HOME RANGE AND MOVEMENTS OF THE GREATER PRAIRIE CHICKEN (*TYMPANUCHUS CUPIDO PINNATUS*) WITH NOTES ON ACTIVITIES

by

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TABLE OF CONTENTS

INTRODUCTION AND REVIEW OF LITERATURE

A review of literature covering the ecological aspects of the greater prairie chicken (*Tympanuchus cupido pinnatus*) reveals little data on home range and movements of individual birds (Bent 1932, Yeatter 1943, Schwartz 1945, Hamerstrom and Hamerstrom 1949, Mohler 1952, Baker 1953). In 1963, a 6-year study of greater prairie chicken ecology was initiated in the Flint Hills region of northeastern Kansas. The objectives of the study were to determine: (1) daily and seasonal movement patterns, (2) behavioral patterns, (3) incidence of endoparasitic helminths, and (4) habitat preferences. This report presents data on daily and seasonal movements of the greater prairie chicken.

Movements and home ranges of vertebrates have been extensively studied by biologists using a variety of methods. The concept of home range was initiated by Seton (1909:26) who pointed out that, "No wild animal roams at random over the country; each has a home region, even if it has not an actual home." Burt (1940:25) defined home range as, "that area about its established home which is traversed by the animal in its normal activities of food gathering, mating and caring for young." Sanderson (1966) presented a detailed review of methods used to study mammal movements and home ranges; including direct observation, natural signs, radioactive materials, dyes for urine and feces, photographic devices and radiotelemetry. Techniques for studying the migration, movements and home ranges of birds are similar to and have evolved concurrently with mammalian methods.

Methods of marking birds for movement studies have been reviewed in detail by Cottam (1956). Cottam reported the earliest recorded account of marking involved the use of metal rings on herons in Germany in 1710.

Cottam remarked that systematic banding was started about 1900 in Denmark and the United States. In 1920 bird banding was placed under Federal supervision in the United States and Canada and by 1956 nearly 8,000,000 birds had been banded in the United States and Canada (Cottam 1956). Cottam also described the techniques of color leg banding, color-marking broods, color-marking adults with dyes, and neck banding which enable biologists to identify birds under field conditions. Other methods such as back tags (Blank and Ash 1956), patagial tags (Anderson 1963) and anodized colored aluminum leg bands (Hamerstrom and Mattson 1964) have recently been developed and enable field identification of marked animals.

A considerable amount of information for greater prairie chickens has been obtained by using the methods described above coupled with direct observation of flock movements. The first reports of prairie chicken movements involved observations of migrational tendencies. Cook (1888) observed large flocks of greater prairie chickens migrating from Minnesota and Iowa to southern Iowa and northern Missouri. In the early 1900's migration of greater prairie chickens was a regular phenomenon and was most evident in the northernmost regions (Schorger 1943). Bennitt and Nagel (1937) noted an influx of greater prairie chickens into northern Missouri during fall months. Hamerstrom and Hamerstrom (1949) discussed the migration of Wisconsin prairie chickens. Today greater prairie chickens appear more sedentary and reports of migrational tendencies are rare in the literature. Leopold (1931) stated that a reduced tendency for migration might be associated with the widespread introduction of corn and Schwartz (1945) noted that prairie chickens spend their entire lives in the same area if their food requirements are satisfied.

Greater prairie chickens have an abundant food supply during the summer and movements are normally confined to small areas (Hamerstrom and Hamerstrom 1949). Hamerstrom and Hamerstrom (1949) reported the cruising radius of male greater prairie chickens to be perhaps 1 mile or less and brood movements were not extensive. Schwartz (1945) observed that male and female greater prairie chickens of Missouri stayed in an area of 320 acres or less in the summer. Schwilling (1961) in Nebraska, found a marked hen with a brood to move 0.5 mile during the summer.

In contrast to summer, fall is a time of considerable movement when small flocks and individuals gather to form large packs (Hamerstrom and Hamerstrom 1949). Once autumn packs are formed they tend to remain in definite areas (Hamerstrom and Hamerstrom 1949). Schwartz (1945) observed the fall range of greater prairie chickens to be between 160 and 1280 acres with the size depending on the proximity of the fall booming ground to feeding, roosting and loafing areas. Baker (1953) reported a fall range of about 640 acres for greater prairie chickens in Kansas. Banding studies of Hamerstrom and Hamerstrom (1949) disclosed a maximum movement of 29 miles, however, two-thirds of all returns showed movements of less than 3 miles. Band returns listed by Baker (1953) showed movements of 0.25 to 0.50 miles from trap sites. Ammann (1957) found Michigan greater prairie chickens moved to fall feeding areas which were 10 to 15 miles from the nearest booming grounds.

During winter months greater prairie chickens establish daily feeding routines and midwinter flocks have a daily cruising radius of 0.5 to 1 mile (Hamerstrom and Hamerstrom 1949). Schwartz (1945) found the range of Missouri greater prairie chicken flocks to be 640 acres or less depending on the availability of food and roosting cover. The home range of winter flocks in Nebraska was about 2000 acres or more (Mohler 1952). Band returns reported by Hamerstrom and Hamerstrom (1949) showed movements of 4.3 miles and less. In Michigan, Ammann (1957) observed a female greater prairie chicken movement of 30 miles and presumed others in the same flock moved the same distance. Horak (1965) noted Kansas greater prairie chickens moved about 0.75 mile to winter feeding areas and moved distances of 1 and 2 miles from winter trap sites.

Movements in the spring were characterized by a return to the booming grounds with the great majority of these movements less than 2 miles, however, some were up to 8 miles (Hamerstrom and Hamerstrom 1949). After returning to the booming ground, greater prairie chickens range 1 mile or less from the booming grounds and most nests were between 1 and 1.25 miles of the booming grounds (Hamerstrom and Hamerstrom 1949). Schwilling (1961) and Schwartz (1945) observed males to move 1 to 3 miles to booming grounds. Observations by Baker (1953) and Hamerstrom and Hamerstrom (1949) showed occasional movements of male greater prairie chickens from one booming ground to a different booming ground in the same spring.

The banding and marking methods which provided the preceding data have proven valuable, however they seldom permit the accumulation of precise data on home range and daily and seasonal movements of individual greater prairie chickens. If individual data are to be discerned, biologists must be near the marked animal and expend vast amounts of field time. Even if the biologist can afford the time for such observations, his closeness to the banded animal may alter the normal activity of that animal. Therefore, if biologists are to acquire large amounts of precise movement data from unconfined animals, a technique is needed which overcomes the shortcomings of simple direct observations. The need for different and more refined methods of securing data on animal movements has resulted in the formation of a new interdisciplinary field; biotelemetry.

Biotelemetry is the result of cooperation among electronic specialists and biologists. It is defined by Slater (1965:81) as the "instrumental technique for gaining and transmitting information from a living organism and its environment to a remote observer." Biotelemetry enables the biologist to obtain previously inaccessible data and to obtain more precise data (Adams 1965).

Adams (1965) pointed out that transmitters attached to animals may affect their movements, but this effect can be minimized by miniaturizing the transmitter. Slagle (1965) observed that wild animals do incur injury and impairment of various organs but continue to live apparently normal lives, therefore; we may assume that animals can naturally adapt to small devices attached to or implanted in their bodies.

An early use of telemetry for ecological research was employed by Busser and Mayer (1957) for obtaining information from incubating penguin eggs. Le Munyan et al. (1959) designed a transmitter weighing 122.5 grams and having a range of 25 yards for use in studying the ecology of woodchucks (Marmota monax). Cochran and Lord (1963) found this transmitter unsuitable for studying movements of mammals due to its restricted range of transmission and developed units with greater capabilities. The transmitter developed for mammals by Cochran and Lord (1963) had a life expectancy of 166 days, range of 1100 yards and weight of 30 grams. Their transmitter designed for birds had an expected life of 83 days, weight of 13 grams and had a calculated range of 65,000 yards. The telemetry system designed by Cochran and Lord (1963) has been used on rabbits (Sylvilagus floridanus), striped skunks (Mephitis mephitis), raccoons (Procyon lotor) and pheasants

(Phasianus colchicus). This same basic tracking system was employed by Tester et al. (1964) for studying movements of white-tailed deer (Odecoileus virginianus). This transmitter provided two years of operation, weighed 180 grams and had an anticipated operating range of 8-10 miles when the signal was received by 80 and 100 feet high towers. Jeter and Marchinton (1964) also used the Cochran and Lord apparatus for tracking white-tailed deer. Cochran et al. (no date) used the same system for tracking Canada geese (Branta canadensis). Lord et al. (1962) used this system for monitoring the flight of mallard ducks (Anas platyrhynchos).

A system designed by Craighead et al. (1963) was used to track grizzly bears (Ursus arctos horribilus). This system was tested in 1960 and used on grizzly bears in 1961. In a later report Craighead and Craighead (1965) stated that telemetry allows a variety of data to be collected at a distance with a minimum of time, effort and manpower and the observer does not influence the behavior of the subject. Craighead and Craighead pointed out that one of the greatest assets of telemetry is its capabilities of putting an observer in position to observe an instrumented animal.

More recent telemetry materials include a transmitter designed by Singer (1963) for use on pigeons (Columba livia). Merriam (1963) designed a transmitter to study the movements of woodchucks. Verts (1963) reported on equipment and techniques for radio tracking striped skunks. Sanderson and Sanderson (1964) used telemetry for studying the movements of rats (Rattus spp.) in Malaya. Ellis (1964) adopted equipment similar to that used by Verts (1963) for monitoring the movements of raccoons. Storm (1965) incorporated the system designed by Cochran and Lord (1963) for radio tracking red foxes (Vulpes fulva). Southern (1965) reported the design of telemetry equipment for use on Bald Eagles (Haliaeetus leucocephalus), herring gulls (Larus argentatus), mallards, bobwhite quail (Colinus virginianus), rough-legged hawks (Buteo lagopus) and gray partridges (Perdix perdix).

Another system first reported by Marshall (1960) was used by Marshall et al. (1962) for determining the summer activities of porcupines (Erethizon dorsatum). This system was modified for use on ruffed grouse (Bonasa umbellus) (Marshall and Kupa 1963). Marshall (1965) reported on the continued use, improvement and advantages of this system and stated that behavioral data as well as movement data could be obtained using this system. Cebula (1966) used the system reported by Marshall (1965) in radio tracking greater prairie chickens and found it to be a reliable and useful technique.

General references to the technique of radio telemetry are gradually becoming availabla. The work of Cochran and Lord (1963) and Verts (1963) included procedures in design and operation of radio tracking systems. Adams (1965) discussed progress and advantages of biotelemetry. Slagle (1965) presanted the design of a system suitable for radio tracking raccoons including circuit diagrams and potential cost of the equipment. Slade et al. (1965) discussed the accuracy and reliability of biotelemetry equipment which was used in ruffed grouse studies by Marshall (1965) and greater prairie chicken studies by Cebula (1966). Pienkowski (1965) presented formulae for predicting transmitter range and life while Ko (1965) presented data on the evolution of miniaturization of transmitters.

Biotelemetry is capable of producing vast and sometimes overwhelming amounts of data. Cochran et al. (1965) reported the development of an automatic tracking system which could receive and record a maximum of 1920 locations on each of 52 different transmitter equipped animals every 24 hours. This system was employed in tracking red foxes, white-tailed dear, raccoons, cottontail rabbits and snowshoe hares (*Lepus americanus*). Tester and Heezen (1965) used this system to test a deer drive census. The use of digital computers to process the accumulated information was reported by Siniff and Tester (1965). Patric *et al*. (no date) reported the development of a single-bearing radio tracking system for use on white-tailed deer.

A review of literature on movements and home ranges of the greater prairie chicken revealed that previous research consisted of observations of flock movements supplemented by banding and marking methods. The home range of individual prairie chickens could not be precisely described using these methods. In tracing the history of radio telemetry it is evident that radio telemetry will enable biologists to gather this heretofore unobtainable data and to more precisely investigate this important aspect of the ecology of the greater prairie chicken.

MATERIALS AND METHODS

Study Area

The study area was located 22 miles south of Manhattan in T12S, R7E of Geary County, Kansas and was enclosed almost entirely by the 6000-acre Simpson Ranch (Fig. 1). During the fall and winter a portion of the study was conducted east and south of the Simpson Ranch. The topography of the area was characterized by branched, rounded ridges fringed with limestone rock outcrops and intersected with small drainages. The elevation varied from 1180 in the lowland drainages to over 1400 feet on the highest ridge tops.[1]

Vegetation of the area is characteristic of the Flint Hills region of

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

northeastern Kansas as described by Herbel and Anderson (1959) with the exception of some of the ridge tops which were in cultivation in the late 1920's and now have an abundant growth of annuals. Vegetation averaged about 12 inches in height with the dominants being little bluestem (*Andropogon scoparius*)[2], big bluestem (*Andropogon gerardi*), tall dropseed (*Sporobolus asper*), western wheatgrass (*Agropyron smithii*), sideoats gramma (*Bouteloua curtipendula*), blue gramma (*Bouteloua gracilis*), and buffalo grass (*Buchloe dactyloides*). Other grasses and forbs occurring were slimflower scurfpea (*Psorelea tenuiflora*), threeawn grass (*Artistida spp*.), Japanese brome (*Bromus japonicus*), downy brome (*Bromus tectorum*), western ragweed (*Ambrosia psilostachya*), western yarrow (*Achillea millefolium*), green milkweed (*Asclepias viridiflora*), broomweed (*Gutierrezia dracunculoides*), purple prairieclover (*Petalostemum purpureum*), and Louisiana sagewort (*Artemisia ludoviciana*).

