling, then strutting, and eventually strong territorial disputes of cocks occurred. The old cocks eventually were joined by young birds and hens. Cocks courted hens but did not copulate. Daily activities were prevalent at dawn and dusk, as in spring, but were less vigorous in fall. The first hen was observed on a display ground during mid-October.

Unless further study of fall activities indicates otherwise, fall display ground inventories should be conducted during mid-October. Observations at each ground should be made from sunrise to one hour past sunrise, and these should be made concurrently on several display grounds. Additional studies are needed during the fall months to determine the sex of birds on the grounds in fall.

TERRITORIALITY

Present prairie chicken inventory methods are based on the premise that each cock continually uses the same small courtship territory daily during a certain portion of spring. Since banded birds were marked for individual identification in the field, recurrent activities of individuals could be followed for this study. Although it appears simple to identify the banded birds, it took several minutes to read each individual bird band number. Most of the time was consumed observing a bird, waiting for the moment when the position of the leg band and sunlight would be optimum, and the bird at the proper distance for focusing the telescope. And, although results seemed satisfactory at the time, I never knew how many other banded birds went unnoticed, though I was aware that they strutted into view, then disappeared again into the vegetation.

On fall display grounds old cocks usually re-established courtship territories that they frequented in the spring. Young birds milled about, with no apparent territory selections.

After absence of the birds from the traditional grounds in winter, once again the old birds claimed their original territories in late winter, and young birds began seeking territories. During late winter some birds moved about from one ground to another while large packs were disintegrating. One cock moved twice, as described later under the section on movements. By mid-April territories were fairly well established for the breeding season which already was in progress. Most territories were about 12 to 15 feet in diameter.

Among the activities of 17 cocks that were identified during two or more seasons, 15 used the same location each time (Table 6). Only two changed locations and they remained on the same display ground.

An additional bird, not included in the above group, changed from one display ground in the spring of 1959 to a nearby ground in the spring of 1960. Since the first ground was not re-used in 1960 apparently the birds shifted, but not necessarily to the same place. The banded bird moved eight-tenths of a mile, although a new display ground was established two-tenths of a mile away.

In summary, prairie chicken cocks, during their life, occasionally changed display territories, but the predominate tendency was to maintain the same territory each season.

PERMANENCY OF DISPLAY GROUNDS

Davison mapped the location of spring display grounds from 1932 to 1936 and during 1938 in the 16-section Davison Study area. I mapped the spring grounds from 1958 to 1961, and the fall grounds during 1958 and 1959. The peak known prairie chicken density in the 1930's was twice as high as in 1950's.

Davison found 55 display grounds. I found 28 grounds, 17 (61 percent) of which were old grounds in the same place that were present in the 1930s' (Table 7) (Figure 20)[1]. Eleven of the 17 grounds that I found were prominent grounds in the 1930's, i.e., prairie chickens used them nearly every

spring season, and during most fall seasons. Yet, many of the prominent grounds were not used in one or more intervening years.

[1] Used by permission from Davison's field notes.

The more permanent, nucleus-type display grounds, are probably very important to the birds. They may provide an organizational base of the social structure, or they may merely be maintained in the very best habitat for nesting. These are the grounds that are used nearly every year, even when population density is low. As population density increased from a low ebb, birds usually returned to other known historical grounds, but occasionally also to place not known to have been used formerly.

NESTING STUDIES

Nests were found with the aid of a 40-foot long flushing bar mounted on the front of a pickup truck or jeep (Figure 21). Chains, with tin cans dangling on the free end, were attached at two-foot intervals to help flush hens from nests.

TABLE 6

Observation of 17 banded lesser prairie chickens on gobbling ground territories in the Davison study area, 1957-1960

Gobbling Ground	Band Number	Individuals Repeating On Same Display Area					
		Spring 1957	Spring 1958	Fall 1958	Spring 1959	Fall 1959	Spring 1960
West Horse	56-34	X	—	—	X*	—	—
Davison	57-28	—	X	X	—	—	—
	57-30	—	X	X	X	—	—
	57-34	—	X	—	X	—	—
	57-37	—	—	X	X	—	—
	57-50	—	X	X	X	—	—
	57-76	—	—	—	X	X	—
	57-142	—	—	—	X	X	—
	57-164	—	—	—	X	X	—
	57-179	—	—	—	X	X	—
Butterfly	57-62	—	—	X	X	—	—
	57-200	—	—	—	X	—	X**
Twin Tanks	56-76	—	—	—	X	—	X
	57-72	—	—	—	X	—	X**
Perry	57-113	—	—	—	X	—	X
	57-123	—	—	—	X	—	X
Cross	57-56	—	—	—	—	X	X

* All display grounds were inspected every spring and fall. Temporary absence or failure to identify birds is unexplicable.

** Definite change in location of territory on the same gobbling ground.

Display Ground Number	1932	1933	1934	1935	1936	1938	1957	1958	1959	1960	1961	1966* Apr 16
1	7											
2		13	4	9	10	8			6	15	7	0
3	24	9										
4				3						10		
5	11											
6				8	6							
7	29	22	18	12	8	17		8	14	17	12	
8			2									
9	23	15	7		6							
10				11								
11		10										
12		3					*		7	5		
13	15	11	13	7	4							
14	12	21	20	30	19	34		38	43	35	30	
15		23		3								
16				9	15							
17									3			
18		12	14	8	9	7						
19									1			
20	29	29	5								3	
21	4								10			
22		6		1						5		
23	13					1						
24	6	12	8	12	11	19		7	12	14	13	
25	13	11	12	11	7	9						
26										4		
27									4			
28	7	8										
29	3	4	1									
30	35	31	37	20	21	32		12	15	21	21	
31	5	6	6									
32	21	23	13	15	11	8		14	26	17	11	
33	8	8	13	15	14	11						
34	21	37	20	26	23			19	25	32	20	
35		8		5								
36	9	9	5	10	8	8						
37		9		6	14							
38										2		
39		9		6	3	2			2			
40	2										8	
41		5	5		1							
42										6		
43	11	20	18	19	13							
44	34	12										
45	13											
46					2	4						
47	31	38	15	18	4				18	10	13	
48			11	14	19	24						
49		13										
50										9	22	
51		13							3			
52		13			8							
53	26	29	25	18	13	28		7	24	17	18	
54	10	26	16	13	5	11			9	11	17	
55			17	12	10		*					
56		11										
57	21	18	12	7	8	10				5		
58									6	7		
59	14	9							9	16	13	9
60	5	14	3	1								
61		10	9	5	1							
62	27	32	24	26	24	33	12	26	40	33	35	20
62					1							
64											11	
Total	489	612	353	360	298	266	12	131	277	291	254	

* No observation was made in 1957 on grounds numbered 12 to 55

Three nests were found in 1956, one in the Davison and two in the Catesby study areas. In 1959, when 800 acres were surveyed with the aid of a flushing bar in the Davison study area, four more nests were found (Table 8).

Nests were on the ground in the broad open prairie. They were placed in a hollow, scratched out in the sand, about four inches deep and eight inches in diameter, and usually were lined to a depth of one and one-half inches with shin oak leaves and grasses. One nest had excellent overhead cover furnished by two thriving clumps of sand lovegrass. When first found, most of the shelter was provided by old grass from the previ-

