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Movements and Habitat Use By Hen Pheasants During Brood Rearing

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MOVEMENTS AND HABITAT USE BY HEN PHEASANTS DURING BROOD REARING

BY

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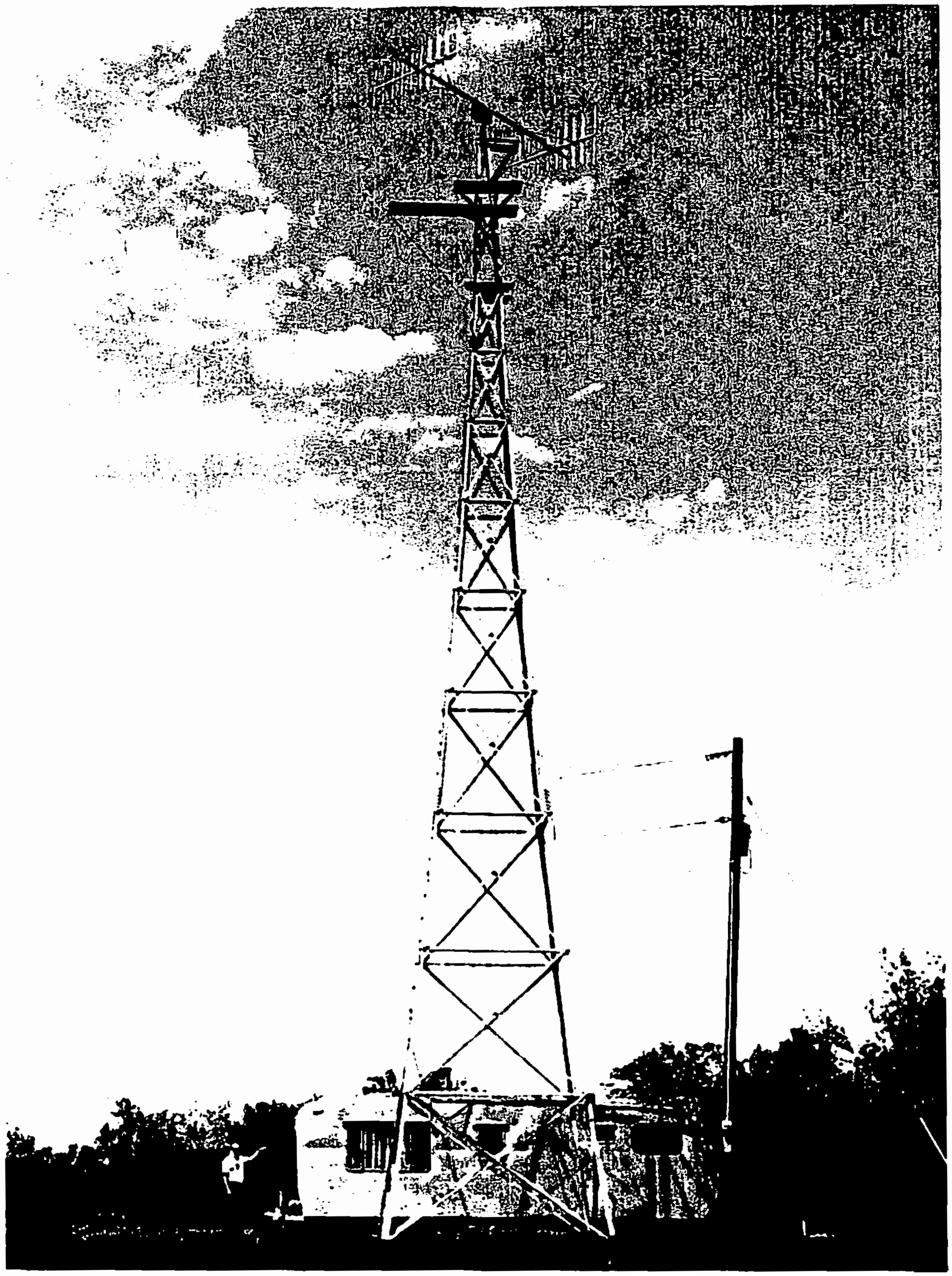

Frontispiece. Permanent receiving station used to radio-track pheasants

MOVEMENTS AND HABITAT USE OF HEN

PHEASANTS DURING BROOD-REARING

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.

Thesis Advisor Date

Head, Wildlife and Fisheries Sciences Department Date

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INTRODUCTION

Land-use patterns characteristic of prime pheasant range in the Great Plains and prairie region have 50-75 percent of the land under cultivation according to Kimball et al. (1956). Farmland is pheasant habitat, and the production of pheasants is therefore greatly influenced by farming practices.

Considerable research has been done on rates of pheasant production, nest success, and cover preferences for nesting. However, little information has been obtained on movements and cover preferences for brood rearing. Most studies of the type of cover utilized by pheasant broods have been based on roadside and random field observations. Kozicky and Hendrickson (1951) carried out studies of the type of cover used by broods in Iowa. Hammer (1965) in Nebraska established random transects in various cover types to determine cover utilization by pheasant broods. Linder and Agee (1965) also studied cover for nesting and brood rearing in Nebraska.

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 detailed information in activities and movements of many species. Trautman and Dahlgren (1965) indicated that population levels were determined by survival of the young as well as hatching success. Hessler (1968) used biotelemetry techniques to study mortality of juvenile pheasants released in natural conditions. Kuck et al. (1970) reported on movements and behavior of hen pheasants during the nesting season. Carter (1971) discussed seasonal movements and hunting recoveries. Because little is known about cover preferences and movements of the hen and brood after nesting, the objectives of this study were:

1. To determine activity trends and movements of hens and broods on a typical agricultural landscape; and
2. To determine cover preferences for various components of farmland habitat at different periods following nesting.

DESCRIPTION OF STUDY AREA

Field studies were conducted on a private farm (W 1/2 and SE 1/4 of Section 22 and SE 1/4 of Section 21, Township 110 N, Range 49 W) 3 miles east of Brookings, in eastcentral South Dakota. This 640-acre area was selected because its land use is typical of the area and because of its proximity to South Dakota State University. Access rights and a site for erection of a permanent receiving station were leased from the landowner.

Climate of the area is continental. South Dakota State University Experiment Station weather recording facilities located several miles west of the study area provided data. Temperatures vary between -20 F and 110 F. Average annual precipitation is 20 inches, of which 80 percent falls during the growing season (U.S. Weather Service, Brookings, S. D.).

Topography of the area is flat to gently sloping. There are no closed depressions or wetlands on the area, with all runoff eventually draining into the Big Sioux River via the Deer Creek watershed. Soils are mostly fine-textured loams and sandy loams (Westen et al. 1959).

Agriculture is the main source of income for the area, with corn the principal crop. About 80 percent of the 640-acre area is under rotation cultivation, 14 percent is in pasture and haylands, and about 6 percent is in shelterbelts, farmsteads and waste areas (Table 1).

The proportion of different cover types and their location varied somewhat during the study (Figs. 1 and 2). The 100-acre

Table 1. General land use on farm study area, 1969 and 1970.

	1969		1970	
Cover Type	Acres	Percent of Total	Acres	Percent of Total
Corn	188	29	205	32
Small Grain	158	25	155	24
Residual Cover[a]	122	19	126	20
Pasture	56	9	56	9
Summer Fallow	41	6	34	5
Alfalfa	37	6	26	4
Shelterbelt & Farmstead	17	3	17	3
Ditches[b]	16	2	16	2
Spoil Pits	4	1	5	1
Totals	640	100	640	100

[a] Second-growth vegetation or undisturbed from previous year.

[b] Includes road and drainage ditches.

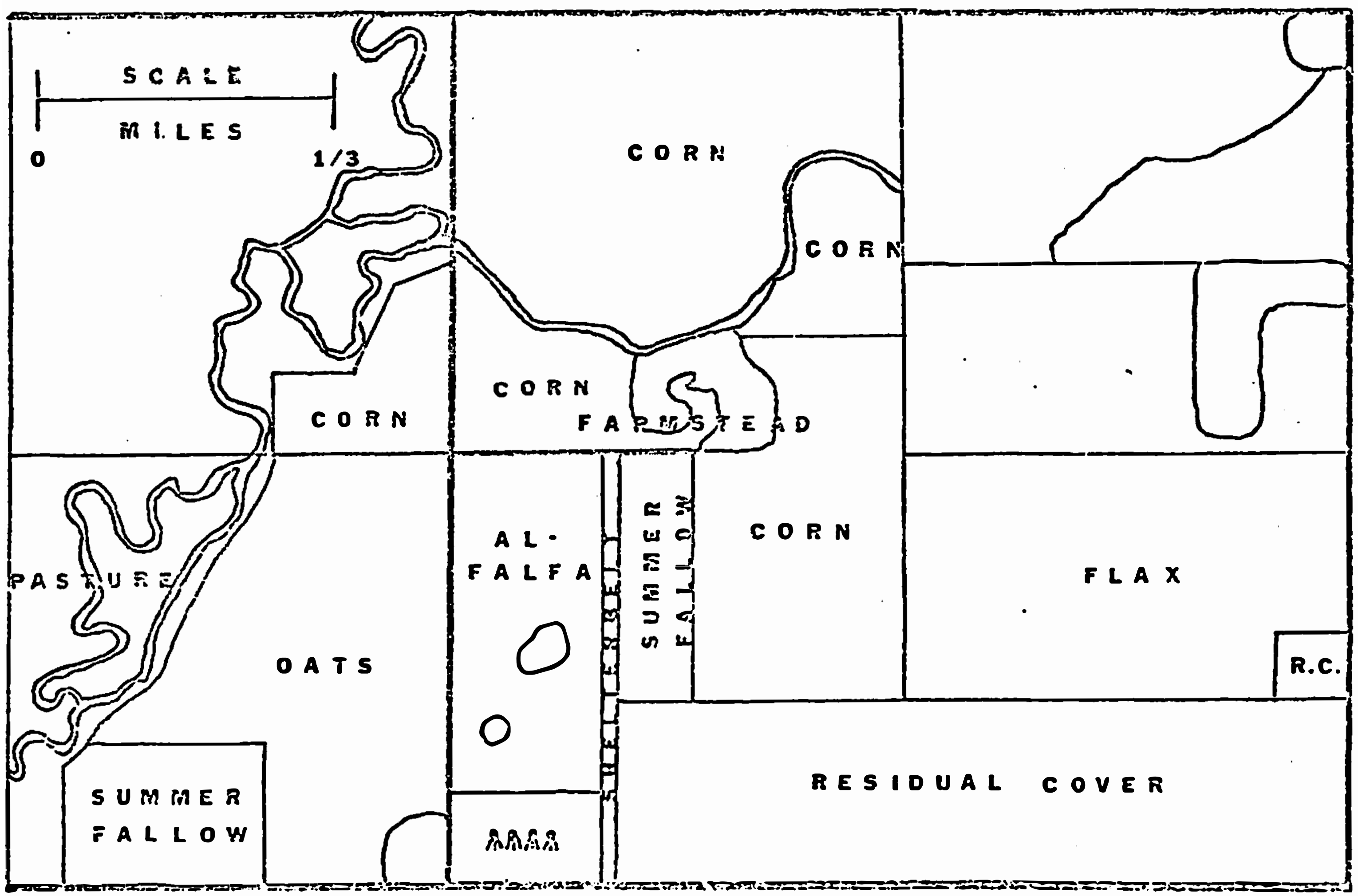

Figure 1. Distribution of major habitat types on study area, 1969.

