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# Seasonal Movements and Habitat Selection of Pheasant Cocks in South Dakota

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# SEASONAL MOVEMENTS AND HABITAT SELECTION OF PHEASANT COCKS IN EASTERN SOUTH DAKOTA

BY

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SEASONAL MOVEMENTS AND HABITAT

SELECTION OF PHEASANT COCKS

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.

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# SEASONAL MOVEMENTS AND HABITAT SELECTION OF PHEASANT COCKS IN EASTERN SOUTH DAKOTA

## Abstract

ROBERT A. FEDELER

Data were gathered on seasonal movements and habitat selection of 30 pheasant (Phasianus colchicus) cocks that were radio-equipped in eastern South Dakota from 1970 to 1972.

Pheasant cocks stayed in an area of less than 100 acres from spring through hunting season. In winter, cocks used even smaller areas more intensively. Cocks moved about their home range by shifting their activity center rather than by adjustment in range of daily travel. Adult cocks seemed to have strong site attachments on a year-round basis. Immature cocks were more mobile, especially during the fall prior to hunting season.

In spring, adult cocks were least mobile, but utilized the widest diversity of cover types. During summer, land retired under a 1-year program provided a preferred cover type when left undisturbed for the major part of the growing season. Cocks selectively utilized picked cornfields and woody cover during the winter.

Apparently management areas of approximately 100 acres could attract and support pheasant cocks in an agricultural area. Areas managed for pheasants should have diverse cover types, especially during

the breeding season. A later hunting season, when more corn is harvested, could possibly increase hunter success. Woody cover and residual cover could serve as a management tool for the cock segment of the population by: (1) affecting spring dispersal by providing preferred cover, (2) serving as a focal point of harvest by concentrating birds and hunter effort, and (3) providing preferred winter cover.

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# INTRODUCTION

The ring-necked pheasant (Phasianus colchicus) is the most economically important species of wildlife in South Dakota. Pheasant hunting is a multi-million dollar industry in South Dakota. In 1970 and 1971, total pheasant hunter expeditures were 8.2 and 8.7 million dollars (Trautman et al. 1973).

Pheasant population levels are principally determined by survival and reproductive success of hens. Hence most management and research attention has been directed at the female segment of the population. To gain insight into management problems concerning the male segment of the population, this study was initiated in 1971 to gather information on seasonal mobility, behavior, and habitat selection.

Winter-to-spring movements of cocks and hens have been investigated in Iowa (Grondahl 1953 and Weston 1954) and in South Dakota (Janson 1947 and Kimball 1949). Many workers have described the breeding behavior of cock pheasants in the wild. Bent (1932) summarized much of the early work done in North America. Wight (1945) first interpreted breeding habits from the viewpoint of the game manager. Baskett (1947) made general observations of breeding-season behavior of cocks, as did Taber (1949) and Collias and Taber (1951). More recently, Burger (1966) made observations of aggressive behavior in cocks during the breeding season.

Most studies of habitat preference of pheasants have involved the female segment of the population. Hamerstrom (1936) and Baskett (1947) in Iowa, Linder et al. (1960) in Nebraska, Trautman (1960) in South Dakota, and many others have reported on utilization of nesting cover. Kozicky and Hendrickson (1951), in Iowa, and Hammer (1965) and Linder and Agee (1965), in Nebraska, reported on cover types utilized by hens and broods.

The above-mentioned studies were all done by direct visual observation of marked or unmarked birds. The development of radio-tracking systems (LeMunyan et al. 1959; Marshall 1960; and Cochran and Lord 1963) and of radio-telemetry procedures (Marshall and Kupa 1963) has enabled wildlife biologists to obtain more detailed information on activities and movements of wildlife species. In South Dakota, Kuck et al. (1970) and Hanson (1971) reported on movements and habitat selection of hens during nesting and brood-rearing periods, respectively. Carter (1971) discussed seasonal movements and hunting recoveries of cocks and hens. Ruth (1972) reported on influence of weather on movement and habitat use of hen pheasants during brood-rearing.

## STUDY AREA

Field studies were conducted in 1971-72 in east-central South Dakota, 3 miles east of Brookings (Sections 21 and 22, Township 110 N, Range 49 W). The study area consisted of a central 640-acre area and any contiguous 160-acre area ($\frac{1}{4}$ section) into which radioed birds moved.

The topography of the area is flat to gently rolling. Soils are glacial in origin and overlain by loess (Westin et al. 1958). The climate is continental. Temperatures range between -20 F and 110 F. Average annual precipitation is 20 inches, of which 80 percent falls during the growing season (Spuhler et al. 1971).

Agriculture is the principal source of farm income in the area, with corn and small grains the major crops. During 1971-72, 32 percent of the study area was in corn and 35 percent in small grains. Seven percent was in pasture, 3 percent in hayland and 11 percent in residual cover. The remaining 10 percent was divided between woody cover (3 percent), road and drainage ditches (3 percent), spoil pits (1 percent), and idle cover (3 percent)(Table 1). Small grains included flax, wheat, and oats. Residual cover included second-growth vegetation and herbaceous cover undisturbed from the previous year. Woody cover consisted of two shelterbelts, each 0.5 mile long and nine rows wide, and scattered willow (Salix spp.) clumps in low-lying areas. In 1972, 129 acres were retired under the U. S.

Table 1. Acreage and percentage (in brackets) of cover types on study area, 1970-72.

| Year | Total Acres | Acreage and Percentage of Individual Cover Types | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Corn | Small Grain | Residual Cover | Pasture | Summer Fallow | Alfalfa | Woody Cover | Ditches | Spoil Pits | Idle Cover |
| 1970 | 640 | 205 (32) | 155 (24) | 126 (20) | 56 (9) | 34 (5) | 26 (4) | 17 (3) | 16 (2) | 5 (1) | — |
| 1971 | 1,600 | 678 (43) | 472 (30) | 157 (10) | 102 (6) | 44 (3) | 25 (2) | 69 (4) | 48 (3) | 5 (1) | — |
| 1972 | 2,080 | 480 (23) | 884 (42) | 192 (9) | 142 (7) | 39 (2) | 83 (4) | 63 (3) | 50 (2) | 18 (1) | 129 (6) |
| 1970-72 Mean | 1,440 | 454 (32) | 504 (35) | 158 (11) | 100 (7) | 39 (3) | 45 (3) | 49 (3) | 38 (3) | 9 (1) | 43 (3) |

Department of Agriculture Feed Grain Program and left undisturbed through the major part of the growing season. This idle cover was dominated by a dense stand of annual weeds (foxtail, Setaria spp.; sunflower, Helianthus spp.; Canada thistle, Cirsium arvense; quackgrass, Agropyron repens; milkweed Asclepias spp.; volunteer corn, and nettles Urtica spp.) until plowed in August.

Estimated spring breeding densities from crowing counts on the study area from 1970-72 were 2.8, 3.3, and 1.4 cocks per 100 acres, respectively.

## METHODS AND MATERIALS

### Capture and Marking

Birds were captured by nightlighting with a vehicle-mounted unit (Labisky 1968) and a back-pack unit (Drewien et al. 1967). All birds captured were marked with sequentially numbered butt-end aluminum leg bands. All adult and young hens over 8 weeks old were backtagged. Adult cocks and young were fitted with radio transmitters or backtags. Backtags were made of U. S. Naugahyde as described by Labisky and Mann (1962). Backtags and transmitters were mounted on the center of the back, between the wings, fastened by a loop of No. 18 automotive wire around each upper humerus.

