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To the Graduate Council:

I am submitting herewith a thesis written by George R. Buckner entitled "Survival, movements and food habits of released pen-reared bobwhite quail in Tennessee." I have examined the final electronic 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.

Ralph W. Dimmick, Major Professor

We have read this thesis and recommend its acceptance:

Boyd L. Dearden, James L. Byford

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

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Ralph W. Dimmick

Ralph W. Dimmick, Major Professor

We have read this thesis and recommend its acceptance:

Boyd S. Deardon

James L. Byford

Accepted for the Council:

L. Evans Roth

Vice Chancellor
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SURVIVAL, MOVEMENTS AND FOOD HABITS OF RELEASED PEN-REARED BOBWHITE QUAIL IN TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

George R. Buckner II

March 1978

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ABSTRACT

Research was conducted on the 3,035 ha Napier Game Farm, Lewis County, Tennessee. A total of 7,960 pen-reared bobwhites (Colinus virginianus) were banded and released as juveniles during the summer of 1975 and 7,400 during the summer of 1976. An additional 600 were released during December 1976.

More than 50 percent of summer stocked quail were not available for harvest in October during both years. Population levels continued to decline rapidly during the early part of the hunting season but appeared to stabilize during late winter despite continued hunting pressure. Post-hunting season trends suggested almost a total loss of quail for both years. Breeding season population estimates were 88 birds in 1976 and 200 in 1977 for the 171 ha Reed Road Study area. These estimates were higher than those for March of 1976 and 1977.

Pen-reared quail dispersed widely from initial release points. Band numbers indicated that coveys consisted of birds from several different release sites. Fall coveys were also composed of birds released throughout the summer. Movements from release to October, release to harvest, release to March and release to breeding season averaged 0.37, 0.40, 0.40 and 1.40 km respectively.

Analysis of 532 quail crops indicated bicolor lespedeza (52.8 percent volume) and milo (28.3 percent volume) were the most important fall and winter foods during the 2-year period. Native foods were not abundant during the study period and unimportant in the total fall and winter diet.

A total of 1,979 pen-reared quail was harvested on Napier during 136 party hunts. The harvest rate was 12.6 percent in 1975-76 and 11.3 percent in 1976-77. Release date and release method had no effect on recovery rates. However, release location, stocking density, heredity and environment may influence recovery rates. Midseason releases did not increase the number of birds encountered by hunters suggesting that midseason releases merely replaced quail already on the area. However, midseason releases did increase harvest rates, indicating these birds were more vulnerable to harvest than summer released birds.

Wild-reared quail comprised less than 2 percent of the fall 1975 population, and no wild quail were in a sample of 154 quail captured in October 1976. The proportion of wild quail increased to 9.1 percent of the March estimate in 1977 and comprised 43 and 25 percent of the breeding season populations in 1976 and 1977. Wild-reared quail comprised 11.1 and 3.4 percent of the harvest in 1975-76 and 1976-77. This discrepancy suggests wild quail were not proportionally represented during sampling procedures.

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CHAPTER I

INTRODUCTION

Artificial propagation and stocking of bobwhite quail has long been practiced by private organizations and state wildlife agencies to supplement native bobwhite populations or reestablish populations in areas where they have been extirpated. Extensive research has shown that summer and fall stocking is costly and ineffective in increasing overall quail populations in statewide programs. (Klimstra 1976, Ballinger 1967, Stanford 1960, Buechner 1950, Goodrum 1949, Missouri Conservation Federation 1947). Stocking with pen-reared quail is being used successfully by private organizations on a "put-and-take" basis, mostly in the operation of private shooting preserves. However, "put-and take" methods of stocking often result in poor quality hunting (Kozicky 1972).

Stocking with pen-reared quail during the summer months has been undertaken on public and private management areas in an attempt to provide artivicially high populations of pen-reared quail that possess the flight characteristics of wild-reared bobwhites. This research project was conducted on the Napier Game Farm, a private shooting preserve where the primary goal is to provide high quality hunting using released pen-reared bobwhite quail. To achieve this goal, the area is intensively managed and stocked during the summer months with juvenile pen-reared bobwhites. The recovery rates and over-winter survival of pen-reared quail on the area were believed to be very low. The status

of the wild-reared segment of the population was not known but also believed to be very low. The primary management objectives on Napier include increasing the survival and recovery of pen-reared quail and encouraging increases in numbers of wild-reared quail on the area.

The primary objective of this research project was to determine what factors in the management program were contributing to low harvest rates of pen-reared and wild-reared quail. Included in the research plan was a food habits study to determine the effectiveness of food plots and an estimate of over-winter survival of pen-reared and wild-reared bobwhites.

CHAPTER II

DESCRIPTION OF STUDY AREA

I. LOCATION AND PHYSIOGRAPHY

The Napier Game Farm, a 3,035 ha (hectare) private shooting preserve is located in Lewis County, Tennessee. It lies within the Highland Rim section of the Interior Low Plateau province of middle Tennessee. Elevation is 305 m (meters). The topography is rolling to hilly.

Soils consist of shallow, cherty loess overlying residuum derived from a variety of limestones (Overton et al. 1952). Mountview, Bodine and Baxter soil series characterize the area. These soils are rocky, low in inherent fertility and very prone to erosion (TVA 1951). Only a few areas are suitable for row-cropping and forest cover occupies a large portion of the county.

Approximately 1,259 ha of Napier are utilized exclusively for quail hunting and could be divided into six management areas (Figure 1). The areas were established on the basis of isolation from other areas and/or major changes in topography. Management areas were treated as separate entities during stocking procedures and party hunts.

Area boundaries correspond to local designations for boundaries with one exception; the area known as the "left side of the Little Buffalo Road" is included in the Polly's Branch area, The management areas are as follows(Figure 1): (1) Reed Road study area or left side of the railroad bed road; (2) right side of the railroad bed road;

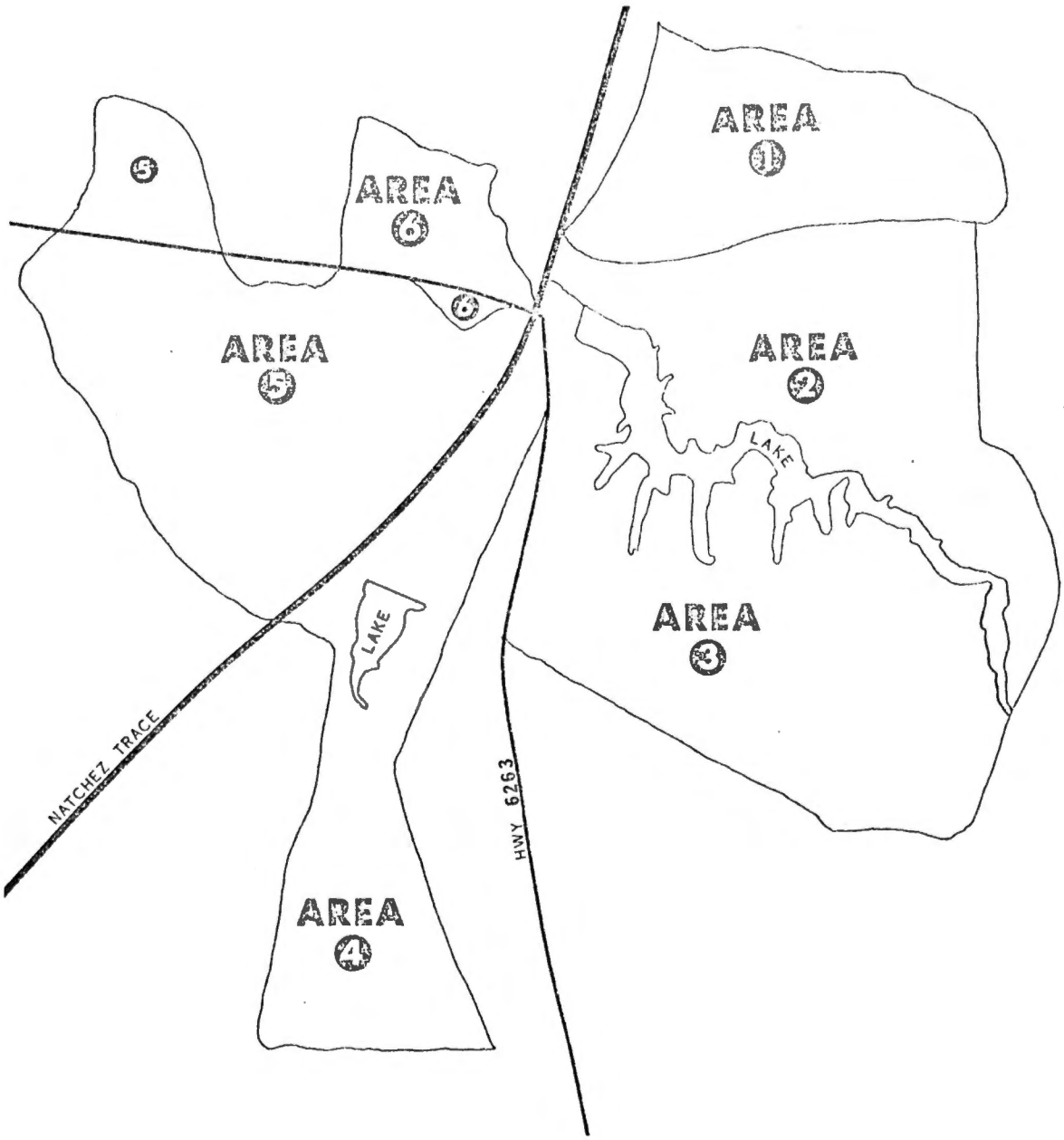

Figure 1. Map of Management Areas, Napier Game Farm

(3) Chief Creek; (4) Squaw Creek (airstrip); (5) Polly's Branch; (6) Mud Dike.

Management area 1 (Reed Road area) was selected as a study area for analysis of quail populations (Figure 2). The area contains 171 ha and the quail habitat on this area is believed to be representative of habitat conditions over most of Napier. The Reed Road area is roughly a rectangle bounded on three sides by gravel county roads. The west edge of the area is located approximately 0.4 km (kilometers) from the Natchez Trace Parkway. With the exception of a small portion on the east boundary of the area, the Reed Road area is surrounded by lands of the Napier Game Farm.

II. CLIMATE

The climate is humid and temperate with hot summers and mild winters. The growing season averages 192 days and there is abundant rainfall averaging 128.5 cm (centimeters) annually (Overton et al. 1952). Snowfall is light and melts rapidly averaging 20 cm annually. The ground seldom freezes to a depth of more than 1 cm. The average annual temperature is about 15.3° Celsius. During the study, temperatures and precipitation ranged about average for the period July 1975 to October 1976. However, Tennessee experienced one of its coldest winters during 1976-77. Temperatures ranged 8° to 15° Celsius below normal for the period November 1976 to February 1977. Snow cover of 0.25 cm or ? or .25m more was recorded on 12 days during January and February 1977.