Trees and shrubs were the dominant plants in the lowlands and along the creeks. Species found in the cultivated and old fields included sorghum (*Sorghum vulgare*), alfalfa (*Medicago sativa*), yellow sweetclover (*Melilotus officinalis*), wheat (*Triticum spp*.) and smooth brome (*Bromus inermis*). Vegetation analysis presented by Robel (1964) for the northern portion of the study area is descriptive of most of the entire area.

Light grazing pressure coupled with pasture rotation was experienced by most of the study area throughout the year. The area was not burned but prairie hay was baled and removed from some of the hillsides in 1964 and 1965. The northern of the tracts designated as an old field was heavily grazed and part of it was mowed in the summer of 1965 but the southern tract

2) Common and scientific names follow Anderson, 1961.

was ungrazed and unmowed throughout the study period. Wheat and sorghum were cultivated in the cropland on the study area.

Prairie chickens were numerous throughout the study area and were observed in greatest abundance during the winter when flocks outside the area utilized the grain fields on the area. Censuses of the three booming grounds present on the area showed about 34 displaying males during 1964 and 1965 (Cebula 1966) and about 50 during the spring of 1966. This would approximate 6 birds per square mile on the study area during the spring of 1964 and 1965 and 10 per square mile for the spring of 1966.

Live-trapping and Banding

Prairie chickens were live-trapped throughout the study period to facilitate attachment of leg bands, patagial markers and radio transmitters. A cannon-net was the most extensively used trapping device in this study. The cannon-net consisted of a 40 x 60-foot woven nylon net having a 2-inch mesh and three Miller composite type cannons. A 50-cap blasting machine connected to 12-gauge factory charges was used to detonate the cannons. This trap was employed exclusively on the booming grounds. A portable electric fence was erected around the booming grounds to prevent interference of trapping activities by cattle. Tape recorded vocalizations of booming prairie chickens as described by Silvy and Robel (1967) were used to expedite trapping of male prairie chickens.

Three types of traps were constructed to capture greater prairie chickens at fall and winter feeding areas. A funnel-type walk-in trap was constructed by arranging three 3 x 15-foot sections of 2 x 4-inch mesh welded fencing wire in an elongated oval arrangement with the ends directed in to form funnels. A bob-type trap (Taber and Cowan 1963) was constructed using a 3 x 16-foot section of 2 x 4-inch mesh welded fencing wire connected to form a square with swinging wire bobs placed in a 24 x 18-inch opening at the bottom of the trap. Several single-funnel walk-in traps were constructed using 3 x 10-foot sections of 2 x 4-inch mesh welded fencing wire with ends directed in to form a single funnel. Cotton fish netting was used to cover the tops of the three types of traps. Ear corn and whole milo were used to bait the traps. Bait stations were established prior to placement of the traps in the fall and winter feeding areas. All baited traps were inspected daily to prevent escape and reduce injury of captured birds.

Another trap employed was a 5 x 30-foot mist net having a 1.25-inch mesh. The net was attached to bamboo poles and stretched over vegetation near the periphery of the booming ground. The edge distal to the booming ground was elevated and the proximal edge anchored to the ground. Prairie chickens walked under the elevated portion as they approached the booming ground and became entangled in the net.

An 8 x 10-foot section of cotton fish netting suspended between two bamboo poles was used for night recaptures of transmitter equipped prairie chickens and to capture incubating female prairie chickens on nests. After the investigator located a prairie chicken the net was placed over the bird by one or two other workers who approached the birds from the opposite direction.

Other equipment used included; (1) black cotton stockings which were placed over the heads of captured birds to prevent escape, (2) numbered aluminum leg bands, (3) colored plastic bands, and (4) patagial tags. All captured prairie chickens were released immediately at the capture site after banding, marking and attachment of transmitters.

Radio Telemetry

The telemetry materials and techniques used in this study were developed by Marshall (1965), described by Cebula (1966) and constructed for this study by Sidney L. Markusen of Esko, Minnesota. The transmitters measured 0.5 x 1.25 inches, weighed 6 to 7 grams and were encased in nylon tape coated with epoxy (Plate I, Fig. 1). The transmitters were of the continuous broadcasting type and operated at discrete frequencies between 150.815 and 151.085 megacycles with a power output of 0.01 watts. A crystal oscillator circuit transistor and an 11-inch spring wire antenna comprised each transmitter. Transmitters were powered by mercury batteries weighing 12 grams (Burgess or Mallory RM401).

Harnesses fashioned from 0.1-inch diameter plastic tubing were used to attach the transmitters to prairie chickens. Two 10-inch lengths of the tubing containing wire leads were built onto the front of each transmitter. For attachment to prairie chickens a loop large enough to fit around the neck of a prairie chicken was formed. Slits were made in the tubing at this loop and the wire leads extracted and clipped with about 0.5-inch excess. Normally the battery was soldered to the leads and then taped with plastic electrical tape (Plate I, Fig.1) or coated with liquid tape to exclude moisture and prevent short circuits in the battery attachment. Toward the end of the study period, a small plastic vial with tight-fitting ends through which the wire leads passed to the battery was used to encase the battery.

Attachment to a prairie chicken was accomplished by placing the loop over the head of the prairie chicken so that the battery was suspended over the bird's crop. The ends of the tubing were passed under each wing with one end threaded through an opening in the rear of the transmitter and tied with a square knot (Plate I, Fig. 2). The excess tubing was clipped and the ends were taped with plastic electrical tape.

Biotelemetry receiving equipment consisted of three portable receivers specifically designed for radio tracking. These were originally 10-channel receivers but all were converted to 12-channel receivers during the study. The receivers were transistorized, crystal controlled, double conversion superheterodyne mechanisms. Two of the receivers were powered by 10 size "C" flashlight batteries and the other was powered by 10 size "D" flashlight batteries. The components were contained in an aluminum case 6 x 7 x 12-inches and weighed 4.5 pounds. Padded canvas carrying bags were constructed for each receiver for protection and ease of handling (Plate II, Fig. 2). The receivers were equipped with earphones for audible detection of transmitter signals. A signal strength meter permitted visual detection of transmitter signals. Receiver controls consisted of an on-off switch and volume control, channel selector, battery test, circuit switch, sensitivity control, beat frequency oscillator (BFO) switch and control, meter gain and vernier tuner. Various directional antennae were connected to the receivers by coaxial fittings.

Receiver operation was accomplished by turning the set on and selecting the desired channel for receiving a specified transmitter. The vernier tuner was slowly adjusted and the antenna was rotated until a tone was audibly detected. Vernier tuning was continued to obtain maximum volume of the signal. Finer tuning was obtained by adjusting the BFO and sensitivity controls. The antenna was then rotated to determine the null points on either side of the maximum signal reception. The azimuth of the signal was calculated by bisecting the arc between the null points. This procedure was repeated at another antenna to obtain a second azimuth on the same transmitter and both azimuths were plotted to determine the location of the transmitter.

Three different designs of directional receiving antennae were used in combination with the portable receivers. They consisted of eight permanent receiving stations, one mobile receiving station and three hand held directional antennae. Each hand held directional antennae consisted of a tubular conduit handle supporting two 30-inch heavy wire elements at right angles. A lead-in cable about 2 feet long connected the antennae to the portable receivers (Plate IV, Fig. 1). Use of the hand held antennae was confined to night recaptures, for determining locations on prairie chickens beyond the range of permanent antennae, and where vehicular travel was not practical. Radio tagged prairie chickens were located by circling the position of the bird and obtaining several bearings from different locations. The locations of radio tagged birds were noted in relation to visible landmarks and later plotted on aerial photographs. The hand held antennae were also used to flush transmitter equipped birds to check on their physical condition and to determine precise locations.

The permanent and mobile antennae were 8-element yagi type directional antennae constructed by inserting heavy wire elements of the proper length through a 10-foot length of 0.5-inch diameter electrical conduit and soldering them in place (Fig. 2). The seventh or driven element was composed of heavy wire connected to the conduit by three 0.25-inch bolts and a 3-inch bakelite insulator. A coaxial balun loop 27.75-inches long was attached to each driven element. The lead-in cables were RG 58 A/U coaxial cable extending from the driven element to the mast, through a cork stopper in the top of the mast and out a hole above the base and ending in a coaxial fitting (Fig. 3).

The permanent antennae were supported by a 20-foot mast constructed from two 10-foot lengths of 1.25-inch diameter galvinized steel conduit. A 1.5-inch muffler clamp was used to attach the yagi antenna to the masts. A 30-inch base with metal wings welded to the sides and buried 24 inches in the ground supported the masts. Welded to the top of the base was an 8-inch metal flange which was used for attachment of the compass cards. The compass cards were 8-inch photographs of a circular protractor which were glued to masonite discs, covered with transparent acetate and glued to the metal flanges (Plate II, Fig. 2). Pointers were constructed by modifying television insulator standoffs and attaching them to the antennae masts. Support for the mast was furnished by four guy wires attached to a slip-ring retained by a collar bolted through the mast 48 inches from the top. Canvas covers were attached to the masts above the compass cards for protection when not in use. Barbed wire fences approximately 20 feet square were erected around the antennae to exclude cattle and to anchor the guy wires (Plate II, Fig. 1).

The permanent antennae were erected in a gridlike pattern along the ridge tops of the study area approximately 0.5 mile apart. The antennae were aligned on an imaginary base line extending between the permanent antennae. Alignment was accomplished by stationing a worker at one antenna and another worker at another antenna. A spotting scope was positioned at the second antenna and sighted on the first antenna which was then aligned parallel to the imaginary line between the two antenna with the open end pointing toward the second. Alignment was periodically checked to insure accuracy. An evaluation of the accuracy of the permanent antennae by Slade et al. (1965) revealed a mean error of 96 feet for two azimuth locations for the summed distance classes. The mean error in feet was positively correlated with the distance from the receiver to the transmitter (Slade et al. 1965).

The mobile receiving station was constructed by mounting a directional yagi antenna on the top of a 10-foot mast extending through the roof of a pickup truck. A compass card was secured to the roof of the truck and a pointer was inserted through a hole in the mast (Plate III, Fig. 2). The lead-in cable extended from the yagi through a window into the cab to the receiver (Plate III, Fig. 1). Azimuths were recorded as degrees deviation from imaginary base lines connecting the mobile station with visible landmarks.

Attempts were made to locate each radio equipped prairie chicken once or twice a day at different hours to determine the daily and seasonal movements. Continuous tracking periods consisting of radio locations at 30-minute intervals for extended periods supplemented determinations of daily movements. All radio determined locations were plotted on base maps to provide a history of each individual prairie chicken tracked. The home ranges in acres were calculated for each individual prairie chicken following the method used by Cebula (1966) and the movement distance in yards from each successive location was determined by measurement from a base map. Distances of movement for each individual prairie chicken for this phase of the study and for the entire study were stratified into monthly categories. Standard errors were calculated for each month-class using the method described by Snedecor (1956). A measurement of the length-width ratios of home range was determined using the method proposed by Stumpf and Mohr (1962).

RESULTS

Trapping and Banding

During the entire study a total of 84 prairie chickens was trapped with 56 of these being trapped in the 1965-1966 phase of the study. Table 1 presents a summary of the trapping results for the entire study and for the 1965-1966 phase of the study. A total of 55 prairie chickens was banded for the entire study with 33 banded during the 1965-1966 phase of the study. Twenty-six prairie chickens were recaptured during the entire study and 20 were recaptured during the 1965-1966 phase. Twenty-one radio-tagged prairie chickens were recaptured during the entire study and 15 of these were recaptured during the 1965-1966 study. No birds received crippling injuries during the present phase of the study. However, 5 juveniles were scalped by a holding box after being captured by the hand drop-net. Apparent complete recoveries were noted in later checks of two transmitter equipped birds in the "scalped" group.

Radio Telemetry

All telemetry equipment performed satisfactorily with the exception of one shipment of 6 transmitters which had defective crystals. A total of 48 transmitters were placed on 33 different prairie chickens during the entire study. Thirty-five were placed on 26 prairie chickens during the 1965-1966 phase of the study. Twenty-eight transmitters were recovered during the entire study and 17 were lost. Nineteen were recovered, 13 were

Table 1. Summary of prairie chickens trapped by all methods for the entire study and for the 1965-1966 phase of the study.

	Number	Trapping Method			
	Trapped	cannon-net	walk-in	hand drop-net	mist-net
Entire study					
Males	52	44	2	5	1
Females	25	13	1	11	0
Juveniles	7	0	2	5	0
Totals	84	57	5	21	1
1965-1966 phase					
Males	33	27	0	5	1
Females	16	8	0	8	0
Juveniles	7	0	2	5	0
Totals	56	35	2	18	1

lost and 3 were still transmitting when the 1965-1966 phase was terminated. A total of 1211 "bird days" of location data were collected with 804 collected during the 1965-1966 phase of the study. An average of 36.7 days of location data per prairie chicken was obtained for the entire study and 30.9 days per prairie chicken during the 1965-1966 segment. A total of 1570 locations were recorded on the 33 birds resulting in 47.6 locations per bird. In the 1965-1966 phase, 1024 locations on 26 prairie chickens were obtained; an average of 39.3 locations per prairie chicken.