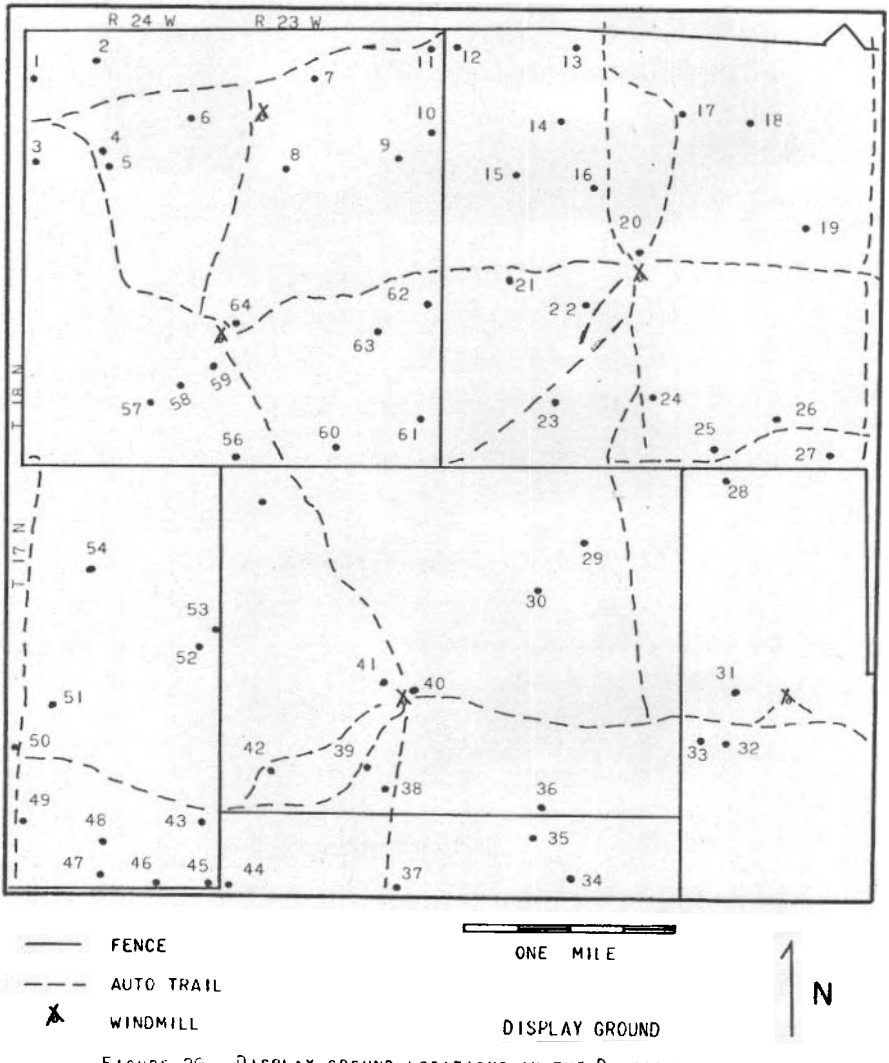


FIGURE 20. DISPLAY GROUND LOCATIONS IN THE DAVISON STUDY AREA, 1932 TO 1961.

Figure 21

The 40-foot bar and chains mounted on the truck were used to flush hens from their nests.

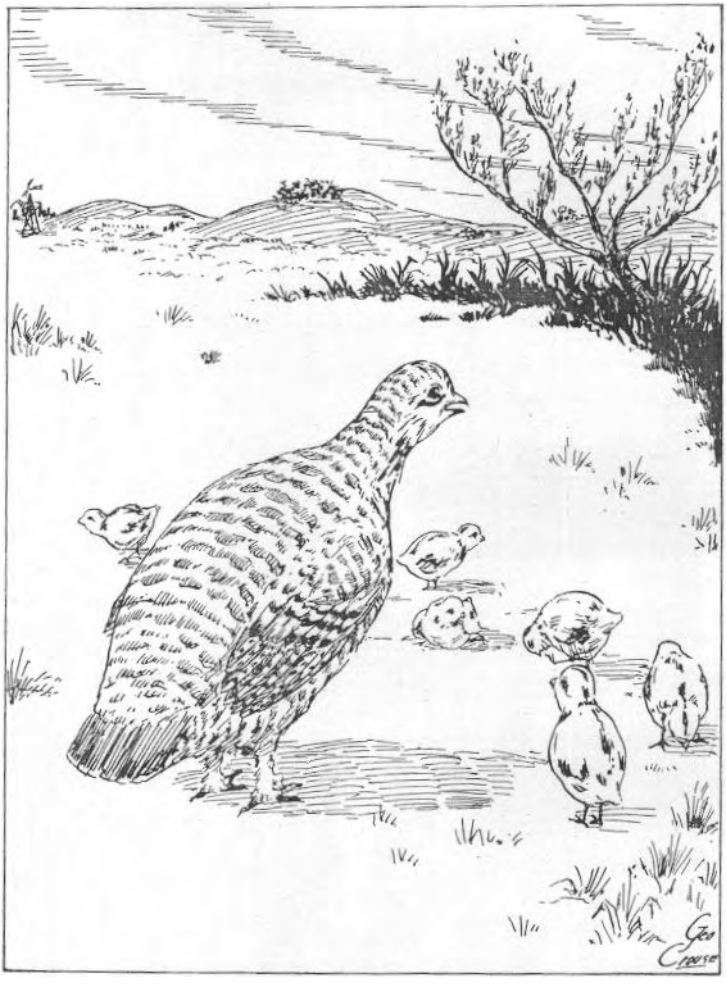


Table 8

Lesser prairie chicken nests found in Ellis County, Oklahoma 1956 and 1959, and notes from literature

Nest Number	Date Found	No. Eggs	Date Eggs Hatched	No. Hatched	Days Under Observ.	Nest Excav.	Nest Lined	Between Grass Clumps	Other Vegetation	Reference
1	May 27, 1956	13	?	?	—	yes	yes	Little bluestem	Shine oak 15"	
2	June 6, 1956	6	Missing	0	18	yes	no	Little bluestem-Needle grass	None	
3	June 6, 1956	8	Missing	0	18	yes	no	Little bluestem-Needle grass	None	
4	May 16, 1959	13	June 6	13	21	yes	yes	Sand lovegrass	Shin oak 12"	
5	May 21, 1959	11	June 10	11	20	yes	yes	Little bluestem	Shin oak 12"	
6	May 28, 1959	13	May 28	13	1	yes	yes	Little bluestem	Shin oak 12"	
7	May 28, 1959	11	June 12	10*	15	yes	yes	Little bluestem-Sand bluestem	Shin oak 12"	
8	May 28, 1920	12	**			yes	yes		Bunch of sage	Bent, 1932
9	June 2, 1920	12	**			yes	yes		Bunch of sage	Bent, 1932
10	June 2, 1920	13	**			yes	yes		Under tumbleweed	Bent, 1932

* One egg missing

** Data from literature on nest found near Liberal, Kansas

ous year's growth. As incubation progressed new growth added to the protective covering (Figures 22-25). No nests were found among shrubs more than 15 inches high.

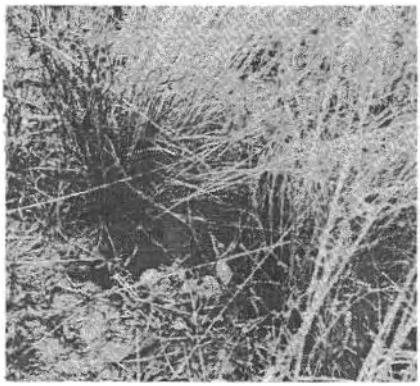


Figure 22

Nest No. 4 was between two clumps of sand lovegrass. May 16, 1959, a day or two after incubation began, the eggs were partially covered by old bunch grass.

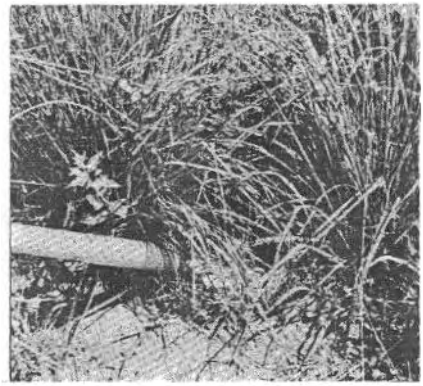


Figure 23

On June 8, nest No. 4 was better concealed by the new spring growth of grass.

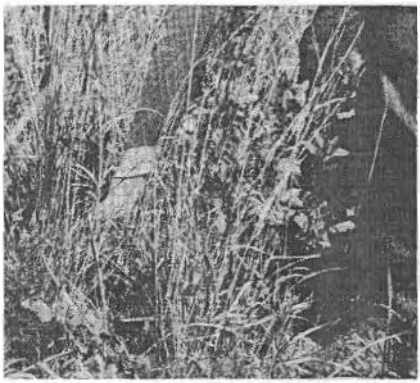


Figure 24

Nest No. 6 was in the center of a large clump of little bluestem grass, photographed June 1, 1959.