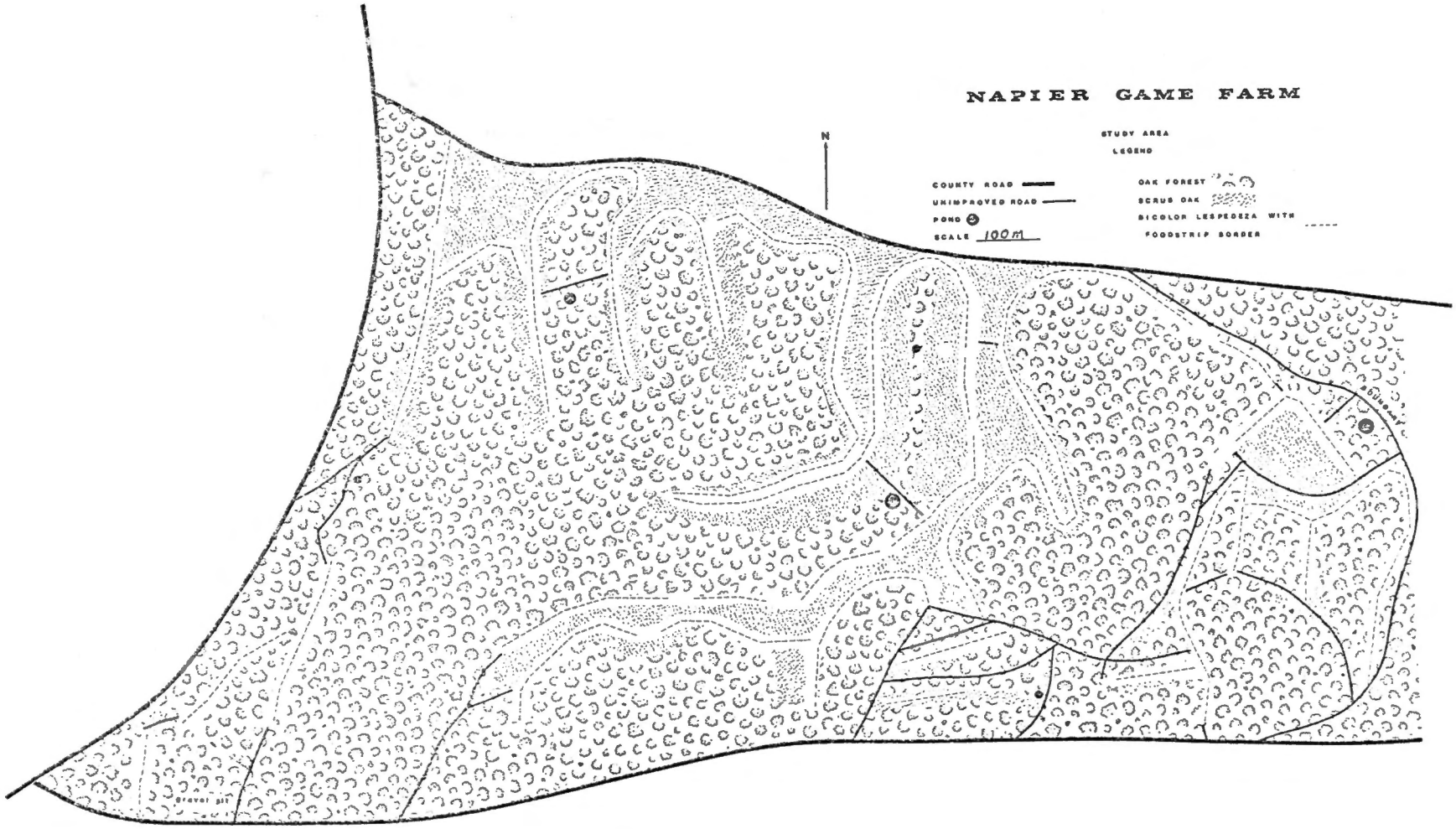

Figure 2. Map of 171 Ha Reed Road Study Area

III. VEGETATION

Management areas 1 through 5 contain approximately 1,188 ha (94 percent of hunting area) and can be characterized by two main vegetative types: (1) food strip clearings and (2) second-growth oak (Quercus spp.)-hickory (Carya spp.) stands.

Food strips are continuous strip clearings which generally follow ridge tops (Figure 2). Strips average 23 m in width. At the beginning of the study, 68 km of these clearings had been created. An additional 16 ha were cleared on the Reed Road area between March and June 1976, by widening existing food strips to 37 m. Food strip clearings planted with annual and perennial quail food plants occupied 155 ha (11 percent) of the area in 1975-76 and 171 ha (14 percent) in 1976-77.

Second growth oak-hickory type exists in two stages: (1) a shrub stage with woody growth between 0.61 m and 7.6 m and (2) mature or near mature stands of second-growth oak and hickory with a canopy height greater than 7.6 m. The criterion for height divisions was adopted from MacArthur and MacArthur (1961).

In some areas shrub oak-hickory borders food strips for 10 to 20 m before intergrading into the more mature oak-hickory stands. Shrub oak areas contained dense understory growths of oak and hickory seedlings, broomsedge (Andropogon virginicus) and bracken fern (Pteridium aquilinum). The mature or near mature stands of oak-hickory generally occupy slopes too steep for agriculture. Of 1,188 ha in management areas 1-5, approximately 500 ha consist of shrub oak-hickory and the remainder the more mature hardwood stands.

Management area 6 (71 ha) differs from the other areas somewhat in vegetation and topography. This area is relatively level with poorly drained soils. Fifty percent (35 ha) of the area is cleared of trees and brush. Approximately 11 ha were planted with corn, milo and soybeans during the study period. the 24 ha of cleared land not utilized for crop production consisted of overgrown fields.

IV. QUAIL MANAGEMENT

Food Plots

Food plots consisted of a continuous strip of bicolor lespedeza (Lespedeza bicolor) flanked by continuous 3.7 m wide strips of milo (Sorghum vulgare) and millet (Seteria italica). Bicolor plantings averaged 4.5 to 6 m in width.

Bicolor, the most abundant quail plant food at the beginning of the study, occupied 31 to 41 ha (2.6 to 3.4 percent of the area) of Napier. Seed production and plant vigor were classified as good during both years using a classification system initiated by Rosene (1956). Most of the bicolor plantings had not been managed in the 10 years prior to the study except for periodic fertilizing. Rosene (1956) stated that seed production of bicolor begins to decrease if plants are not cut back and fertilized once every three years. In March, 1976, bicolor strips on the Reed Road area were chopped, burned and fertilized with 10-10-10 fertilizer at 340 kg/ha. About one-half of the remaining hectares of bicolor were also fertilized but not chopped. This was the first application of fertilizer to bicolor strips since 1972.

Milo was planted on 20.6 ha in 1975 (1.7 percent of the area) and 24.7 ha (2.0 percent of the area) in 1976. About 6 ha of milo was destroyed by deer (Odocoileus virginianus) each year. Seed production of milo was considered good during both years of the study.

Nineteen and 25 ha of millet were planted on Napier in 1975 and 1976 respectively. Seed production of millet was considered poor during both years.

Sericea lespedeza (L. cuneata) was originally planted along bicolor strips but has been disked under in recent years. However, sericea is evident throughout strips and may have been the second most abundant plant food on Napier.

A winter wheat (Triticum aestivum) field of about 2 ha and a 2 ha soybean (Glycine max) field provided food for quail on Napier. Another 2 ha soybean field along a boundary of Napier provided an additional food source.

Controlled Burning

Controlled burning was implemented in 1969 and continued on an irregular basis. During March 1975 one-half of Napier was burned. The Reed Road area was not included in the burn area. In March 1976, all of the management areas were burned.

Native Foods

Native quail foods were not considered abundant on Napier during the study period. Native quail food plants such as ragweed (Ambrosia spp.), partridge pea (Cassia spp.) and wild bean (Strophostyles spp.) were generally apparent only along plow furrows and

isolated depressions where increased soil moisture created favorable growing conditions.

However, native foods were much more prevalent during the 1976-77 hunting season than during the previous year. Controlled burning and fertilizing during March 1976 enhanced growths of legumes and ragweed which, with the exception of bicolor, was estimated to be the most abundant quail food plant over 450 ha of the area. Ragweed was considered the most abundant food on the Reed Road area during the fall of 1976. Ragweed occupied most of the 16 ha of additional clearings established on this area during March 1976. Smooth sumac (Rhus glabra) was abundant during both years of the study occupying 6-12 ha in scattered clumps throughout the area.

The acorns of Oaks (Quercus spp) yield was very low in 1975-76. Though acorns were produced in 1976-77, no estimate of availability was obtained. Goats Rue (Tephrosia virginiana) occurred frequently following controlled burns in 1976.

CHAPTER III

METHODS

I. QUAIL STOCKING

During 1963 to 1976, 500 to 8,000 pen-reared bobwhites were released per year on Napier. During 1975, 7,960 pen-reared bobwhites were released; 8,000 were released in 1976.

Quail used for stocking were reared in facilities at Napier to age 6 weeks using standard hatchery techniques. When about 6 weeks old, quail were moved to a combination indoor-outdoor pen where they were exposed to environmental conditions for about 4 weeks prior to release. Flight pens were not utilized. Quail retained for release as adults in December were also held in these indoor-outdoor pens.

At 10 weeks old, quail were segregated into groups of 20 birds and banded with serially numbered leg bands. The 20 bird "coveys" were placed in specially designed release boxes (Hardy and McConnell 1967) and held overnight prior to release.

Quail "coveys" were released at predetermined sites marked with numbered metal tags. Tags were suspended about 1.8 m above the ground along hunter access roads adjacent to bicolor strips. Spacing of tags was 90 to 120 m. Band sequence and tag number were recorded for each covey released. Birds were "dumped" from release boxes rather than allowed to leave boxes quietly as recommended by some authors (Hardy and McConnell 1967, Baumgartner 1944).

A "call bird" was retained in each release box following releases and the box suspended on a tripod 1 m above the ground. Food (milo) and water were provided for the "call bird" and covey. It was expected that the "call bird" would hold birds in the vicinity of the supplemental food and water until they became acclimated to conditions in the wild. During 1975, half of the "call birds" were retained for 1 week and half for 2 weeks. In 1976 all "call birds" were released from their container after 1 week.

Each management unit of Napier was stocked at three separate intervals each year. In June, coveys were released at intervals of 180 to 245 m along alternate numbered release sites. July covey releases were also spaced 180 to 245 m using the alternating numbered release sites not utilized during June. During the final stocking in August, quail were released at the same sites as birds released in June.

An average of 500 quail were released per week between 3 June and 1 September, 1975 and 29 June and 14 September, 1976. Additional releases of 100 and 500 mature quail were made on 3 December, and 8 December, 1976, respectively.