Home Ranges

Of the 26 prairie chickens radio-tracked during the study a sufficient number of locations was obtained to estimate individual home ranges for 20 birds. Home ranges and movements for all birds radio-tracked are in the appendix. Numbers with a prefix M are males, F are females and J are juveniles. Sex differentation of juveniles was not attempted. The home range of male prairie chickens ranged from 128 acres to 1431 acres with the largest area of home range occurring in fall and the smallest in summer. The average home range of 4 male prairie chickens tracked during and shortly after the booming season was 330 acres (Fig. 4, 5, 6, and 8). After booming activities ceased the average summer home range of 2 males was 205 acres (Fig. 7 and 9). During fall 2 males M32 and M34 (Fig. 10 and 11) had ranges of 1431 and 590 acres, respectively. Sufficient data for calculation of the home range of male prairie chickens in winter were not obtained. The average spring home range of 7 female prairie chickens was 280 acres and ranged from 141 to 607 acres (Fig. 12, 13, 14, 15, 16, 17, and 18). The early spring to late summer home range of F14 was 558 acres (Fig. 20). The late fall home range of prairie chicken F33 was 314 acres (Fig. 22).

No data were obtained in the 1965-1966 study on the home range of female prairie chickens in winter. Two juvenile prairie chickens radio-tracked during late summer had an average home range of 227 acres (Fig. 23 and 24). The home range of a juvenile radio-tracked in fall was 1121 acres (Fig. 25). No data were obtained on juveniles at other periods of the year. The length-width ratios of the home ranges were 1.8:1 for adult prairie chickens and 1.6:1 for juveniles.

Movements

Table 2 summarized the daily movement data for the entire study separated into classes by months of the year. Table 3 presents movement data for the 1965-1966 phase of the study. These data show an increase in distance of movement as fall arrived and continued long movements throughout winter until the spring booming season is nearly completed. In the summer all individuals moved relatively short distances when compared to other months of the year. Standard errors for the respective months indicate movements were more erratic during the fall, winter and early spring than in summer. The unusually high standard error for males during April was the result of the daily movement of bird M39 (Fig. 8) from the central booming ground to a feeding area 2200 yards south. The monthly movements of male prairie chickens were greater than female movements with the exceptions of May, June and August. Juvenile prairie chickens were the least mobile during August, September and October, however, mobility sharply increased in November and remained high into December.

The results of continuous tracking studies are presented in Table 4. A female prairie chicken, F22, with a brood moved an average of 106 yards

Table 2. Summary of entire study monthly movement distances from successive daily locations for male, female and juvenile greater prairie chickens. Number in parentheses represents the number of prairie chickens radio-tracked.

	Number of Locations			Total Distance Moved per Month[1/]			Mean Distance of Daily Movement		
	Male	Female	Juvenile	Male	Female	Juvenile	Male	Female	Juvenile
January	5(1)	---	---	7062	---	---	1412±454	---	---
February	23(2)	12(1)	---	24090	10296	---	1047±132	858±142	---
March	44(6)	34(2)	---	36080	16940	---	820±150	498±56	---
April	37(3)	137(8)	---	36168	81794	---	978±499	597±38	---
May	50(3)	104(9)	---	24015	55984	---	480±38	538±40	---
June	137(8)	39(6)	---	46789	13794	---	341±19	354±43	---
July	127(3)	---	---	32185	---	---	253±17	---	---
August	121(3)	13(1)	26(2)	25510	4070	3784	211±19	313±47	146±21
September	28(1)	18(1)	46(2)	6073	3212	7920	217±38	178±39	172±53
October	9(1)	---	22(2)	8954	---	7084	995±328	---	322±22
November	23(3)	7(1)	34(1)	20416	2415	38302	888±151	345±65	1265±140
December	24(1)	23(1)	12(1)	23078	16945	11198	962±99	737±86	933±150

1/ All distance movements in yards.

Table 3. Summary of 1965-1966 phase monthly movement distances from successive daily locations for male, female and juvenile prairie chickens. Number in parentheses represents the number of prairie chickens radio-tracked.

	Number of Locations			Total Distance Moved per Month[1/]			Mean Distance of Daily Movement		
	Male	Female	Juvenile	Male	Female	Juvenile	Male	Female	Juvenile
January	5(1)	---	---	7062	---	---	1412±454	---	---
February	---	---	---	---	---	---	---	---	---
March	40(5)	---	---	28512	---	---	713±124	---	---
April	9(1)	90(5)	---	19800	56428	---	2200±0	627±47	---
May	38(2)	74(6)	---	19294	39094	---	508±44	528±48	---
June	54(3)	20(4)	---	18121	7238	---	335±27	362±72	---
July	99(2)	---	---	26796	---	---	271±24	---	---
August	94(2)	13(1)	26(2)	22730	4070	3784	242±23	313±47	146±21
September	28(1)	18(1)	46(2)	6073	3212	7920	217±38	178±39	172±53
October	9(1)	---	22(2)	8954	---	7084	995±328	---	322±22
November	23(3)	7(1)	34(1)	20416	2415	38302	888±151	345±65	1265±140
December	24(1)	23(1)	12(1)	23078	16945	11198	962±99	737±86	933±150

1/ All distance movements in yards.

per 0.5 hour during continuous tracking in May, 1965. In June, 1965 prairie chicken F14 with a brood of 13 averaged 169 yards per 0.5 hour. Prairie chickens M1 and M11 averaged 44 yards per 0.5 hour during June and 65 yards per 0.5 hour during July. During the continuous tracking of M1 and M11 during June no movement from the previous location occurred 27 of 50 locations. During July no movement from the previous location was detected 8 of 20 locations.

Table 4. Summary of continuous tracking on male and female prairie chickens. Number in parentheses represents the number of prairie chickens tracked.

	Number of locations		Total yards		Mean distance moved per 0.5 hour	
	Male	Female[1/]	Male	Female	Male	Female
May	---	23 (1)	---	2432	---	106±11
June	50 (2)	25 (1)	2222	4224	44±30	169±25
July	20 (2)	---	1294	---	65±32	---

1/ with brood

Other movements of interest include a movement from one booming ground to another by prairie chicken M35 (Fig. 4). Bird M35 visited the central booming ground on the morning of 25 March 1966 and then moved to the vicinity of the northern booming ground. He was on the north booming ground the next morning. Bird M35 was found near the north booming ground on two other occasions although he mainly frequented the central booming ground. Seasonal and daily movements and movement patterns were evident in several radio-tracked birds. The histories of selected individual prairie chickens are presented herein to illustrate these seasonal and daily movements and activities.

Prairie chicken M21 (Fig. 28) was tracked by Cebula (1966) in spring

1965 and confined his movements to an area west of the central booming ground. He was retrapped on the central booming ground during the fall of 1965. During this fall tracking period M21 confined his movements to a feeding area east of the booming ground.

Prairie chicken M1 (Fig. 9) was trapped with the cannon-net on the central booming ground 21 April 1964 and retrapped and radio-equipped by Cebula (1966) on 6 June 1965 with the cannon-net aided by tape recorded vocalizations of booming prairie chickens. Bird M1 was an active breeder on the booming ground and was the last male to leave the booming ground at the end of the season which was about 25 May in 1965. During June M1 was often in the vicinity of the booming ground but was not observed to display. During June he was attracted to the booming ground on several occasions by tape recorded vocalizations of displaying prairie chickens. His latest visit to the booming ground aided by the tape recorder was 28 July 1965. Number 17 exhibited punctual daily movements revealed by continuous tracking and locations at different hours. He would walk to the west edge of an old field and fly west about 300 yards or more to an area of heavy cover for roosting. At sunrise he would walk and feed from his roost to the old field where the daylight hours would be spent resting. Bird M1 was recaptured twice at night using the hand drop-net, flashlight, hand-held antenna and portable receiver. During August several cattle were placed in the old field and later the east and south portions of the old field were mowed. Apparently this disturbance caused M1 to move approximately 1 mile south to another old field and remain there until the signal was lost on 26 August 1965. The signal was located 29 August near a farm pond. A check on his location revealed that M1 was the victim of a predator, probably a coyote (<u>Canis latrans</u>). During the tracking period M1 averaged 285 yards per daily movement, had a home range of 128 acres and a length-width ratio of 1.3:1.

Prairie chicken M32 (Fig. 10) was trapped 22 October 1965 on the central booming ground with the cannon-net and tape recorder. Bird M32 did not revisit the booming ground. Two days following his recapture, M32 had moved 1 mile west of the booming ground and then moved 1.5 miles south on the third day. Prairie chicken M32 remained in this vicinity for 4 days, moved 1.75 miles east to a feeding area and remained in that area for 5 days, moved back 1.75 miles to his former area for 4 more days and then moved east again to the feeding area. He was next located nearly midway between the two preferred areas and later moved west to a different feeding area and remained in this vicinity for 3 days until the signal was lost. Bird M32's mean distance of movement was 1016 yards per day, his length-width ratio was 1.5:1 and his home range for the tracking period was 1431 acres.

Prairie chicken M34 (Fig. 11) was captured 24 November 1965 on the central booming ground with the cannon-net aided by the tape recorder. Bird M34 remained near the booming ground for 2 days and then moved east to the vicinity of a feeding area and joined with a flock of other prairie chickens. He established a daily feeding routine of morning and evening visits to a feeding area. The daylight hours between feeding periods were spent within 0.5 mile north or east of the feeding area. Following the evening feeding period M34 would fly with the flock about 0.75 mile northwest to roost on the slopes of the heavily vegetated ridges. He could not be located during the last 3 days of December, however, the signal was relocated 1 January 1966 about 1.9 miles south of the last known location. Bird M34 remained in this area near a feeding field until the signal was again lost 6 January 1966. His mean distance of daily movement was 983 yards, his home range was

590 acres for November and December and his home range length-width ratio was 1.6:1.

Prairie chicken M23 was trapped 6 June 1965 by Cebula (1966) on the central booming ground with the cannon-net aided by the tape recorder. Bird M23 was radio-tracked for 12 days in June, 1965 after booming activities ceased and had a range of 103 acres (Cebula 1966). He was retrapped using the same methods on 7 May 1966 and radio-tracked until 15 June 1966 when this phase of the study terminated (Fig. 5). The home range of M23 during this period was 196 acres and completely overlapped the 1965 home range. He visited the booming ground daily and displayed in a normal manner (Plate IV, Fig. 2) until 30 May 1966 when regular booming activities ceased. He moved a mean distance of 547 yards per day during the booming season and 330 yards after booming activity ceased. He was observed to be an active breeder in 1965 and 1966 and maintained nearly the same territory on the booming ground during both seasons. He was recaptured 13 June 1966 using a flashlight and hand drop-net. Bird M23's length-width ratio for the 1966 tracking period was 2.5:1.

Prairie chicken F33 (Fig. 22) was trapped 23 November 1965 at night using the hand drop-net. Bird F33 was tracked entirely with the hand-held antennee since the bird was beyond the range of the permanent antennae and east of the study area. She exhibited a twice daily feeding routine with a flock of 20 to 30 other prairie chickens. With few exceptions, roosting and daytime areas were north of the feeding field in areas of heavy cover. The signal was lost on 29 December 1965 and not relocated again. She had a mean daily movement distance of 645 yards, a home range of 314 acres and a length-width ratio of 1.3:1.

Prairie chicken F41 (Fig. 17) was captured 6 April 1966 on the central booming ground with the cannon-net. Bird F41 moved 1 mile south of the capture site two days later. This bird remained south of the booming ground and established no detectable movement patterns. On 12 May 1966 the nest of F41 was found 2584 yards (1.5 mile) south of the booming ground. This nest was destroyed shortly thereafter by a predator and the bird was not relocated until 19 May 1966 when F41 was recaptured and a new transmitter placed on the bird. Following the recapture F41 visited the booming ground two times and apparently was mated. On 4 June 1966 her second nest attempt was located and it was 1210 yards from the booming ground. Less than 10 feet away from F41's nest another prairie chicken nest was located. Bird F41 left the nest once or twice a day at varying times to feed. This renesting attempt was destroyed by a predator 25 June 1966 and the signal on F41 could not be located thereafter. Prairie chicken F41 had a home range of 607 acres, a mean daily movement distance of 624 yards and a length-width ratio of 1.9:1.

Prairie chicken F14 (Fig. 20) was captured 17 April 1965 on the central booming ground with the cannon-net. This bird was tracked by Cebula (1966) until 15 June 1965. Her nest with 13 eggs was found 9 May 1965 and was 1320 yards from the central booming ground. Bird F14 was observed to leave the nest to feed for 25-30 minute periods during the morning and evening. All 13 eggs in the clutch hatched 3 June 1966 and the hen proceeded to move slowly west. One week after her brood hatched F14 had moved her brood 2 miles to a grassy ravine. Continuous tracking on 22 June 1965 revealed that F14 moved 169 yards per 0.5 hour with her brood. The signal was lost 24 June 1965 and not relocated until 23 August 1965 nearly 0.75 mile from the last known location. Bird F14 was retrapped along with 5 of her remaining brood of 8 and the transmitter replaced. During this late summer tracking period F14 moved to a grassy ravine and remained there until the signal was lost 14 September 1965. Bird F14 had a home range of 558 acres, a mean daily movement distance of 304 yards, and a length-width ratio of 2.3:1.

