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To the Graduate Council:

I am submitting herewith a thesis written by Ronald Harry Saunders entitled "Some Behavioral and Demographic Characteristics of a Bobwhite Quail (Colinus virginianus) Population." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife Management.

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SOME BEHAVIORAL AND DEMOGRAPHIC CHARACTERISTICS OF A BOBWHITE QUAIL (*COLINUS VIRGINIANUS*) POPULATION

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Ronald Harry Saunders

December 1973

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ABSTRACT

The study area was a 578-acre-tract within a quail management area on the Ames Plantation in West Tennessee. A total of 234 quail were trapped in 1971 and 410 quail were trapped in 1972. Seven quail (five unmated males and one mated pair) were radiotracked.

Quail were very sedentary during the breeding season (99 percent moved less than 1/2 mile). The average home range area of unmated males during the breeding season was 17.0 acres. Quail showed little inclination to switch areas used from season to season. Little change occurred in range used from spring to summer (98 percent moved less than 1/2 mile), summer to fall (97 percent moved less than 1/2 mile), and breeding season to breeding season (100 percent moved less than 1/2 mile). Ninety-six percent of the observations of color-marked birds were within 1/2 mile of their marking point.

Daily activity patterns suggest a minor morning activity peak of short duration and a major, more lengthy, afternoon activity peak. Unmated males, though, were responsive to the call of an unmated female at any time of the day. At least a limited amount of mate interchange occurred during the study.

Population estimates derived from a Lincoln index and from trapping records suggest that approximately 700 quail (1.2 quail per acre) used the area early in the 1972 breeding season. A population estimate based on a count of whistling cocks yielded a lower estimate - suggesting that not all unmated males whistle on any given morning. The number of different males whistling and the total number of

whistles heard were greater during the period of sunrise to 40 minutes after sunrise than they were during the period of 40 to 75 minutes after sunrise.

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CHAPTER I

INTRODUCTION

Summer is a most important season in the life history of the bobwhite quail (Colinus virginianus) from the standpoint of production. Consequently, a thorough understanding of the necessary requirements for successful breeding is invaluable for quail management. To determine some of these requirements, this study examined the following aspects of the breeding behavior of the bobwhite quail in southwestern Tennessee: (1) chronology of the breeding season, (2) home range characteristics, (3) movements, (4) activity patterns, (5) pair bond fidelity, (6) population estimates, and (7) whistling cock counts.

Although quail may mate and whistling may begin as early as February (Rosene, 1969), covey dissolution does not occur until April over most of the bobwhite's range. In Texas, Lehmann (1946a) reported that pairs outnumbered coveys 3:1 on April 13, while Parmalee (1955) found that covey breakup occurred in the second and third weeks of April. Coveys undergo dispersal by the end of April in Wisconsin (Errington, 1933), Texas (Lehmann, 1953), and Alabama (Speake and Haugen, 1960). Quail spend the April-to-September period as single unmated males or mated pairs actively engaged in reproductive activities. The peak in both hatching and calling activity usually occurs in June or July (Fatora et al., 1966). Although most of the reproductive activity is completed by the first of September, some pairs may remain active until late October (Rosene, 1969).

Few conclusive data have been gathered on home range characteristics during the breeding season. Lewis (1954) combined his data with those of Murphy and Baskett (1952) and found greater movement in the spring than in the summer. Loveless (1958), however, found summer movement to exceed spring movement on an area where artificial feeders were used. Emlen (1939) and Raitt and Genelly (1964) found that a breeding California quail (Lophortyx californica) population consists of two parts, one a relatively sedentary segment consisting mainly of mated pairs; the other a more mobile population of unmated males. The relationship between pairing and mobility is poorly known for bobwhites, although many workers feel that unmated males exhibit greater movement (Murphy and Baskett, 1952; Hood, 1955; Loveless, 1958). Urban (1972) found the unmaled males' home range to be nearly twice that of mated males and females. Analyses of the home range characteristics for bobwhites during spring and summer are presented in the current study.

Varying degrees of movement of bobwhites have been reported in the literature. The shifting from winter to breeding season range may occur in April while the covey is still an intact unit (Urban, 1972). He found that coveys may shift ranges in the spring, with spring ranges incorporating sizable weedy areas suitable for nesting. Kabat and Thompson (1963) found that 79 percent of the quail on their 4,500-acre Wisconsin study area moved off the area during the breeding season - 66 percent of this movement occurred in the spring. Movement of the Plains bobwhite (C. v. taylorii) during the breeding season is nearly twice that which occurs during the non-breeding season (Robinson, 1957). Definite movements from breeding season to winter

range have occurred in Oklahoma (Duck, 1943), Texas (Lehmann, 1946b), and Florida (Loveless, 1958). Duck explained these movements as movement from areas of preferred nesting habitat to areas of preferred winter habitat. Most Missouri quail raise broods and establish winter home ranges near their hatching point (Agee, 1957), although movement in the fall is greater than movement during the summer (Murphy and Baskett, 1952). Even though excessive movements may occur in different parts of the bobwhite's range, Stoddard (1931) and Leopold (1933) concluded that the bobwhite is essentially sedentary. Movements during the breeding season, from early spring range to breeding season range, from breeding season range to fall range, and from breeding season to breeding season are discussed in the present study.

Few precise records of activity patterns of bobwhites during the breeding season are available. Fatora and Duever (1968) established diurnal activity peaks in Georgia by means of roadside counts. Urban (1972) found that unmated males exhibit more lengthy hourly movement than mated males. The present study establishes the diurnal activity patterns of telemetered quail at two-hour intervals. The type of ground cover used during the different periods of the day is also discussed.

The bobwhite is thought to be monogamous throughout the breeding season. Stoddard (1931) reported strong pair-bond fidelity between birds of mated pairs. Rosene (1969) noted that a mated male will always drive off unmated males that venture too close to his mate. Stettner et al. (1966) reported very strong pair-bond fidelity among penned bobwhites - even after three weeks separation. Urban (1972)

mentioned that two mated males moved lengthy distances to decoy hens in cock and hen traps. Bobwhites can be polygamous in captivity (Baldini et al., 1952). The monogamous behavior of the bobwhite is examined in in the present study.

Although direct counts of birds may be undertaken when quail are in coveys, these are impractical during the breeding season when vegetation is dense and birds are scattered. Stoddard (1931) noted that the number of males heard calling (i.e., unmated males) could be used as an index to breeding season populations when the sex ratio is known. Three methods of determining the population on the study area during the breeding season are presented and compared.

Whistling cock counts have been used by many authors as a means of estimating fall populations. A call index was related to hunter success in Missouri (Bennitt, 1951), and Rosene (1957) related the number of males heard whistling in the breeding season to the number of coveys present during the hunting season. However, Norton et al. (1961) found statistical errors in both Bennitt's and Rosene's work. Robel et al. (1969) reported that time of year, time of day, wind velocity, temperature, and relative humidity all affect the number of whistles heard. Stoddard (1931) and Bennitt (1951) thought that the bobwhite call was given only by unmated males, but other authors indicate that both mated and unmated bobwhites whistle (Kabat and Thompson, 1963; Fatora et al., 1966; Rosene, 1969). The present study attempts to correlate the number of males heard whistling on any morning to the number of unmated males on the area. It also examines the effect of time of year and time of day on the number of males heard whistling

and the relationship between the number of males whistling and total number of whistles heard.

The present study examines several aspects of the breeding behavior of quail during the breeding season, with emphasis being placed on the behavior of male bobwhites. Home range characteristics during the breeding season are examined. Movements during the breeding season, from early spring range to breeding season range, from breeding season range to fall range, and from breeding season to breeding season are established. Diurnal activity peaks are recorded - primarily through radiotracking. The strength of the pair bond in the bobwhite is examined and methods of population estimation during the breeding season are presented. A weekly whistling cock count run on the area is analyzed and compared to the known population of adult quail on the area.

CHAPTER II

DESCRIPTION OF STUDY AREA

I. LOCATION AND REGIONAL PHYSIOGRAPHY

The study was conducted on the Ames Plantation, an 18,600 acre Agricultural Experiment Station located in Fayette and Hardeman Counties, Tennessee. A 578-acre tract within a quail management area was used for the study. The topography is smooth and lies within the Plateau slope of southwestern Tennessee.

The southwest corner of the study area is located 2.0 miles north of LaGrange, Tennessee on federal aid secondary highway 8113. The southeast corner is located 1.1 miles from Tennessee Route 18 on the Buford Ellington Road. The study area is roughly a rectangle lying between these roads. The north and south boundaries consist of gravel or field roads. A gravel road separates the area into the east and west parts (Figure 1).

Soils consist of a six-foot layer of loess overlying coastal plains materials. Grenada, Loring, and Calloway series characterize the area. Drainage ranges from well to poorly drained. Elevation is 600 feet (Flowers et al., 1964). Eight small permanent ponds are dispersed over the area. Several intermittant streams originate on the area and cut deeply into the soils. One large sand ditch roughly bisects the western portion of the study area.



Figure 1. Map of the study area, a 578-acre-tract within a quail management area on the Ames Plantation in West Tennessee.

II. CLIMATE

The climate is humid and temperate. The growing season averages 209 days and there is a high annual rainfall - averaging 51.6 inches (University of Tennessee, n.d.). During the study, temperatures at nearby Bolivar, Tennessee, averaged 3.1 degrees below normal for the period of May to August, 1971, and 2.2 degrees below normal for the period of April to August, 1972. Daily maximum temperatures exceeded 90 degrees for 44 days in 1971 and 27 days in 1972. Precipitation for May to August, 1971, totaled 21.12 inches with all months being within 1 inch of the normal except for August which was 4.62 inches above normal (U. S. Department Commerce, 1971). Precipitation for April to August, 1972, totaled 23 inches with April having 1.09 inches below average, July 2.77 inches above average, and the rest within 1 inch of normal (U. S. Department Commerce, 1972).

III. VEGETATION

Many different vegetation types characterize the area. The western portion of the area consists of 368 acres. It is characterized by long, narrow soybean (Glycine max) fields along the north and south boundaries surrounding a wooded interior. These fields are irregularly dissected by eroded areas or areas of poor drainage. A cotton (Gossypium hirsutum) field encompassing 17 acres is found in the southeast corner of the area. A 34-acre field follows the western boundary of the area. In 1971 this field was planted entirely in soybeans, while in 1972 the field was planted half in soybeans and half in corn (Zea mays). A deep sand ditch, running east-west, roughly bisects the

area. A hardwood forest follows the ditch on both sides. Oaks (Quercus sp.) and hickories (Carya sp.) dominate the hardwood forest. The poorly-drained areas support stands of sweetgum (Liquidambar styraciflua), willow oak (Quercus phellos), and American elm (Ulmus americana). Honeysuckle (Lonicera japonica) and black locust (Robinia pseudoacacia) thickets are scattered over the area. A natural short-leaf pine (Pinus echinata) stand totaling five acres is found in the south-central portion of the area. This pine stand varies from fairly dense near the soybean fields to a savannah-like complex near the sand ditch. Ninety-nine acres of the area consist of fallow areas supporting growth of broomsedge (Andropogon virginicus).

The eastern part of the study area consists of 210 acres. Two large cotton fields comprise 51 acres of the area. The southern portion of the area entails a 28-acre cedar (Juniperous virginiana) thicket with an understory varying from unburned broomsedge to a dense honeysuckle-blackberry (Rubus sp.) growth. The center of the area is made up of 12 acres of pole-sized hardwoods with an understory of honeysuckle. To the north, south, and west of this woods lie many small (one to four acre) soybean fields separated by idle ground or cover strips. Narrow bands of hardwood trees follow the roads forming the north and west boundaries, with a four-acre sweetgum stand located in the northwest corner.

The area is bordered to the north, east, and west by fields of soybeans interspersed with hardwood stands and pasture. A large loblolly pine (Pinus taeda) thicket follows the southwest boundary, while hardwood stands with a few cotton and soybean fields interspersed along the border form the rest of the southern boundary.

IV. QUAIL POPULATIONS

Quail were censused just prior to trapping each year of the study. Censuses were made by direct flush count by personnel of the Department of Forestry of The University of Tennessee. The census in March, 1971, revealed a population of one quail per 2.0 acres. The population in March, 1972, had increased to one quail per 1.7 acres. Winter censuses were conducted approximately three months after the termination of trapping. These censuses revealed a population of one quail per 1.6 acres in December, 1971, and one quail per 1.4 acres in December, 1972.

V. MANAGEMENT

Controlled burning was conducted on the area just prior to trapping each year. During the spring of 1971, approximately one-half of the entire area was burned in alternating blocks. During the spring of 1972, the whole western half of the study area was burned with the exception of the crop fields, the poorly drained areas, and patches of dense honeysuckle. Only the fallow fields and cover strips along the north-central border of the eastern half of the study area were burned in 1972. During the spring of 1972, strips were disced through some of the less dense woodlands on the western portion of the study area. Portions of these strips were planted with soybeans while other parts were left to undergo natural succession. During the summer of 1972, four "soybean" fields were left fallow to comply with a soil bank program. These fields were planted with sorghum (Sorghum vulgare) in early July, 1972. The sorghum fields were not harvested in the fall, in contrast to the crops from all of the other fields on the area.

CHAPTER III

METHODS

Quail were live-trapped on the study area and each bird caught was banded on the right leg. The information recorded for all quail caught included band number, sex-age class, date, time of day, location, and whether or not a back-tag or radio-transmitter was attached to the bird. All males caught at certain trapsites were color-marked with a particular color of back-tag. Transmitters were attached to birds at the point of capture when needed for study.

I. SUMMER TRAPPING

Type of Trap Used

A modification of the cock and hen traps used by Stoddard (1931) was used in this study. The traps were constructed of 1/2 inch mesh hardware cloth and measured 8 inches high and 30 inches on each side. A holding compartment for the hen (measuring 8 x 8 x 8 inches) was fastened to the center of the trap. Traps used the first year were divided into two halves by partitions of hardware cloth. Two funnel-type entrances approximately four inches high were placed at opposite ends of the trap. During the second year of the study, one of the funnel-type entrances was closed and another funnel was placed inside the trap running from one corner to the center. Apertures for removing birds were cut into the top of each compartment of the trap and covered with slit pieces of rubber inner tube.