### Radio-tracking Equipment and Procedures

The telemetry system used in this study was described by Hanson (1971) and Hanson and Progulske (1973). It consisted of radio transmitters, a stationary receiving unit, a mobile receiving unit, and a hand-held receiving unit. Transmitters, constructed by the Electrical Engineering Department at South Dakota State University, had an expected transmission life of approximately 100 days, with a range of 0.75 mile from the stationary antenna and 0.50 mile from the mobile receiving unit. Each transmitter emitted a continuous signal on a separate frequency between 151.0 and 151.1 megahertz and weighed 25 to 26 grams. A Drake tunable receiver with converter was used at both stationary and

mobile receiving units. The stationary receiving station was fitted with a two-yagi receiving antenna, atop a 70-foot steel tower, phased to create a null in an audible signal when aimed directly at the transmitter. The azimuth was read directly from a Telrex rotation indicator. The mobile receiving unit was fitted with a single-yagi receiving antenna. The azimuth was determined by locating the nulls in the audible signal on either side of the maximum signal intensity. The distance between the nulls was halved to obtain the signal azimuth. The stationary receiving station and the mobile unit were used to locate a bird using procedures similar to those described by Marshall and Kupa (1963). Simultaneous fixes were taken at two different locations and birds were located by the intersection of azimuths.

All fixes were subject to error due to distance of the bird from the receiver (Cochran et al. 1965), operator error in signal interpretation and recording (Heezen and Tester 1967), antenna misalignment, and bird movement (Kuck et al. 1970). Hanson (1971) determined that location error for the system in use was no more than 40-50 feet at a range of 0.5 mile. Since most fixes were taken over considerably shorter distances, this degree of error was considered acceptable.

Data Analysis

Movement.—Heezen and Tester (1967) described and recommended six parameters in studying animal movements: (1) total home-range acreage; (2) major axis (greatest linear dimension of home range); (3) home

range shape; (4) activity center (average of all X-Y coordinates for a specified period of time); (5) mean activity radius (mean distance from the activity center to all points); and (6) seasonal change in distribution of activity center.

Each location was entered on an IBM card showing date, time, cover type, and weather conditions; data were analyzed at the South Dakota State University Computer Center. Locations to be used were selected by dividing daylight hours (one-half hour before sunrise to one-half hour after sunset) into four equal periods. Only that location closest to the midpoint of the period was used. The computer calculated X-Y coordinates of each fix, activity center, activity radius, and length of major axis for any specified period of time. Computer maps of pheasant locations and movements were made for all birds for specified periods of time. Biweekly home-range acreages were calculated for each bird for which 10 or more fixes were available. Home-range acreages were determined by a modification of Mohr's minimum-area method (1945) and a grid system (Tester and Siniff 1965). To use the minimum-area method, the peripheral points of the main grouping of locations were connected. The enclosed area was measured with a compensating polar planimeter. To use the grid system, the study area was gridded into 2,304, 1.1-acre plots. This choice of plot size was arbitrary, but consistent with accuracy of the telemetry system and provided for detailed cover-type mapping. Home-range acreages were determined by

multiplying the number of squares with one or more locations by 1.1 acres. Home-range shape was determined by drawing around the outermost 1.1 acre squares with fixes in them. Squares without fixes but within home-range boundaries were considered part of the home range.

Habitat Utilization.—To examine seasonal cover use, the study area was divided into 160-acre units. If a bird frequented a particular unit, it was assumed that it exercised its cover preference over the entirety of that unit. Available acreages of each habitat type were determined for each unit. Major changes in habitat resulting from agricultural activities were recorded throughout the year. A habitat-preference index was calculated by comparing the observed number of fixes in a cover type with the expected number of fixes in that cover type assuming random utilization of the study area. The expected number of fixes in a given cover type was based on the percentage of land area it constituted times percentage of time available. For example, if a field of residual cover constituted 10 percent of the area and was available for an entire period, 10 percent of the readings would be expected in this cover type. If an unharvested small grain field constituted 10 percent of the area but was cut halfway through a period, only 5 percent of the readings would be expected in this cover type.

Data were pooled and grouped into five phenological periods. The five periods were: (1) spring (March 16 to June 15), (2) summer (June 16 to August 31), (3) fall (September 1 to opening date of hunting season), (4) hunting season, and (5) winter (closing date of hunting season to March 15). Meteorological conditions in conjunction with various phases of pheasant life history were considered in establishing these periods. Equivalent periods were not necessarily of equal duration each year, however. For example, the hunting season in 1971 was 47 days in length, compared with 59 days in 1972. Composite parameter values were also calculated using all readings for each bird for the first of the four above-mentioned periods. Few data were gathered in winter because of transmitter malfunction during cold weather and dispersal of birds off the study area.

All home-range and movement parameters in this study must be considered minimum values because readings were not taken continuously. Tester and Siniff (1965) have shown that such parameters become more representative as the number of fixes increases.

# RESULTS

## Capture Data

A total of 460 pheasants (cocks and hens) was captured and banded during the study. Of these, 323 were backtagged and 48 were radio-equipped (Table 2). After a short period of adjustment to the transmitter harness, no adverse effects were noted on behavior or movement. Previous studies by Kuck (1968), Hanson (1971), and Carter (1971), in which similar techniques were employed, also indicated no adverse effects of radio-equipping. Of the 48 radio-equipped birds, 26 cocks provided sufficient data for analysis of movement and habitat selection. Additional data from four cocks radio-equipped in 1970 were included. Overall, 30 cocks were successfully radio-tracked for a total of 1,598 days. A total of 3,904 locations on 1,473 days were used from 6,600 locations recorded (Table 3).

## Movement

Major Axis.—A composite major-axis length was calculated using all readings for each bird from March 16 to the end of the hunting season. The mean of these values for 19 adult cocks was 0.85 ± 0.34 (SD) mile, with a range of 0.35 to 1.49 miles. The mean composite major-axis length for immature cocks was 1.12 ± 0.56 miles, and ranged from 0.59 to 2.32 miles.

Table 2. Number of pheasants captured, marked and radio-equipped, 1971-72.

| Year and Sex | Captured | | Marked | | Radio-equipped | |
|---|---|---|---|---|---|---|
| | Immature | Adult | Immature | Adult | Immature | Adult |
| 1971 | | | | | | |
| Cocks | 58 | 19 | 40 | 8 | 5 | 11 |
| Hens | 58 | 68 | 40 | 56 | 3 | 12 |
| | 116 | 87 | 80 | 64 | 8 | 23 |
| 1972 | | | | | | |
| Cocks | 108 | 9 | 75 | 3 | 10 | 6 |
| Hens | 111 | 29 | 73 | 28 | 0 | 1 |
| | 219 | 38 | 148 | 31 | 10 | 7 |
| Total | 335 | 125 | 228 | 95 | 18 | 30 |

Table 3. Summary of transmitter days, data days, and number of locations for pheasant cocks, 1970-72.

| Bird No. | Age | Date On-Off | Transmitter Days | Data Days | No. of Locations | No. of Locations Used |
|---|---|---|---|---|---|---|
| 263 | A | 6-17-70 to 8-14-70 | 59 | 51 | 137 | 105 |
| 272 | A | 4-21-71 to 5-21-71 | 32 | 27 | 136 | 69 |
| 393 | A | 6-17-70 to 4- 9-70 | 80 | 62 | 183 | 129 |
| 396 | A | 4- 7-70 to 7- 7-70 | 92 | 58 | 173 | 126 |
| 398 | A | 4- 7-70 to 6-10-70 | 65 | 39 | 100 | 65 |
| 440 | I | 11- 4-72 to 12-18-72 | 45 | 33 | 110 | 85 |
| 442 | I | 11-22-72 to 1-23-73 | 63 | 29 | 98 | 77 |
| 443 | I | 1-16-73 to 2-19-73 | 35 | 14 | 65 | 46 |
| 522 | A | 3-19-71 to 5-20-71 | 62 | 56 | 307 | 149 |
| | | 7-18-72 to 10-30-72 | 105 | 82 | 340 | 240 |
| 528 | A | 3-31-71 to 4- 5-71 | 35 | 22 | 191 | 69 |
| 531 | A | 3-26-71 to 5- 4-71 | 11 | 6 | 60 | 23 |
| | | 9-16-71 to 10-16-71 | 31 | 28 | 148 | 73 |
| 534 | A | 4- 2-71 to 5- 5-71 | 34 | 21 | 113 | 40 |
| 537 | A | 4- 2-71 to 5- 4-71 | 33 | 30 | 186 | 79 |
| 538 | A | 4- 2-71 to 5- 5-71 | 34 | 28 | 206 | 79 |
| 577 | I | 8-10-71 to 10-22-71 | 74 | 64 | 397 | 169 |
| 589 | A | 8- 2-72 to 11- 9-72 | 94 | 65 | 239 | 181 |
| 613 | A | 7-16-72 to 10-28-72 | 105 | 81 | 344 | 241 |