Prairie chicken J28 (Fig. 24) was captured 23 August 1965 with the hand drop-net along with 4 other juveniles and F14. This bird was scalped by a holding box used in the trapping operation and could not fly immediately following its release. By 1 September 1965 the bird appeared fully recovered and when flushed flew about 250 yards. On 6 September 1965 J28 was located with a flock of 15 other prairie chickens. Bird J28 and the flock remained in this vicinity until the signal was lost 20 September 1965. This bird was killed 7 November 1965 by a hunter 6.7 miles east of the last known location. Prairie chicken J28 moved an average of 114 yards per day alone and 365 yards per day when united with the flock of 15 prairie chickens. Bird J28 had a home range of 248 acres and a length-width ratio of 1.2:1.

Prairie chicken J31 (Fig. 25) was captured 17 October 1965 with J30 (Fig. 21) in a baited walk-in trap. For 10 days J31 exhibited limited daily movements and a reluctancy to fly. Bird J31 moved east 0.75 mile to a feeding area and joined with a flock of up to 35 prairie chickens. Further observations of J31 revealed predictable daily movement patterns of feeding twice daily (morning and evening) and usually spending midday about 0.25 to 0.50 mile east or northeast of the feeding field. Following the evening feeding period J31 and others in the flock would fly about 1 mile or more west to a roosting area in heavy cover near the limestone rock outcrops. Attempts to recapture J31 were unsuccessful because other birds in the flock flushed causing J31 to flush. The greatest distance between consecutive daily locations for J31 was recorded between 18 November and 19 November 1965. Approximately 2.5 miles separated its midday location from its roost location. No signal was detected from J31 following 10 December 1965. Bird J31's mean distance of daily movement was 358 yards in October, 1127 yards in November and 933 yards in December. The home range of J31 was 1121 acres and the home range length-width ratio was 2.1:1.

Reproductive Activities of Female Prairie Chickens

During this study a significant amount of information on nesting, incubating and brooding female prairie chickens was obtained. Information of this type is valuable, thus it is presented in this paper. Table 5 summarizes these data. Five female prairie chickens were captured on the display ground and two were captured while on nests. Nests were 704 to 2684 yards from the booming ground. The average clutch size was 11.1 and late season nests had smaller clutches than nests established earlier. Prairie chicken F41 attempted a second nest following destruction of the first nest. All eggs hatched in those nests that were successful. Three nests were destroyed by predators. Two hens with broods were tracked during 1965, however no broods were successfully tracked during the 1966 nesting season.

DISCUSSION

The radio telemetry equipment used in this study has been thoroughly discussed and evaluated by Cebula (1966). Rather than discuss radio telemetry techniques in this paper, attention will be devoted to a brief evaluation of trapping methods and a discussion of home range and movement data obtained by telemetry.

Table 5. Summarized data from nesting, incubating and brooding female prairie chickens.

Bird Number	Date of Capture	Location of Capture	Distance from Nest to Booming Ground	Number of Eggs	Fate of Nest	Number of Eggs Hatched	Fate of Hen or Brood
F14	4-17-65	CBG[1/]	1320 yds.	13	hatched 6-3-65	13	tracked until 9-20-65
F22	5-24-65	nest	1540 yds.	15	hatched 5-27-65	15	tracked for 12 days
F41	4-6-66	CBG	2684 yds.	9	destroyed by predator 5-13-66	0	signal relocated 5-19-66
			1210 yds.	7	destroyed by predator 6-25-66	0	signal lost 6-25-66
F42	4-6-66	CBG	1342 yds.	13	hatched 5-30-66	13	killed by predator 5-31-66
F51	5-15-66	nest	1364 yds.	15	hatched 5-26-66	15	signal lost 5-27-66
F52	5-17-66	CBG	1804 yds.	9	destroyed by cattle 6-20-66	0	still transmitting 6-30-66
F53	5-19-66	CBG	704 yds.	8	destroyed by predator 6-10-66	0	signal lost 6-10-66

1/ Central booming ground

According to Cebula (1966) trapping greater prairie chickens for mobility studies is a major problem. The data in Table 1 are deceptive to one unfamiliar with trapping prairie chickens. Trapping prairie chickens during summer, fall and winter was difficult. Baker (1953) and Horak (1965) likewise experienced difficulty in trapping during these seasons. During the spring booming season prairie chickens are easily procured for attachment of radio transmitters using the cannon-net at the booming grounds. During the fall booming season prairie chickens were found to be erratic in their visits to the booming ground, causing considerable difficulty in trapping.

During this study 57 (67 percent of the total) prairie chickens were trapped with the cannon-net, however, equal time was not devoted to all trapping methods. The cannon-net was employed extensively during spring display periods with the other methods scarcely used at this time. Cannon netting proved to be a reliable technique, however, cannon netting could have affected the behavior of displaying prairie chickens and could cause injuries. J. Horak (pers. comm.) and F. N. Hamerstrom, Jr. (pers. comm.) also express this opinion. During this study prairie chickens were observed to alter their display territories after several firings of the cannon-net over their territory. Firing the cannon-net for 3 days in succession during May 1966 resulted in a displacement of territory of the dominant male in this study. Displaying prairie chickens were easily alerted and were easily flushed following extensive display ground trapping operations during March, however, 60 firings resulted in only two crippling injuries. It is the opinion of the author that injuries received in cannon-net trapping are of minor importance, however, behavioral influences should not be overlooked.

Other techniques for trapping on display grounds are available which may not influence behavior. The mist-net, as described earlier, is a possible alternative. Using mist nets prairie chickens are trapped on the periphery of the booming ground causing little disturbance. Trapping for individual prairie chickens could be accomplished using this method.

Cebula (1966) encountered considerable difficulty in trapping during fall and winter. The cannon-net was used successfully on fall display grounds in this study, however, tape recorded vocalizations of booming prairie chickens aided trapping operations (Silvy and Robel 1967). Trapping operations on fall and winter feeding areas yielded meager results which may be attributed to lack of snow and abundant food. Studies by (Hamerstrom and Hamerstrom 1949, Baker 1953, Schwilling 1961, Horak 1965) indicate that snow cover is a definite aid to trapping on feeding areas. Abundant food and lack of snow cover hampered the results of these efforts.

Although considerable difficulty was encountered in trapping prairie chickens during certain seasons, several were trapped yielding a significant amount of home range and movement data. Previous workers have obtained scant data on the home range and movements of individual prairie chickens using banding and marking methods. The data obtained during this study enables direct evaluation of the home range and movements of specific individuals. In some instances the information obtained agrees with previous authors, however must of it has never been acquired which makes comparisons difficult.

The home range of radio-tracked prairie chickens during the summer was smaller than other seasons. Hamerstrom and Hamerstrom (1949) suspected the summer cruising radius of male greater prairie chickens to be 1 mile or less. Schwartz (1945) observed male and female prairie chickens stayed in an area of 320 acres or less. Cebula (1966) recorded a home range of 46 acres for a male prairie chicken radio-tracked throughout the summer of 1964. The average home range for two male prairie chickens radio-tracked throughout the summer of 1965 was 205 acres. This is in agreement with previous observations. The activities of the male prairie chickens radio-tracked in the summer indicated that home range size was determined by the availability of food and suitable roosting and loafing habitat. Movements within the home range were to and from these requirements. Prairie chickens M1 and M11 exhibited daily movements to favorite roosting and loafing areas. Food requirements probably influenced movements only to a slight degree because food is abundant during summer (Hamerstrom and Hamerstrom 1949).

The summer range and movements of female greater prairie chickens with broods were not thought to be extensive (Hamerstrom and Hamerstrom 1949). Lehman (1941) observed Attwater's prairie chicken (Tympanuchus cupido attwateri) to stay within 0.5 mile of the nest for two or three weeks after which they moved to good, shady cover near water. Schwartz (1945) observed broods to move toward swales if any are nearby. Jones (1963) noted that broods moved to disturbed areas such as old fields. The range for prairie chicken F14 was more extensive than reported by previous authors. Immediately after her brood hatched F14 moved her brood nearly 2 miles overland and across an old field to a grassy ravine and remained there until the signal was lost. This movement was accomplished in 7 days. Apparently the requirements necessary for rearing a brood were met by the grassy ravine. When relocated 2 months later F14 was 0.5 mile from the ravine. A few days following recapture F14 had moved to another grassy ravine similar to the previous one. The grassy ravine used early in the brooding period was nearly 2 miles from the nest site and the second ravine was 0.75 mile from the nest site. Therefore, it appears that nesting and brooding habitat differ.

Juvenile prairie chickens radio-tracked during the summer exhibited a period of low mobility immediately following attachment of radio transmitters. Marshall (1964) noted juvenile ruffed grouse to behave in a similar manner. In this study this could have been a response to the transmitter, however, prairie chickens J24 and J28 were injured in the trapping operation. After adjustment to the transmitter or recovery from the injury, mobility increased abruptly resulting in J24 and J28 reuniting with broods. Movements of the broods were not extensive at this time and were mostly confined to grassy ravines. Requirements for juveniles appeared to remain the same from time of hatching until late summer.

Autumn is a time of much movement when individuals, broods and small flocks gather to form large packs (Hamerstrom and Hamerstrom 1949). Schwartz (1945) observed that the fall home range was 160 to 1280 acres. Baker (1953) estimated the fall home range to be 640 acres while Mohler (1952) estimated the fall home range to be 2000 acres or more. The data obtained by the present study generally agrees with the conclusions drawn by the preceding authors although M32 did not join a flock. Although Hamerstrom and Hamerstrom (1949) observed that large flocks do not form until cold weather comes, M34 joined with a flock and established daily feeding routines even though the weather was mild throughout the tracking period. Schwartz (1945) and Baker (1953) observed daily movement from the fall booming ground to feeding, roosting and loafing areas. Male prairie chickens in this study did not follow this routine. Booming ground visits were not made following the capture. In this study the fall movements centered about the fall feeding area with daily movements to roosting and loafing areas. The proximity of suitable areas for these activities appeared to determine the fall home range.

The fall movements of a radio-tracked female prairie chicken agrees with data obtained by (Baker 1953, Hamerstrom and Hamerstrom 1949, Schwartz 1945). Prairie chicken F33 exhibited a daily routine of moving to feeding, loafing and roosting areas. Activities centered about the feeding area with roosting and loafing areas in close proximity. The small home range size (314 acres) resulted from the proximity of feeding, loafing and roosting areas.

Fall movements of juvenile prairie chickens may be more complex and extensive than mature birds and a "fall shuffle" may occur (Hamerstrom and Hamerstrom 1949). This "fall shuffle" may be similar to the "crazy flight" (Edminster 1947) of ruffed grouse. Data from this study indicates that a "fall shuffle" may occur in this region. Prairie chicken J28 was radio-tracked during late summer and was killed during the fall hunting season 6.7 miles east of the last known location. Hamerstrom and Hamerstrom (1949) noted movements similar to this in banded birds. Additional data are necessary to evaluate the significance of this movement pattern.

The fall movements and home ranges of radio-tracked juvenile prairie chickens are similar to male and female movements. However, juveniles were observed to exhibit a period of inactivity immediately after transmitter attachment. Prairie chickens J30 and J31 were not injured in the trapping operation thus a period of adjustment to the transmitter probably caused this inactivity. Marshall (1964) observed this in juvenile ruffed grouse. Juvenile prairie chicken J31 joined with a flock and displayed daily movement patterns from feeding to loafing and roosting areas. Prairie chickens in this flock utilized different areas for loafing and roosting with roosting areas located 1 mile or more from the loafing area. Mohler (1952) observed that prairie chickens utilize the same cover for roosting and loafing. Proximity of suitable roosting and loafing habitat to feeding places appeared to control movements of J31 and other prairie chickens in the flock. An analysis of available roosting habitat would be necessary for further evaluation of these movements.

Prairie chickens appeared to utilize the same areas in winter as in fall. Observation of flock movements indicated no change in movement patterns. However, prairie chicken M34 moved from one feeding place to another one in early winter. Hamerstrom and Hamerstrom (1949) observed that prairie chickens did not consistently use the same feeding places in winter as they did in fall and mild weather often dispersed large flocks during winter. Perhaps the change in feeding area of bird M34 was caused by one of the above behavioral characteristics.

Movements in the spring are characterized by a return to the booming grounds (Hamerstrom and Hamerstrom 1949). No prairie chickens were radio-tracked at the time of return to the booming grounds, although movements of 1 mile or more probably occurred since feeding places were located at least 1 mile from the booming ground. Cebula (1966) noted movements of 1 to 2 miles from winter feeding areas to booming grounds. After returning to the booming ground prairie chickens range a mile or less from the booming ground (Hamerstrom and Hamerstrom 1949 and Schwartz 1945). Data from radio-tracked male prairie chickens are in agreement with these data. Although the average spring home range was 330 acres several of these birds moved 1 mile or more from the booming ground. The mean distance of daily movement during March was nearly 0.5 mile and over 0.5 mile during April. During this period prairie chickens utilized essentially the same roosting and loafing areas. Apparently feeding was accomplished at loafing areas. Weight loss was noticeable in male prairie chickens trapped during the latter part of the booming season suggesting that food availability was not optimum in the vicinity of the display grounds.

Movements from one booming ground to a different booming ground have been recorded by Hamerstrom and Hamerstrom (1949). Cebula (1966) also observed movements between booming grounds. No explanation was offered for this behavior. Prairie chicken M35 moved from the central booming ground to the north booming ground and then back to the central booming ground. This movement may have resulted from the high population density during the spring of 1966.