Procedure Used in Trapping

Traps were distributed over the study area in a manner that would allow every male on the area to have an opportunity to enter a trap. The study area was divided into seven compartments of comparable size. Compartments were usually trapped for two successive days before traps were moved to the next compartment. When eight traps per day were used, as was the usual case, two weeks were required to trap the entire study area. Each time a compartment was trapped was termed a "trapping session"; each time the entire study area was trapped was termed a "trapping round." Trapsites were changed after a site had been trapped for two successive trapping rounds.

Traps were usually placed in cover strips where the ground vegetation was sparse and shade was available for the calling hens. If shade was unavailable or spotty, limbs and/or weeds were placed over the trap to protect the calling hens or trapped birds. Food and water were supplied for the calling hens.

Decoy hens were placed in the traps between 7:00 and 8:00 A.M. and the traps were checked regularly at two to three hour intervals. From June 1 to September 1, 1972, decoy hens were left in the traps overnight every other night of trapping to enhance early morning trapping.

II. TRAPPING AND COLLECTING OF QUAIL IN WINTER

Bait trapping with corn was conducted on the area from November 22, 1972, until December 5, 1972. Single funnel wire traps were distributed over the area in suitable cover at a density of about one trap per five acres. Traps were checked twice daily beginning at 10:30 A.M.

and 4:30 P.M. Numbered red leg bands were affixed to each bird caught. Data recorded were band number, age, sex, trapsite number, and previous band number if present.

Quail were collected by shooting during the winter of 1972. Personnel of the Department of Forestry, The University of Tennessee, accompanied the hunting parties and recorded location, sex, age, and band number of each quail collected. Records were also kept of unbanded birds collected.

III. COLOR-MARKED QUAIL

Every male quail captured at certain designated trapsites was marked with one of eight colors. Streamers measuring 25 by 90 millimeters were attached by aluminum pins to a harness cut to fit around the birds' wings. Streamers and harness were constructed of heavy plastic or naugahyde obtained from various auto upholstery shops.

Each time a color-marked bird was sighted, the date, color, and location were recorded. If the bird flushed, the landing point was also recorded.

IV. TELEMETERED QUAIL

The 12-channel telemetry system used in the study was purchased from Sidney Markusen, Esko, Minnesota. The receiver, equipped with eight size D flashlight batteries, weighed five pounds. A small hand antennae was used with the receiver. Eight radio-transmitters, with frequencies ranging from 150.830 Mc. to 151.070 Mc., were purchased

from Wildlife Materials Inc., Carbondale, Illinois. The transmitters were equipped with waterproofed batteries and plastic straps to be used as a harness. The transmitters weighed approximately 11.5 grams and emitted an intermittant signal. Transmitters were attached to the backs of the quail in a manner previously described by Brander (1968).

Effect on Quail

Transmitters did not appear to impede appreciably the movement of quail. Percival and Webb (1971) reported that the attachment of radio-transmitters to both birds of a bobwhite pair did not adversely affect the reproductive success of pen-reared quail. Ramakka (1972) found that the attachment of radiotransmitters weighing 4.16 grams did affect the breeding behavior of male woodcock (Philohela minor). Upon release, telemetered quail in the present study flew normally to cover. The time until "regular" behavior began varied from a few hours to two and one-half days. Telemetered quail could not be discerned from regular native quail when they were flushed coincidentally.

Locating Signals

Locations of telemetered quail were fixed at two hour intervals, diurnally. After a signal was detected, the quail was approached and circled at a distance that would not flush the bird. Each location was plotted on a field map. Signals were usually first heard at around 200 yards and the quail circled at 35 yards. The distance that a signal was first heard depended upon the transmitter, the length of time the transmitter had been activated, the cover the quail was in, the cover between the observer and the bird, and the wind conditions.

V. WEATHER

Bihourly temperature, total daily rainfall, and total daily wind movement were obtained from an official weather station of the U. S. Weather Bureau located on the Ames Plantation three miles from the study area. Relative values of temperature, cloud cover, and wind velocity were recorded at each trapping round and telemetry location.

VI. STATISTICAL COMPARISONS

Data processing was chiefly performed by computer programming. The relationship of the type of cover used at two hour intervals was examined by use of a Chi-square test for goodness of fit. Duncan's Unequal Multiple Range Test was used to examine relationships between two-hour movement periods during the day. All tests were run at the 95 percent level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

In 1971, 234 quail were marked on the study area; 410 individuals were marked in 1972. Seventy-four of the quail captured in 1972 were marked previously, yielding a total of 570 individuals captured during the two-year study. A total of 1478 captures was recorded, with the preponderance of these being males (487 males - 1270 captures) (Table I).

It required 1414 trap days to obtain the 1478 captures (1.05 per day), with unmated males yielding the highest ratio (.81 per day) (Table II). Daily trapping ratios varied from 0 to a high of 2.75 on June 23, 1972. The peak ratio in 1971 was 2.25 on July 27.

About half (324/644) of the quail were caught only once in the same year, while only two were trapped more than 12 times (Table III). Some males were trap prone and returned to the same trap as frequently as five times in one day, yielding little movement data. Great individual variation in behavior occurred, as one male was caught 18 times at only three trapsites while another was caught 10 times at 10 different trapsites. Of the 320 quail caught two or more times, 248 were caught in at least two different trapsites (Table IV), thus yielding movement data.

The ratio of adults to subadults decreased from 1:2.51 in 1971 to 1:2.03 in 1972 (Table V). Maximum ages were not determined, although 13 males and 1 female trapped in 1972 were at least three years old.

TABLE I

SEX, AGE, AND MATING STATUS OF QUAIL TRAPPED ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASONS OF 1971 AND 1972

Class	1971		1972		Total	
	Number of Individuals	Number of Captures	Number of Individuals	Number of Captures	Number of Individuals	Number of Captures
Males[a]	180	426	307	844	487	1270
Unmated	164	402	290	756	454	1158
Mated	24	24	69	88	93	112
Females[a]	27	29	92	128	120	157
Unmated	6	6	23	26	29	32
Mated	22	23	75	102	98	125
Young	27	40	10	11	37	51
Total	234	495	410	983	644	1478

[a]Unmated and mated categories may not add up to total since some birds were caught as both mated and unmated on different captures and fell into both categories.

TABLE II

TRAP SUCCESS RELATED TO SEX-AGE GROUPS ON THE AMES PLANTATION IN WEST TENNESSEE FOR THE BREEDING SEASONS OF 1971 AND 1972

Class	Number of Quail Caught Per Trap Day		
	1971	1972	Total
Males (Adult)	.884	.907	.899
Females (Adult)	.058	.137	.110
Young	.083	.012	.036
Total	1.025	1.056	1.045

TABLE III

NUMBER OF TIMES INDIVIDUAL QUAIL WERE TRAPPED ON THE AMES PLANTATION DURING THE BREEDING SEASONS OF 1971 AND 1972

Number of Times Trapped	Males			Females			Young	Total		
	1971	1972	Total	1971	1972	Total	Total	1971	1972	Total
1	85	129	214	25	62	87	23	124	200	324
2	38	58	96	2	27	29	14	53	86	139
3	18	43	61	-	4	4	-	18	47	65
4	15	26	41	-	-	-	-	15	26	41
5	13	14	27	-	-	-	-	13	14	27
6	4	11	15	-	-	-	-	4	11	15
7	1	7	8	-	-	-	-	1	7	8
8	3	11	14	-	-	-	-	3	11	14
9	1	1	2	-	-	-	-	1	1	2
10	1	4	5	-	-	-	-	1	4	5
11	-	-	-	-	-	-	-	-	-	-
12	1	1	2	-	-	-	-	1	1	2
>12	-	2	2	-	-	-	-	-	2	2
Total	180	307	487	27	93	120	37	234	410	644

TABLE IV

NUMBER OF DIFFERENT TRAPS ENTERED BY INDIVIDUAL QUAIL DURING THE BREEDING SEASONS OF 1971 AND 1972 ON THE AMES PLANTATION IN WEST TENNESSEE

Number of Different Traps Entered	Males			Females			Young	Total		
	1971	1972	Total	1971	1972	Total	Total	1971	1972	Total
1	115	160	275	26	72	98	23	155	241	346
2	40	70	110	1	18	19	14	54	89	143
3	16	37	53	-	3	3	-	16	40	56
4	16	24	30	-	-	-	-	6	24	30
5	2	10	12	-	-	-	-	2	10	12
6	1	3	4	-	-	-	-	1	3	4
7	-	2	2	-	-	-	-	-	2	2
8	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-
10	-	1	1	-	-	-	-	-	1	1
Total	180	307	487	27	93	120	37	234	410	644

TABLE V

AGE RATIOS OF MATURE QUAIL TRAPPED DURING THE BREEDING SEASONS OF 1971 AND 1972 ON THE AMES PLANTATION IN WEST TENNESSEE

Class	1971		1972	
	Number	(Percent)	Number	(Percent)
Males				
Subadult	127	(70)	206	(67)
Adult	53	(30)	101	(33)
Females				
Subadult	21	(78)	62	(67)
Adult	6	(22)	31	(33)
Total				
Subadult	148	(71)	268	(67)
Adult	59	(29)	132	(33)
Age ratio	1:2.51		1:2.03	

Four males were trapped in 1971 that had been banded in a previous study and were at least three years old when trapped. One of these four males was also trapped in the summer and fall of 1972, making him at least four years old. Summer trapping methods precluded determining sex ratios. The adult sex ratio obtained from bait trapping and shooting of 142 quail in the fall of 1972 was 145 males for each 100 females.

I. CHRONOLOGY

Most birds mate in late winter while still strongly associated with coveys (Rosene, 1969). In the present study, the disintegration of coveys into mated pairs and singles was a gradual process, culminating during the last week in April and the first week in May. The chronology of disintegration was similar for both years. Coveys were regularly observed in early April, with most birds still in coveys until mid-April. From mid-April until early May, the coveys slowly broke up and birds usually appeared as small groups, pairs, or singles.

Trapping was initiated while most quail were in coveys. Fifty-eight quail were captured before mid-April, while most quail were still strongly associated with coveys. Sixty-three additional quail were caught between mid-April and May 1, when coveys were in the process of dissolving. These 121 quail probably were using the ranges they occupied during winter. During the entire study period, only two males moved more than 1/2 mile, and this movement occurred in the mid-April to May 1 period. Thus it appears that what lengthy movement that does take place occurs while coveys are in the process of dissolving.

Urban (1972) reported that covey ranges shifted during April in Illinois. He found that coveys lacking sizable weedy areas in their late winter home range expanded their range to include such areas. On Ames Plantation adequate nesting areas were available over the entire study area and would require no more than slight shifts for utilization to occur (Figure 1, page 7). Small shifts were detected when comparing the home ranges of telemetered quail with those established by trapping early in the breeding season (Figures 2 and 3).

Trapping records show the pattern of covey dissolution. From the beginning of trapping until mid-April, the majority of birds captured were unmated males that apparently had been attracted to the calling hens from intact coveys. Before mid-April, only 21 percent (4/19) of the quail were caught as mated pairs or groups in late evening. These four were captured on a warm day in early April. From mid- to late-April, 44 percent (15/34) of the quail caught in late evening were either pairs or groups. These pairs and groups probably split from the coveys in the daytime, only to be lured in by the call of the decoy hens for coveying as dark approached. Lehmann (1946a) and Rosene (1969) mentioned that coveys dissolve during the day and regroup at night to roost during the warmer days of mid-April, probably explaining this trapping pattern.

Quail may regroup into coveys even after complete dissolution when severe weather occurs early in the breeding season. On May 24, 1971, a covey of 11 quail was flushed from an open soybean field and flew 60 yards together to cover. Two hours after the covey was sighted, a severe thunderstorm struck the area. The next day, a covey of eight

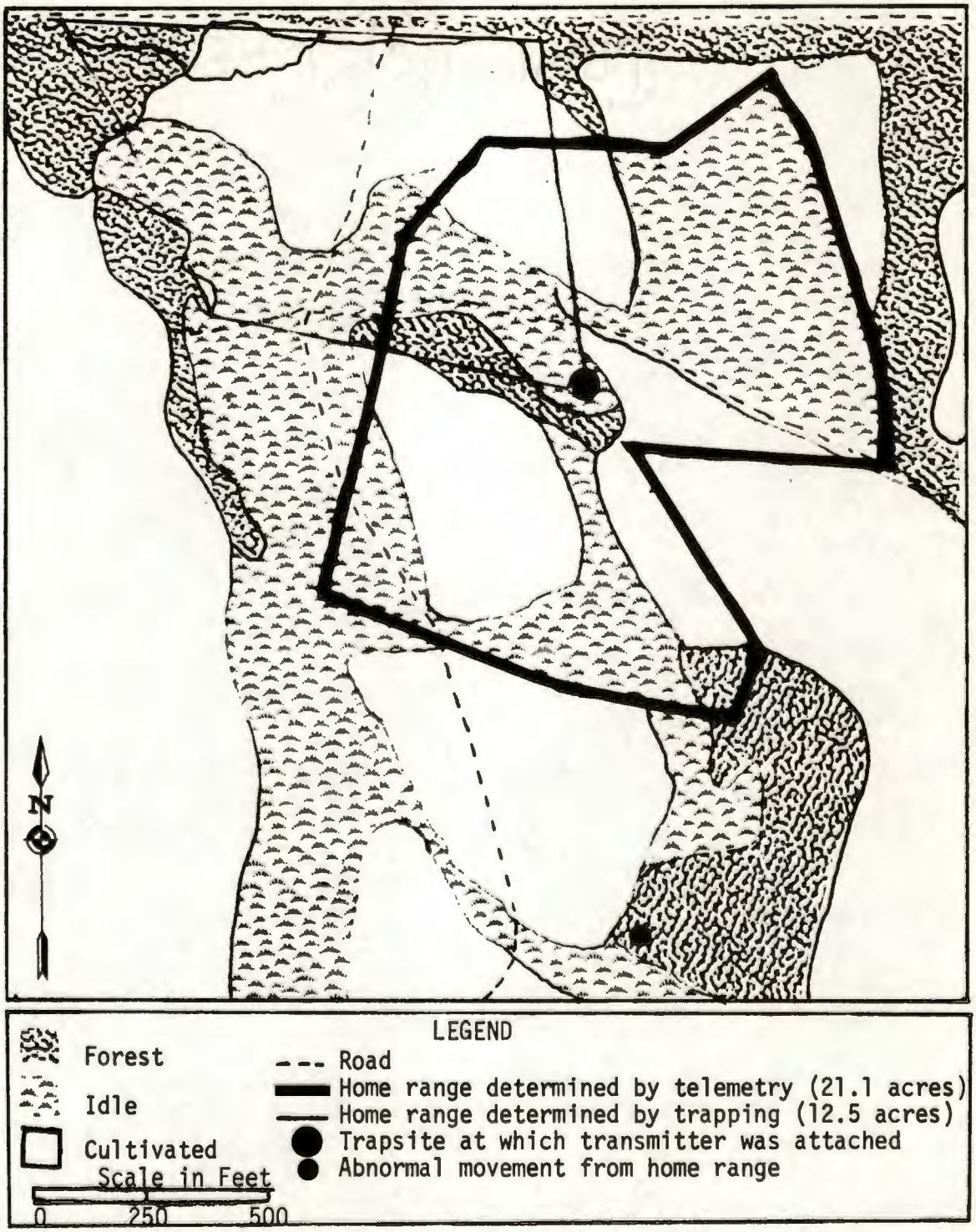


Figure 2. Home range of unmated male radiotracked from May 26 to June 21, 1972, on the Ames Plantation in West Tennessee.