Table 3. (Continued).

| Bird No. | Age | Date On-Off | Transmitter Days | Data Days | No. of Locations | No. of Locations Used |
|---|---|---|---|---|---|---|
| 616 | I | 9- 7-71 to 11-21-71 | 76 | 50 | 302 | 143 |
| 622 | I | 9- 8-71 to 11-14-71 | 68 | 65 | 368 | 181 |
| 684 | A | 10- 6-71 to 12-31-71 | 87 | 47 | 333 | 163 |
| 692 | A | 10- 6-71 to 1-12-73 | 99 | 78 | 381 | 206 |
| 704 | A | 3- 6-72 to 5-14-72 | 70 | 41 | 132 | 71 |
| 705 | A | 3-14-72 to 5-14-72 | 85 | 46 | 189 | 94 |
| 709 | A | 7-13-72 to 10-13-72 | 92 | 70 | 319 | 214 |
| 710 | I | 7-18-72 to 10-17-72 | 92 | 70 | 309 | 212 |
| 718 | I | 8- 4-72 to 10-26-72 | 84 | 61 | 228 | 184 |
| 806 | I | 11- 4-72 to 12-14-72 | 41 | 33 | 111 | 85 |
| 830 | A | 9-14-72 to 12- 6-72 | 84 | 68 | 219 | 169 |
| 841 | I | 11-22-72 to 1-23-73 | 63 | 29 | 105 | 52 |
| 846 | I | 11-22-72 to 12-20-72 | 29 | 19 | 71 | 55 |
| Totals | | | 2,059 | 1,473 | 6,600 | 3,904 |

During the spring period, mean major-axis length for 11 adult cocks was 0.41 mile (Table 4). This increased ($P<0.05$) to 0.57 mile during the summer period (Table 5). Through the fall and hunting periods it did not change significantly ($P>0.05$) from the summer value (Tables 6 and 7).

Major-axis length of immature cocks increased from 0.56 mile in summer to 0.79 mile in the fall, subsequently declining to 0.56 mile during the hunting season (Tables 5, 6, and 7). The differences, however, were not significant ($P>0.05$).

The mean composite major-axis length for 19 adult cocks (0.85 mile) was larger than the unweighted mean of the major axes for the four periods (0.52 mile). Similarly, the mean of the composite major-axis length for 11 immature cocks (1.12 miles) was larger than that for the three periods (0.64 mile).

Activity Radius.—A composite activity radius was calculated using all readings for each bird from March 16 to the end of hunting. The mean of these values for 19 adult cocks was 0.15 ± 0.07(SD) mile, varying from 0.08 to 0.31 mile. The mean composite activity radius for 11 immature cocks was 0.16 ± 0.04 mile, varying from 0.11 to 0.24 mile.

During the spring period, mean activity radius for adult cocks was 0.11 mile (Table 4). This dropped to 0.10 mile during the summer period and increased ($P<0.05$) to 0.14 mile during the fall period and hunting period (Tables 5, 6, and 7).

Table 4. Biweekly home-range size and activity parameters of adult pheasant cocks, spring period, 1970-72.

| Dates | Number of Birds | Number of Readings | Major Axis (miles) | Activity Radius (miles) | Home Range (Acres) Grid System | Home Range (Acres) Minimum Area |
|---|---|---|---|---|---|---|
| Mar. 16-31 | 5 | 140 | 0.36 | 0.09 | 13.9 | 19.8 |
| Apr. 1-15 | 9 | 233 | 0.41 | 0.09 | 15.6 | 20.0 |
| Apr. 16-30 | 9 | 222 | 0.40 | 0.09 | 14.9 | 18.9 |
| May 1-15 | 5 | 115 | 0.39 | 0.10 | 13.9 | 21.1 |
| May 16-31 | 2 | 24 | 0.41 | 0.14 | 8.3 | 21.4 |
| Jun. 1-15 | 2 | 38 | 0.52 | 0.16 | 15.9 | 33.2 |
| Mean (N=11) | | | 0.41 | 0.11 | 13.8 | 22.4 |
| Standard deviation | | | 0.05 | 0.03 | 2.8 | 5.4 |

Table 5. Biweekly home-range size and activity parameters of pheasant cocks, summer period, 1970-72.

| Dates | Number of Birds | Number of Readings | Activity Axis (miles) | Activity Radius (miles) | Home Range (Acres) Grid System | Home Range (Acres) Minimum Area |
|---|---|---|---|---|---|---|
| Adults | | | | | | |
| Jun. 16-30 | 3 | 72 | 0.62 | 0.10 | 18.3 | 30.4 |
| Jul. 1-15 | 4 | 87 | 0.50 | 0.10 | 15.7 | 25.6 |
| Jul. 16-31 | 6 | 203 | 0.52 | 0.11 | 22.9 | 27.8 |
| Aug. 1-15 | 6 | 204 | 0.55 | 0.11 | 21.5 | 23.2 |
| Aug. 16-31 | 5 | 149 | 0.64 | 0.10 | 19.8 | 27.4 |
| Mean (N=8) | | | 0.57 | 0.10 | 19.6 | 26.9 |
| Standard deviation | | | 0.06 | 0.00 | 2.8 | 2.7 |
| Immatures | | | | | | |
| Jul. 16-31 | 1 | 46 | 0.56 | 0.10 | 22.0 | 18.5 |
| Aug. 1-15 | 2 | 69 | 0.56 | 0.11 | 20.4 | 24.3 |
| Aug. 16-31 | 3 | 97 | 0.56 | 0.12 | 22.7 | 44.3 |
| Mean (N=3) | | | 0.56 | 0.11 | 21.7 | 29.0 |
| Standard deviation | | | 0.00 | 0.01 | 1.2 | 13.5 |

Table 6. Biweekly home-range size and activity parameters of pheasant cocks, fall period, 1970-72.

| Dates | Number of Birds | Number of Readings | Activity Axis (miles) | Activity Radius (miles) | Home Range (Acres) Grid System | Home Range (Acres) Minimum Area |
|---|---|---|---|---|---|---|
| Adults | | | | | | |
| Sep. 1-15 | 3 | 107 | 0.46 | 0.10 | 22.7 | 30.6 |
| Sep. 16-30 | 6 | 195 | 0.63 | 0.15 | 20.9 | 27.9 |
| Oct. 1-Hunt | 8 | 263 | 0.63 | 0.18 | 23.9 | 34.1 |
| Mean (N=8) | | | 0.57 | 0.14 | 22.5 | 30.8 |
| Standard deviation | | | 0.10 | 0.04 | 1.5 | 3.1 |
| Immatures | | | | | | |
| Sep. 1-15 | 4 | 131 | 0.54 | 0.14 | 22.6 | 35.9 |
| Sep. 16-30 | 4 | 132 | 1.05 | 0.17 | 25.6 | 32.0 |
| Oct. 1-Hunt | 5 | 191 | 0.80 | 0.13 | 27.1 | 31.8 |
| Mean (N=5) | | | 0.79 | 0.15 | 25.1 | 33.2 |
| Standard deviation | | | 0.25 | 0.02 | 2.3 | 2.3 |