The pre-nesting home range of a female prairie chicken has been reported by Cebula (1966) as 206 acres. In this study 7 female prairie chickens had an average spring home range of 280 acres. Movements of 1 mile or more from winter feeding areas to booming grounds probably occurred. Data on nest building and rate of egg laying were not obtained since nests were not found until incubation commenced. Nests found ranged from 704 to 2684 yards from the central booming ground. Two of these birds were trapped while on nests so it is not known whether they visited the central booming ground. Hamerstrom and Hamerstrom (1949) and Trippensee (1953) found nests were within 1.25 miles of booming grounds. No explanation is available for nests being no closer than 704 yards to the booming ground. Vegetation analysis of the area surrounding the booming ground might offer an explanation. The average clutch size was 11.1 which agrees with data by (Ammann 1957, Baker 1953, Hamerstrom 1939).

Prairie chicken F41 renested following destruction of her first nesting attempt by a predator. Birds F52 and F53 were suspected to be renesting due to the late season booming ground visits and the small clutch size. Baker (1953) found a strong degree of negative correlation between the date of first egg laid, the size of the clutch and eggs deposited. Hamerstrom (1939) thought prairie chickens renested and Lehmen (1941) found Attwater's prairie chicken renested as many as two times. Data obtained by this study substantiates renesting in greater prairie chickens.

Home ranges and movements of female prairie chickens during the reproductive season appeared to be governed by the proximity of nesting habitat, feeding areas and booming grounds. Feeding periods of incubated prairie chickens were usually twice a day at mornings and evenings although F41 fed at irregular intervals. Schwartz (1945) observed incubating hens to regularly feed early in the morning and late in the evening. Movements of 0.5 mile or more from nesting to feeding areas occurred. Preferred feeding places were grain fields and old fields.

Three nests were destroyed by predators and one hen with a brood was destroyed by a predator. Another hen, F51 could not be located the day following the hatch and was suspected of being killed by a predator. Known nest predation was higher than reported by Schwartz (1945) and Baker (1953). Striped skunks were thought to be the most common nest predators. Schwartz (1945) considered predation to be relatively unimportant.

Predation was also evident on prairie chickens other than reproductive females. Of the 26 prairie chickens radio-tracked, 8 incidents of predation were known to occur. The coyote was the presumed predator in all but one of these non-nest predations. One bird, F46, was the victim of an avian predator.

Although predation was high, predator control practices are not recommended since one objective of this study was to determine home ranges and movements under natural conditions.

The home range and movement data assembled by this study should not be considered complete. More data are needed on the mean distance of movement between successive locations as this appears useful for comparing movements between sex- and age-classes during different seasons. The data obtained to date furnish an index to movement activity and is perhaps more valuable than the home range data. With only a few locations obtained on a prairie chicken the mean distance of movement can be utilized whereas a few locations furnish little home range information.

Linearity for prairie chicken home ranges was established using methods proposed by Stumpf and Mohr (1962). Linearity could have resulted from the long ridges present on the area. However, the birds appeared to perform different functions at the ends of their ranges i.e. feeding, roosting, displaying, loafing, etc. Thus, linearity could have resulted from the orientation of various areas of activity.

Previous to the innovation of radio telemetry, precise data on the mobility of individual prairie chickens was inaccessible. Radio telemetry has provided a means of collecting home range and movement data. Telemetry enables biologists to describe an individual's home range in detail. The ecological significance of the home range as well as areas of use and islands of disuse can be evaluated. With continued cooperation between biologists and electronics specialists radio telemetry can permit the evaluation of ecological concepts which were previously beyond the reach of scientific research.

SUMMARY

In 1963 a 6-year study of greater prairie chicken ecology was initiated on a 6000-acre study area in northeastern Kansas. This paper reports aspects of daily and seasonal movements, home range and activities of prairie chickens. Data were obtained using a radio-telemetry system developed by Marshall and Kupa (1963) and adopted for greater prairie chicken mobility studies by Cebula (1966).

Trapping methods utilized were cannon-nets, walk-in traps, mist nets and a hand drop-net. Telemetry equipment consisted of minature radio transmitters, portable receivers, and portable, mobile and permanent receiving antennae.

A total of 84 prairie chickens were trapped during the entire study and 56 were trapped during the 1965-1966 study. Fifty-five prairie chickens were banded in the entire study and 33 banded during the 1965-1966 phase of the study. Forty-eight radio transmitters were placed on 33 different prairie chickens during the entire study and 35 were placed on 26 prairie chickens during the present study. A total of 1211 "bird days" of data was collected with 804 collected during the 1965-1966 phase of the study. Averages of 36.7 location days per bird for the entire study and 30.9 per bird for the present study were obtained.

Sufficient locations to evaluate the home range were obtained for 20 of the 26 birds tracked. The average spring home range of four male prairie chickens was 330 acres. The average summer home range of two male prairie chickens was 205 acres. During the fall two male prairie chickens had home ranges of 1431 and 590 acres. Seven female prairie chickens had spring home ranges of 280 acres. One female tracked from early spring to late summer

had a home range of 558 acres. The late fall home range of a female was 314 acres. Two juvenile prairie chickens radio-tracked in late summer had an average home range of 227 acres. A juvenile tracked in fall had a home range of 1121 acres.

Movements from successive daily locations showed an increase in distance as fall arrived and continued long movements throughout the winter and until the spring booming season was nearly completed. Summer was a period of low mobility for all sex- and age-classes.

Excessive use of the cannon-net was thought to effect behavior of displaying prairie chickens. Another method of display ground trapping was proposed which should not affect behavior.

Movements of male prairie chickens in summer appeared to be governed by the availability of loafing and roosting habitat.

Requirements for females with broods were met by grassy ravines.

Daily feeding routines were established in the fall, however, males did not visit booming grounds following capture there. The proximity of suitable loafing and roosting areas to the feeding place determined the fall home range.

A "fall shuffle" of juveniles was thought to occur although additional data are necessary to validate this assumption.

Movements and home ranges of male prairie chickens in spring centered about the display ground.

Nests of prairie chickens were 700 yards or more from the booming ground. One prairie chicken renested and two others were suspected of renesting. Predation was considered an important factor in nest failures.

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LITERATURE CITED

Adams, L. 1965. Progress in ecological biotelemetry. BioSci. 15(2): 83-86.

Ammann, G.A. 1957. The prairie grouse of Michigan. Game Div., Dept. of Conserv. Lansing, Mich. 181 pp.

Anderson, A. 1963. Patagial tags for waterfowl. J. Wildl. Mgmt. 27(2): 284-288.

Anderson, K.L. 1961. Common names of a selected list of plants. Tech. Bull. 117. Kansas Agr. Exp. Sta., Kansas State Univ. 59 pp.

Baker, M.F. 1953. Prairie chickens of Kansas. State Biol. Survey Misc. Pub. No. 5. 66 pp.

Bennitt, R. and W.O. Nagel. 1937. A survey of the resident game and furbearers of Missouri. Univ. of Mo. Studies. 20(2): 215 pp.

Bent, A.C. 1932. Life histories of North American gallinaceous birds. U.S. Nat. Hist. Mus. Bull. 162. pp. 242-285.

Blank, T.H., and J. S. Ash. 1956. Marker for game birds. J. Wildl. Mgmt. 20(3): 328-330.

Burt, W.H. 1940. Territorial behavior and populations of some small mammals in southern Michigan. Univ. of Mich. Mus. Zool. Misc. Pub. 45. 58 pp.

Busser, J. H., and M. Mayer. 1957. Radio thermometer that fits in a penguin egg. Naval Res. Rev. pp. 9-13.

Cebula, J. J. 1966. Radio-telemetry as a technique used in greater prairie chicken Tympanuchus cupido pinnatus mobility studies. M.S. Thesis. Kansas State University, Manhattan. 61 pp.

Cochran, W.W., and R.D. Lord Jr. 1963. A radio-tracking system for wild animals. J. Wildl. Mgmt. 27(1): 9-24.

______, D.W. Warner, J.R. Tester, and V.B. Kuechle. 1965. Automatic radio-tracking system for monitoring animal movement. BioSci. 15(2): 98-100.

______, ______, and D.G. Raveling. (No date). A radio-transmitter for tracking geese and other birds. Mus. Nat. Hist., Univ. Minn. 4 pp. (Mimeog.).

Cook, W.W. 1888. Report on bird migration in the Mississippi Valley in the years 1884 and 1885. U.S. Dept. Agr. Div. Econ. Orn. Bull. 2. 313 pp.

Cottam, C. 1956. Marking birds for scientific purposes. Ecol. 37(4): 675-681.

Craighead, F.C., J.J. Craighead, and R.C. Davies. 1963. Radio-tracking of grizzly bears. In: Slater, 1963. pp. 133-148.

_____ and ______. 1965. Tracking grizzly bears. BioSci. 15(2): 88-92.

Edminster, F.C. 1947. The ruffed grouse, its life story, ecology and management. Macmillan Co., New York. 385 pp.

Ellis, R.J. 1964. Tracking raccoons by radio. J. Wildl. Mgmt. 28(2): 363-368.

Hamerstrom, F.N., Jr. 1939. A study of Wisconsin prairie chicken and sharptailed grouse. Wilson Bull. 51: 105-120.

_________, and Frances Hamerstrom. 1949. Daily and seasonal movements of Wisconsin prairie chickens. The Auk. 66(4): 313-337.

_________, and O.E. Mattson. 1964. A numbered, metal color-band for game birds. J. Wildl. Mgmt. 28(4): 850-852.

Herbel, C.H., and K.L. Anderson. 1959. Response of true prairie vegetation on major Flint Hills range sites to grazing treatments. Ecol. Monog. 29: 171.

Horak, J. 1965. Progress of prairie chicken studies in Kansas. Kansas Forestry, Fish and Game Comm., Pratt. 7 pp. (Mimeog.).

Jeter, L.K., and R.L. Marchinton. 1964. Preliminary report of telemetric study of deer movements and behavior on the Elgin Field Reservation in northwestern Florida. Florida Game and Fresh Water Fish Comm., 30 pp. (Mimeog).

Jones, R.E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Mgmt. 27(4): 757-778.

Ko, W.H. 1965. Progress in minaturized biotelemetry. BioSci. 15(2): 118-121.

Lehman, V.W. 1941. Attwater's prairie chicken, its life history and management. North American Fauna, No. 57. U.S. Fish and Wildlife Service, Wash. D.C. 63 pp.

Le Munyan, C.D., W. White, E. Nybert, and J.J. Christian. 1959. Design of a minature radio transmitter for use in animal studies. J. Wildl. Mgmt. 23(1): 107-110.

Leopold, A. 1931. Report on a game survey of the north central states. Sporting Arms and Ammunition Mfrs. Institute. Madison, Wisc. 299 pp.

Lord, R.D., Jr., F.C. Bellrose, and W.W. Cochran. 1962. Radiotelemetry of the respiration of a flying duck. Science. 137: 39-40.

Marshall, W.H. 1960. Development and use of short wave radio transmitters to trace animal movements. Univ. Minn. pp. 1-27. (Mimeog.)

_______, G.W. Gullion, and R.G. Schwab. 1962. Early summer activities of porcupines as determined by radiopositioning technique. J. Wildl. Mgmt. 26(1): 75-79.

_______, and J.J. Kupa. 1963. Development of radio-telemetry techniques for ruffed grouse studies. Trans. N.A. Wildl. and Nat. Res. Conf. 28: 443-456.

_______. 1964. Progress report: Studies of movements, behavior and activities of ruffed grouse using radio telemetry techniques. Univ. Minn. 12 pp. (Mimeog.).

_______. 1965. Ruffed grouse behavior. BioSci. 15(2): 92-95.

Merriam, H.G. 1963. Low frequency telemetric monitoring of woodchuck movements. In: Slater, 1963. pp. 155-171.

Mohler, L.L. 1952. Fall and winter habits of prairie chickens in southwest Nebraska. J. Wildl. Mgmt. 16(1): 9-23.

Patric, E.F., A. Longacre, and R.J. Doan. (No date). A modified approach to animal position finding. Syracuse Univ. 4 pp. (Mimeog.).

Pienkowski, E.C. 1965. Predicting transmitter range and life. BioSci. 15(2): 115-118.

Robel, R.J. 1964. Quantitative indices to activity and territoriality of booming (Tympanuchus cupido pinnatus) in Kansas. Trans. Kans. Acad. Sci. 67: 702-712.

Sanderson, G.C., and Beverly C. Sanderson. 1964. Radio-tracking rats in Malaya - a preliminary study. J. Wildl. Mgmt. 28(4): 752-768.

_______. 1966. The study of mammal movements - a review. J. Wildl. Mgmt. 30(1): 215-235.

Schorger, A.W. 1943. The prairie grouse and sharp-tailed grouse in early Wisconsin. Trans. Wis. Acad. Sci., Arts and Letters. 35: 1-59.

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

Schwilling, M.D. 1961. Trapping and movements of prairie grouse. Pittman-Robertson Job Completion Report W-33-R-3 Job 2. 5 pp.

Seton, E.T. 1909. Life histories of northern animals. Vol. 1. Charles Schribner's Sons, New York. 693 pp.

Silvy, N.J., and R.J. Robel. 1967. Recordings used to increase trapping success of booming prairie chickens. J. Wildl. Mgmt. (In press).