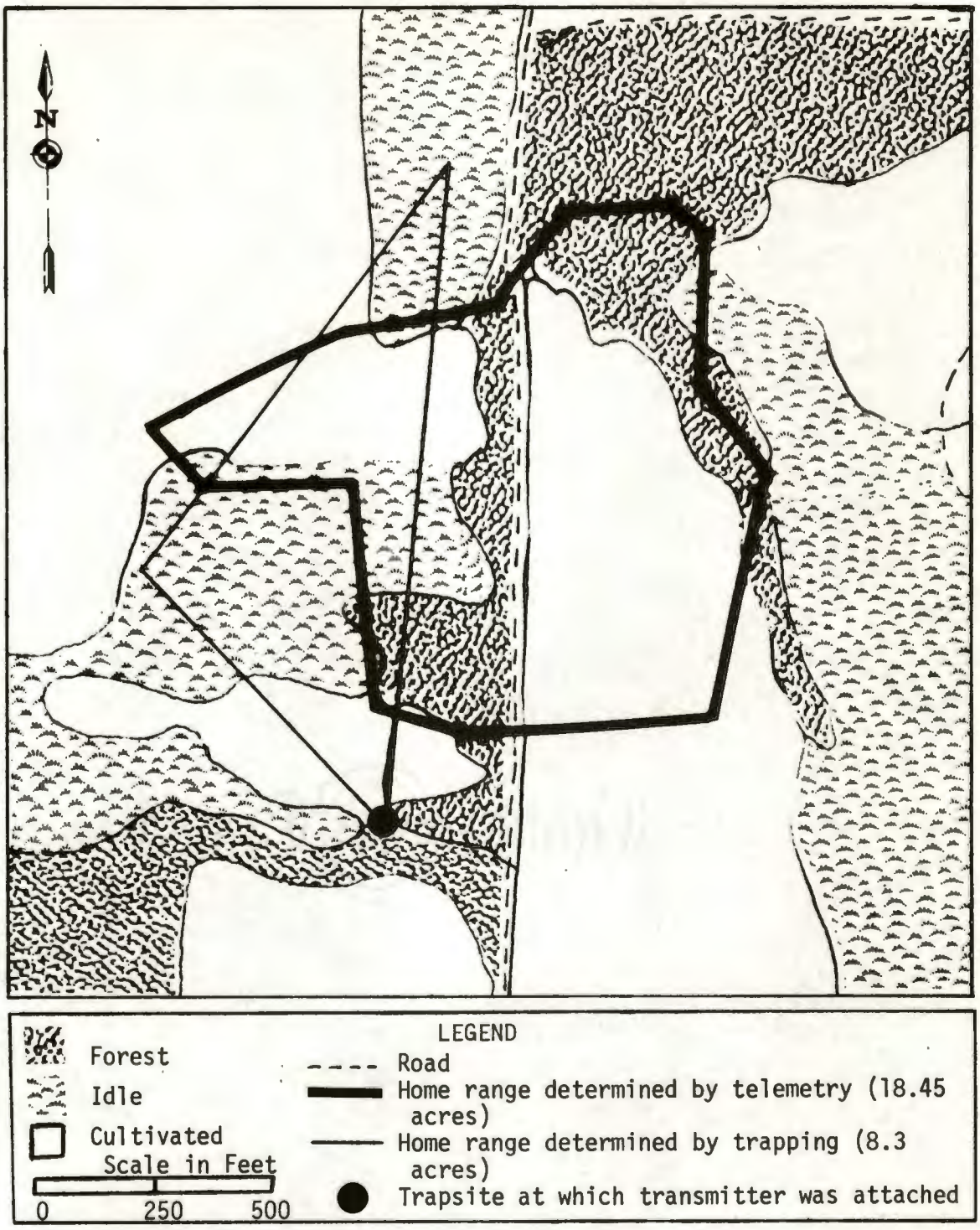


Figure 3. Home range of unmated male radiotracked from June 28 to July 13, 1972, on the Ames Plantation in West Tennessee.

quail was flushed within 150 yards of the previous covey flush. In 1972, coveys of four and six quail were seen on May 8, and a covey of 10 quail was observed on May 9. A severe rain storm occurred on the evening of May 8. The above coveys were observed from one to three weeks after all coveys on the study area had disbanded. In Texas, Lehmann (1953) found that quail will covey in the breeding season during periods of extreme weather - in his case drought. The late spring "coveys" in the present study probably provided a temporary protective measure and were not a reflection of "non-breeding" in the population.

The adult birds spent the period from early April to late August as mated pairs or singles. The mated pairs were actively engaged in nesting activities while the unmated birds (predominantly males) spend most of their time calling and feeding alone or associating themselves with a mated pair. Broods were first noticed on the study area in late May and the number of young seen increased as the breeding season progressed. By the end of August, trapping success had drastically decreased and calling activity had all but ceased (Table VI), although some mated pairs continued egg laying and incubation until late September (Dimmick, personal communication). Trapping records suggest that coveys begin forming by late August. By early November (and probably before) all of the quail on the area had joined coveys. Although the time of breeding activity extended over a long period (eight to nine months) and included different activities, most of the quail displayed limited movement during the breeding season.

II. HOME RANGE CHARACTERISTICS

Maximum home range dimensions were established by measuring the

TABLE VI

EFFECT OF TIME OF DAY AND TIME OF YEAR ON THE NUMBER OF DIFFERENT QUAIL HEARD WHISTLING ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1972

Date	Station 1		Station 2		Station 3		Total	
	Time 1[a]	Time 2[b]	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
May 10	7	5	4	6	5	5	16	16
May 17	5	5	6	7	8	5	19	17
May 26	8	5	9	6	6	7	23	18
June 1	9	8	10	8	10	7	29	23
June 8	9	10	8	8	10	5	27	23
June 14	9	8	7	6	8	7	24	21
June 21	10	7	8	7	6	5	24	19
June 30	10	6	7	7	3	7	20	20
July 8	8	6	7	4	4	5	19	15
July 15	10	7	7	8	5	6	22	21
July 23	8	11	9	8	9	7	26	26
July 31	11	10	11	11	9	8	31	29
August 4	5	4	6	7	5	5	16	16
August 11	7	5	7	2	5	8	19	15
August 17	4	2	3	2	2	2	9	6
August 24	0	0	0	0	0	0	0	0
Total	120	99	109	97	95	89	324	285

[a]Started at sunrise and continued until 40 minutes after sunrise.

[b]Started at 40 minutes after sunrise and continued until 75 minutes after sunrise.

distance between the birds two most distal trapsites or telemetry locations. Quail caught at two or more trapsites or at the same trapsite on two different trapping rounds provided data adequate for determining dimensions. The dimension data were intended to estimate the maximum distance moved within a home range during different seasons. Home range areas were established by connecting the outermost locations of telemetered quail or by connecting the outermost trapsites for quail trapped at three or more different trapsites. The area data were intended to estimate the maximum areas, in acres, of home ranges of the quail during the breeding season.

Dimensions During Spring (March 27 to May 31)

Quail on the study area showed little inclination for moving long distances between their late winter covey range and their individual ranges during the breeding season. Sixty-eight of the 70 quail (97 percent) observed during this period moved less than 1/2 mile, while 59 of 70 (84 percent) showed a maximum home range dimension of less than 1/4 mile (Table VII). The mean distance moved by 64 males was 866 ± 780 feet, while six female ranges averaged 462 ± 363 feet. Only two birds, both males, moved more than 1/2 mile. Both of these males established their summer home range on the area by May 1. The qualifications given by Murphy and Baskett (1952) for analyzing home ranges from trapping records apply here. These qualifications are: (1) the grain bait and decoy females may have influenced movement, (2) the chances of retrapping the more sedentary birds were greater than of retrapping the highly mobile ones, and (3) the returns may represent minimum distances because birds may have wandered beyond the

TABLE VII

DISTANCES QUAIL MOVED DURING CERTAIN SEASONS ON THE AMES PLANTATION IN WEST TENNESSEE. RESULTS ARE SUMMATION OF DATA COLLECTED IN THE 1971 AND 1972 BREEDING SEASONS

	Spring				Summer				Total Breeding Season				
									Males				
Distance in Miles	Males (n=64)	Females (n=6)	Young (n=0)	Total (n=70)	Males (n=144)	Females (n=11)	Young (n=14)	Total (n=169)	Unmated (n=193)	Mated (n=18)	Females (n=27)	Young (n=14)	Total (n=252)
0 - 1/4	53	6	0	59	113	10	14	137	162	16	24	14	216
1/4 - 1/2	9	0	0	9	31	1	0	32	29	2	3	0	34
1/2 - 3/4	1	0	-	1	0	0	0	0	1	0	0	0	1
3/4 - 1	1	0	0	1	0	0	0	0	1	0	0	0	1

trap locations and returned before being trapped. The low mobility within the area and the fact that 34 percent (81/234) of the quail banded in 1971 were retrapped on the study area in 1972 illustrate the markedly sedentary nature of the quail population during this study.

Dimensions During Summer (June 1 to September 1)

Summer was a season of very low mobility, as no quail moved more than 1/2 mile in the summer. Seventy-eight percent (113/144) of the males and 91 percent (10/11) of the females moved less than 1/4 mile (Table VII). The maximum home range dimension of all trapped quail was 787 ± 476 feet (mean ± standard deviation), with males (827 ± 490 feet) having slightly larger ranges than females (621 ± 429 feet).

Home Range Characteristics During the Total Breeding Season (March 27 to September 1)

Dimensions of home ranges during the entire breeding season were determined for 252 quail through trapping and for 7 quail by radio-tracking. Home range areas were established for all 7 telemetered quail, while 104 of the trapped quail yielded enough captures to give an indication of their home range areas.

Dimensions during the total breeding season. A total of 252 quail (193 unmated males, 18 mated males, 27 females, and 14 young-of-the-year) was captured frequently enough to establish the dimensions of their home ranges for the entire breeding season (Table VII). Five unmated males and one mated pair were radiotracked for sufficient time to establish home range dimensions.

Unmated males (856 ± 824) had larger home ranges than mated males

(678 ± 412 feet) or females (609 ± 453 feet). The difference, however, was not statistically significant, possibly due to the comparatively small numbers of mated males (18) and females (27) for which data were available and the high variance inherent to the study. It is quite possible, however, that the data would be biased to show greater movement for unmated males, since they would be more likely to be trapped. Urban (1972) found through telemetry that unmated males have significantly larger home ranges than mated males. He found female home ranges to average smaller than mated or unmated males, though these results were not tested statistically.

Maximum home range dimensions of all telemetered quail averaged 1527 feet in length and 1026 feet in width. Home range shape of telemetered quail varied greatly - from nearly circular (Figure 2, page 24) to elongate (Figure 4). The home range dimensions of trapped birds also varied greatly, with many appearing to be nearly a straight line. It appeared that when enough trapping locations were obtained to get a reasonable idea of the home range, it resembled an ellipse of dimensions comparable to those established through radiotracking (Figure 5).

