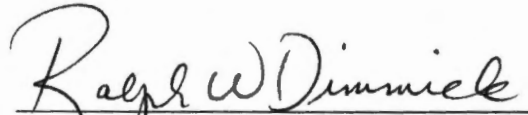
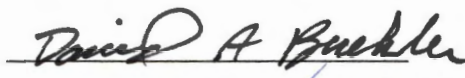
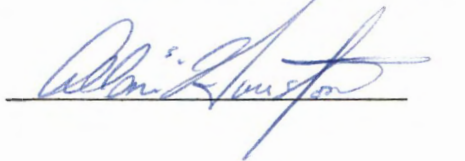


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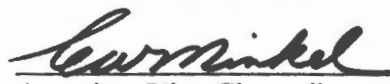
I am submitting herewith a thesis written by Christopher Donald Kreh entitled "Movements, Habitat Selection, and Survival of Northern Bobwhites in Response to Disturbance During Field Trials." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.


Dr. Ralph W. Dimmick, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:


Associate Vice Chancellor and
Dean of The Graduate School

**MOVEMENTS, HABITAT SELECTION, AND SURVIVAL OF NORTHERN
BOBWHITES IN RESPONSE TO DISTURBANCE DURING FIELD TRIALS**

**A Thesis
Presented for the
Master of Science Degree
The University of Tennessee, Knoxville**

**Christopher Donald Kreh
August 1997**

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Abstract

This study evaluated the effects of field trial disturbance on northern bobwhite quail (*Colinus virginianus*) with respect to 1) survival, 2) movements, and 3) habitat utilization on Ames Plantation in western Tennessee. A total of 81 bobwhites in 20 coveys was monitored via radio-telemetry on 3 study areas in late winter (January 9 - April 1) during 1995 and 1996. Each year, bobwhites on the Morning Field Trial Area (MFTA) and the Evening Field Trial Area (EFTA) were subjected to 2 weeks of disturbance in mid-February produced by bird dog field trials. Bobwhites on the Control Area (CA) were not exposed to field trial activities. Though late winter survival was higher in 1995 (0.944, $n=36$, SE 0.040) than in 1996 (0.728, $n=45$, SE 0.068) ($p < 0.05$), survival was unaffected by disturbance as estimates did not differ significantly among study areas in either year ($p > 0.05$ in all cases). Mean hourly movement during the study was 37.1 m (SE 1.2 m), but differed among study areas and between years. Hourly movements were greater in 1995 (40.8 m, SE 1.4 m) than in 1996 (29.2, SE 2.2 m). Hourly movements on MFTA (48.3 m, SE 2.6 m) were greater than on EFTA (35.3 m, SE 6.6 m). Hourly movements were lowest on CA (29.5 m, SE 1.8). On average, coveys on MFTA retreated 62.3 m (SE 17.5 m) from the field trial course during periods of disturbance. On EFTA, coveys retreated 25.1 m (SE 6.6 m). However, movements were not great enough to remove bobwhites from their

home ranges. Multiresponse permutation procedures revealed that 18 of the 20 coveys made spatial adjustments within their home ranges during late winter. Disturbance was not the sole factor influencing bobwhites, as adjustments occurred on CA, as well as on MFTA and EFTA. Analyses of habitat utilization revealed that bobwhites changed their utilization of available habitats in only 2 of 6 cases. With few exceptions, analyses of habitat selection comparing use and availability revealed that bobwhites used partially-stocked stands more than expected and agricultural fields less than expected.

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List of Abbreviations

<u>Abbreviation</u>	<u>Description</u>
CA	Control Area
EFTA	Evening Field Trial Area
MFTA	Morning Field Trial Area
DSTU	Disturbance Period
PRED	Pre-disturbance Period
POSD	Post-disturbance Period

Chapter I.

Introduction

The effects of human-caused disturbance upon wildlife populations have been studied in a variety of situations and for many different species. Military training activities have been shown to influence home range dynamics and activity patterns in coyotes (*Canis latrans*) (Gese et al. 1989) and raptors (Andersen et al. 1990). Logging operations have caused mountain lions (*Felis concolor*) to alter their activity patterns (Van Dyke et al. 1986), but may not cause elk (*Cervus elaphus*) to alter their home ranges (Edge et al. 1985). Knight (1984) described how boating activity disrupted the feeding activities of bald eagles (*Haliaeetus leucocephalus*). Dorrance et al. (1975) found that snowmobile activity forced white-tailed deer (*Odocoileus virginianus*) to increase their movements and home range size.

Northern bobwhite quail (*Colinus virginianus*) have the ability to alter their normal behavior in response to disturbance. Although bobwhites are normally sedentary (Smith et al. 1982), drastic movements have been documented. Duck (1943) reported bobwhites moving up to 43 km in a search for winter habitat in Oklahoma. Lehman (1984) reported movements of 43 km and 128 km by two bobwhites in south Texas. Rosene (1969:85) felt that bobwhite coveys could adjust their ranges and habitat use as circumstances dictated. Roseberry (1964) evaluated the

effect of heavy snowcover in Illinois and found that bobwhites changed habitat use by focusing their attention upon brushy cover and areas of dense honeysuckle.

Previous researchers have speculated and reported that bobwhites become more secretive when faced with bird dog training and hunting activities, and abandon their home ranges if necessary. Stoddard (1931:46) felt that hunting pressure forced bobwhites to focus on thicker cover. Rosene (1969:94) reported that several consecutive weeks of dog training activity caused 33 of 51 coveys to abandon an area in Alabama. Klimstra (1972) reported that many coveys abandoned an Illinois area when facing heavy hunting pressure. Furthermore, Klimstra (1972) found that hunting success declined substantially over the season as well. Kellogg et al. (1982) used bird dogs to methodically hunt a Florida study area on repeated occasions. They found that the proportion of the bobwhite population found by dogs declined significantly with successive hunts.

Previous telemetry studies evaluated bobwhite responses to a variety of disruptive situations and provided information regarding survival, habitat use, and movements. Bobwhite populations subjected to hunting have lower survival than unhunted populations (Curtis et al. 1988, Robinette and Doerr 1993, Dixon et al. 1996). Mueller et al. (1988a) radio-monitored bobwhites on a northern Florida area where the available habitat was substantially altered by mid-March burning. Bobwhites focused on areas of unburned habitat, and in some cases, abandoned their home ranges. Janvrin (1991) found that hunting pressure caused most radio-marked coveys in

Missouri to increase their daily movements, though coveys rarely abandoned home ranges. Wiseman (1977) concluded that field trials in northeastern Oklahoma resulted in inconsequential disturbance to radio-monitored coveys. Dimmick and Yoho (1972) reported on the effects of a very large and prominent field trial in western Tennessee. Disturbance caused one radio-marked covey to disintegrate, though similar responses were absent in other radio-marked coveys. They concluded that field trial disturbance was sufficient to effect dramatic responses in some cases, though the distribution and density of coveys on the area were generally unaffected.

In recent years, there has been a substantial decline in the number of coveys found during the National Championship Field Trial, which is held annually in western Tennessee. There is much concern among field trial participants that the lack of success may be the result of the trial's negative impacts on bobwhites. Bobwhites would be less available to bird dogs if field trial disturbance forces them to alter their behavior or abandon their home range. Therefore, this study was designed to provide information pertinent to field trial management, and to advance the understanding of how bobwhites relate to disturbance. Specifically, the objective of this study was to evaluate the effects of late winter field trial disturbance upon bobwhites with respect to:

- 1) movements
- 2) habitat utilization and selection
- 3) survival.

Chapter II.

Study Areas

Fieldwork was conducted on the Ames Plantation, a 7,527-ha unit of the University of Tennessee Agricultural Experiment Station located in Fayette and Hardeman Counties. The area is near Grand Junction, TN, approximately 96 km east of Memphis and 16 km north of the Mississippi state line.

Ames Plantation lies within the Coastal Plain physiographic region of the state (Flowers 1964). The gently rolling terrain is dissected by a system of intermittent streams, which drain westward to the Mississippi River. Deep loess soils overlay the sand and clay of the coastal plain. The soils are well-drained and suited for agriculture, though some poorly drained areas do occur. These areas, with soils of the Henry series, produce a series of moist or flooded forest patches across the landscape.

The climate of the area is typical of that found across much of the mid-south, with hot summers and mild, wet winters (Flowers 1964). On average, a 200-day growing season extends from April through October. During summer, the average daily temperature ranges from 18 to 21 C, with temperatures exceeding 32 C on approximately 69 days. Average daily temperatures in winter range from 0 to 13 C. Below freezing temperatures can be expected about 60 days each year. Annual precipitation averages 135 cm, with late winter and spring receiving more than the

other seasons. Snowfall averages 11.6 cm, but rarely remains on the ground for extended periods.

Ames Plantation incorporates a wide variety of activities, including beef, swine, dairy, agriculture, and forestry operations. Approximately 2,000 ha of the plantation are designated as bird dog field trial grounds. Two field trials are conducted annually, including the prominent National Championship Field Trial held in mid-February.

The field trial grounds are a mosaic of agricultural fields, pine (*Pinus spp.*) and hardwood forests, and old fields in various stages of succession. Soybeans and corn are cultivated in the agricultural fields. Non-agricultural fields are composed of species such as sericea lespedeza, panicum grasses (*Panicum sp.*), partridge pea (*Cassia fasciculata*), bicolor lespedeza (*Lespedeza bicolor*), and broomsedge (*Andropogon virginicus*). Most of the hardwood stands are dominated by upland oaks (*Quercus spp.*), whereas the pine stands are dominated primarily by loblolly pine (*P. taeda*). These species occur in mixed pine-hardwood stands as well. A few bottomland hardwood stands exist, composed chiefly of lowland oaks and sweetgum (*Liquidambar styraciflua*).

Management of the field trial grounds attempts to provide suitable habitat for the northern bobwhite (*Colinus virginianus*) with a venue capable of supporting bird dog field trials. Prescribed burning is accomplished in late winter, immediately following the National Championship Field Trial. Some burning takes place in the hardwood forests. One third of the old field and brushy habitat is burned annually.

Feed patches of corn, milo, and soybeans are planted in strips along the edges of fields and woods. Additional strips are disced to facilitate the growth of natural vegetation. Many hectares of grassy cover are mowed in late fall in an effort to allow bird dogs to remain visible during the winter field trials.

Walking flush censuses (Dimmick et al. 1982) were conducted on the morning field trial grounds during the 2 years of this study. Bobwhite density was estimated to be 1.3 quail/ha (.53 quail/acre) in December of 1994 and .97 quail/ha (.39 quail/acre) in December of 1995 (Dimmick, unpublished data). Censuses were not conducted on the evening portion of the field trial grounds, but quail densities were thought to be similar.

Three specific study areas were utilized during the study. Experimental study areas were located on the morning and evening field trial grounds where bobwhites were exposed to disturbance created by field trial activity. A control area was located away from the field trial grounds.

Morning Field Trial Area (MFTA)

The MFTA is a 355-ha mosaic of woodlands and fields (Fig. 1). The area corresponds to the portion of the morning field trial grounds known as the Turner Ditch area. Slightly more than half of the area is forested, much of which is partially stocked hardwood scrub (Table 1). Agricultural and non-agricultural fields compose 21.5% and 23.9% of the area, respectively. Agricultural fields are planted with

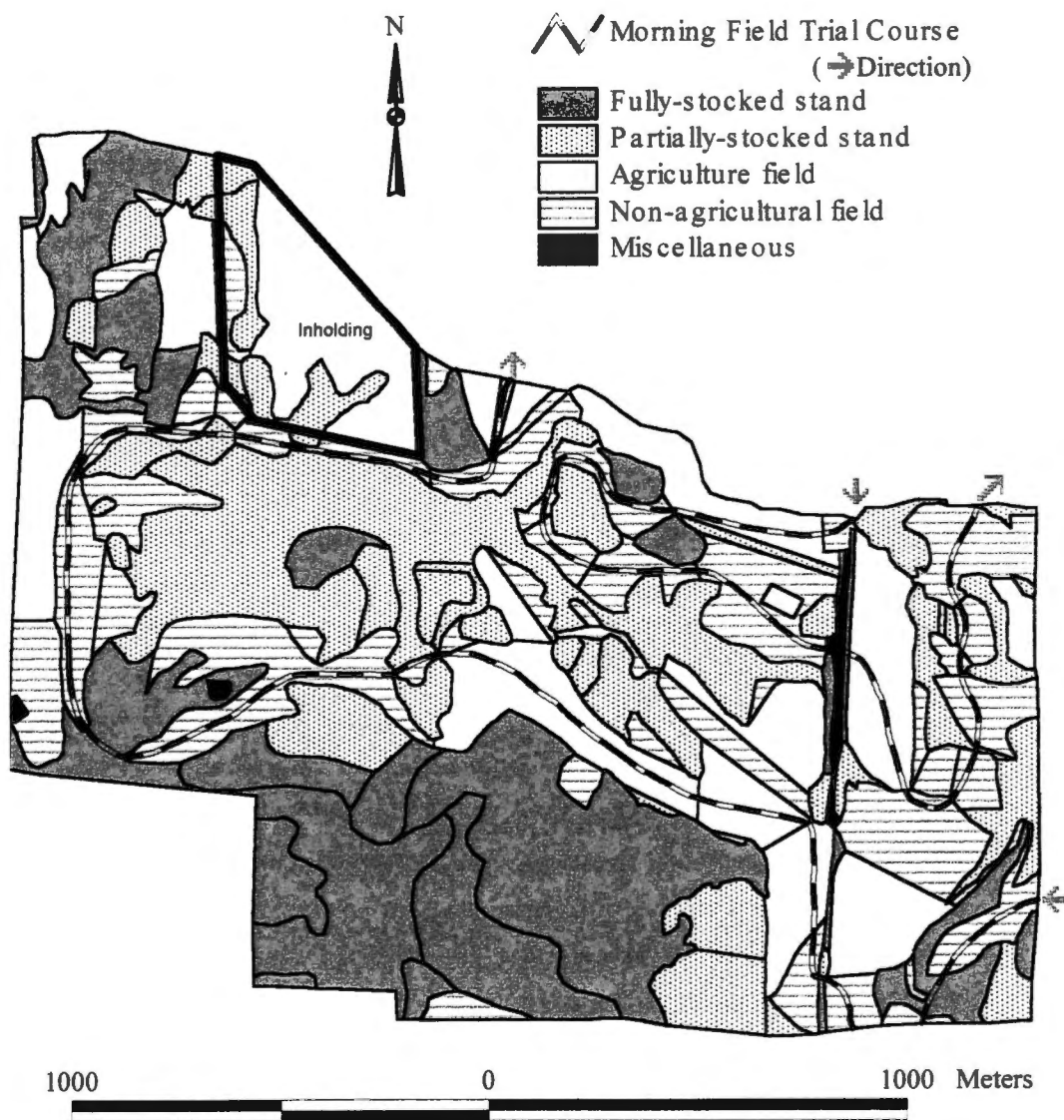


Figure 1. Habitat types and field trial course on the Morning Field Trial Area, a 355-ha portion of the morning field trial grounds of Ames Plantation, Fayette Co., Tennessee.

Table 1. Number of hectares and percentage of 5 habitat categories on 3 study areas on Ames Plantation, Fayette and Hardeeman Co., Tennessee, 1995-1996.

Habitat Type	Study Area					
	Morning Field Trial Area		Evening Field Trial Area		Control Area	
	Hectares	Percent	Hectares	Percent	Hectares	Percent
Fully-stocked forest	100.3	28.2	115.1	57.1	243.8	68.3
Partially-stocked forest	92.1	25.9	17.9	8.9	14.9	4.2
Agricultural field	76.3	21.5	45.2	22.4	80.8	22.6
Non-agricultural field	85.0	23.9	18.7	9.3	5.1	1.4
Miscellaneous	1.6	0.5	4.8	2.4	12.6	3.5
Total	355.3	100.0	201.7	100.0	357.2	100.0

soybeans and corn. Some fields are designated as no-till, but most are tilled conventionally. Conventionally tilled cotton is cultivated on a portion of an inholding adjacent to the study area. Some bobwhites from the study area used the inholding on occasion. Mean size of the agricultural fields is 4.5 ha (SD 3.7 ha). Mean size of non-agricultural fields is 1.7 ha (SD 1.9 ha).