Singer, A. 1963. Some solutions to the problems of homing. In: Slater, 1963. pp. 125-132.

Siniff, D.B., and J.R. Tester. 1965. Computer analysis of animal movement data obtained by telemetry. BioSci. 15(2): 104-108.

Slade, N.A., J.J. Cebula, and R.J. Robel. 1965. Accuracy and reliability of biotelemetric instruments used in animal movement studies in prairie grasslands of Kansas. Trans. Kans. Acad. Sci. 68(1): 173-179.

Slagle, A.K. 1965. Designing systems for the field. BioSci. 15(2): 109-112.

Slater, L.E. 1963. Biotelemetry. Proc. Interdisciplinary Conf. Pergamon Press, New York. 373 pp.

________. 1965. Introduction. BioSci. 15(2): 81-83.

Snedecor, G.W. 1956. Statistical methods. Iowa State University Press. Ames, Iowa. 534 pp.

Southern, W.E. 1965. Avian navigation. BioSci. 15(2): 87-88.

Storm, G.L. 1965. Movements and activities of foxes as determined by radio-telemetry. J. Wildl. Mgmt. 29(1): 1-13.

Stumpf, W.A., and C.O. Mohr. 1962. Linearity of home ranges of California mice and other animals. J. Wildl. Mgmt. 26(2): 149-154.

Taber, R.D., and I. McT. Cowan. 1963. Capturing and marking wild animals. Pages 250-283. In: H.S. Mosby (ed.), Wildlife investigational techniques. Printed for The Wildlife Society by Edwards Brothers, Inc., Ann Arbor, Michigan. 419 pp.

Tester, J.R., D.W. Warner, and W.W. Cochran. 1964. A radio-tracking system for studying movements of deer. J. Wildl. Mgmt. 28(1): 42-45.

________, and K.L. Heezen. 1965. Deer response to a drive census determined by radio telemetry. BioSci. 15(2): 100-104.

Trippensee, R.E. 1953. Wildlife management. Vol. 1. Upland game. McGraw-Hill, New York. pp. 233-261.

Verts, B.J. 1963. Equipment and techniques for radio-tracking striped skunks. J. Wildl. Mgmt. 27(3): 325-339.

Yeatter, R.E. 1943. The prairie chicken in Illinois. Nat. Hist. Survey Bull. 22(4): 377-416.

APPENDIX

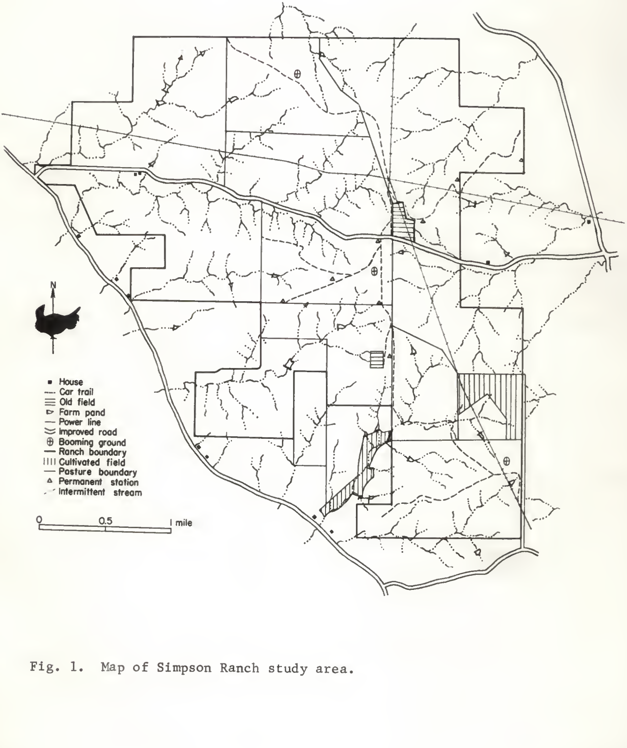


Fig. 1. Map of Simpson Ranch study area.

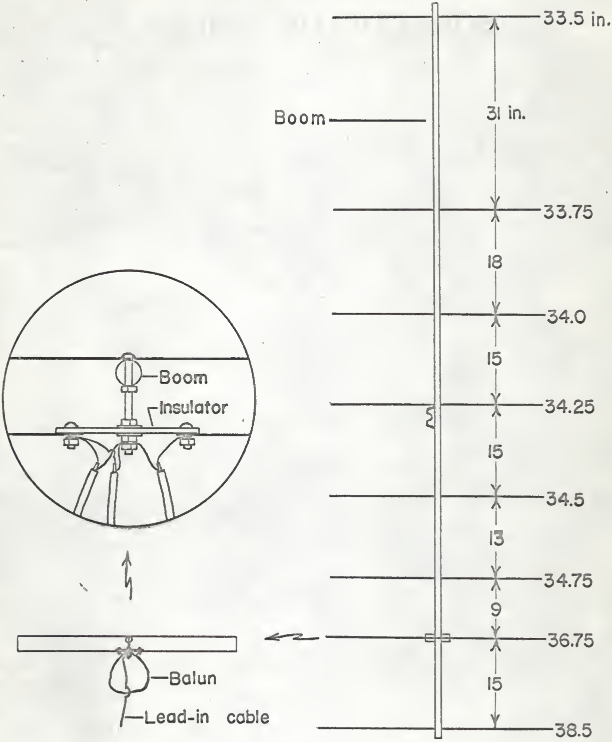


Fig. 2. Construction details of directional yagi receiving antenna utilized in both permanent and mobile stations.

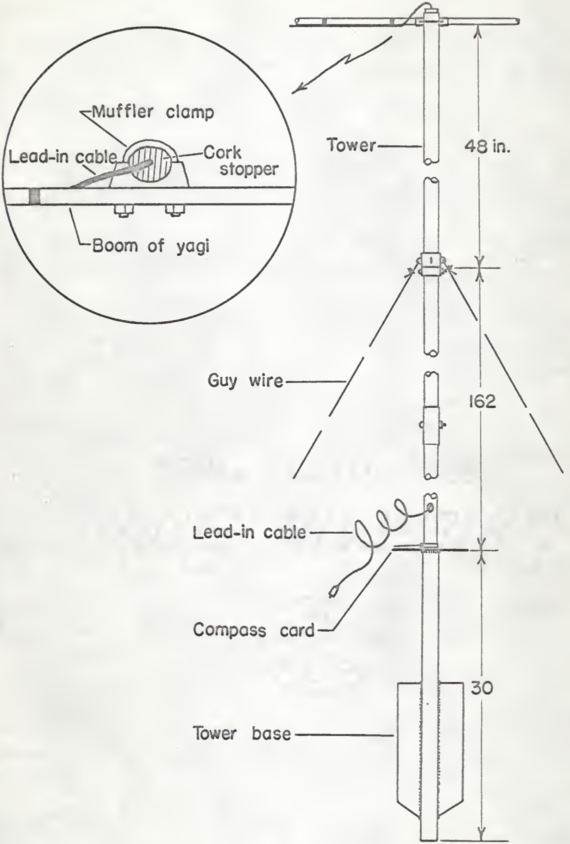


Fig. 3. Construction details of a permanent station.

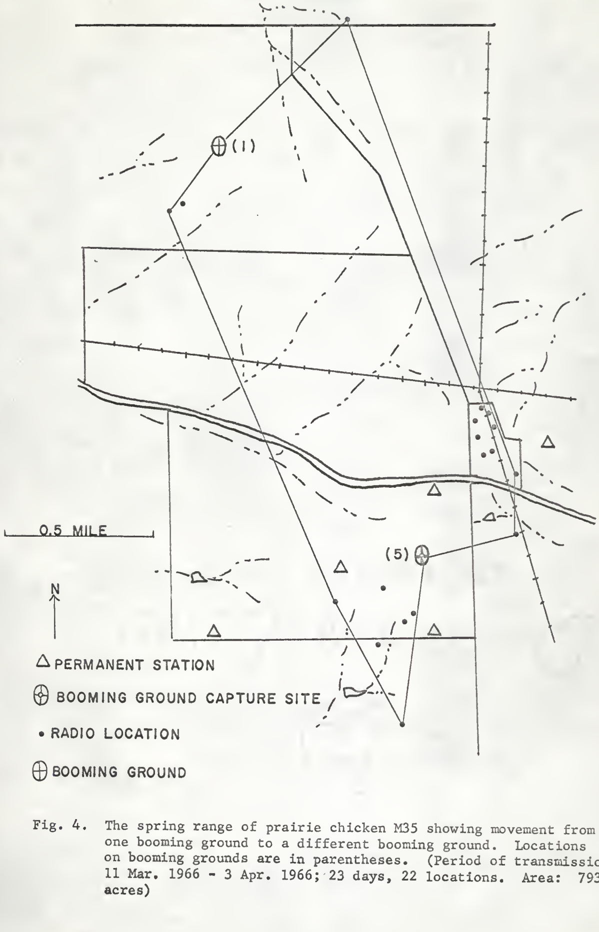


Fig. 4. The spring range of prairie chicken M35 showing movement from one booming ground to a different booming ground. Locations on booming grounds are in parentheses. (Period of transmission: 11 Mar. 1966 - 3 Apr. 1966; 23 days, 22 locations. Area: 793 acres)

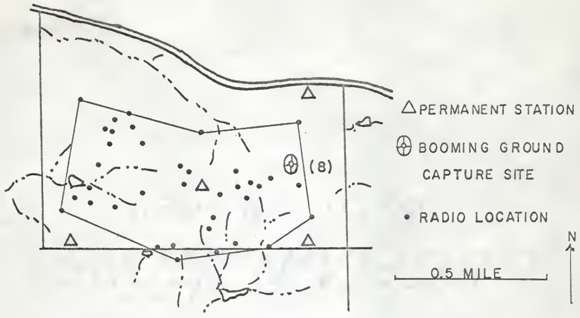


Fig. 5. The late spring range of prairie chicken M23 including the locations on the booming ground in parentheses. (Period of tracking: 7 May 1966 - 15 June 1966; 40 days, 45 locations. Area: 196 acres)

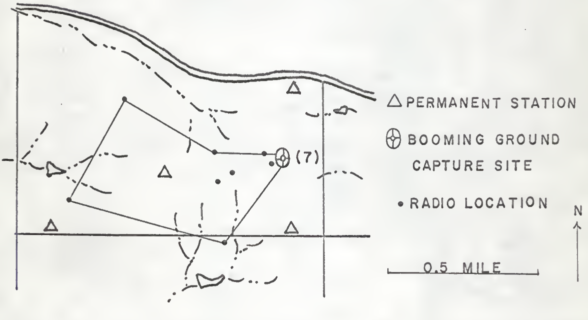
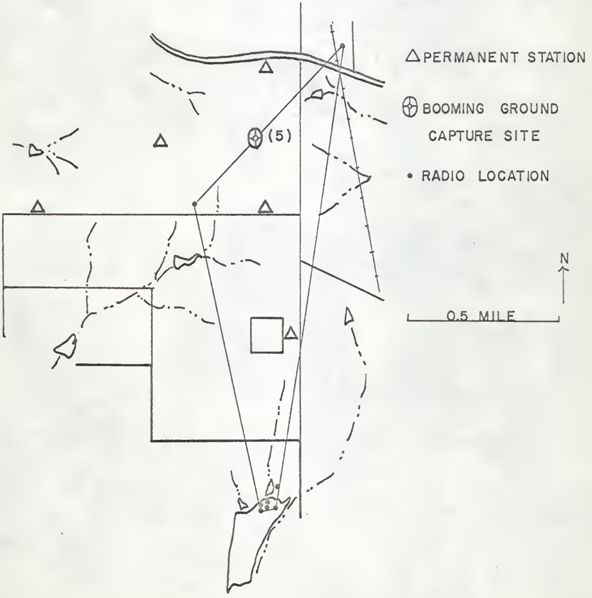


Fig. 6. The late spring range of prairie chicken M43 including the locations on the booming ground in parentheses. (Period of transmission: 7 May 1966 - 17 May 1966; 10 days, 12 locations. Area: 109 acres)

Fig. 7. The summer range of prairie chicken M11 immediately following the booming season. (Period of transmission: 2 June 1965 - 23 Sept. 1965; 113 days, 208 locations. Area: 282 acres)

Fig. 8. The spring range of prairie chicken M39 showing movements from the booming ground to a feeding area south of the booming ground. (Period of tracking: 26 Mar. 1966 - 11 Apr. 1966; 16 days, 15 locations. Area: 224 acres)