The data strongly indicate that the breeding season is a period of very low mobility for bobwhites in West Tennessee. More than 99 percent of the 252 quail for which adequate data were obtained moved less than 1/2 mile, while most (84 percent) moved less than 1/4 mile. It is realized that the average home range is probably greater than the 772 ± 560 feet established by trapping because: (1) the probability of catching a bird on the two most distal points of its home range is low,

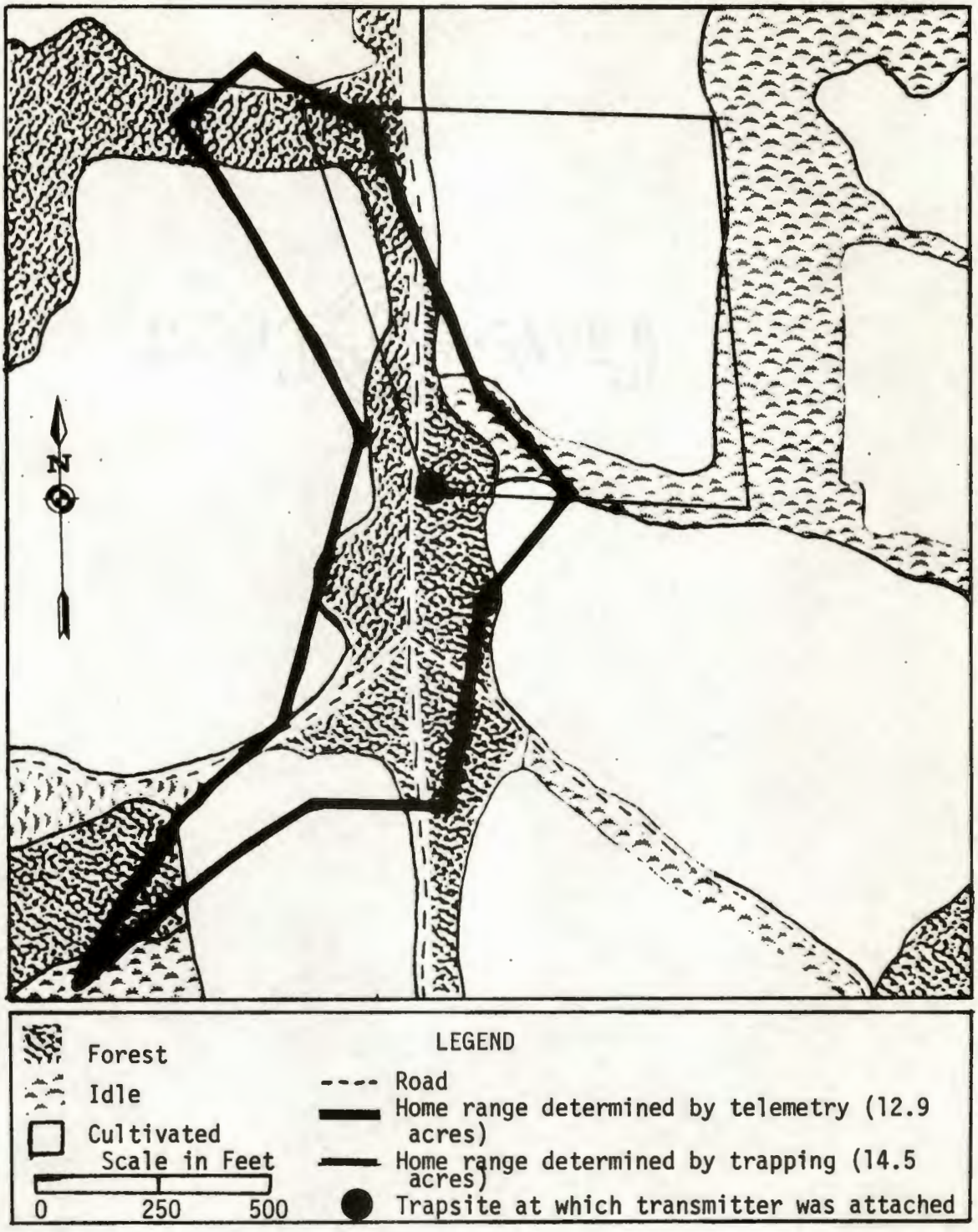


Figure 4. Home range of unmated male radiotracked from May 19 to June 6, 1972, on the Ames Plantation in West Tennessee.

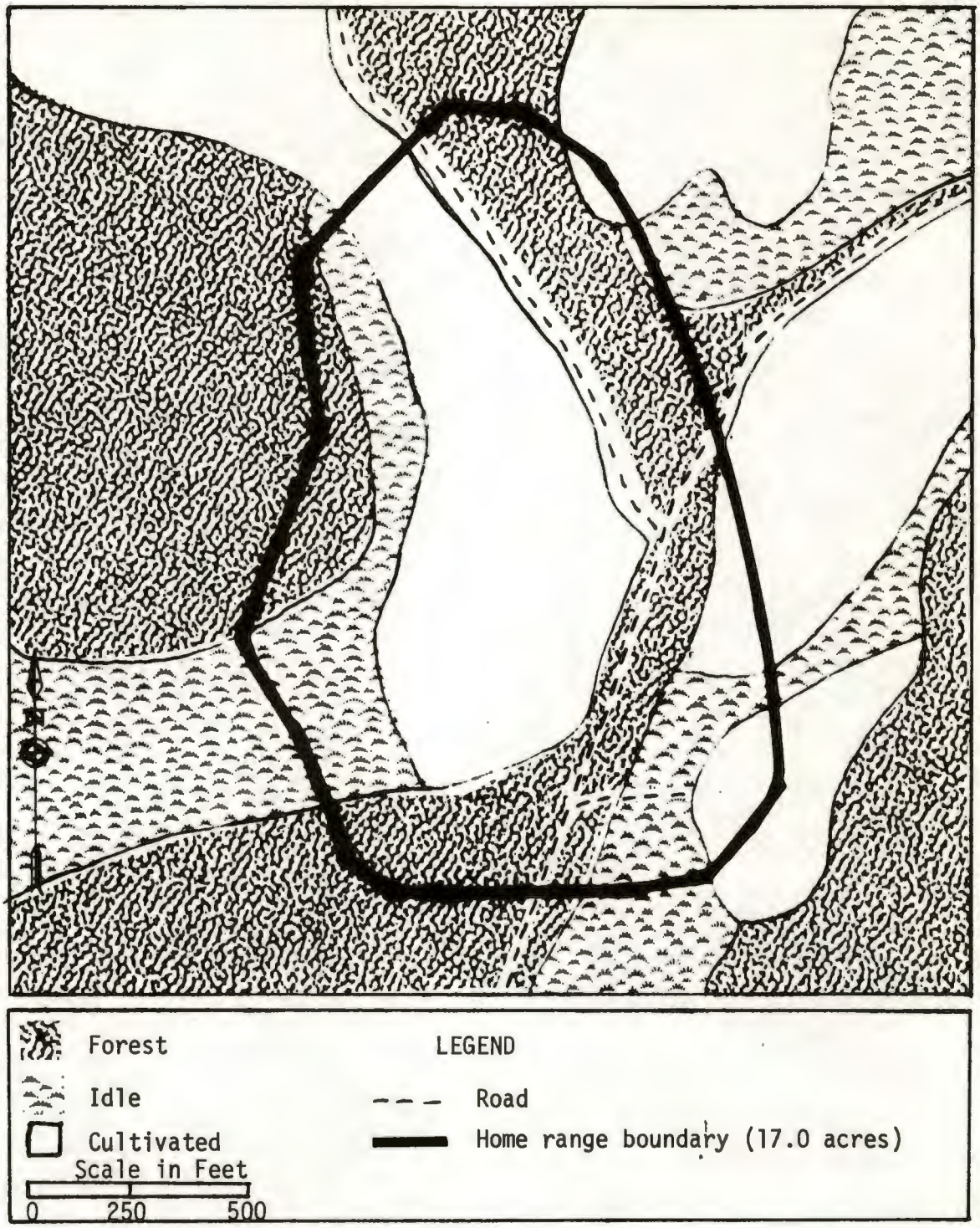


Figure 5. Hypothetical drawing of a typical unmated male home range as estimated from examining home range characteristics of quail on the Ames Plantation in West Tennessee during the breeding seasons of 1971 and 1972.

(2) birds with only part of their home range on the study area would not show the actual maximum home range dimension, and (3) birds inclined toward greater mobility may have moved off of the study area.

The movement of 14 young-of-the-year quail averaged 505 ± 125 feet. Thirteen of these birds represented only two broods, thus not enough data for different broods were gathered to make any concrete statements, although the movements of young-of-the-year did seem limited. The period of capture for junveniles fell between July 7 and September 1.

Area encompassed during the total breeding season. Home ranges of 104 quail (92 unmated males, 9 mated males, and 3 females) were established through trapping. Accurate home ranges of three unmated males and one mated pair were established through radiotracking. Home ranges of two additional unmated males were determined, although radiotracked for only a limited period of time. Home ranges of these two males were comparable to the three unmated males radiotracked for a longer period of time.

Home range areas of the unmated males determined by trapping varied from 1/4 to 71 acres, while the mated males home ranges varied from 1/2 to 21 acres (Figure 6). No realistic estimations of female home range areas were established through trapping. Sufficient data were not gathered to compare the home range size of mated and unmated males in the present study. Urban (1972) found home ranges of mated males and females to be only half that of unmated males.

Only the summer home ranges of the two males that showed definite seasonal shifts were used in the analysis. It is realized that most of

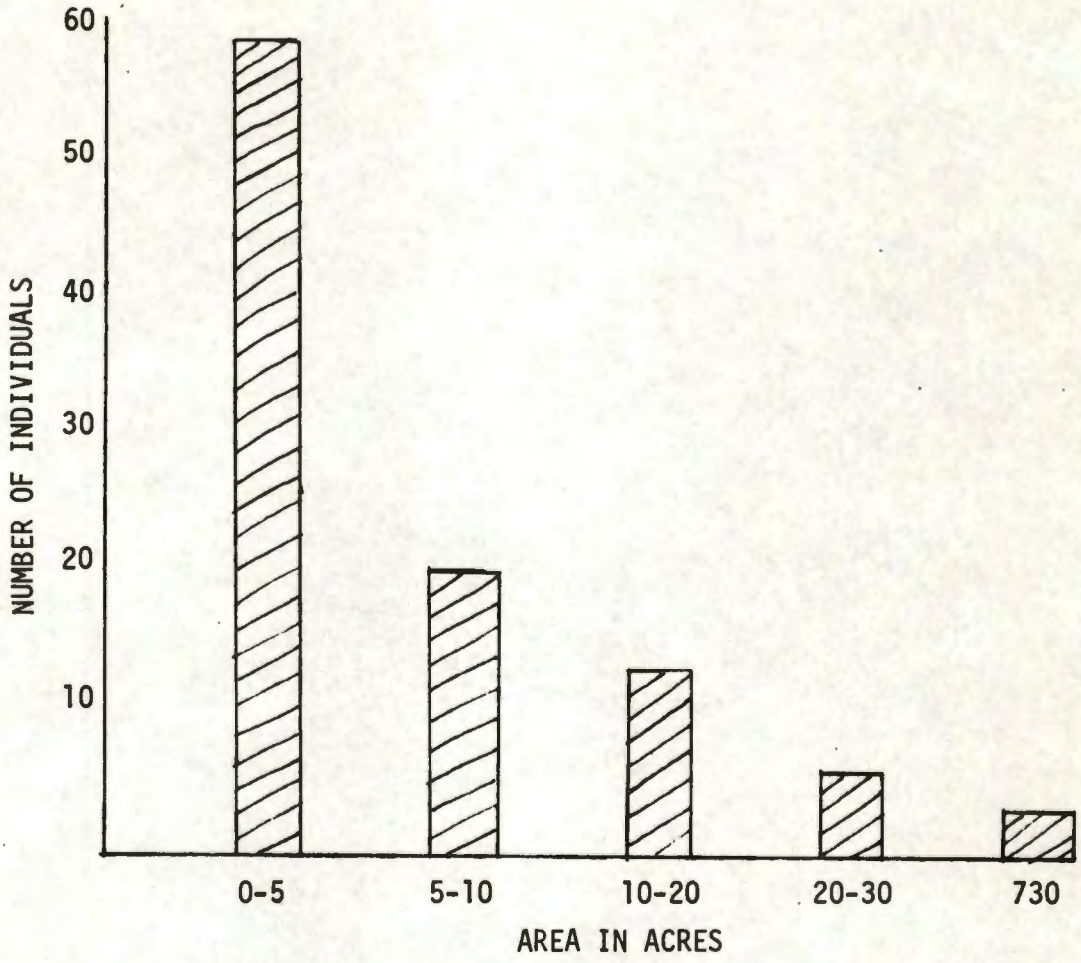


Figure 6. Distribution of home range areas determined through trapping on the Ames Plantation in West Tennessee for the breeding seasons of 1971 and 1972.

the trapped birds probably had larger home ranges than those defined because: (1) the birds probably were not trapped at all the extremities of their home ranges, (2) some of the birds probably had their home ranges partly off of the area, and (3) some of the home ranges appeared as nearly straight lines. In an attempt to obtain a realistic estimation of home range areas, all observations of less than five acres were discarded in the analysis of home range areas (Figure 6). It was noticed that many home ranges of less than five acres appeared as straight lines or near the edge of the area. The 71 acre home range was also discarded. Although these arbitrarily imposed qualifications are subject to criticism, it is thought that they increased the accuracy of home range estimations through trapping. The average home range area of the 43 male quail was 12.5 (± 8.2) acres. The difficulty encountered when trying to estimate home range areas through trapping reduced the value of trapping as a tool for determining home range areas.

The five radiotracked unmated males had an average home range size of 17 ± 3 acres. A comparison of four of these birds home ranges determined by both trapping and radiotracking is presented in Figure 2, page 24; Figure 3, page 25; Figure 4, page 32; and Figure 7. These figures suggest that the home range established by trapping is about half of the home range established by radiotracking. The comparison is complicated by the fact that slight seasonal shifts may have occurred in the home ranges established by trapping.