Evening Field Trial Area (EFTA)

The EFTA is a 201-ha mixture of woodlands and fields situated atop a small ridge (Fig. 2). The area corresponds to the portion of the evening field trial grounds known as the Cox Ridge area. Much of the area is forested, with fully stocked stands accounting for 57.1% of the total area. Corn and soybeans are planted on 45.2 ha of agricultural fields. Both conventional tillage and no-till are used on the area. Agricultural fields off Ames Plantation, but immediately adjacent to EFTA, are planted with conventionally tilled cotton and corn. Some bobwhites from the study area crossed boundaries and utilized these habitats. Non-agricultural fields comprise less than 10% of the area. Mean size is 2.5 ha (SD 2.6 ha) for agricultural fields and 2.4 ha (SD 0.66 ha) for non-agricultural fields.

Control Area (CA)

CA is a system of large fields surrounded by vast expanses of fully stocked forest (Fig. 3). The area is in a portion of Ames Plantation known as the Hancock

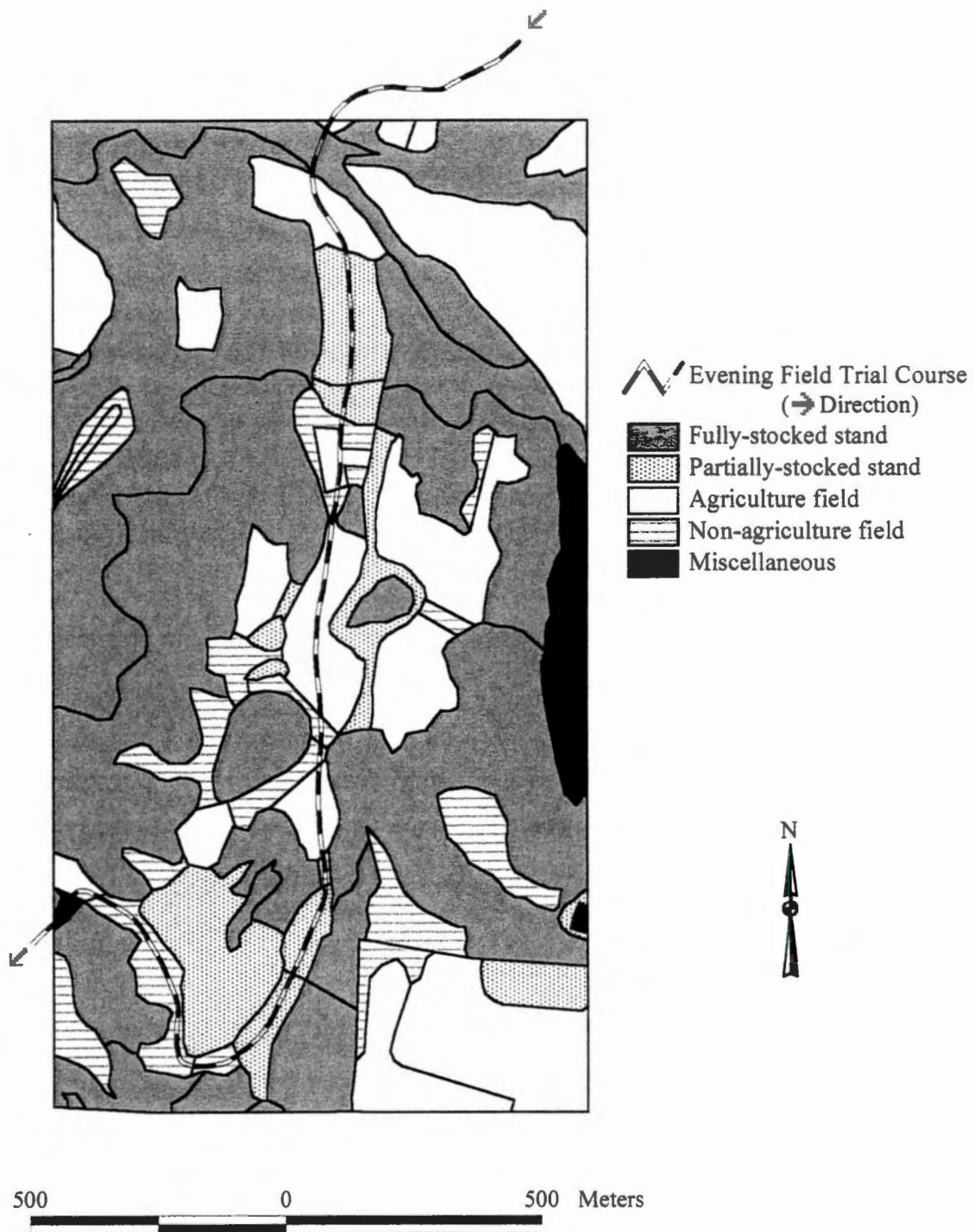


Figure 2. Habitat types and field trial course on the Evening Field Trial Area, a 202-ha portion of the evening field trial grounds of Ames Plantation, Fayette and Hardeman Co., Tennessee

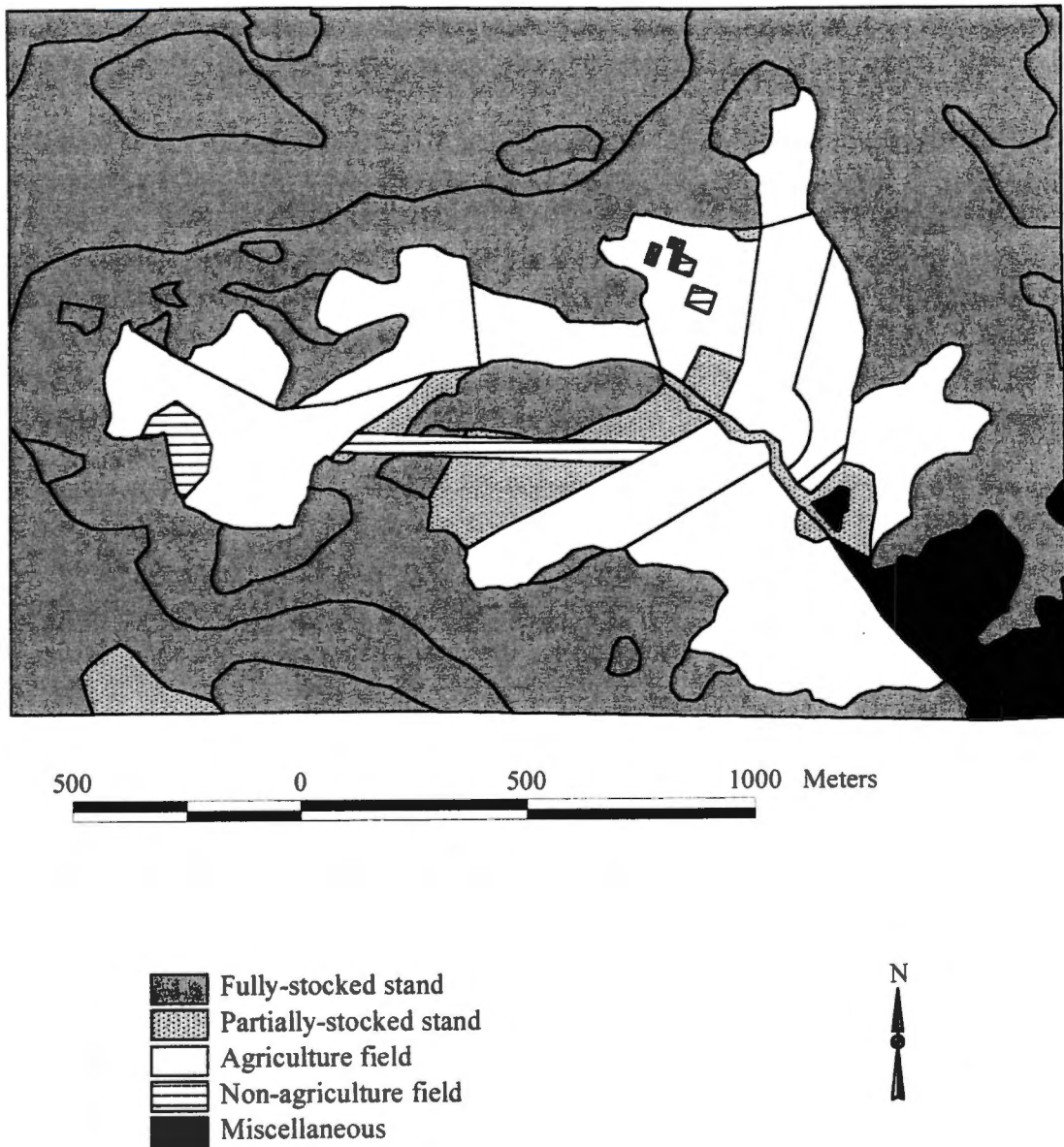


Figure 3. Habitat types on the Control Area, a 357-ha area outside of the Ames Plantation field trial grounds, Fayette Co., Tennessee.

Place. The area is not within the field trial grounds and management focuses on row crop agriculture rather than field trials and bobwhites. Within the 357 ha delineated as the study area, 80.8 ha (22.6%) of agricultural fields are planted with no-till corn, soybeans, and cotton (Table 1). Mean size of the agricultural fields is 6.7 ha (SD 4.2 ha). Fully stocked forest [243.8 ha (68.3%)], covers the majority of the area. Partially stocked forest and non-agricultural fields are relatively scarce, representing only 4.2% and 1.4%, respectively.

Chapter III.

Methods

Disturbance

Bobwhites residing on MFTA and EFTA in 1995 and 1996 were exposed to episodes of field trial disturbance. Field trials followed established routes and were conducted during the same calendar period each year; thus, they provided fairly consistent levels of disturbance to bobwhites. Field trial disturbance was quantified by the number of days the trial passed through the study area, the number of times bobwhites were flushed, and the number of spectators involved each day. Two field trials were conducted each year. The Hobart Ames Invitational field trial was held in December, but was not directly evaluated as a part of this study. This project focused on the National Championship Field Trial, which attracts a much larger gallery and consequently, creates a greater amount of disturbance.

The National Championship Field Trial for pointing bird dogs is held annually during mid-February on the Ames Plantation. The trial requires about 2 weeks to complete, generally beginning on the second Monday in February, and continuing until all the dogs have competed. Dogs do not compete on Saturdays or Sundays. Approximately 35 to 40 dogs compete each year, most of which are English pointers. These dogs are judged on the basis of stamina and speed, as well as their ability to

locate and point game birds. During the period of this study, the National Championship Field Trial was held February 13 - 23, 1995 and February 12 - 23, 1996.

The field trial grounds consist of 2 separate courses, a morning course and an evening course, each of which is approximately 19 km in length. Each day, a brace of dogs starts at 0800 and hunts for 3 hours on the morning course. At 1330, another brace begins on the evening course and hunts for an equal amount of time. The dogs are followed by dog handlers, scouts, judges, and a gallery of spectators, all of whom are riding horses. In 1995, the average estimated gallery size was 179 riders on the morning course and 283 riders on the evening course. Gallery sizes were comparable in 1996.

Dogs search the predetermined course at a fairly rapid pace with the accompanying gallery creating a substantial amount of noise and commotion. Handlers often rely on loud voice commands to control their dogs. Galleries ride through much of the surrounding habitat and often flush coveys not found by the dogs. When dogs do locate quail, they remain on point until the judges and gallery can assemble nearby. The covey is flushed and a shotgun is fired in the air to test the dog's steadiness. Quail are not shot, and typically, the dogs are not directed toward the scattered covey to locate singles.

Approximately 8,200 m of the morning field trial course is within MFTA (Fig. 1). The circuitous route, which enters, exits, and reenters the area, traverses most of the fields on the area. The dogs initially reach the area at 0830, and spend a total of

about 30 minutes on the area. EFTA contains approximately 2,500 m of the evening field trial course. The area is situated near the end of the route, so the dogs do not reach the area until approximately 1530 to 1600. The evening course is much more linear; the dogs essentially make 1 north to south pass through the area, requiring approximately 10 minutes.

Trapping

A total of 81 bobwhites in 20 coveys was captured and radio-marked during 1995 and 1996 (Table 2). Additional information pertaining to captured bobwhites is contained in the Appendix. Trapping was conducted from December 17, 1994 through February 3, 1995, and from January 9 - 21, 1996. Walk-in funnel traps similar to those used by Stoddard (1931) were distributed throughout each of the study areas in places that coveys were known or thought to reside. Traps were baited with either whole or cracked corn and checked twice daily, once at midday and again at dusk.

Sex, age, and weight of each captured quail were recorded. Birds were classified as either juvenile or adult based on characteristics of the primary coverts (Rosene 1969). Weight was recorded to the nearest gram using a spring scale.

Quail were outfitted with leg bands and necklace-style radio-transmitters. Mean weight of radio-marked quail was 170 g (SE 1.4, range 130 - 200). Radio-transmitters were manufactured by American Wildlife Enterprises and by Holohil Systems Ltd. Each captured quail was banded with 1 individually numbered leg band.

Table 2. Number of radio-marked bobwhites and coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Year					
	1995		1996		1995 - 1996 Combined	
	Number of Bobwhites	Number of Coveys	Number of Bobwhites	Number of Coveys	Number of Bobwhites	Number of Coveys
Morning Field Trial Area	18	6	23	3	41	9
Evening Field Trial Area	9	4	13	2	22	6
Control Area	9	3	9	2	18	5
Total	36	13	45	7	81	20

Radio-transmitters consisted of a 26 cm antenna, an adjustable neck loop, and a waterproof coated transmitter. Total weight of the transmitter was 6 g. The neck loop was tied around the bird's neck and secured with glue. The transmitter was positioned close to the breast and the antenna trailed posteriorly over the bird's back. Transmitters used in 1995 emitted a steady pulsing signal. Transmitters used in 1996 contained mortality switches that doubled the pulse rate when the transmitter was immobile for 12 hours. All quail were released at their point of capture. Those captured late in the evening were held overnight and released the following morning.

Radio Telemetry

Bobwhites were radio-tracked from January 15 - August 12, 1995 and from January 12 - August 9, 1996. Radio tracking was conducted using a portable radio receiver (Telonics, Inc., Mesa, AZ) and a hand held 2 or 3 element directional antenna. Most locations were obtained by triangulation, although some were determined from homing or visual sightings. The estimated life of transmitters was 6 months. Radio signals could be detected from as far away as 1 km, but readings were generally taken at approximately 100 - 200 m.

Triangulation Procedures

Obtaining a triangulated location for a radio-marked quail involved a process of several steps. Initially, the radio signal was obtained from an established telemetry

station. The direction to the quail was determined with the antenna, and the azimuth of that direction was measured to the nearest degree using a hand held compass. Time, azimuth, and telemetry station number were recorded on a data sheet. After moving to a nearby telemetry station, the process of determining and recording the direction to the bird was repeated. In this fashion, azimuths were recorded from at least 2 - 3 telemetry stations.

Since the UTM coordinates of the telemetry stations were known, the location of the radio-marked quail could be computed as the intersection of the azimuths. In order to achieve accurate locations, azimuths used in computations were required to differ by at least 60° but not more than 120° . Additionally, the maximum elapsed time allowed between the first and last locations was 20 minutes.

On occasion, the exact location of a radio-marked bobwhite needed to be determined, such as when death was suspected. These locations were obtained by homing on the radio-signal until the quail was observed or flushed, or the radio-collar was found. Homing was not used for routine locations to avoid unnecessarily disturbing radio-marked quail.