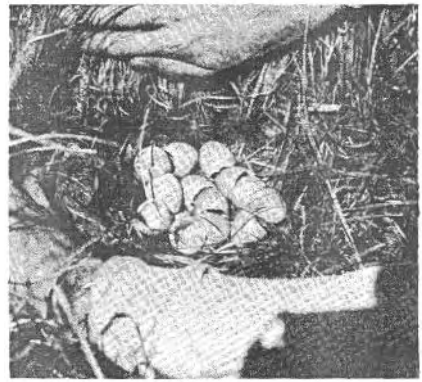


Figure 25

The grass and leaf linning of nest No. 6 is apparent in this picture, photographed June 1, 1959, four days after hatching.

Several observations were made of three nesting hens. Individual hens did not always face the same direction. The average number of eggs in seven nests with complete clutches was 10.7. Five early nests, begun by the hens in April or the first two weeks of May, had 11 to 13 eggs, and average 12.2. Two nests established in late May, had six and eight eggs, an average of seven. Davison (1935) stated "13 eggs is probably near the average, 12 being as common as 14." Bent (1932) said a full nest consisted of 11 to 13 eggs.

It is interesting that the empty egg shells in Nest No. 5 remained uncrushed in the nest cavity for at least 10 months (until April 1960). When the nest was two years old (April 1961) shell fragments remained but grass had grown into the nest cavity, and one and one-half inches of litter covered the shell fragments.

Two nests, No's. 6 and 7, were about 15 yards apart.

BROOD STUDIES

Each summer from 1956 to 1959 I studied broods in the Davison study area from July 15 to September 1 to develop techniques for forecasting reproductive success and study habitat use. Daily observations were most fruitful from 10:00 A.M. to 4:00 P.M., while prairie chickens were under motts in hot weather. The motts covered only a small portion of the landscape. This facilitated the search for birds.

During the summers of 1957 and 1958 a total of 900 miles was driven in shinnery, from mott to mott, while hunting broods. Only one brood was found in the low shinnery, whereas 27 broods were found in motts.

Brood Size

When young birds were counted in broods they were found to be from four to 14 weeks old, the age levels that few birds disappeared from the broods.

The number of broods found in the Davison Study area increased each year while spring density of cocks increased from 1957 to 1959. At the same time, the number of birds per brood varied slightly up and down (Table 9).

TABLE 9

Broods observed in the Davison Study area
from 1932 to 1935 and 1956 to 1960.

Year	Cocks per square mi. in spring	Number of Broods found	Juveniles per brood
1932*	—	15	7.5
1933	—	51	6.5
1934	—	75	5.5
1935	—	35	5.2
1956	4.0	9	6.2**
1957	3.5	13	7.2***
1958	9.0	14	7.0
1959	17.3	36	7.3
1960	18.3	—	—

* 1932-1935 from Davison (1940).
** Based on six broods
*** Based on nine broods

Intermingling of brooks made it difficult to determine actual brood size. In 1959 one or more juvenile birds were trapped from 23 of the 36 groups of young birds observed. From the study of molt of primary wing feathers it appeared that at least 10 additional broods were intermingled with these 36 groups (Table 10). If there was actually 46 instead of 36 broods present, then the average brood size would have been only 5.7 (264 birds in 46 broods) instead of 7.3 birds per brood (Table 10). When more than eight birds were found together usually two broods were present. Groups of 11 or more were sometimes composed of three broods. Observations of free-ranging birds can be obtained easier than birds can be trapped and agerd, but the results apparently do not give a good representa of reproductive success or rate of survival. Intermingling of broods was equally common when population density was high and low.

Brood Range

Broods seemed to be more mobile in dry years when grass and shinnery cover was sparse than during wet seasons when cover was dense. During the summer of 1956, a severe drought year when population density was very low, one marked brood was observed in 13 places in July and August, and they covered a minimum enclosed area of 256 acres. The greatest distance between points of observation was 1.43 miles. On the other hand, in 1959 when rainfall was near the long term mean and vegetation was dense, three marked broods were found in no more than three places, and on a smaller range of about 160 acres.

Habitat Use

In summer, during hot weather, lesser prairie chickens apparently required adequate shade. During summer they were found only in pastures, never in cultivated fields. In the shin oak type of vegetation prairie chickens gathered in the shade of oak motts, but only when it was very hot. In sand sagebrush and mixed-grass prairie types they moved into the shade of sagebrush, skunkbrush, sand plum, ragweed, and other bushy plants and forbs.

The dependence of prairie chickens on good shade in summer is indicated by the following correlations between weather, soil moisture, and habitat use:

1. Insolation (solar radiation). Prairie chickens were found in motts only on clear days. Motts provided better shade than shinnery (Figures 26 and 27).

2. Air temperature. More prairie chickens were found in motts on hot days than on cool days (Figure 28). A direct correlation existed between the number of birds in motts and daily maximum temperatures, except during late August soon after a 1.02 inch rain when ground moisture was high. All weather data are from Climatological Data, U. S. Weather Bureau, Ashville.

3. Wind velocity. There appeared to be little correlation between wind velocity and the number of prairie chickens in motts, except winds above 30 miles per hour may have reduced usage slightly.

Table 10

Number of birds found in thirty-six groups of juvenile birds and the probable number of broods represented in each group, shin oak type study area, summer, 1959

Number of Juvenile Birds in Group		Number of Broods in Group
8		1
11		1
9		1
11*		1
13*		2
2		1
8*		1
7*		1
5*		1
12*		2
8		1
11		2
5		1
5		1
7*		1
3*		1
8		1
5*		1
13*		3
5*		1
12*		2
3*		1
6*		1
7*		1
5*		1
7		1
9*		2
6*		1
9		1
9*		2
5*		1
1*		1
7*		2
6*		2
8		1
8		1
264	36 grouped	46 broods

* A portion of the group was trapped; otherwise number of broods was assumed to be one.

Figure 26

Oak motts had low shrubby vegetative cover similar to that furnished by shinnery, and the high leaf canopy, to provide shade.

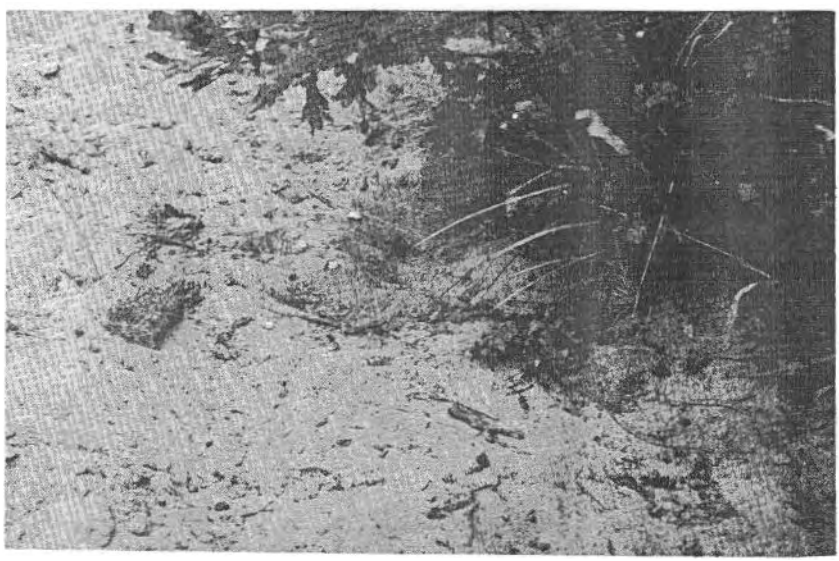


Figure 27. Prairie chicken dusting form at the base of oak trees in motts.

