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Overwinter movements and survival of ring-necked pheasant hens in north central Iowa

Anjeanette L. Perkins
Iowa State University

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Overwinter movements and survival of ring-necked pheasant hens in north central Iowa

by

Anjeanette L. Perkins

A Thesis Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

Major: Animal Ecology

Iowa State University
Ames, Iowa

1992
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My first fortune cookie in Ames said "You should be able to undertake and complete anything" but I could not have completed this project without the help of many individuals. First, I am grateful to my advisors, Paul Vohs and Bill Clark, for their good ideas, suggestions, and support. My thanks also goes to (pheasant) chick-chaser and fellow student, Dean Ewing, for his friendship and work.

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The Iowa DNR and the Iowa Cooperative Fish and Wildlife Research Unit provided support. Alice Tostenson also provided financial support through the LaVon Tostenson Scholarship.

I appreciate my roommates, Kathy (10¢) and Martha (Gooch), for putting up with me and thank my family for their continued support of my educational endeavors. Finally, I would like to amend my fortune to include "With God's strength and love...". Thanks be to God. YIPPEE! ☺
GENERAL INTRODUCTION

Wildlife habitat has been reduced and fragmented in agricultural landscapes. This change in quantity and structure of habitat has been linked to the reduction of pheasant populations in many parts of the United States (Farris et al. 1977, Dahlgren 1988). It is important to gain knowledge about the specific influences of fragmented landscapes on pheasant ecology and demographics to effectively manage pheasant populations.

Survival of pheasant hens is critical to population levels, and the winter season appears to be a period of high hen mortality (Jarvis and Simpson 1978, Penrod et al. 1987). Whiteside and Guthery (1983) investigated pheasant movements on multiple study sites with different landscapes in Texas, but little work has been done in the Midwest to relate survival to landscape structure on different areas. Movements and habitat use appear related to mortality and influenced by landscape configuration (Penrod et al. 1987, Gatti et al. 1989).

My objectives study were to: 1) estimate and compare daily movements and seasonal home ranges of hens between 2 study areas with different landscapes; 2) estimate and compare habitat use between areas; 3) relate movements and habitat use to weather conditions; 4) estimate and compare survival of
hens between areas; 5) examine possible explanatory variables for survival including movement, habitat, and weather.

Explanation of Thesis Format

This thesis was written under the guidelines for the alternate thesis format set forth by the Graduate College Thesis Manual (Iowa State University 1990) and contains 2 sections suitable for publication. Section 1 considers the movements and habitat use of pheasant hens. Section 2 compares survival estimates of pheasant hens between areas and years and examines variables that influence survival. A General Summary follows Section 2, and literature cited in the Introduction and Summary follow the Summary. Each section was written by the author and edited by Dr. W. R. Clark and Dr. P. A. Vohs.
SECTION 1. OVERWINTER MOVEMENTS OF RING-NECKED PHEASANT HENS
ABSTRACT

I estimated movement patterns and habitat use of 169 radio tagged pheasant hens (Phasianus colchicus) during winters in 1989-91 on 2 study areas in north central Iowa. The parameters were contrasted between the Kossuth Study Area (KSA), chosen to represent landscapes dominated by intensive rowcrop agriculture, and the Palo Alto/Clay Study Area (PSA), representing a more diverse landscape. I measured the linear distance (m) between roost and daytime locations, measured the distance between consecutive roost locations (m), and grouped these measures into 14-day intervals across the winter from 01 January to 01 April. Home range size (ha) was calculated using the harmonic mean estimator and individual locations collected from 27 November to 01 April. I identified habitat use at 2 scales by comparing the proportion of habitat in the home ranges relative to the study areas, and by comparing the observed proportions of locations in habitat within home ranges to expected proportions. The range of daily movements during the winter was 292-407 m in 1989-90 and 185-323 m in the more severe winter of 1990-91, but the differences were not significant in either year. There were no differences among daily activity periods in 1989-90. The average movement for the morning period (221 m) in 1990-91 was smaller than the midday (256 m) and afternoon averages (248 m). In 1989-90
there was no difference in average movements between areas, but in 1990-91 movements were smaller on KSA ($\bar{x} = 215$; PSA, $\bar{x} = 268$). On KSA the daily movements were larger in 1989-90 ($\bar{x} = 330$ m) than in 1990-91. The distance between roost locations did not differ among 14-day intervals nor between years on each area. The average distances between roosts on KSA, 113 m in 1989-90 and 78 m in 1990-91, were larger than on PSA in both years (1989-90, $\bar{x} = 68$ m; 1990-91, $\bar{x} = 43$ m). The home range estimate on KSA (122 ha) in 1990-91 was significantly larger than the estimate on PSA (46 ha). GRASS habitats were selected, and STUBBLE habitats were avoided on both study areas, during both years, and at both scales. On KSA in 1990-91 more locations than expected were in WOODY habitats, and on PSA more WETLAND was in the home range relative to the study area.
Habitat changes over time have been cited as a cause of decreased ring-necked pheasant (*Phasianus colchicus*) populations around the United States (Nomsen 1969, Labisky 1976, Jarvis and Simpson 1978, Dahlgren 1988) including north central Iowa (Farris et al. 1977). Mohlis (1974) analyzed land use changes relative to pheasant habitat in north central Iowa from 1938-72 and reported that rowcrops increased from 32.5% of the land area in 1938 to 58.4% in 1972 while vegetation important as winter cover, including set aside and idle lands, groves, and wetlands, declined 32.8%. Fischer (1974) reported that the width of fencerow cover in Winnebago County had been reduced to 1 m on each side of the fences. The specific influences of the change in agricultural landscapes on pheasants is not well understood.