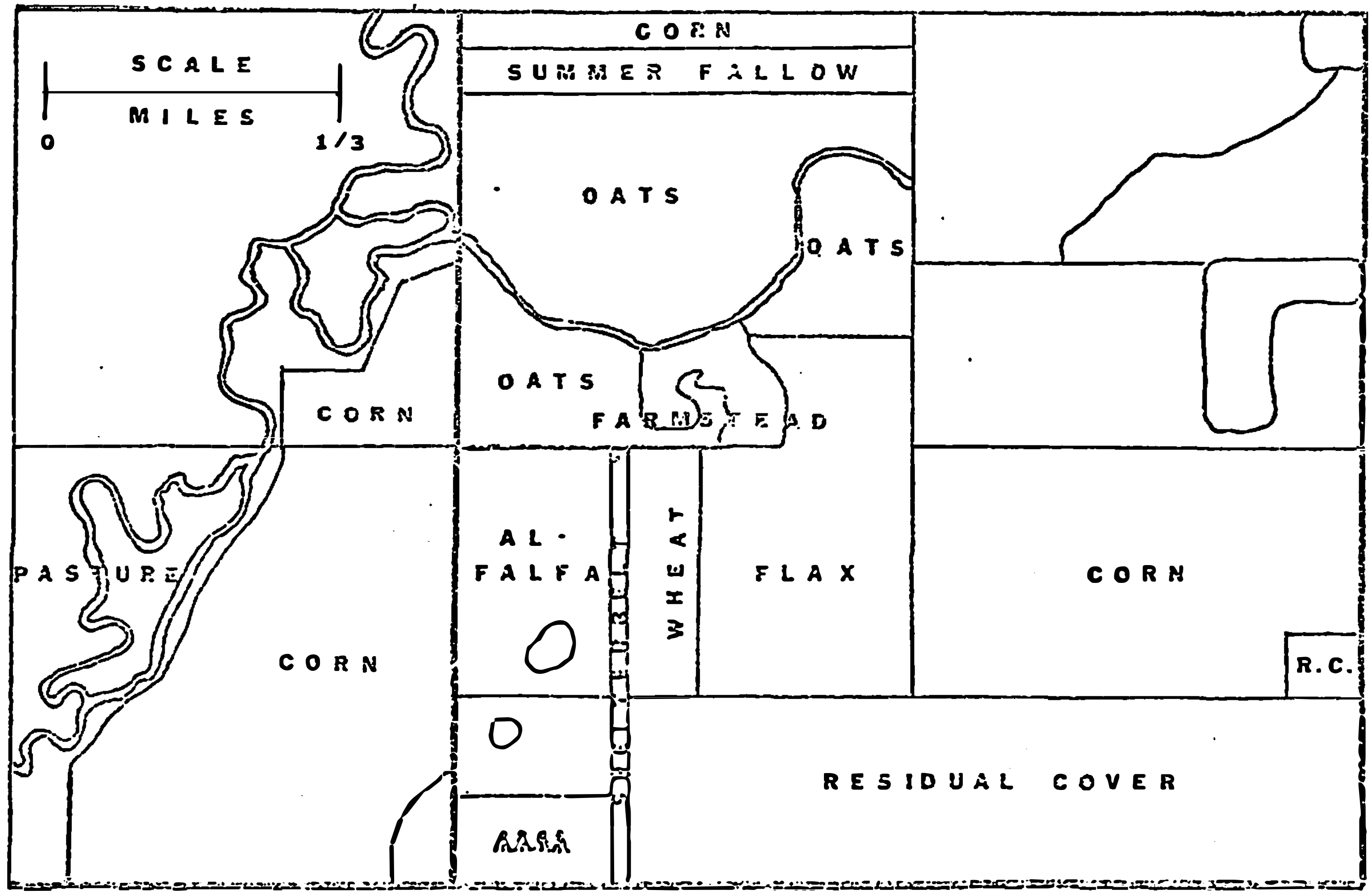

Figure 2. Distribution of major habitat types on study area, 1970.

field of second growth rye was retired from crop production under the U.S.D.A. Feed Grain Program, in both 1969 and 1970. Approximately 60 percent of the study area consisted of potential nesting and brood-rearing cover for pheasants, while the remainder consisted of corn fields, shelterbelts, and summer fallow.

METHODS AND MATERIALS

Capturing Birds for Marking

Several methods of nightlighting were used to capture pheasants. A pickup-truck was fitted with a car-top carrier containing mounts for flood lights (Labisky 1968). This unit was systematically driven through areas where pheasants were believed to be roosting. A crew of two to four men was needed for ideal operation. Nightlighting on foot in roosting cover inaccessable to vehicle travel was accomplished by a back-pack generator similar to that described by Drewien et al. (1967). Large hoop nets (30" dia.) on 10-foot handles were used to capture the birds.

In August and September when hens and broods roosted in close proximity, the backpack and the vehicle units were used together. When a brood was sighted, the person wearing the flood-light unit walked in expanding concentric circles around the vehicle until the area was thoroughly searched. The majority of birds was captured in retired cropland and residual vegetation.

Marking Systems

All birds captured were marked with sequentially numbered butt-end aluminum leg bands. Backtags and radio-transmitters were used to identify individual birds without recapturing them. Backtags and/or radio transmitters were placed only on birds at least 7 weeks of age.

Backtags were made of a vinyl upholstery material (U.S. Naugahyde), and were similar to those described by Labisky and Mann (1962). Numbers, letters, and various geometric designs were used to label the tags. Transmitters and backtags were placed in a dorsal position and slightly posterior to the base of the wings. Initially, a 1/4-inch strip of elastic sewing braid was used for attachment of the transmitters because it was flexible and would accommodate the growth of younger birds. However, abrasion against the wing caused the loss of several transmitters and backtags. Cured buckskin strips were most suitable for attachment. Small, brightly colored pieces of Naugahyde were attached to each transmitter to aid the retrieval of lost transmitters or of dead birds in heavy cover.

Previous telemetry studies of pheasants by Hessler (1968), Kuck et al. (1970), and Carter (1971) indicated no adverse effects of radio-equipping on pheasant behavior and movement. In this study, no recaptured birds showed evidence of physical hindrance by the transmitters. Slight abrasion occurred under the wings of some birds, but appeared to have little effect. Radio-equipped birds carried out normal breeding activities, nested, and cared for broods without notable sign of transmitter interference.

Locating Radio-tagged Birds

The radio-tracking system (Fig. 3) consisted of transmitters, a stationary semiautomatic receiving station (Frontispiece), a mobile receiving unit, and hand-held unit as described by Kuck (1968). The

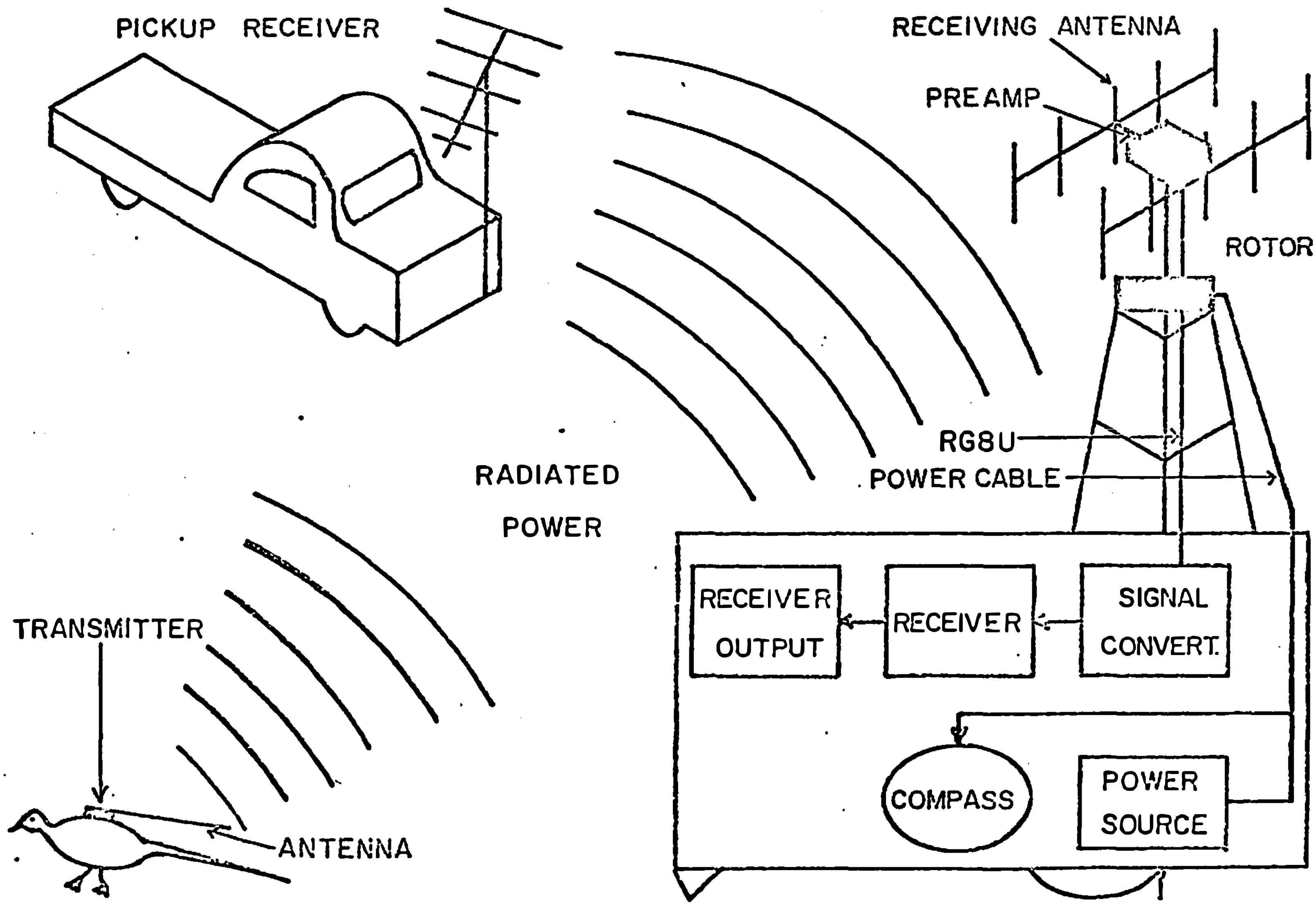

Figure 3. Functional diagram of radio-telemetry system used during the study.

stationary receiving system was developed by the Electrical Engineering Department of SDSU.

Transmitters had a continuous signal with an omnidirectional whip antenna constructed of piano wire. Each transmitter operated on a separate frequency in the range of 151.0 - 151.1 megahertz (MHz) and was composed of 10 electrical components on a printed circuit board (Fig. 4) plus a certified mercury heart cell (Mallory RM-CC1W-T2). Potential power of the certified cells was 1,000 milliamp hours (mA). The estimated life of the cell was 90 to 100 days. Each unit was encapsulated in silicon resin (General Electric, RTV) and weighed 25 to 26 grams.

Two 10-element yagi receiving antennas at the central station were phased so that when aimed directly at the signal, they gave signal cancellation, which created a null. The antenna mast, mounted on a rotating shaft, was located on a 70-foot steel tower. Continuous rotation of the antenna in either direction was accomplished by an electrically driven rotator system (Telrex). A 27-foot air-conditioned trailer at the base of the tower provided uniform atmospheric conditions for the receiving equipment and control console.

Portable directional antennas were mounted on 20- and 30-foot masts located in areas where pheasants were concentrated. A directional yagi antenna atop a 15-foot swing-down mast was mounted on a pickup truck for the mobile unit. A hand-held directional antenna was used where the mobile unit could not travel or to flush birds to

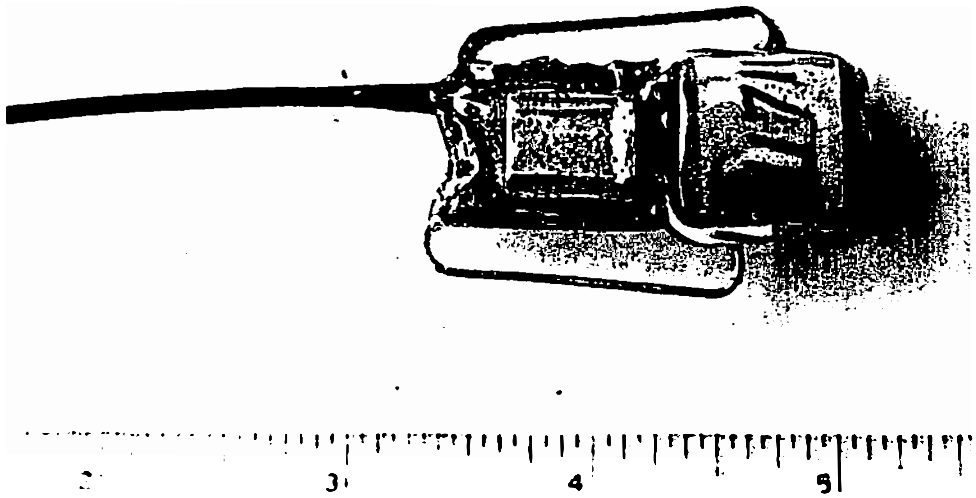

Figure 4. Continuous wave transmitter with an omnidirectional whip antenna.