Most quail on the study area had a breeding season home range of less than 25 acres; only 6 of 111 quail contained a larger area in

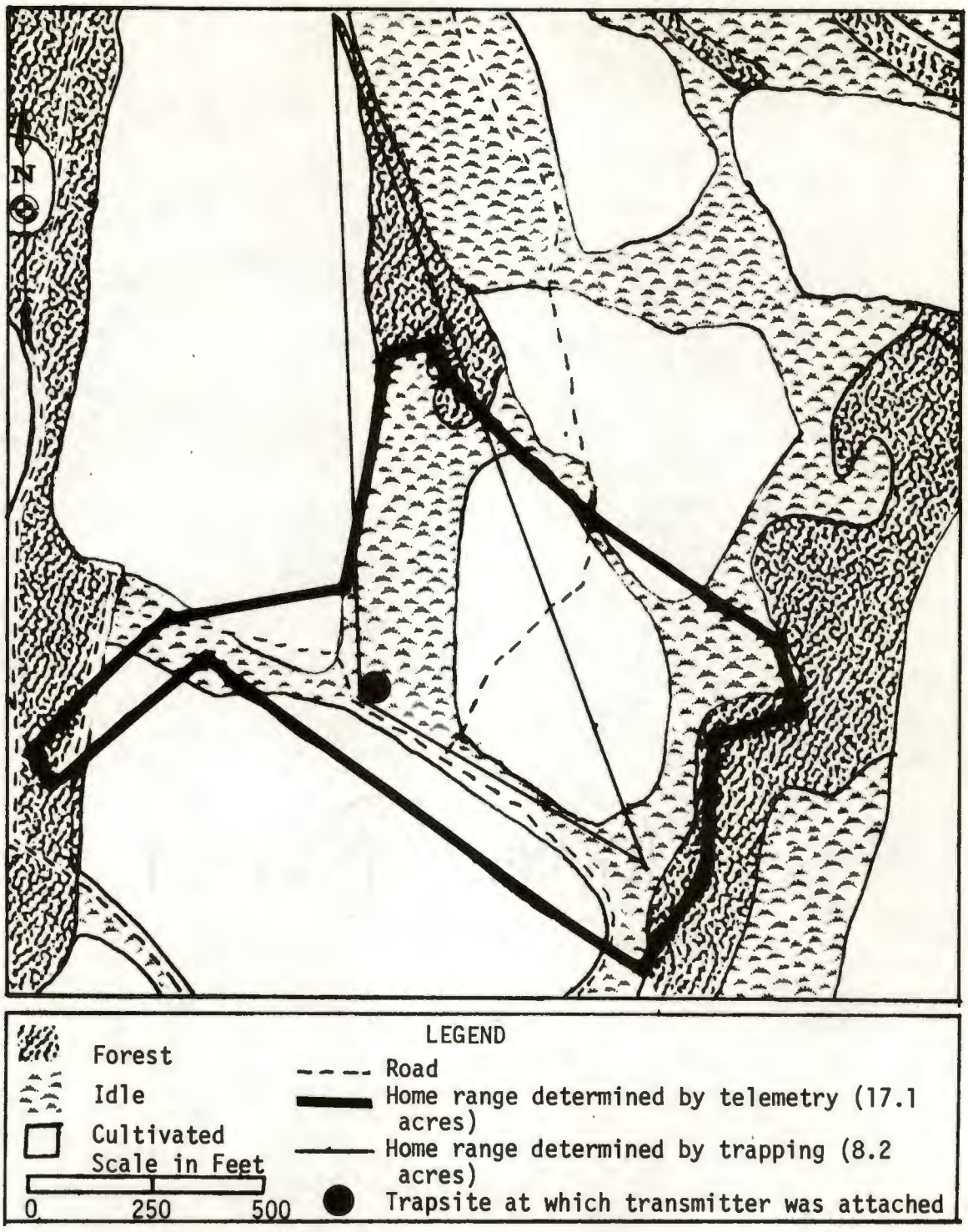


Figure 7. Home range of unmated male radiotracked from June 1 to June 16, 1972, on the Ames Plantation in West Tennessee.

their home range. The 17-acre home range determined through radiotracking is thought to be a realistic estimate of the area occupied by unmated males.

Accurate home range data were obtained from one mated pair through radiotracking. Their home range encompassed 38.4 acres (Figure 8). It is very possible that this pair was radiotracked following nest destruction. Urban (1972) found that hens may move considerably following nest destruction. It is not thought that the established home range is an accurate example of the home range of the average mated pair. The pair did suggest strong pair-bond fidelity as they were located together at every check after the initial "adjustment" period and reunited quickly following disturbance.

Fidelity to home range boundaries. Home range boundaries were roughly established within five days after "normal" behavior began following transmitter attachment. Quail usually remained within the confines of their home range thereafter.

Some data were gathered to suggest that males will venture beyond the normal boundaries of their home range to the call of an available hen. One male (Figure 2, page 24), for which good home range data were obtained, approached a decoy hen in a trap that was 500 feet from the nearest point of his home range. He did not enter the trap and returned to his normal home range within four hours. He never again left his normal home range. Another radiotracked male (Figure 7) left his home range by 550 feet one afternoon. He returned to his normal home range the next morning; the reason for this movement was not determined.

Four unmated males were trapped outside of their established home

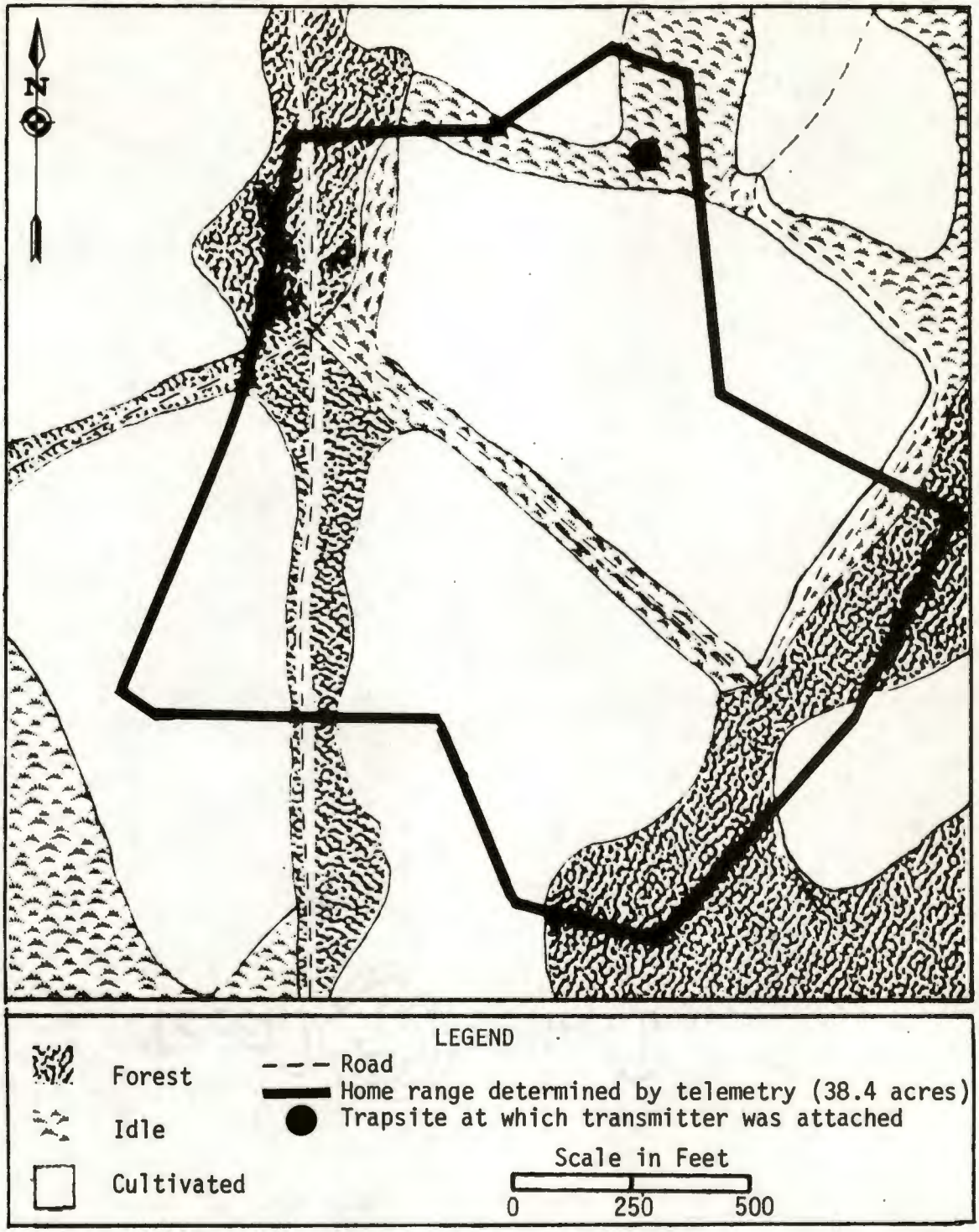


Figure 8. Home range of mated pair radiotracked from June 19 to July 12, 1972, on the Ames Plantation in West Tennessee.

ranges. One (Figure 3, page 25) never ventured closer than 315 feet to the trapsite at which his transmitter was attached. Another (Figure 7, page 37) was trapped 660 feet from his nearest radiotracking point only 12 days after his transmitter was removed. The other instances that the males were trapped outside of their home range that was determined by radiotracking possibly reflect slight seasonal movements rather than movement from an established home range.

It appears that even though home range boundaries usually are observed rather stringently, the stimulus of the call of an available hen is strong enough to cause the unmated male to leave his established home range.

Activity centers within home ranges. Only one telemetered bird (Figure 2, page 24) exhibited a definite activity center (more than 20 locations within a 50 square yard area). This center was a small cover strip from which he and other males were frequently heard calling. This activity center was used frequently for loafing throughout the day and was situated near the center of the home range. However, this male did not restrict his calling to this one location and occasionally did not use the center for entire days. None of the other unmated males showed definite activity centers and used their entire range nearly uniformly. The mated pair (Figure 8) showed signs of an activity center as they were found 18 times within the established limits. This area was a honeysuckle-hardwood complex and was used primarily as a roosting headquarters.

III. MOVEMENTS

Telemetered quail were located at two-hour intervals during the day. The straight line distance between these locations was established as the distance moved in the period. Daily movements were established as the sum of the bihourly movement for telemetered quail and the distance between the two most distal trapsites for trapped quail. Seasonal movements were established as the movement from a trapsite in one season to a trapsite in the other season (e.g., the last trapsite in the breeding season of 1972 to the first 1972 fall trapsite or collecting point established breeding season to fall movement).

Daily Movements

Daily movements were obtained from five unmated males and one mated pair through radiotracking and 37 birds that were caught at two or more trapsites in the same day. Telemetered quail occasionally covered their entire home range in one day, although no set patterns of movement became evident. Radiotracked unmated males moved a mean distance of 2145 feet per day. This average daily movement is greater than the 1281 feet reported by Yoho (1970) as the average daily movement of coveys on the area in late winter. Longer day length (resulting in one additional period) undoubtedly had a major effect on their distance moved. It did appear that unmated males moved more than birds in coveys, though, as average movements were higher for all periods except the first. The radiotracked mated pair averaged 3199 feet moved per day. Again, it is thought that this pair represents

the movements of a pair following nest destruction and are not indicative of a typical mated pair.

Daily movement of 37 birds determined by trapping varied from 92 to 1228 feet, averaging 627 ± 236 feet. Thirty-five of these birds were males and two were females. The two females moved 684 and 667 feet. These daily movements suggest that quail frequently move around within their entire home range, as the maximum distance moved for all quail over the entire breeding season was determined by similar methods as only 772 ± 560 feet.

The use of decoy hens temporarily restricted the daily movement of birds on the area. On 146 occasions, a male was trapped in the same trap at least two times in one day. Males were caught at least three times in the same trap in the same day on 31 occasions while two males were caught in the same trap five times in one day. Although the traps temporarily restricted the movement of males, the traps were moved often enough (every other day) to allow for adequate movement since trapping took place over a five month period.

Movement from Spring to Summer Range

Quail showed little inclination to move between the spring and summer seasons of the same year. Distances recorded were the distance from the first spring to the first summer trapsite. Most birds (121/123 - 98 percent) moved less than 1/2 mile while many (102/123 - 83 percent) moved less than 1/4 mile (Table VIII).

Subadult males (males going into their first breeding season) did not show significantly greater movement than adult males. Seventy-seven subadult males moved 753 ± 599 feet, while 33 adult males

TABLE VIII

DISTANCES MOVED FROM SPRING TO SUMMER RANGE ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASONS OF 1971 AND 1972

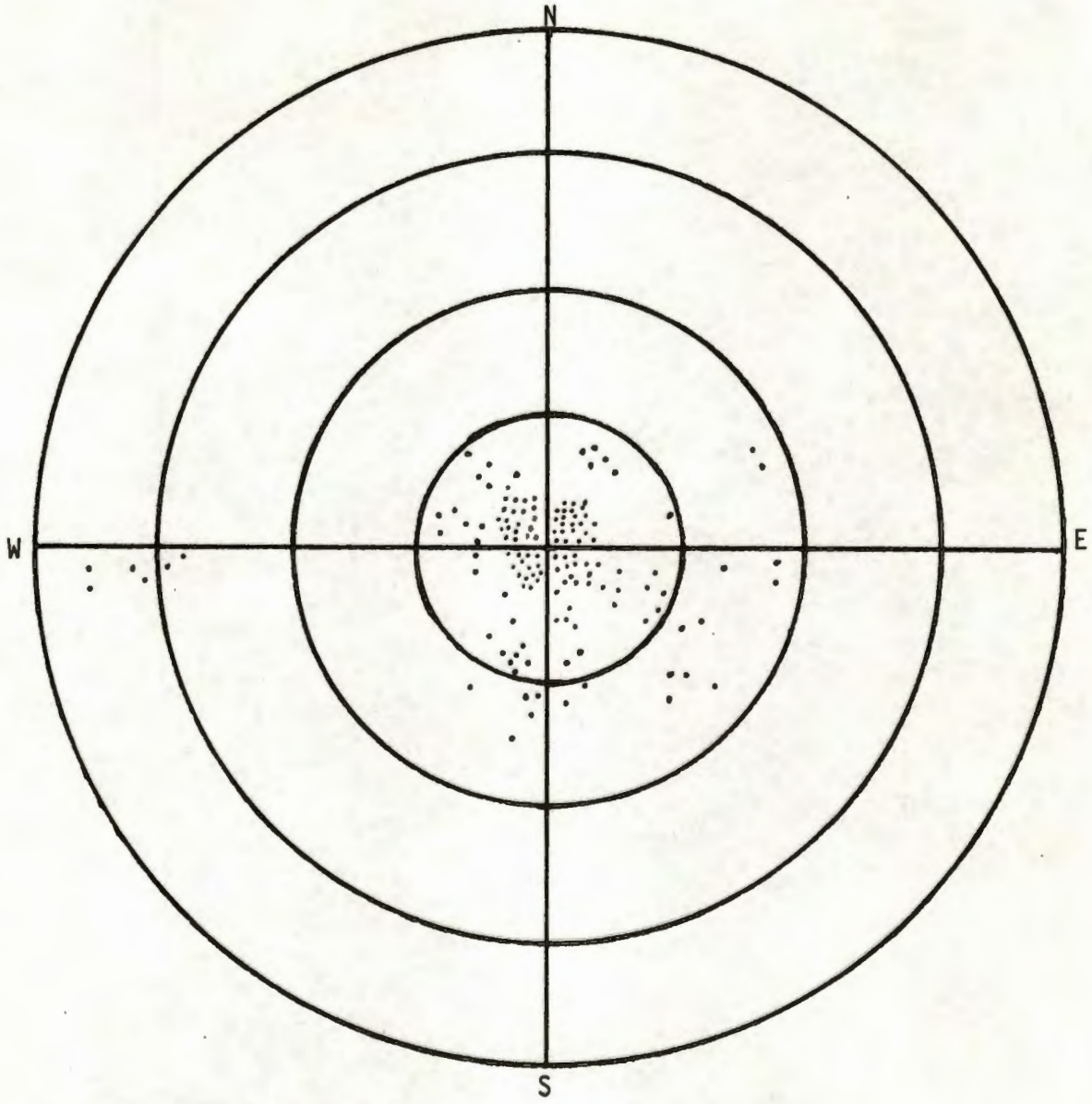
Distance in Miles	Males			Females (n=13)	Total (n=123)
	Subadult (n=77)	Adult (n=33)	Total (n=110)		
0 - 1/4	63	28	91	11	102
1/4 - 1/2	13	4	17	2	19
1/2 - 3/4	1	1	2	0	2
>3/4	0	0	0	0	0

averaged 660 ± 747 feet. The mean distance moved by 13 females was 562 ± 518 feet. These data may not signify shifts in home range between spring and summer, as distance moved from spring to summer (708 ± 633) is not noticeably different from movement during the spring (831 ± 760), summer (787 ± 476), or total breeding season (772 ± 560). An examination of trapping records suggests that much of the movement is probably within a home range rather than a switch in areas used.