Pheasants are considered an "edge" species, and "good" pheasant habitat has been defined as an area where the necessary cover types are in close proximity so that the birds do not have to move far or frequently (Warner 1988). In north central Iowa, Mohlis (1974) suggested that winter cover quality decreased because increased field sizes, removal of fences, and reduced interspersion of cover types increased the distance between feeding and cover areas. Gates and Hale (1974) observed that food sources were used only when cover
was nearby and that a winter change in cover use was associated with a reduction of food in the area. Gatti et al. (1989) reported that the percentage of home range area in food patches was inversely related to home range size in winter.

Movement patterns and mortality appear related and influenced by landscape structure. Daily movements tend to be small in the winter, averaging between 200-800 m (Grondahl 1953, Weston 1954, Gates and Hale 1974, Whiteside and Guthery 1983), however, estimates are often poor because data were gathered by visual observations with small sample sizes.

Survival of pheasant hens is critical to population levels, and the winter season appears to be a period of high hen mortality (Dumke and Pils 1973, Gates and Hale 1974, Jarvis and Simpson 1978, Penrod et al. 1987). Telemetry studies by Penrod et al. (1987) and Gatti et al. (1989) in New York and Wisconsin, respectively, found that, as a group, hens that died had larger home ranges than hens that survived. In the New York study, hens that died had a higher percentage of openland and grassland within their home ranges. Several movement studies investigated multiple study areas (Weston 1954, Gates and Hale 1974, Whiteside and Guthery 1983), but the Whiteside and Guthery study in Texas was the only 1 to compare areas of different habitat quality.

To study the influence of landscape structure on pheasant behavior, I investigated winter movement and habitat use of
pheasant hens on 2 areas with different landscapes in north central Iowa. One area was chosen to represent a landscape dominated by intensive agriculture, and the other chosen to represent a more diverse landscape. I attempted to estimate and compare daily movements and seasonal home ranges on the 2 areas. Habitat use within home ranges was also estimated and compared between areas. The influence of weather on movements and habitat use was examined.
METHODS

I conducted the study on 2 areas in north central Iowa. The Kossuth Study Area (KSA), 93.2 km$^2$ in northeastern Kossuth County dominated by rowcrop agriculture, was chosen to represent an intensive agricultural landscape (Fig. 1). The Palo Alto Study Area (PSA), 124.3 km$^2$ in northwestern Palo Alto and adjoining Clay counties, was chosen to represent a more diverse landscape and was larger in area to compensate for lakes (Fig. 2). Land use on PSA included rowcrop fields but also Conservation Reserve Program (CRP) areas and idle fields as well as areas managed for wildlife by government agencies.

Crop type and non-agricultural land use data were obtained from Agricultural Stabilization and Conservation Service 35mm 2x2 compliance slides for both study areas. The data were confirmed and updated by on-site observations. I used MIPS (Map and Image Processing System, MicroImages, Inc.$^1$) Geographic Information System (GIS) to digitize the land use data and build raster based maps of each study area. The GIS system provided computer-based applications designed to assemble and analyze spatial data (Shaw and Atkinson 1990). The resulting maps were coded with cover types and field borders defined by enclosed polygons, and also coded with UTM

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$^1$ Mention of manufacturers do not constitute endorsement.
Figure 1. Habitat map of the Kossuth study area (KSA), Kossuth County, Iowa, 1990-91
Figure 2. Habitat map of the Palo Alto/Clay study area (PSA), Palo Alto and Clay counties, Iowa, 1990-91
(Universal Transverse Mercator) coordinates for each area.

Climatological data were taken from records published for Iowa by the National Oceanic and Atmospheric Administration. The reporting station for PSA was Emmetsberg, approximately 16 km south east of the study area. For KSA, the reporting station for snow fall was Titonka, approximately 16 km south, and for temperatures was Swea City, approximately 16 km west.

From fall 1989 to spring 1991, pheasant hens were captured at each area by nightlighting (Labisky 1968), primarily in the fall (25 September-24 October 1989, 17 September-16 October 1990), and by bait trapping as snow cover allowed. Hens were marked with leg bands and fitted with 12-g necklace-type (Riley and Fistler 1992) radio transmitters (Holohill Systems Ltd., Woodlawn, Ontario, Canada). Mortality switches in the transmitters doubled the pulse rate when motionless for 4 hours.