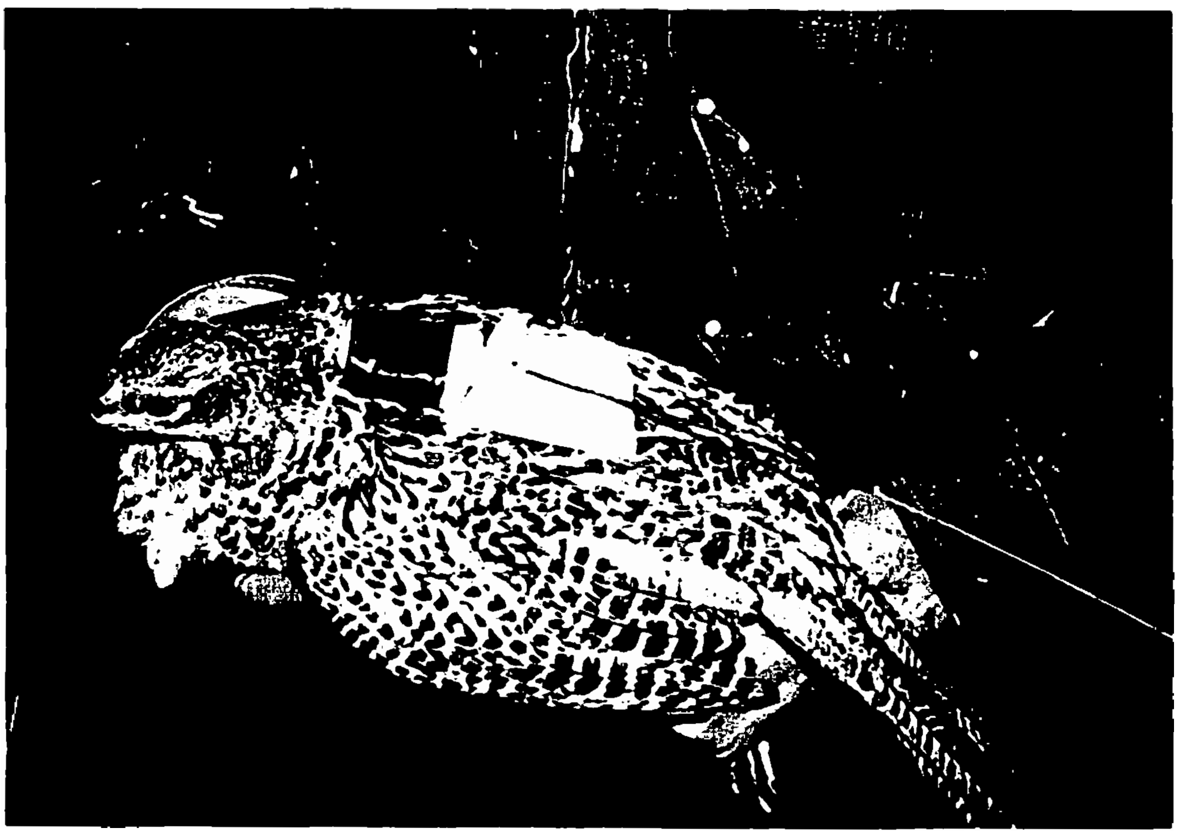

Figure 5. Complete transmitter package attached to pheasant hen.

determine their condition. The receiver used in all cases was a 6-channel, superheterodyne crystal receiver manufactured by Sidney L. Markusen, Esko, Minnesota.

Incoming signals were picked up at the central receiving station antenna and passed to a low-noise antenna preamplifier (1 MHz bandwidth) with a power gain of 50 decibels. A large coaxial cable (RG8U) minimized power loss in conducting the signal from the antenna preamplifier to a frequency converter in the station trailer. The converter changed the signal from 151 MHz to 1 MHz. After conversion, the signal was received on a commercial 4-band receiver (National NC109) with an upper frequency capability of 20 MHz. A beat frequency oscillator (BFO) in the receiver made it possible to detect a radio-equipped bird by listening for an audio tone on an auxiliary speaker.

Radio-equipped birds were located by taking simultaneous fixes from two different locations (Fig. 3), using either the central receiving station and one portable antenna, or several combinations of portable antennas and the mobile unit. Two-way radio receivers were used to obtain simultaneous bearings on the radio-equipped birds.

Marshall and Kupa (1963) and Slade et al. (1965) described procedures for determining azimuths from a series of directional yagi antennas. Azimuth is defined as a horizontal angle measured clockwise from a base direction. The azimuth of radio-equipped birds from the central receiving station was determined by a Telrex rotation indicator. By listening to the receiver and rotating the antenna, the signal was monitored. At the null point, the compass dial indicated the azimuth of the bird. Azimuths from portable directional antennas were based on audio interpretation of the transmitter signal. By rotating the antenna either direction from the maximum intensity of signal, two null points were determined. The arc between these points was halved to obtain the signal azimuth.

Heezen and Tester (1967:127) defined system error as the "... angle between the system-determined bearing and the true bearing of the animal." Cochran et al. (1965) indicated that increased distance of the radio-equipped animal from the receiver would result in increased location error. Other reported sources of error include reading and recording the bearings (Heezen and Tester 1967), antenna misalignment, and bird movement (Kuck 1968). In this study, simultaneous readings from two stations eliminated bird movement as a source of error. However, operator error and distance from the receiving antenna caused some variance in readings. By comparing azimuths of test transmitters at known locations with computer plots, location error was determined to be 40 to 50 feet at a half mile distance. Strip cover use would be underestimated by an error this large. Since most fixes were taken from a shorter distance, this error was considered acceptable.

Data Analysis

The large volume of movement data obtainable through radio-telemetry has made new methods of data processing necessary. Siniff and Tester (1965) described the use of computers in analyzing movement distances as well as in map construction.

Heezen and Tester (1967) recommended the following parameters to be of value in studying movements by radio telemetry: total home range area, greatest linear dimension of home range (major axis), home range shape, activity center, mean activity radius, and seasonal change in distribution of activity radius. The activity center for each bird was determined by averaging all X-Y coordinates for all locations. The mean distance from this activity center to all locations was the activity radius.

In this study, data obtained by intersecting azimuths from radio locations of birds were entered on raw data sheets and later transferred to machine punch cards. Each card represented one fix for a specific bird. The card also carried information on the date, time, cover type, and weather conditions for each fix. A FORTRAN IV program was prepared for analysis of data in an IBM 360-40 computer. The computer calculated the X-Y coordinates of each fix, activity centers, activity radii, and length of major axis of the home range.

Maps were constructed by an IBM plotter using the points of location calculated from radio-tracking data. The central receiving station was designated as 0.0, and all locations were relative to this point. Maps were produced up to 18 inches square, with selected proportions enlarged as necessary to distinguish between individual locations. Scales of 4, 6, 8, and 10 inches to the mile were used. Maps with location points only or with points sequentially connected were produced by the plotter.

Bi-weekly home ranges (in acres) were calculated for each individual bird for which 5 or more fixes were made. Home range areas were determined by joining outermost points of location (Mohr 1947) and measuring the enclosed area with a compensating polar planimeter.

All home range and movement parameters were minimum values because readings were not continuously taken during a 24-hour basis. Siniff and Tester (1965) have shown that such parameters become more representative as the number of fixes increases.

Connecting peripheral fixes to determine home range area caused several problems in interpretation. Whether the outline should be convex or follow each outer point had to be decided. By using the convex method, several remote locations may indicate a much larger home range than actually used by a bird. In determining the range areas in this study, all points were used, with the outline including only the main grouping of locations.

The actual activity center is not necessarily at the geometric center of the range (Mohr and Stumpf 1966). A higher use of one end of the range would tend to shift the mathematical average of X-Y coordinates in that direction. It was noted that many of the ranges were linear, with different activities at each end of the range. Hence the activity center was located somewhere between the two areas that the bird used most frequently.

A habitat-use index (Robel et al. 1970) was calculated by dividing the percentage of all fixes for a given bird in a given cover type by the percentage of the study area occupied by that cover type. An index greater than 1.0 indicated use greater than random expectation. A value less than 1.0 indicated less use than expected.

To show any seasonal change in habitat use and movements, a bi-weekly period of analysis was chosen. This was the shortest time period that could be used and still have enough locations per period to give valid results.

Habitat-use indices were calculated to show diurnal as well as seasonal cover preferences. Daylight hours were arbitrarily divided into three periods: morning, midday, and afternoon, each representing approximately equal intervals. The period from 1/2 hour after sunset to 1/2 hour before sunrise was designated as night.

RESULTS

Capture and Radio-tracking Data

A total of 242 pheasants (cocks and hens) was captured and banded during the study (Table 2). Of these, 128 were backtagged and 30 were radio-equipped. Fourteen radio-equipped hens provided information on movements and habitat use during the brood-rearing period. From June, 1969, to October, 1970, 1,117 locations were recorded, an average of 79 locations per bird (Table 3).

Radio locations were obtained on 356 days out of 573 total days of radio operation. The signals of several birds were lost for a month's time before their signals were received again. Premature signal loss or reduction resulted from battery weakening or failure, antenna breakage, and shift in transmitter frequency possibly caused by contraction of the encapsulation material.

Ages of all juvenile pheasants captured were determined to estimate the peak date of hatch on the study area. Hatching dates of 168 juveniles were determined by backdating from their estimated age at capture. The hatching distribution (Fig. 6) indicated primary and secondary peaks in both years.

The hatching curve in 1969 reached its primary peak in the second week of June with a secondary peak the first week of July. In 1970, the first peak occurred in the third week of June, dropped to a low level the first week of July, and then rose again to peak the third week of the same month. Nest abandonment in mid-May caused by heavy

Table 2. Capture information, 1969 and 1970.

	1969			1970			
	Cocks	Hens	Total	Cocks	Hens	Total	Total
All Birds							
Juvenile	37	43	80	45	46	91	171
Adults	12	14	26	13	32	45	71
	49	57	106	58	78	136	242
Backtagged							
Juvenile	23	6	29	33	26	59	88
Adults	7	8	15	5	20	25	40
	30	14	44	38	46	84	128
Radio-equipped							
Juvenile	2	1	3	0	0	0	3
Adults	4	5	9	10	8	18	27
	6	6	12	10	8	18	30

Table 3. Summary of radio-tracking information for 14 pheasant hens.