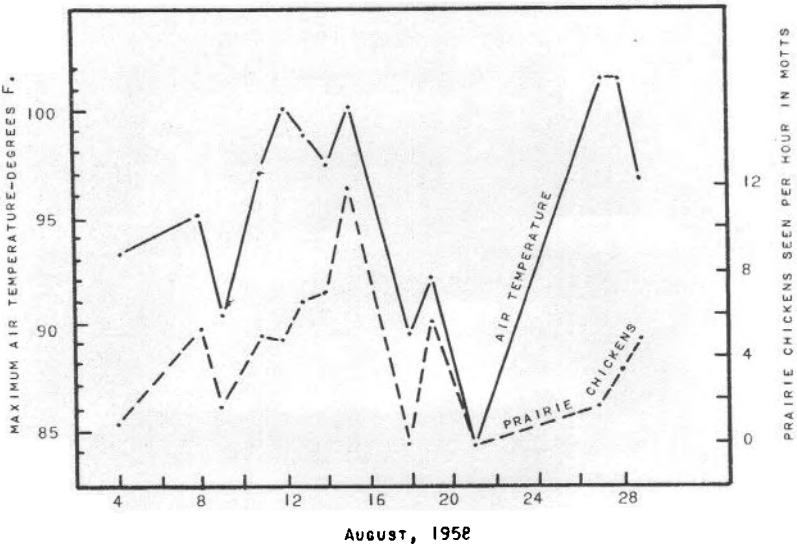


FIGURE 28. NUMBER OF LESSER PRAIRIE CHICKENS SEEN IN SHADE OF OAK MOTTS PER HOUR OF OBSERVATION AND MAXIMUM AIR TEMPERATURE; 10:00 A.M. TO 4:00 P.M. IN THE DAVISON STUDY AREA.

4. Soil moisture (three inches below the ground surface). More prairie chickens were found in motts when the ground was dry than when it was moist (Figure 29). This relationship is even clearer if the observations of August 18, are not considered, since air temperature was only 89° F.

Relative soil moisture was measured with an Aquaprobe, a battery powered instrument capable of determining sub-soil moisture from dry to wet on a scale calibrated from 0 to 10. The Aquaprobe was manufactured by General Scientific Equipment Company, 3011 Dixwell Avenue, Hamden 14, Connecticut.

It is important to recognize that birds used motts only when **both** temperature was high and ground moisture was low. An example was August 15, 1958, when the temperature was 100° F., and the soil was very dry (rated only 0.5), seven broods were found in motts and 11 birds were captured. This is 50 percent of the broods seen and 42 percent of the birds captured during the summer (Table 11). Observations each day were from 10:00 AM to 4:00 PM.

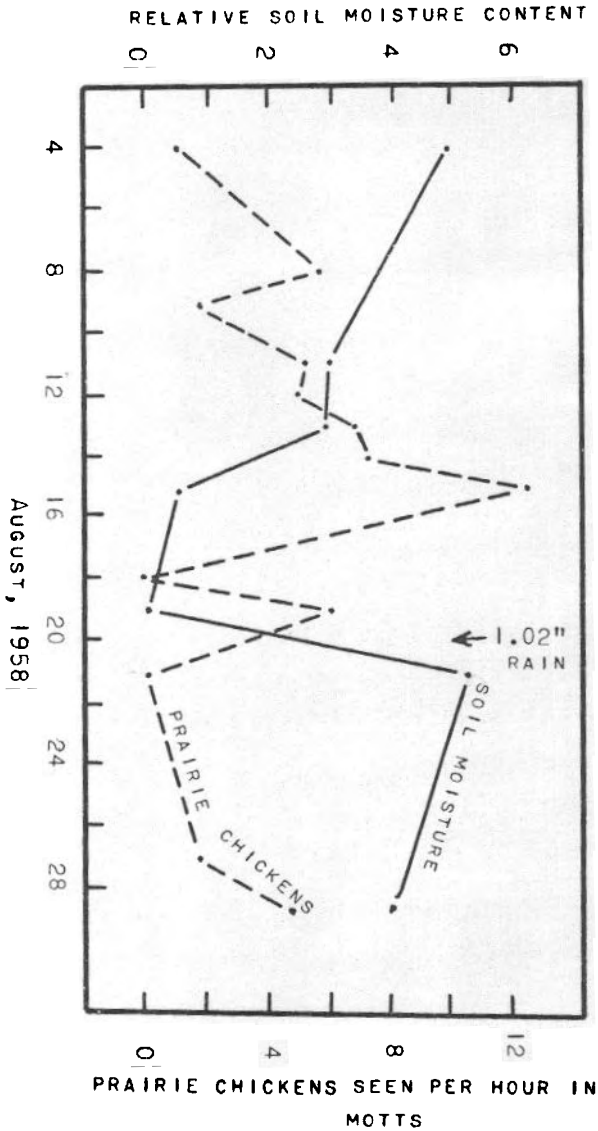


Figure 29. Number of lesser prairie chickens seen in shade of oak motts per hour of observation from 10:00 A.M. to 4:00 P.M. and relative soil moisture content. A good negative correlation exists except August 18 when air temperature was only 89° F. Davison study area.

TABLE 11

Number of lesser prairie chickens trapped and prevailing weather conditions, summer of 1958, Ellis County, Oklahoma

Date	Number Birds Trapped	Maximum Air Temperature	Relative Soil Moisture	Sky
August 9	1	90	4.0	Clear
August 11	3	97	3.0	Clear
August 13	1	97	3.0	Clear
August 14	7	97	2.0	Clear
August 15	11	100	0.5	Clear
August 28	3	101	4.0	Clear
Total	26			

Finding and trapping prairie chickens was less rewarding when either temperature or soil moisture was not optimum (Table 11). The August 25, 1958 maximum air temperature was the highest of the summer, on a working day (100° F.), however, only two broods were found and only three birds were trapped. The soil moisture content was high (4.0). On the other hand, the soil was dry August 18, 1958 (about 0.5), but it was cool (89° F.), and no birds were found.

I believe herein is the reason lesser prairie chickens occur only in regions with brushy vegetation. The need of shade in summer is critical when temperatures near or exceed 100° F. Apparently, grassy vegetation does not provide sufficient shade, particularly during extreme droughts when temperatures are highest and grass cover is sparse.

Additional brood studies and inventories of birds on fall display grounds should be conducted annually to provide better knowledge of reproductive success and the loss of young.

ROOSTING COVER

Roosting sites were found in grassed ravines, in draws and on ridges (Figures 30 and 31). Moderately grazed pastures were used more frequently than heavily overgrazed ones. Roost sites were not found with overhead cover more than three feet high. Birds roosted singly or in groups, but when in groups individual birds were a few feet apart.

ESCAPE COVER

The phrase "escape cover" as used by Leopold (1933), referred to shelter used by an animal that discouraged a predatory species. Perhaps that is not a fitting term to use with regard to adult prairie chickens. However, the strong power of flight of the adult lesser prairie chicken permits it to escape many potential predators, and the place it eventually alights seems to be of little consequence.

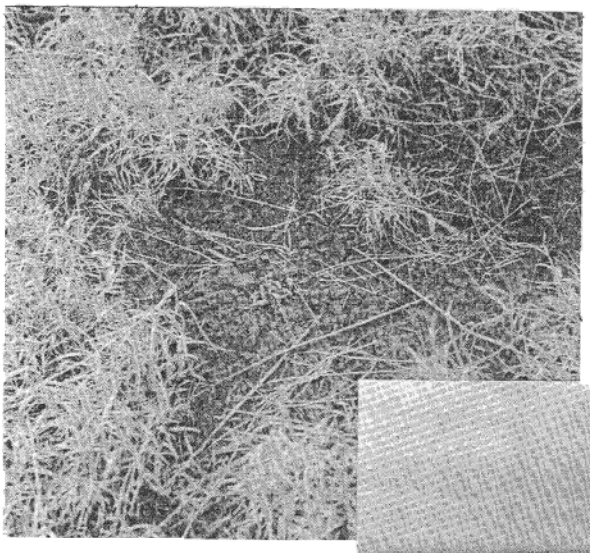


Figure 30

Roosting site of lesser prairie chicken in silver bluestem pasture; photographed March 26, 1959.

Figure 31

View of silver bluestem grass in vicinity of the prairie chicken roosting site shown in Figure 30.

After being flushed by a marsh hawk, lesser prairie chickens often flew to a distant ridge, a fourth to a half mile or more away, and lit in open grassland or in the vicinity of a mott.

SEASONAL MOVEMENT OF BIRDS

Prairie chicken movements were most limited in summer and most extensive in winter. The summer range of a hen and brood appeared to be only about 160 to 256 acres. Summer movements of cocks probably were very limited, but were not definitely measured.

In September when the birds began watering at ponds and water tanks at windmills, their movements became more obvious and probably more extensive. Also, they were visiting traditional display grounds. During this same time the bird's insect diet was supplemented by maturing forb seeds. Later in autumn and winter as the demand for grain outgrew the supply in pastures, prairie chickens sometimes fed in cultivated grain fields.

