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SEASONAL MOVEMENTS AND BEHAVIOR OF RING-NECKED
PHEASANTS IN EASTERN SOUTH DAKOTA

BY
ARTHUR V. CARTER

A thesis submitted
in partial fulfillment of the requirements for the
degree, Master of Science,
Major in Wildlife Biology,
South Dakota State
University

1971

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SEASONAL MOVEMENTS AND BEHAVIOR OF RING-NECKED
PHEASANTS IN EASTERN SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Date

Head, Department of
Wildlife and Fisheries
Sciences

Date

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ABSTRACT

Information was gathered on mobility, behavior, and related activities of pheasants from July 1966 to July 1968 by banding and/or marking 160 birds with backtags and radio transmitters.

Food was readily available since the winters were mild with little snow. Birds moved less than 1/4 mile from roosting areas to cornfields and weed patches to feed.

Numbers of birds dispersing from the study area in spring varied each of the years, but 60 to 70 remained there during the two reproductive seasons. Adult cocks traveled less than 1/4 mile when dispersing and adult hens moved less than 1/2 mile. Movements by two juvenile cocks averaged over 1/2 mile and one juvenile hen traveled two miles. Adult and juvenile cocks moved less than 1/4 and 1/2 mile, respectively, from capture sites according to hunting recoveries.

Home ranges of hens and breeding cocks overlapped during early nesting periods. Hens sometimes nested within the territories of their chosen cocks. Following nest destruction hens sought other crowing cocks up to one mile away. Home ranges for five hens in harems averaged 69 acres while two hens not in harems averaged 25 acres. Home ranges for six cocks with harems averaged nine acres while those without harems (five) averaged 15 acres. Two radio-equipped juvenile cocks occupied 60-acre areas during hunting season.

Eight of the ten cock territories observed encompassed roadsides which contained undisturbed cover. Home ranges for six radio-equipped hens contained undisturbed cover in which nests for three of four hens were located.

During summer, adult birds and hens with broods were located in cornfields during the day and returned to small grain, soilbank, and alfalfa fields to roost. One hen moved her one-week old brood nearly 1/2 mile after the alfalfa was mowed.

Rest periods from incubation were infrequent but appeared to occur during mid-morning and/or mid-afternoon.

INTRODUCTION

Many ecology studies have been made of ring-necked pheasants (Phasianus colchicus) in the wild. Most have been seasonal, with very few conducted throughout the year.

Several people have studied the breeding behavior of pheasants. Taber (1949) in Wisconsin; Kendeigh (1941) in Iowa; Wight (1945) in Michigan; Hiatt and Fisher (1947) in Montana; Baskett (1947) in Iowa; and Kuck (1968) in South Dakota.

Many investigations have been completed on nesting behavior of pheasants: Hamerstrom (1936) in Iowa; Baskett (1947) in Iowa; Linder and Agee (1965) in Nebraska; and Trautman and Fredrickson (1967) in South Dakota.

Pheasant mobility studies include: Janson (1947) in South Dakota; Weston (1954) in Iowa; Grondahl (1953) in Iowa; and Kuck (1968) in South Dakota.

The present study was conducted from July 1966 to July 1968 in east-central South Dakota. The objective was to gather information on the mobility, behavior, and related activities of pheasants throughout the year.

DESCRIPTION OF STUDY AREA

The study area (Section 9, Township 109 N, Range 48 W) is on privately owned farmland 11 miles southeast of Brookings, South Dakota (Fig. 1). It lies at the extreme southern portion of the Prairie Coteau, a highland in eastern South Dakota.

The climate of Brookings County is variable. Springs are cool, moist, and windy; summers are sunny and hot; autumns are dry, cool, and sunny; and winters are cold and sometimes severe (Westin et al. 1958). Temperatures range from 109 F to -41 F. Mean temperatures are approximately 17 F in winter and 66 F in summer. Annual precipitation averages 20 inches, of which 80 percent falls during the growing season (April - September). Snowfall averages 23 inches per year. Prevailing winds average approximately 10 mph from the south in summer and about 12 mph from the northwest in winter (U. S. Dept. of Commerce 1966). Topography is generally flat to gentle sloping. Soils are of glacial origin and mantled with loess from two to four feet thick (Westin et al. 1958).

Only remnants of once-dominant prairie grasses now exist, including big bluestem (Andropogon gerardi), little bluestem (A. scoparius), switchgrass (Panicum virgatum), and Indian grass (Sorghastrum nutans) (Kuchler 1964). The area is heavily farmed, with only the soilbank, railroad right-of-way, and portions of small draw extending through the section being undisturbed. Four to five acres on the east-central portion were put into the Feed Grain Program in 1967. Corn, oats, flax, barley, and alfalfa were the

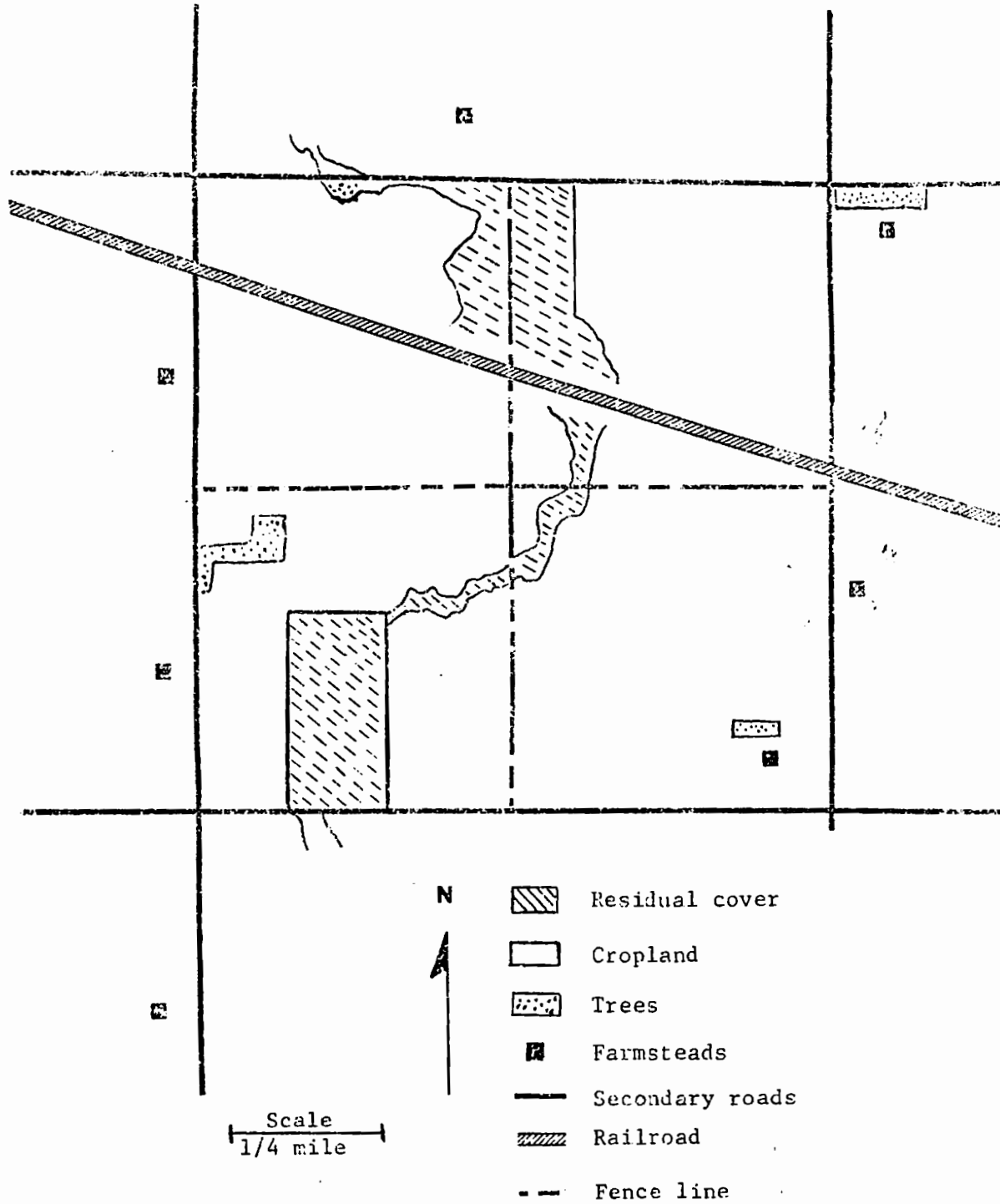


Figure 1. Cover types on the study area.

main crops grown during the study.

A small covey of Hungarian partridge (Perdix perdix) and numerous mourning doves (Zenaidura macroura) were the only other upland game birds observed on the area. Waterfowl visited the sloughs in early spring. Larger mammals noted were striped skunks (Mephitis mephitis), badgers (Taxidea taxus), raccoons (Procyon lotor), red foxes (Vulpes fulva), and white-tailed deer (Odocoileus virginianus).

Approximately 150 pheasants wintered on the area in 1966-67. Apparently some birds moved onto the area during fall and early winter because few birds were sighted on adjacent land during the winter. An estimated 70 to 80 birds remained on the area during the reproductive period. Approximately 60 birds wintered on the section during the winter of 1967-68, most of which remained the following spring.

Winter sex-ratio counts were based on roadside and flush observations (Foss and Rose 1959), supplemented by information obtained through nightlighting and trapping. Results in 1966-67 revealed a ratio of 9 males: 10 females and in 1967-68 a ratio of 1 males: 4 females.

METHODS AND MATERIALS

Capture Methods

Several techniques were used to capture pheasants for marking, the most successful of which were spot-lighting (Smith 1954; Labisky 1959) and back-pack night-lighting (Drewien et al. 1967). The latter was most effective on calm, damp nights when birds held or flushed to only a few yards away.