Bird	Age	Date On/Off	Actual Days	Successive Days	Locations
215	A	6/26-10/20/69	106	117	400
216	A	6/30-7/23/69	21	24	72
218	A	7/10-8/1/69	20	22	62
273	J	9/25-12/14/69	20	81	33
308	A	9/23-10/17/69	20	25	53
312	J	8/24-12/6/69	22	74	45
243	A	6/18-6/22/70	5	5	9
332	A	6/21-8/27/70	24	68	57
334	A	7/16-9/1/70	36	48	113
336	A	8/10-9/4/70	21	26	68
350	A	8/25-9/21/70	20	28	75
425	A	9/4-9/11/70	5	8	25
426	A	9/4-10/6/70	24	33	79
427	A	9/16-9/29/70	12	14	26
Totals			356	573	1117

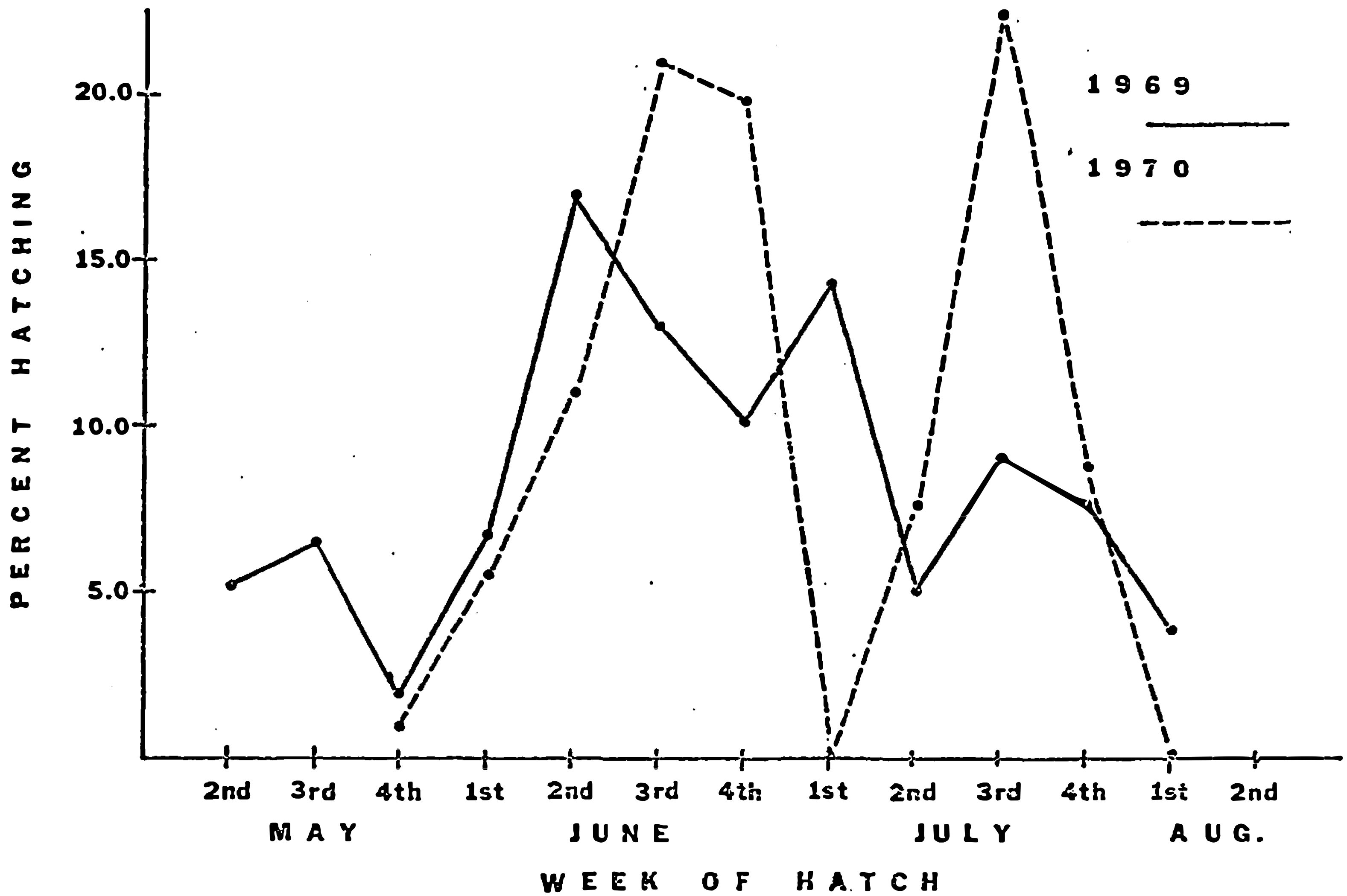

Figure 6. Hatching phenology determined from captured juveniles, 1969 and 1970.

rains and cold temperatures may have accounted for the low occurrence of hatches in early July.

Home Range Areas

Total range areas, major axes, and activity radii were calculated for each hen. The average home range size was 85 acres (± 41 acres), varying from 16 to 182 acres (Table 4). Major axes varied from 0.28 to 1.18 miles with a mean of 0.67 miles (±0.29). Birds moved an average of 0.16 miles (±0.03) from their activity centers. Activity radii ranged from 0.07 miles to 0.38 miles.

Data were pooled and bi-weekly means were calculated (Tables 5 and 6) to reveal seasonal trends in these parameters (Table 7). A significant increase in home range size ($P < 0.01$) occurred during the post-breeding season. There was no significant seasonal change in the length of activity radius ($P > 0.05$), but the length of the major axis did change ($P < 0.05$) to a significant degree.

The smallest bi-weekly home ranges occurred during the last 2 weeks of June (22 acres) and the first 2 weeks of October. Home ranges remained almost constant during July (32 to 34 acres) and the first 2 weeks of August (39 acres). Maximum home range size occurred the last 2 weeks of August (72 acres) and the last 2 weeks of September (55 acres).

The mean of the total home range area occupied from June to September (85 acres) was larger than the mean of the bi-weekly home

Table 4. Range areas and activity parameters for 14 pheasant hens, based on all locations for each bird.

	Bird	Locations	Major Axis (Miles)	Activity Radius (Miles)	Range Area (Acres)
1969					
	#215	400	0.84	0.17	182.2
	#216	72	0.85	0.12	63.0
	#218	62	0.31	0.07	19.6
	#273	33	1.12	0.38	120.9
	#308	53	0.75	0.20	117.0
	#312	45	0.64	0.15	86.0
1970					
	#243	9	0.30	0.09	21.0
	#332	57	0.77	0.19	120.7
	#334	113	0.90	0.13	115.9
	#336	68	0.53	0.13	72.2
	#350	75	0.40	0.10	62.3
	#425	25	0.28	0.09	16.1
	#426	79	0.62	0.09	53.5
	#427	26	1.18	0.29	133.6
Total		1117			
Mean			0.67	0.16	84.6
Standard Deviation			0.29	0.03	40.8

Table 5. Summary of range areas and activity parameters for pheasant hens, 1969.

Period	No. Birds	No. Fixes	Average Major Axis (Miles)	Average Activity Radius (Miles)	Average Home Range Area (Acres)
June 15-30	1	10	0.27	0.09	21.7
July 1-15	3	123	0.46	0.09	29.5
July 16-31	3	110	0.23	0.53	11.1
Aug. 1-15	1	55	0.31	0.07	28.1
Aug. 16-31	1	84	0.68	0.18	98.5
Sept. 1-15	1	63	0.48	0.07	43.0
Sept. 16-30	4	90	0.42	0.12	41.6
Oct. 1-15	4	99	0.42	0.11	34.7
Oct. 16-31	3	18	0.28	0.09	23.5
Total		665			
Bi-weekly Mean			0.34	0.12	40.7
Standard Deviation			0.42	0.15	25.2

Table 6. Summary of range areas and activity parameters for pheasant hens, 1970.

Period	No. Birds	No. Fixes	Average Major Axis (Miles)	Average Activity Radius (Miles)	Average Home Range Area (Acres)
June 15-30	2	30	0.28	0.99	22.3
July 1-15	1	14	0.66	0.11	34.1
July 16-31	1	45	0.50	0.10	56.9
Aug. 1-15	2	54	0.60	0.12	50.3
Aug. 16-31	4	103	0.53	0.11	44.4
Sept. 1-15	5	128	0.40	0.12	32.1
Sept. 16-30	3	67	0.67	0.44	69.1
Oct. 1-15	1	11	0.31	0.08	7.1
Total		452			
Bi-weekly Mean			0.49	0.15	39.5
Standard Deviation			0.15	0.15	19.9

Table 7. Summary of range areas and activity parameters for pheasant hens, 1969 and 1970.

Period	No. Birds	No. Fixes	Average Major Axis (Miles)	Average Activity Radius (Miles)	Average Home Range Area (Acres)
June 15-30	3	40	0.28	0.09	22.0
July 1-15	4	137	0.56	0.10	31.8
July 16-31	4	155	0.36	0.08	34.0
Aug. 1-15	3	109	0.45	0.09	39.2
Aug. 16-31	5	187	0.61	0.14	71.2
Sept. 1-15	6	191	0.44	0.09	37.6
Sept. 16-30	7	157	0.55	0.28	55.4
Oct. 1-15	5	110	0.37	0.09	20.9
Oct. 16-31	3	18	0.28	0.09	23.5
Total		1104			
Bi-weekly Mean			0.46	0.11	37.2
Standard Deviation			0.11	0.06	16.6

range area (37 acres). This would indicate a shift of activity centers or increasing mobility as the season progressed.

The X-Y plotter map of all locations for bird No. 215 (Fig. 7) demonstrated a seasonal shift in home range as result of changing cover availability and farming operations on the area. This bird was captured in an alfalfa field (A) that was being cut at the time. A brood patch present at time of capture indicated that she was incubating. After being captured and tagged, she moved 1/4 mile across a road to a corn field (B). For several days she remained inactive at this site. She then moved into an oats field and renested in a weedy area of the field (C), returning to the corn field and fencerow at night. As egg-laying and incubation proceeded, movement was progressively confined from a distance of 0.09 miles (160 yards) to about 0.01 miles (20 yards) around the nest site. Several days before hatching, the oats field was swathed except for the nest site. She remained near the nest site for 1 week, gradually expanding her movements into the freshly cut stubble (D). Two weeks after hatching, her center of activity was 200 yards from the nest. Long movements were recorded 2 to 3 weeks after hatching. Her average activity radius increased to 0.18 miles (320 yards) with several long movements back to the alfalfa field. The smallest bi-weekly range (2.9 acres) of this bird prevailed during the final stages of incubation. Her largest home range occurred approximately 4 weeks after hatching when she returned to the alfalfa (A), shifting her activity center 350 yards.

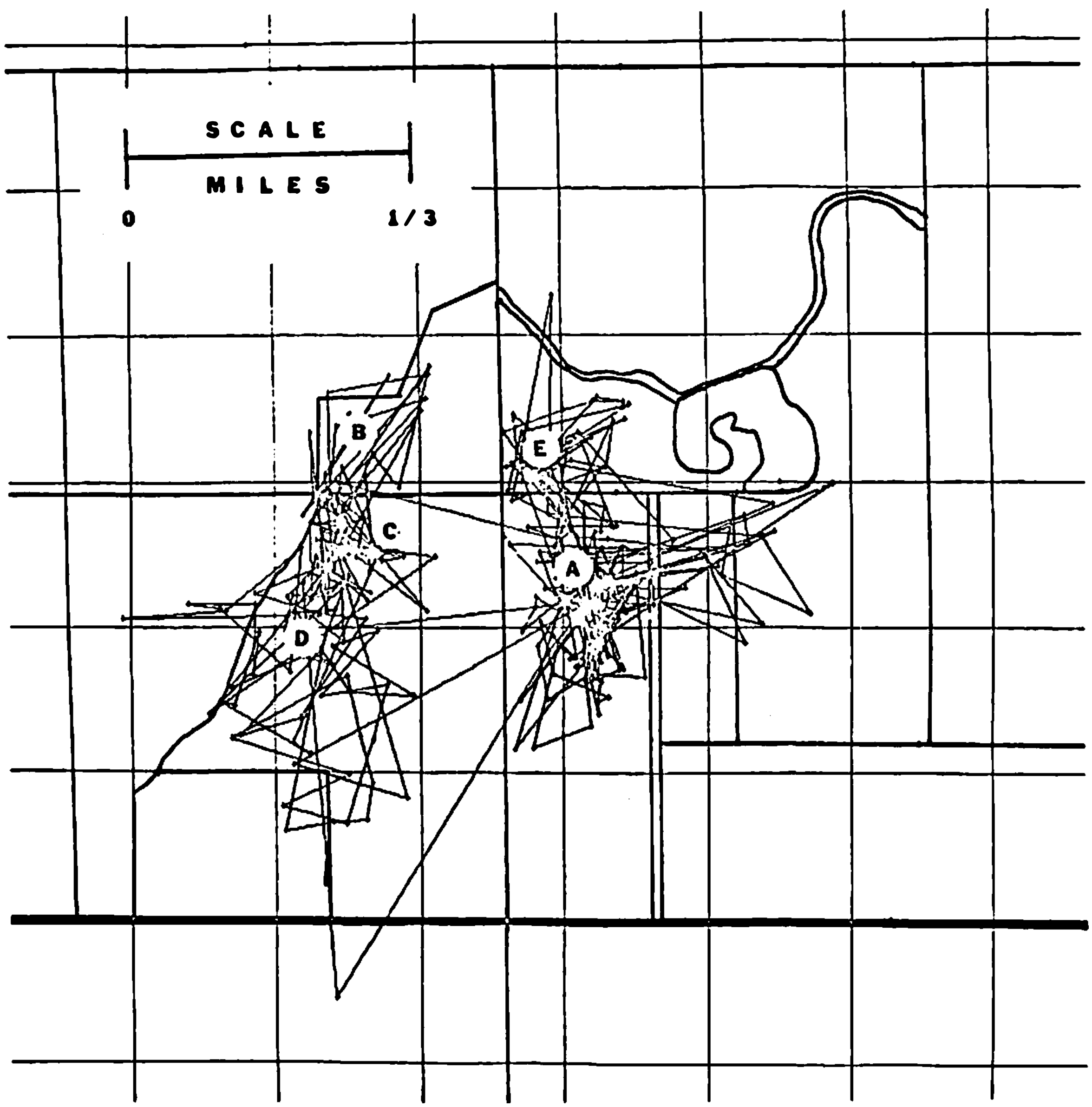

Figure 7. Photo of X-Y plotter map of Bird #215 showing seasonal change of main activity areas.