The extend of these movements is reflected by the observation of 114 banded birds. Most of the banded birds were identified or recaptured only

once. A few were identified two or three times. One bird was identified seven times. Sixteen birds were identified only when they revisited the place where they were captured.

Most of the known movements were less than two miles. Ninety birds (79 percent of those observed) were found within two miles of their point of capture, and III (97.4 percent) were within four miles (Table 12). One bird moved ten miles, the maximum known distance.

Table 12

Known movements of 114 lesser prairie chickens from trap site to most distant point of observation in the Davison study area, 1956-1960.

Distance in Miles	Number of Birds Observed
0.00-0.20	41
0.25-0.45	0
0.50-0.70	9
0.75-0.95	19
1.00-1.20	14
1.25-1.45	1
1.50-1.70	3
1.75-1.95	3
2.00-2.45	11
2.50-2.95	5
3.00-3.45	1
3.50-3.95	4
4.00-4.95	1
5.00-5.95	1
6.00-6.95	0
7.00-7.95	0
8.00-8.95	0
9.00-9.95	0
10.00-10.95	1
	114

One phase of the lifetime movements of lesser prairie chickens not previously described in the literature is the extent to which birds move from their brood range to adult range. Since cocks usually maintain the same display ground territory throughout life, this focal point will be compared with the place of capture of juvenile birds.

Lesser prairie chickens trapped as juveniles in summer were found on display grounds in the vicinity of their brood ranges but not necessarily on the nearest ground. The maximum known movement in a group of 14 young birds from the brood range to spring display ground was 2.9 miles (Table 13). The minimum distance was one-half mile. Six moved less than one mile.

TABLE 13

Movements of banded juvenile lesser prairie chickens from brood ranges in summer to display grounds the following spring in the Davison study area, 1956-1960.

Distance in Miles	Number of Birds
0.00-0.45	0
0.50-0.95	6
1.00-1.45	2
1.50-1.95	1
2.00-2.45	3
2.50-2.95	2
	14

In another group of three young birds trapped in summer, and observed on **fall** display grounds, one was 2.0 miles, one was 0.6 mile, and another was 0.7 mile from the place of capture in summer. None of the birds were found on the ground nearest the place of capture. Birds of the same brood sometimes gathered on the same display ground, whereas birds of other brood units sometimes split up, going to separate grounds (Figure 32).

The distances from points of capture in fall and winter to locations on spring display grounds demonstrated another measure of seasonal movements of young birds. In a group of 32 birds, 25 (78 percent) moved less than one and one-half miles (Table 14). The maximum movement of an individual bird was five miles. These short movements reflect heavy usage of grassland pastures as contrasted to long flights to grain fields. Most birds were trapped in the pasture, and, of course, display grounds were in the pasture.

TABLE 14

Movement of young lesser prairie chickens trapped in fall and winter to display grounds the first spring after their capture, Davison study area, 1956-1961

Distance	Number of Birds	
in Miles	Cocks	Hens
0.00-0.45	17	0
0.50-0.95	0	0
1.00-1.45	7	1
1.50-1.95	0	1
2.00-2.45	1	2
2.50-2.95	0	0
3.00-3.95	2	0
4.00-4.95	0	0
5.00-5.95	0	1
	27	5

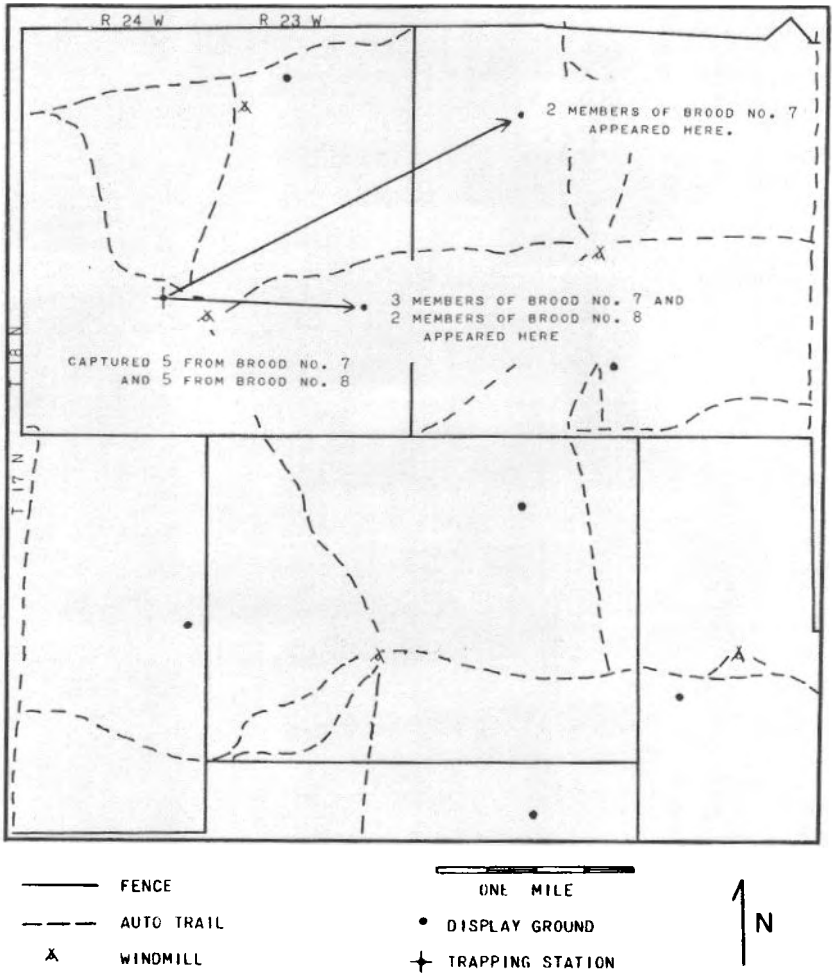


FIGURE 32. MOVEMENTS OF SEVEN LESSER PRAIRIE CHICKEN MALES FROM THEIR BROOD RANGE IN 1957 TO DISPLAY GROUNDS IN 1958 AND 1959.

By comparison, **adult** birds trapped in fall and winter moved shorter distances. In a group of 17 adults, the maximum movement was 1.45 miles, and 15 moved less than one mile (Table 15). This agrees with, and is a part of the data that show old birds to be most stable on display grounds, whereas, young birds transfer from ground to ground until the first breeding season. Data in Table 15 are limited to observations on display grounds only during the spring immediately following the birds capture in fall or winter, and include data from 1956 to 1961.

TABLE 15

Movements of adults trapped in fall and winter to subsequent display grounds in the Davison study area, 1956-1961

Distance in Miles	Number of Birds
0.00-0.45	10
0.50-0.95	5
1.00-1.45	2
	17

Viewed from another aspect, where all data were summarized, birds trapped as adults moved less, on the average, than birds trapped as juveniles in summer (Table 16). Hens moved farther on the average than cocks.

TABLE 16

Average distances moved by banded lesser prairie chickens from every trap site to spring display grounds.

Agen when trapped	Cocks		Hens	
	Number	Average distance in miles	Number	Average distance in miles
Juvenile	40	.93	6	2.12
Adult	20	.46	1	3.75

One young-of-year bird appeared on three display grounds during one spring: trapped on one ground February 2; seen 1.3 miles away on a second ground March 23; and 1.2 miles from the second ground on a third ground throughout that spring. Actions of this bird were exceptional. Most young birds were seen on only one ground.

Flock movements in winter from pastures to grain fields were observed frequently in 1959-1960. Continuous flights of one and one-half miles by birds to and from grain fields were seen morning and evening.

One bird banded in the pasture was observed in a grain field in winter and back in the pasture in spring on a gobbling ground; a distance of about three miles out and two miles back.

In summary, birds moved greater distances during their first year of life than thereafter. Some, and perhaps most, young birds used display grounds during the first fall after they were hatched. Some occupied grounds within a quarter or half mile of their brood range, while others moved more than two miles. Additional movement and mixing of the population occurred in spring as juveniles moved from feeding grounds to display grounds and from one display area to another. Hens usually moved farther than cocks.