Nine birds were trapped in winter with a modified Ohio pheasant trap (Leedy and Hicks 1945). Poor trapping success was attributed to mild winters with little snow cover which allowed birds to feed freely in nearby cornfields. Most pheasants were caught during windy days. Traps, baited with ear corn, were placed in small willow patches which birds utilized for loafing, especially when winds reached 15 mph or more. No birds were trapped in cornfields.

Several hens were netted on nests and one cock was caught by hand during molt. A decoy trap (Rogers 1964) was also employed for capturing territorial cocks.

Marking Techniques

All birds captured in this study were banded with an aluminum, butt-end, numbered leg band. Birds not fitted with radio transmitters were marked with a backtag similar to that described by Labisky and Mann (1962). Straps for securing tags on birds were made of rayon and nylon elastic, the latter being more durable. Tags were numbered

with white plastic paint. Several colors of tags were employed with white tags and black numbers most easily identified in the field; however, numbers were difficult to distinguish unless pheasants were within 200 to 300 yards of the observer and positioned to display the markers. Tagged birds were nearly impossible to recognize while flying unless flushed at close range. Jackson (1967) reported that backtags on prairie grouse were difficult to distinguish unless the birds had their heads erect and were either standing or walking from the observer.

Several backtags broke where stapled to the straps. Others rolled or split at the edges, making identification difficult or impossible and paint peeled off one tag after 39 days.

Radio transmitters purchased from Sidney Markusen, Esko, Minnesota, were used for monitoring pheasants for the first year of study. The radio-package harness, a modification of that described by Kuck (1966) and Brander (1968), consisted of stranded, vinyl-coated, electrical wire (0.102" dia.) which extended around both wings and fastened underneath or behind the radio. Ends were secured by crimping in a splice cap. Electrical leads were wrapped with electrician's tape and covered with light plastic tubing. The harness allowed quick mounting and proper fitting.

Transmitters, constructed at the Electrical Engineering Department, South Dakota State University, were used in 1967-68. These allowed the battery and transmitter to be easily harnessed as a single unit and reduced chance of mechanical failure. Transmitter

signals were 151.010 to 151.085 MHz. A 1.34 volt certified cell (Mallory Battery Co. Terrytown, New York) was the most reliable transmitter battery.

Two receivers employing four stationary directional antennae (SDA) and one hand directional antenna (HDA) were used. Operation and design of antennae were according to Marshall and Kupa (1963) and Slade et al. (1965).

A continuous-tuning receiver constructed from a standard automobile radio and a 151.25 MHz converter (International Crystal Co., Oklahoma City, Oklahoma) with an intermediate frequency of 1000 KHz was also used for locating radioed birds.

Observations and locations of back-tagged birds were made by cruising the area with a vehicle. Radio-equipped birds were located by taking an azimuth on the radio signal from two different SDA's and connecting the intersects according to Slade et al. (1965). Nearly all radio fixes were made during daylight hours. Locations of marked birds were plotted on maps to show home-range. Home-range size was determined by connecting the outermost locations. Locations were expressed as radial distance from a common center obtained by determining the approximate geometric center of the aggregate observations.

RESULTS AND DISCUSSION

Marking of Birds

One hundred sixty pheasants were banded and/or marked with backtags or radios. Six hens were marked off the study area to compare behavior of birds not subjected to spot-lighting to behavior of those on the area spot-lighted several times. It was thought that continuous disturbance by night-lighting might alter normal patterns of behavior and cover selection. Observations indicated, however, that behavior and movement of pheasants subjected to frequent spot-lighting changed very little. These findings coincide with those reported by Mallette and Bechtel (1959) in California. Weather conditions, amount of vegetation present, and age of birds proved to be more significant influences on susceptibility to capture.

Seven roosters and ten hens were fitted with radio transmitters; however, limited data were obtained from six due to radio malfunction. One other hen was killed by a predator after one day of instrumentation. Juveniles too small to tag were banded and later marked with a backtag if recaptured.

Movement of Birds

Winter

Pheasants generally remained in two separate flocks during the winters of 1966-67 and 1967-68, the railroad right-of-way was the approximate dividing line.

Pheasants wintering on the north side of the section utilized the railroad right-of-way, draw bottom, and willows during inclement weather. Birds also used these areas for loafing and to some extent for roosting during mild weather; however, the majority roosted in tall vegetation along the draw. Pheasants in the southern portion roosted primarily in soilbank cover. Little roosting was observed in the shelterbelt except for a few nights in January, 1967, when new snow was followed by high winds. Grondahl (1953) reported that pheasant roosting in shelterbelts was most prevalent when temperatures were below 20 degrees, when winds exceeded 10 mph, and when snow depth was greater than six inches. Pheasants on both sides of the section moved less than 440 yards to cornfields adjacent to the section or to weed patches scattered in and along the draw.

Pheasants in the south-central soilbank appeared to return each night to roost in the same portions of the field. Primarily hens were found in the northeast corner, cocks in the southwest corner, and both sexes in the east-central and west-central portions. This tendency was clearly shown by radioed hen #120 which was flushed several times in the northeast corner during recapturing attempts. Hen #144 likewise was found several times roosting near the same site north of the railroad tracks.

With no blizzards and little snow cover, winter survival was excellent during both winters of the study. Only one pheasant was found dead (cause unknown), that being an adult cock tagged December 1, 1966, in the soilbank. He was picked up seven weeks later in a

cornfield less than 440 yards from the capture and release site.

Movement during spring dispersal was similar for cocks in 1967 and 1968 (Table 1). Adults averaged 310 yards with a range of zero to 1000 yards. The two marked juveniles traveled slightly over 1000 yards. Farthest dispersal recorded was five miles in 1967 by a cock of unknown age. Janson (1947) found maximum movement of 10 miles within four weeks of spring breakup.

Observed movement of hens in 1967 was slightly greater than that recorded in 1968 (Table 1). Adults averaged 1080 yards with a range of zero to two miles compared with 567 yards and a range of zero to 1320 yards in 1968. One juvenile traveled two miles in 1967. Based on limited evidence available, juveniles tended to move a greater distance than adults and females a greater distance than males.

The differences in spring mobility between years may have been a function of the larger winter population present on the area in 1967. In 1967-68, the number of wintering birds was 60 percent lower than 1966-67, the result of exceptionally mild winter conditions, reduced availability of winter cover, and heavier harvest of cocks the previous hunting season. Weston (1954) observed that spring movements from a state-owned area in Iowa for consecutive years were virtually the same. However, he stated that the number of pheasants that remained to nest on the areas each year showed little change even though observed maximum winter population showed pronounced differences.

Table 1. Range and mean distances traveled by marked birds during spring dispersal, 1967 and 1968.

	Sample	1967 Distances traveled (yards)		Sample	1968 Distances traveled (yards)	
		Range	Mean		Range	Mean
Males						
Adults	6	0-1,000	310	5	0-950	400
Juveniles	1		1,080	1		1,000
Females						
Adults	4	0-3,520	1,080	7	0-1,320	567
Juveniles	1		3,520	--		

Spring and Summer

Males

Data of marked cocks were gathered on mobility and home-range size. One radio-equipped cock provided four days of radio tracking which yielded 17 locations. Observations of 10 cocks marked with backtags provided 149 locations (Table 2). Average radial movement was 157 yards with a range of 64 to 354 yards.

Average home-range size of six cocks with harems was nine acres. Average radial movement of this group was 167 yards with a range of 64 to 354 yards (Table 2). Five of six cock territories were located near the perimeter of the study area. Each included some type of residual cover whereas the other territory near the middle of the

Table 2. Summary of movement data for male birds in spring and summer.

Identification Band no. and marker type	Age	Observation period	Duration (days)	Total Loca- tions	Home range (acres)	Average radial distance (yards)	
With harem							
1/BT	Adult	9/9/66, 4/20/67 - 9/16/67	151	14	13	354	
10/BT	Adult	9/14/66, 4/16/67 - 9/28/67	167	23	5	126	
17/BT	Adult	5/3/67 - 8/3/67	93	11	3	64	
70/R *	Adult	5/10/67 - 6/24/67	46	19	10	170	
85/BT	Adult	8/28/67 - 9/20/67, 4/6/68 - 7/18/68	128	20	15	154	
127/BT	Juv.	4/18/68 - 6/29/68	73	10	8	132	
					Average	9	167
Without harem							
24/BT	Adult	4/25/67 - 7/7/67	74	14	13	151	
45/BT	Adult	4/4/67 - 9/28/67	178	12	8	178	
132/BT	Adult	4/18/68 - 7/18/68	92	8	5	83	
143/BT	Adult	4/24/69 - 7/12/69	80	18	44	247	
153/R	Adult	7/16/69 - 7/19/69	4	17	4	72	
					Average	15	146
Average for all birds						157	

* Non-functional

section did not. All territories included at least three cover types.

Average home-range size of five cocks without harems was 15 acres. Average radial movement was 146 yards with a range of 72 to 247 yards. Home-ranges of three were located at the edge of the study area as were those of cocks with harems. Four of the areas encompassed at least three cover types including undisturbed vegetation.

The average distance traveled by cocks with harems was approximately the same as cocks without harems. Home-range size was also similar except for one unmated cock (#143) which had the largest home-range (44 acres). His movements were more erratic with less defined boundary. He often passed through territories of other males and pursued their hens. A second unmated cock (#132), impaired with a "peg leg," was never observed to display aggressive behavior toward other cocks. His movements averaged less than the mean recorded for all cocks.

Extended moves were undertaken by four cocks. Bird #1, which had the largest average radial distance for cocks, made three such moves of nearly one mile within the same vicinity, once during winter (February 16) and twice during spring (April 20 and May 3). Without these movements his radial distance of travel would have been similar to the average recorded for all other cocks.

Cock #5 was tagged September 14, 1966, near the abandoned farmstead on the west side of the area. This bird also made two extended

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moves from the area he normally used and then returned. One long movement was observed for cock #35 (April 16) when he was sighted near the southeast corner of the area over 880 yards from his territory. One movement of nearly 880 yards was recorded for cock #58, two days following capture.