Table 7. Biweekly home-range size and activity parameters of pheasant cocks, hunting season, 1970-72.

| Dates | Number of Birds | Number of Readings | Activity Axis (miles) | Activity Radius (miles) | Home Range (Acres) Grid System | Home Range (Acres) Minimum Area |
|---|---|---|---|---|---|---|
| Adults | | | | | | |
| Hunt-Oct. 31 | 6 | 209 | 0.63 | 0.13 | 18.9 | 21.5 |
| Nov. 1-15 | 4 | 123 | 0.52 | 0.14 | 19.8 | 29.6 |
| Nov. 16-30 | 3 | 86 | 0.43 | 0.15 | 19.4 | 16.8 |
| Mean (N=6) | | | 0.53 | 0.14 | 19.4 | 22.6 |
| Standard deviation | | | 0.10 | 0.01 | 0.5 | 6.5 |
| Immatures | | | | | | |
| Hunt-Oct.31 | 4 | 142 | 0.50 | 0.13 | 22.0 | 22.2 |
| Nov. 1-15 | 4 | 150 | 0.62 | 0.15 | 26.7 | 40.1 |
| Nov. 16-30 | 6 | 202 | 0.63 | 0.16 | 19.4 | 30.9 |
| Dec. 1-Winter | 4 | 32 | 0.49 | 0.23 | 7.2 | 5.9 |
| Mean (N=9) | | | 0.56 | 0.17 | 18.8 | 24.8 |
| Standard deviation | | | 0.07 | 0.04 | 8.3 | 14.6 |

Mean activity radius of immature cocks showed a general increase through the summer, fall, and hunting periods (0.11, 0.15, and 0.17 mile, respectively) but the trend was not significant ($P>0.05$) (Tables 5, 6, and 7).

Mean composite activity radius for 19 adult cocks (0.15 mile) was larger than the unweighted mean for the four periods (0.12 mile). Similarly, the mean composite activity radius for 11 immature cocks (0.16 mile) was larger than that for the three periods (0.14 mile).

Home-range Acreage.—A composite home-range acreage was calculated for each bird using all readings from March 16 to the end of hunting. Based on the grid method of calculating home-range acreage, average composite home-range acreage was 53.9 ± 26.4(SD) acres for 19 adult cocks and 54.1 ± 26.8 acres for 11 immature cocks. Home ranges of adult cocks varied from 20.9 acres to 116.6 acres and that for immature cocks from 19.8 to 82.5 acres.

Average home-range acreage of adult cocks was smallest during the spring period, at 13.8 acres (Table 4). This differed ($P<0.05$) from home-range acreage during the summer period, 19.6 acres (Table 5). Mean home-range size of adult cocks did not change significantly through fall (22.5 acres) and hunting periods (19.6 acres) (Tables 6 and 7).

The mean home range of immature cocks was 21.7 acres during the summer period (Table 5). This increased ($P<0.05$) to a maximum size of

25.1 acres during the fall period, but declined to 18.8 acres during the hunting period (Tables 6 and 7).

Home-range acreages calculated using the minimum-area method showed similar seasonal trends, but were generally larger (Tables 4, 5, 6, and 7).

## Seasonal Cover Use

Spring through Hunting Season.—Adult cocks were most frequently found in five cover types between March 15 and the end of hunting season, viz., unpicked corn, residual cover, harvested small grains, woody cover, and idle cover (Table 8). Habitat use differed markedly between seasons. During spring, 80 percent of the readings were in harvested small grains, residual cover, picked corn, uncut alfalfa, and woody cover. During summer, approximately 80 percent of locations were in unpicked corn, idle cover, unharvested small grains, and residual cover. By fall, approximately the same percentage of readings were restricted to only two cover types—unpicked corn and residual cover. This trend continued into the hunting season with residual cover, unpicked corn, and woody cover receiving primary use.

Immature cocks were most frequently found in four cover types from June 16 to the end of the hunting season, viz., unpicked corn, idle cover, residual cover, and woody cover (Table 9). Habitat use by immatures also differed between seasons. Immatures were radio-tracked in summer only in 1972. Approximately 90 percent of locations were in

Table 8. Percentage of locations occurring in each habitat type and habitat selection of adult cocks, 1970-72.

| Cover Types | Spring (Mar. 16-Jun. 15) | | | | Summer (Jun. 16-Aug. 31 | | | | Fall (Sept. 1-Hunt) | | | | Hunt (Hunting Season)[a] | | | | Composite (Mar. 16-Winter) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Exp.[b] | Index[c] | Pct.[d] | Obs. | Exp. | Index | Pct. | Obs. | Exp. | Index | Pct. | Obs. | Exp. | Index | Pct. | Obs. | Exp. | Index | Pct. |
| Unpicked corn | 0 | 70 | 0.00 | 1 | 247 | 170 | 1.45 | 34 | 400 | 167 | 2.39 | 71 | 117 | 65 | 1.80 | 28 | 764 | 472 | 1.61 | 31 |
| Picked corn | 115 | 121 | 0.95 | 15 | 0 | 14 | 0.00 | 1 | | | | | 33 | 59 | 0.55 | 8 | 126 | 194 | 0.64 | 5 |
| Residual cover | 142 | 90 | 1.57 | 18 | 86 | 111 | 0.77 | 12 | 66 | 33 | 2.00 | 11 | 181 | 65 | 2.78 | 44 | 475 | 299 | 1.58 | 19 |
| Unharvested small grain | 8 | 41 | 0.19 | 1 | 111 | 149 | 0.74 | 15 | | | | | | | | | 119 | 190 | 0.62 | 5 |
| Harvested small grain | 184 | 152 | 1.21 | 24 | 2 | 58 | 0.03 | 1 | 8 | 153 | 0.05 | 2 | 7 | 90 | 0.07 | 2 | 201 | 453 | 0.44 | 8 |
| Grazed pasture | 43 | 50 | 0.86 | 5 | 53 | 61 | 0.86 | 7 | 27 | 41 | 0.65 | 5 | 1 | 34 | 0.02 | 1 | 124 | 166 | 0.74 | 5 |
| Uncut alfalfa | 93 | 21 | 4.42 | 12 | 8 | 23 | 0.34 | 1 | | | | | 6 | 21 | 0.28 | 1 | 109 | 77 | 1.41 | 4 |
| Cut alfalfa | 8 | 9 | 0.88 | 1 | 1 | 7 | 0.14 | 1 | 0 | 16 | 0.00 | 1 | 0 | 6 | 0.00 | 1 | 10 | 37 | 0.27 | 1 |
| Woody cover | 83 | 35 | 2.37 | 11 | 3 | 23 | 0.13 | 1 | 18 | 23 | 0.78 | 3 | 56 | 20 | 2.80 | 14 | 160 | 101 | 1.58 | 6 |
| Ditches and fencelines | 25 | 18 | 1.38 | 3 | 32 | 21 | 1.62 | 4 | 14 | 19 | 0.73 | 2 | 2 | 13 | 0.15 | 1 | 73 | 73 | 1.00 | 3 |
| Spoil pits | 20 | 17 | 1.17 | 3 | | | | | | | | | | | | | 21 | 10 | 2.10 | 1 |

Table 8 (continued).