Monitoring Survival

A bobwhite was considered to be alive until the date of its last radio-location, at which time it was either classified as dead or censored from the sample of surviving bobwhites. Survival status was monitored throughout the field season with repeated

radio-tracking. If a radio-marked quail did not move for 2 -3 days, or if a transmitter's mortality signal was activated, homing was used to determine the quail's status. When feathers or blood were found with the transmitter, or when transmitters were found in avian predator nests, the bobwhite was classified as dead. If a radio-marked bobwhite's signal could not be detected on a study area, an effort was made to determine if the bird had left the area. At such times, a vehicle equipped with a whip antenna was used to methodically search the surrounding area. Repeated searches were made, with the majority of the effort concentrated within 3 km of the bird's last known location. When no radio-signal could be detected, or when a transmitter was found with no indications of mortality, the bobwhite was censored from the pool of surviving birds. Censoring bobwhites from the sample serves to inflate the standard error of survival estimates, and may bias the estimates if censoring is not independent of a bobwhite's fate (Pollock et al. 1989b).

Allocation of Time

Radio-monitoring was most intensive during the 7-week period surrounding the National Championship Field Trial. Four days each week were devoted to collecting daily locations of all radio-marked bobwhites. On these 4 days, radio-marked bobwhites were located once each day. Diels were conducted on the remaining 3 days, with 1 diel being devoted to each of the 3 study areas. During other periods of

the study, diels were not conducted, and daily locations were obtained 3- 4 times each week.

During a diel, 5 to 7 radio-marked bobwhites in 2 to 4 coveys were tracked continuously throughout the day. Locations were obtained hourly from sunrise until sunset. One final location was taken before sunrise the following morning to determine if coveys had moved during the night. Three diels were conducted on CA in 1995, and 5 were conducted there in 1996. Five diels were conducted on MFTA and EFTA each year.

To avoid interference and negative public perception, radio-telemetry was not conducted simultaneously with the National Championship Field Trial. During the 2-weeks of the field trial activity each year, radio-locations of bobwhites on MFTA and EFTA were collected only during certain times of the day. Radio-marked bobwhites on the EFTA were located before noon, while the field trial was being conducted on the morning field trial course. Bobwhites on the MFTA were located during the afternoon. As the field trial was not conducted on Saturdays or Sundays, diels on MFTA and EFTA were accomplished on those days. During the remainder of the study period radio-marked bobwhites were monitored throughout the day.

Telemetry Error

Mean telemetry error was determined by comparing the actual and estimated locations of transmitters placed throughout the study areas. Initially, an assistant

would hang a radio transmitter somewhere within the confines of 1 of the study areas. With the operator having no knowledge of the transmitter's whereabouts, an estimated location was determined telemetrically with the same procedures used to track radio-marked bobwhites. As with radio-tracking of bobwhites, this location was based upon a set of azimuths taken from 2 - 3 telemetry stations.

Next, the transmitter's location was flagged with fluorescent tape, and azimuths from the telemetry stations to the transmitter were measured with a staff mounted surveyor's compass. This second set of visually determined azimuths was used to compute the actual location of the collar. The distance between the telemetrically estimated location and the visually determined actual location was considered to be the telemetry error. This process was conducted 20 times on each study area during the spring of 1996. Mean telemetry error was 42.8 m (SE 5.0 m).

Habitat Assessment

Habitat composition of each study area was delineated and stored in a computer based Geographical Information System (GIS). In the field, habitat patches were classified into 5 general types, fully stocked stands, partially stocked stands, agricultural fields, non-agricultural fields, or miscellaneous. Additional distinctions within each category were noted as well.

Fully Stocked Stands

Forest stands in which a relatively dense spacing of trees produced complete canopy closure were classified as fully stocked stands. The understory of these stands tended to be sparse and composed mainly of saplings and seedlings. The category included upland hardwoods, bottomland hardwoods, pine stands, and mixed pine-hardwood stands.

Partially Stocked Stands

Forests in which canopy closure was incomplete or sporadic were considered partially stocked. Saplings, briars, grasses, and vines produced a dense, brushy understory. Patches of partially stocked stands included recent clearcuts, young pine plantations, hardwood scrub, or pine scrub.

Agricultural Fields

Areas where row crops were planted and subsequently harvested were classified as agricultural fields. The category included conventionally-tilled and no-till fields of corn, soybean, and cotton.

Non-agricultural Fields

Open fields that were not used for row crop production were classified as non-agricultural fields. The category included recently disturbed fallow areas, broomsedge dominated old fields, and overgrown fields dominated by saplings and briars.

Miscellaneous

Areas not included in the above categories were classified as miscellaneous. Ponds, roadways, homeplaces, and heavily grazed pastures were all included in this category.

Geographic Information System

Prior to initiation of the project, a vector based Geographic Information System (GIS) of the Ames Plantation was available. The GIS was created using ArcInfo software, with each habitat patch being represented as an individual polygon within the computer generated coverage. However, the GIS lacked sufficient detail, and required some changes and improvements.

Maps of the study areas were checked in the field for accuracy, the polygons were classified according to the habitat categories, and modifications were made as necessary. In areas where the GIS was inadequate, polygons were either combined or split to better represent the habitat. Changes were initially plotted on the field maps, and later digitized into the computer program with ArcInfo software.

Slight inaccuracies were inherent in the GIS, largely as a result of distortions in the aerial photographs from which it was originally digitized. Inadequacies were partially corrected by referencing the GIS against the telemetry stations with an ArcInfo process known as rubber sheeting. The process allowed the habitat polygons to be altered to fit the telemetry stations, as the telemetry station locations were the more accurate of the 2. While most adjustments were less than approximately 20 m, the process appeared to improve the accuracy of the GIS.

Global Positioning System

During the summer of 1995 and the spring of 1996 a global positioning system was used to obtain coordinates for 110 telemetry stations. Fifty-seven stations were on MFTA, 34 were on the EFTA, and 19 were on CA. Coordinates were recorded in Universal Transverse Mercators (UTM), and were accurate to within 5 m.

Data Analysis

Survival

Late winter survival was estimated on each study area each year with the Kaplan-Meier staggered entry procedure (Kaplan and Meier 1958, Cox and Oakes 1984:48, Pollock et al. 1989b). Estimates represent the probability of an individual quail surviving from January 9 - April 1. Differences among study areas and between years were compared with the log rank test and considered significant when $p < 0.05$.

The radio-marking process did not appear to affect survival adversely in the short-term, as no radio-marked quail died or were censored within 7 days of being radio-marked. Thus, all radio-marked quail were included in the survival analyses.

Hourly Movements

Hourly movements of radio-marked coveys were measured repeatedly over a 7-week period in late winter. Field trial disturbance occurred during weeks 4 and 5. Movements were categorized according to both the week and the hour of the day in which they occurred. Movements between successive locations that occurred at least 45 but not more than 75 minutes apart were incorporated in the analyses.

Hourly movement data were evaluated using analysis of variance with the general linear model (GLM) procedure in SAS (SAS Inst., Inc. 1989). Year, study area, week, time of day, and all possible interactions were included as independent variables in the model. When a variable's effect was found to be significant at $p < 0.05$, the least significant difference (LSD) option was used to determine where differences among levels of the variable occurred. The LSD test maintains the type I error rate at 0.05 and compares all combinations of levels of the variable.

Home Range

Minimum convex polygon (MCP) home ranges were constructed for each covey using the computer program TELEM (Coleman and Jones 1986). MCP's

contain all radio-locations of a covey from January 9 through April 1. Home range size was compared among study areas and between years using analysis of variance with the GLM procedure in SAS (SAS Inst., Inc. 1989), using study area and year as variables that predict home range size. When variables were significant at $p < 0.05$, the LSD test was used to determine where differences occurred.

Pre-Disturbance, Disturbance, and Post-Disturbance Periods

Multi-response permutation procedures, habitat utilization analyses, and computing mean distances from the field trial course all required radio-locations to be independent. To maintain independence among observations, no more than 1 radio-location/ day was used from each covey. When multiple locations of a covey occurred on the same day, the location nearest 0800 was used and the rest were excluded from the analysis.

Independent radio-locations were divided into 3 time periods with respect to field trial disturbance. Those occurring from January 9 - February 12, 1995 and January 11 - February 11, 1996 were classified as pre-disturbance (PRED). The during-disturbance (DSTU) period included locations taken from February 13 - 23, 1995 and February 12 - 23, 1996. Locations collected from February 24 - April 1 of both years were classified as post-disturbance (POSD). April 1 was designated as the ending date of the late winter period based on general weather patterns and the timing of covey break up.

Distance from Field Trial Course or Center Line of Study Area

The mean distance from the field trial course in the PRED, DSTU, and POSD time periods was computed for all radio-marked coveys on MFTA and EFTA. On CA, the mean distance from a designated center line which approximately bisected the fields on the area was computed in the same 3 time periods. Distances from field trial courses or center line of the study area were computed using the NEAR command in ArcInfo. For each covey, the change in mean distance from the field trial course or center line of the study area was computed as the difference between the mean distances in different time periods. Changes in mean distance between time periods were evaluated using paired t-tests with the univariate procedure in SAS (SAS Institute Inc. 1989) and considered significant when $p < 0.05$. Additionally, the mean distance from field trial course on MFTA and EFTA was evaluated with respect to day of the DSTU period. Distance from field trial course and day of DSTU period were incorporated with the GLM procedure in SAS (SAS Institute Inc. 1989).

Multi-Response Permutation Procedures (MRPP)

The spatial distributions of independent locations in PRED, DSTU, and POSD time periods were evaluated for each radio-marked covey with multi-response permutation procedures(MRPP) using the computer program BLOSSOM (Biondini et al. 1988, Slauson et al. 1991). The procedures determined whether or not coveys used different areas during the 3 late winter time periods, either by abandoning their home

ranges, or altering activity within their home ranges. If spatial distributions of the 3 time periods differed when compared simultaneously, specific tests among the time periods determined where differences occurred. Differences were considered significant when $p < 0.05$.

Habitat Use and Preference

Habitat use was determined through spatial overlays in Arc Info, and tabulated on each study area each year for the PRED, DSTU, POSD time periods. To maintain acceptable sample sizes in each time period, habitat use was pooled across coveys within study areas each year. Thus, habitat use was evaluated by study area, rather than by covey.

Changes in habitat use among the 3 time periods were evaluated with chi-square goodness of fit tests in SAS (SAS Inst., Inc. 1989). Differences were considered significant when $p < 0.05$. If habitat use differed significantly when comparing all time periods simultaneously, specific tests among time periods determined where changes occurred.

Habitat preference was determined by comparing use to availability (Neu et al. 1974). On each study area, availability was determined by the proportion of each habitat type within a minimum convex polygon which included all late winter radio-locations of bobwhites on the area in 1995 and 1996. Usage and availability were compared using chi-square tests and considered significantly different when $p < 0.05$.

Where usage and availability differed significantly, Bonferroni z-statistics were used to determine whether individual habitat types were used more or less than expected.

Chapter IV.

Results

Disturbance Levels

Amount of disturbance was quantified by the number of times radio-marked coveys were thought to be flushed by field trial activities, and from estimates of gallery size made by Ames Plantation personnel riding in the trial. Four of the 14 radio-marked coveys on MFTA and EFTA were not flushed during DSTU, which corresponded to episodes of field trial activity (Table 3). Eight of the 14 coveys were flushed once and two coveys were flushed twice. The average estimated size of the horse gallery during the 1995 National Championship Field Trial was 179 riders (range 75 - 600) on MFTA and 283 riders (range 150 - 700) on EFTA (Table 4). The largest gallery of 1995 was 700 riders on EFTA on February 20. Gallery sizes during the 1996 National Championship Field Trial were thought to be similar to those in 1995, though estimates were not recorded.

Survival

Kaplan-Meier survival estimates for the January 9 - April 1 time period ranged from a low of 0.638 on MFTA in 1996 to a high of 1.00 on CA in 1995 (Table 5). Log

Table 3. Number of times radio-marked coveys on 2 study areas were thought to be flushed during the National Championship Field Trial, Ames Plantation, Fayette and Hardeman Co., Tennessee, February 13-23, 1995 and February 12-23, 1996.

Year	Study Area	Covey	Number of Flushes
1995	Morning Field Trial Area	A95	2
		B95	1
		C95	0
		D95	1
		E95	0
	Evening Field Trial Area	F95	1
		G95	2
		H95	1
		I95	0
1996	Morning Field Trial Area	A96	1
		B96	0
		C96	1
	Evening Field Trial Area	D96	1
		E95	1

Table 4. Number of riders in the horse gallery during the National Championship Field Trial on 2 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, February 13-23, 1995.

Date	Study Area	
	Morning Field Trial Area	Evening Field Trial Area
2/13/95	110	175
2/14/95	110	200
2/15/95	75	240
2/16/95	115	200
2/17/95	240	400
2/20/95	600	700
2/21/95	125	150
2/22/95	160	200
2/23/95	80	-
Mean (SE)	179 (55)	283 (65)

Table 5. Number of radio-marked quail, Kaplan-Meier survival estimates, and standard error for late winter (January 9 - April 1) on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Year					
	1995			1996		
	n	Kaplan-Meier Survival Estimate	SE	n	Kaplan-Meier Survival Estimate	SE
Morning Field Trial Area	18	0.941 A	0.055	23	0.638 B	0.106
Evening Field Trial Area	9	0.889 A	0.121	13	0.769 B	0.117
Control Area	9	1.000 A	0.000	9	0.889 B	0.104
Combined	36	0.944 C	0.040	45	0.728 D	0.068

A Survival differences among study areas in 1995 not significant ($p > .05$ in all cases)

B Survival differences among study areas in 1996 not significant ($p > .05$ in all cases)

C-D Survival in 1995 significantly higher than in 1996

rank tests showed that survival did not differ among study areas in either 1995 or 1996 ($p > 0.05$ in all cases). Samples were pooled across study areas to produce overall survival estimates for 1995 and 1996. Late winter survival was significantly lower in 1996 (0.728) than in 1995 (0.944) ($p=.019$).

Over the 2 years of the study, 2 radio-marked quail that resided on the field trial grounds died in the DSTU time period (Table 6). No radio-marked quail died on CA during the same time periods, and no quail were censored on any study area. Pooled data from both years showed that survival during disturbance did not differ significantly between CA and either MFTA or EFTA ($p > 0.05$ in both cases).

Hourly Movements

The overall mean hourly movement rate for the study was 37.1 m, but differed among study areas and between years (Table 7). Hourly movements on MFTA were greater than on EFTA ($p < 0.05$). Hourly movements on EFTA were greater than on CA ($p < 0.05$).

Overall, hourly movements were significantly lower in 1996 than in 1995 ($p < 0.05$), though the trend was not consistent on all study areas ($p < 0.01$) (Table 7). The decrease was most pronounced on MFTA, where the mean hourly movement declined from 54.3 meters in 1995 to 29.9 meters in 1996. This decrease did not occur on CA where mean hourly movement increased slightly, but non-significantly, between 1995 and 1996.

Table 6. Number of radio-marked quail, number of deaths, and number of quail censored during field trial disturbance on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Year								
	1995			1996			Combined		
	n	Death	Censored	n	Death	Censored	n	Death	Censored
Morning Field Trial Area	17	1	0	19	0	0	36	1*	0
Evening Field Trial Area	8	0	0	13	1	0	21	1*	0
Control Area	9	0	0	8	0	0	17	0*	0
Combined	34	1	0	40	1	0	74	2	0

* Survival on neither the Morning or Evening Field Trial Areas differed significantly from that on the Control Area ($p > .05$ in both cases)

Table 7. Mean hourly movement in meters of radio-marked coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Year					
	1995		1996		Combined	
	n	Mean Hourly Movement (SE)	n	Mean Hourly Movement (SE)	n	Mean Hourly Movement (SE)
Morning Field Trial Area	175	54.3 (2.8)	57	29.8 (5.6)	232	48.3 (2.6) ¹
Evening Field Trial Area	238	38.8 (1.9)	92	26.2 (3.0)	330	35.3 (1.7) ²
Control Area	146	28.0 (2.0)	112	31.4 (3.4)	258	29.5 (1.8) ³
Combined	559	40.8 (1.4) ^A	261	29.2 (2.2) ^B	820	37.1 (1.2)

^{A-B} Mean hourly movement differed significantly between 1995 and 1996

¹⁻²⁻³ Mean hourly movement differed significantly among all three study areas

Mean hourly movements declined significantly during the 7-week period in which they were measured ($p < 0.01$) (Fig. 4). Hourly movements on MFTA and EFTA appeared to decrease markedly, while movements appeared to remain stable on CA. The statistical evidence to support a differential effect by study area was fairly weak ($p < 0.1$). During weeks 4 and 5, which represent the DSTU time period, drastic changes were not apparent on MFTA or EFTA. Movements appeared to increase during week 5, but they increased on CA as well.