Cock #153 was monitored for four days in mid-July. During this time he was in molt and quite inactive, occupying an area of nearly 4 1/2 acres (Fig. 2). Three primary cover types were present: corn, oats, and alfalfa-bromegrass. During the heat of the day he utilized the cornfield and weedy-growth of a ditch in the oats field. He roosted in the oats at night and was monitored along the field edges during morning and evening hours.

Cocks were associated with crowing sites which were often barren knolls or areas with short vegetation. This finding is in agreement with that reported by Kuck (1968).

Cocks appeared to know approximately where members of their harem were nesting, and from crowing sites would "beckon" to members of their harems by crowing intermittently for five to ten minutes during mid-morning and mid-afternoon hours. After several crowings, hens joined cocks to feed and court.

Females - Data following are discussed according to yearly activities and are presented for individual birds as related to a given activity, i.e. nest establishment, mate selection, nest activities, and brooding. Seven adult hens were monitored for 148 days, providing 381 radio locations (Table 3).

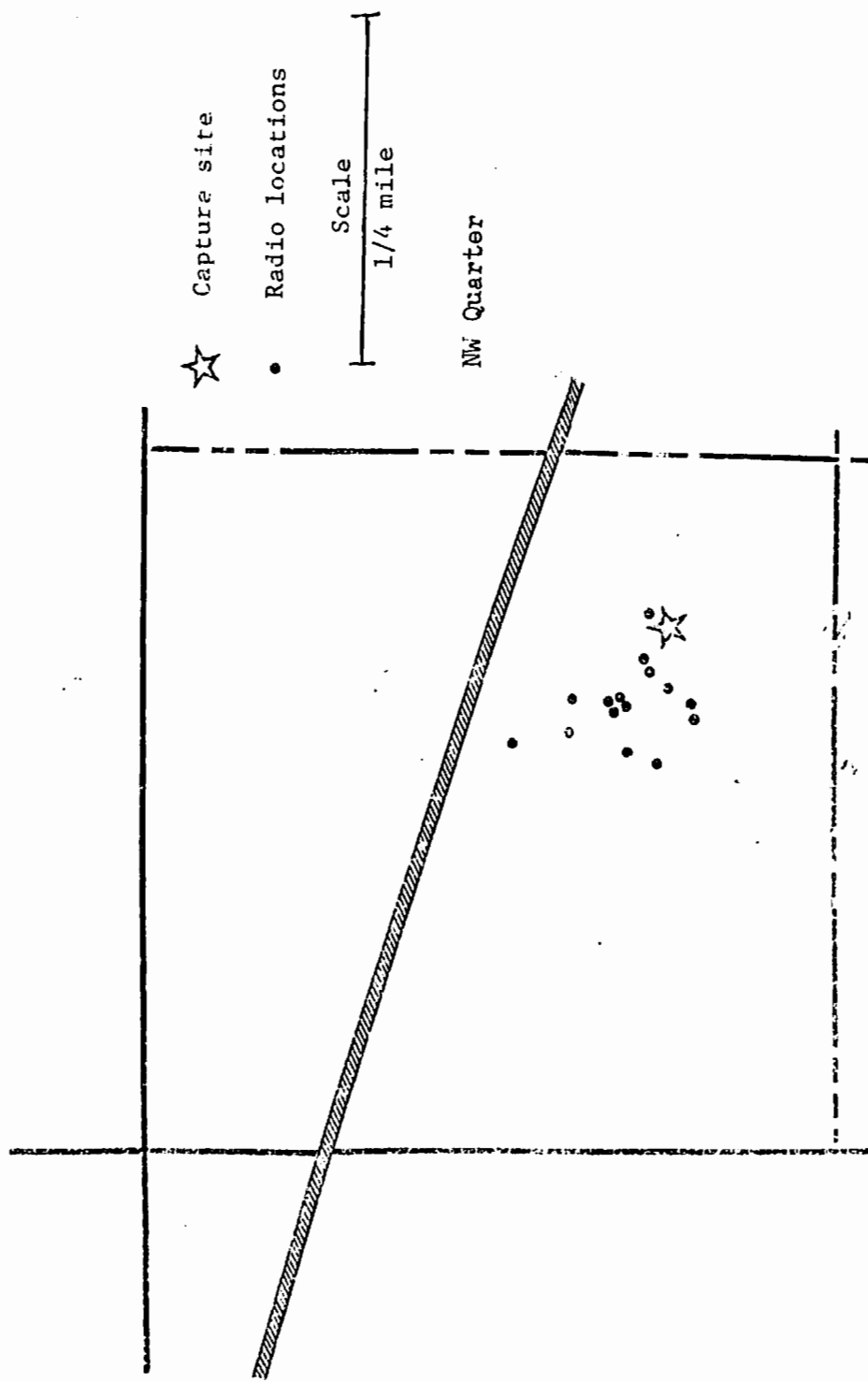


Figure 2. Radio locations for cock #153 during molt--July 16-July 19, 1968.

Table 3. Summary of movement data for seven radio-equipped hens in spring and summer.

	Identification band No.	Age	Tracking period	Duration (days)	Total loca- tions	Home range (acres)	Average radial distance (yards)
In harem	66	Adult	4/20/67 - 5/17/67	27	16	103	389
	76	Adult	7/13/67 - 8/11/67	29	59	75	215
	120	Adult	5/3/68 - 7/19/68	280	83	129	159
	144	Adult	3/22/68 - 6/15/68	85	43	15	221
	152	Adult	6/28/68 - 7/19/68	21	54	24	108
					Average	69	218
Not in harem	74	Adult	6/6/67 - 9/28/67	115	95	42	203
	93	Adult	9/7/67 - 9/28/67	17	12	8	112
					Average	25	158

Home-Range of Established Nesters - Data for five radio-marked hens showed an average radial movement during the breeding season (courtship and nesting) of 218 yards with a range of 108 to 389 yards. Average home-range size was 69 acres.

One hen (#66) ranged over approximately 103 acres during a three-week period between the time she was captured (April 20) and observed in a harem (May 13). Home-range sizes of two other hens (#120 and #144) from the time of spring dispersal to initial nest establishment were 75 and 15 acres with an average of 45 acres. During the renesting interval, two additional hens (#76 and #152) occupied home-ranges averaging 31 acres. Kuck (1968) reported an average home-range size of 29 acres among five hens during the reproductive season.

Bird #66 was radioed April 20, 1967, while roosting in the soilbank in the south-west portion of the section (Fig. 3). She remained in this area for the next two days. On April 23 while winds were blowing up to 40-50 mph, she was located in the shelter-belt on the west side of the area. Her signal was picked up six days later when she was sighted near the southwest corner of the area. On May 2 and 3 she was roosting near the site of capture. The next night she roosted approximately 440 yards south of the study area. Nine days later she was observed with a cock in the latter vicinity, and on May 17 she was roosting in a nearby alfalfa field. Her signal was lost after several unsuccessful attempts to

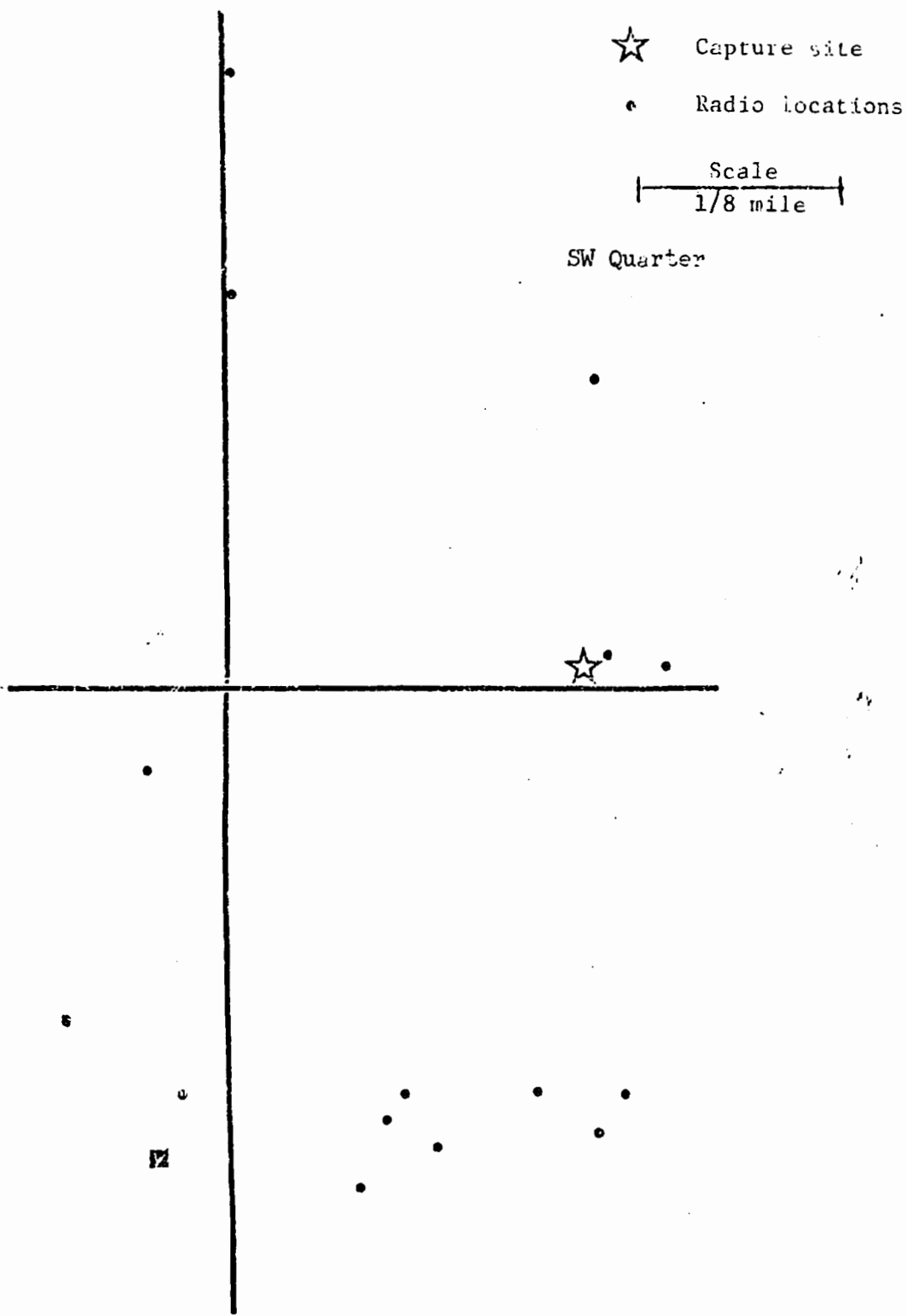


Figure 3. Radio locations for hen #66 during early phase of reproduction cycle--April 20-May 17, 1968.

capture her to change batteries. Average radial distance was 389 yards for 16 locations. Her home range was 103 acres.