II. COLLECTION OF HARVEST DATA

Quail hunting on Napier consisted of a party of 3 to 5 hunters in a hunting car, and a guide on horseback. Guides were employees of the Napier Game Farm and handled the pointing bird dogs. The guides also collected and recorded harvest data in the absence of the investigator. Hunters were guests of the Napier Game Farm and hunting ability ranged from first-time novices to seasoned quail hunters. For the most part,

the same group of guests hunted the area during both years of the study. Thus, hunter ability was considered relatively comparable during the 2-year study period. Hunting trips were usually regimental with a definite starting and ending time and place. Hunting parties systematically hunted bicolor strips until coveys were located. Two hunts, one in the morning and one in the evening, lasting approximately 3 hours each were usually taken by each party. Each harvested bird was tagged at the location of kill and information collected included band number, date and location of kill, number of quail in the covey and number of cripples or lost birds from each covey. All wild-reared quail were recorded as such with sex of the bird noted in most cases. One wing from each wild quail was also collected to determine age ratios of wild-reared birds.

Crops from all quail harvested during the 1975-76 hunting season were collected and preserved for later analysis. During the 1976-77 hunting season, 20 crops were collected each week of the season. Analysis of crop contents was similar to the method described by Korschgen (1948).

III. POPULATION SURVEYS

Fall and Winter Trapping

Quail were live-trapped with grain bait (whole kernel corn Zea mays) on the Reed Road area just prior to and immediately following the hunting season during both years of the study. Pre-hunting season trapping was conducted between 19 September and 4 October, 1975 and

24 September and 10 October, 1976. Post-hunting season trapping occurred between 13-23 March, 1976 and 19-29 March, 1977. Single funnel live traps similar to those described by Stoddard (1931) were used.

Traps were distributed over the area in a 2 ha grid, with specific placement of each trap determined by appropriate habitat. Initial trap locations were used throughout the study period whenever possible. Traps were checked twice daily at 1000 and 1700 hours. Data collected included band number and trap location for pen-reared quail and sex, age and trap location for wild quail. All wild quail were tagged with a numbered leg band.

Summer Trapping

Cock-and-hen trapping was conducted on the Reed Road area between 15-25 June, 1976 and 9-20 June, 1977. The single funnel live trap used for bait trapping was modified for cock-and-hen trapping by placing a 20 x 20 x 15 cm holding compartment for the hen in the center of the trap.

Traps were distributed over the area in an effort to include home ranges of all males on the area. Traps were placed along forest-food strip borders where ground vegetation was sparse and shade for the hen was available. Females were left in the field on a 24 hour basis to take advantage of early morning quail activity. The study area was divided into two compartments of about 81 ha each. Ten traps were placed in a compartment and maintained for a period of 5 days before moving to the next compartment. Data collected included band number,

age and trap location. Unmarked wild quail were tagged with a numbered leg band.

Direct Flush Counts

The Reed Road area was censused by direct flush counts on the day preceding initiation of post-hunting season live trapping for 1975 and 1976. Two additional direct flush counts were conducted on the area on 6 December, 1976 and 5 February, 1977. Flush counts were not utilized before pre-hunting season live-trapping because dense brush made flushing and counting unreliable.

Direct flush counts utilized 5 to 7 people traversing the area walking abreast approximately 20 m apart (Dimmick pers. comm.). A record was kept of the number, location and size of bobwhite coveys flushed.

CHAPTER IV

RESULTS AND DISCUSSION

I. POPULATION TRENDS

Seasonal population levels were determined for the Reed Road area during both years of the study. Population trends on this area were believed to be indicative of quail numbers over most of Napier.

Pre-Hunting Season Populations

Capture data were incorporated in a modification (J. T. Tanner pers. comm.) of the Jolly-Seber (1965) multiple-mark recapture population model to derive population estimates. Data met the basic underlying assumptions of the Jolly-Seber model to a greater degree than the assumptions of other population models. Thus, this population estimator was believed to best represent data collected.

A pre-hunting season population estimate of 570 (± 10 percent standard error) birds was estimated for the 171 ha Reed Road area during 1975. An estimate of 442 (± 10 percent standard error) was derived prior to the hunting season in 1976. This is 39 (± 10 percent) percent and 32 (± 10 percent) percent of the original numbers released on the area during the respective study periods (Table 1).

Several investigators have discussed the tendency of multiple-mark recapture population models to underestimate true population levels (Eberhardt 1969, Cormack 1966). Roff (1973) indicated that the Jolly-Seber estimate is reliable only if the standard deviation is 5 percent

Table 1. Pre-Hunting Season Population Estimates Derived from Jolly-Seber Multiple-Mark Recaptures, Reed Road Study Area, 1975-76, 1976-77

Year	Number Released	Number Captures	Number Birds Captured	Population Estimate	Standard Deviation	Percent Remaining at Beginning of Hunting
1975	1,460	910	339	570	50.8	35-43
1976	1,300	227	154	442	330.0	31-37

or less of the population estimate. Standard deviations for population estimates on the Reed Road area (Table 1) were greater than the 5 percent maximum stipulated by Roff (1973). Thus, fall population levels may have been somewhat underestimated.

However, it appears that 50 percent or more of all quail stocked during the summer months were not available for harvest in October (Figure 3). Of major studies reviewed, only Baumgartner (1944) provided an estimate of numbers of pen-reared quail surviving from summer releases to opening of the hunting season. He indicated that up to 50 percent of summer released bobwhites survived to the hunting season in Oklahoma when native populations were very low. However, Baumgartner further stated that only a limited number of pen-reared birds survived when native populations were high.

Wild-reared bobwhites comprised only a small portion of the quail population prior to the hunting season during the study period. Six of 339 (1.8 percent) birds captured during September and October, 1975 were wild-reared quail. No wild-reared birds were in a sample of 154 quail captured during September and October 1976.

Mid-Hunting Season Population Trends

Walk-flush censuses were conducted on the Reed Road area twice during the 1976-77 hunting season (23 November, 1976-5 February, 1977). The November census revealed 8 coveys averaging 12 birds per covey. Assuming that 50 percent of the population was flushed using this technique (Dimmick pers. comm.),a population level of 192 quail was derived. This is a decline of 250 birds (43 percent) from the

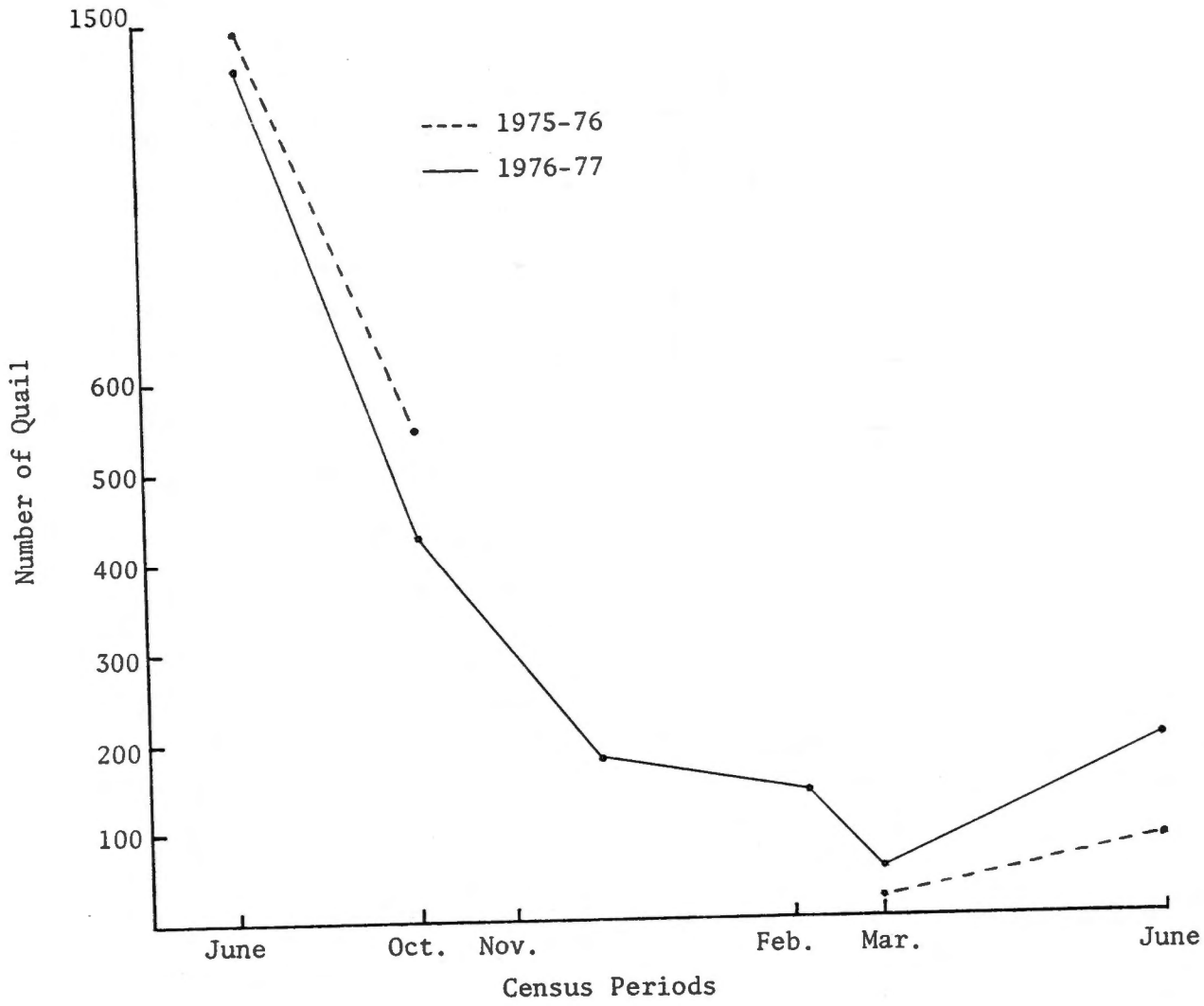

Figure 3. Seasonal Population Trends of Pen-Reared Quail, Napier Game Farm, 1975-76, 1976-77

pre-hunting season population estimate. Fifty-seven percent (143 birds) of this loss was accounted for by harvest and crippling.

The February walk-flush census produced 152 quail (50 percent adjustment factor applied), a decline of 38 birds from November. However, 78 quail were harvested on the area between 23 November, 1976, and 5 February, 1977. These data suggest an increase in quail numbers during this period. But, the difference between the November and February estimates is small and may be due to sampling error. The relative equality of these estimates does suggest, however, that the quail population may have stabilized during this period.

Post-Hunting Season Populations

Walk-flush censuses were used in conjunction with post-hunting season live-trapping to derive population estimates for this period. Live-trapping was undertaken immediately following the walk-flush census.

One quail was flushed and one quail trapped following the 1975-76 hunting season. Two coveys of 10-12 quail were repeatedly observed on the Reed Road area during live-trapping but attempts to capture these birds failed. All indications pointed to a very low residual population on the area.

Following the 1976-77 hunting season, a walk-flush census revealed 5 coveys averaging 6 birds/covey. Using the assumption that 50 percent of the population was flushed during the census, a population of 60 quail was estimated for the Reed Road area. Forty-four quail were live-trapped following the 1976-77 hunting season yielding a population

estimate of 45-55 animals. The sample size was too small for an accurate estimate using the Jolly-Seber method, but it was comparable to the estimate of 60 birds derived from the walk-flush census. Four of the 44 (9.1 percent) quail captured during this period were wild-reared. Again, the indication was of a low post-hunting residual population.