MANAGEMENT

SUPPLEMENTAL FOOD PLOTS

The Oklahoma Wildlife Conservation Department leased 35 areas in western Oklahoma for production of food and cover for wildlife. Seven were leased in 1955, seven in 1956, and 21 in 1957. All plots, ranging in size from seven to 20 acres each, were originally contracted for a five-year period. Fencing materials and cost of construction were provided by the Department. Seed and annual payments ranged from $2 to $12 per acre. Twenty-seven areas were contracted for grain production of winter food. Three were leased for grain production and grass cover. Five grassland areas were leased, and were protected from grazing. Prairie chickens usage of these plots was determined as long as the contracts remained in force. Many contracts were dissolved so the land could be placed in the Federal Soil Bank Program, USDA late in 1958.

Of the 35 plots under contract during the winter of 1957-1958, 16 were in the lesser prairie chicken range. Yet, only one food plot was known to have been used by prairie chickens during the winter. This was surprising since farmers reported that during the previous winter nine of the plots had been used. It was even more surprising, since prairie chickens generally were known to feed in grain fields in winter.

During the winters of 1955-1956 and 1956-1957, the locations of 151 flocks were found in western Oklahoma through interviews with farmers and ranchers. Most of the birds reported were seen in sorghum fields. But during the winter of 1957-1958 prairie chickens were not observed using grain in cultivated fields. Several flocks were observed southeast of Arnett that apparently spent the entire winter in the vast (70,000 acre) shin oak grassland area, whereas, some had left this pasture during previous winters. The change in winter feeding habits apparently was influenced by increased production of acorns, grass seed, and forb seed in the pastures. This year (1957) was the first wet year following a long drought. Vegetative ground cover had been sparse. Large clumps of little bluestem grass were dead, dormant or sprouting from only about 5 percent of the root clump. With increased moisture, forbs and legumes prospered and produced an abundance of seed. Apparently with low prairie chicken density, and high seed production, there was ample winter food available in pastures.

Again, in the winter of 1958-1959, prairie chickens did not feed in sorghum fields south of Arnett near the main Davison study area, but usage of cultivated grain increased elsewhere—in mixed grass and sand sagebrush types. Of 12 food plots in the prairie chicken range, nine were used.

The next year, the winter of 1959-1960, lesser prairie chickens used all four food plots maintained during the winter. Prairie chicken population density was higher than in previous years. Birds flocked to grain fields in large groups, 80 or more birds, especially in late winter when snow was 10 to 12 inches deep for a week or more. While snow was on the ground, most birds were found in fields where shocked grain sorghum bundles were present.

HUNTING

Past Hunting Seasons In Oklahoma

Lesser prairie chickens were hunted in Indian Territory without legal restriction until 1890. In that year the U. S. Congress declared western Oklahoma to be "Oklahoma Territory" and the First Territorial Legislature assembled. The Legislature passed a law that restricted hunting of lesser prairie chicken to a period from September 1 to December 31 of each year (Statutes of Oklahoma, 1890, pg. 587, Ch. 38, Sec. 1). The open season was changed in 1895, to a period from November 1 to February 1, of the following year (Oklahoma Terr.) Session, 1895); and in 1899 it was changed to September 1 to January 1, of the following year (Oklahoma Terr.) Session, 1899). In 1909, two years after statehood, the open season was set for September 1 to November 1, except no hunting was allowed on Sundays. The first bag limit was set in 1909. The limit was fifteen birds per day, and one hundred per season (Oklahoma Session, 1909). Hunting continued under these restrictions until 1915, when the legislature passed a law prohibiting prairie chicken hunting at any time (Oklahoma Session, 1915).

Perhaps the gradual reduction in hunting opportunity and final closure of the season, was warranted by reduced numbers and distributions of lesser prairie chickens. We know there was a major change in the face of the earth wrought by the hundreds of settlers permitted to establish farms and ranches in western Oklahoma between 1890 and 1900. However, since legislative actions similarly reduced and eliminated hunting of other game animals, it probably represented a trend in governmental thinking as well as **uncertainty** about the status of game populations.

In 1929, the Oklahoma Legisalture passed a law which gave the Oklahoma Game and Fish Commission authority to open the season on prairie chicken when the birds become so numerous as to endanger private property or farm crops (Oklahoma Session, 1929). The Commission permitted open seasons in 1929, 1931 and 1933 (Table 17).

TABLE 17

Lesser prairie chicken seasons and bag limits
Oklahoma, 1929 to 1951.

Year	Period	Daily Bag Limit	Possession Limit
1929	Sept. 9-13	6	12
1931	Sept. 15-17	5	No Limit
1933	Oct. 2-4	5	10 During Season
1950	Dec. 2	2	2
1951	Dec. 11, 13, 15	2	6

The next open season was a statewide, one-day hunt, held December 2, 1950. Only two prairie chickens per hunter were allowed (Oklahoma Game and Fish Department, Commission Minutes, 1950). It had been reported that there were a few more prairie chickens than usual (Anon., 1950). The total kill of the one-day hunt was estimated to be between 600 and 1,000 greater and lesser prairie chickens combined, taken by approximately 6,000 hunters (Anon., 1951).

The most recent open season on lesser prairie chickens in Oklahoma was in 1951. A three-day season was set, although according to the opinion of some biologists there was a slight decrease in the lesser species' production (Temple, 1951). Two prairie chickens per day were allowed on December 11, 13, and 15, during a statewide hunt (Oklahoma Game and Fish Department, Commission Minutes, 1951).

Open seasons in 1950 and 1951 apparently were followed by greatly reduced numbers of prairie chickens. Residents of western Oklahoma expressed indignation because they thought the birds were nearly annihilated by the hunt. Yet, across the state line in Texas, where the birds were not hunted, population densities dropped about 54 percent from 1952 to 1953, (Jackson, et al., 1956). Experiencing one of the most severe droughts on record, the plains became parched and virtually barren. Grass became nearly dormant and cattle grazed old growth to the ground. Without good grass cover for nesting, ample brush cover for shade during record breaking high temperature, and sufficient forb seed or acorn production for food, prairie chicken reproduction and survival probably was very poor.

Future Hunting Outlook

About 1940, the total lesser prairie chicken population was calculated to be about 14,914 birds (Duck and Fletcher, loc. cit.). After making a late winter and spring survey in 1956, Summars (1956) estimated there were between 2,500 and 3,000 lesser prairie chickens in Oklahoma. In the spring of 1960, there were probably at least fifteen thousand (15,000) lesser prairie chickens in Oklahoma. The 1960 spring survey revealed an average of 18.31 cocks per square mile in the Davison study area, 11.25 cocks per square mile in mixed-grass prairie type, and 2.33 cocks per square mile in sand sagebrush type. Assuming that 40 percent of the birds were hens, there would have been 30.5, 18.8 and 3.9 birds per square mile. Expanding this with minimum density in the 2,391 square miles of occupied range, there could have been at least fifteen thousand (15,000) birds. Since habitat conditions were good in 1960, and moreover, population levels remained high again in 1961 in the Davison study area, it is possible the fall population in 1960 was at least double the spring population, or about 30,000 birds.

Hamerstrom, et al., (1957), stated with regard to greater prairie chickens on a smaller range in Wisconsin than lesser chickens occupy in Oklahoma: "Biologically, we see no reason to discourage hunting during years of abundance provided that two conditions are met: first, an actual harvestable surplus must have been produced. Second, hunting—including crippling loss—must not remove more than the surplus."

"There are no precise figures to show what the allowable kill should be. Our best guess, at present is 25-30 percent of the population, perhaps somewhat more during the rise and somewhat less during the decline, with a closed season when the population drops to about 50 percent of the high."

With a resident lesser prairie chicken population of about thirty thousand (30,000) birds in the fall of 1960, perhaps 7,500 to 9,000 could have been killed, including crippling losses, assuming proper distribution of

harvest. During the same year, in northeastern Oklahoma, 2,411 hunters bagged an estimated 3,134 greater prairie chickens during a two-day season held October 21 and 22, 1960, on a slightly larger range than that of the lesser prairie chicken.[2]

Because of the population recovery of lesser prairie chickens at about ten year intervals, open season should be considered when population density appears to be increasing. Annual spring inventories should be continued in order to keep abreast of future population trends. Summer brood surveys and fall display ground surveys should be conducted to ascertain reproduction.