Mean hourly movement throughout the day ranged from a low of 32.5 m at 1100 to a high of 44.5 m at 0700 (Table 8). While these data seem to follow a pattern of decreased movement during the middle of the day, linear regression revealed the trend to be non-significant ($p=.542$).

Home Range

Mean home range size across all study areas and both years of the study was 9.5 ha (Table 9). While mean home range sizes among study areas were not equal, evidence to suggest that differences were significant was fairly weak ($p=.076$). Home range size did not differ between 1995 and 1996 ($p=.580$), and the interaction between study area and year was also non-significant ($p=.303$).

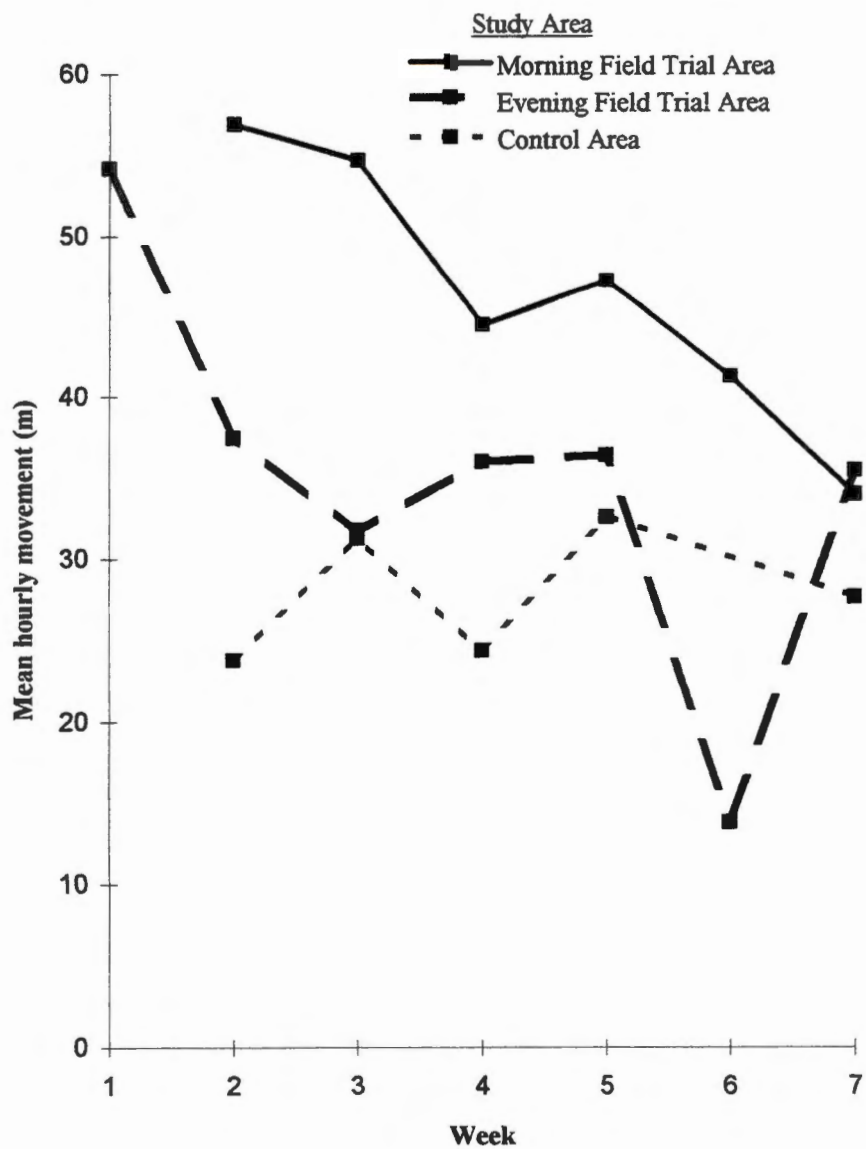


Figure 4. Mean hourly movement by week for radio-marked coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996. Field trial disturbance occurred during weeks 4 and 5.

Table 8. Mean hourly movement (m) by time of day for radio-marked coveys on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Time of Day	n	Mean Hourly Movement (SE)*
0700	51	44.5 (5.7)
0800	74	40.5 (3.5)
0900	69	40.7 (4.3)
1000	74	39.0 (4.9)
1100	79	32.5 (3.3)
1200	71	35.3 (3.5)
1300	79	32.8 (3.5)
1400	72	38.4 (4.7)
1500	68	33.2 (3.0)
1600	60	34.6 (3.6)
1700	68	36.6 (3.9)
1800	49	40.2 (5.7)

* Differences in movements not statistically significant ($p > .05$)

Table 9. Minimum convex polygon home range size (ha) from January 9 - April 1 for radio-marked coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study area	Year				1995/1996 Combined Mean (SE)
	1995		1996		
	Covey	MCP	Covey	MCP	
Morning Field Trial Area	A95	15.2	A96	7.1	
	A295	13.6	B96	7.4	
	B95	15.3	C96	9.5	
	C95	4.3			
	D95	9.7			
	E95	6.8			
	Mean (SE)	10.8 (1.8)		8.0 (0.7)	9.9 (1.3)
Evening Field Trial Area	F95	6.5	D96	3.5	
	G95	6.9	E96	5.3	
	H95	12.0			
	I95	6.9			
	Mean (SE)	8.1 (1.3)		4.4 (0.9)	6.8 (1.1)
Control Area	J95	11.3	F96	9.2	
	K95	6.6	G96	18.6	
	L95	13.7			
	Mean (SE)	10.5 (2.1)		13.9 (4.7)	11.8 (2.1)
Combined	Mean (SE)	9.9 (1.1)		8.7 (1.9)	9.5 (0.9) ¹

¹ Home range size did not differ significantly among study areas or between years ($p > .05$ in both cases)

Distance from Field Trial Course or Center Line of Study Area

Radio-marked coveys tended to move away from areas of field trial disturbance on MFTA (Table 10) and EFTA (Table 11). On MFTA radio-marked coveys were 62.3 m farther away from the course in the DSTU period as compared to the PRED period ($p < 0.01$). In a similar fashion, coveys were 38.0 meters farther away in the DSTU period as compared to the POSD period ($p < 0.01$). Radio-marked coveys on EFTA were 25.1 m farther away from the field trial course in the DSTU period as compared to the POSD period ($p < 0.01$). On both MFTA and EFTA, coveys did not move increasingly farther from the course with successive days of field trial activity (Fig. 5). Bobwhites on CA showed no significant changes in distances from the centerline of the study area (Table 12).

Spatial Distributions of Locations

MRPP tests revealed many instances where coveys significantly altered the spatial distribution of their locations during late winter (Table 13). Average within-time-period distances ranged from a low of 49.9 m for covey H95 to a high of 293.6 m for covey L95, both of which occurred in the DSTU period (Table 14). standardized test statistics in the procedures ranged from -17.0 to 0.5 (Table 15). Only 2 of 20 coveys, both of which resided on EFTA, showed no significant differences. On MFTA coveys made significant changes between PRED and DSTU, and between DSTU and POSD as well, suggesting a response to disturbance. Coveys on CA made similar

Table 10. Mean distance from field trial course (m) during pre-disturbance¹, disturbance², and post-disturbance³ time periods and differences in mean distances from field trial course among time periods for radio-marked coveys on the Morning Field Trial Area, Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Covey	Time period			Difference Between Time Periods (m)	
	Pre-disturbance	Disturbance	Post-disturbance	Disturbance - Pre-disturbance	Disturbance - Post-disturbance
A95 ⁴	85.7	91.5	86.3	8.6	5.2
A295 ⁴	-	-	68.8	-	22.7
B95	75.2	106.9	66.0	31.8	40.9
C95	137.9	195.5	140.6	57.5	54.9
D95	113.4	181.5	137.0	68.1	44.4
E95	24.8	115.2	45.2	90.4	138.5
A96	104.0	138.5	93.2	34.4	45.2
B96	112.5	156.1	136.1	43.6	20.0
C96	184.8	352.0	300.4	167.2	51.6
Mea	104.8	167.1	120.8	62.3 S	47.0 S
SE	16.5	28.8	24.9	17.5	5.9

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁴ Coveys A95 and A295 were together before and during the field trial, but separated on February 28, 1995.

⁵ Change in distance from field trial course tested and found to be significantly greater than zero (paired t-test, $p < .01$).

Table 11. Mean distance from field trial course (m) during pre-disturbance¹, disturbance², and post-disturbance³ time periods and differences in mean distances from field trial course among time periods for radio-marked coveys on the Evening Field Trial Area, Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Covey	Time period			Difference Between Time Periods (m)	
	Pre-disturbance	Disturbance	Post-disturbance	Disturbance - Pre-disturbance	Disturbance - Post-disturbance
F95	90.1	103.4	100.8	13.3	2.6
G95	37.3	64.0	84.5	26.8	-20.4
H95 (347) ⁴	147.6	165.9	117.3	18.3	48.7
H95 (526) ⁴	144.7	182.2	175.3	37.5	6.9
I95	153.2	194.4	149.1	41.2	45.3
D96	58.6	53.9	62.5	-4.7	-8.6
E96	180.4	223.7	168.3	43.3	55.4
Mean	116.0	141.1	122.5	25.1 S	18.6 S
SE	20.4	25.3	11.6	6.6	11.6

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁴ Quail 347 and 526 in covey H95 separated for a 7 day period during and after the field trial.

^S Change in distance from field trial course tested and found to be significantly greater than zero (paired t-test, $p < .01$).

^{ns} Change in distance from field trial course tested and found not to differ significantly from zero (paired t-test, $p > .05$).

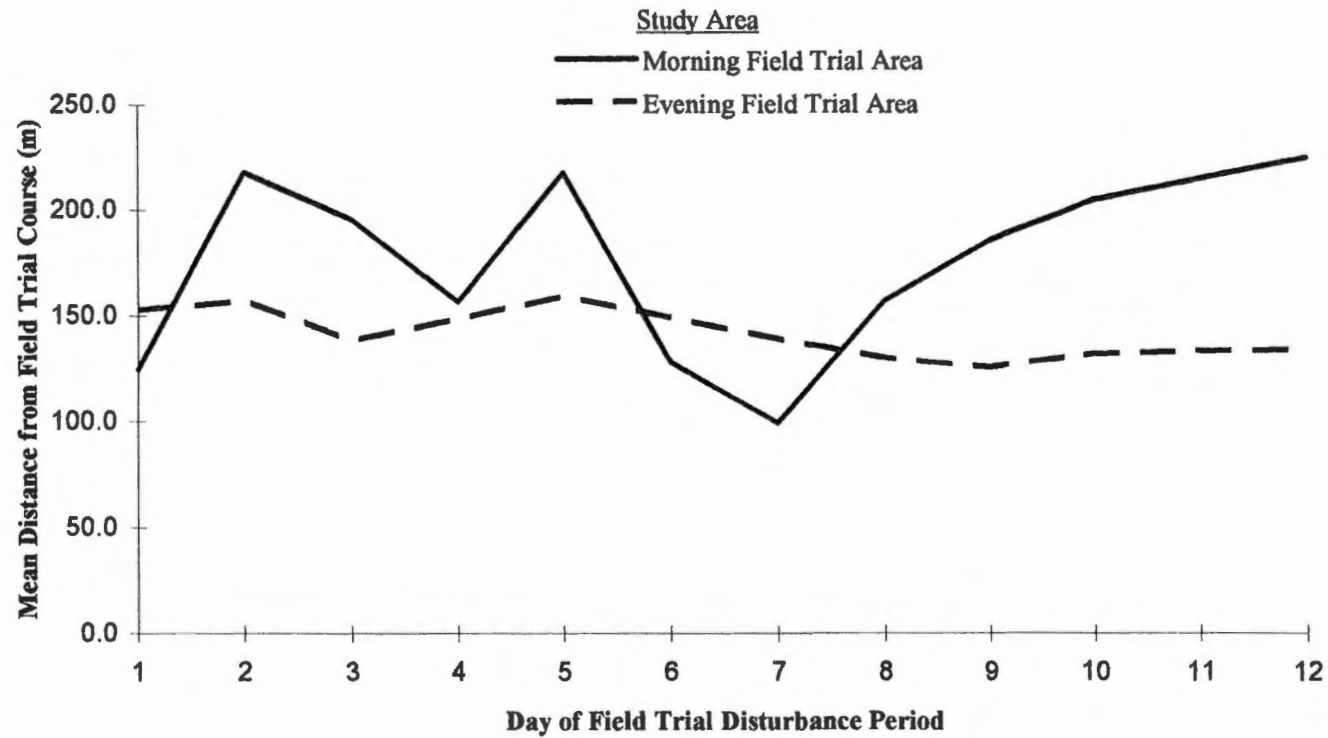


Figure 5. Mean distance of radio-marked coveys from field trial courses by day of field trial disturbance period on the Morning Field Trial Area and Evening Field Trial Area, Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996. Field trial disturbance did not occur on days 6 and 7, which represent Saturday and Sunday. On each study area, differences in mean distance did not differ significantly by day of the disturbance period ($p > 0.05$ in both cases).

Table 12. Mean distance (m) from a line bisecting the study area during pre-disturbance¹, disturbance², and post-disturbance³ time periods and differences in mean distances among time periods for radio-marked coveys on the Control Area, Ames Plantation, Fayette Co., Tennessee, 1995-1996. Although no disturbance occurred on the area, time periods corresponded to field trial disturbance on other areas.

Covey	Time period			Difference Between Time Periods (m)	
	Pre-disturbance	Disturbance	Post-disturbance	Disturbance - Pre-disturbance	Disturbance - Post-disturbance
J95	69.3	44.8	18.4	-24.5	26.5
K95	47.1	30.1	50.2	-17.0	-20.1
L95	43.1	102.3	18.8	59.1	83.4
F96	266.2	143.7	202.9	-122.5	-59.3
G96	52.1	31.8	163.7	-20.3	-131.8
Mean	95.6	70.5	90.8	-25.0 ns	-20.3 ns
SE	42.8	22.5	38.7	28.9	36.7

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

^{ns} Change in distance from line bisecting the study area tested and found not to differ significantly from zero (paired t-test, $p > .05$).

Table 13. Results of multi-response permutation procedures (MRPP) comparing the spatial distributions of radio-locations from pre-disturbance, disturbance, and post-disturbance time periods for coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Covey	MRPP Comparison		
		Overall ⁴	Pre-disturbance vs Disturbance	Disturbance vs Post-disturbance
Morning Field Trial Area	A95 ⁷	S ⁵	ns ⁶	S
	A295 ⁷	S	ns	S
	B95	S	ns	S
	C95	S	ns	S
	D95	S	S	S
	E95	S	S	S
	A96	S	S	S
	B96	S	S	ns
	C96	S	S	ns
Evening Field Trial Area	F95	ns	-	-
	G95	S	ns	S
	H95(347) ⁸	S	ns	S
	H95(526) ⁸	S	ns	S
	I95	S	ns	S
	D96	S	ns	S
	E96	ns	-	-
Control Area	J95	S	S	ns
	K95	S	S	ns
	L95	S	ns	S
	F96	S	S	ns
	G96	S	ns	S

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁴ Before, during, and after field trial disturbance time periods compared simultaneously, if $p > .05$ no further comparisons were made

⁵ The symbol (S) denotes a comparison significant at $p < .05$.