Breeding Season Populations

The number of unmated males captured during cock-and-hen trapping was coupled with an estimated sex ratio to determine breeding season population levels. Though a sex ratio was not established during this study, previous investigators (Kabat and Thompson 1963, Robinson 1957, Stoddard 1931) have established a normal sex ratio of 54 males to 46 females for the early spring period. It was assumed that sex ratios on Napier would be near this figure.

During the spring of 1976, seven unmated males were trapped on the area. Using an assumed 54:46 ratio of males to females would yield a population of 88 quail. The same approach, based upon the number of unmated males caught (16) during June 1977 indicated a population of about 200 birds on the Reed Road area. Thus, the total spring population density on the Reed Road area was 1 bird/1.9 ha in June 1976 and 1 bird/ 0.8 ha in 1977. A Chi-square test indicated that June population levels for 1977 were significantly greater ($P < 0.05$) than population levels for June 1976. Habitat improvements undertaken in the spring of 1976 that encouraged weedy areas and increased the food supply may have contributed to this increase. However, further investigations will be

necessary to discount the possibility that the difference was due to seasonal fluctuations in the quail population.

Breeding season populations of pen-reared quail on the Reed Road area were estimated to be 83-86 percent and 50-59 percent lower than fall populations for 1975-76 and 1976-77. These results appear to differ; however, the difference may be more apparent than real. Population estimates for fall 1976 were probably underestimated. Population estimates for fall 1975 were believed to be more representative of the true population levels. Of this loss of pen-reared quail between October and June, 27-33 percent and 57-69 percent was attributed to hunting and crippling losses between October and February, 1975-76 and 1976-77. Again, estimates derived for 1975-76 are believed to best represent true population levels.

If the proportion of wild to pen-reared quail in the June sample is indicative of the true proportion in the population, then the total annual loss of pen-reared quail was about 97 percent for 1975-76 and 90 percent for 1976-77.

Three of 7 (43 percent) male quail captured in June 1976 and 4 of 16 (25 percent) captured in June 1977 were wild-reared. Thus, it appears that the wild-reared segment of the population increased between March and June during both years. Population levels for March and June were derived by different population estimators. However, the increase is believed to be real and not due to sampling error.

Klimstra (1972) found that quail populations on an intensively managed area in southern Illinois increased following the hunting season.

He suggested that these birds had been forced off the area by severe hunting pressure. Although egress and ingress are believed to be responsible for the population fluctuations on Napier during the spring, hunting pressure was not considered to have been excessive. In most cases, only one hunt was conducted on the Reed Road area each week.

Although numbers of wild-reared quail in the sample were very low, it appears that population levels were lowest in the fall and highest in the spring. These trends are inverse to expected trends of most native quail populations. Numbers of wild-reared quail on Napier may have been influenced by summer releases of pen-reared quail. The sudden influx of large numbers of pen-reared quail may have forced native birds off the area. Sexton and Norman (1972) found that releasing pen-reared quail on areas already occupied by native birds increased population pressures and resulted in a loss of native birds. Summer releases may have also disrupted nesting activities resulting in decreased reproduction. Errington (1945) suggested that summer gains in resident quail populations may be depressed by the introduction of additional birds to the population.

II. MOVEMENTS

Movements were obtained by measuring straight line distances between initial summer release sites and first-capture trap locations or harvest sites and between subsequent trap locations. All movements were calculated from aerial photographs. In some cases, random samples of birds were selected for analysis of data.

Quail dispersed widely from initial release points and did not significantly retain integrity of the original "covey." Band numbers

indicated that most multiple captures consisted of birds from several different release sites. Of 21 groups of 5 or more birds captured together, 20 groups were represented by birds from 4 or more release sites. Mixing of age groups also appeared random, with coveys in early fall composed of birds released at different periods throughout the summer.

Summer Movements

Summer was considered to be the period from initial summer releases to pre-hunting season live-trapping in September. Average distances moved from release to initial capture for quail liberated in June, July, and August 1975 were 0.37, 0.35 and 0.37 km respectively. Movements by quail released during June and August 1976 averaged 0.31 and 0.29 km. Seventy-seven percent of 180 birds in the sample moved less than 0.50 km (Table 2). A one-way nested analysis of variance test indicated no significant difference ($P < 0.05$) in movements between release and capture for the five monthly release cohorts.

Movements from Fall Trapping to Winter Harvest

Movements for this period were derived from harvest data. Random samples of quail harvested on the Reed Road area were selected for analysis of data. Average distances moved from last capture in September or October to harvest for 36 bird samples was 0.50 km (range 0-3.6 km) for birds harvested in 1975-76 and 0.37 km (range 0-2.60 km) for birds harvested in 1976-77 (Table 3). A one-way analysis of variance

Table 2. Distance Traveled from Release to Initial Live-Capture for Pen-Reared Bobwhites Released on Reed Road Study Area, 1975-76, 1976-77

	Month Released				
	1975			1976	
Distance Moved	June	July	August	June	August
0 < 0.5 km	24*	30	30	28	26
0.5 < 1.0 km	8	5	6	7	9
1.0 < 1.5 km	3	1	0	1	1
1.5 < 2.0 km	1	0	0	0	0

*Number Moving This Distance

Table 3. Movements from October Live-Trapping to Harvest, Reed Road Study Area, 1975-76, 1976-77

	Number Moving This Distance	
Distance Moved	1975-76	1976-77
0 < 0.5 km	25	31
0.5 < 1.0 km	9	4
Over < 1.0 km	2	1

test indicated no significant ($P < 0.05$) difference in the average winter movements between years.

Movements Obtained from Quail Captured during March

Movements from October. Seven pen-reared quail captured during the pre-hunting season trapping were recaptured during March 1977. These birds had moved an average of 0.27 km (range 0.1-2.4 km) from points of last-capture in September and October to points of first-capture in March. All but one of these birds had moved less than 0.50 km during this period (Table 4).

Movements from initial release. Only one quail was captured during post-hunting season trapping in March 1976. This bird had not been previously trapped and initial release was 0.20 km from point of capture.

Movements from initial summer release to capture in March 1977 were measured for 32 quail not previously caught. Twenty-eight of 32 had moved an average of 0.50 km with 19 (59 percent) moving less than 0.50 km. Four birds had moved onto the Reed Road area from other areas traveling distances of 2.60, 2.70, 2.70 and 2.90 km (Table 4).

Movements Obtained from Quail Captured during the Breeding Season

Movements during the breeding season. Breeding season movements were derived from movements of males during cock-and-hen trapping; nine males, 1 of which was wild-reared were captured during June 1976. Ten pen-reared and 8 wild-reared males were captured during June 1977.

Table 4. Distances Moved from Release to March Capture and from Fall Capture to March Capture on Reed Road Study Area, 1976-77

	Number Individuals in Sample		
Distance Moved	Release to March Capture	Oct. Capture to March Capture	Totals
0 < 0.5 km	19	6	25
0.5 < 1.0 km	9	0	9
1.0 < 1.5 km	0	1	1
Over 1.5 km	4	0	4

Sample sizes were small, but there appeared to be no difference between movements of pen-reared and wild-reared quail (Table 5). Movements between years also appeared similar.

Males apparently traveled widely during the early portion of the breeding season during both years. Seven males provided movements within a single day ranging from 0.24 to 0.80 km (Figure 4). Thirteen males provided 27 movements on consecutive days during the study period. All consecutive day movements were less than 0.80 km with 24 (86 percent) less than 0.50 km.

Movements from release to breeding season. Fourteen pen-reared males not previously captured had moved an average distance of 1.40 km (range 1.7-3.7 km) from points of initial release (Table 5). However, 4 of 5 pen-reared females captured during this period had apparently been relatively sedentary moving an average of 0.40 km from points of summer release.

Yearly Movements

Movement records for summer to fall, fall to winter, and spring to breeding season suggested little difference in seasonal movements. However, sample sizes for some of these periods were insufficient to permit statistical analysis.

Adequate data were obtained for comparison of movements from release to September live-trapping, release to harvest, release to spring live-trapping and release to breeding season. Average movements for these periods were 0.37, 0.40, 0.40 and 1.40 km respectively. No

Table 5. Distances Moved by Quail Captured During the Breeding Season, Reed Road Study Area, 1975-76, 1976-77

	Capture Intervals and Number Captured				
	Release to Breeding Season	Oct. Capture to Breeding Season		Mar. Capture to Breeding Season	
Distance Moved	Pen-Reared	P-R	Wild	P-R	Wild
0 < 0.5 km	4	2	0	1	1
0.5 < 1.0 km	10	0	0	0	0
1.0 < 1.5 km	0	0	0	0	0
Over 2.0 km	4	0	0	0	0