Hen #76 was radioed July 13, 1967, in the north-central portion of the soilbank. At the time of capture she was not nesting nor was she with a brood (Fig. 4). She remained in the vicinity of the capture site until 2:30 p.m. the following day when she moved into an ungrazed pasture and remained there until evening. The following day she was located in the north end of a sweet clover field between 10:00 a.m. and noon. It is believed she had started nesting or renesting. Two days later, at 6:45 a.m., she was roosting near the site of capture and at 7:30 a.m. she moved to the clover. Close observations for the next seven days revealed that she was definitely nesting. On July 24 the radio signal became faulty but indications were that she remained at the north end of the clover all day and night. It is believed that she started incubating on this date. The signal during the next six days indicated that she was relatively sedentary, spending most of her time on the nest, but on July 31 her movements became erratic and she was never located in the vicinity of the nest again. Subsequent investigation revealed the nest had been preyed upon as remains of six or seven eggs were present. The bird moved off the area and was observed with a crowing cock approximately 440 yards south on August 4 where she spent the ensuing week. On August 11 she returned to the clover field where she had been nesting. The bird was sacrificed in order to recover the transmitter for

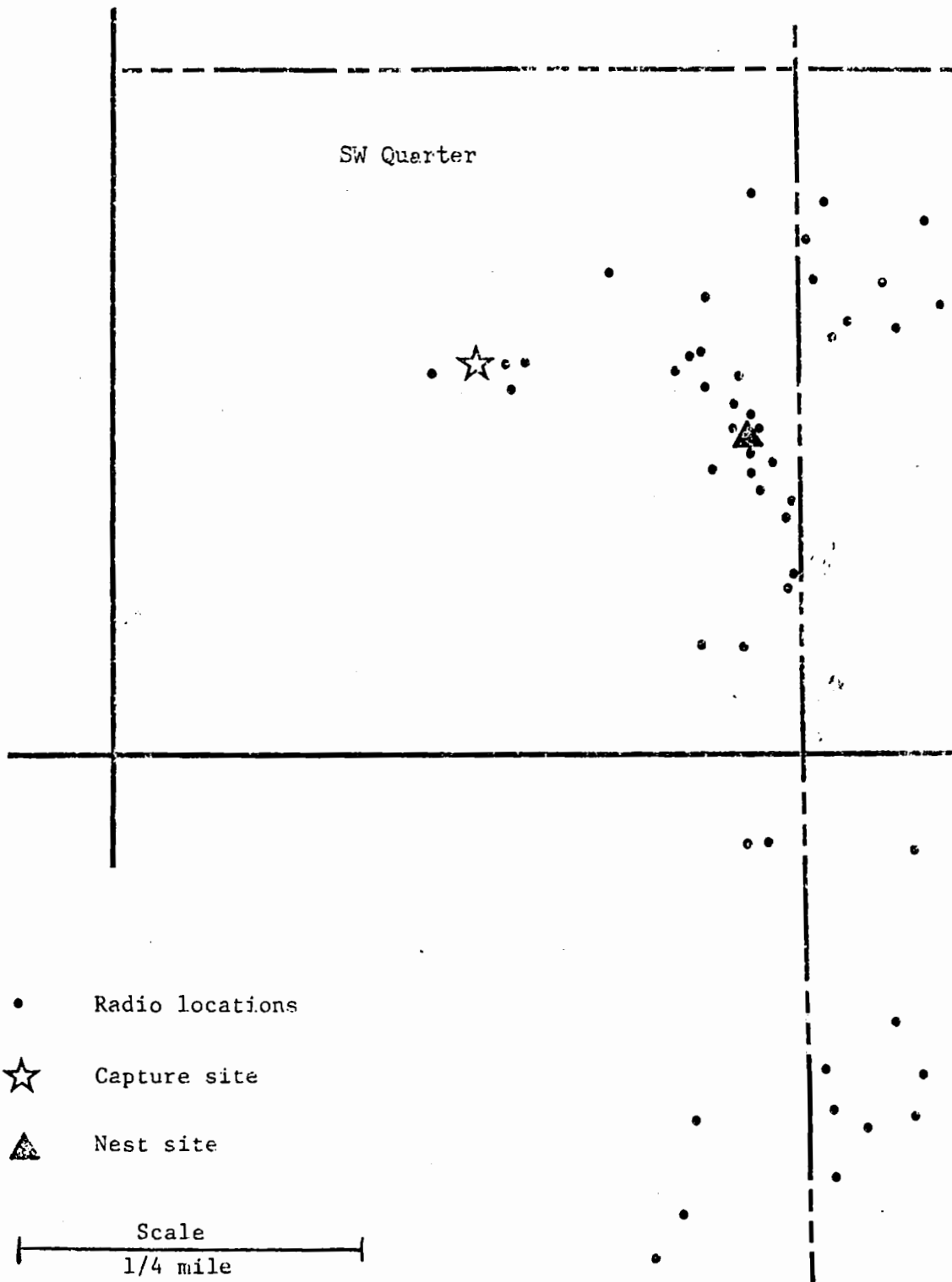


Figure 4. Nest and radio locations for hen #76 during early phase of reproductive cycle and following nest destruction--July 13-August 11, 1967.

repair. After her nest was destroyed she ranged over an area of 38 acres. Previous to this disruption she occupied an area of approximately 37 acres.

Hen #120 was captured in the soilbank and marked with a backtag on October 23, 1967 (Fig. 5); she was recaptured nearby on December 8. The radio ceased functioning immediately after recapture apparently because of cold weather. This bird was seen in the soilbank during winter. On May 3 following spring dispersal she was recaptured in the diverted acreage along the east side of the section nearly 1320 yards from the previous sighting. Two days after reinstrumentation she was observed in the harem of a nearby cock. Twelve days later she was in another cock's territory. On May 17 she was seen with a third cock which was marked. For the four-week period May 3 to June 4 she ranged over an area of 75 acres.

She later established a nest in a road ditch and brought off a brood late in the afternoon of June 27. She moved her chicks only 15 feet from the nest the first evening and returned to roost at the nest overnight. The following day she moved her brood into a nearby alfalfa field, recently cut, and remained there only until the next day. She then moved eastward into an adjacent pasture where she remained for the next three days. She was found again on July 9 with her brood in an oats field adjacent to the pasture. Three days later she returned to the alfalfa field near the nest site and resided there for five days. On July 17 she was observed 880 yards southeast of the nest site and remained in this vicinity for the following two days,