[2] Unpublished data furnished by H. G. Williamson and G. B. Wint, Oklahoma Wildlife Conservation Department, based on reports of about one-half of the hunters.

Biologically, I believe an open season in Oklahoma can be based on the same principles outlined for greater prairie chickens in Wisconsin (Hamerstrom, et al, 1957). In western Oklahoma a season about October 20, probably would result in a low kill, with most of the hunting occurring in grassland pastures. In September, birds would be in the pastures, but kills would be moderate since young birds would not be as strong on the wing as in October. Hunters could approach closer to the birds, and they would fly shorter distances when flushed. Cocks would be on gobbling grounds during both months. The maximum harvest could be expected in most years by hunting in late November or December, when prairie chickens usually gather in cultivated grain fields to feed.

Shooting hours from sunrise to sunset would be acceptable to hunters, and would not adversely effect the birds, provided other regulations were designed to limit kill to the desired number. The bird harvest could be reduced by hunting only in the afternoon, if this were deemed necessary for reasons other than biological ones.

Since the lesser prairie chicken has a very limited range in Oklahoma as compared with the bobwhite quail, hunter concentrations caused serious problems in 1951, during the three day season. This can be partially alleviated by opening the season concurrently with the opening date of other seasons. In recent years, greater prairie chicken and waterfowl seasons have been opened on or about October 20. Even though some lesser prairie chickens begin concentrating in grain fields early in November, an opening date the first week of November, concurrent with pheasant, waterfowl and greater prairie chicken seasons should not result in too great a concentration of hunters or harvest of lesser prairie chickens. Also, the turkey season might be opened at the same time.

A two week season probably could be permitted if other special seasons were that long and held concurrently. However, special seasons during the past few years have been set for one or two weekends, staggered so as not to overlap. In 1961, greater prairie chicken season was held the third week of October, pheasant season during the first two week ends of November, turkey season during the third week, and deer season during the fourth week of November. Under this type of program, only two or

three days of lesser prairie chicken hunting should be permitted until some trial seasons are completed.

When open seasons are considered they should be based on information available at that time, and above all, regulations should not permit harvest to exceed the recommended 25-30 percent of an increasing or peak population. The lesser prairie chicken is an intriguing, colorful bird in courtship display. But its usefulness as a game species should also be considered when populations can support limited hunting. Emphasis should be placed on a sporting hunt in the grasslands rather than a firing line situation in grain fields.

HABITAT MANAGEMENT

Principles of habitat management

Grasslands should be considered first in prairie chicken habitat management. Broad open expanses of prairie grassland, in excess of four square mile blocks are needed. Moderate grazing, that leaves clumps of grass throughout the year for spring nesting, is vital in high quality habita.

Supplemental food plots are needed during some years for maximum prairie chicken population density in western Oklahoma. In planning supplemental winter food these factors should be considered:

1. High grain production can be obtained only on good soils.
2. Grain should be within two miles of birds to be fed.
   A. Prairie chickens readily travel up to two miles, but the farther they travel the more hazards they may encounter. They occasionally hit high voltage lines in flights to grain fields.
   B. Where possible, provide winter grain near fall display grounds. Prairie chickens feed more readily in fall and winter at grain bait stations near fall display grounds than at other feed stations in pastures.

Effects of Brush Control

One important component of lesser prairie chicken habitat is "brushy" vegetation. Shinnery oak, sand sagebrush, plum and skunkbrush commonly provide shade in summer. Sagebrush and skunkbrush provide protection from strong winds in winter. Lesser prairie chicken range does not extend to grasslands where brush is absent. Sagebrush leaves and shin oak acorns are eaten by prairie chickens.

In recent years mechanical and chemical control of shinnery has become more common on grasslands occupied by lesser prairie chickens. In dense shinnery oak and grasslands a 50-80 percent reduction in density of shinnery is desired by ranchers for increased grass production. Shinnery, with its extensive root system, is needed to prevent wind erosion of the coarse, sandy soils it inhabits.

The effects of shinnery control on prairie chickens are not yet known, but probably will be: (1) a reduction in winter food; (2) an increase in

grass cover. As far as the lesser prairie chicken is concerned this may be beneficial. The first need of prairie chickens apparently is good grass cover for nesting, rearing broods, and protection from weather in winter. Lesser prairie chicken nests and broods have been found in pastures where brush had been reduced 50-80 percent. Secondly, ample food must be available. Supplemental winter food can be provided more easily than grass cover can be increased. However, even if winter food is not provided, and winter losses of prairie chicken are high, lower spring populations may be able to produce sizeable fall populations if grass cover is good.

Although annual spring censuses are being conducted in regions where shinnery control is being practiced, it is doubtful that a fair evaluation of effects of brush control can be obtained by this method alone. If grass conditions are improved by shinnery control, and hatching and brood rearing success is improved, this could better be detected by spring and fall inventories together. If reproduction is increased by brush control, but food supplies diminish, increased populations in fall might dwindle to low numbers in spring because of food shortages, and the real effect of brush control remain undetermined.

RESTOCKING

Areas now considered for restocking with lesser prairie chickens are large grassland tracts, 80-90 percent grassland, the remaining being cultivated land, within the former occupied range of the species. There are 1,439 square miles of land in this category. Two categories of rangeland for stocking are recognized: (1) grassland tracts entirely suitable for restocking by virtue of quality of grass and interspersion of cultivated grain crops, and (2) grassland tracts where stocking is recommended in selected areas only, based on species composition of grasses. Lands in category 1, are in west-central Cimarron County and in Woods County along the Cimarron River. Lands in category 2, which make up the remainder of the designated potential range, have short grasses primarily, but some small units with mid-grasses—hairy, blue and sideoats grama, and silver bluestem. Each area should be considered individually for stocking (Figure 3).

Wild trapped birds are recommended for transplanting. It is suggested that birds be moved while their density in occupied areas is increasing (Ammann, 1957).

SUMMARY

1. Ecology, density and population trend of lesser prairie chickens in western Oklahoma from 1955 to 1961, indicated a favorable status of this species.

2. The lesser prairie chicken **(Tympanuchus pallidicinctus)**, a member of the grouse family, is classified as a single species. Recent speculation about its taxonomic status is discussed.

3. Twelve counties in Oklahoma, and five states still contain lesser prairie chickens. In Oklahoma the species occupies 2,391 square miles, and has a potential range of about 3,825 square miles. Although the annual occupied range varies, the basic range in Oklahoma has not changed significantly since 1940.

4. Separation of sexes and age groups are discussed. One criterion for distinguishing young-of-year and adults in late winter, and not previously described, is coloration of the covert over the outer primary wing feather. There is white in the distal portion of the shaft in young birds.

5. Study areas were selected in each of the three prairie grassland types occupied by lesser chickens in Oklahoma. Most of the ecological studies were made in the shin oak type in the Davison Study Area. General observations and inventories of cocks were made also in the sand sagebrush and mixed grass prairie types.

6. A total of 454 birds were captured, 437 of which were banded and released for study from August 1956 to November 1959, in the Davison Study Area with the Davison drive net and drop net. One hundred and fourteen (114), (26 percent) of the marked birds, were later identified in the field or recaptured.

7. In addition to traditional bird marking methods, a new wing tag was devised. It was composed of an aluminum wing band and numbered tag made of duran plastic with nylon cloth backing.

8. Density of male birds was extremely low in 1956 and 1957, following a severe drought, but it increased 423 percent from 1957 to 1960, then decreased slightly in one area. In the Davison Study area population density peaked at one-half the level it reached in the 1930's.

9. Regular spring courtship displays of cocks on traditional courtship grounds began in late February, and ended in May. Hens visited grounds from mid-March until mid-May.

10. In the Davison Study area cocks regularly displayed on traditional courtship grounds in fall from late August until the first severe inclement weather in November or December. Fall inventories gave inconclusive information on reproductive success because of insufficient personnel to make thorough studies. With additional effort, fall inventories might produce valuable data for evaluation of reproductive success and loss of young.

11. A comparison of display grounds used from 1932 to 1938, and 1958 to 1961, including fall surveys in 1958 and 1959, revealed that 61 percent

of the grounds used in recent years, when population density was low, were used in the 1930's. Yet, many of these grounds were not used in intervening years. The most permanent grounds, those used continuously when population density was low and used most frequently in other years, were utilized most in fall.