Movement During the Breeding Season

Colored back-tags were placed on 101 different male quail at eight different trapsites in an attempt to evaluate the extent of movement within the study area and to surrounding land. These birds were observed 138 times (Figure 9). Only six observations (probably the same bird) were obtained from more than 1/2 mile from the marking trapsites. One back-tagged bird was later trapped in this area. No other lengthy movements were detected and 96 percent of the observations were within 1/2 mile of their marking location. These data substantiate the results by other methods that there was little to no movement during and between seasons on the study area.

Although 214 out of the 487 males caught in the study were caught only once and could have conceivably moved off the study area, it is thought that the following possibilities are more likely: (1) the males became trap shy, (2) the males became or remained mated and stayed away from the traps (75 of the 214 males were classified as mated at their time of capture), or (3) the male died. A combination of these three possibilities may explain the failure to retrap these



Scale: 3" = 1 mile
Number of observations = 138

Figure 9. Direction and degree of movement of male bobwhite quail as determined by back-tagging on the Ames Plantation in West Tennessee during the breeding seasons of 1971 and 1972.

males. This reasoning is strengthened by the observations that: (1) little lengthy movement was detected on the study area and (2) 34 percent of the birds banded in 1971 were retrapped in 1972. This proportion (81/234) represents roughly the expected survival ratio on the study area. Had significant numbers of quail emigrated, capturing 81 quail banded one year previous would have been unlikely.

Movement from Breeding Season to Fall Range

Quail were captured during the fall of 1972 by two methods: bait trapping and shooting (Table IX). There was no significant difference in the movement detected by these two methods. One male that was collected approximately one mile from the study area was not used in comparing these techniques since comparable data were not available through trapping. The data provided some insight into the relationship between the individuals' summer and winter ranges.

Of the 63 different quail for which data were available, only two, both males, moved more than 1/2 mile. Forty-one males trapped or shot on the study area moved a mean distance of 948 ± 714 feet; 18 females averaged 786 ± 518 feet; and 3 young-of-the-year averaged 807 ± 599 feet. The difference in movement between males and females was not significant. Not enough data were compiled on young-of-the-year to make a statistical comparison. Again it must be emphasized that the overall mean of 894 ± 653 feet between the last summer location and the first fall observation does not necessarily mean that the quail moved this distance to establish their winter range. Most birds do not make lengthy movements from summer to winter range, and when winter habitat requirements are met, most quail (97 percent in this case) form coveys on or very near their summer home range.

TABLE IX

MOVEMENT OF QUAIL FROM THEIR 1972 SUMMER HOME RANGE TO THEIR 1972 FALL HOME RANGE ON THE AMES PLANTATION IN WEST TENNESSEE

Distance in Miles	Summer to Fall Trapping Point				Summer to Fall Collecting Point				Total			
	Males (n=27)	Females (n=11)	Young (n=2)	Total (n=40)	Males (n=16)	Females (n=10)	Young (n=1)	Total (n=27)	Males (n=42)	Females (n=18)	Young (n=3)	Total (n=63)
0 - 1/4	20	10	1	31	11	6	1	18	30[a]	14[a]	2	46
1/4 - 1/2	6	1	1	8	4	4	-	8	10	4[a]	1	15
1/2 - 3/4	1	-	-	1	-	-	-	-	1	-	-	1
3/4 - 1	-	-	-	-	-	-	-	-	-	-	-	-
1 - 1-1/4	-	-	-	-	1[b]	-	-	1[b]	1[b]	-	-	1[b]

[a]Three females and one male were both trapped and collected, thus resulting in the subtotals not equalling the total for these two categories.

[b]Collected off of study area.

Movement from Breeding Season Range to Breeding Season Range

Seventy-four quail banded in 1971 were recaptured in the breeding season of 1972. These data were used to evaluate the stability of home range ties between years.

No quail moved more than 1/2 mile and 77 percent moved less than 1/4 mile between the first summer trapsite in 1971 and the last summer trapsite in 1972 (Table X). Twenty-five of the 74 birds were captured at the same trapsite both years. The 74 quail included 52 mature males (29 percent of those banded in 1971) and 15 young (56 percent of those banded in 1971).

Mature males (790 ± 585 feet), mature females (809 ± 549 feet), and young (747 ± 643 feet) all showed similar patterns. The average movement for all sex-age groups combined was 783 ± 586 feet, roughly comparable to the maximum dimension of a bird's home range during a single breeding season. Thus it appears that quail spend successive breeding seasons in the same general area. Young of the preceding summer also establish their first breeding season home range near their rearing grounds.

Seven quail that were banded in 1971 and were not retrapped in the breeding season of 1972 were captured in the fall of 1972. These birds, four mature males and three young, were quite sedentary as the maximum movement recorded was only 1056 feet and the average movement was 520 feet.

Marsden and Baskett (1958) developed an "extinction" series and determined that the probability of recapture of a quail after one year is .01441. The formula that yielded the probability of recapture took

TABLE X

MOVEMENT OF QUAIL FROM THEIR 1971 BREEDING SEASON HOME RANGE TO THEIR 1972 BREEDING SEASON HOME RANGE ON THE AMES PLANTATION IN WEST TENNESSEE

Distance in Miles	Males (n=52)	Females (n=7)	Young (n=15)	Total (n=74)
0 - 1/4	40	6	11	57
1/4 - 1/2	12	1	4	17
>1/2	0	0	0	0

into account natural mortality, egress and ingress, and trapping intensity on the area. The large proportion of birds caught after one year in the present study (34 percent) implies that some factors differed in the present study. Possible reasons for discrepancies are: (1) more intensive trapping in the present study, (2) less mortality in the present study, and (3) less egree and ingress on the area. Although all of these reasons probably had an effect, it further indicates that there was little egress and ingress on the present study area.

Yearly Movements

Movements recorded for the spring to summer, summer to fall, and summer to summer seasons indicated no significant difference using Duncan's New Multiple Range Test. The average distances moved between seasons were very similar to that moved during the entire breeding season. Thus it is possible that little or no movement occurred between seasons, as the average movement between seasons could be encompassed by the normal breeding season home range.

Yoho and Dimmick (1972) reported that the winter home ranges on the same area as the current study averaged 16.7 acres and that coveys displayed rigid fidelity to their home ranges. Four males originally trapped by Yoho in the spring of 1970 were recaptured in the present study. Three were captured in the summer of 1971 and one in the summer and fall of 1972. The maximum distance moved by these birds was only 660 feet.

The data indicate that where suitable year round habitat is available (i.e., nesting cover, escape cover, and food), most of the quail can be expected to move less than 1/2 mile, while many will move

less than 1/4 mile. Thus, if favorable year round habitat is produced, a quail population equal to the carrying capacity of the created habitat can be expected to remain on the area.

IV. ACTIVITY PATTERNS

Seasonal Activity Patterns

Slight peaks in trapping success occurred during the biweekly periods of May 22 to June 4, June 19 to July 2, and July 17 to July 30 both years (Tables XI, XII, and XIII). The latter two peaks coincided with the hatching peaks of 1971, which occurred between June 16 to 30 and July 16 to 31. Only the June 19 to July 2 trapping peak was matched by a hatching peak in 1972 (Dimmick, unpublished data). If the hatching and trapping peaks are related, it would suggest that mated males may be available for remating - possibly late in the incubation period. Since mated males are separated from their female mates for extended periods during the incubation period, it might be possible to lure them into traps by the use of decoy females.

The call index conducted on the area in 1972 revealed calling peaks on June 1 and July 31 (Table VI, page 27), roughly matching the first and last trapping peaks. Peaks in calling activity are related to peaks in hatching (Speake and Haugen, 1960; Fatora et al., 1966). Thus, it is probable that since mated males will "bobwhite" when not accompanied by a hen (Kabat and Thompson, 1963; Stokes, 1967), they are also available to be lured into a trap by the call of a decoy hen at this time.

TABLE XI

INFLUENCE OF SEASON ON TRAPPING RESULTS ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1971

Date	Number of Quail Captured							
	Males			Females			Total Young	Total
	Unmated	Mated	Total	Unmated	Mated	Total		
May 8-May 21[a]	32	1	33	-	-	-	-	33
May 22-June 4[a]	44	4	48	-	-	-	-	48
June 5-June 18[a]	24	2	26	-	2	2	-	28
June 19-July 2	86	6	92	-	4	4	-	96
July 3-July 16	62	2	64	3	4	7	-	71
July 17-July 30	85	2	87	1	2	3	8	98
July 30-August 13	60	4	64	1	7	8	16	88
August 14-August 28	9	4	13	1	3	4	16	33
Total	402	25	427	6	22	28	40	495

[a]Only four traps were used in these biweekly periods instead of the usual eight.

TABLE XII

INFLUENCE OF SEASON ON TRAPPING RESULTS ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1972

Date	Number of Quail Captured							
	Males			Females			Total Young	Total
	Unmated	Mated	Total	Unmated	Mated	Total		
March 27-April 9	29	2	31	-	2	2	-	33
April 10-April 23	63	12	75	2	17	18	-	93
April 24-May 7[a]	51	6	57	2	7	9	-	66[a]
May 8-May 21	74	12	86	4	14	18	-	104
May 22-June 4	117	19	136	1	19	20	-	156
June 5-June 18	93	5	98	1	6	7	-	105
June 19-July 2	117	11	128	3	12	15	-	143
July 3-July 16	53	4	57	1	7	8	2	68
July 17-July 30	94	6	100	5	5	10	2	112
July 31-August 13	49	6	55	3	8	11	2	68
August 14-August 28	16	5	21	4	6	10	5	36
Total	756	88	844	26	102	128	11	983

[a]Five normal trap days were missing in this trapping session while researcher attended a meeting.

TABLE XIII

INFLUENCE OF SEASON ON TRAPPING RESULTS ON THE AMES PLANTATION IN WEST TENNESSEE FOR THE BREEDING SEASONS OF 1971 AND 1972

Date	Number of Quail Captured							
	Males			Females			Total Young	Total
	Unmated	Mated	Total	Unmated	Mated	Total		
March 27-April 9[a]	29	2	31	-	2	2	-	33
April 10-April 23[a]	63	12	75	2	16	18	-	93
April 24-May 7[a]	51	6	57	2	7	9	-	66[c]
May 8-May 21[b]	106	13	119	4	14	18	-	137
May 22-June 4[b]	161	23	184	1	19	20	-	204
June 5-June 18[b]	117	7	124	1	8	9	-	133
June 19-July 2	203	17	220	3	16	19	-	239
July 3-July 16	115	6	121	4	11	15	2	138
July 17-July 30	179	8	187	6	7	13	10	210
July 31-August 13	109	10	119	4	15	19	18	156
August 14-August 28	25	9	34	5	9	14	21	69
Total	1158	113	1271	32	124	156	51	1478

[a]Not trapped in 1971.

[b]Only four traps used in 1971 instead of the usual eight.

[c]Five normal trap days missed in this trapping session while researcher attended a meeting.

Daily Activity Patterns

Activity patterns were established for two hour periods during the day. The distance moved during these periods was the criterion used in establishing activity peaks. Bihourly movement patterns of unmated males revealed a minor activity peak in the first period and a major afternoon peak cresting in the last period (Table XIV, Figure 10). The afternoon activity peak was of much longer duration than the morning peak. Activity during any one period was highly variable, resulting in little significant difference between periods (Table XV). Peaks in activity correlate closely with quail activity peaks established by Fatora and Duever (1968) in their roadside count study.

Activity peaks of the mated pair (Table XVI) are similar to those of unmated males, although peaks occur in the second period in the morning (8:00 to 10:00 A.M.) and the next to last period in the afternoon (4:00 to 6:00 P.M.).