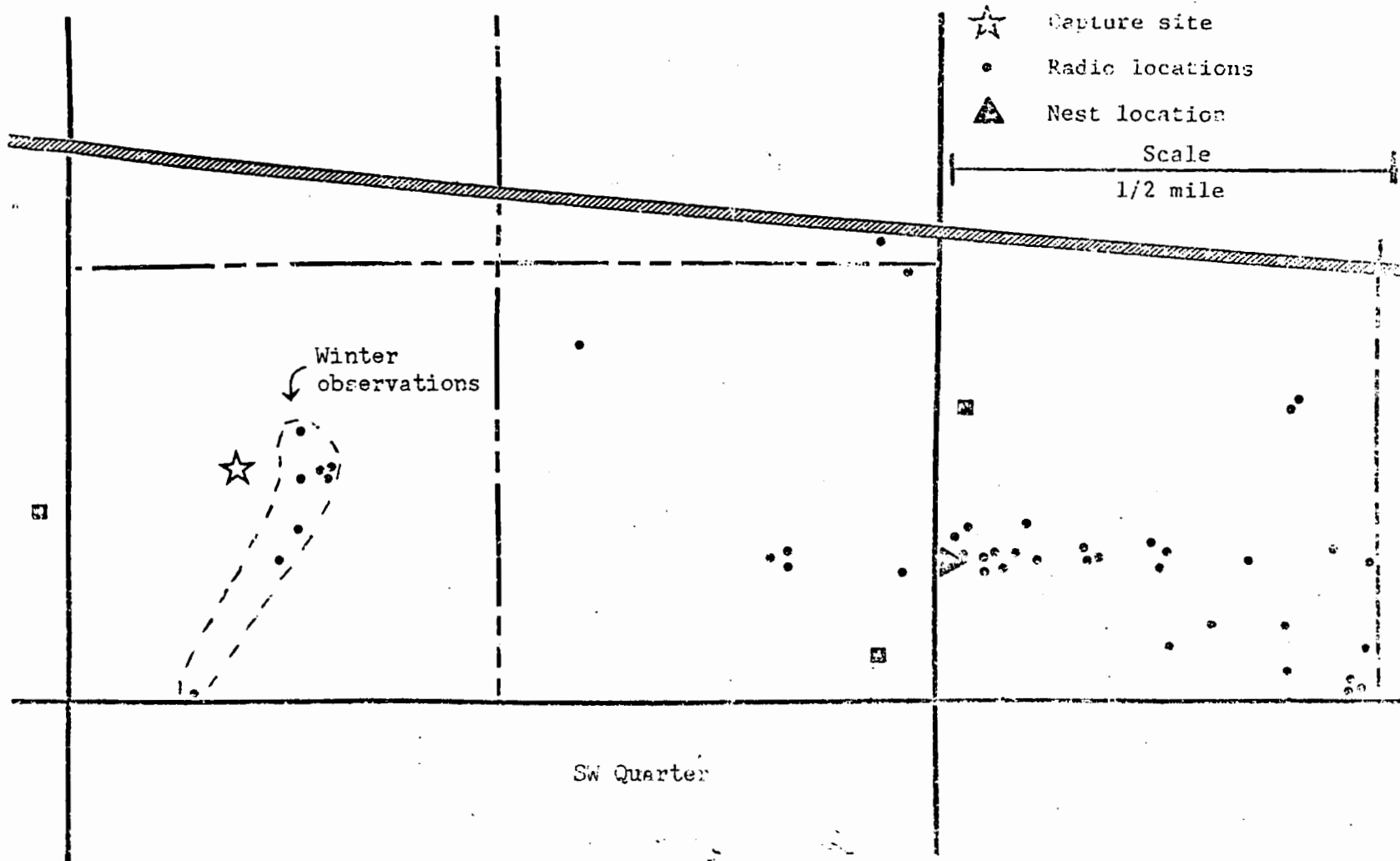


Figure 5. Nest and radio locations for hen #120 during winter, courtship, incubation and early brood rearing--October 23, 1967-July 19, 1968.

at which time field work was terminated. Her home-range during winter (12/8/67 - 2/22/68), breeding (5/3/68 - 6/27/68), and brood-rearing (6/27/68 - 7/19/68) periods were 4, 75, and 54 acres, respectively.

Hen #144 was captured March 22, 1968, in a walk-in trap set in the willows on the north side of the section (Fig. 6). She was held overnight and radio-equipped the following day. For the next 2 1/2 weeks her activities were similar to those of other hens observed in the area. She roosted in the railroad right-of-way and in sweet clover near to where she where she was trapped and fed in a nearby cornfield. She moved to the northeast shelterbelt during strong winds.

Average radial distance of movement during early spring (3/22/68 - 4/7/68) was 251 yards. Continued monitoring during April indicated she was occupying an area of approximately 15 acres and was in a harem. The signal became faulty on May 21 and she was located only once between this date and June 6, within the territory of her chosen cock. Her signal was lost again until June 11 when she was located nesting in a marked cock's territory. She was observed the following morning in a nearby alfalfa field where she was netted and re-radioed. She left the area June 12 and was observed nearly 1320 yards from her nest two days later. The nest was checked when it was apparent that she had abandoned it. Evidence indicated that it had been destroyed by a predator.

Hen #152 was netted and radio-equipped while nesting in the extreme west end of the railroad right-of-way on June 28, 1968

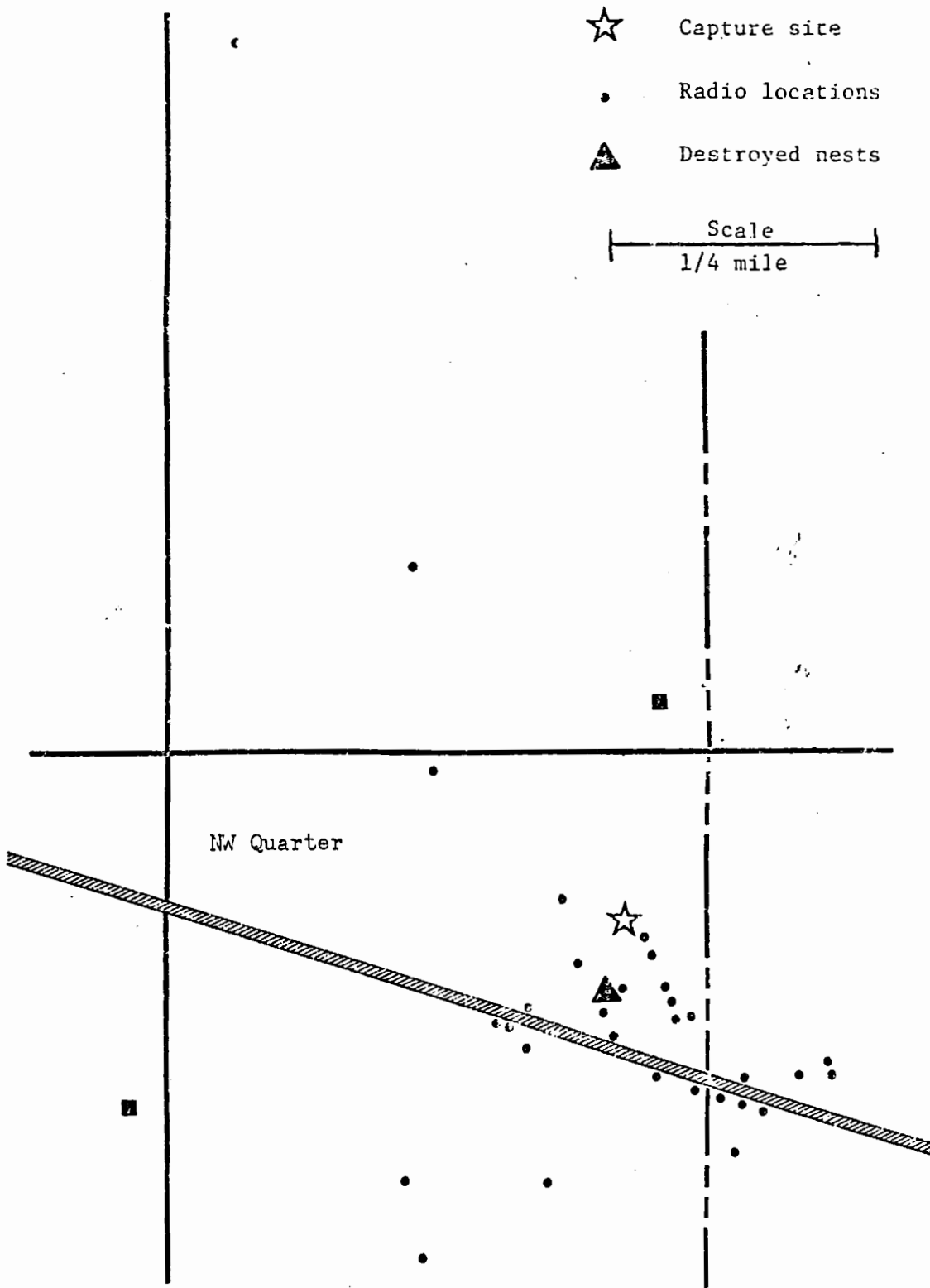


Figure 6. Nest and radio locations for hen #144 during early spring, incubation and following nest destruction--March 22-June 15, 1968.

(Fig. 7). She was captured in mid-afternoon and promptly left the nest site upon release. She spent the remainder of the day in an adjoining alfalfa field. The following morning, at 6:15 a.m., she was across the tracks from the nest. At 9:10 a.m. she was in a crowing cock's territory in the northwest corner of the section. She remained in this general vicinity for the next five days and was observed in the territories of two crowing cocks. On July 2 she roosted in the railroad right-of-way apparently in response to a third crowing cock. The bird was not located again until July 8, approximately two days after laying her first egg in a renesting attempt. It is believed she laid her last egg on July 16 and began incubating the next day. She was observed off the nest only once during the following two days. The bird occupied an area of approximately 24 acres after being instrumented.

Mate Selection by Hens and Location of Nests - Two of three hens monitored during early spring were each observed with one cock. One (#144) nested within the territory of the cock which serviced her while the other (#66) gave indications of doing so before her signal was lost. A third hen (#120) was sighted with three cocks in their respective territories, two of which accompanied her on several occasions. She selected a nest site within the cock's territory in which she was most often monitored. His territory was centrally located among the three, all within a 60-acre area.

Three females were monitored during renesting attempts. Each left the section following abandonment or destruction of their nests