⁶ The symbol (ns) denotes a non-significant comparison, $p > .05$.

⁷ Coveys A95 and A295 were together during pre-disturbance and disturbance periods

⁸ Quail 347 and 526 in covey H95 separated from February 19 - 26, 1995

Table 14. Number of locations and mean distance between pairs of locations (m) during pre-disturbance¹, disturbance², and post-disturbance³ time periods for radio-marked coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Covey	Time period					
		Pre-disturbance		Disturbance		Post-disturbance	
		Locations	Mean Distance Between Locations	Locations	Mean Distance Between Locations	Locations	Mean Distance Between Locations
Morning Field Trial Area	A95 ⁴	13	198.5	6	290.5	18	204.2*
	A295 ⁴	10	256.1	5	230.6	14	156.3*
	B95	10	140.7	8	250.1	17	105.7*
	C95	7	117.0	7	98.7	17	108.8*
	D95	14	112.1	9	88.8*	16	194.1*
	E95	8	53.5	7	87.0*	12	103.6*
	A96	21	160.2	10	77.0*	20	140.1*
	B96	14	162.9	8	864*	18	83.5
	C96	19	135.6	9	119.8*	16	152.4
Evening Field Trial Area	F95	14	182.1	8	200.2	13	214.5
	G95	13	81.2	7	175.5	16	128.3*
	H95(347) ⁵	19	64.8	8	149.9	10	108.2*
	H95(526) ⁵	16	74.5	8	49.9*	13	113.1*
	I95	17	112.2	8	61.3	15	97.9*
	D96	19	104.0	9	117.2	21	53.4*
	E96	20	120.5	9	104.3	20	80.9*
Control Area	J95	7	184.8	6	148.4*	14	80.8
	K95	6	96.3	5	60.2*	12	147.2
	L95	3	78.4	7	293.6	14	81.7*
	F96	17	161.0	10	154.2*	19	193.3
	G96	16	251.1	10	81.7	19	151.3*

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁴ Covey A95 and A295 were together before and during field trial disturbance, but separated on February 28, 1995.

⁵ Quail 347 and 526 from covey H95 separated from February 19 - 26, 1995.

* Indicates that the spatial distribution of the locations differs significantly from the locations in the previous time period (MRPP, $p < .05$).

Table 15. Multi-response permutation procedure (MRPP) standardized test statistics from comparisons of spatial distributions of radio-locations from pre-disturbance¹, disturbance², and post-disturbance³ time periods for coveys on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Covey	MRPP Comparison		
		Overall ⁴	Pre-disturbance vs Disturbance	Disturbance vs Post-disturbance
Morning Field Trial Area	A95 ⁵	-2.8	0.5	-1.5
	A295 ⁵	-7.4	-1.0	-9.0
	B95	-2.1	-1.5	-2.0
	C95	-3.6	-1.2	-3.1
	D95	-2.9	-4.7	-2.7
	E95	-5.5	-6.8	-4.5
	A96	-4.2	-3.1	-5.7
	B96	-3.8	-2.5	-0.5
	C96	-8.7	-9.5	-0.6
Evening Field Trial Area	F95	-0.7	-	-
	G95	-3.6	0.1	-2.1
	H95(347) ⁶	-17.0	-2.8	-13.1
	H95(526) ⁶	-15.5	-1.3	-9.5
	I95	-2.4	-1.1	-3.3
	D96	-3.1	0.6	-5.0
Control Area	E96	-1.3	-	-
	J95	-6.2	-2.4	0.5
	K95	-2.2	-1.6	-0.2
	L95	-5.2	-0.8	-5.7
	F96	-4.1	-4.2	-1.0
	G96	-8.1	-1.4	-6.8

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁴ Before, during, and after field trial disturbance time periods compared simultaneously, if $p > .05$ no further comparisons were made

⁵ Coveys A95 and A295 were together during pre-disturbance and disturbance periods

⁶ Quail 347 and 526 in covey H95 separated from February 19 - 26, 1995

shifts, in response to factors other than disturbance. Coveys on EFTA seemed to make significant changes mainly POSD.

Habitat Use

Coveys on MFTA spent a high percentage of time in partially stocked stands in both 1995 (55.6%) and 1996 (54.0%) (Table 16). On EFTA coveys utilized fully stocked stands 41.6% of the time in 1995. In 1996 coveys heavily utilized both partially (44.9%) and fully (44.9%) stocked stands. In 1995 on CA, coveys were most often located in partially stocked stands (57.5%). In 1996, coveys on CA were often located in agricultural fields (40.7%).

Habitat use on MFTA was computed from 189 and 137 independent locations in 1995 and 1996, respectively (Table 17). In 1995, habitat use during DSTU differed significantly from usage in either PRED or POSD (Chi-square, $p < 0.05$ in both cases). During DSTU, usage of fully stocked stands increased while usage of partially stocked stands decreased. Habitat use on the area in 1996 did not differ significantly among the 3 time periods (Chi-square, $p > 0.05$).

Habitat use on EFTA was computed from 154 and 98 independent late winter locations in 1995 and 1996, respectively (Table 18). Habitat use among PRED, DSTU, and POSD time periods did not differ significantly in either 1995 or 1996 (Chi-square, $p > 0.05$ in both cases).

Table 16. Number of radio-locations (%) in each of 4 habitat types during late winter (January 9 - April 1) on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Habitat Type	Study Area					
	Morning Field Trial Area		Evening Field Trial Area		Control Area	
	1995	1996	1995	1996	1995	1996
Fully Stocked Stand	29 (15.3%)	25 (18.2%)	64 (41.6%)	44 (44.9%)	3 (4.1%)	26 (28.6%)
Partially Stocked Stand	105 (55.6%)	74 (54.0%)	32 (20.8%)	44 (44.9%)	42 (57.5%)	23 (25.3%)
Agricultural Field	22 (11.6%)	7 (5.1%)	30 (19.5%)	9 (9.2%)	28 (38.4%)	37 (40.7%)
Field Non-agriculture	33 (17.5%)	31 (22.6%)	28 (18.2%)	1 (1.0%)	0 (0.0%)	5 (5.5%)
Total	189 (15.3%)	137 (100%)	154 (100%)	98 (100%)	73 (100%)	91 (100%)

Table 17. Number of radio-locations¹ in each of 4 habitat types during pre-disturbance², disturbance³, and post-disturbance⁴ time periods on the Morning Field Trial Area on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Year	Habitat Type	Time Period							
		Pre-disturbance		Disturbance ^s		Post-disturbance ^s		Combined	
		n	%	n	%	n	%	n	%
1995	Fully Stocked Stand	7	12.1	13	35.1	9	9.6	29	15.3
	Partially Stocked Stand	30	51.7	17	45.9	58	61.7	105	55.6
	Agricultural Field	4	6.9	2	5.4	16	17.0	22	11.6
	Field Non-agriculture	17	29.3	5	13.5	11	11.7	33	17.5
	Total	58	100.0	37	100.0	94	100.0	189	100.0
1996		Pre-disturbance		Disturbance ^{ns}		Post-disturbance ^{ns}		Combined	
	Habitat Type	n	%	n	%	n	%	n	%
	Fully Stocked Stand	14	25.9	7	25.0	4	7.3	25	18.2
	Partially Stocked Stand	26	48.1	15	53.6	33	60.0	74	54.0
	Agricultural Field	4	7.4	1	3.6	2	3.6	7	5.1
	Field Non-agriculture	10	18.5	5	17.9	16	29.1	31	22.6
	Total	54	100.0	28	100.0	55	100.0	137	100.0

^s Denotes a time period in which habitat use differed significantly from habitat use in the previous time period (Chi-square, $p < .05$)

^{ns} Denotes a time period in which habitat use did not differ significantly from habitat use in the previous time period (Chi-square, $p > .05$)

¹ Combines independent radio-locations from all coveys on the study area

² Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

³ Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

⁴ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

Table 18. Number of radio-locations¹ in each of 4 habitat types during pre-disturbance², disturbance³, and post-disturbance⁴ time periods on the Evening Field Trial Area on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Year	Habitat Type	Time Period							
		Pre-disturbance		Disturbance ^{ns}		Post-disturbance ^{ns}		Combined	
		n	%	n	%	n	%	n	%
1995	Fully Stocked Stand	25	39.7	14	43.8	25	42.4	64	41.6
	Partially Stocked Stand	16	25.4	7	21.9	9	15.3	32	20.8
	Agricultural Field	15	23.8	6	18.8	9	15.3	30	19.5
	Field Non-agriculture	7	11.1	5	15.6	16	27.1	28	18.2
	Total	63	100.0	32	100.0	59	100.0	154	100.0
1996	Fully Stocked Stand	17	43.6	10	55.6	17	41.5	44	44.9
	Partially Stocked Stand	17	43.6	7	38.9	20	48.8	44	44.9
	Agricultural Field	5	12.8	0	0.0	4	9.8	9	9.2
	Field Non-agriculture	0	0.0	1	5.6	0	0.0	1	1.0
	Total	39	100.0	18	100.0	41	100.0	98	100.0

^{ns} Denotes a time period in which habitat use did not differ significantly from habitat use in the previous time period (Chi-square, $p > .05$)

¹ Combines independent radio-locations from all coveys on the study area

² Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

³ Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

⁴ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

Late winter habitat use on CA in 1995 and 1996 was computed from 73 and 91 independent locations, respectively (Table 19). Though no field trial disturbance occurred on the study area, locations were grouped into time periods corresponding to those utilized on the other study areas. Habitat use in 1995 did not differ significantly among the time periods (Chi-square, $p > 0.05$). In 1996, habitat use was similar within PRED and DSTU time periods (Chi-square, $p > 0.05$), but differed significantly between the DSTU and POSD time periods (Chi-square, $p < 0.05$). The difference was chiefly the result of a dramatic increase in the number of radio-locations occurring within agricultural fields.

Across all study areas and in both years of the study, significant differences in the overall late winter habitat use existed on only 2 occasions (Table 20). Habitat use differed among time periods on MFTA in 1995, and in 1996 habitat use differed among time periods on CA. Changes in habitat use did not occur on MFTA area in 1996 nor on the EFTA in either 1995 and 1996.

Habitat Selection

Estimates of habitat availability, as determined from minimum convex polygons containing all radio-locations on a study area, were not equivalent across the 3 study areas (Table 21). On CA, 77.6% of the available area was agricultural field, which composed only about 25% of MFTA and EFTA. Availability of fully stocked forest was highest on EFTA and lowest on the CA.

Table 19. Number of radio-locations¹ in each of 4 habitat types during pre-disturbance², disturbance³, and post-disturbance⁴ time periods on the Control Area on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996. Although no disturbance occurred on the area, time periods correspond to field trial disturbance on other areas.

Year	Habitat Type	Time Period							
		Pre-disturbance		Disturbance ^{ns}		Post-disturbance ^s		Combined	
		n	%	n	%	n	%	n	%
1995	Fully Stocked Stand	2	7.4	1	5.0	0	0.0	3	4.1
	Partially Stocked Stand	18	66.7	10	50.0	14	53.8	42	57.5
	Agricultural Field	7	25.9	9	45.0	12	46.2	28	38.4
	Field Non-agriculture	0	0.0	0	0.0	0	0.0	0	0.0
	Total	27	100.0	20	100.0	26	100.0	73	100.0
1996	Fully Stocked Stand	16	48.5	6	30.0	4	10.5	26	28.6
	Partially Stocked Stand	9	27.3	10	50.0	4	10.5	23	25.3
	Agricultural Field	6	18.2	3	15.0	28	73.7	37	40.7
	Field Non-agriculture	2	0.1	1	0.1	2	0.1	5	5.5
	Total	33	93.9	20	95.1	38	94.7	91	94.5

^s Denotes a time period in which habitat use differed significantly from habitat use in the previous time period (Chi-square, $p < .05$)

^{ns} Denotes a time period in which habitat use did not differ significantly from habitat use in the previous time period (Chi-square, $p > .05$)

¹ Combines independent radio-locations from all coveys on the study area

² Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

³ Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

⁴ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

Table 20. Results from Chi-square tests comparing habitat use¹ during pre-disturbance², disturbance³, and post-disturbance⁴ time periods on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Study Area	Year	Time Periods Compared		
		Overall ⁵	Pre-disturbance vs Disturbance	Disturbance vs Post-disturbance
Morning Field	1995	S	S	S
Trial Area	1996	ns	-	-
Evening Field	1995	ns	-	-
Trial Area	1996	ns	-	-
Control Area	1995	ns	-	-
	1996	S	ns	S

¹ Habitat use determined from independent locations of all radio-marked coveys on each study area each year

² Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

³ Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

⁴ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁵ All time periods compared simultaneously, if $p > .05$ no further comparisons were made.

^S Denotes a significant comparison, $p < .05$

^{ns} Denotes a non-significant comparison, $p > .05$

Table 21. Amount of each of 4 habitat types from composite home ranges¹ on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Habitat Type	Study Area					
	Morning Field Trial Area		Evening Field Trial Area		Control Area	
	ha	%	ha	%	ha	%
Fully Stocked Stand	33.7	18.1	27.3	48.6	3.1	7.6
Partially Stocked Stand	65.2	35.0	6.9	12.3	5.4	13.3
Agricultural Field	47.4	25.5	14.0	25.0	31.6	77.6
Field Non-agriculture	39.9	21.4	7.9	14.1	0.6	1.4
Total	186.2	100.0	56.1	100.0	40.8	100.0

¹ Composite home ranges defined as minimum convex polygons encompassing all radio-locations from January 9 - April 1 from all coveys on the study areas in 1995 and 1996.

During 1996, radio-marked coveys on MFTA used partially stocked stands more than expected and agricultural fields less than expected (Table 22). Habitat selection on the area during 1995 was comparable to 1996, with a few notable exceptions. In 1995 radio-marked coveys showed a preference for partially stocked stands in the PRED and POSD periods, but not in the DSTU time period. The decrease in use of partially stocked stands during the field trials corresponded with an increase in use of fully stocked stands, though the increase was not great enough to indicate that fully stocked stands were preferred habitat.

Partially stocked stands were used significantly more than expected on EFTA during both 1995 and 1996 (Table 23). Agricultural fields were used as expected in 1995, but were used less than expected in 1996. Use of fully stocked stands did not differ from their availability in either 1995 or 1996 ($p > 0.05$).

On CA in 1995, partially stocked forests were used more than expected and agricultural fields were used less than expected across the entire late winter time period (Table 24). In 1996, radio-marked coveys used both fully and partially stocked forests more than expected and used agricultural fields less than expected in the PRED and DSTU time periods. All habitat types were used in proportion to their availability POSD in 1996.

In general, coveys on each study area and in both years selected habitat in a similar fashion (Table 25). In many cases, radio-marked quail used partially stocked stands more than expected based on availability. The DSTU period on MFTA in 1995

Table 22. Chi-square analyses of late winter (January 9 - April 1) habitat selection on the Morning Field Trial Area, Ames Plantation, Fayette Co., Tennessee, 1995-1996. Tests were performed separately where previous analyses showed that habitat use differed significantly among pre-disturbance¹, disturbance², and post-disturbance³ time periods.