The hen and brood began to frequent the corn field (E) when the alfalfa was cut in early September. The birds confined most of their activity to the corn during October.

The bi-weekly home range for #215 was 33.1 acres. The total home range for the entire period of radio-tracking was 182.2 acres.

Activity Parameters

The average activity radius for all bi-weekly periods combined was 0.11 miles ($\pm$ 0.06) (Table 7), ranging from 0.08 miles (140 yards) the last 2 weeks of July to 0.28 miles (490 yards) the last 2 weeks of September.

The mean major axis for all bi-weekly periods was 0.46 miles (800 yards), ranging from 0.28 miles to 0.61 miles. Periods of most restricted movement based on this parameter were the last 2 weeks of June (0.28 miles) and the last 2 weeks of October (0.28 miles). During June and July, most hens remained in rather restricted areas of residual cover, used for nesting and/or care of young. Hen #218 (Fig. 8) provides an example of the small home range occupied at this stage of reproduction (20 acres). Mean activity radii, major axes, and home range sizes showed parallel trends from June to October (Fig. 9).

Home range outlines of pheasant hens were variable in shape (Fig. 10 to 14). As examples, Hen #218 occupied a compact area located primarily in residual cover (Fig. 8), whereas Hen #427 (Fig. 14) moved considerable distances each day between areas of day

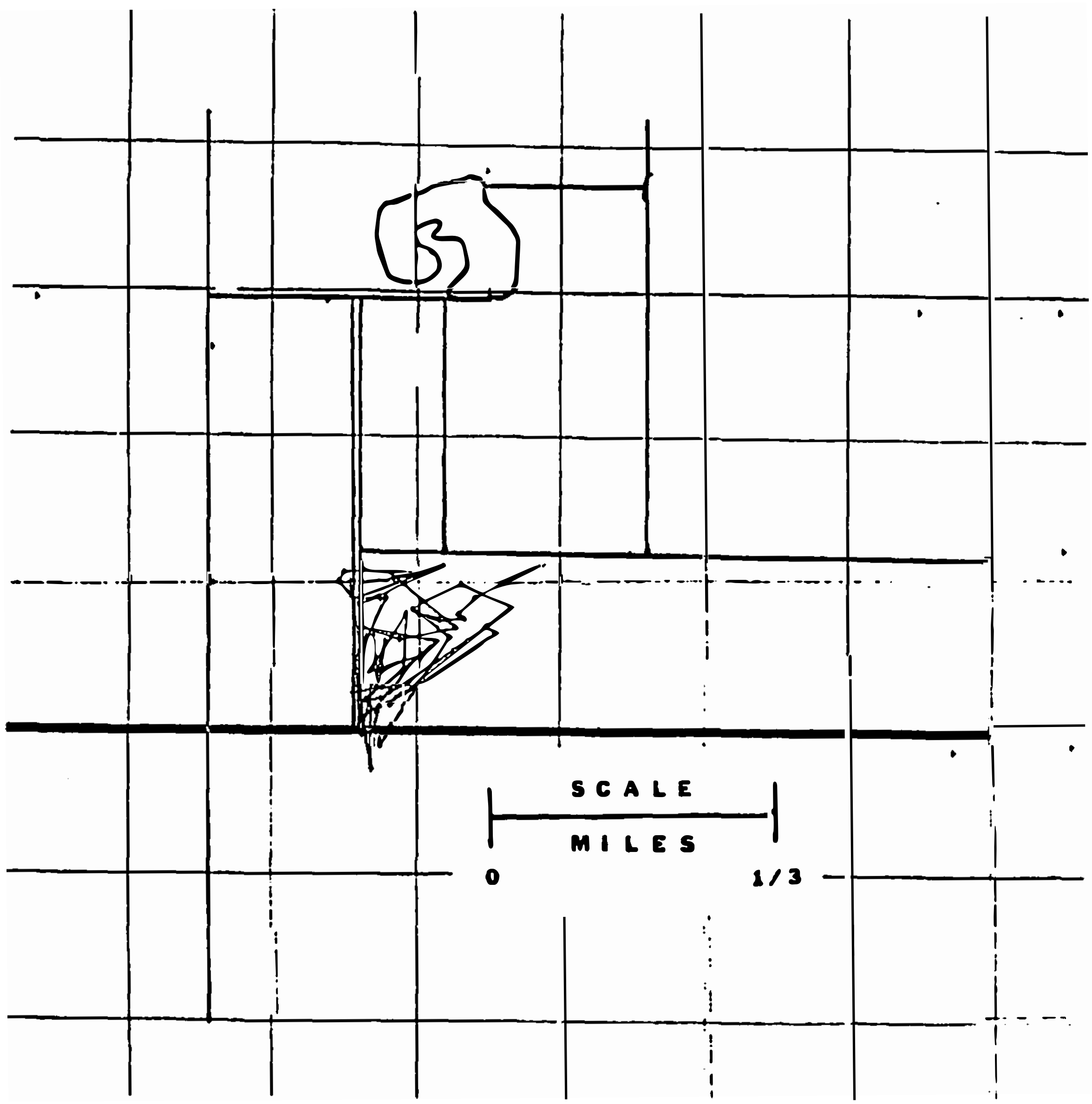

Figure 8. X-Y plotter map of Bird #218 from 7/10/69 to 7/30/69.

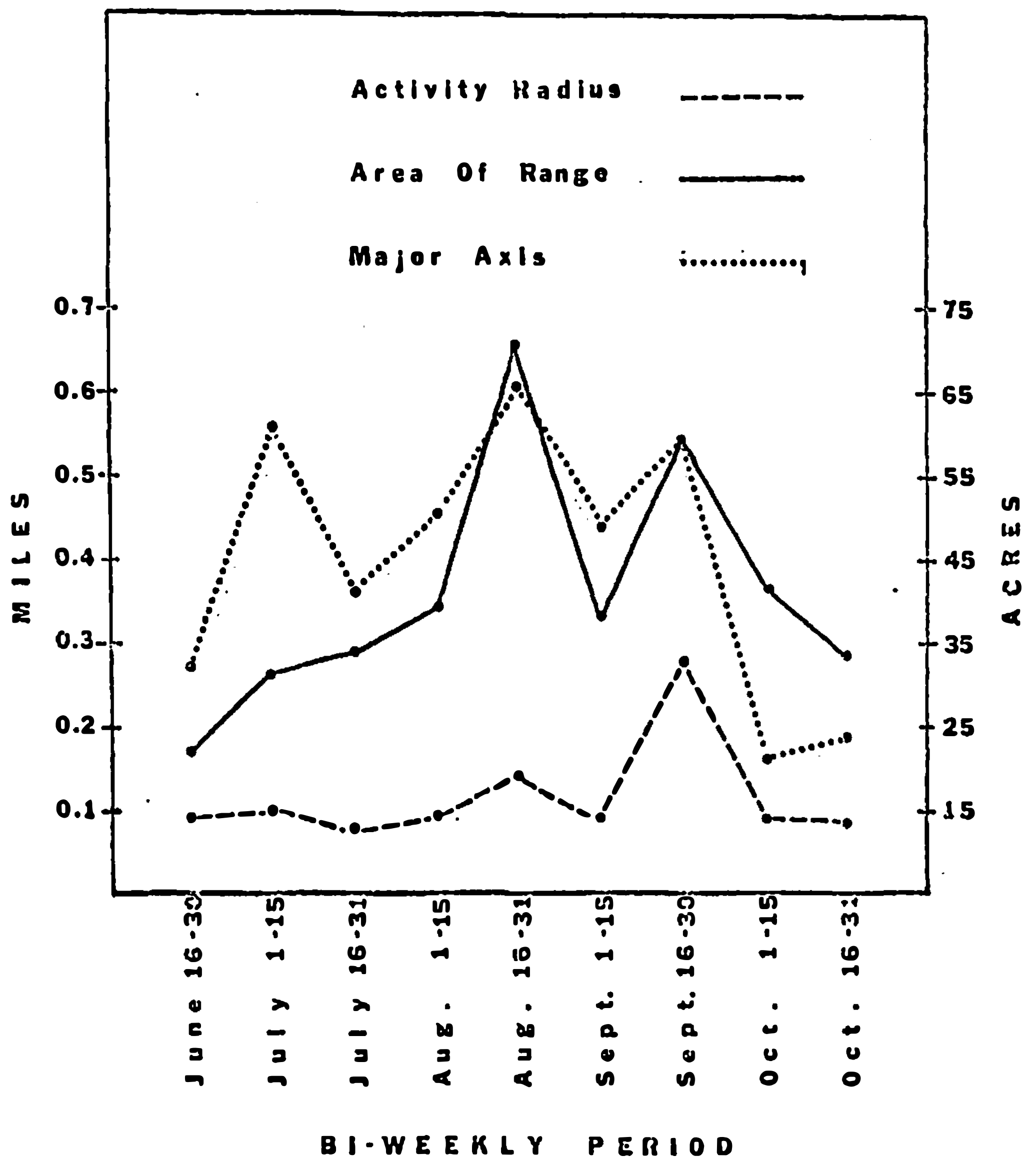

Figure 9. Bi-weekly change in range area, major axis, and activity radii based on Table 7.

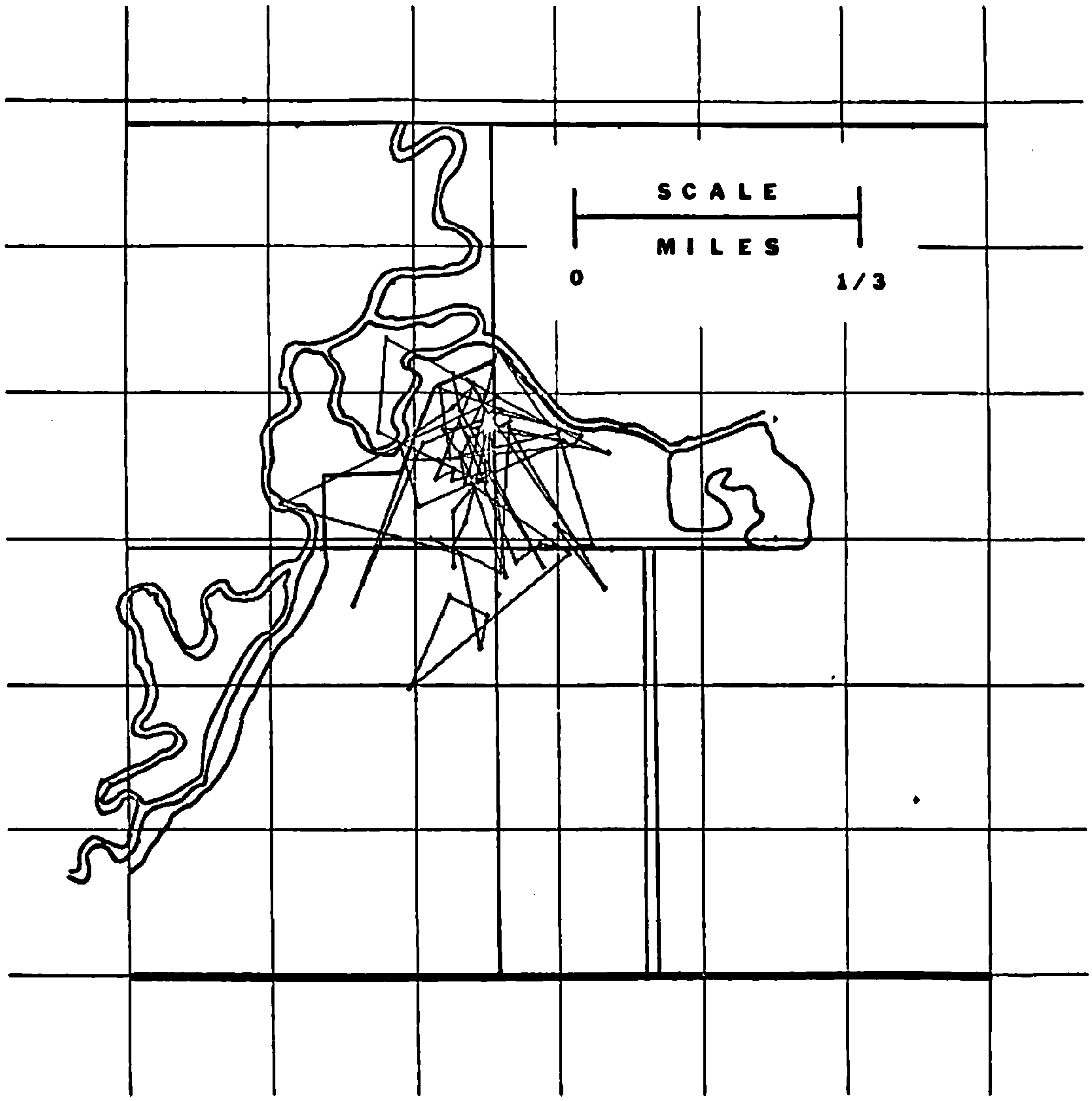

Figure 10. X-Y plotter map of Bird #350 from 8/25/70 to 9/21/70.