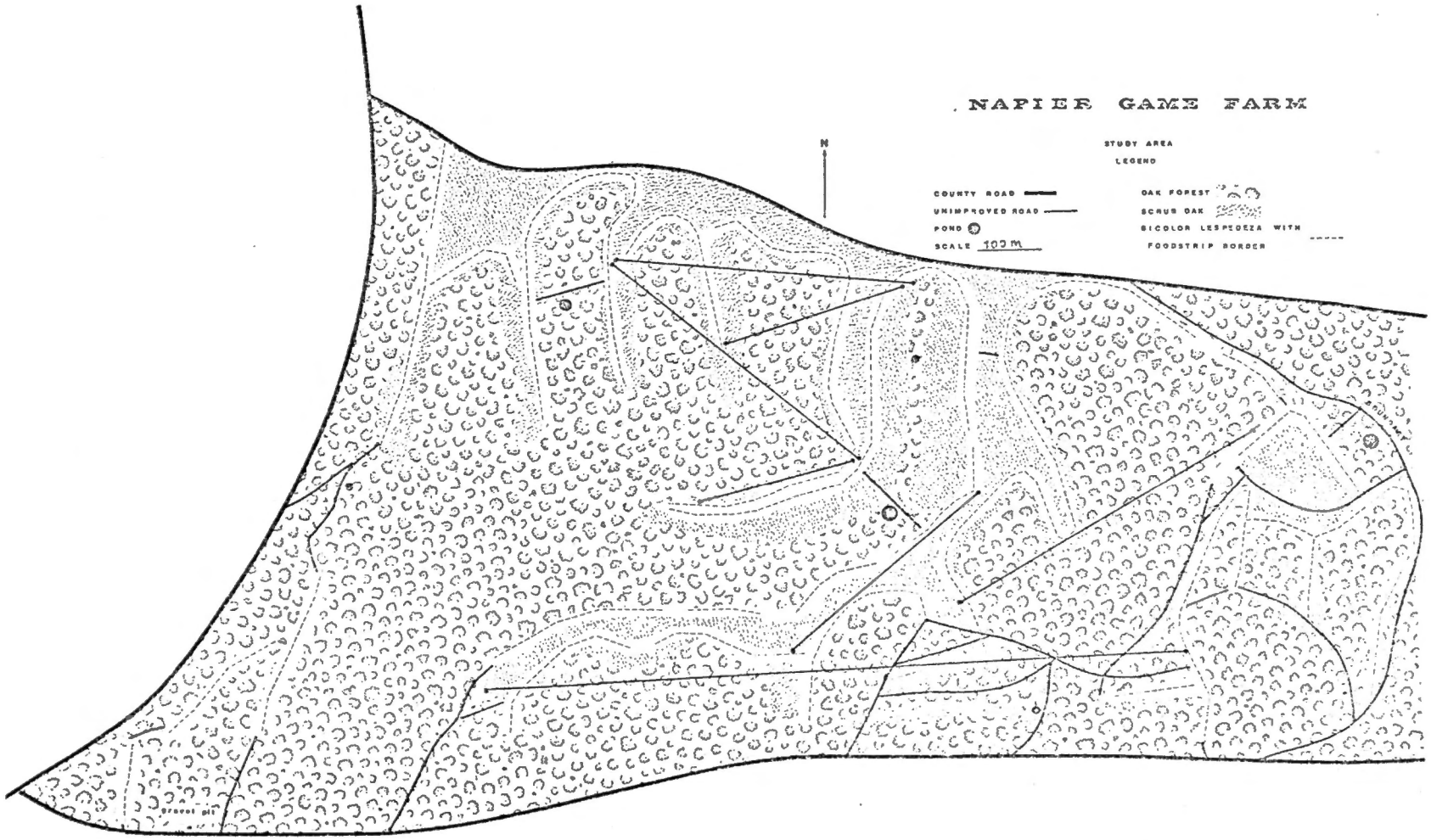

Figure 4. Distances Moved by Males Within a Single Day During the Breeding Season, Reed Road Study Area, 1975-76, 1976-77.

significant difference ($P < 0.05$) occurred in movements between years thus, distances were averaged.

Several investigators (Saunders 1973, Yoho and Dimmick 1972a, Agee 1957, Leopold 1933, Stoddard 1931) have indicated average annual movements of 0.40 km or less for native quail. Yoho and Dimmick (1972a) and Saunders (1973) found that most quail on their study areas could be expected to move 0.40 km or less if adequate year-round habitat was available.

Movements of pen-reared quail on intensively managed areas similar to Napier have been reported by two investigators. Baumgartner and Stonaker (1941) reported average movements of 2.30 km from points of summer release to fall harvest for juvenile bobwhites in Oklahoma. Klimstra (1976) indicated that juvenile pen-reared quail released in southern Illinois moved 0.48-0.80 km from points of release within 2-3 weeks. However, he also found that average distances moved became greater as the length of time between release and harvest increased.

Yearly movements on Napier suggested pen-reared bobwhites moved an average distance of 0.40 km or less from release through spring live-trapping. These average movements agree with data presented for native quail. Average movements recorded for release to the breeding season (1.40 km) indicated a significant increase ($P < 0.05$) in distances moved. However, a gradual seasonal increase in movements as suggested by Klimstra (1976) was not evident in data collected on Napier. It appears that the increase in movements occurred during the breeding season or between March and the breeding season.

Breeding season movements may have been skewed by movements of unmated males. Emlen (1939) found that nomadic valley quail (Loportyx californicus) wandered extensively. Thus, breeding season movements recorded for males on Napier may not be representative of movements for the entire population.

It is also possible that the increase in movements recorded for males during the breeding season actually occurred earlier—sometime between March and June—and may have involved entire coveys. Urban (1972) found that coveys lacking contiguous weedy areas of suitable size (2.20 ha) within their range, expanded this range to include such areas. This modification of covey ranges reportedly took place in April

III. FOOD HABITS

The contents of 532 crops collected from quail harvested on Napier during the 1975-76 and 1976-77 hunting season were analyzed. An attempt was made to collect a representative sample of crops from each management area during 30 day periods throughout the season.

Korschgen (1948), Johnson (1941) and Davison (1940) have indicated that a sample of 100-200 crops are needed from an area to properly identify the food habits during any one season. Thus, this sample should adequately represent the food habits of quail on Napier during fall and winter.

A total of 44 plant food items was identified, with plant matter comprising 99.0 percent of all foods represented. Two plant species, bicolor lespedeza (52.8 percent) and milo (28.3 percent) were the most

important food items (Table 6). Bicolor and milo occurred in 79.2 percent and 36.2 percent of crops analyzed.

Milo was the most important early fall food of quail on Napier during the study period. This seed was used almost exclusively (94.7 percent) during October 1976 (Table 7). However, the importance of milo declined rapidly as the season progressed with this seed comprising less than 1 percent of the total diet by late January 1976. This decline in utilization of milo was believed to reflect a scarcity of seed rather than a shift in the food preference of quail. Milo was not evident on the ground or in seed pods at this time.

Michael and Beckwith (1946) found milo the most preferred food of 53 selected foods fed penned bobwhites. Bicolor was included in this select food group ranking fourteenth. Korschgen (1948) ranked milo second as a food for wild quail in the highly agricultural prairie region of Missouri. Robel (1969) found that Kansas bobwhites utilized milo throughout September-April but more extensively during January and February.

Milo was less important in early fall, 1976 comprising 50.0 percent of the diet in October (Table 8). This decrease in importance between October 1975 and October 1976 is attributed to an increase in the native food supply. Milo was also used in a supplemental feeding program during the period 1-25 January, 1977. Milo was broadcast throughout bicolor strips at a rate of 159 kg/km of food strip. Each management area was treated one day per week. During supplemental feeding, milo comprised 46.7 percent of the January diet and was the most important single food item during this period (Table 8).

Tabel 6. Food Items Comprising 0.1 Percent or More of the Fall and Winter Diet of Quail Collected on the Napier Game Farm, 1975-77

Food Items	Percent Volume	Frequency Occurrence
Bicolor Lespedeza	52.8	79.2
Milo	28.3	36.2
Ragweed	4.8	28.2
Acorn	3.0	5.1
German Millet	1.7	14.3
Soybean	1.7	4.8
Smooth Sumac	1.1	9.7
Animal Foods	0.9	22.9
Wild Bean	0.9	5.8
Leafy Green Vegetation	0.7	19.0
Common Lespedeza (*L. striata*)	0.6	11.3
Panic Grasses (*Panicum* spp.)	0.6	7.2
Partridge Pea	0.5	11.8
Sericea Lespedeza	0.2	10.6
Pokeweed (*Phytolacca americana*)	0.2	4.2
Crabgrasses (*Digitaria* spp.)	0.1	4.9
Other Plant Foods	1.8	6.2

Table 7. Plant Foods Comprising 1 Percent or More of Total Volume of Fall and Winter Diet, Napier Game Farm, 1975-76

	Time Period					
Food Items	10-01 to 10-24	10-25 to 11-23	11-24 to 12-22	12-23 to 01-22	01-23 to 02-22	Totals 1975-76
Number Crops Examined	10	72	66	59	66	273
Bicolor Lespedeza	0.9	22.5	60.6	97.2	84.2	63.1
Milo	94.7	65.1	26.8	0.5	0.2	27.1
Soybean	--	3.6	--	--	6.2	2.2
Leafy Green Vegetation	--	0.2	0.6	--	3.8	1.3
Other Plant Foods	--	0.6	4.1	0.4	1.2	1.4

Table 8. Plant Foods Comprising 1 Percent or More of Total Volume of Fall and Winter Diet, Napier Game Farm, 1976-77

Food Items	Time Period 10-01 to 10-24	10-25 to 11-23	11-24 to 12-22	12-23 to 01-22	01-23 to 02-22	Totals 1976-77
Number Crops Examined	52	62	66	32	47	259
Bicolor Lespedeza	3.4	27.7	51.3	27.6	86.9	40.5
Milo	50.0	24.7	25.5	46.7	3.1	29.6
Ragweed	21.8	17.3	11.6	1.2	0.3	10.5
Acorn	--	7.3	5.2	17.5	1.2	6.5
German Millet	9.5	3.6	1.1	2.4	0.6	3.1
Wild Bean	0.8	3.3	0.1	--	0.2	2.2
Smooth Sumac	0.2	2.9	1.5	1.2	0.8	1.4
Panic Grasses	1.4	2.4	0.2	0.5	2.2	1.2
Soybeans	--	5.1	--	--	--	1.0

Utilization of bicolor, the most important single food item, varied from less than 1 percent in October 1975 to 97.2 percent for the period 23 December, 1975-22 January, 1976. During 1976-77, use of bicolor varied between 3.4 percent in October to 86.9 percent volume for the period 23 January-22 February, 1977. The only significant difference in the utilization of bicolor between the two years occurred during the period 23 December-22 January. Bicolor comprised 97.2 percent of the diet for this period during 1975-76 compared to 27.6 percent for 1976-77. This decrease in importance of bicolor for 1976-77 is attributed to the supplemental feeding of milo during January 1977.

German millet was unimportant in the fall and winter diet of quail on Napier comprising less than 1 percent of the 1975-76 diet and 3.1 percent of the diet in 1976-77. However, millet may contribute to the late-summer food supply. Eubanks (1972) found millet the fifth most important food on Ames Plantation and indicated this seed appeared to be attractive to broods and coveys in September. Baldwin and Handley (1946) ranked German millet fifteenth (1.8 percent volume) of 15 foods consumed by bobwhites in Virginia; quail for that study were collected in winter.

Sericea lespedeza was not utilized by quail on Napier despite its widespread distribution and abundance. Of the major food habits investigations reviewed, only Dickson (1971) and Handley and Cottam (1931) indicated sericea to be important in the diet of bobwhites. Dickson ranked sericea third by weight and fourth by occurrence in 279 quail crops collected on the Georgia Piedmont.

Milo and bicolor comprised 90.2 percent volume of the fall and winter diet during 1976-77 compared to 70.1 percent volume during 1975-76. This difference is significant ($P < 0.05$) and may be related to the relative abundance of native food plants. Native foods were not abundant during 1975-76 and no native food contributed more than 1 percent to the fall and winter diet. However, native foods appeared much more abundant in 1976-77. During this year they comprised 21.8 percent volume, with ragweeds (10.5), acorns (6.5), wild bean (2.2), sumac (1.4) and panic grasses (Panicum spp) (1.2) each contributing more than 1 percent to the diet (Table 8, page 36).

Rosene (1956) indicated quail showed preferences for seeds of certain plants but not to the exclusion of other available foods. He also found that the extent of use of bicolor versus native foods depended largely upon the abundance of bicolor as compared to native foods. Thus, the almost exclusive use of milo (94.7 percent volume) in October 1975 and bicolor during January and February of 1975-76 and 1976-77 may indicate an inadequate supply of native quail food plants on Napier throughout the fall and winter periods.