12. Hens nested on the ground in open prairie. The most successful nests were placed between clumps of grass residue of the previous year's growth that provided overhead cover.

13. Five early spring nests had an average of 12.2 eggs. Two late ones had an average of seven eggs. The average in all seven nests was 10.7 eggs.

14. Determination of brood size was complicated by intermingling of broods.

15. In summer, during hot weather, lesser prairie chickens required good shade. Shin oak, oak motts, sagebrush, skunkbrush and sand plum were the best sources of summer shade.

16. Studies of seasonal movements of birds included observations of adults first banded as juveniles. Of the marked birds observed, 97.4 percent moved less than four miles. Birds moved farther during their first year of life than thereafter. Hens moved farther, on the average, than cocks. Some young birds went to display grounds within a quarter or half mile of their brood ranges, while others moved more than two miles.

17. Supplement winter food plots leased by the Oklahoma Wildlife Conservation Department in lesser prairie chicken range were used very little during the period of evaluation. However, during this time prairie chicken density was low, and grain in pastures was much more abundant than usual. A long drought was ended and abundant moisture on overgrazed pastures created an excellent weed growth and weed seed production.

18. Lesser prairie chicken hunting was first regulated in Oklahoma territory in 1890. After 1915, open seasons were permitted only in 1929, 1931, 1933, 1950 and 1951.

19. Future hunting seasons are recommended when annual spring and fall inventories indicate an adequate supply of birds in fall. Possible hunting dates and regulations are discussed.

20. Grassland management, supplemental food in winter, and possible effects of brush control are discussed.

21. Recommendations are included for stocking some grasslands in Oklahoma.

CONCLUSIONS

Anxiety regarding perpetuation of the lesser prairie chicken seems to be unfounded. The geographic range in Oklahoma is about the same size it was twenty years ago. Population density has changed greatly from time to time in the past and has been high enough at times for legal hunting. Broad, open expanses of grassland, with some brushy plants, apparently are required by lesser prairie chickens. Lesser prairie chickens constitute a limited wildlife resource, and should be managed as such—not neglected. At the 1960 population level, hunting seasons were biologically sound.

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LITERATURE CITED

1. Aldrich, J. W. and A. J. Duvall. 1955. Distribution of American gallinaceous game birds. U. S. Fish and Wildl. Ser., Cir. 34; 1-23.

2. Allen, J. M. 1955. Indiana Pittman-Robertson Wildlife Restoration. 1939-1955. P-R Bul. No. 3, Div. of Fish and Game, Ind. Dept. of Conserv., Indianapolis.

3. Ammann, G. A. 1944. Determining the age of pinnated and sharp-tailed grouses. Journ. Wildl. Mgt. 8: 170-171.

4. _____. 1957. The prairie grouse of Michigan. Game Div., Dept. of Conserv., Lansing.

5. Anon. 1946. Prairie chicken census on the Davison Ranch area. Unpublished field notes. Files of the Oklahoma Game & Fish Department, Oklahoma City.

6. _____. 1950. Surprise Prairie Chicken Hunt Granted; Pheasants Also on December Agenda. Oklahoma Game & Fish News, Nov., pg. 17, Oklahoma City.

7. _____. 1951. Legal game for a day. Oklahoma Game and Fish News, Jan., pg. 22, Oklahoma City.

8. A.O.U. Checklist, 1957. Checklist of North American Birds, Fifth Ed., American Ornithologist's Union.

9. Baker, Maurice. 1953. Prairie chickens of Kansas. Univ. Kansas Mus. Nat. Hist. and State Biol. Sur., Misc. Pub. 5, pg. 68.

10. Bent, A. C. 1932 Life histories of North American Gallinaceous birds, Pub. No. 162, U. S. Govt. Printing Office, Washington, D. C.

11. Copelin, Farrell F. 1958. Distribution of lesser prairie chickens in Oklahoma, Unpublished, Job 5, W62R, Okla. Wildl. Conserv. Dept., Okla. City.

12. Craighead, J. J. and D. S. Stockstad. 1956. A colored neckband for marking birds. Jour. Wildl. Mgt. 20: 331-332.

13. Davison, Verne E. 1935. Game bird project. Unpublished, Oklahoma Game and Fish Dept., Okla. City. 105 pp.

14. _____. 1940. An 8-year census of lesser prairie chickens. Jour. Wildl. Mgt. 4: 55-62.

15. DeArment, Dick. 1963. Correspondence, Texas Game and Fish Dept., Wheeler, Texas.

16. Duck, L. G. 1942. The lesser prairie chicken in Region II. Unpublished. Submitted to the Oklahoma Game and Fish Dept. March 15, Okla. City. Page 19.

17. Duck, L. G. and Jack B. Fletcher. ca. 1944. A survey of the game and furbearing animals of Oklahoma, Okla. Game and Fish Dept., Okla. City. State Bul. 3.

18. Frary, Ladd G. 1957. Evaluation of prairie chicken ranges. P-R Project W-77-R-3 Completion Report, N.M. Dept. of Game and Fish, Santa Fe.

19. Hamerstrom, F. N., Jr., Oswald Mattson and Frances Hamerstrom. 1957. A guide to prairie chicken management. Tech. Bul. No. 15. Wisc. Conserv. Dept., Madison.

20. Hamerstrom, Frederick and Frances. 1955. Population density and behavior in Wisconsin prairie chickens. **(Tympanuchus cupido pinnatus)**. Acta XI Congr. Int. Orinth. 1954 pp. 459-466.

21. Jackson, A. S., DeArment, R. E. Van Cleve, C. M. Rowell, R. L. Downing, C. J. Barstow. 1956. P-R report on game population trends in Texas panhandle. Proj. W-45-R-6, Job 11, Texas Game and Fish Dept., Austin.

22. Jacobs, Karl F. 1959. Restoration of the greater prairie chicken. Okla. Wildl. Conserv. Dept., Fed. Aid Div., Okla. City.

23. Jones, Glen. 1947. Prairie chicken census on the Davison ranch area. Unpublished field notes. Files of the Okla. Game and Fish Dept., Okla. City.

24. Lehmann, Valgene W. 1941. Attwater's prairie chicken. Its life history and management. N. Amer. Fauna 57, Fish and Wildl. Ser., USDI.

25. Leopold, Aldo. 1933. Game management. Chas. Scribner's sons, N. Y.

26. Lumsden, H. G. 1960. Correspondence, Research Branch, Dept. of Lands and Forests, Maple, Ontario.

27. Oklahoma Game and Fish Dept. 1950. Minutes of Oklahoma Game and Fish Commission, Nov. 13, Okla. City.

28. Oklahoma Game and Fish Dept. 1951. Minutes of Oklahoma Game and Fish Commission, Aug. 6, Okla. City.

29. Oklahoma (Terr.) Session 1895. Session laws of 1895. Ch. 26, Sec. 1.

30. _____ 1899. Session laws of 1899, Ch. 15, Sec. 1. Oklahoma Session. 1909. Session laws of 1909. Ch. 19, Art. II, Secs. 2 and 3.

31. _____ 1915. Session laws of 1915. Ch. 185, Sec. 2.

32. _____ 1929. Session laws of 1929. Ch. 27, Sec. 5.

33. Petrides, G. A. 1942. Age determinations in American Gallinaceous game birds. Trans. N. Am. Wildl. Conf. 7:308-328.

34. Rowley, N. E. 1960. Correspondence. Soil Conservation Service, Stillwater, Oklahoma.

35. Schwartz, C. W. 1945. The ecology of prairie chicken in Missouri. The Univ. of Mo. Studies 20:1-99 app.

36. Statues of Oklahoma, 1890. 1891. Compiled from the laws passed by the first legislative assembly of the Territory. pp. 587, Ch. 38, Sec. 1.

37. Summars, V. C. 1956. Lesser prairie chicken census. Unpublished P-R project No. W-62-R-1, Job No. 5, Okla. Game and Fish Dept., Oklahoma City.

38. Temple, Lawrence. 1951. What chance for hunter this season? Okla. Game and Fish News, Nov., pp. 3, Okla. City.

39. Wint, G. B. 1951. Improved method for marking game birds for identification in the field. Arts and Sci. Studies, Biol. Ser. No. 3, Okla. State Univ. Stillwater.