Year	Time Period	Habitat Type	Habitat Availability	Observed # Locations	Expected # Locations	Observed in Habitat	Low 90% Confidence Interval	Upper 90% Confidence Interval
1995	Pre-disturbance	Fully Stocked Stand	0.181	7	10.50	0.121	0.025	0.217
		Partially Stocked Stand ^P	0.350	30	20.30	0.517	0.370	0.664
		Agricultural Field ^A	0.255	4	14.79	0.069	-0.006	0.143
		Non-agricultural Field	0.214	17	12.41	0.293	0.159	0.427
		Total	1.000	58	58.00	1.000		
	Disturbance	Fully Stocked Stand	0.181	13	6.70	0.351	0.176	0.527
		Partially Stocked Stand	0.35	17	12.95	0.459	0.276	0.643
		Agricultural Field ^A	0.255	2	9.44	0.054	-0.029	0.137
		Non-agricultural Field	0.214	5	7.92	0.135	0.009	0.261
		Total	1.000	37	37.00	1.000		
	Post-disturbance	Fully-stocked Stand ^A	0.181	9	17.01	0.096	0.096	0.164
		Partially Stocked Stand ^P	0.35	58	32.90	0.617	0.617	0.729
		Agricultural Field	0.255	16	23.97	0.170	0.17	0.257
		Non-agricultural Field ^A	0.214	11	20.12	0.117	0.117	0.191
		Total	1.000	94	94.00	1.000		
1996	Combined	Fully Stocked Stand	0.181	25	24.80	0.182	0.109	0.256
		Partially Stocked Stand ^P	0.35	74	47.95	0.540	0.445	0.636
		Agricultural Field ^A	0.255	7	34.94	0.051	0.009	0.093
		Non-agricultural Field	0.214	31	29.32	0.226	0.146	0.306
		Total	1.000	137	137.00	1.000		

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

^P Habitat preferred, lower 90% confidence limit on use greater than availability

^A Habitat avoided, upper 90% confidence limit less than availability

Table 23. Chi-square analyses of late winter (January 9 - April 1) habitat selection on the Evening Field Trial Area, Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Year	Habitat Type	Habitat Availability	Observed # Locations	Expected # Locations	Observed in Habitat	Low 90% Confidence Interval	Upper 90% Confidence Interval
1995	Fully Stocked Stand	0.486	64	74.84	0.416	0.327	0.505
	Partially Stocked Stand ^P	0.123	32	18.94	0.208	0.135	0.281
	Agricultural Field	0.250	30	38.50	0.195	0.123	0.266
	Non-agricultural Field	0.141	28	21.71	0.182	0.112	0.251
	Total	1.000	154	154.00	1.000		
1996	Fully Stocked Stand	0.486	44	47.63	0.449	0.336	0.562
	Partially Stocked Stand ^P	0.123	44	12.05	0.449	0.336	0.562
	Agricultural Field ^A	0.250	9	24.50	0.092	0.026	0.157
	Non-agricultural Field ^A	0.141	1	13.82	0.010	-0.013	0.033
	Total	1.000	98	98.00	1.000		

^P Habitat preferred, lower 90% confidence limit on use greater than availability

^A Habitat avoided, upper 90% confidence limit less than availability

Table 24. Chi-square analyses of late winter (January 9 - April 1) habitat selection on the Control Area, Ames Plantation, Fayette Co., Tennessee, 1995-1996. Tests were performed separately where previous analyses showed that habitat use differed significantly among pre-disturbance¹, disturbance², and post-disturbance³ time periods corresponding to field trial disturbance on other areas.

Year	Time Period	Habitat Type	Habitat Availability	Observed # Locations	Expected # Locations	Observed in Habitat	Low 90% Confidence Interval	Upper 90% Confidence Interval
1995	Combined	Fully Stocked Stand	0.076	3	5.55	0.041	-0.011	0.093
		Partially Stocked Stand ^P	0.133	42	9.71	0.575	0.446	0.705
		Agricultural Field ^A	0.776	28	56.65	0.384	0.256	0.511
		Non-agricultural Field	0.015	0	1.10	0.000	0.000	0.000
		Total	1.000	73	73.00	1.000		
1996	Pre-disturbance and Disturbance	Fully Stocked Stand ^P	0.076	22	4.03	0.415	0.263	0.567
		Partially Stocked Stand ^P	0.133	19	7.05	0.358	0.211	0.506
		Agricultural Field ^A	0.776	9	41.13	0.170	0.054	0.285
		Non-agricultural Field	0.015	3	0.80	0.057	-0.014	0.128
		Total	1.000	53	53.00	1.000		
	Post-disturbance	Fully Stocked Stand	0.076	4	2.89	0.105	-0.006	0.217
		Partially Stocked Stand	0.133	4	5.05	0.105	-0.006	0.217
		Agricultural Field	0.776	28	29.49	0.737	0.577	0.897
		Non-agricultural Field	0.015	2	0.57	0.053	-0.029	0.134
		Total	1.000	38	38.00	1.000		

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

^P Habitat preferred, lower 90% confidence limit on use greater than availability

^A Habitat avoided, upper 90% confidence limit less than availability

Table 25. Preference and avoidance results from Chi-square habitat selection analyses on 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996. Tests were performed separately where previous analyses showed that habitat use differed significantly among pre-disturbance¹, disturbance², and post-disturbance³ time periods.

Study Area	Year	Time Period	Habitat Type			
			Fully Stocked Stand	Partially Stocked Stand	Agricultural Field	Non-agricultural Field
Morning Field Trial Area	1995	Pre-disturbance		P ⁴	A ⁵	
		Disturbance			A	
		Post-disturbance	A	P		A
	1996	Combined ⁶		P	A	
Evening Field Trial Area	1995	Combined		P		
	1996	Combined		P	A	A
Control Area	1995	Combined		P	A	
	1996	Pre-disturbance/Disturbance Post-disturbance	P	P	A	

¹ Pre-disturbance period was January 9 - February 12, 1995 and January 9 - February 11, 1996.

² Disturbance period was February 13- 23, 1995 and February 12 - 23, 1996.

³ Post-disturbance was February 24 - April 1, 1995 and February 24 - April 1, 1996.

⁴ The symbol (P) indicates that the habitat type was used significantly more than expected.

⁵ The symbol (A) indicates that the habitat type was used significantly less than expected.

⁶ Combined - locations pooled across all time periods.

and POSD on CA in 1996 were the only times that partially stocked stands were not a preferred habitat type. Agricultural fields were used less than expected in all cases except on MFTA in the POSD period in 1995 and on EFTA in all time periods 1995.

Chapter V.

Discussion

Late Winter Survival

Late winter (January 9 - April 1) survival estimates in this study, 0.944 in 1995 and 0.728 in 1996 (Table 5), were slightly higher than estimates by other researchers. Roseberry and Klimstra (1972) reported a mean January to March loss of 29.6%. Mueller et al. (1988*b*) reported a mortality rate of 0.27 for 34 radio-marked bobwhites in northern Florida during a 45-day period in March and April. During a 5-year radio-telemetry study, Curtis et al. (1988) reported monthly survival rates for 159 bobwhites from a hunted population in North Carolina and 478 bobwhites from an unhunted population in northern Florida. Monthly survival during January, February, and March ranged from 0.592 to 0.848; this period was a time of particularly low survival.

Low bobwhite survival has been reported in other seasons as well. Pollock et al. (1989*a*) reported annual survival of 0.167 from a 15 year band return study in northern Florida. Burger et al. (1995) estimated annual survival at 0.053 and fall-spring survival at 0.159 for 1,001 radio-marked bobwhites in Missouri. On 3 study areas in the coastal plain of South Carolina, Dixon et al. (1996) found November-March survival rates to be 0.288, 0.350, and 0.359. From a radio-telemetry study, Curtis et al. (1988) reported winter survival rates of 0.254 for hunted bobwhites in

North Carolina and 0.660 for an un hunted population in northern Florida. Robinette and Doerr (1993) also radio-monitored samples of hunted and nonhunted bobwhites. They reported winter survival rates ranging from 0.308 to 0.737. Roseberry and Klimstra (1972) censused bobwhite populations repeatedly during winter on their southern Illinois study area. From 18 years of observations they reported a mean of only 33.8% of the November population surviving until April each year.

Variation in Survival Rates

Late winter survival was significantly higher in 1995 (0.944) than in 1996 (0.728). Differences in survival may have resulted from differences in weather and food availability, or possibly from the use of different radio-telemetry equipment in the 2 years. Many other researchers have cited weather and food availability as factors influencing winter survival (Edwards 1972, Robel 1972, Stanford 1972, Robel et al. 1974, Roseberry and Klimstra 1984,). In general, weather was milder in 1995 than in 1996. Bobwhites were noticeably easier to capture in 1996 than in 1995, which likely reflected changes in their needs for protective cover and food. However, trapping experience and better knowledge of the study areas may have been important, too. In 1995, 47 days were required to capture 36 bobwhites. In 1996, 45 bobwhites were captured in only 12 days.

The difference in survival estimates between 1995 and 1996 could have been due to the use of different radio-transmitters in the 2 years of the study. Radio-

transmitters used in 1996 contained mortality switches, while those used in 1995 did not. Mortality indicators would decrease the likelihood of incorrectly censoring a mortality event. However, it seems unlikely that this affected survival estimates as there were only 2 deaths and 3 quail censored in 1995 compared with 12 deaths and 2 quail censored in 1996.

Other authors have reported annual fluctuations in survival. During their 18-year study in southern Illinois, Roseberry and Klimstra (1972) reported that survival and mortality varied substantially from year to year. November to April losses ranged from 36% to 81% and January to April losses ranged from 4.4% to 52.3%. Pollock et al. (1989a) also found substantial differences in survival from year to year. During their 15-year study in northern Florida, annual survival rates ranged from 0.098 to 0.241.

Impact of Disturbance on Survival

Bobwhites on MFTA and EFTA did not die in large numbers as a direct result of disturbance, as only 2 radio-marked individuals died during periods of disturbance (Table 6). One death occurred on MFTA in 1995, the other occurred on EFTA in 1996. Covey A95 resided on MFTA, and was located and flushed by the field trial on the morning of February 16, 1995. Radio-telemetry procedures later indicated that 1 member of the covey died that day. Quail 769, a member of covey E96 on EFTA in

1996, was last known to be alive on February 15. Covey E96 was located and flushed by the field trial on only 1 occasion, February 12, 1996.

In the DSTU period, survival on the field trial areas did not differ significantly from survival on the control area (Table 6). Even if all mortality on MFTA and EFTA in the DSTU periods resulted from field trial activity, it is unlikely that populations were greatly affected. Bobwhite populations can typically sustain harvest levels of 30 - 45 % without adverse effects (Rosene 1969, Roseberry 1979, Landers and Mueller 1986). As only 2 of the 57 (3.5%) radio-marked bobwhites exposed to field trial disturbance died during the DSTU periods, direct mortality was apparently very unlikely.

Late winter disturbance also apparently had no measurable indirect impacts on longer term survival. If the constant field trial activity had reduced the overall fitness of bobwhites, then January 9 - April 1 survival rates should have differed between field trial and control areas. However, late winter survival on MFTA and EFTA did not differ from survival on CA (Table 5).

Other researchers have studied bobwhites in potentially disruptive situations and have drawn similar conclusions. Mueller et al. (1988a) studied the effect of removing substantial amounts of cover from bobwhite home ranges by mid-March burning. They found no significant differences in bobwhite survival as a result of the cover reductions. Yoho (1970) monitored 16 radio-marked bobwhites in 9 coveys that were exposed to the National Championship Field Trial on Ames Plantation in February

of 1970. In a similar fashion, Wiseman (1977) monitored radio-marked bobwhites in 7 coveys that were exposed to field trial disturbance during March of 1976 in the tallgrass prairie of Oklahoma. Neither Yoho (1970) nor Wiseman (1977) reported incidents of mortality of radio-marked bobwhites as a result of field trial disturbance.

Hourly Movements

Bobwhites are thought to be most active in early morning and late afternoon (Stoddard 1931:45, Rosene 1969:92). Radio-telemetry projects have confirmed and quantified this. From a west Tennessee study, Yoho and Dimmick (1972a) found that winter coveys moved an average of only 390 m each day, with the greatest movements occurring early and late in the day. In a similar fashion, Shaffery (1988) employed radio-transmitters containing activity indicators and reported that bobwhites on his Arkansas study area decreased activity at mid-day.

In the current study, estimates of hourly movements suggested a pattern of decreased movement at mid-day. However, this trend was not statistically significant (Table 8). Two factors may account for this. First, estimates incorporated information from many coveys over a 7-week period. Each covey may have adjusted movements according to their unique set of circumstances, but there was no evidence that a general pattern emerged. Secondly, and perhaps more importantly, the true daily activity patterns may have been obscured by errors associated with radio-telemetry triangulation. The mean hourly movement across all study areas and years was only

37.1 m (SE 1.2), while the mean error of telemetry locations was estimated to be 42.8m (SE 5.0).

The significantly lower hourly movements in 1996 than in 1995 (Table 7) may have resulted from harsher winter conditions. In general, weather conditions were harsher in 1996 than in 1995. Previous authors have reported that bobwhite movements are influenced by weather. Roseberry (1964) found that coveys restricted their movements during periods of heavy snow cover. Yoho and Dimmick (1972a) found movements to be significantly correlated with the diurnal temperature, with coveys moving less on cold days.

Bobwhite movements are partly the result of habitat composition and food availability. Bell et al. (1985) evaluated winter and spring movements between feeding and roosting areas on 4 study sites in Louisiana pinelands. Bobwhite movements differed among the 4 study sites and were smaller in spring than in winter. They attributed differences among the study areas to habitat quality and speculated that seasonal differences were the result of changes in food availability. Hourly movements in the present study differed significantly among study areas and declined through late winter, possibly as a result of differences in habitat quality and food availability. CA consisted of large, open, agricultural fields that surrounded relatively small areas of protective cover. Hourly movements were lowest on CA; bobwhites may have been restricted to localized areas of adequate habitat. Furthermore, food resources on all study areas likely were declining during the late winter (Rosene 1969:105). This may

help explain the decrease in hourly movements; bobwhites may have been forced to focus their attention on the few areas where food was available.

The impact of disturbance on hourly movement rates is not fully understood. Yoho and Dimmick (1972a) reported that coveys altered their daily activities by restricting movements after being flushed. Janvrin (1991) found that hunting pressure produced the opposite effect. Hunting pressure caused coveys on their Missouri study area to increase their movements. However, Yoho and Dimmick (1972a) and Janvrin (1991) were able to measure covey movement rates on the same day that disturbance occurred, something not accomplished in the present study. Trends in hourly movements on MFTA and EFTA remained constant through episodes of field trial disturbance, indicating that disturbance had no impact (Fig. 4). However, hourly movements on the MFTA and the EFTA were collected only on weekends, while disturbance occurred only on weekdays. Therefore, the immediate effect of disturbance upon hourly movements could not be evaluated, nor are results from this study comparable to those of Yoho and Dimmick (1972a) or Janvrin (1991).

Distance From Field Trial Course

Disturbance caused a temporary shift in covey locations, as bobwhites were radio-located farther away from the field trial course during periods of disturbance (Tables 10 and 11). Most movements did not remove quail from their established home ranges. On average, coveys shifted no more than 62.3 m on MFTA and no more

than 25.1 m on the EFTA. The longest response by any covey was only 167 m. Furthermore, coveys showed a tendency to move back toward the field trial course after the cessation of disturbance. The apparent differences in response between MFTA and EFTA may be due to the radio-telemetry procedures. Coveys on the EFTA were located in the morning, before disturbance occurred each day. Coveys on the MFTA were located during the afternoon, after disturbance had occurred.

Movements away from the field trial course by bobwhites in this study appear inconsequential when compared to drastic responses reported by other researchers. Dimmick and Yoho (1972) radio-monitored bobwhites during field trial disturbance in western Tennessee and documented the permanent dislocation of one covey from its home range. Klimstra (1972) noted that intense hunting pressure forced many coveys to desert a study area in Illinois. Rosene (1969:94) reported that several weeks of daily bird dog activity forced 33 of 51 coveys to abandon an area in Alabama.