| Cover Types | Spring (Mar. 16-Jun. 15) Obs. | Exp.[b] | Index[c] | Pct.[d] | Summer (Jun. 16-Aug. 31) Obs. | Exp. | Index | Pct. | Fall (Sept. 1-Hunt) Obs. | Exp. | Index | Pct. | Hunt (Hunting Season)[a] Obs. | Exp. | Index | Pct. | Composite (Mar. 16-Winter) Obs. | Exp. | Index | Pct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Summer fallow | 19 | 35 | 0.54 | 3 | 3 | 21 | 0.14 | 1 | 6 | 97 | 0.06 | 1 | 7 | 40 | 0.17 | 2 | 35 | 193 | 0.18 | 1 |
| Sweet clover | | | | | 18 | 7 | 2.57 | 3 | 23 | 8 | 2.87 | 4 | | | | | 44 | 16 | 2.75 | 2 |
| Newly seeded fields | 32 | 116 | 0.27 | 4 | | | | | | | | | | | | | 32 | 116 | 0.27 | 1 |
| Idle cover | | | | | 155 | 70 | 2.21 | 21 | | | | | | | | | 155 | 70 | 2.21 | 8 |
| Chi square values | 436.94(12d.f.) | | | | 295.78(12d.f.) | | | | 632.16(8d.f.) | | | | 486.65(9d.f.) | | | | | | | |

[a]October 16 to November 26, 1971; October 21 to December 17, 1972.

[b]The expected number of fixes in a given cover type was based on the percentage of land that cover type consistuted times the percentage of time available, and assuming random utilization.

[c]Observed divided by expected.

[d]Percent of total fixes occurring in this cover type are in parenthesis. Except for rounding errors, each column totals 100.0.

Table 9. Percentage of locations occurring in each habitat type and habitat selection of immature cocks, 1970-72.

| Cover Type | Summer (Jun. 16-Aug. 31) | | | | Fall (Sep. 1-Hunt) | | | | Hunt (Hunting Season)[a] | | | | Composite (Jun. 16-Dec. 17) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Exp.[b] | Index[c] | Pct.[d] | Obs. | Exp. | Index | Pct. | Obs. | Exp. | Index | Pct. | Obs. | Exp. | Index | Pct. |
| Unpicked corn | 40 | 48 | 0.83 | 19 | 357 | 169 | 2.11 | 79 | 380 | 131 | 290 | 71 | 777 | 348 | 2.23 | 65 |
| Picked corn | 0 | 6 | 0.00 | 1 | | | | | 24 | 70 | 0.34 | 4 | 24 | 74 | 0.32 | 2 |
| Residual corn | 11 | 16 | 0.68 | 5 | 31 | 11 | 2.81 | 7 | 40 | 33 | 1.21 | 8 | 82 | 60 | 1.36 | 7 |
| Unharvested small grains | 34 | 55 | 0.61 | 16 | | | | | | | | | 34 | 55 | 0.61 | 3 |
| Harvested small grains | 5 | 18 | 0.27 | 2 | 25 | 109 | 0.22 | 6 | 10 | 141 | 0.07 | 2 | 40 | 268 | 0.14 | 3 |
| Grazed pasture | 0 | 6 | 0.00 | 1 | 10 | 68 | 0.14 | 2 | 0 | 34 | 0.00 | 1 | 10 | 108 | 0.09 | 1 |
| Uncut alfalfa | 20 | 4 | 5.00 | 10 | | | | | | | | | 20 | 5 | 4.00 | 2 |
| Cut alfalfa | | | | | 2 | 27 | 0.07 | 1 | 6 | 21 | 0.28 | 1 | 10 | 51 | 0.19 | 1 |
| Woody cover | 4 | 7 | 0.57 | 2 | 1 | 14 | 0.07 | 1 | 56 | 14 | 4.00 | 11 | 61 | 35 | 1.74 | 5 |
| Ditches and fencelines | 3 | 6 | 0.50 | 1 | 6 | 14 | 0.42 | 1 | 7 | 13 | 0.53 | 1 | 16 | 33 | 0.48 | 1 |

Table 9 (continued).

| Cover Type | Composite (Jun. 16-Aug. 31) Obs. | Exp.[b] | Index[c] | Pct.[d] | Fall (Sep. 1-Hunt) Obs. | Exp. | Index | Pct. | Hunt (Hunting Season)[a] Obs. | Exp. | Index | Pct. | Composite (Jun. 16-Dec. 17) Obs. | Exp. | Index | Pct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Summer fallow | 0 | 6 | 0.00 | 1 | 3 | 33 | 0.09 | 1 | 4 | 65 | 0.06 | 1 | 7 | 98 | 0.07 | 1 |
| Idle Corn | 89 | 34 | 2.61 | 43 | | | | | | | | | 89 | 36 | 2.72 | 8 |
| Chi Square Value | 191.83(10d.f.) | | | | 369.48(7d.f.) | | | | 857.39(8d.f.) | | | | 1,168.92(11d.f.) | | | |

[a]October 16 to November 28, 1971; October 31 to December 17, 1972.

[b]The expected number of fixes in a given cover type was based on the percentage of land that cover type constituted times the percentage of time available, and assuming random utilization.

[c]Observed divdied by expected.

[d]Percent of total fixes occurring in this cover type are in parenthesis. Except for rounding errors, each column totals 100.0.

idle cover, unpicked corn, unharvested small grains, and uncut alfalfa. During the fall period in 1971 and 1972, approximately the same percentage of readings occurred in only three cover types—unpicked corn, residual cover, and harvested small grains. During the hunting season, approximately 90 percent of the birds were located in unpicked corn, woody cover, and residual cover (Table 9).

Because all cover types were not of equal acreage or available for equal lengths of time, actual cover preferences were better revealed by index values calculated by comparing observed number of fixes in a cover type with expected number of fixes in that cover type.

Index values indicated that adult cocks selectively utilized eight cover types from March 16 to the end of the hunting season. Listed in order of decreasing index values, these were: sweet clover, idle cover, spoil pits, unpicked corn, residual cover, woody cover, and uncut alfalfa. Adult cocks showed an apparent avoidance (fewer readings than would have been expected by chance) of picked corn, unharvested and harvested small grains, grazed pasture, cut alfalfa, summer fallow, and newly seeded fields. An index value indicating neither preference nor avoidance, was calculated for ditches and fencelines for the entire period (Table 8).

Index values also indicated seasonal differences in selection of cover types (Table 8). During spring, adult cocks selected for six different cover types. Ranked in order of index values these were: (1) uncut alfalfa, (2) woody cover, (3) residual cover, (4) ditches and fencelines, (5) harvested small grains, and (6) spoil pits. During summer, preferential use was made of idle cover, unpicked corn, sweet clover, ditches, and fencelines. In fall, unpicked corn, sweet clover, and residual cover were preferred. Adult cocks selected residual cover, woody cover, and unpicked corn during the hunting season. Index values indicated that immature cocks selectively utilized five cover types from June 16 to the end of the hunting season. Listed in order of decreasing index values, these were: uncut alfalfa, idle cover, unpicked corn, woody cover, and residual cover. Immature cocks tended to avoid picked corn, unharvested and harvested small grains, grazed pasture, cut alfalfa, ditches and fencelines, spoil pits, summer fallow, sweet clover, and newly seeded fields (Table 9).

Immature cocks also showed a seasonal change in habitat preferences. In summer, idle cover and uncut alfalfa were preferred. In the fall, use was made principally of unpicked corn and residual cover. Unpicked corn, residual cover, and woody cover were preferred through the hunting season (Table 9).

Winter Period.—Because of transmitter failure and movement of birds off the study area, few data were gathered during winter months. Due to small sample size (7 cocks, 242 readings), data for this period were analyzed separately.

For adult cocks, the mean major-axis length, activity radius, and home-range acreage was 0.62 mile, 0.20 mile, and 15.7 acres, respectively. For immature cocks, comparable values were 0.41 mile, 0.18 mile and 12.9 acres (Table 10).