Response to the Call of Females

Male quail responded to the call of an available hen readily throughout the day (Table XVII). No distinct peaks were obvious when the data were pro-rated to equate the number of trap-checks per period. Trapping peaks were not as pronounced as activity peaks (Table XIV), as the minimum catch of 290 males in the 1:00 to 4:00 P.M. period is only 67 less than the peak of 357 in the 10:00 A.M. to 1:00 P.M. period. The high number of quail caught in the 7:00 to 10:00 A.M. and 10:00 A.M. to 1:00 P.M. periods may have developed because these periods contained the first check of the day, and quail had not yet encountered the traumatic experience of being trapped that day. The lack of a

TABLE XIV

BIHOURLY MOVEMENT PATTERNS OF UNMATED MALE QUAIL DETERMINED THROUGH RADIOTRACKING ON THE AMES PLANTATION IN WEST TENNESSEE FOR THE BREEDING SEASON OF 1972

Period	N	Distance Moved (Feet)		Range (Feet)		Coefficient of Variation (Percent)
		$\bar{x}$	(S.D.)	Low	High	
Before 8:00 A.M.	44	296	(214)	0	729	72
8:00-10:00 A.M.	41	239	(176)	0	782	74
10:00 A.M.-12:00 N	39	268	(235)	0	1025	88
12:00 N-2:00 P.M.	37	257	(241)	0	1083	94
2:00-4:00 P.M.	36	313	(243)	0	909	78
4:00-6:00 P.M.	34	365	(269)	0	1028	74
After 6:00 P.M.	34	407	(321)	0	1204	79

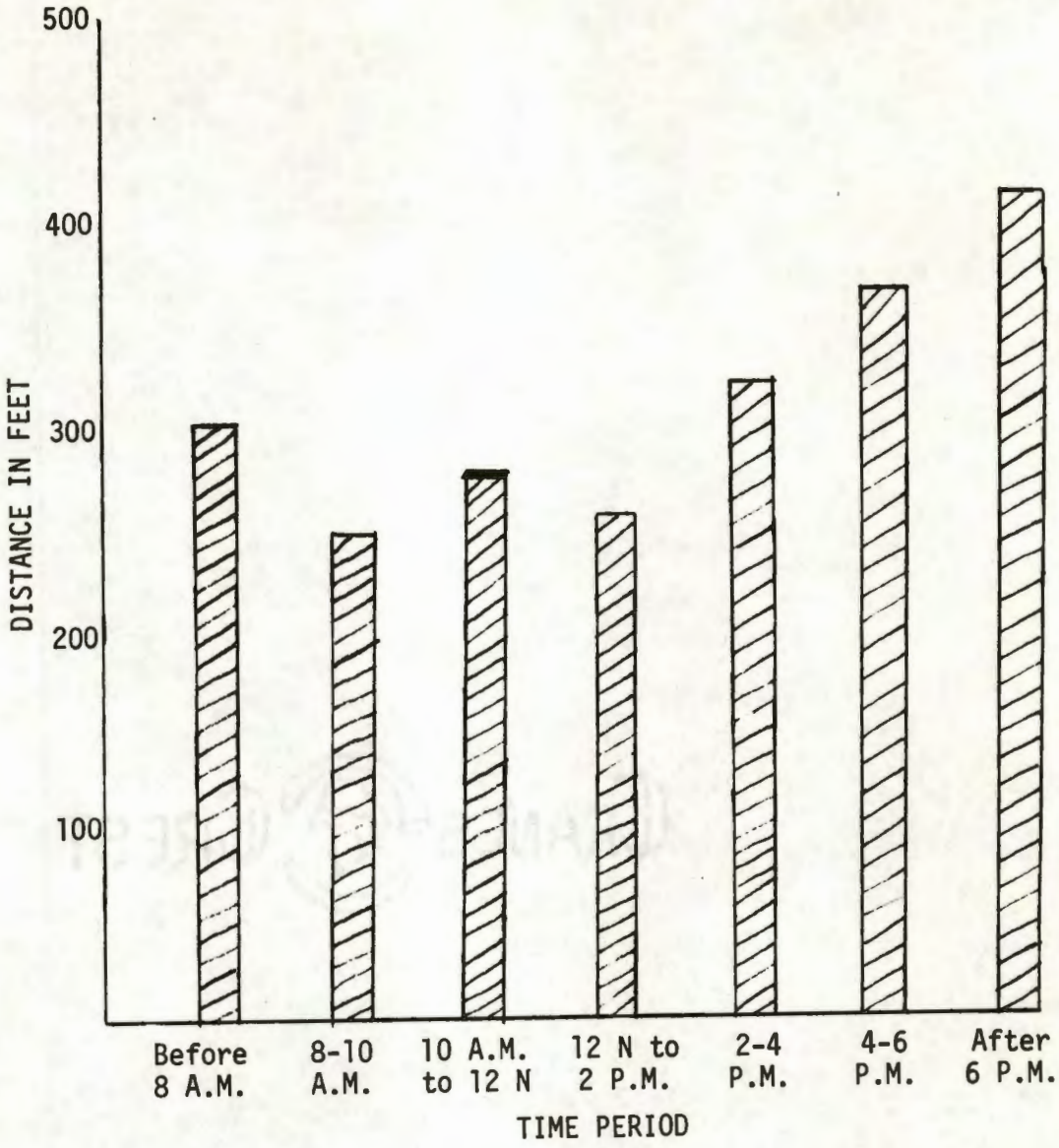


Figure 10. Bihourly movement patterns of unmated male quail determined through radiotracking on the Ames Plantation in West Tennessee for the breeding season of 1972.

TABLE XV

RESULTS OF DUNCAN'S NEW UNEQUAL MULTIPLE RANGE TEST FOR BIHOURLY MOVEMENT PATTERNS OF UNMATED MALE QUAIL ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1972

Average Movement in Feet						
8:00 A.M.-10:00 A.M.	12:00 N 2:00 P.M.	10:00 A.M.-12:00 N	Before 8:00 A.M.	2:00 P.M.-4:00 P.M.	4:00 P.M.-6:00 P.M.	After 6:00 P.M.
239	257	268	296	313	365	407

TABLE XVI

BIHOURLY MOVEMENT PATTERNS OF A MATED PAIR DETERMINED THROUGH RADIOTRACKING ON THE AMES PLANTATION IN WEST TENNESSEE FOR THE BREEDING SEASON OF 1972

Period	N	Distance Moved (Feet)		Range (Feet)		Coefficient of Variation (Percent)
		$\bar{x}$	(S.D.)	Low	High	
Before 8:00 A.M.	16	452	(405)	0	1482	90
8:00-10:00 A.M.	15	504	(366)	0	1152	73
10:00 A.M.-12:00 N	15	397	(325)	0	1021	82
12:00 N-2:00 P.M.	15	340	(224)	0	858	66
2:00-4:00 P.M.	14	523	(293)	0	960	56
4:00-6:00 P.M.	13	618	(382)	135	1383	62
After 6:00 P.M.	14	418	(361)	0	1084	86

TABLE XVII

INFLUENCE OF SEASON VERSUS TIME OF DAY ON TRAPPING SUCCESS ON THE AMES PLANTATION IN WEST TENNESSEE FOR THE BREEDING SEASONS OF 1971 AND 1972

	Number of Birds Captured in Time Period																	
	7:00 A.M.-10:00 A.M.			10:00 A.M.-1:00 P.M.			1:00 P.M.-4:00 P.M.			4:00 P.M.-7:00 P.M.			7:00 P.M.-1:00 P.M.			Total		
Biweekly Period	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
March 27-April 9	0	-	-	6	-	6	10	-	10	15	2	17	-	-	-	31	2	33
April 10-April 23	1	-	1	21	3	24	14	3	17	36	9	45	3	3	6	75	18	93
April 24-May 7	4	1	5	15	4	19	14	2	16	13	1	14	10	2	12	56	10	66
May 8-May 21	4	3	7	39	7	46	21	2	23	24	2	26	31	4	35	119	18	137
May 22-June 4	21	2	23	53	7	60	41	3	44	38	7	45	31	1	32	184	20	204
June 5-June 18	23	2	25	26	-	26	30	2	32	24	3	27	21	2	23	124	9	133
June 19-July 2	23	4	27	63	6	69	47	2	49	55	7	62	31	1	32	219	20	239
July 3-July 16	7	1	8	39	5	44	30	2	32	28	4	32	17	3	20	121	15	136
July 17-July 30	12	2	14	58	2	60	45	4	49	42	3	45	29	3	32	186	14	200
July 31-August 13	7	4	11	33	5	38	32	1	33	27	5	32	23	4	27	122	19	141
August 14-August 28	1	1	2	4	4	8	6	3	9	12	4	16	8	2	10	31	14	45
Total	103	20	123	357	43	400	290	24	314	314	47	361	204	25	229	1268	159	1427
Corrected[a] Totals	340	66	406	357	43	400	290	24	314	314	47	361	346	43	389			

[a]Totals are pro-rated to allow for the number of trap checks per period.

significant midday slack in trapping success suggests that even though unmated males were less active during this period (Figure 10), the call of a decoy hen was sufficient stimulus to lure males to the traps.

Cover Type Used

Each time a quail was located by telemetry, the type of ground cover used was recorded (Table XVIII). A Chi-square test revealed that a significant differene exists (x^2 = 60.45*) in the type of cover used during the different periods of the day. Although the location of the difference within the table was not established, two distinct patterns were evident: (1) intensive use of woods with a honeysuckle understory during all periods of the day and (2) cultivated fields were not used as roosting sites.

Woods with a honeysuckle understory was the cover type most commonly used during all periods of the day. The mated pair used only this type as roosting sites, while the unmated males were less predictable.

Never was a radiotracked quail found to spend the night in a cultivated field. Quail were commonly found in cultivated fields during the day, probably searching for summer foodstuffs (Eubanks, 1972). These data suggest that although cultivated fields are readily used during the day, they do not provide appropriate cover for roosting.

Effect of Weather on Daily Activities

Average temperature and relative values of cloud cover and wind velocity were compared to the distance radiotracked quail moved in two

TABLE XVIII

COVER TYPE USED BY QUAIL AS DETERMINED BY RADIOTRACKING ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1972

Time	Type of Vegetation						
	Soybean or Oats Field	Cotton Field	Woods	Unburned Grasses	Burned Grasses	Honeysuckle and Woods	Total
8:00 A.M.	11[a]	8	1	14	5	37	76
10:00 A.M.	3	2	1	28	6	31	71
12:00 N	15	1	3	9	5	38	71
2:00 P.M.	10	5	4	16	5	25	65
4:00 P.M.	14	2	2	15	6	25	64
6:00 P.M.	13	3	6	10	5	24	61
9:00 P.M. (Dark)	-	-	3	16	6	38	63
Total	66	21	20	108	38	218	471

[a]Number of locations of radiotracked quail during the time period.

hour periods. No relationships were evident although sufficient data were not obtained to make any concrete statements.

V. PAIR BOND FIDELITY

An attempt was made to determine the strength of the pair bond between male and female quail of a mated pair. If the pair bond fidelity was strong between birds of a mated pair, it was reasoned that the pair would remain together throughout the entire breeding season. If one or both of the birds of a mated pair showed sexual interest in another quail, the presence of strong pair bond fidelity would be questionable.

Each time a quail was trapped it was classified as to mating status. When a pair of birds was caught in a trap, they were classified as mated. If only one quail was caught in a trap, but a quail of the opposite sex flushed near the trap, the trapped bird was also classified as mated. All other captured quail were classified as unmated.

Of the 120 females caught in the study, 18 were unmated and 14 were classified as having unknown mates each time trapped (Table XIX). The presence of 18 unmated females in the population may indicate a certain amount of mate interchange, although the usefulness of this information is questionable. The remaining 88 females yielded information that was used directly in evaluating the fidelity of pair bonds.

On eight occasions females were caught associated with at least two different males. On three of these occasions, the females first

TABLE XIX

MATE INTERCHANGE OF ALL FEMALES AND THEIR MATES CAUGHT ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASONS OF 1971 AND 1972

Classification	Number	Percent
Monogamous	33	27
Female Polygamous	8	7
Male Polygamous	47	39
Unmated	18	15
Mate Unknown	14	12
Total	120	100

mate was known to be alive (trapped at a later date) when she was trapped with a second male. The fate of the males of the other five pairs was not known.

Although most females were not trapped often enough to yield data on mate interchange, the males mated to many of these females were. The mates of 47 of these 88 females showed tendencies toward polygamy, being caught mated to a different female or unmated. Although it is admitted that the female mates of some of these males could have died during the breeding season, it seems unlikely that the overall percentage of interchange (55/88 or 62 percent) can be totally explained through natural mortality. It seems more likely that some interchange occurred during the study.

Thirty-three pairs of birds did not show signs of polygamy in the study. Twenty-six of these pairs, however, were caught only once and neither bird was ever caught again, suggesting monogamy but yielding no concrete supportive data. Only two pairs were caught together on more than one occasion with neither bird ever showing signs of polygamy.

During the study nine males were mated to at least two different females. One of these males was mated to three different females. From the above records, it seems likely that at least a limited amount of mate interchange occurs during the breeding season in the wild.

It was difficult to determine accurately the matedness of captured birds. It is possible that two birds caught in the same trap had entered the trap coincidentally from different directions. The system used for classifying birds is believed satisfactory, because

of 130 males caught more than one time in the same day, only one was ever classified as mated - and that on only one trapping occasion. Two females, one classified as unmated both times and the other mated once and unmated once, were also trapped twice in the same day. Since the probability of catching unmated males is higher than that of catching mated males or females by the use of cock and hen traps, these records strengthen the mating classification system used.

Although the period of mate interchange was not established in this study, it seems possible that it would occur during the incubation period of the nesting cycle. It is agreed by many quail researchers that, during the incubation period, mated males will utter the "bobwhite" call (Rosene, 1969; Kabat and Thompson, 1963). This indicates that the mated male is interested in sexual activity with a female - since the bobwhite call is a sexual call and is not given between birds of an intact mated pair (Stokes, 1967). Stokes (1967) reported males of a pair to give the bobwhite call if separated from their mates for a few hours. Urban (1972) noted three lengthy movements of telemetered mated male bobwhites during the period when the males mate was believed to be incubating. Two of these movements were to decoy hens in cock and hen traps and the reason for the other movement was not given. Thus it appears that mated males are interested in other females during the period when their mates are incubating, and mate interchange may occur if an unmated female is available.

Another situation resulting in mate interchange would be when a female produces two broods in a single nesting season. According to Stanford (1972), a male will occasionally incubate a nest while the

female begins another nesting cycle. McMillan (1964) reported double brood production in California quail. It is very possible that if the male did assume incubation duties, the hen would remate. Stoddard (1931) mentioned that females may occasionally find new mates when the males assumed the incubation duties, although he lacked proof.