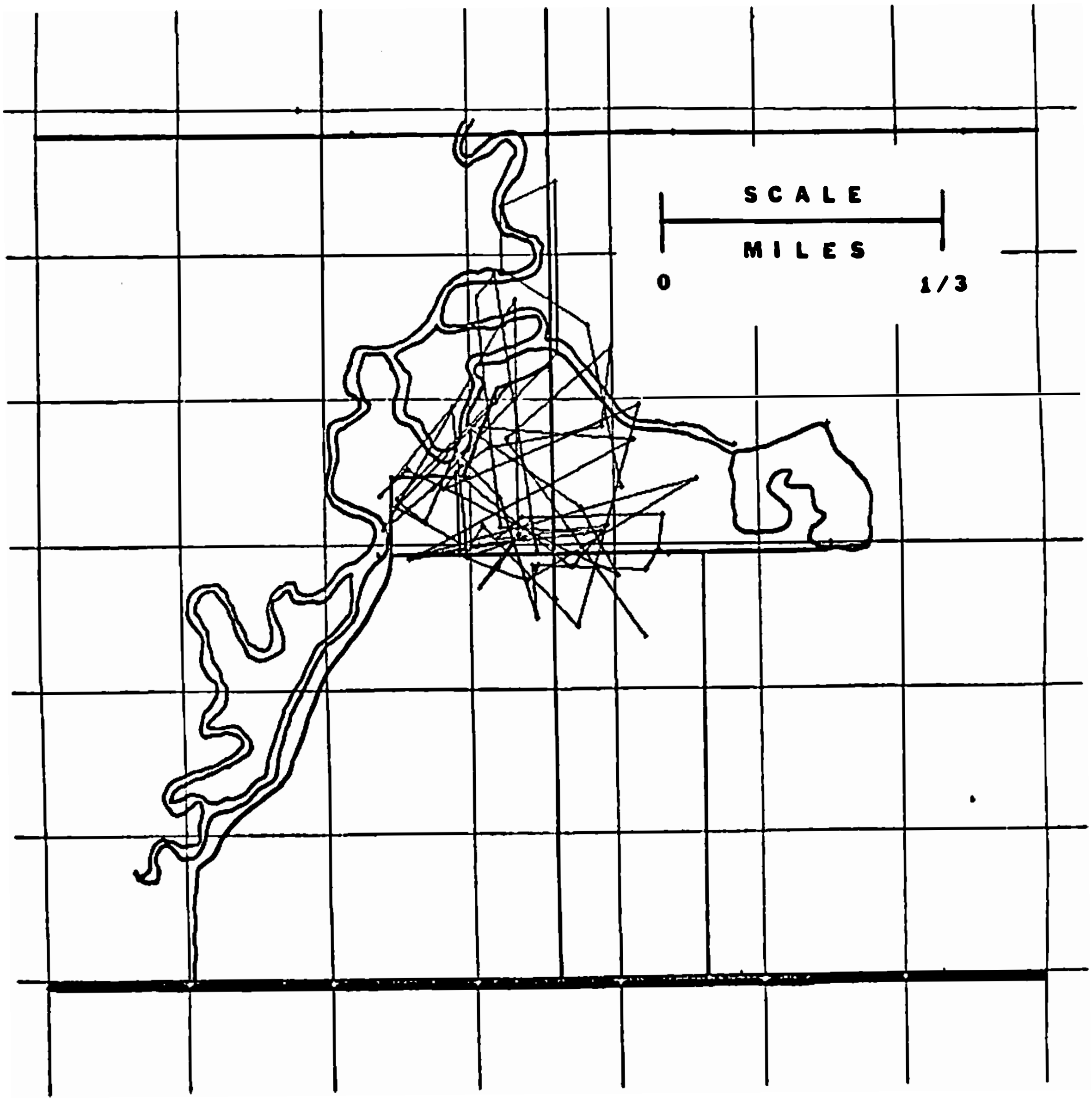

Figure 11. X-Y plotter map of Bird #336 from 8/10/70 to 9/4/70.

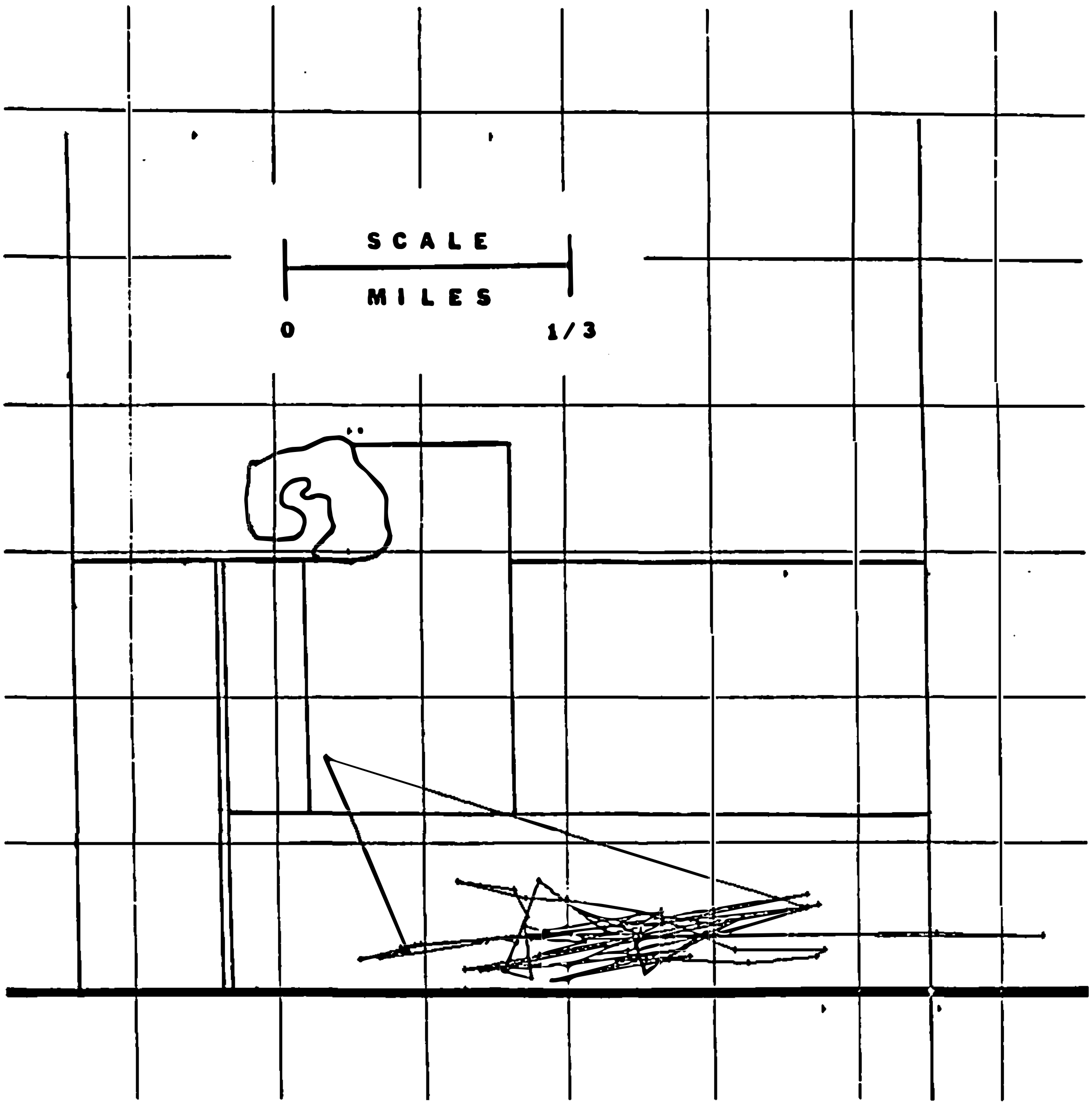

Figure 12. X-Y plotter map of Bird #216 from 7/1/69 to 7/16/69.

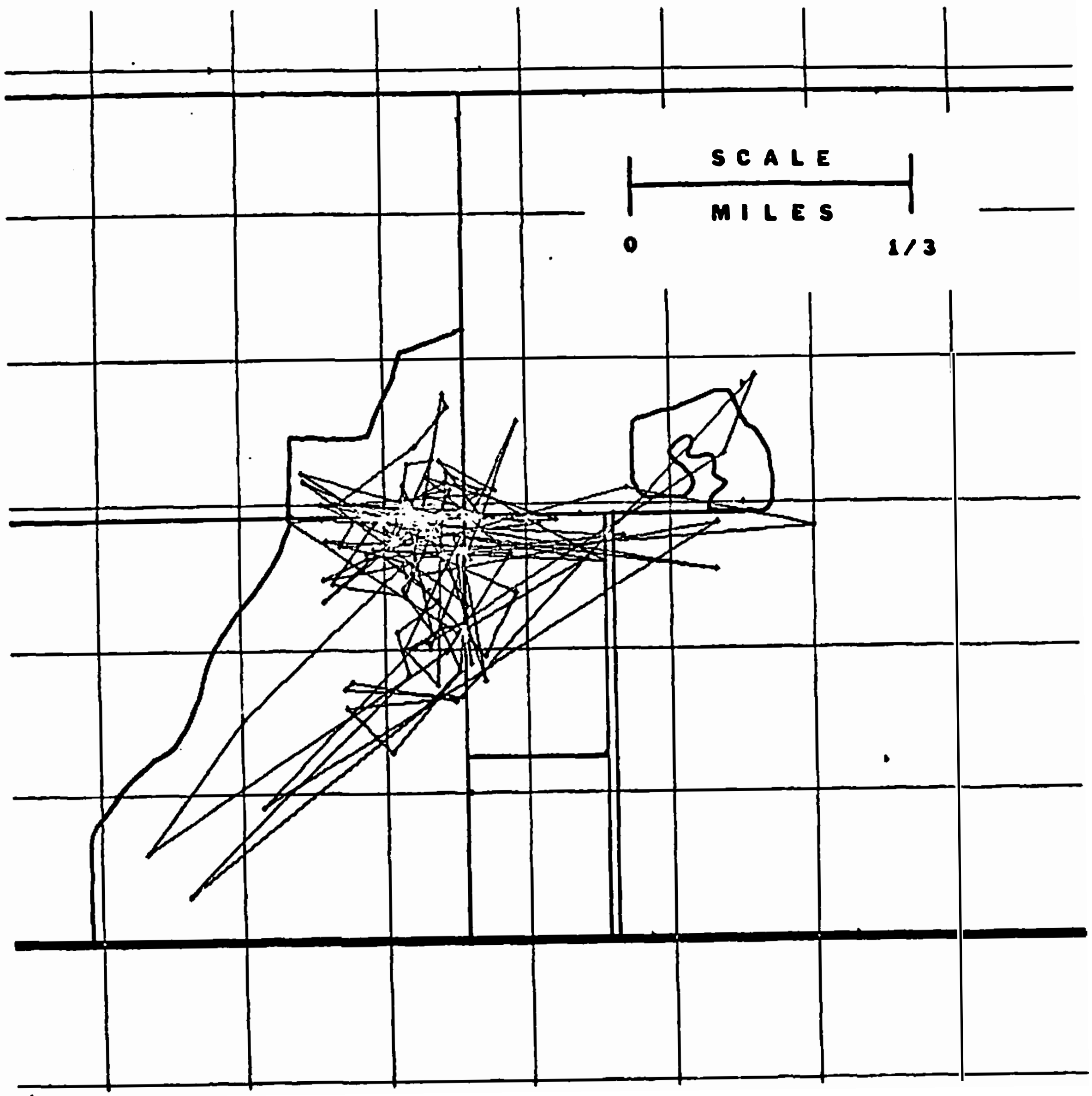

Figure 13. X-Y plotter map of Bird #332 from 7/16/70 to 9/1/70.