For three adult cocks monitored during the winter period, 57 percent of the fixes were in picked corn, 25 percent in residual cover, 10 percent in woody cover, and the remaining 8 percent in small-grain stubble and summer fallow. Among four immature cocks, 53 percent of the locations were in picked corn, 19 percent in woody cover, 18 percent in residual cover, and the remaining 10 percent distributed between harvested small grains, ditches and fencelines, and summer fallow (Table 11).

Index values indicated that adult cocks selectively utilized picked corn, woody cover, and residual cover and showed an apparent avoidance for summer fallow and harvested small grains. For immature cocks, index values indicated a selection for woody cover, residual cover, and picked corn and avoidance of hay and small-grain stubble and summer fallow (Table 11).

Table 10. Biweekly home-range size and activity parameters of pheasant cocks, winter period, 1970-72.

| Dates | Number of Birds | Number of Readings | Major Axis (miles) | Activity Radius (miles) | Home Range (Acres) Grid System | Home Range (Acres) Minimum Mean |
|---|---|---|---|---|---|---|
| Adults | | | | | | |
| Dec. 1-15 | 1 | 12 | 0.82 | 0.35 | 13.2 | 13.2 |
| Dec. 16-31 | 2 | 50 | 0.70 | 0.19 | 19.8 | 30.1 |
| Jan. 1-15 | 1 | 19 | 0.58 | 0.18 | 17.6 | 41.5 |
| Mar. 1-15 | 1 | 17 | 0.38 | 0.09 | 12.1 | 4.8 |
| Mean (N=3) | | | 0.62 | 0.20 | 15.7 | 22.4 |
| Standard deviation | | | 0.19 | 0.11 | 3.6 | 16.5 |
| Immatures | | | | | | |
| Dec. 16-31 | 3 | 47 | 0.43 | 0.28 | 13.6 | 10.6 |
| Jan. 1-15 | 2 | 40 | 0.35 | 0.09 | 9.4 | 8.6 |
| Jan. 16-31 | 3 | 47 | 0.38 | 0.20 | 12.1 | 26.0 |
| Feb. 1-15 | 1 | 20 | 0.46 | 0.16 | 16.5 | 8.9 |
| Mean (N=4) | | | 0.41 | 0.18 | 12.9 | 13.5 |
| Standard deviation | | | 0.05 | 0.08 | 2.9 | 8.4 |

Table 11. Percentage of locations occurring in each habitat type and habitat selection of pheasant cocks, winter period, 1970-72.

| Cover Type | Adults | | | | Immatures | | | | Age Classes Combined | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Exp.[a] | Index[b] | Pct.[c] | Obs. | Exp. | Index | Pct. | Obs. | Exp. | Index | Pct. |
| Picked corn | 57 | 36 | 1.58 | 57 | 69 | 27 | 2.55 | 53 | 126 | 63 | 2.00 | 55 |
| Residual cover | 25 | 14 | 1.78 | 25 | 23 | 18 | 1.27 | 18 | 48 | 32 | 1.50 | 21 |
| Harvested small grains | 0 | 14 | 0.00 | 7 | 7 | 40 | 0.17 | 6 | 7 | 54 | 0.12 | 3 |
| Cut alfalfa | | | | | 0 | 6 | 0.00 | 1 | 7 | 13 | 0.53 | 3 |
| Woody cover | 8 | 6 | 1.33 | 10 | 25 | 5 | 5.00 | 19 | 33 | 11 | 3.00 | 15 |
| Summer fallow | 1 | 7 | 0.14 | 1 | 4 | 30 | 0.13 | 3 | 5 | 37 | 0.13 | 2 |
| Chi square value | 40.69(4d.f.) | | | | 202.37(5d.f.) | | | | 186.33(5d.f.) | | | |

[a]The expected number of fixes in a given cover type was based on the percentage of land area that cover time constituted times percentage of time available, and assuming random utilization.

[b]Observed divided by expected.

[c]Percent of total fixes occurring in this cover type are in parenthesis. Except for rounding errors, each column totals 100.0.

When data for adults and immatures were combined for the period, index values indicated that picked corn, woody cover, and residual cover were preferentially used, whereas small grain stubble, hay stubble, and summer fallow were avoided (Table 11).

# DISCUSSION AND CONCLUSIONS

## Activity Parameters and Home Ranges

Seasonal movements up to 10 miles between winter and summer range have been reported for pheasant cocks in South Dakota (Kimball 1949). Once a cock becomes established in an area, however, he tends to become much more sedentary. The mean major-axis length of adult cocks in the present study from spring through the hunting season was less than 1.0 mile. The mean home-range size of adult cocks during this period was less than 60 acres. Comparable statistics for immature cocks were somewhat larger—1.12 miles and 54.1 acres—but movement was still confined to a relatively small area. When examined for individual seasons, these movement parameters were even smaller. For example, home-range size of bird No. 522 during summer (B) was 21.6 acres with a major-axis length of 0.6 mile (Fig. 1), but his composite (March 16 to the end of hunting) home-range acreage and major-axis length were 116.6 acres and 1.49 mile, respectively. From these data, it would appear that pheasants can be managed on relatively small tracts of land. Just what the minimum size might be is difficult to say. On my study area, pheasant cocks seemed to satisfy their basic habitat requirements on areas of 100 acres or less from spring through hunting season. Management areas of this size could apparently attract and support pheasant cocks in an agricultural area.