Spatial Distributions of Locations

Most radio-marked coveys made spatial shifts within their home ranges during the 3 late winter time periods (Table 13). Only 2 of 20 coveys showed no significant changes among the PRED, DSTU, and POSD time periods. Significant shifts were found in coveys on CA as well as MFTA and EFTA, suggesting that bobwhites respond to factors other than disturbance. Similarly, Dimmick and Yoho (1972) found that field trial disturbance affected only a portion of the coveys on an area. Many

factors other than disturbance, such as food, cover, and weather, regulate covey activity and distribution (Roseberry 1964, Yoho and Dimmick 1972a, Mueller 1988a). MRPP tests are particularly sensitive and do not necessarily imply that shifts are dramatic (White and Garrot 1990). In this study, bobwhites made adjustments within their home ranges, but did not abandon them for new areas. For example, covey A96 made shifts within its home range on the MFTA (Fig. 6), as did covey G96 on CA (Fig 7). The radio-locations of covey F95 on the EFTA (Fig. 8) serve as an example of a covey which did not make significant shifts.

Home Range

Mean home range size in this study (9.4 ha) was larger than that reported from a previous telemetry study on Ames Plantation by Yoho and Dimmick (1972b) (6.6 ha). The differences may be due to methods used to estimate home ranges. Home ranges in this study were computed with minimum convex polygons. However, Yoho and Dimmick (1972b) incorporated concave characteristics in their estimates, which would serve to make home ranges smaller. Home range dynamics have been used by researchers to evaluate disturbance to bobwhites. Dimmick and Yoho (1972) reported that 1 of 5 radio-marked coveys disintegrated and abandoned their home range when exposed to field trial disturbance. Janvrin (1991) obtained large (generally >100) samples of radio-locations for 26 coveys on a heavily hunted study area in Missouri.

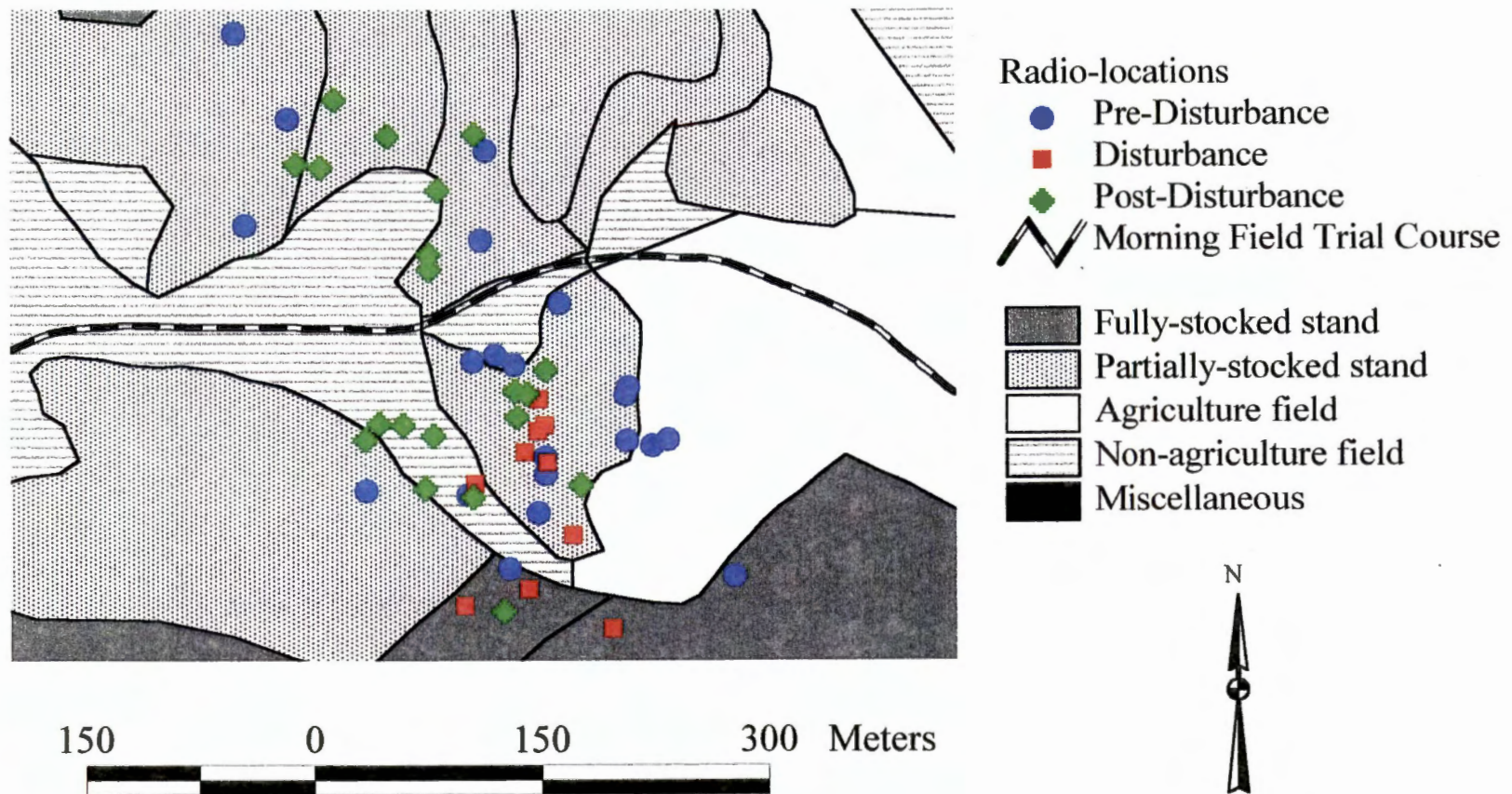


Figure 6. Radio-locations of covey A96 during pre-disturbance (January 9 - February 11), disturbance (February 12 - 23), and post-disturbance (February 24 - April 1) periods in 1996 on the Morning Field Trial Area, Ames Plantation, Fayette Co., Tennessee.

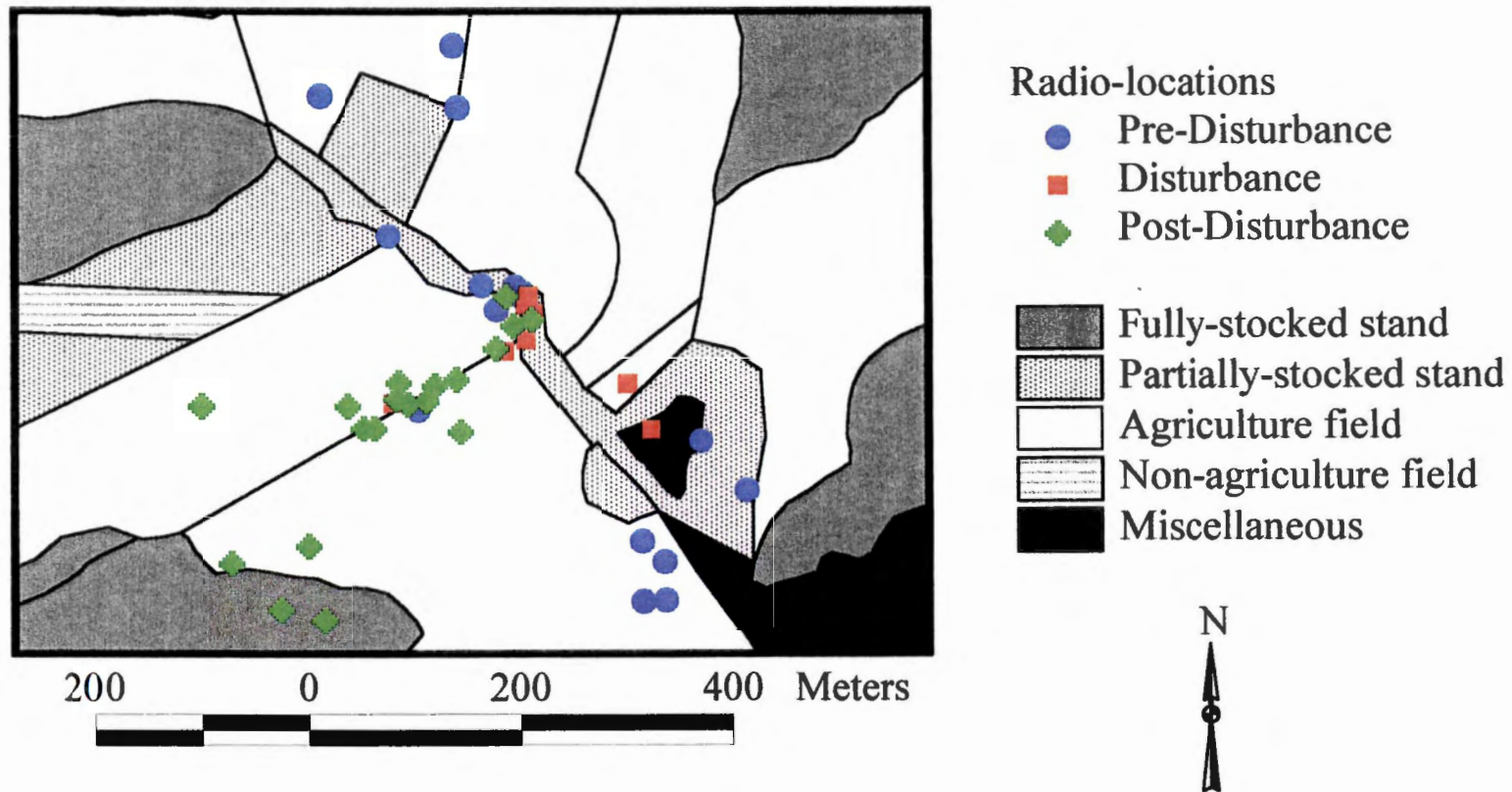


Figure 7. Radio-locations of covey G96 during pre-disturbance (January 9 - February 12), disturbance (February 13 - 23), and post-disturbance (February 24 - April 1) periods in 1996 on the Control Area, Ames Plantation, Fayette Co., Tennessee. Although no disturbance occurred on the area, time periods corresponded to field trial disturbance on other areas.

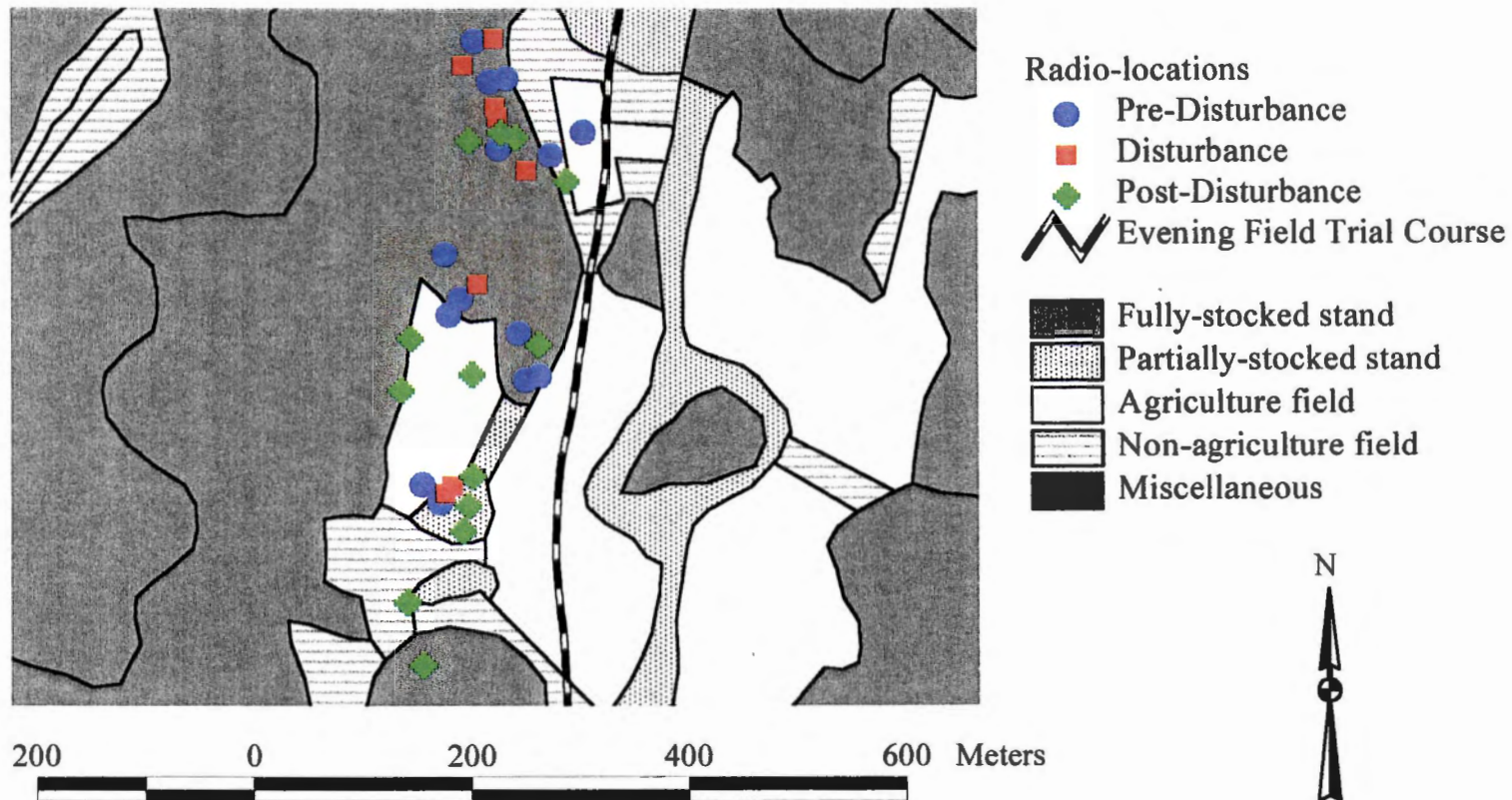


Figure 8. Radio-locations of covey F95 during pre-disturbance (January 9 - February 12), disturbance (February 13 - 23), and post-disturbance (February 24 - April 1) periods in 1995 on the Evening Field Trial Area, Ames Plantation, Fayette and Hardeman Co., Tennessee.

He reported that coveys did not abandon their home ranges in the face of heavy hunting pressure. Wiseman (1977) established home ranges for 7 coveys in Oklahoma prior to field trial disturbance. Radio-telemetry revealed that coveys did not abandon their home ranges during field trials.

Comparing home range size among the PRED, DSTU, and POSD periods would require making some critical assumptions, and likely would not add to conclusions made from other analyses. The number of radio-locations obtained was not nearly as great as those reported by Janvrin (1991), and bobwhites were not tracked for a lengthy period prior to disturbance, as in Wiseman's (1977) study. Most bobwhites in the current study were captured in mid-January, and in general, less than 30 independent locations were obtained by mid-February, when field trial activities commenced. As such, most home ranges could not be completely delineated prior to the DSTU period. However, based on other analyses and general field observations, coveys did not abandon their home ranges. Bobwhites did not make long movements away from their home ranges during the DSTU period. On average, they retreated less than 64 m from the field trial course, which was not sufficient to remove them from their home ranges.

Habitat Use and Selection

With few exceptions, bobwhites in this study preferred partially stocked stands and avoided agricultural fields (Table 25). An earlier radio-telemetry study on Ames

Plantation yielded similar conclusions. Yoho and Dimmick (1972b) evaluated the habitat use of individual coveys according to amounts of habitat within their home ranges. They found that bobwhites spent little time in cultivated fields, and used other cover types in proportion to their availability. However, stating that bobwhites avoid agricultural fields may misrepresent the situation. Agricultural crops are an important winter food source (Eubanks and Dimmick 1974), even though time spent feeding in open fields may be minimal. Exum et al. (1982), using multiple component analysis, predicted that winter covey usage was highest in areas with agricultural fields, idle lands, and forests in close proximity to one another.

Though old fields and idle lands are regarded as important components of winter habitat (Roseberry et al. 1979, Exum et al. 1982), bobwhites in this study did not show preference toward non-agricultural fields. In fact, bobwhites on MFTA in the DSTU period in 1995 and on EFTA in the POSD period in 1996 used non-agricultural fields significantly less than their availability (Table 25). However, old fields and grassy areas on MFTA and EFTA were heavily mowed in an effort to improve the visibility of dogs during field trials. Mowing removed substantial amounts of cover, and potentially lowered the suitability of these areas as winter bobwhite habitat.