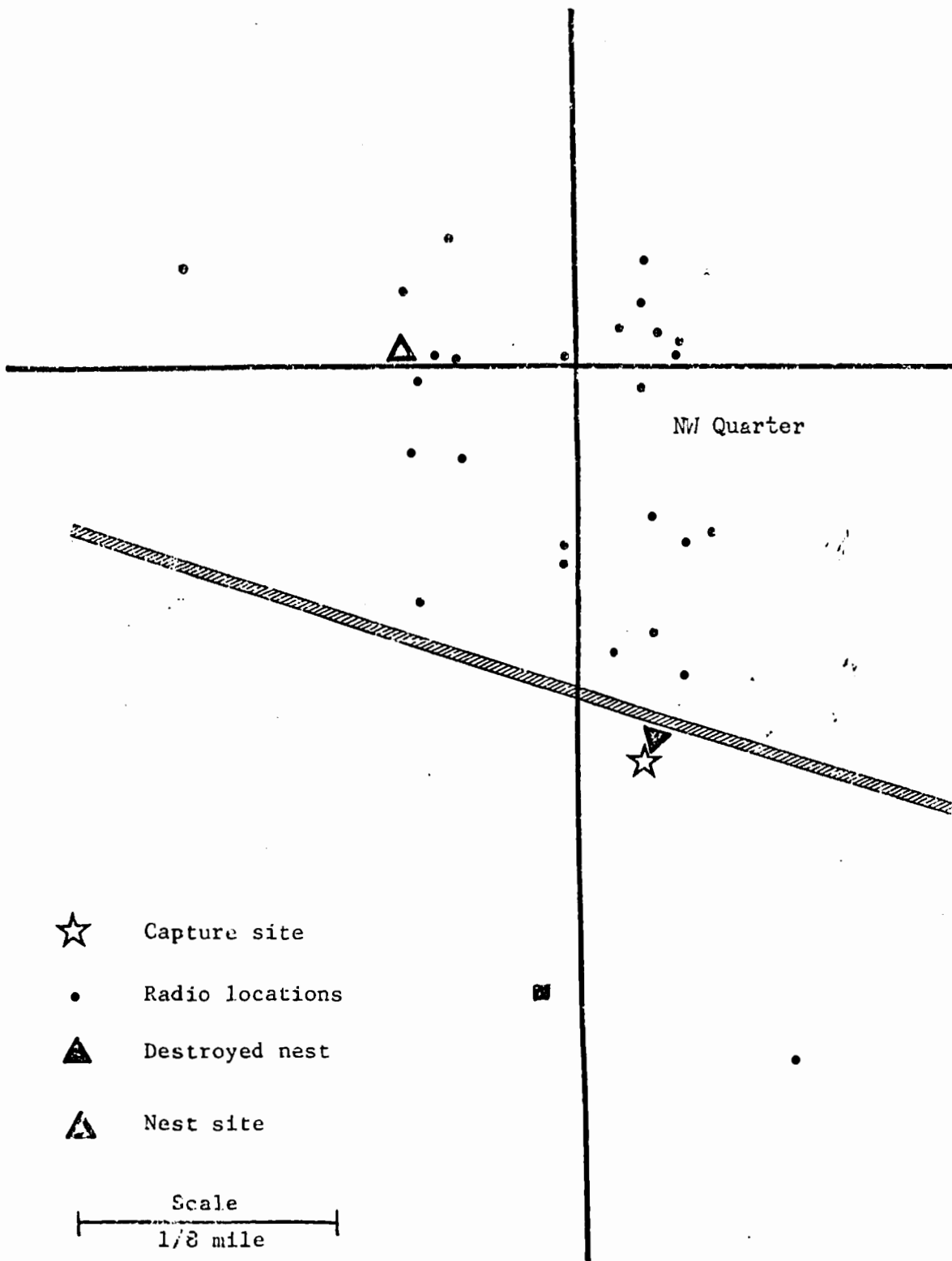


Figure 7. Nest and radio locations for hen #152 during renesting interval--June 28-July 19, 1968.

and were observed in harems within four days. Two of them (#76 and #144) were each observed with a single cock. No additional data were collected from either bird as one was sacrificed to recover the radio for repair and the signal of the other was lost. The third female (#152) was located near the territories of three crowing cocks which were located in a 40-acre area. She nested outside all three territories but on the periphery of the most centrally located one.

These data indicate that hens may or may not nest within the territory of the cock and that they may associate with more than one cock. Kuck (1968) reported that a hen normally associated with one cock during each nesting. Seubert (1952) studying re-nesting behavior of pheasants under pen conditions, stated that once a hen joined a cock's harem she seldom shifted to others, and that initial nests and second nests are generally established within her cock's territory.

Nest Site Activities - Most hens observed during egg-laying were on the nest in mid-afternoon. However, one hen (#76) was monitored in the vicinity of the nest between 10:00 a.m. and 12 noon on approximately the day she laid her first egg. On other occasions this bird was on or near the nest in the mornings as well as in the afternoons. Her early presence in the vicinity of the nest during the day may have been a result of her seeking vegetative cover offering protection from the hot sun. She roosted in the scilbank and during the egg-laying period walked to her nest in the clover field in the mornings.

There appears to be lack of agreement as to when rest periods from incubation are taken. Leopold (1933) mentioned that pheasant

hens rest at dawn and at 4:00 p.m. Kuck (1968) stated that most hens left their nests in afternoons. In this study some movement on the nest was detected from monitored birds during mid-morning and mid-afternoon. One hen (#120) was located off her nest only once, that being from 7:45 p.m. to 8:45 p.m.

Nest Abandonment and Renesting - Pheasants, like many other gallinaceous birds, readily abandon their clutches and frequently renest following disturbance during egg-laying or incubation. Two hens radio-equipped while incubating deserted their nests. Both clutches were subsequently destroyed by predators and stage of incubation could not be determined. These instances of nest abandonment were blamed on instrumentation as the hens failed to return to the nest sites and promptly moved to territories of crowing cocks 440 yards and one mile distant. A similar move was made by a hen whose nest was destroyed by a predator.

Another hen caught on her nest on the first or second day of incubation was marked with a backtag and immediately placed back on the nest where she remained incubating. Kuck (1968) reported a hen that deserted her clutch after instrumentation on the 18th to 20th day of incubation.

One radio-marked hen (#152) was instrumented in an early stage of incubation on June 28. Subsequently she abandoned her clutch, but later renested and brought off a brood. Another hen (#76) which was not on a nest at the time of capture (July 13) began nesting two

days following instrumentation. Her clutch was destroyed on the sixth or seventh day of incubation. Four days later she was observed in a harem 880 yards from her previous nest. She remained in this area for the ensuing 11-day period before returning to the study area near her original nest site where the transmitter was recovered for repair. Aside from being observed with a crowing cock and returning to the vicinity where she had previously been nesting, she gave no indications of renesting. Kuck (1968) reported similar movement of 1 1/4 mile for a hen that was monitored for 19 days following instrumentation and accidental nest destruction.

The renesting interval of one hen (#152) which abandoned her nest in early incubation was eight to nine days. This compares with renesting intervals of 10 and 11 days reported by Kuck (1968) among two hens whose clutches were broken up in early incubation. Seubert (1952) stated that the renesting interval depends on the stage of incubation when disturbance occurs, the more advanced the stage of incubation the greater the length of the renesting interval. However, he stated that renesting rarely occurs after a certain point in the nesting season, regardless of the stage of incubation. He found July 1 to be the approximate renesting terminal date under pen conditions.

Kuck (1968) reported that two hens renested approximately 200 yards from their initial nest sites. This distance is less than observed for one hen (#152) which renested about 334 yards from her previous nest. Gates (1966) reported on the renesting of 14 marked

pheasants in the wild, which, on the average, renested 405 yards from their original nest sites.

Hens with and without broods - Kuck (1968) reported that brood movement was restricted to the vicinity of the nest for the first three weeks following hatching. In the present study, one hen (#120) moved her brood nearly 880 yards seven days after hatching, the extraordinary distance of the move I attributed to the lack of vegetative cover in the roadside in which the nest was located. She returned to the vicinity of the nest following regrowth of the adjacent alfalfa field. Linder and Agee (1965) stated that pheasant nesting and brooding areas were in close proximity. Gates (1966) reported that two marked hens which renested were observed with 11- and 4-week-old broods 440' and 264 yards, respectively, from the site of hatching.

Two hens (#74 and #93) without broods were monitored for 158 days and averaged 163 yards radial movement. Average home-range size was 25 acres. In general, travel by both birds was similar with the exception of a few longer movements made by the hen radio-tracked later in the year. Both birds appeared to favor roosting in undisturbed cover over grain stubble. During August one hen spent much time in a cornfield, especially during hot days.

Bird #74 was night-lighted and marked with a backtag on June 6, 1967, in soilbank cover. She was subsequently recaptured and radio-equipped on August 15 approximately 110 yards from the original capture site (Fig. 8). She was never observed in a harem nor sighted within

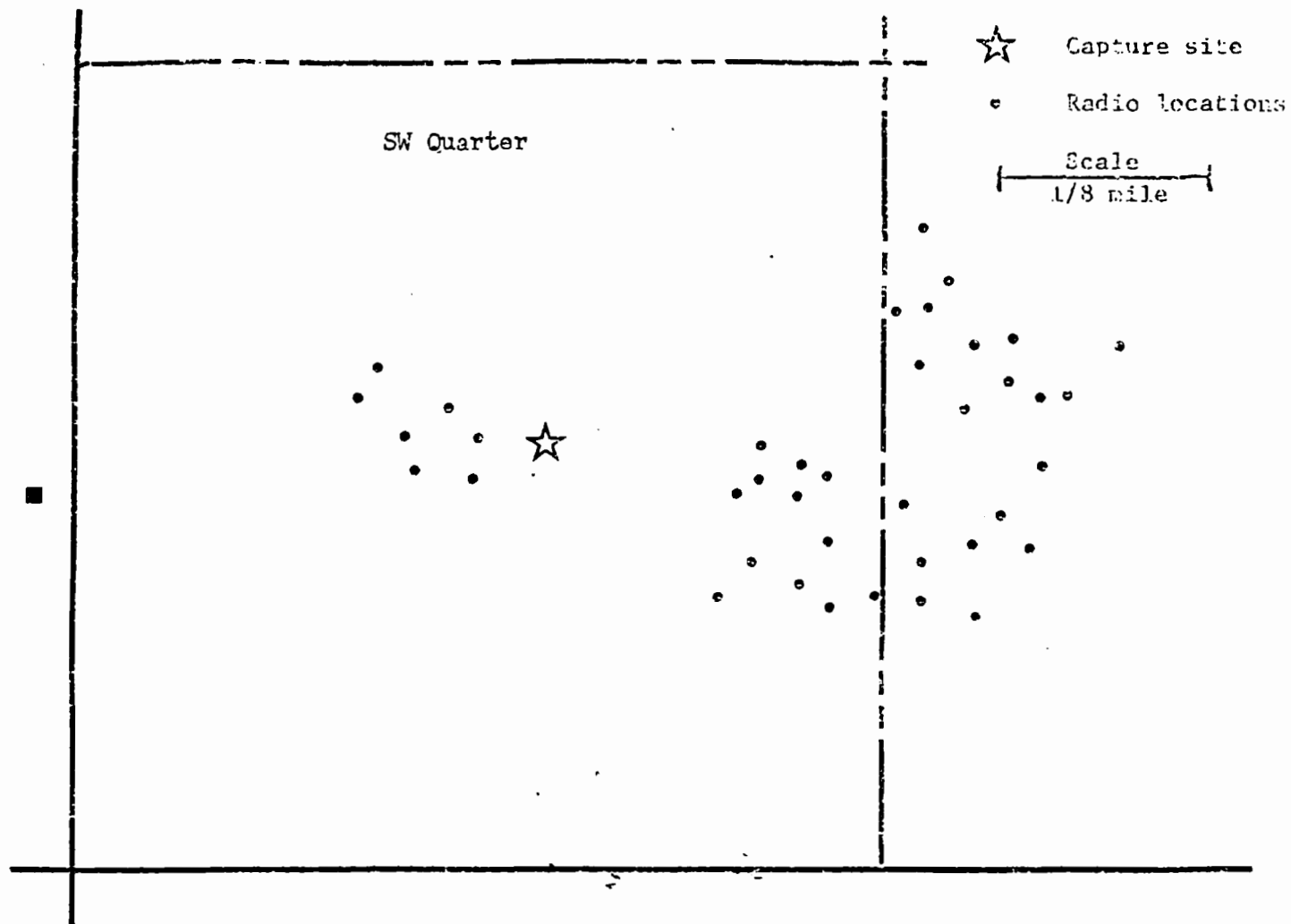


Figure 8. Radio locations for hen #74--June 6-October 13, 1967.