Such native plant foods as beggarweed (Desmodium spp.), common lespedeza (L. striata), Korean lespedeza (L. stipulacea) and milk peas (Galactia spp.) cited as important food items for bobwhites in many food habits investigations (Landers and Johnson 1976) were of little or no value on Napier. These species rarely occurred on the area during the study period. However, Goats Rue was abundant in 1976 but was not utilized as a fall or winter food.

IV. RECOVERY OF RELEASED PEN-REARED QUAIL

A total of 1,979 pen-reared bobwhites was harvested on Napier during 136 party hunts. Of this total, 1,004 birds were harvested on 76.5 hunts during 1975-76 and 975 on 56.5 hunts during 1976-77. The harvest rate was 12.6 percent in 1975-76 and 11.3 percent in 1976-77.

Effect of Release Date on Recovery Rates

Recovery rates varied from 8.3 percent to 22.2 percent in 1975-76 (Table 9) and 4.4 percent to 15.6 percent in 1976-77 (Table 10). However, there appeared to be no positive or negative correlation between recovery rates and weekly release dates for birds liberated 5 to 20 weeks prior to the hunting season. No explanation for the variation in recovery of weekly release cohorts was apparent.

Analysis of recovery rates by monthly periods suggested that a greater proportion of birds released in August were harvested than those released in June or July. The recovery rate for birds released in August 1975 was 14.6 percent compared to 10.1 and 12.8 for June and July (Table 11). A similar relationship existed in 1976, with returns of 8.9, 11.1 and 12.1 percent for birds liberated in June, July, and August respectively. Birds released in September were harvested at a lower rate than birds released in July, and at a higher rate than those released in June (Table 11). However, none of these differences were significantly different ($P < 0.05$).

Data collected from pen-reared quail on other intensively managed areas similar to Napier provide conflicting conclusions as to the

Table 9. Recovery of Released Pen-Reared Quail by Weekly Periods, 19 October, 1975-25 February, 1976

Release Date	No. Rel.	No. Rec.	% Rec.	No. Banded Quail Recovered During Weekly Hunting Periods																		
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
6-03-75	600	53	8.8		4	4	14		5	2	2	1	8	7	3			1	2			
6-10-75	300	49	16.3	6	3	7	3	3	4		3	5	8	2	3			2				
6-17-75	700	58	8.3	6	2	5	8	5	4	1	3	3	1	3		2	1	4	3	2	4	1
6-24-75	780	81	10.4	2	5	9	11	10	9		6	2	1	2	2	3	1	1	4	2	3	8
Totals	2380	241	10.1	14	14	25	36	18	22	3	14	11	18	14	8	5	2	8	9	4	7	9
7-01-75	720	95	13.2		14	4	7	9	1	6	3	4	8	14		7	1	5	6	2	1	3
7-08-75	120	14	11.7		5					1			3				3	1		1		
7-15-75	800	96	12.0	3	11	6	30	7	14	2	12			1	2	1	1	3		3		
7-22-75	180	40	22.2	6	2	6	6	1	3			1	6	3	2	1	1		1			1
7-29-75	800	91	11.4	4	14	6	15	11	3	1	4	1	5	11	5	2		1	3	2	1	2
Totals	2620	336	12.8	13	46	22	58	28	21	10	19	6	22	29	9	11	6	10	10	8	2	6
8-05-75	520	64	12.3		6	10	12	6	1	1	3	5		4	1	2		6	3	3		1
8-12-75	600	73	12.2		9	1	6	11	1	7	7	3	14	5	1			5		2	1	
8-19-75	860	145	16.9	1	24	20	28	16	5	5	12	6	6	9		3	1	1	3		3	2
8-26-75	780	120	15.4	13	17	7	19	9	11	5	7	5	6	8	2	1	1	2	1	2	2	2
Totals	2760	402	14.6	14	56	38	65	42	18	18	29	19	26	26	4	6	2	14	7	7	6	5
9-01-75	200	25	12.5		3	3	6	2	2	1				1		3		1		1		2
Grand Total	7960	1004	12.6	41	119	88	165	90	63	32	62	36	66	70	21	25	10	33	26	20	15	22

Table 10. Recovery of Released Pen-Reared Quail by Weekly Periods, 21 October, 1976-22 February, 1977

Release Date	No. Rel.	No. Rec.	% Rec.	No. Banded Quail Recovered During Weekly Hunting Periods																	
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
6-29-76	620	55	8.9	14	2	7	5	1	2		1	2	2	1			1		1	4	10	2
7-13-76	800	120	15.0	8	1	13	33	12	6	9	7	7	2	1	1		4		3	5	7	1
7-20-76	460	53	11.5	7	4	11	7	8	5		4	2	2							1		2
7-27-76	800	56	7.0	1	11	14	8	13			2	1								6		
Totals	2060	229	11.1	16	16	38	48	33	11	9	13	10	4	1	1	0	4	0	3	12	7	3
8-02-76	160	7	4.4		3	2	2															
8-03-76	1120	123	11.0	5	3	16	25	13	9	6	9	12	2	8					1	6	7	1
8-10-76	800	125	15.6	17	11	10	19	20	7	1	3	7	5	4		2	3		2	2	10	2
8-11-76	240	24	10.0	3	4	5	7	2	2											1		
8-17-76	560	79	14.1	5	13	11	8	9	7		6		2	7						9		2
8-31-76	1260	142	11.3	22	14	31	5	36	4		8	7		2			2			1	6	3
Totals	4140	500	12.1	52	48	75	66	80	29	7	26	26	9	21	1	2	5	0	3	19	23	8
9-14-76	580	55	9.5	11	6	5	10	5	1		4	3	1	3			1			3	1	1
Summer Total	7400	839	11.3	93	72	125	129	119	43	16	44	41	16	26	2	2	11	0	7	38	41	14
12-03-76	100	6	6.0								2	1		1	1	1						
12-08-76	500	130	26.0									11	31	50		1				26		11
Winter Total	600	136	22.7	0	0	0					2	12	31	51	1	2	0	0	0	26	0	11
Grand Total	8000	975	12.2	93	72	125	129	119	43	16	46	53	47	77	3	4	11	0	7	64	41	25

Table 11. Recovery of Summer Released Pen-Reared Quail by Monthly Periods, Napier Game Farm, 1975-76, 1976-77

Release Month	Number Released	Number Recovered	Percent Recovered
1975-76			
June	2,380	241	10.1
July	2,620	336	12.8
August	2,760	402	14.6
September	200	25	12.5
Totals	7,960	1,004	12.6
1976-77			
June	620	55	8.9
July	2,060	229	11.1
August	4,140	500	12.1
September	580	55	9.5
Totals	8,000	839	11.3

effects of time on recovery rates. Klimstra (1976) reported that increasing the length of time between release and harvest adversely affected recovery rates of pen-reared bobwhites in Illinois. However, Webb and Nelson (1971) reported insignificant differences in recovery rates for quail released over a period of 2 to 10 weeks prior to the hunting season in South Carolina.

Recovery rates for midseason releases were 6 percent of 100 released on 3 December and 26 percent of 500 released on 8 December, 1976 (Table 10). These recovery rates do not appear to differ from recovery rates recorded for the various weekly releases during the summer of 1975 and 1976 (Tables 9 and 10). However, sample sizes were small making positive conclusions difficult.

Fourteen pen-reared quail released in 1975 were recovered during 1976-77 hunting season. These birds were harvested throughout the areas and represented several of the weekly release periods of the 1975 season.

Effects of Release Location on Recovery Rates and Availability of Birds

Recovery rates for the six management areas were compared on the basis of numbers of quail harvested/ha/party hunt. Availability of birds was judged by the numbers of coveys flushed and the number of birds harvested per covey. Recovery rates varied between 0.03 and 0.22 birds/ha/party hunt during the 1975-76 hunting season and 0.05 and 0.24 birds/ha/party hunt for 1976-77 (Table 12). Statistical analysis of data using Student-Newman-Kuels multiple range test indicated

Table 12. Recovery Rates and Coveys Flushed by Management Areas, Napier Game Farm, 1975-77

Manage. Area	Hectares	Party Hunts	Total Harvest	Coveys Flushed	Coveys/Hectare/ Party Hunt	Number Harvested	
						Per Party Hunt	Per Covey Flushed
1975-76							
1	171	10.5	159	---	---	0.09	---
2	279	22.0	376	---	---	0.06	---
3	194	7.5	140	---	---	0.09	---
4	224	6.0	79	---	---	0.06	---
5	320	22.5	252	---	---	0.03	---
6	71	8.0	123	---	---	0.22	---
Totals	1,259	76.5	1,129				
1976-77							
1	171	15.0	232	113	0.04	0.09	2.0
2	279	12.5	185	94	0.03	0.05	1.9
3	194	6.0	118	48	0.04	0.10	2.4
4	224	5.0	81	38	0.03	0.07	2.1
5	320	17.0	324	154	0.03	0.06	2.1
6	71	4.0	69	26	0.09	0.24	2.6
Totals	1,259	59.5	1,009	473			2.1

recovery rates for management area 6 during 1975-76 and 1976-77 were significantly greater than for areas 1-5. No differences in recovery rates were found among areas 1-5 for the 2-year period. Numbers of birds/ha/party hunt for individual management areas were not significantly different ($P < 0.05$) between years.

Differences in topography and land use may have contributed to higher harvest rates on management area 6. Approximately 39 percent of this area contained overgrown fields indicated as vital to successful quail management (Urban 1972, Ellis et al. 1969, Casey 1965, Stoddard 1931).

Management areas 1-5 contained food strips, shrub oak-hickory and mature or near mature timbered areas. Very few weedy areas were present. Ellis et al. (1969) stated that quail management utilizing food plots alone does not provide adequate weedy areas with abundant growths of native quail food plants. He found management practices in Illinois utilizing food plots alone resulted in a decrease in quail populations. Ellis also indicated that use of fire in conjunction with food plots created bare ground succession necessary for native quail food plants to become established. However, on Napier, ragweed was the only food plant to become well established during the study period. This plant food was abundant in the fall of 1976 possibly as a result of fertilization of bicolor strips following controlled burns.

Effects of Release Method on Recovery Rates

Two methods of release were evaluated for quail liberated during the summer of 1975. Approximately half of all released coveys had call

birds retained for 2 weeks and the other half for 1 week. A sample of 782 harvested birds was evaluated to determine if harvest rates differed for the two groups. A Chi-square test indicated no significant difference ($P < 0.05$) between harvest rates of quail from coveys with call birds retained 1 week (12.2 percent—375 of 3,060 released) versus birds from coveys with call birds retained 2 weeks (13 percent—407 of 3,040 released).

Recovery rates for pen-reared quail on Napier fall within a wide range of recovery rates reported for similar types of management areas. Klimstra (1976) indicated that 8.2 percent of birds released 7-12 weeks prior to hunting in southern Illinois were recovered. This was a 5-year average. Webb and Nelson (1971) reported a 33.5 percent recovery rate for quail released in South Carolina 2-10 weeks before hunting. Environmental conditions, hunting pressure and length of time between release and harvest were considered to have had an effect on recovery rates.