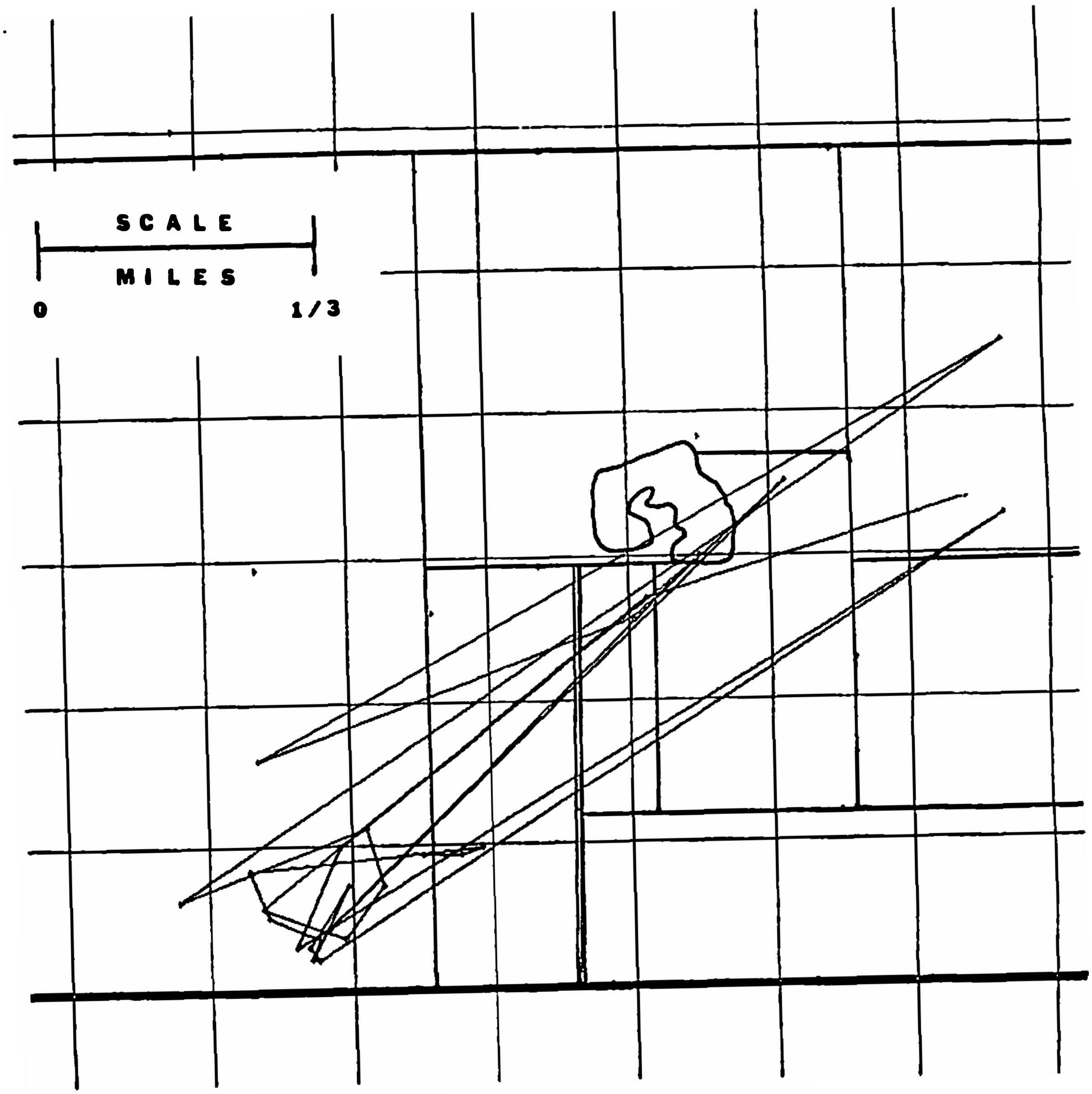

Figure 14. X-Y plotter map of Bird #427 from 9/16/70 to 9/29/70.

and night-time use. Bird #218 was monitored in July, while #427 was monitored in September. Linear shape of home ranges was a common condition. In most cases, the more circular home ranges were occupied during periods of restricted mobility when nesting was in process and brood members were 1 to 4 weeks old. As broods became older, radio-tracked hens tended to expand their travel at either end of the home range, using the areas between largely as travel lanes.

Seasonal Cover Use

Locations obtained from June, 1969, to October, 1970, were used to show cover use. Since all birds in this study were females, age-classes were pooled to determine seasonal cover preferences and changing patterns of cover use. Birds were found most frequently in four cover types from June through October. These were: corn, small grain, residual cover, and alfalfa (Table 8).

Habitat use changed with the seasons (Fig. 15). Use of residual cover and grain was heaviest in early summer. Approximately 90 percent of the locations in June and first 2 weeks of July were recorded in these cover types. Small grain continued to be of importance through the end of August, declining from 80 percent of locations in June to 7 percent in September. Residual cover was of importance in June and July, having 50 percent of total locations in the first part of July. In mid-August 37, 23 and 21 percent of the locations were in corn, alfalfa, and grain respectively.

Table 8. Percentage of locations per cover type by bi-weekly period showing seasonal use, 1969 and 1970.

Cover Type	No. of Fixes	June 15-30	July 1-15	July 16-31	Aug. 1-15	Aug. 16-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31
Corn	370	0	2	22	31	37	29	56	67	61
Small Grain	250	80	39	32	50	22	7	4		
Residual	154	10	50	30			8	10	3	
Pasture	45		8	1	9	5	5	2	1	
Summer Fallow	30				3	4	1	10	3	
Alfalfa	162	5		3	4	24	36	14	11	22
Shelter Belts	41		2	8	1	2	6	3	5	
Ditches	43	5		3	3	4	6	1	8	17
Spoil Pits	8					2	3			
Total	1104									

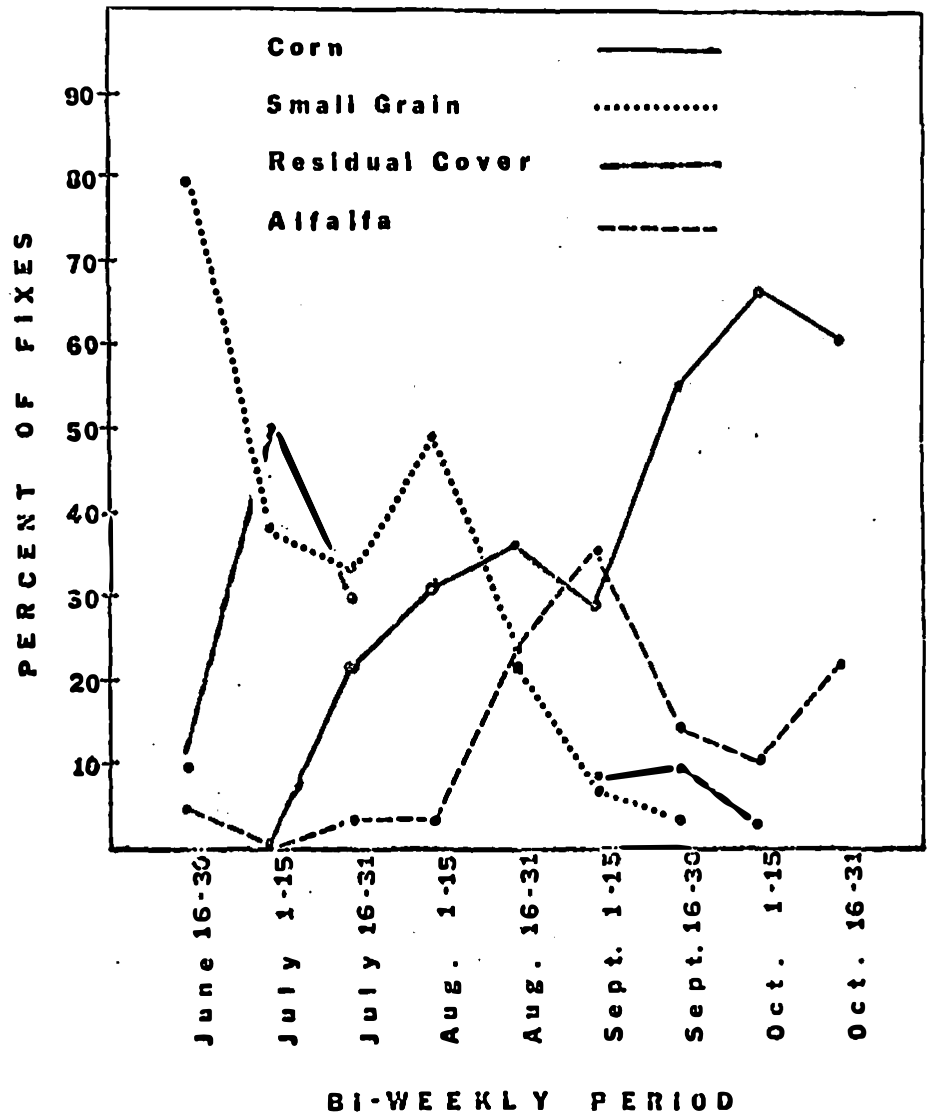

Figure 15. Composite graph of percent of locations/cover type indicating seasonal changes in cover type use.

Corn began to receive use the first 2 weeks of July, increasing to about 70 percent of all locations by the end of October.

Because all cover types were not of equal acreage, actual cover preferences were better revealed by an index value calculated by dividing the percentage of all locations which occurred in a given cover type by the percent of total land area occupied by that type.

Weighted index values for each cover type (Table 9) indicated that alfalfa was most preferred (range 0.8 to 14.3). Road and drainage ditches (1.6) were highly preferred during all periods as indicated by the high proportion of bi-weekly indices greater than 1.5. Small grain ranked next with a mean index of 1.3 (range 0.3 to 3.9). Birds preferred small grain the most during the last 2 weeks of June and first 2 weeks of July. Shelterbelts followed with a mean index of 1.2 (range 0.3 to 3.9). Corn, with a mean index of 1.1 (range 0.1 to 2.4), received some use in all periods after July 1. Mean indices less than 1.0 were recorded for residual cover (0.7), spoil pits (0.7), pasture (0.5), and summer fallow (0.5).

Residual cover received its highest indices the first 2 weeks of July and again the first 2 weeks of September after grain harvest had been completed. Pasture received low preference values (range 0.1 to 1.4) during all periods. Spoil pits were used only between August 15 and September 15.

Table 9. Habitat use indices by bi-weekly periods determined from 1104 locations.