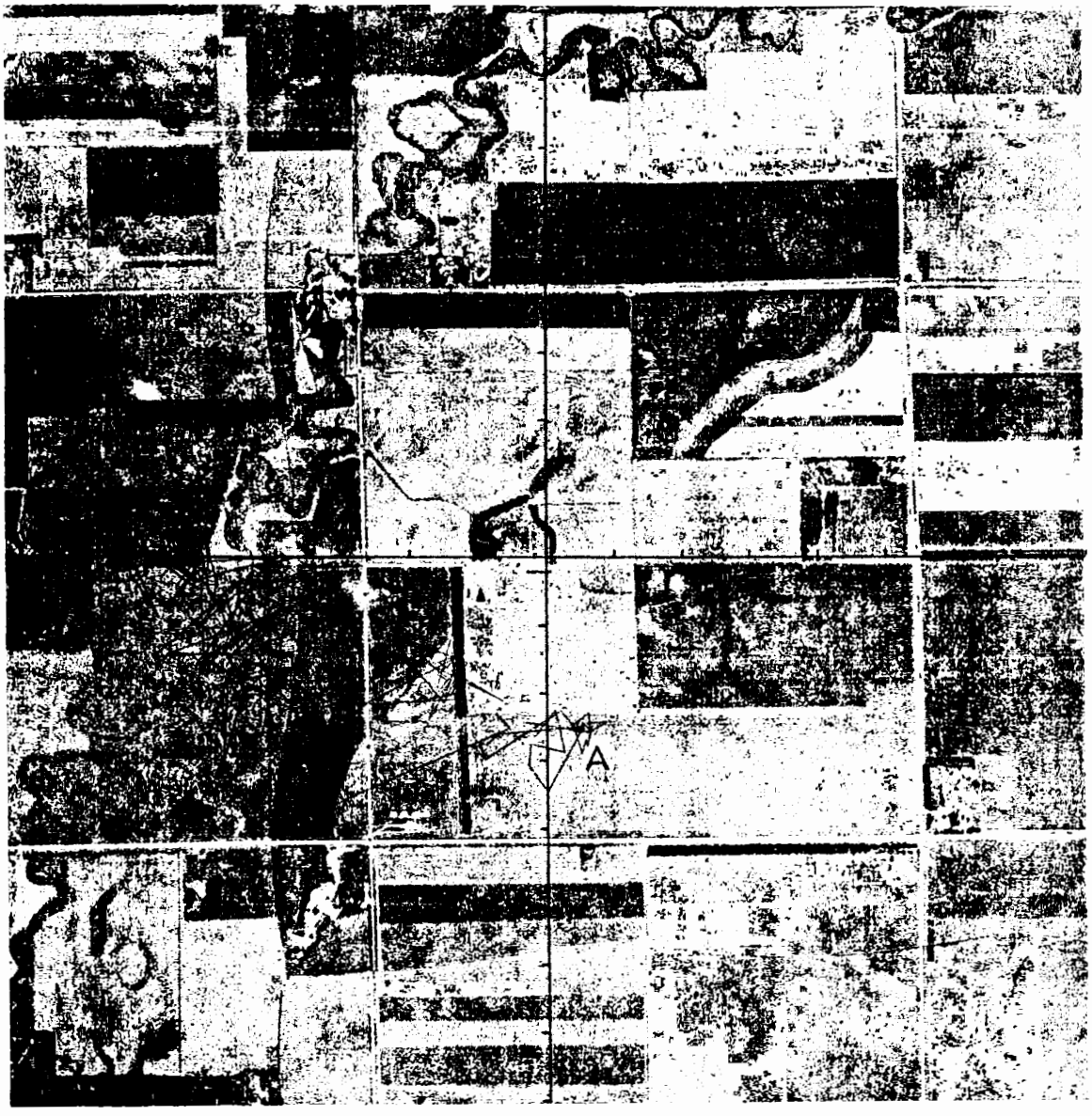


Fig. 1. Movements of cock No. 522 showing seasonal shifts in activity center.

In the present study, pheasant cocks did shift their activity centers and increase or decrease their rate of mobility throughout the year. Cocks moved about their seasonal home range by frequently shifting their activity center as the season progressed. For example, a map of all locations for bird No. 522 (Fig. 1) shows a seasonal shift in activity centers probably relating to changes in cover availability due to farming activities. This bird was first captured on March 19, 1971, in a 100-acre rye field (A) where he defended a territory. When the field of residual cover was plowed on April 28 he moved approximately 200 yards west and established another territory in an uncut alfalfa field and shelterbelt. He was monitored in this area until the transmitter failed on May 20. The bird was recaptured on July 18, 1972, in residual cover within 100 yards of the area he defended in spring, 1971. After being captured he moved 0.25 mile across a road into a 100-acre field of idle cover (B). He remained in this field almost exclusively until it was plowed August 21. He then moved northwest into a complex of residual cover and unpicked corn (C), feeding in unpicked corn during the day and roosting in residual cover at night. Bird No. 522 remained in this area into the hunting season, making occasional forays back to the area he defended in spring, 1971. The transmitter failed on October 30.

Although birds frequently shifted their activity centers, the average distance traveled from the activity center remained relatively

constant. The mean activity radius changed significantly ($P<0.05$) only between summer and fall periods among adult cocks and did not vary significantly among immature cocks between any periods (Tables 5, 6, and 7). Apparently cocks have a relatively constant cruising radius from March 16 to the end of hunting season. Population shifts on my study area during this period occurred through a series of short-distance "shuffles" rather than long, direct movements.

Spring was the period of most restricted movement of adult cocks; average home-range size and major-axis length were 13.8 acres and 0.41 mile (Table 4). Carter (1971) reported an average home-range size of 12 acres during breeding season. In Wisconsin, Burger (1966) mapped the size of 63 cock territories and observed a range of 1.2 to 9.8 acres in 1956 and 1.2 to 6.2 acres in 1957. He attributed difference in size of home range to population density, with smaller territories occurring at higher population densities—4.6 and 7.2 crowing cocks per 100 acres in 1956 and 1957. Territory sizes in South Dakota were considerably larger, but breeding densities were much lower—3.3 and 1.4 crowing cocks per 100 acres in 1971 and 1972, respectively. No significant change in territory size was noted between 1971 and 1972.

After breeding season, adult cocks tended to become more mobile. An increase ($P<0.05$) in both home-range size and major-axis length was observed during the summer months (Table 5). Hanson (1971) reported a similar increase for hens during this period. Major-axis length

remained relatively constant throughout fall and hunting periods at 0.57 and 0.53 mile, respectively (Tables 6 and 7).

The major-axis length of immature cocks increased from 0.56 mile in summer to a peak of 0.79 mile in fall, subsequently declining to 0.56 mile during hunting season (Tables 5, 6, and 7). Apparently immature cocks become more active during late-summer and early fall months as brood structure broke down and they became progressively more independent. The "fall-shuffle" is apparently more pronounced among immature birds that have not yet developed a site attachment as have adult cocks. Similar results have been reported for ruffed grouse (Bonasa umbellus) (Chambers and Sharp 1958, Hale and Dorney 1963) and prairie chickens (Tympanuchus cupido) (Robel et al. 1970). This period of greater mobility of immature cocks immediately prior to and during the opening of hunting season could increase their vulnerability to the gun, perhaps contributing to a higher rate of shooting mortality of immature cocks.

Home-range size of adult cocks did not vary significantly ($P>.05$) through summer, fall, and hunting periods (Tables 5, 6, and 7). Mean home-range sizes of immature cocks were larger than those of adult cocks during summer and fall periods, but were smaller during the hunting period. This trend paralleled observed changes in major-axis length (Fig. 2). The mean home-range acreage for individual periods of both immature and adult cocks was smaller than the composite