The current study does not provide specific information regarding the suitability of conventional and no-till agricultural fields, though some general information may be pertinent. All agricultural fields on CA were designated as no-till, while all but two agricultural fields on MFTA were tilled conventionally. Agricultural fields on EFTA

area were managed with both conventional-tillage and no-till. While differences in tillage methods did occur among study areas, analyses of habitat selection yielded similar results from each area (Table 25). Agricultural fields were used significantly less than expected based on availability in 3 of 4 analyses for MFTA, 1 of 2 analyses for EFTA, and 2 of 2 analyses for CA. This general trend seems to support conclusions made by Minser and Dimmick (1988). They evaluated bobwhite utilization of conventionally-tilled and no-till areas on Ames Plantation and concluded that tillage method had little effect on the suitability of crop fields as winter habitat. The critical factor was whether or not the agricultural crops and cover were plowed under in the fall.

Bobwhites have the ability to utilize alternative habitats when necessary. Mueller (1988a) reported that bobwhites concentrated their use on small amounts of natural and man-made cover when significant amounts of habitat were removed with mid-March burning. Roseberry (1964) found that heavy snowfall caused bobwhites to increase use of honeysuckle thickets and woody areas and decrease use of open or harvested agricultural fields. Stoddard (1931:46) felt that hunting pressure caused bobwhites to remain near dense thickets.

Two of 6 analyses of habitat selection showed that bobwhites altered their habitat utilization during late winter; only 1 alteration of habitat utilization could have resulted from disturbance (Table 25). Bobwhites on MFTA in 1995 utilized the habitat in significantly different ways during the PRED, DSTU, and POSD time periods (Table

22). On MFTA in 1995, bobwhites showed a preference for partially stocked stands in the PRED and POSD periods, but usage of this habitat type decreased during the DSTU period to the point that it was not preferred. The decrease in use of partially stocked stands in the DSTU period corresponded to a marked increase in use of fully stocked stands. Use increased from 12.1% in the PRED period to 35.1% in DSTU, and then fell to 9.6% in the POSD period.

In 1996, changes in habitat use occurred on CA, where no disturbance occurred, but not on MFTA or EFTA where bobwhites were exposed to disturbance. On CA in 1996, the use of agricultural fields was 15 % during the DSTU period. Use of agricultural fields increased to 74% in the following time period, POSD. This drastic increase requires further explanation. Two coveys were being radio-tracked on CA in 1996, 1 of which concentrated its use on a small part of its range during the POSD period. This covey remained almost exclusively in a narrow fencerow surrounded by agricultural fields during the POSD period. As the fencerow was too narrow to be identified in the GIS coverages, all the covey's locations were classified as occurring in agricultural fields. Even if the fencerow had been incorporated into the GIS coverage, telemetry accuracy would likely have limited the ability to correctly place the covey in the habitat.

Chapter VI.

Management Implications

Field trial disturbance effected only slight responses from bobwhites in this study, and may be inconsequential from a management perspective. On average, bobwhites retreating from field trial disturbance moved less than 63 m. Late winter survival was not lowered, and changes in habitat utilization were minor as well. Other researchers utilizing radio-telemetry have made similar conclusions. Wiseman (1977) found that disturbance from Oklahoma field trials was not sufficient to force bobwhites to leave their home ranges. Janvrin (1991) radio-monitored Missouri bobwhites exposed to heavy levels of hunting. Coveys responded only by increasing their daily movements, not by abandoning home ranges. During a previous study on the Ames Plantation, Dimmick and Yoho (1972) radio-monitored 1 covey which responded somewhat drastically to field trial disturbance. However, the response was not universal among all coveys and they concluded that the distribution of coveys on the field trial grounds was generally unaffected by field trial disturbance.

Among other factors, the number of coveys located during a field trial is a function of the density of bobwhites on the area, their location in relation to the field trial course, and the type of habitat in which they reside. In this study, most radio-marked coveys were located on only 1 or 2 occasions. Maintaining a sizable bobwhite

population by providing high quality habitat, especially in close proximity to field trial routes, may be the most efficient method of increasing field trial success. While burning and mowing cover along the field trial route may improve the visibility of bird dogs, it likely also will serve to lower the area's suitability for bobwhites. Researchers have often cited non-agricultural fields as an important winter habitat for bobwhites (Roseberry et al. 1979, Exum et al. 1982). However, bobwhites in this study did not heavily utilize non-agricultural fields, but spent large amounts of time in partially stocked stands. Partially stocked stands are brushy, and offer only limited hunting opportunities for an all-age bird dog. The grassy cover in non-agricultural fields, if protected from mowing, may provide a suitable area for bobwhites that can be readily searched by bird dogs.

Radio-monitored bobwhites in this study reaffirmed that coveys concentrate their activities around a few "headquarter" areas. Managing specific sites along field trial routes as covey headquarters may help increase the number of coveys which dogs are able to encounter. Covey headquarters could provide idle lands, protective cover, and agricultural fields in close juxtaposition, a combination that is desirable to bobwhites (Exum et al. 1982). Honeysuckle and other dense vegetation is particularly useful (Yoho 1970, Exum et al. 1982), and could be protected by excluding fire. Maintaining food plots or unharvested agricultural crops in headquarter areas would produce healthier bobwhites (Robel 1972), and may help to center covey activity near field trial courses.

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Appendix

Appendix. Additional information pertaining to captured bobwhites from 3 study areas on Ames Plantation, Fayette and Hardeman Co., Tennessee, 1995-1996.

Leg Band Number	Radio Frequency	Study Area ¹	Covey	Age ²	Sex ³	Weight (g)	Year	Radio-monitoring Period		
								Begin	End	Fate
159	150.914	MFTA	B95	A	M	175	1995	1/9/95	6/28/95	predated
160	150.107	MFTA	D95	J	F	165	1995	1/10/95	5/22/95	predated
161	150.137	MFTA	D95	J	F	175	1995	1/10/95	2/11/95	censored
165	150.498	MFTA	E95	A	M	165	1995	1/14/95	4/27/95	predated
166	150.736	MFTA	E95	A	M	200	1995	1/14/95	4/12/95	predated
167	150.644	MFTA	E95	J	F	170	1995	1/14/95	4/10/95	censored
169	150.437	MFTA	A95	J	F	175	1995	1/17/95	5/19/95	censored
170	150.887	MFTA	A295	A	M	180	1995	1/18/95	5/10/95	censored
171	150.853	MFTA	A95	J	F	170	1995	1/18/95	2/16/95	predated
172	150.713	MFTA	A95	J	F	190	1995	1/18/95	5/19/95	predated
173	150.826	MFTA	A95	J	M	190	1995	1/18/95	7/3/95	predated
170	150.465	MFTA	A295	J	F	180	1995	1/18/95	8/12/95	survived
175	150.557	MFTA	A95	A	M	160	1995	1/18/95	4/28/95	censored
176	150.677	MFTA	C95	A	F	170	1995	1/19/95	8/7/95	censored
177	150.257	MFTA	A95	J	F	175	1995	1/19/95	5/10/95	predated
178	150.226	MFTA	A95	J	F	175	1995	1/19/95	8/12/95	survived
180	150.314	MFTA	A95	J	F	165	1995	1/18/95	5/10/95	predated
184	150.379	MFTA	A95	J	F	184	1995	1/18/95	8/12/95	survived
179	none	MFTA	-	J	M	195	1995			
181	none	MFTA	-	A	M	195	1995			
182	none	MFTA	-	J	F	185	1995			
183	none	MFTA	-	J	M	183	1995			
185	none	MFTA	-	J	M	175	1995			
162	150.165	EFTA	I95	J	M	180	1995	1/12/95	2/27/95	censored
163	150.796	EFTA	H95	J	F	160	1995	1/14/95	2/3/95	predated

¹ (MFTA) denotes the Morning Field Trial Area, (EFTA) denotes the Evening Field Trial Area, (CA) denotes the Control Area

² (A) denotes adults, (J) denotes juveniles

³ (M) denotes males, (F) denotes females

Appendix. (cont.)

Leg Band Number	Radio Frequency	Study Area ¹	Covey	Age ²	Sex ³	Weight (g)	Year	Radio-monitoring Period		
								Begin	End	Fate
164	150.346	EFTA	H95	J	F	175	1995	1/14/95	3/17/95	censored
168	150.526	EFTA	H95	J	M	160	1995	1/15/95	6/9/95	predated
186	150.770	EFTA	G95	J	M	175	1995	1/18/95	7/31/95	censored
199	151.184	EFTA	F95	J	F	165	1995	2/2/95	7/13/95	predated
187	150.283	EFTA	F95	A	M	200	1995	1/19/95	4/14/95	predated
189	151.457	EFTA	I95	J	M	175	1995	1/22/95	7/24/95	predated
190	150.619	EFTA	I95	J	F	150	1995	1/22/95	7/24/95	censored
188 ⁴	151.041	CA	J95	J	M	170	1995	1/21/95	5/8/95	censored
191 ⁵	151.102	CA	J95	A	F	150	1995	1/25/95	3/7/95	censored
192	151.067	CA	J95	J	F	130	1995	1/25/95	5/10/95	censored
193	151.130	CA	J95	A	M	180	1995	1/28/95	5/10/95	predated
194 ⁴	151.585	CA	K95	J	F	170	1995	1/29/95	8/9/95	survived
195	151.012	CA	K95	J	M	175	1995	1/29/95	5/19/95	censored
196	150.949	CA	K95	J	M	165	1995	1/29/95	4/24/95	censored
197	150.978	CA	K95	J	M	165	1995	1/30/95	5/24/95	predated
198	150.157	CA	L95	J	F	185	1995	2/1/95	6/6/95	censored
476	151.729	MFTA	C96	A	M	185	1996	1/12/96	8/9/96	survived
482	151.108	MFTA	C96	J	M	165	1996	1/12/96	4/9/96	censored
481	151.028	MFTA	C96	J	F	170	1996	1/12/96	1/25/96	predated
480	151.409	MFTA	C96	A	F	165	1996	1/12/96	1/30/96	predated
479	151.689	MFTA	C96	A	F	175	1996	1/12/96	3/21/96	predated
478	151.709	MFTA	C96	J	F	170	1996	1/12/96	6/23/96	predated
477	151.549	MFTA	C96	J	?	175	1996	1/12/96	2/11/96	predated

¹ (MFTA) denotes the Morning Field Trial Area, (EFTA) denotes the Evening Field Trial Area, (CA) denotes the Control Area

² (A) denotes adults, (J) denotes juveniles

³ (M) denotes males, (F) denotes females

⁴ Bobwhite was recaptured, but not radio-marked, in 1996

⁵ Bobwhite was captured and radio-marked in both 1995 and 1996

Appendix. (cont.)

Leg Band Number	Radio Frequency	Study Area ¹	Covey	Age ²	Sex ³	Weight (g)	Year	Radio-monitoring Period		
								Begin	End	Fate
471	150.087	MFTA	B96	J	M	165	1996	1/12/96	3/25/96	predated
475	150.830	MFTA	B96	J	F	175	1996	1/12/96	5/10/96	censored
473	150.798	MFTA	B96	J	F	165	1996	1/12/96	3/21/96	censored
472	150.095	MFTA	B96	J	F	170	1996	1/12/96	6/28/96	predated
474	150.277	MFTA	B96	J	F	170	1996	1/12/96	3/25/96	predated
483	151.389	MFTA	A96	J	M	190	1996	1/12/96	7/26/96	predated
486	151.289	MFTA	A96	J	M	175	1996	1/12/96	3/22/96	predated
485	151.072	MFTA	A96	J	M	170	1996	1/12/96	8/9/96	survived
484	151.326	MFTA	A96	A	M	170	1996	1/12/96	5/28/96	predated
487	151.222	MFTA	A96	J	M	175	1996	1/11/96	6/10/96	predated
493	151.088	MFTA	A96	J	M	170	1996	1/11/96	1/25/96	censored
492	151.168	MFTA	A96	J	M	180	1996	1/11/96	8/9/96	survived
491	151.208	MFTA	A96	J	M	190	1996	1/11/96	5/21/96	predated
488	151.247	MFTA	A96	J	F	170	1996	1/11/96	6/28/96	predated
498	151.308	MFTA	A96	J	M	180	1996	1/11/96	5/21/96	predated
490	151.149	MFTA	A96	J	M	175	1996	1/11/96	3/9/96	predated
467	150.077	EFTA	E96	J	M	175	1996	1/13/96	2/27/96	predated
466	151.221	EFTA	E96	J	M	180	1996	1/13/96	8/6/96	censored
469	151.753	EFTA	E96	J	F	170	1996	1/13/96	8/8/96	predated
468	151.769	EFTA	E96	J	M	180	1996	1/13/96	2/16/96	predated
470	151.569	EFTA	E96	J	M	165	1996	1/13/96	4/15/96	predated
465	151.250	EFTA	E96	J	M	175	1996	1/13/96	4/29/96	censored
464	151.308	EFTA	E96	J	M	165	1996	1/13/96	3/25/96	predated
495	151.189	EFTA	D96	J	F	150	1996	1/11/96	7/2/96	mortality
496	151.428	EFTA	D96	J	F	155	1996	1/11/96	6/6/96	predated

¹ (MFTA) denotes the Morning Field Trial Area, (EFTA) denotes the Evening Field Trial Area, (CA) denotes the Control Area

² (A) denotes adults, (J) denotes juveniles

³ (M) denotes males, (F) denotes females

Appendix. (cont.)

Leg Band Number	Radio Frequency	Study Area ¹	Covey	Age ²	Sex ³	Weight (g)	Year	Radio-monitoring Period		
								Begin	End	Fate
500	151.449	EFTA	D96	A	M	165	1996	1/11/96	5/26/96	censored
498	151.469	EFTA	D96	J	M	140	1996	1/11/96	7/9/96	censored
497	151.268	EFTA	D96	J	M	155	1996	1/11/96	5/3/96	censored
494	151.047	EFTA	D96	J	F	150	1996	1/11/96	4/29/96	mortality
465	none	EFTA	-	J	M	175	1996			
464	none	EFTA	-	J	M	165	1996			
191 ⁵	151.492	CA	G96	A	F	160	1996	1/21/96	4/4/96	censored
456	151.668	CA	G96	J	M	180	1996	1/21/96	4/15/96	predated
457	151.509	CA	G96	J	F	145	1996	1/21/96	6/5/96	censored
458	151.529	CA	G96	J	M	150	1996	1/20/96	5/2/96	censored
459	151.629	CA	F96	A	M	170	1996	1/17/96	5/17/96	predated
460	151.609	CA	F96	A	F	170	1996	1/17/96	8/9/96	survived
461	151.789	CA	F96	J	M	155	1996	1/17/96	2/7/96	predated
462	151.812	CA	F96	A	F	180	1996	1/17/96	6/28/96	predated
463	151.648	CA	F96	J	F	180	1996	1/17/96	7/1/96	predated
455	none	CA	-	A	M	165	1996			

¹ (MFTA) denotes the Morning Field Trial Area, (EFTA) denotes the Evening Field Trial Area, (CA) denotes the Control Area

² (A) denotes adults, (J) denotes juveniles

³ (M) denotes males, (F) denotes females

⁵ Bobwhite was captured and radio-marked in both 1995 and 1996

VITA

Christopher Donald Kreh grew up in Kingsport, Tennessee. He graduated from Sullivan South High School in May of 1989. He began his undergraduate career in August of 1989 at Tennessee Technological University. He later transferred to the University of Tennessee, Knoxville, where he received a Bachelor of Science degree in Wildlife and Fisheries Science in December of 1994. Since then he has been working toward a Masters of Science degree in Wildlife and Fisheries Science, which he received from the University of Tennessee, Knoxville in August of 1997. His diversity of interests, educational background, and strong love for the wildlife profession will serve him well in future endeavors.

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