Data collected on Napier indicated that release date and release method had no significant effects on recovery rates. However, release location did significantly affect recovery rates. Apparently failure to provide proper habitat was influencing location specific recovery rates on Napier.

There are some other factors which may also have influenced recovery rates of quail on Napier. Data presented on population trends indicated that the size of the native population may influence initial survival and ensuing recovery rates. Baumgartner (1944) indicated a maximum

survival of 50 percent on areas where native populations were extremely low. Napier is such an area.

Stocking density may have influenced recovery rates on Napier. Stocking rates varied between 5.0 and 8.4 birds/ha in 1975 and 5.0 and 8.5 in 1976 (Tables 13 and 14). Data indicated no difference in recovery rates between areas with stocking rates of 5.0 birds/ha and those with 8.5 birds/ha. Stocking that achieved total population densities greater than 5.0 birds/ha on Napier apparently resulted in increased mortality and emigration from the areas. Thus, it appears that stocking rates greater than 5.0 birds/ha do not add to the harvest rate. It is possible that stocking rates much lower than 5.0 birds/ha may be equally effective.

A third variable that may affect recovery rates is the source of quail used for stocking. Kozicky (1972) reported that heredity and environment were important factors in the survival and quality of pen-reared bobwhites. This factor may have influenced recovery rates of the 600 midseason releases. The 500 quail released on management area 5 (26 percent recovery) were reared in facilities at Napier. One hundred birds released on the Reed Road area (6 percent recovery) were purchased from an outside source.

Effect of Hunting Season Length on Harvest and Availability of Birds

Harvest rates for the 1975-76 hunting season averaged 14.7 birds/party hunt. Numbers of birds harvested declined from 21.8 birds/party hunt during the first 30-day period of the season to 10.3 during the

Table 13. Number of Quail Released and Harvested by Management Area, Napier Game Farm, 1975-76

Management Area	Hectares	Number Released	Released/ Hectare	Number Harvested		No. Harvested/Ha Party Hunt
				Pen-Reared	Wild	
1	171	1,460	8.5	140	19	0.09
2	279	1,820	6.5	340	36	0.06
3	194	980	5.0	126	14	0.09
4	224	1,220	5.4	61	18	0.06
5	320	1,960	6.1	235	17	0.03
6	71	520	7.3	102	21	0.22
Totals	1,259	7,960	6.3	100	125	

Table 14. Number of Quail Released and Harvested by Managment Area, Napier Game Farm, 1976-77

Management Area	Hectares	Number Released	Released/ Hectare	Number Harvested		No. Harvested/Ha Party Hunt
				Pen-Reared	Wild	
1	171	1,400	8.2	228	4	0.09
2	279	1,620	5.8	179	6	0.05
3	194	900	4.6	111	7	0.10
4	224	1,120	5.0	78	3	0.07
5	320	2,360	7.4	314	10	0.06
6	71	600	8.4	65	4	0.24
Totals	1,259	8,000	6.3	975	34	

third period (Table 15). These data indicated a drop of 42 percent in birds harvested/party hunt between the first and second harvest periods. However, numbers of birds harvested/party hunt declined by only 19 percent between the second and third periods and appeared to stabilize during the final 30-day period. No data on coveys flushed is available for the 1975-76 hunting season.

The total number of birds harvested during the 1976-77 hunting season was lower than during the previous year. This decrease in total harvest is attributed to a 22 percent decline in the number of party hunts. However, the harvest rate was greater, averaging 16.9 birds harvested/party hunt (Table 15). Harvest rates for the first 30-day period of the 1976-77 season were slightly lower than during the same period in 1975, but declined less rapidly as the season progressed.

Declining numbers of coveys flushed/party hunt and smaller average coveys indicated a steady decline in numbers of birds encountered and numbers of birds harvested/party hunt. The number of birds encountered declined 22 percent between the first and second 30-day periods, 32 percent between the second and third and 23 percent between the third and fourth 30-day periods (Table 15). Numbers of birds harvested/party hunt declined 30 percent between the first and second harvest periods and 25 percent between the third and fourth periods. These declines can be attributed to similar declines in the number of coveys encountered. However, birds harvested/party hunt increased 12 percent between the second and third 30-day periods as the numbers of coveys encountered continued to decrease. This increase in hunter success is attributed to midseason releases.

Table 15. Recovery Rates by 30-Day Periods, Napier Game Farm, 1975-76, 1976-77

Time Period	Dates	Party Hunts	Total Harvest	Coveys Flushed	Coveys/ Party Hunt	Average Covey Size	Number Harvested	
							Per Party Hunt	Per Covey Flushed
1	10/19-11/20, 1975	25.0	544	N.A.[1]	---	---	21.8	---
2	11/21-12/25, 1975	23.0	289	---	---	---	12.6	---
3	12/26-01/25, 1976	15.5	159	---	---	---	10.3	---
4	01/26-02/25, 1976	13.0	137	---	---	---	10.5	---
Subtotal		76.5	1,129	---	---	---	14.7	---
1	10/19-11/20, 1976	27.5	560	249	9.1	17.7	20.6	2.2
2	11/21-12/25, 1976	14.5	209	120	8.3	17.1	14.4	1.7
3	12/26-01/25, 1977	6.0	98	45	7.5	12.9	16.3	2.1
4	01/26-02/25, 1977	11.5	142	59	5.1	14.8	12.3	2.4
Subtotal		59.5	1,009	473	7.9	12.1	16.9	2.1
Grand Total		136.0	2,138[2]				15.7	

[1] Information not available.

[2] Wild-reared quail included.

The total harvest on the Reed Road area was 159 birds for the 1975-76 season and 232 birds for the 1976-77 season. This represents a harvest rate of 27.9 percent and 52.5 percent of estimated fall populations for the area.

These figures are somewhat lower than reported harvest rates for some native bobwhite populations. Vance and Ellis (1972) reported average harvest rates of 59 and 68 percent of fall populations in southern Illinois. Roseberry and Klimstra (1972) found that 66.2 percent of estimated fall populations were harvested. Several investigators (Vance and Ellis 1972, Rosene 1969, Stoddard 1931) have indicated that 50-70 percent of fall populations can be harvested with no detrimental effects on overall population levels. Thus, the very low spring populations on Napier are not a result of over harvest.

V. HARVEST OF WILD-REARED QUAIL

Wild-reared quail comprised 11.1 percent of the harvest in 1975-76 and 3.4 percent in 1976-77 (Table 16). Wild-reared quail appeared to be well-distributed throughout management areas. Harvest data suggested wild-reared birds were mixed with coveys of pen-reared quail.

Pre-hunting season population estimates for 1975-76 indicated 1.9 percent of the population were wild-reared birds. No wild quail were captured prior to hunting in 1976. This discrepancy between the number of wild-reared quail estimated in the fall and the number in the harvest may be due to a lower probability of capture for wild quail or these birds may have been moving on and off the areas during this period. A combination of these factors is most likely.

Table 16. Recovery of Wild-Reared Bobwhites by 30-Day Periods, Napier Game Farm, 1975-77

Recovery Period	Number Wild Quail Harvested in Management Areas						
	1	2	3	4	5	6	Total
10/19-11/20, 1975	6	12	5	10	6	5	44
11/21-12/25, 1975	11	8	2	2	4	3	30
12/26-01/25, 1976		10		4	7	12	33
01/26-02/25, 1976	2	6	7	2	—	1	18
Totals 1975-76	19	36	14	18	17	21	125
10/19-11/20, 1976	2	4	6	2	4	4	22
11/21-12/25, 1976		1	1	1	2		5
12/26-01/25, 1977	1	1			2		4
01/26-02/25, 1976	1	—	—	—	2	—	3
Totals 1976-77	4	6	7	3	10	4	34
Grand Totals	23	42	21	21	27	25	159

Klimstra (1976) indicated that the proportion of wild-reared birds in the harvest increased as the season progressed. He attributed this increase to a heavy loss of pen-reared quail from hunting and other factors, perhaps suggesting that pen-reared birds are more vulnerable to harvest. However, harvest of wild-reared birds on Napier did not increase as the hunting season progressed and the pen-reared segment of the population declined. Harvest rates of wild-reared quail were greatest in October (41 percent of wild-reared harvested) when harvest rates of pen-reared quail were highest (Table 16).

Age ratios obtained from a wing collection indicated 32 percent of the 1975-76 wild quail harvest were adults. During 1976-77, 15 percent of the wild quail were adults. Sample sizes were believed too small (96 in 1975-76; 20 in 1976-77) to be reliable estimates of the age ratio.

Predation

Predators captured several newly liberated pen-reared bobwhites on Napier, though quantitative estimates of the total effect were not known. During late summer 1976, 32 bands from pen-reared quail were recovered from fox (Vulpes fulva or Urocyon cinereoargenteus) scats collected on the area. Sixteen bands were recovered on three consecutive days from scats believed to have been left by a single fox.

Marsh hawks (Circus cyaneus) were very abundant during the winter of 1975-76 and Red-tailed hawks (Bueto jamaicensis) were numerous during the spring and summer of both years. However, no direct observations

were made of these birds killing or harassing quail, nor were hawk pellets with quail remains observed.

VI. EFFECTS OF MIDSEASON RELEASES ON HUNTER SUCCESS AND AVAILABILITY OF BIRDS

Midseason releases dominated the late-winter harvest on management area 5, comprising 80.6 percent (75 of 93 harvested) and 68.7 percent (55 of 80 harvested) of the harvest for the periods 18 December-25 January-25 February, 1976-77.

Harvest rates were higher on area 5 than other areas immediately following releases. Numbers of coveys flushed per party hunt were not significantly greater ($P < 0.05$) for area 5 than other areas. However, the number of birds harvested per covey was significantly greater ($P < 0.05$) for area 5 than other areas (Table 17).

Harvest rates for area 5 declined rapidly during the second 30-day period following midseason releases with the number of birds harvested/party hunt about equal to hunting success on areas that were not stocked with midseason releases. A linear regression comparing numbers of quail harvested/ha/party hunt with season length ($r = -0.74$) indicated midseason releases did not increase the overall late-winter harvest on management area 5 (Figure 5).

The reasons for the rapid decline in harvest rates on area 5 during the second 30-day period of the season are not known. However, the number of party hunts on this area during a 37-day period following releases was as great as for all other areas combined. It is possible that severe hunting pressure may have caused birds to leave the area.