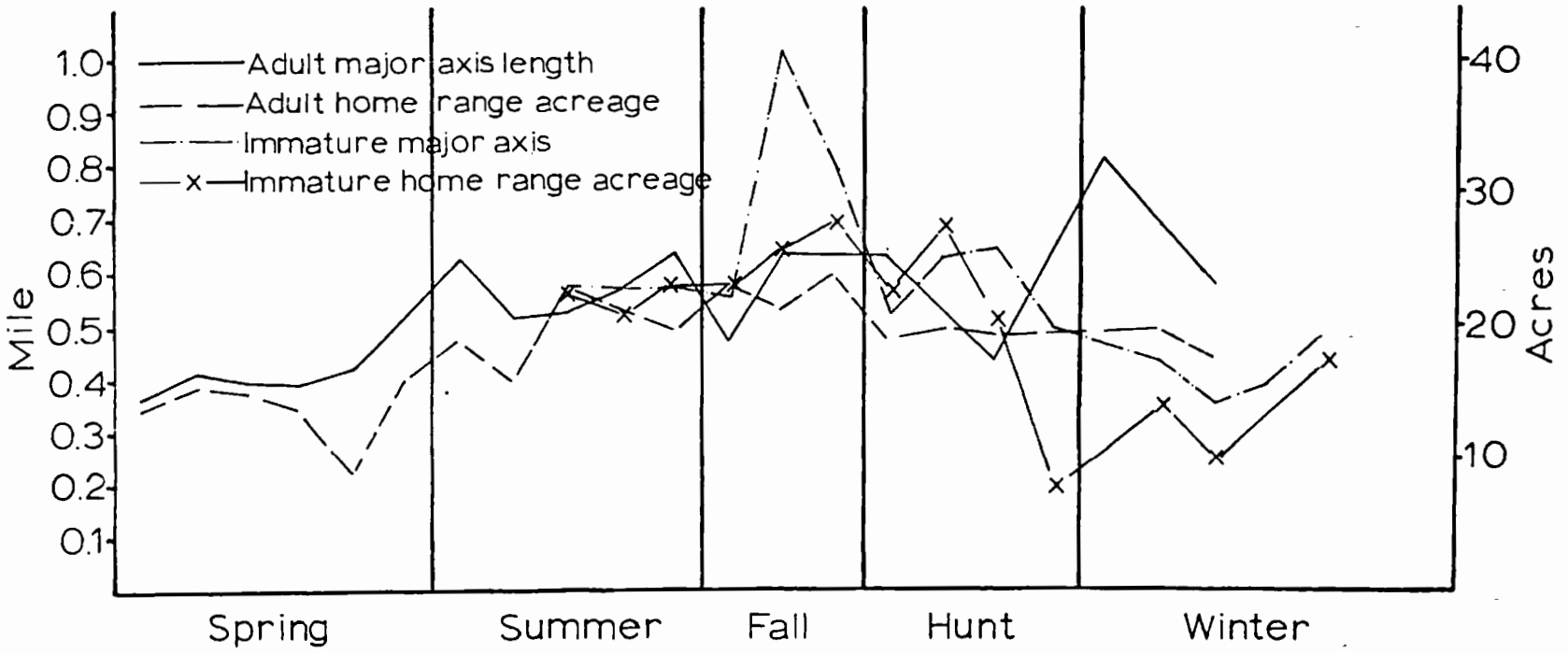


Fig. 2. Seasonal change in home-range acreage and major-axis length for adult and immature cocks.

home-range acreage. This again seems to indicate that a pheasant cock periodically shifts its activity center, not utilizing its entire seasonal home range at any one period of time.

Habitat Use

Analysis of cover use was quantitative rather than qualitative. The number of locations per cover type, without considering the quality of cover, was used to calculate index values to reflect preference or avoidance.

Adult cocks demonstrated a marked seasonal cover preference. Use of agricultural crops varied in response to crop development and farming practices (Table 8). Unpicked corn was highly preferred throughout summer, fall, and hunting periods, but picked corn was avoided in both spring and hunting periods. Unharvested small grain constituted a considerable percentage of the study area, but was avoided. Harvested small grain was selectively used in spring, but was avoided in summer, fall, and hunt periods. Uncut alfalfa was highly preferred in spring, but was avoided throughout the remaining three periods. Cut alfalfa was used less than expected throughout all four periods. Summer fallow and newly seeded fields were always avoided.

Use of permanent cover by adult cocks varied with the season (Table 8). Residual cover was heavily preferred throughout the study, being utilized less than expected only during summer months. Woody cover was preferentially used during spring and hunting periods, but

was used less than expected through milder seasons. Ditches and fencelines were preferred in spring and summer months and spoil pits only in spring. Grazed pasture was avoided at all seasons.

Two other cover types, idle cover and sweet clover, were heavily utilized. Preference was shifted from both agricultural crops and permanent cover to these cover types when they were available during summer (Table 8).

Patterns of cover use by immature cocks were similar to that of adults (Table 9). Idle cover and uncut alfalfa were selected in summer, but use was shifted to unpicked corn and residual cover in fall. During hunting season, unpicked corn and woody cover were preferentially used.

Land-use patterns characteristic of prime pheasant range in the Great Plains and Prairie Region typically have 50-75 percent of the land area under cultivation (Kimball et al. 1956). In this study it appeared that a combination of agricultural land and residual cover met basic habitat requirements of pheasant cocks. Fifty percent of all readings were in unpicked corn and residual cover. The habitat-preference index indicated high overall preference for these cover types. The importance of residual cover to pheasant populations has long been recognized. Pheasant populations have generally decreased in South Dakota with more intensive agriculture and loss of residual cover, except during the Soil Bank era (Dahlgren 1963).

Residual cover is a vitally important but diminishing cover type. Other cover types in this study were utilized less, or were preferred for shorter periods of time, but may nevertheless offer management possibilities for the cock segment of the population.

Woody cover constituted only 3 percent of the study area and was selectively used only during spring and hunting periods (Table 8). Woody cover was present in 9 of 11 territories in the spring and in 9 of 12 home ranges during hunting. The habitat preference index indicated a high rate of selection for this cover type in both periods. Because cocks apparently select this cover type in spring, woody cover could be important in cock dispersal and distribution of crowing territories. Wight (1945) reported that brush or trees formed an essential part of territories for cocks in Michigan. The distribution of woody cover in an area could affect the size of the territorial cock population, and hence the breeding population of that area. Woody cover was not used extensively through summer and fall periods, but was again selected during hunting season. Underharvest of cocks is one of the problems of pheasant management in South Dakota (Dahlgren 1967); woody cover could serve to concentrate birds and hunting effort to increase hunting success. Lyon (1961) reported that for an underharvested population in Colorado, pheasant hunting could be significantly improved by woody cover.

In 1972, approximately 129 acres on the study area were retired under the U. S. Department of Agriculture Feed Grain Program. These

acres had been planted to corn during the 1971 growing season and consisted of picked cornfields in spring, 1972. Due to a late and wet spring, the farm manager did not work these fields until the last week of June when they were disked in an effort to control weeds. Weeds were well established by this time, however, and control was poor. These fields were dominated by annual weeds until they were plowed in August. While these idle fields were available, 21 percent of the locations of adult cocks (Table 8) and 43 percent of the locations of immature cocks (Table 9) occurred in this cover type. The habitat preference index indicated a high rate of selection for this cover type over other available agricultural crops by both adult and immature cocks. In this case, a highly preferred cover type was established on land retired under a 1-year contract when it was left undisturbed throughout the major part of the growing season. Perhaps annual weed control laws should be reviewed, keeping in mind present farming practices, the cost of control, and in this case, wildlife benefits.

During spring months, six cover types had a positive use-index value, indicating preferential use by cock pheasants (Table 9). For three of these cover types—uncut alfalfa, harvested small grains, and spoil pits—this was the only period in which adult cocks exhibited a positive selection. The other three, woody cover, residual cover, and ditches and fencelines, were preferentially used during other periods. Harvested small grains occurred in 9 of 11 territories during spring

and had a positive use-index value. This cover type was avoided throughout the remainder of the year. Use of these areas was apparently associated with breeding activity. Burger (1966) found that in his study all territories contained areas either barren of vegetation or with short herbaceous cover throughout spring. Hanson and Progulske (1973) indicated the importance of uncut alfalfa for nesting and brood rearing. Immature cocks selected for this cover type in the summer (Table 5). Adult cocks selected for this cover type in the spring (Table 4), but use decreased when it was disturbed by farming activities at other times. Apparently a greater diversity of habitat is required in spring than at other times. Burger (1966) also reported that territorial cocks selected a variety of cover types. Spring is a time of minimum food availability and the only season in which cocks require open ground for courtship and display. Areas managed for pheasants should have diverse cover, especially during spring.

Winter Period

The activity radius of immature cocks in winter was larger than for other periods, but the mean major-axis distance and home-range acreage were smallest of the five periods (Table 10). Similarly, the mean activity radius for adult cocks was larger during winter than any other period, and only home-range acreage during the spring period was smaller. The mean major-axis length for adult cocks during winter was larger than means of other periods. This apparent discrepancy could be

a result of a change in home range shape or greater mobility, but was more likely the result of a small sample size (3 birds, 88 readings). Based on available evidence, it appears that during winter months pheasant cocks tend to use smaller areas more intensively.

This apparent change in movement behavior has some implications for distribution of winter cover. A pheasant apparently does not shift its activity center as frequently during winter months as during other periods. Once a pheasant moves into a wintering area it tends to use a relatively small area more intensively. If habitat of a wintering area is inadequate to provide for a bird the entire winter, it may be forced to range farther or to shift its activity center more often. In agricultural areas, perhaps a "cluster" of preferred wintering areas in a township would be more beneficial than several wintering areas scattered throughout.

Adult and immature cocks preferred to use picked corn, woody cover, and residual cover during winter months (Table 11). Close proximity of these cover types could enhance over-winter survival.

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