	Locations	Corn	Small Grain	Residual	Pasture	Summer Fallow	Alfalfa	Shelter Belts	Ditches	Spoil Pits
1969		(29)[a]	(25)	(19)	(9)	(6)	(6)	(3)	(2)	(1)
June 15-30	10		3.6				1.7			
July 1-15	123	0.1	1.3	3.0	1.0			0.9		
July 16-31	110	0.1	1.7	2.3				3.9	0.9	
Aug. 1-15	55		3.3		1.4	0.9				
Aug. 16-31	84				0.4	1.6	7.2	1.2		3.6
Sept. 1-15	63	0.1				0.3	14.3	1.6		6.3
Sept. 16-30	90	1.6		0.4		2.8	3.9	1.8		
Oct. 1-15	99	2.4			0.1	0.5	2.0	1.7	4.6	
Oct. 16-31	18	2.1					3.7		8.4	
1970		(32)	(24)	(20)	(9)	(5)	(4)	(3)	(2)	(1)
June 15-30	30		3.2	0.7			0.8		3.4	
July 1-15	14		3.9					2.4		
July 16-31	45	2.3	0.3		0.2		2.8		3.4	
Aug. 1-15	54	2.0	0.7		0.6		1.9	0.6	2.8	
Aug. 16-31	103	2.1	0.5		0.8		2.0	0.3		
Sept. 1-15	128	1.3	0.5	0.6	0.8		2.7	2.1	4.3	0.8
Sept. 16-30	67	2.2	0.4	0.6	0.5		0.8		1.5	
Oct. 1-15	11	2.3		1.4						
Total	1104									
Weighted Means		1.1	1.3	0.7	0.5	0.5	2.7	1.2	1.6	0.7

[a] Percent of study area

Cover Use by Time of Day

Daily periods were broken down into four segments: morning, midday, afternoon, and night. No difference in cover use between 2-week periods was evident from Appendix Table 1. The use indices from both years were pooled, and an overall weighted mean was calculated to show use by time of day.

Corn was most preferred during midday and afternoon hours, with indices ranging from 0.5 to 1.3. No preference for small grain was shown for any time of day, with the indices ranging from 0.5 to 0.9. Values for residual cover ranged from 0.5 to 1.3, being most preferred at night. For pasture and summer fallow, all indices were less than 1.0, ranging from 0.2 to 0.6.

Alfalfa was preferred at all times of the day, having mean indices of 1.9 to 6.0. Night was the time of highest preference with a mean index of 6.0. Shelterbelts had a fairly high mean index of 2.0 in the mornings. Other periods of the day ranged from 0.4 to 0.9. Ditches were used at all times of the day, being preferred most at night (3.0), followed by afternoon (2.7), and morning (2.2). Use of spoil pits was greatest during midday (1.7) with some use in morning (0.3), and no use during afternoon or night.

Table 11 shows the mean use indices in descending order for each daily period. Alfalfa was the most preferred in the morning, followed by ditches, shelterbelts, and corn. During the midday period, alfalfa again ranked first, with spoil pits, corn and ditches of lesser

Table 10. Weighted mean indices for time-of-day periods showing seasonal preference, 1969 and 1970.

Habitat Type	1969				1970				1969 & 1970			
	N	MD	A	N	M	MD	A	N	M	MD	A	N
	(196)[a]	(245)	(151)	(60)	(159)	(164)	(289)	(40)	(355)	(409)	(240)	(100)
Corn	0.5	0.6	1.0	0.0	1.9	7.1	1.6	0.5	1.0(4)[b]	1.3(3)	1.2(3)	0.5
Small Grain	1.0	1.3	0.8	1.1	1.0	0.9	0.8	1.0	0.9	0.5	0.7	0.8
Residual Cover	0.8	1.0	0.9	1.4	0.3	0.1	0.5	1.1	0.5	0.7	0.8	1.3(3)
Pasture	0.5	0.4	0.3	0.2	0.5	0.5	0.9	0.2	0.5	0.4	0.5	0.2
Summer Fallow	0.8	0.8	0.9	0.3	0.0	0.0	0.0	0.0	0.4	0.5	0.6	0.2
Alfalfa	3.5	2.2	3.2	6.5	1.8	1.4	1.7	5.3	2.7(1)	1.9(1)	2.6(2)	6.0(1)
Shelter Belts	2.8	1.1	0.9	0.0	0.3	0.7	0.4	1.6	2.0(3)	0.9	0.4	0.8
Ditches	0.8	0.8	1.7	1.7	3.8	1.8	7.8	5.0	2.2(2)	1.2(4)	2.7(1)	3.0(2)
Spoil Pits	0.0	2.9	0.0	0.0	0.3	1.7	0.0	0.0	0.3	1.7(2)	0.0	0.0

[a] Locations/time-of-day period

[b] Weighted mean indices ranked in descending order of importance

preference. In the afternoon, ditches, alfalfa, and corn were most preferred. The high preference value for alfalfa at night reflected its importance as roosting cover. Ditches and residual cover also received preferential use at night.

In summary, alfalfa and ditches received extensive use during all periods of the day. Corn was important during the daylight hours and residual cover most important in the afternoon and night.

DISCUSSION AND CONCLUSIONS

Movements and Home Range Areas

Most activities of pheasant hens during the brood-rearing period occurred in areas 45 to 125 acres in size, with daily movements from the center of activity averaging 200 yards and home range having a major axis of 700 yards. Kuck et al. (1970) indicated that home ranges of hens were 20 to 50 acres during the nesting season. The mean of bi-weekly ranges was 37.2 acres in our study, with 1969 and 1970 almost equal (40.7 and 39.5 acres). Our smallest bi-weekly ranges occurred in June (22.0 acres) and July (31.8 and 34.0 acres) during periods of peak hatching activity. The peak of the hatch on the area occurred during the second to fourth weeks of June. These ranges gradually increased to a mean of 71.2 acres the last part of August. As broods became older, hens gradually increased their movements. A period of reduced movement several weeks before and after incubation was noticed. Since hens apparently moved only short distances for 3 to 4 weeks, hence all necessary cover for brood-rearing should be available within that distance. Most hens did not move long distances with broods, but shifted their centers of activity several hundred yards per week away from the nest site.

The mean bi-weekly home range was 37.2 acres. The difference between this and the total mean range area (84.6 acres) was caused by increased mobility as the summer progressed. Also alfalfa and grain harvest practices caused a shift in activity centers.

Habitat Use

The analysis of cover use was quantitative rather than qualitative. The number of locations per cover type were recorded to obtain the use indices rather than considering the quality of cover.

From June through October, birds on our study area were most frequently located in four major cover types (corn, small grain, residual cover, and alfalfa). Habitat use shifted from small grain and residual cover in spring to corn in the fall. This shift may be partially accounted for by the quality and availability of cover resulting from farming practices.

Preference ratings indicated that alfalfa, ditches, and small grain, comprising 32 percent of the total study area, were most preferred over the entire period. If farm practices did not eliminate vegetational cover by mowing alfalfa fields and road ditches and harvesting grain, the bulk of use would occur on these cover types.

Brood counts by Linder and Agee (1965) indicated that wheat and roadsides were used extensively by young birds throughout the day. Hammer (1965) suggested that broods exhibited strong preferences for uncultivated areas. He indicated that roadsides were preferred in morning and evening during early summer, with a gradual shift to midday use as the season progressed.

In our study, alfalfa (5 percent of the area) was most preferred at all times of the day except afternoon. Ditches (2 percent of area) ranked nest to alfalfa in overall importance as day-time cover.

In conclusion, most pheasant hen activity during the period of brood-rearing occurred within an 85-acre area ($\pm$ 40 acres), with home range having a major axis of 700 yards and daily movements from the center of activity averaging 200 yards. The least amount of movement occurred during the peak of hatch, with shifting movements away from the nest site as broods became older. Alfalfa was the most preferred cover type seasonally and diurnally. Ditches had secondary seasonal preference to alfalfa. Corn received most of its use during midday hours and residual cover during afternoon and night. There was a seasonal shift in cover type from residual cover and grains in early spring and summer to corn in fall due to land-use practices and available cover.

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APPENDIX

Appendix Table 1. Time-of-day habitat use indices by bi-weekly periods determined from 1104 locations, 1969 and 1970.

	Morning		Midday		Afternoon		Night	
Period	1969	1970	1969	1970	1969	1970	1969	1970
June 16-30	(3)[a]	(9)	(5)	(10)	(1)	(7)	(1)	(4)
Corn								
Small Grain	4.0	3.2	4.0	2.9	4.0	3.6		1.0
Residual Cover				0.5		0.7		2.5
Pasture								
Summer Fallow								
Alfalfa							4.0	6.2
Shelter Belts								
Ditches								
Spoil Pits								
July 1-15	(33)	(5)	(50)	(6)	(28)	(3)	(12)	
Corn	0.1				0.1			
Small Grain	1.3	3.3	1.5	4.2	0.7	4.2	2.0	
Residual Cover	2.5		3.2		3.4		2.0	
Pasture	1.7		0.4		1.2		0.9	
Summer Fallow								
Alfalfa								
Shelter Belts					1.2			
Ditches								
Spoil Pits								
July 16-31	(33)	(17)	(52)	(19)	(14)	(7)	(11)	(2)
Corn		2.2		2.8	0.2	1.3		3.1
Small Grain	1.6	0.3	1.8	0.4	1.7		1.8	
Residual Cover	1.9		2.3		2.3		2.8	
Pasture				0.6				
Summer Fallow								
Alfalfa		4.4				7.1		
Shelter Belts	8.1		2.5		2.4			
Ditches		3.1	1.9			14.3		
Spoil Pits								

Appendix Table 1. (Continued)

Period	Morning		Midday		Afternoon		Night	
	1969	1970	1969	1970	1969	1970	1969	1970
August 1-15	(17)	(14)	(23)	(24)	(12)	(10)	(3)	(6)
Corn		1.6		2.8		1.6		0.5
Small Grain	2.6	1.5	3.5	0.2	3.7	0.8	4.0	1.4
Residual Cover								
Pasture	2.6	0.8	1.5			2.2		
Summer Fallow	2.0				1.4			
Alfalfa		1.8				2.5		8.3
Shelter Belts				2.1				
Ditches				2.1		5.0		8.3
Spoil Pits			10.0					
August 16-31	(28)	(42)	(30)	(31)	(20)	(24)	(6)	(6)
Corn		1.6		2.8		2.1		1.6
Small Grain	1.6	0.7	1.2		1.6	0.2	2.0	1.4
Residual Cover								
Pasture		0.5	0.7	0.7	0.6	1.4		
Summer Fallow	1.8		2.2		0.8			
Alfalfa	7.1	3.0	6.1		8.3	2.1	8.3	4.2
Shelter Belts	2.3	0.8	1.1					
Ditches		6.0		1.6		4.2		
Spoil Pits			10.0					
September 1-15	(20)	(45)	(24)	(51)	(14)	(18)	(5)	(4)
Corn		0.9		2.1	0.3	1.4		
Small Grain		0.8		0.1		0.2		0.9
Residual Cover		1.0		0.1		0.8		1.1
Pasture		0.7		0.6		1.2		0.7
Summer Fallow					1.2			
Alfalfa	15.0	0.6	13.2	4.4	14.3	1.4	16.7	6.1
Shelter Belts	3.3	2.2	1.4	1.3		1.8		4.7
Ditches		6.7		1.0		5.6		7.2
Spoil Pits		2.2	16.6					

Appendix Table 1. (Continued)

	Morning		Midday		Afternoon		Night	
Period	1969	1970	1969	1970	1969	1970	1969	1970
September 16-30	(22)	(23)	(27)	(19)	(25)	(18)	(16)	(7)
Corn	2.0	2.4	2.2	2.8	1.7	2.1		0.4
Small Grain		0.4		0.4		0.5		
Residual Cover	0.2			0.3	0.4	0.8	1.7	2.9
Pasture		1.0		0.6				
Summer Fallow	3.0		3.1		3.3		1.0	
Alfalfa	3.0	1.1	1.2		2.7		11.5	3.6
Shelter Belts	3.7		2.5					
Ditches						2.8		7.1
Spoil Pits								
October 1-15	(38)	(4)	(30)	(4)	(28)	(2)	(3)	(1)
Corn	2.2	1.6	2.8	3.1	2.3	3.1		
Small Grain								
Residual Cover		2.5				5.0		
Pasture			0.4					
Summer Fallow			1.7					
Alfalfa	2.6				1.8		11.1	
Shelter Belts	1.7				2.4			
Ditches	2.6		3.3		7.1		16.7	
Spoil Pits								
October 16-31	(2)		(4)		(9)		(3)	
Corn			2.6		3.1			
Small Grain								
Residual Cover								
Pasture								
Summer Fallow								
Alfalfa	8.3		4.2				11.1	
Shelter Belts								
Ditches	25.0				5.6		16.7	
Spoil Pits								

[a] Locations per time-of-day period