PERMANENT STATION
BOOMING GROUND
CAPTURE SITE
RADIO LOCATION
0.5 MILE
N


(5)
PERMANENT STATION
BOOMING GROUND
CAPTURE SITE
RADIO LOCATION
N
0.5 MILE

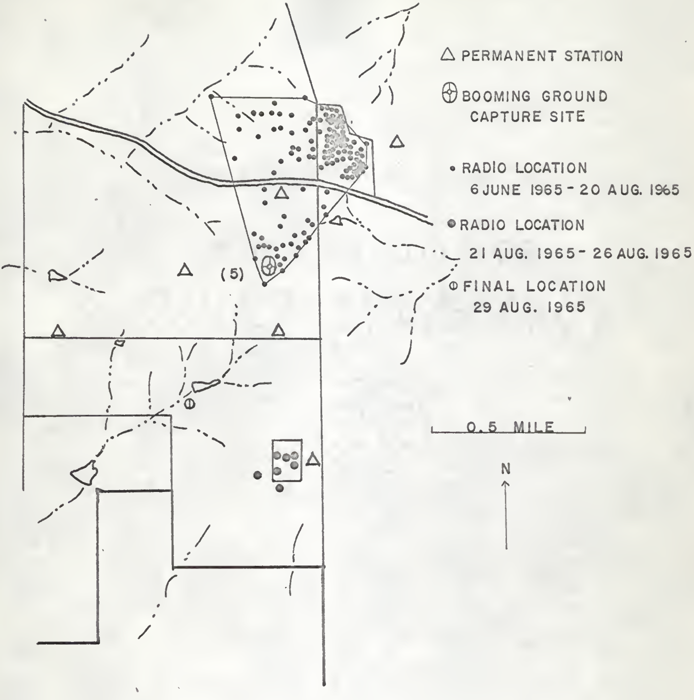
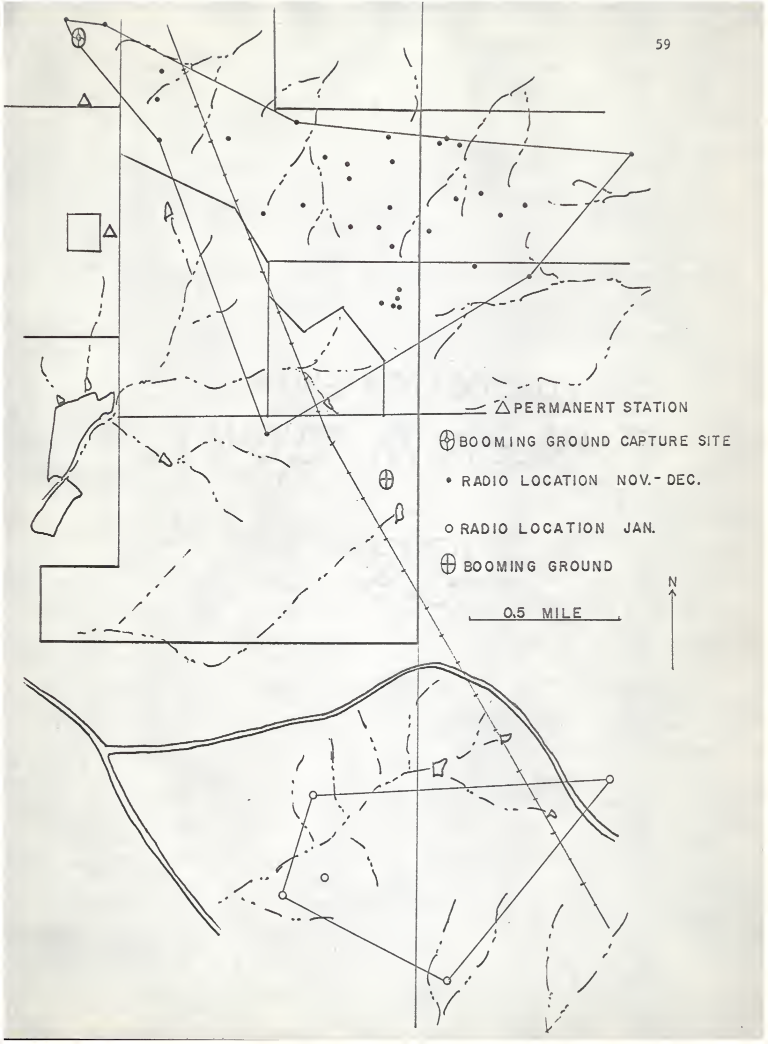


Fig. 9. The summer range and movements of prairie chicken M1 showing late season booming ground visits, southward movement following disturbance in the loafing area and final location following predation. (Period of tracking: 6 June 1965 - 29 Aug. 1965; 84 days, 150 locations. Area: 128 acres)

Fig. 10. The fall range of prairie chicken M32 showing movements between two different feeding areas. (Period of transmission: 22 Oct. 1965 - 16 Nov. 1965; 27 days, 21 locations. Area: 1431 acres)


N
0.5 MILE
PERMANENT STATION
BOOMING GROUND
CAPTURE SITE
RADIO LOCATION
BOOMING GROUND

Fig. 11. The fall and early winter ranges of prairie chicken M34 including locations following a change of feeding area. (Period of transmission: 24 Nov. 1965 - 6 Jan. 1966; 43 days, 37 locations. Area: Nov. - Dec. 590 acres, Jan. 265 acres)


PERMANENT STATION
BOOMING GROUND CAPTURE SITE
RADIO LOCATION NOV.-DEC.
RADIO LOCATION JAN.
BOOMING GROUND
N
0.5 MILE

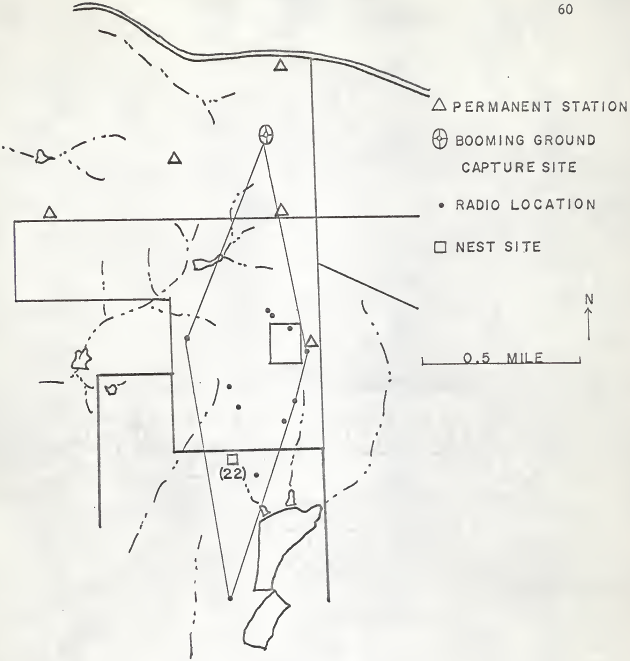


Fig. 12. The late spring range of prairie chicken F52. Nest locations are in parentheses. (Period of tracking: 17 May 1966 - 15 June 1966; 29 days, 36 locations. Area: 161 acres)

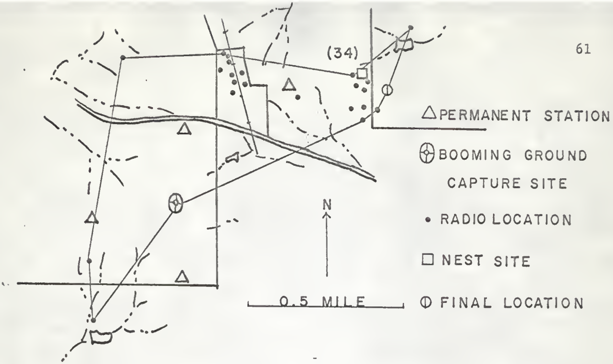


Fig. 13. The spring range of bird F42 showing the number of locations at the nest site and the final location following predation. (Period of tracking: 6 Apr. 1966 - 31 May 1966; 56 days, 67 locations. Area: 262 acres)

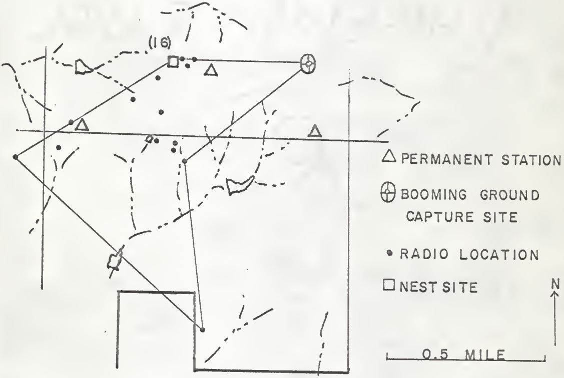


Fig. 14. The spring range of prairie chicken F53 showing the number of locations at the nest site which was destroyed by a predator 10 June 1966. (Period of tracking: 19 May 1966 - 10 June 1966; 23 days, 33 locations. Area 202 acres)

Fig. 15. The early spring range of prairie chicken F54. (Period of transmission: 3 Apr. 1966 - 4 May 1966; 31 days, 32 locations. Area: 293 acres)

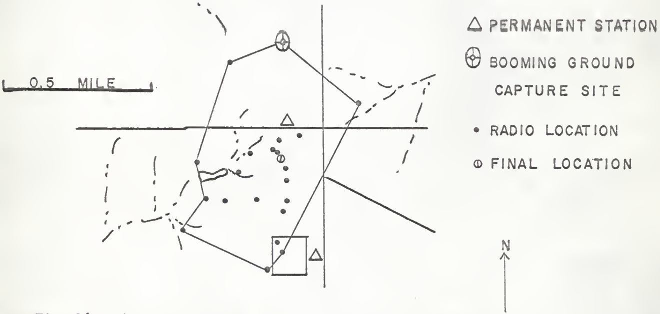


Fig. 16. The early spring range of prairie chicken F46 showing the final location following predation. (Period of tracking: 7 Apr. 1966 - 1 May 1966; 23 days, 19 locations. Area: 141 acres)

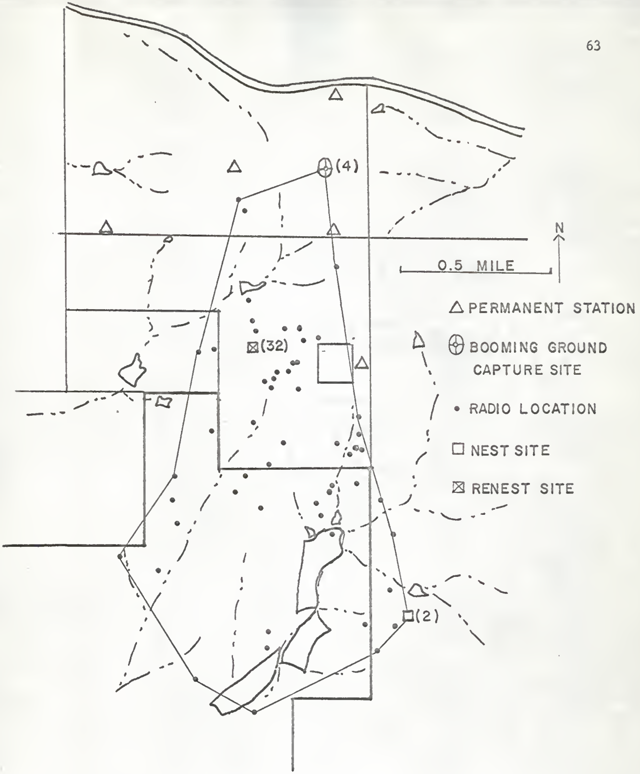


Fig. 17. The spring range of bird F41 including the location of a nest destroyed by a predator, visits to the booming ground and a second nest site. Locations on nests are in parentheses. (Period of transmission: 6 Apr. 1966 - 15 June 1966; 70 days, 71 locations. Area: 607 acres)

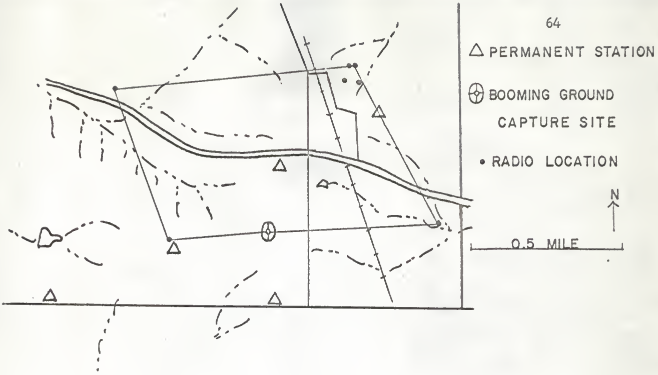


Fig. 18. The range of bird F45 during mid-spring 1966. (Period of transmission: 7 Apr. 1966 - 18 Apr. 1966; 11 days, 8 locations. Area: 295 acres)

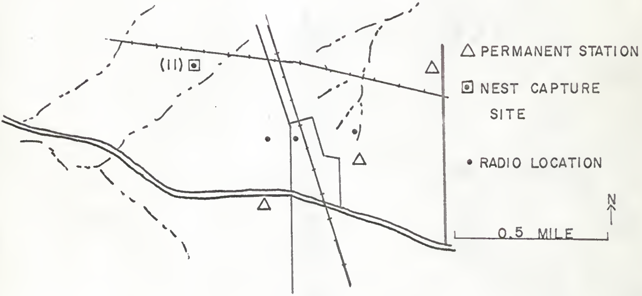


Fig. 19. The nest site and post-hatch movements of bird F51. Prehatching locations on nest are in parentheses. (Period of transmission: 15 May 1966 - 27 May 1966; 12 days, 12 locations)