Table 17. Comparison of Hunting Success on Areas with Midseason and Areas with Preseason Quail Releases, Napier Game Farm, 1977

Harvest Period	Party Hunts	Number Harvested	Coveys/ Party Hunt	Number Harvested Per Party Hunt	Number Harvested Per Covey
12/18, 1976-01/25, 1977					
Areas with Preseason Releases	4.5	53	7.8	11.7	1.5
Area with Midseason Releases	4.5	108	9.0	24.0	2.6
01/26-02/25, 1977					
Areas with Preseason Releases	6.5	84	5.7	12.9	2.3
Area with Midseason Releases	5.0	62	4.5	12.4	2.7

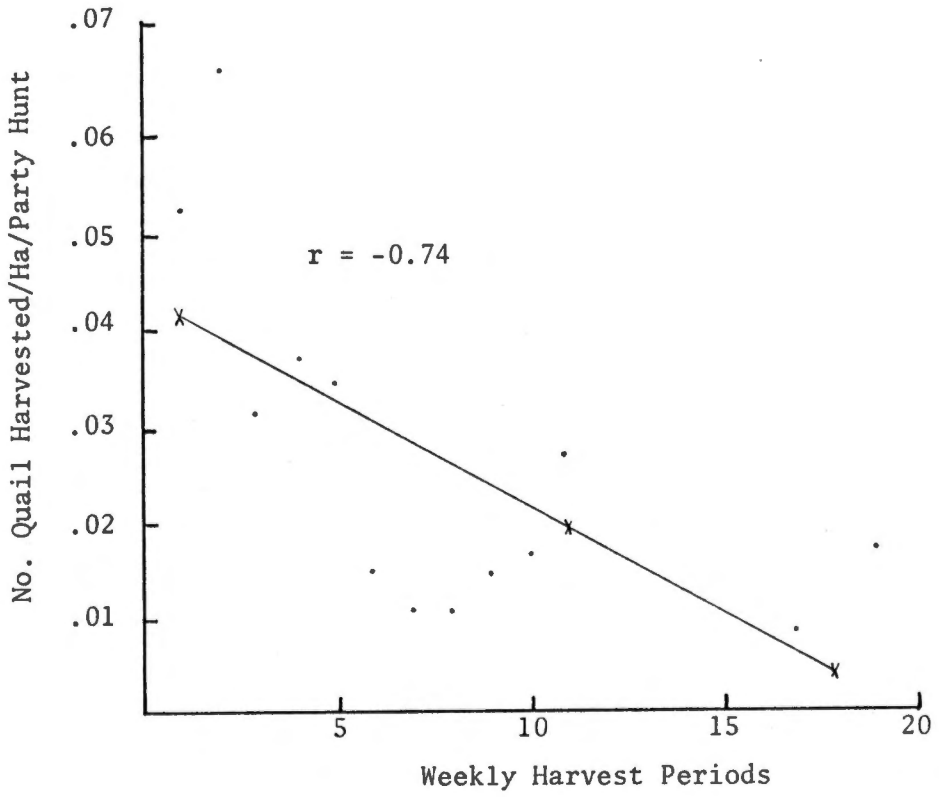

Figure 5. Number of Birds Harvested/Ha/Party Hunt in Relation to Season Length on Management Area 5, 1976-77

Yoho and Dimmick (1972b) found that distrubances during field trials could cause coveys to disintegrate and abandon home ranges. Klimstra (1972) found that excessive hunting caused quail to leave an area. If this were the case on Napier, midseason releases should have been recovered on other areas. However, only one midseason release was reported harvested outside management area 5.

Hunting parties rarely ventured far from food strips in search of coveys. Thus, it is possible that hunting pressure forced birds away from food strips but not off the area. However, late-winter food resources appeared to be limited almost entirely to food strips. Thus, the possibility of birds being in the area but not located by hunters appears to be a very remote possibility.

The accelerated hunting pressure during the first 30 days following releases may have kept coveys scattered. Single and small groups of birds would have been more vulnerable to adverse weather conditions than larger coveys.

Population trends and harvest results suggest that the numbers of birds encountered stabilized during December and January. It is possible that populations had declined to the carrying capacity of the land. Adding additional birds to the area would create competition for dwindling late-winter food supplies. This competition could result in birds becoming stressed and thus more susceptable to disease, starvation and predation (Errington 1945).

The failure of midseason releases to increase the number of coveys encountered by hunters suggests that these birds merely replaced birds

already on the area. The increase in hunter success for the area may have resulted from newly liberated birds being more vulnerable to harvest than summer released birds.

CHAPTER V

SUMMARY

The objectives of this study were to: (1) determine what factors in the management program were contributing to low harvest rates of pen-reared and wild-reared quail populations, (2) delineate primary foods of bobwhites during fall and winter, and (3) determine over-winter survival of pen-reared and wild-reared quail on the area.

Research was conducted on the 3,035 ha Napier Game Farm in Lewis County, Tennessee. The area is intensively managed for quail utilizing food plots and controlled burning. Plantings of bicolor lespedeza, milo and millet occupy approximately 11-14 percent of the area. The remaining portions are covered with shrub oak-hickory and mature or near mature hardwood forest. A 171 ha study area was chosen for analysis of populations.

Juvenile pen-reared bobwhites have been stocked annually beginning in 1963. A total of 7,960 were stocked in 1975 and 8,000 in 1976. During 1975, weekly releases were made between 3 June and 1 September. In 1976, 7,400 were released during the period 29 June-14 September with an additional 100 and 500 mature quail released on 3 and 8 December, 1976. All quail were banded and released at predetermined sites.

Population trends indicated a loss of more than 50 percent of stocked quail between June and October for both years of the study. October estimates for 1975 were 570 (± 10 percent) (35-43 percent of

1,460 stocked). The October 1976 estimate was 442 (± 10 percent) (31-37 percent of 1,300 stocked).

Midseason population trends indicated a 42 percent decline in population levels between 1 October and 23 November, 1976. Fifty-seven percent of this decline was attributed to hunting. Population trends indicated a loss of only 38 birds between 23 November, 1976 and 5 February, 1977. However, 78 quail were harvested during this period, suggesting quail populations may have stabilized during the latter portion of the hunting season.

Post-hunting season population estimates indicated very low populations occurred during March 1976 with only 2 coveys of 10-12 birds estimated for the Reed Road area. Post-hunting season population estimates for March 1977 suggested 45-60 birds on the area. Nine percent of this total consisted of wild-reared quail.

Breeding season populations of pen-reared quail were higher than March levels. Eight-eight quail were estimated for the Reed Road area during June 1976 and 200 for June 1977. The proportion of wild-reared quail in the spring population was also greater than in October or March. Wild-reared birds comprised 43 and 25 percent of 7 and 16 quail trapped during June of 1976 and 1977.

Seasonal movement data indicated pen-reared quail were relatively sedentary from release through post-hunting season trapping in March. However, sample sizes were too small to permit statistical analysis of data. Average movements were compared for release to October trapping, release to harvest, release to post-hunting season trapping and release

to the breeding season. Movements for these periods averaged 0.37, 0,40, 0.40 and 1.40 km respectively. No significant difference ($P < 0.05$) occurred among movements through post-hunting season trapping. These average movements were similar to those recorded for native quail during this period. However, average distances moved from release to the breeding season were significantly greater ($P < 0.05$) than for the other periods tested. Apparently pen-reared quail on Napier were highly mobile during the breeding season or during the period from post-hunting season trapping in March to the breeding season.

Use of cultivated foods dominated the diet of quail during the study period. Bicolor lespedeza and milo were the most important food items comprising 52.8 and 28.3 percent of the fall and winter diet.

Milo was the most important early fall food comprising 94.7 percent of the total diet in October 1975 and 50.0 percent in October 1976. Milo was also used in a supplemental feeding program during January 1977. During this period, milo was the most important single food comprising 46.7 percent of the diet.

Bicolor was the most important single food on Napier during the study period. Use of bicolor increased from less than 1 percent in October 1975 to 97.2 percent in late December and January 1976. Utilization of bicolor varied between 3.5 percent total volume in October 1976 to 86.9 percent volume in late January and February 1977.

Millet, extensively cultivated, was not utilized as a fall and winter food on Napier. This seed comprised 3.1 percent of the diet in 1976-77 and less than 1 percent in 1975-76.

Native foods were not abundant during the study period. No native food comprised more than 1 percent of the diet in 1975-76. In 1976-77, ragweed (10.5), acorns (6.5), wild bean (2.2), sumac (1.4) and panic grasses (1.2) each contributed more than 1 percent to the fall and winter diet.

A total of 1,979 pen-reared quail were harvested on 136 party hunts during the study period. Of this total, 1,004 birds were harvested on 76.5 hunts during 1975-76 and 975 on 56.5 hunts during 1976-77.

Several investigators have indicated such factors as the size of the native quail population, hunting pressure, quality of the birds used for stocking, length of time between release and harvest and quality of the habitat as parameters affecting survival and/or recovery rates for pen-reared quail.

Data collected on Napier tended to corroborate these findings with the exception of length of time between release and harvest. Recovery for quail released 5-20 weeks prior to hunting varied between 8.3 and 22.2 percent during 1975-76 and 4.4 and 15.6 during 1976-77. No significant difference ($P < 0.05$) was found among harvest rates of weekly release cohorts. Recovery rates for 100 and 500 birds released on 3 December and 8 December were 6 and 26 percent. Sample sizes were small but recovery rates did not appear to differ from weekly summer releases.

However, stocking densities may have influenced recovery rates on Napier. Stocking densities varied between 5.0 and 8.4 birds/ha in

1975 and 5.0 and 8.5 in 1976. No significant difference ($P < 0.05$) in recovery rates among areas was noted.

One half of all quail released in 1975 had call birds retained for 1 week and the remaining one half for 2 weeks. A Chi-square test indicated no significant difference ($P < 0.05$) in recovery rates for the 2 groups.

Harvest rates averaged 14.7 birds/party hunt during 1975-76. Numbers of birds harvested/party hunt declined from 21.8 birds/party hunt in October, 1975 to 10.3 for the period ending 25 January, 1976. However, harvest rates appeared to stabilize from this period through the end of hunting on 25 February, 1976.

Total harvest was less during 1976-77 possibly due to a 22 percent decrease in party hunts. However, harvest rates were higher averaging 16.9 birds/party hunt. Numbers of coveys flushed declined 22 and 32 percent during the first two 30-day periods of the 1976-77 season. Hunter success showed similar declines of 30 and 25 percent. However, harvest rates increased 12 percent during the third 30-day period due to additional quail releases. However, numbers of coveys flushed continued to decline.

Approximately 25-31 percent and 48-58 percent of estimated fall populations on the Reed Road study area were harvested during the 1975-76 and 1976-77 hunting seasons. Several investigators have indicated that harvest rates of 50-70 percent of estimated fall populations have no detrimental effects on overall population levels. Thus, harvest rates should have had little effect on spring populations.

Wild-reared quail comprised 11.1 percent and 3.4 percent of the total harvest in 1975-76 and 1976-77 respectively. Numbers of wild-reared quail harvested did not increase as the season progressed and numbers of pen-reared quail declined.

Midseason releases dominated the late-winter harvest on area 5 comprising 80.6 and 68.7 percent of the harvest for the periods 18 December, 1976-25 January, 1977 and 26 January-25 February, 1977. Midseason releases did not result in a significant increase in numbers of coveys flushed but did contribute to higher hunter success. However, coveys flushed/party hunt and hunter success declined rapidly during the second 30-day period following release and was slightly lower than on areas not stocked during midseason. A linear regression ($r = -0.74$) comparing numbers of quail harvested/ha/party hunt with season length indicated that midseason releases did not increase the overall harvest rates for area 5.

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VITA

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