the territory of a crowing cock. Movement and activity of this bird were stereotyped in that she roosted in the north end of the soilbank or the extreme northern portion of the clover acreage where hen #76 roosted. From there she routinely made her way to a cornfield, 440 yards away, in which she spent the greater part of the day, especially during hot weather. In early evenings she commonly foraged in the adjacent alfalfa field and toward late evening returned to the soilbank or clover patch via the ungrazed pasture or fenceline. She seldom flew and most movements were by walking. Her signal was last heard October 13. The average radial distance of movement during the period of radio-tracking was 203 yards and home-range size was approximately 42 acres.

Hen #93 was night-lighted and radio-equipped in diverted cropland on the east side of the section on September 7, 1967 (Fig. 9). She remained in this vicinity until late evening when she moved across the tracks, fed in a rye stubble field, and roosted nearby. Her radio produced a faulty signal the following day and was off the air until September 20, at which time she was located near the site of capture. The signal continued faulty and was last heard on October 23. Twelve radio fixes were obtained, 85 percent within a 300-yard radius of the initial capture site. Average radial movement was 123 yards and home-range size was eight acres during the period of radio tracking.

Fall

Fall egress of birds from the study area each year may have been related to disturbance by hunters. The longest move by a marked bird

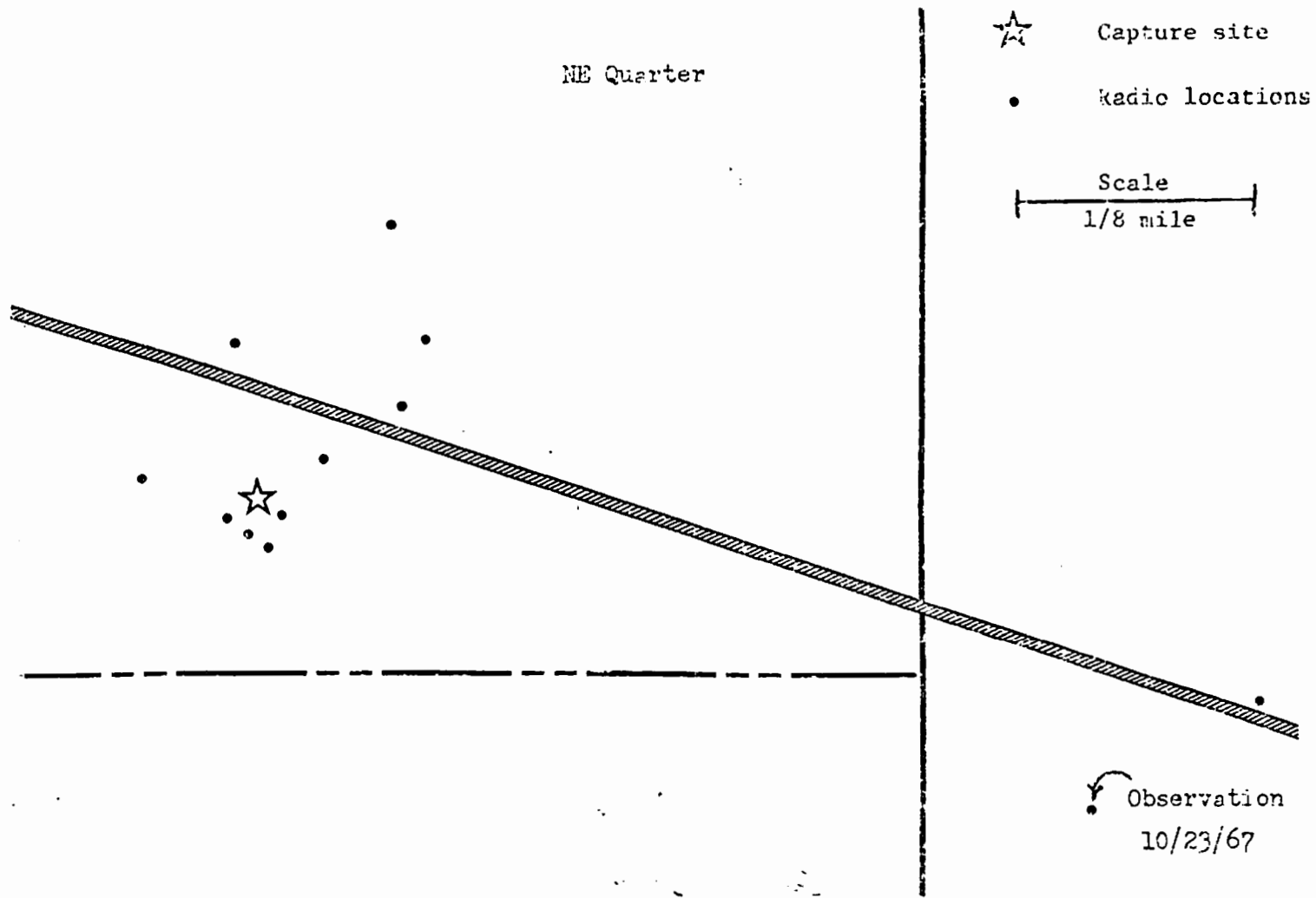


Figure 9. Radio locations for hen #93 during post-reproductive season--September 7-September 28, 1967.

from the section during the hunting season occurred in 1966 when a hen was sighted nearly three miles from where she was captured and released approximately two weeks earlier. In 1967, a juvenile cock was shot 1 1/2 miles from where it was marked and released.

Hunters killed 10 marked birds in 1967, including two hens which were reported as gunshot mortalities by landowners. Of these, six had moved 440 yards or less from the site of capture, three moved 880 yards, and one traveled one mile (Table 4). Adult movement averaged less than 440 yards and juvenile movement less than 880 yards.

Two roosters were radio-equipped during the 1967 hunting season (Table 5). Average home range was 60 acres, considerably greater than that occupied by cock #153 during molt. Both appeared to avoid frequently traveled roads in favor of heavy cover.

Bird #119, a juvenile cock, was spot-lighted October 12 in the draw on the north side of the railroad track (Fig. 10). He was radioed and released south of the tracks the same night. His signal was picked up the following day in the same vicinity. One week later he was located approximately 275 yards from the capture site. At noon, October 21, opening day of the 1967 hunting season, the bird was in a cornfield in the center of the area. A few minutes later two hunters with a dog flushed him out of the cover and into the draw. He moved across the railroad tracks and escaped into tall grass 100 yards north. He remained there approximately 30 minutes and then ran back between the hunters and moved into tall weedy

Table 4. Movement of pheasants determined from hunting recoveries, 1966 and 1967.

Number	Age	Date banded	Date of return	Time interval between banding and return (days)	Distance traveled from banding site (yards)
14	Adult	9/21/66	10/16/66	25	275
19	Juv.	10/12/66	10/16/66	4	375
1	Adult	9/9/66	10/29/67	415	135
45	Adult	1/11/67	10/22/67	284	250
70	Adult	5/10/67	10/23/67	166	880
82	Juv.	8/15/67	11/19/67	96	400
91	Juv.*	9/7/67	10/21/67	44	400
65	Juv.*	9/7/67	10/21/67	44	880
109	Juv.	10/9/67	11/12/67	34	250
110	Juv.	10/9/67	10/21/67	12	880
112	Juv.	10/9/67	10/21/67	12	2640
123	Juv.	10/25/67	11/19/67	25	475
Average					653

* Females illegally shot

Table 5. Summary of movement data for two male birds in fall.