The mated pair radiotracked in the present study showed strong pair bond fidelity, although the pair was not followed during an incubation period.

Thus it appears that the bobwhite may not be completely monogamous in the wild. Data gathered in the present study were not conclusive enough to make any concrete statements, although they do cast doubt on the fidelity of pair bonds and call for future research.

VI. POPULATION ESTIMATES

Three methods of population estimations were tried in an attempt to determine accurately the breeding season population on the area: (1) live-trapping, (2) a whistling cock count, and (3) a Lincoln index.

Population Estimate Derived from Breeding Season Trapping Records

A method using the number of unmated males on the area (as determined by trapping) and the sex ratio was used in an attempt to estimate the breeding season population. It was hoped that the number of unmated males caught during a trapping round or during the entire breeding season could be used. During both years of the study, the number of unmated males caught per trapping round varied only slightly (66 to 76), while the number of unmated males caught over the entire breeding season varied from 164 in 1971 to 282 in 1972 (Table XX).

TABLE XX

POPULATION ESTIMATES DERIVED FROM THE NUMBER OF UNMATED MALES TRAPPED ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASONS OF 1971 AND 1972

Item	Year									
	1971				1972					
	First Trapping Round	Second Trapping Round	Third Trapping Round	Total	First Trapping Round	Second Trapping Round	Third Trapping Round	Fourth Trapping Round	Fifth Trapping Round	Total
Number of Different Unmated Males	67	67	67	164	67	71	76	69	66	282
Population Estimate (Sex Ratio = 60:40)	335	335	335	820	335	355	380	345	330	1410
Population Estimation (Sex Ratio = 55:45)	670	670	670	820	670	710	760	690	660	2820

If the sex ratio during the breeding season could be established, the above data could be used in estimating the population.

Stoddard (1931) stated that the population could be established using the number of whistling cocks (i.e., unmated males) if the sex ratio was known. The only sex ratio established in this study was an adult sex ratio of 59 males to 41 females in the fall of 1972. This sex ratio is near the adult sex ratio of 60:40 reported by other authors (Kabat and Thompson, 1963; Rosene, 1969). Since no spring sex ratio was determined in the study, it is assumed that it fell within the normal ratios of 53:47 to 54:46 established by other authors (Stoddard, 1931; Robinson, 1957; Kabat and Thompson, 1963). Since summer trapping methods precluded the accurate determination of sex ratios, it will be assumed that the sex ratio varied from 53:47 to 60:40 as the breeding season progressed.

Seemingly, a sex ratio of 55:45 would be a fair estimation of the sex ratio fairly early in the breeding season. This would indicate a population of between 670 and 710 quail (67-71 unmated males) using the area at this time. Using the sex ratio of 60:40 as the adult sex ratio late in the breeding season would indicate a population of 330 to 335 adult bobwhites (66-67 unmated males) on the area in August. Thus, by using this method, it would appear that the adult population of birds decreased from around 700 quail early in the breeding season to about 330 late in the year.

When the total number of unmated cocks trapped per year was used, high population estimations were obtained using even the sex ratio of 60:40 (820 in 1971, 1410 in 1972). This would suggest that

many of the quail that were trapped as unmated males were actually mated at some time during the breeding season.

Population Estimate Derived from a Whistling Cock Count

The whistling cock method was also based on the thesis that the population could be estimated by the numbers of whistling cocks if the sex ratio was known. The number of whistling cocks on the area varied from 19 to 31 (Table VI, page 27) during the mid-May to early August period. Peaks of 29 and 31 occurred on June 1 and July 31, respectively. Assuming that the sex ratio varied as discussed in the previous section, the early summer population would be estimated at 290 quail (sex ratio = 55:45, unmated males = 29), while the late breeding season population would be 155 (sex ratio = 60:40, unmated males = 31). Thus, by using this method, it would suggest that the adult population declined from 290 quail early in the breeding season to 155 quail alive on the area late in the breeding season.

Population Estimate Derived from a Lincoln Index

Bait trapping and collecting after the 1972 breeding season provided a means of accurately determining the past breeding season population. It was determined that 63.1 percent of the adult males and 41.4 percent of the adult females were banded during the summer of 1972 - or 54.2 percent of the entire adult population (Table XXI). Since 400 mature birds were banded in 1972, there must have been 738 mature bobwhites ($\frac{54.2}{100} = \frac{400}{X}$) using the 578 acre study area during the breeding season of 1972.

TABLE XXI

NUMBER OF PREVIOUSLY BANDED AND UNBANDED QUAIL CAUGHT BY TRAPPING AND SHOOTING ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE FALL OF 1972

	Trapping					Collecting					Total[a]				
	Banded		Unbanded			Banded		Unbanded			Banded		Unbanded		
Sex	Number	(Percent)	Number	(Percent)	N	Number	(Percent)	Number	(Percent)	N	Number	(Percent)	Number	(Percent)	N
Males	38	(63.3)	22	(36.7)	60	16	(64.0)	9	(36.0)	25	53	(63.1)	31	(36.9)	84
Females	17	(44.7)	21	(55.3)	38	10	(41.7)	14	(58.3)	24	24	(41.4)	34	(58.6)	58
Total	55	(56.1)	43	(43.9)	98	26	(53.1)	23	(46.9)	49	77	(54.2)	65	(45.8)	142

[a]Four banded and one unbanded (banded by a different system) quail were captured using both methods.

Comparison of the Methods of Population Estimations

A comparison of the three methods reveals that the method using the number of males whistling on any given morning resulted in low population estimates. More mature quail were trapped in 1972 (400) than the maximum estimation of the whistling cock method would yield (310). The above suggests that on any given morning not all of the unmated males on the area whistle. This hypothesis is strengthened by the fact that, although the number of unmated males caught per trapping round varied from 66 to 76, the number of whistling males on the area was much less (19 to 31). If both mated and unmated males whistle as is presently thought (Murphy and Baskett, 1952; Hood, 1955; Rosene, 1969), the percentage of unmated males whistling on any given morning would be even lower. It may be possible that a ratio exists between the number of whistling males and the total population. No constant ratio became evident when the data were examined.

The estimates using the Lincoln index and the number of unmated males trapped per trapping round (sex ratio = 55:45) were similar. This suggests that if the true sex ratio on the area were determined, a fairly accurate estimation of the population may be obtained using the number of unmated males caught per trapping round.

VII. WHISTLING COCK COUNTS

A weekly whistling cock count was conducted in the area between May 10 and August 24, 1972. Three listening stations were established on the study area. These stations were situated in a manner so that most of the quail whistling on the area on a given morning could be

heard. Data recorded were station location, date, time, number of different quail heard whistling, and the total number of whistles heard. The survey was begun at sunrise each day. The first four minutes at each station were spent listening for the number of different quail heard. Another four minute period immediately followed in which the total number of bobwhite whistles heard was recorded. This procedure was followed at each station and it took approximately 40 minutes to obtain readings at all three stations. Following completion of the first listening round, the first listening station was returned to and the same procedure was followed in the second listening round. Total time elapsed during the entire procedure averaged 75 minutes. Counts were run only on warm, fairly clear days when wind velocity was low.

Daily and Seasonal Variations in the Number of Different Quail Heard

A two-way analysis of variance (three observations per cell) revealed that significant seasonal ($F = 15.72^*$) and daily ($F = 6.98^*$) differences occurred in the data (Table VI, page 27). The differences were not related ($F = .32$ NS). Robel et al. (1969) also reported time of year and time of day to be significantly related to the number of quail whistles heard. Thus it appears that more quail whistle from sunrise to 40 minutes after sunrise than do in the period of 40 to 75 minutes after sunrise. Male quail had all but ceased whistling by the third week in August.

Daily and Seasonal Variations in the Total Number of Bobwhite Whistles Heard

A two-way analysis of variance (three observations per cell) was

used to examine the relationship between the daily and seasonal variation in the number of bobwhite whistles heard (Table XXII). Results indicated that variation occurred because of time of year ($F = 16.54^*$) and time of day ($F = 7.67^*$), but the interaction was not significant ($F = .61$ NS).

Relationship of the Number of Different Quail Heard to the Total Number of Whistles Heard

A two-way analysis of variance (three observations per cell) revealed that the ratio of the total whistles heard per number of birds calling (Table XXIII) varied significantly ($F = 15.51^*$) with time of year. The ratio did not vary by time of day ($F = 3.71$ NS) and the interaction was not significant ($F = .91$ NS).

TABLE XXII

EFFECT OF TIME OF DAY AND TIME OF YEAR ON THE TOTAL NUMBER OF BOBWHITE WHISTLES HEARD ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1972

Date	Station 1		Station 2		Station 3		Total	
	Time 1[a]	Time 2[b]	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
June 1	53	54	61	56	81	39	195	149
June 8	51	71	81	79	62	22	194	172
June 14	36	56	43	44	78	46	157	146
June 21	55	27	55	40	44	18	154	85
June 30	49	41	42	31	5	31	96	103
July 8	57	50	51	28	26	37	134	115
July 15	70	30	43	26	29	31	142	87
July 23	65	73	60	84	56	42	181	199
July 31	96	87	108	71	80	62	284	200
August 4	35	7	19	31	26	19	80	57
August 11	48	22	35	6	22	37	105	65
August 17	20	2	5	3	3	2	28	7
August 24	0	0	0	0	0	0	0	0
Total	635	520	603	499	512	386	1750	1405

[a]Started at sunrise and continued until 40 minutes after sunrise.

[b]Started at 40 minutes after sunrise and continued until 75 minutes after sunrise.

TABLE XXIII

RELATIONSHIP OF THE NUMBER OF DIFFERENT QUAIL HEARD TO THE TOTAL NUMBER OF WHISTLES HEARD ON THE AMES PLANTATION IN WEST TENNESSEE DURING THE BREEDING SEASON OF 1972

Date	Station 1		Station 2		Station 3		Total	
	Time 1[a]	Time 2[b]	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
June 1	5.9	6.8	6.1	7.0	8.1	5.6	6.7	6.5
June 8	5.7	7.1	10.1	9.9	6.2	4.4	7.2	7.4
June 14	4.0	7.0	6.1	7.3	9.8	6.6	6.5	7.0
June 21	5.5	3.9	6.9	5.7	7.3	3.6	6.4	4.5
June 30	4.9	6.8	6.0	4.4	1.7	4.4	4.8	5.2
July 8	7.1	8.3	7.3	7.0	6.5	7.4	7.1	7.7
July 15	7.0	4.3	6.1	3.2	5.8	5.2	6.5	4.1
July 23	8.1	6.6	6.7	10.5	6.2	6.0	7.0	7.7
July 31	8.7	8.7	9.8	6.5	8.9	7.8	9.2	7.6
August 4	7.0	1.8	3.2	4.4	5.2	3.8	5.0	3.6
August 11	6.9	4.4	5.0	3.0	4.4	4.6	5.5	4.3
August 17	5.0	1.0	1.7	1.5	1.5	1.0	3.1	1.2
August 24	0	0	0	0	0	0	0	0

[a]Started at sunrise and continued until 40 minutes after sunrise.

[b]Started at 40 minutes after sunrise and continued until 75 minutes after sunrise.

CHAPTER V

SUMMARY

The study was conducted on a 578-acre-tract within a quail management area on the Ames Plantation in West Tennessee. Field research was conducted during the March to September months in 1971 and 1972. Data were collected by trapping, color-marking, and radiotracking quail. A total of 1414 trap days yielded 1478 quail captures. In 1971, 234 different quail were trapped, while 410 different quail were captured in 1972. Colored back-tags were attached to 101 male quail. Five unmated males and one mated pair were radiotracked in the study.

Covey dissolution occurred on the area between mid-April and May 1 both years of the study. The first sign of fall covey formation among adult birds appeared in late August.

The maximum home range dimension of quail during the breeding season was usually less than 1/2 mile in length (99 percent), while most (84 percent) quail did not move more than 1/4 mile. No quail moved more than 1/2 mile during the summer. The home range area of unmated male quail on the area was determined as 17.0 acres by radiotracking. Trapping records suggested that few quail home ranges encompassed more than 25 acres during the breeding season. Home range boundaries were usually observed rather stringently, although the call of an available female was sufficient stimulus to cause the unmated male to cross his home range boundary.

Daily movement records established by radiotracking and trapping suggest that quail frequently cover their entire home range in one day. Quail showed little inclination to move great distances during the spring and summer (98 percent less than 1/2 mile) and summer to fall (97 percent less than 1/2 mile) periods. Color marked birds were observed 138 times during the breeding season and 96 percent of these observations were within 1/2 mile of the marking point. Seventy-four of the 234 quail banded in 1971 were retrapped in 1972. None of these 74 birds were trapped further than 1/2 mile from their first 1971 trapsite, while 77 percent moved less than 1/4 mile from their 1971 breeding season home range to their 1972 breeding season range. Combined data for all seasons suggest that there was little egress and ingress on the area and that few quail move more than 1/2 mile on the study area.

Peaks in biweekly trapping success were evident both years of the study. It is possible that the trapping peaks were related to hatching peaks on the area. Daily activity patterns of quail suggest a minor morning activity peak of short duration and a major, more lengthy afternoon activity peak. Unmated males responded to the call of available females about equally throughout the day. Woods with a honeysuckle understory was the cover type most commonly used by quail during all periods of the day and night, while cultivated fields were commonly used throughout the day but were not used for roosting.

Some evidence that birds of a mated pair may switch mates during the breeding season was gathered in the study. Three methods of population estimation were used in the study. These were based on

(1) trapping records, (2) a whistling cock count, and (3) a Lincoln index. The trapping and Lincoln index methods suggested that a population of around 700 quail (1.2 quail per acre) used the study area during the 1972 breeding season. The whistling cock method yielded a much lower estimation - suggesting that not all unmated males whistle on any given morning.

The number of different males whistling and the total number of whistles heard per four minute period varied significantly with time of day and time of year, but the interaction of time of day with time of year was not significant.

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