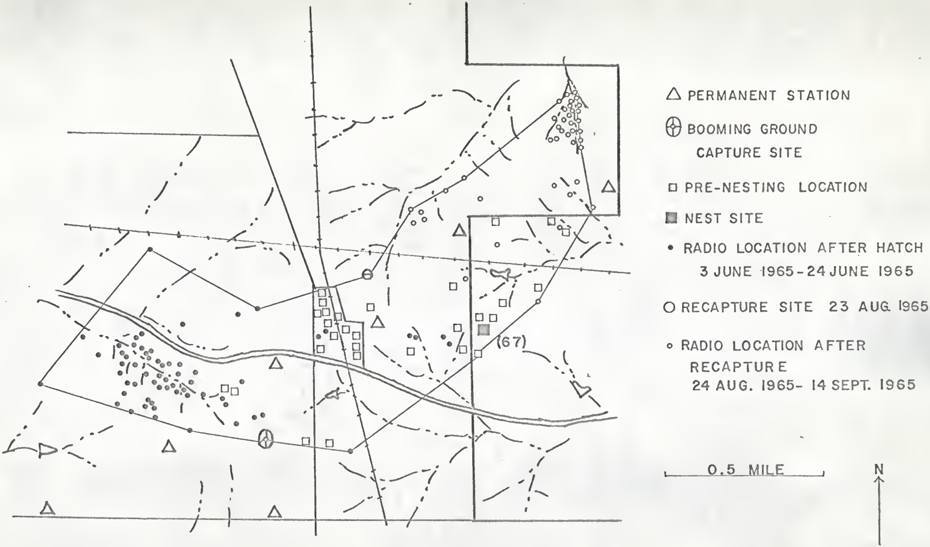


Fig. 20. The spring and summer range of prairie chicken F14 showing the booming ground capture site, pre-nesting locations, nest site, locations following hatch, recapture site and locations following recapture. (Periods of transmission: 17 Apr. 1965 - 24 June 1965; 77 days, 154 locations. 23 Aug. 1965 - 14 Sept. 1965; 23 days, 33 locations. Area: 558 acres)

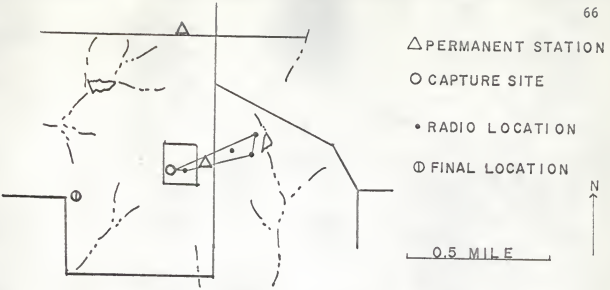


Fig. 21. The fall movements of bird J30 showing baited capture site and the final location following predation. (Period of tracking: 17 Oct. 1965 - 20 Oct. 1965; 3 days, 5 locations)

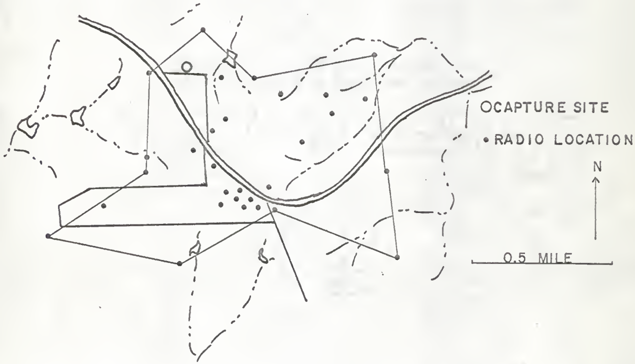


Fig. 22. The late fall movements of bird F33 showing the night capture site and movements around a feeding area. (Period of transmission: 23 Nov. 1965 - 29 Dec. 1965; 35 days, 31 locations. Area: 314 acres)

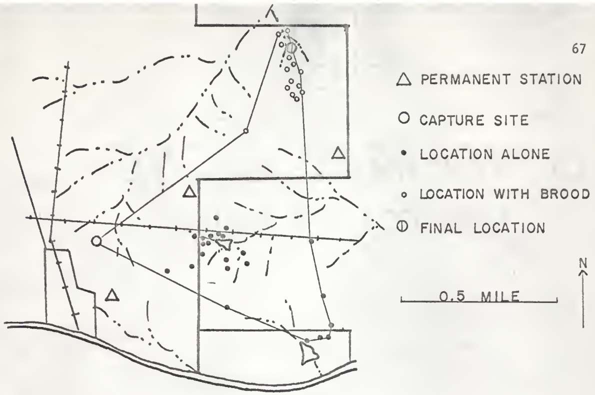


Fig. 23. The late summer range of prairie chicken J24 showing capture site movements alone, movements reunited with F14 and final location following predation. (Period of tracking: 23 Aug. 1965 - 15 Sept. 1965; 24 days, 36 locations. Area: 207 acres)

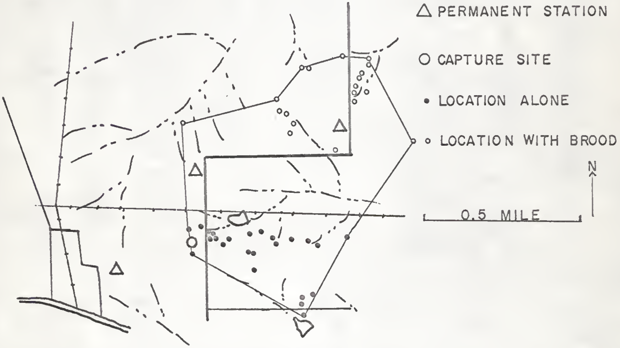


Fig. 24. The late summer range of bird J28 showing capture site, movements alone and movements reunited with a brood of 15 prairie chickens. Bird J28 was killed 7 Nov. 1965 by a hunter 6.7 miles east of the last known location. (Period of transmission: 23 Aug. 1965 - 20 Sept. 1965; 29 days, 40 locations. Area: 248 acres)

Fig. 25. The fall range of prairie chicken J31 showing the baited capture site and movement to a winter feeding area. (Period of transmission: 17 Oct. 1965 - 10 Dec. 1965; 55 days, 65 locations. Area: 1121 acres)

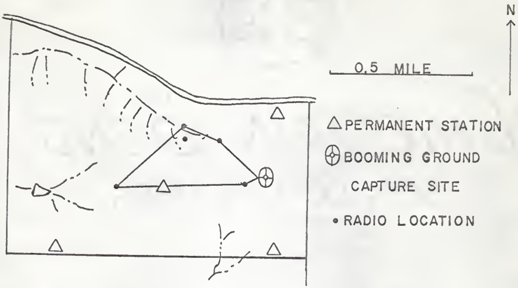


Fig. 26. The spring movements of prairie chicken M36 following capture on the booming ground. (Period of tracking: 12 Mar. 1966 - 17 Mar. 1966; 5 days, 6 locations)

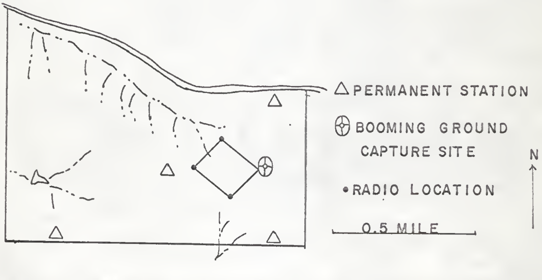


Fig. 27. The spring movements of prairie chicken M37 following capture on the booming ground. (Period of tracking: 12 Mar. 1966 - 15 Mar. 1966; 3 days, 4 locations)

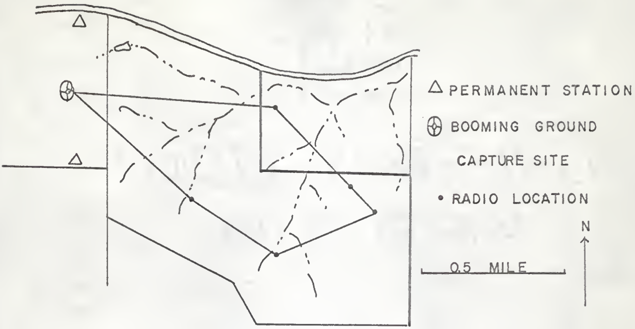


Fig. 28. The late fall movements of prairie chicken M21 following a booming ground capture. (Period of transmission: 24 Nov. 1965 - 1 Dec. 1965; 7 days, 6 locations)

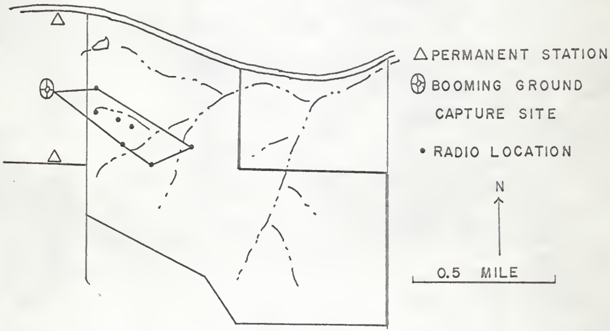


Fig. 29. The spring movements of prairie chicken M38. Bird M38 was captured on the booming ground with a broken wing. (Period of transmission: 10 Mar. 1966 - 16 Mar. 1966; 6 days, 8 locations)

EXPLANATION OF PLATE I

Fig. 1. A view of transmitters, before and after harness is fashioned. Note size and shape of completed harness, battery package, and covering of plastic tape.

Fig. 2. A radio-tagged male prairie chicken ready to be released. The transmitter is visible on bird's back.

PLATE I

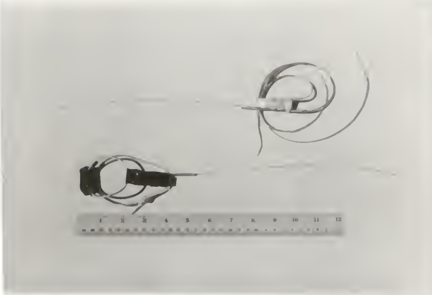


Figure 1.

Figure 2.

EXPLANATION OF PLATE II

Fig. 1. Worker shows rotating directional yagi antenna atop 20 ft. tower of permanent station to determine azimuth of signal.

Fig. 2. Closeup of base of permanent station, portable receiver, and compass card assembly with cover removed.

PLATE II

Figure 1.

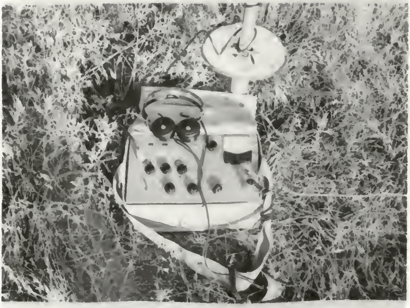


Figure 2.

EXPLANATION OF PLATE III

Fig. 1. The mobile receiving antenna mounted on a pickup truck.

Fig. 2. Detail of mobile unit showing compass card, pointer, and worker rotating the directional antenna.

PLATE III

Figure 1.

Figure 2.

EXPLANATION OF PLATE IV

Fig. 1. The hand held directional antenna being used to pinpoint a radio-tagged prairie chicken.

Fig. 2. A radio-tagged male prairie chicken displaying or "booming" in a normal manner.

PLATE IV

Figure 1.

Figure 2.

HOME RANGE AND MOVEMENTS OF THE GREATER PRAIRIE CHICKEN (*TYMPANUCHUS CUPIDO PINNATUS*) WITH NOTES ON ACTIVITIES

by

CHARLES EDWARD VIERS, JR.

B. S., Marshall University, 1964

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Zoology

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1967

In 1963 a 6-year study of greater prairie chicken (*Tympanuchus cupido pinnatus*) ecology was initiated on a 6000-acre study area in northeastern Kansas. Daily and seasonal movements, home range and activities of greater prairie chickens were investigated. Radio telemetry techniques developed by Marshall (1965) were used in the study.

Prairie chickens were live-trapped with cannon-nets, walk-in traps, mist nets and hand drop-nets. Telemetry materials consisted of minature radio transmitters, portable receivers and portable, mobile and permanent antennae.

Eighty-four prairie chickens have been trapped during the entire study and 56 were trapped during the 1965-1966 phase of the study. Fifty-five prairie chickens were banded for the entire study and 33 were banded during the 1965-1966 study. Forty-eight radio transmitters were placed on 33 different prairie chickens for the entire study and 35 placed on 26 prairie chickens for the present study. An average of 36.7 days of location data per bird for the entire study and 30.9 days for the present study was obtained.

Sufficient locations were obtained to evaluate the home range for 20 of the 26 prairie chickens. The average spring home range of 4 male prairie chickens was 330 acres. The average summer home range for two males was 205 acres. Two male prairie chickens tracked in fall had home ranges of 1431 and 590 acres. Seven female prairie chickens had an average spring home range of 280 acres. The home range of a female prairie chicken tracked from early spring to late summer was 558 acres. The late fall home range of a female was 314 acres. The late summer home range for two juveniles was 227 acres. A juvenile tracked in fall had a home range of 1121 acres.

Movements from successive daily locations showed an increase in distance as fall arrived and continued long movements throughout the winter and until the spring display season was nearly completed. Summer was a period of low mobility for all sex- and age-classes.

Display behavior was thought to be altered by the cannon-net. An alternate trapping method was proposed which should not affect behavior.

Movements of male prairie chickens in summer appeared to be governed by the availability of loafing and roosting habitat.

Requirements for female prairie chickens with broods were met by grassy ravines.

Daily feeding routines were established in fall. The proximity of loafing and roosting places to areas appeared to determine the fall home range.

A "fall shuffle" of juveniles was thought to occur in this region.

Movements and home ranges of male prairie chickens in spring centered about the display ground.

Nests of prairie chickens were 700 yards or more from the display ground. One prairie chicken renested and two others were suspected of renesting. Predation was considered an important factor in nest failures.