Identifica- tion band No. and marker type	Age	Observation period	Duration (days)	Total loca- tions	Home range (acres)	Average radial distance (yards)
119/R	Juv.	10/12/67 - 11/22/67	41	16	60	188
123/R	Juv.	10/25/67 - 11/19/67	25	8	60	284
Average					60	196

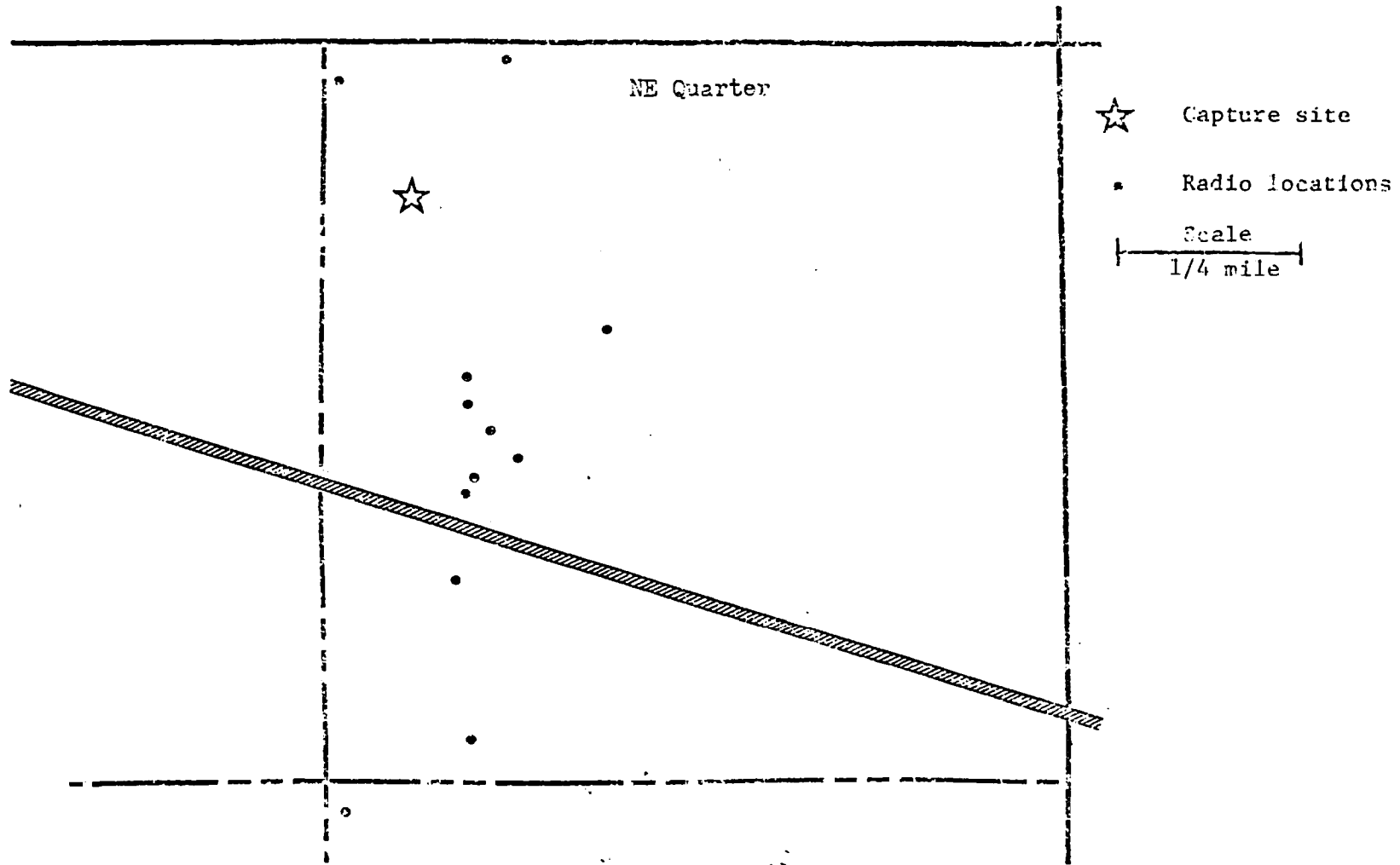


Figure 10. Radio locations for cock #119 during hunting season--October 12--November 22, 1968.

vegetation in the railroad right-of-way. He was still there at sun-down. The stable signal indicated he was sedentary and remained in dense vegetation. The bird spent the next 30 days in the general area in which he was captured, roosting in the draw and feeding in a nearby cornfield. His radio signal was not detected on November 27, 1967. This bird ranged over approximately 60 acres after being radioed. He was never found off the study area and off the quarter-section only once, on the opening day of the hunting season.

Bird #123, a juvenile cock, was captured in soilbank cover on October 25 and carried the radio transmitter for 26 days (Fig. 11). During this period he spent most of his time in or near the soilbank, roosting at times in the east end of a shelterbelt 150 yards north. Movements were similar to Bird #119, confined to a home-range of approximately 60 acres. The bird was never located farther than 575 yards from the capture site. He was shot November 19 in the cornfield at the southwest corner of the section. The radio, when returned by the hunter, was still functioning properly.

Several chicks from the same brood, in addition to chicks from different broods that had grouped together, were marked to study brood organization and breakup, but little information was obtained. Two juvenile cocks of different broods were night-lighted while roosting together. Both were shot 12 days later approximately two miles apart. One remained on the study area and was killed 880 yards west of the capture site while the other was shot 1 1/2 miles from the capture site northwest of the study area.

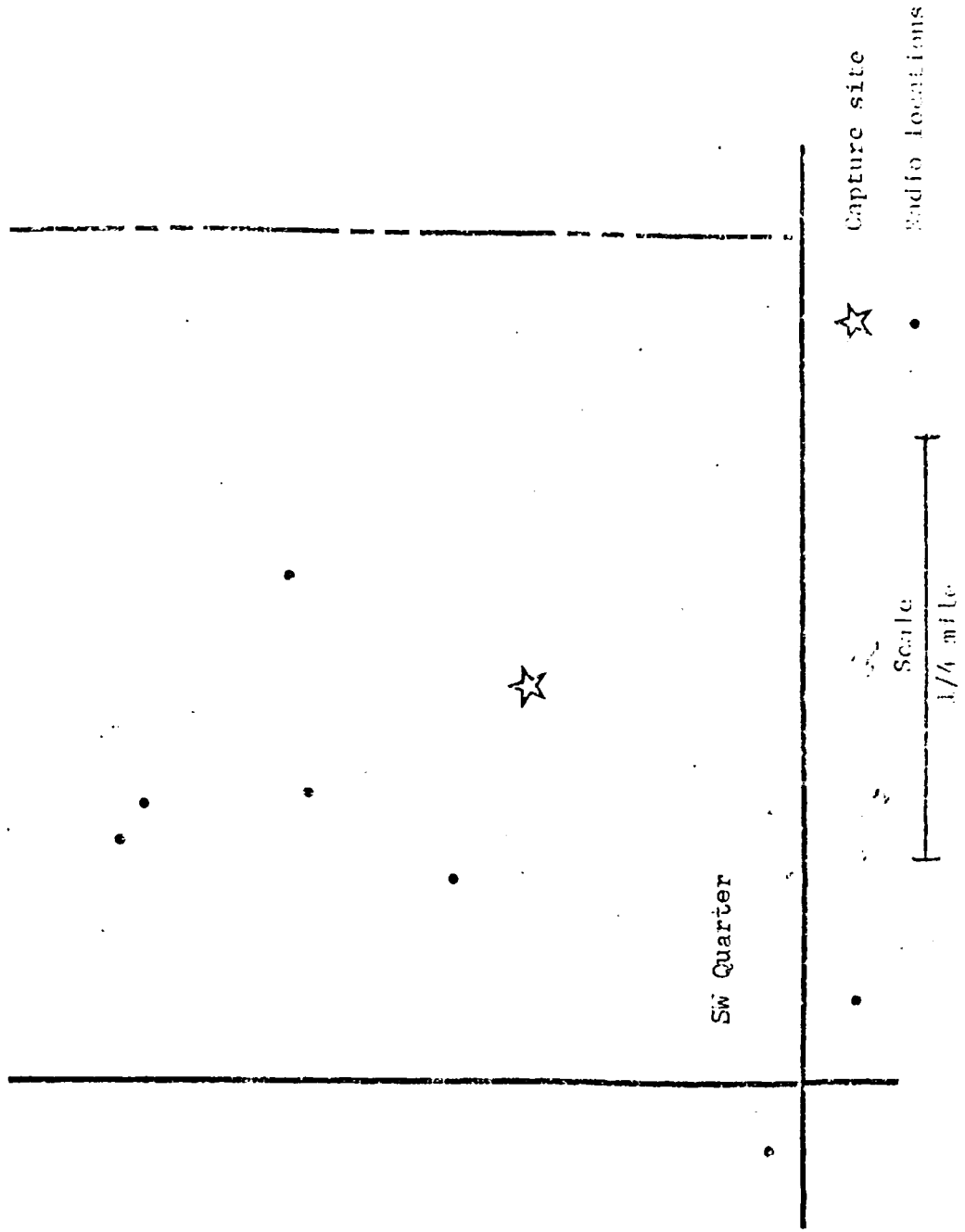


Figure 11. Radio locations for cock #123 during hunting season--October 27--November 19, 1968.

CONCLUSIONS

Pheasants of both sexes moved less than one mile from where marked. Birds traveled less than 1/4 mile to feed during open winters. Juveniles moved greater distances than adults and females traveled farther than males during spring dispersal. Distances of spring dispersal averaged less than 1/2 mile for all sex- and age-groups. Movement during the hunting season was of generally comparable magnitude.

Hens and cocks establish definitive areas of use during the reproductive period. Average home-range size of 18 marked birds was 29 acres; cocks and hens averaging 12 and 57 acres, respectively. Two cocks occupied home-ranges of about 60 acres during the hunting season.

Cocks were associated with crowing sites while hen activities were centered around the nest. Hens may or may not nest within the territory of their chosen mates, and may occasionally associate with more than one cock. Cocks appeared to know approximately where members of their harems were nesting and occasionally "beckoned" them by crowing intermittently for five to ten minutes during mid-morning and mid-afternoon. After several crowings, hens joined cocks to feed and court. These periods of activity appear to correspond with rest periods of incubating hens.

Hens may move as far as one mile to actively crowing cocks during re-nesting attempts. This ability, coupled with high egg fertility,

contradicts the notion that a low cock to hen ratio is detrimental to reproduction.

Thick winter cover attracted birds during inclement weather and contributed to low winter mortality owing to adverse weather and predation.

Selective use of undisturbed nesting cover (primarily roadsides) interspersed with other cover types was demonstrated by location of cock territories and nesting hens. To encourage maximum rates of pheasant productions, such cover should be left undisturbed until after the reproductive season.

Some loafing in cornfields adjacent to nesting and roosting cover was detected during heat of day. One hen moved her brood nearly 1/2 mile seven days after hatching due to lack of vegetation in the nest vicinity.

Future studies of pheasant movement should be conducted on relatively small acreages since this study showed that annual mobility was less than one mile. The influence of cover types on pheasant movements should be further investigated.

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