Each hen was monitored using a vehicle-mounted receiver and antenna system. I adapted the program Triang (White and Garrott 1990) for the calculation of UTM coordinates for each location from triangulations at 3 stops. If birds were missing for 2 weeks or more, a search was conducted using a portable receiver and strut mounted antennas on a fixed wing aircraft.

Each day I chose 8 birds randomly, without replacement, on each study area to be monitored. Daily readings included 1
roost reading and, for 1989-90, 1 daytime reading per bird. In 1990-91 2 daytime readings were obtained per bird. Roost locations were taken between dusk and dawn, usually after dusk. Daytime readings were taken in 1 of 3 activity periods (sunrise-11am, 11am-3pm, 3pm-sunset) to roughly correspond to daily foraging and loafing behavior (Green 1938, Weston 1954).

Movements

I calculated the linear distance (m) from a roost location to a daytime location for each pair of readings for each bird. The linear distance (m) between successive roosts was calculated and adjusted for the number of days between the locations to be consistent. Generally, the fewer birds radioed on KSA resulted in fewer days between successive roost locations. Because other studies have reported seasonal differences in daily movements (Whiteside and Guthery 1983, Gatti et al. 1989), I grouped distances into 14-day intervals starting 01 January through 01 April to test for change during winter. In 1989-90, intensive monitoring of birds did not begin until the second 14-day interval. I used the general linear model (GLM) procedure in SAS (SAS Inst. 1987) to compare daily movements and distances between roosts among 14-day intervals, activity periods, years, and study areas. Least-squares means were calculated, and Student's t test was
used to compare means within classes.

I chose the harmonic mean home range estimator (Dixon and Chapman 1980) because Boulanger and White (1990) found it was the least biased of 4 estimators, including the minimum polygon. Also White and Garrott (1990) recommended the harmonic mean estimator for defining home ranges with 2 centers of activity, and my field observations suggested that some of the hens had more than 1 center of activity. I used MIPS to calculate home ranges for all individuals with 25 or more locations (Mares et al. 1980, Samuel and Garton 1985) between 27 November and 01 April.

Ackerman et al. (1990) recommended, on average, the use of no more than 1 grid cell per data point in harmonic mean calculations. My sample sizes varied from 25 to 87, and so I set the grid density to the lowest value available for each set of locations. Eighty percent isopleths were used to circumscribe the general area of use (Smith 1990). I compared home range area (ha) by year and area with the GLM procedure.

Habitat Use

I used MIPS to overlay home range polygons on habitat rasters to quantify habitats within the home ranges. Habitat types were condensed to 5 habitat categories for analysis: STUBBLE, GRASS, WETLAND, WOODY, and OTHER (Table 1). Total
Table 1. Habitat types included in general habitat categories

<table>
<thead>
<tr>
<th>GRASS</th>
<th>WOODY</th>
</tr>
</thead>
<tbody>
<tr>
<td>grass</td>
<td>farmstead</td>
</tr>
<tr>
<td>mowed/grazed grass</td>
<td>shelterbelt</td>
</tr>
<tr>
<td>plowed grass</td>
<td>woody vegetation</td>
</tr>
<tr>
<td>hay</td>
<td>urban/school</td>
</tr>
<tr>
<td>mowed hay</td>
<td>cemetery</td>
</tr>
<tr>
<td>plowed hay</td>
<td></td>
</tr>
<tr>
<td>oats</td>
<td></td>
</tr>
<tr>
<td>small grain</td>
<td>bean stubble/plowed</td>
</tr>
<tr>
<td>roads/gravel</td>
<td>corn stubble/plowed</td>
</tr>
<tr>
<td>railroad</td>
<td>sorghum stubble</td>
</tr>
<tr>
<td>unknown</td>
<td>small grain stubble/plowed</td>
</tr>
<tr>
<td></td>
<td>oat stubble/plowed</td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
</tr>
<tr>
<td>unharvested corn</td>
<td>WETLAND</td>
</tr>
<tr>
<td>unharvested soybeans</td>
<td>wetlands</td>
</tr>
<tr>
<td>unharvested sorghum</td>
<td></td>
</tr>
<tr>
<td>unknown plowed</td>
<td></td>
</tr>
<tr>
<td>plowed ground</td>
<td></td>
</tr>
<tr>
<td>water</td>
<td></td>
</tr>
<tr>
<td>unclassified</td>
<td></td>
</tr>
</tbody>
</table>
area (ha) of each cover type was obtained for each study area and for individual home ranges. The number of locations by habitat type within the home ranges was also obtained.

I compared the proportions of habitats on the study areas to the proportion of habitats within home range boundaries to examine selection of home range at the scale of the study area. Habitats were considered to be selected if they were present within home ranges in larger proportions than was available on the areas. I also compared the observed number of locations within habitats of home ranges to the expected number to examine selection at a smaller scale. Habitats were considered to be selected if the observed numbers of locations in a habitat were greater than the expected numbers based on availability.

I used the SAS procedure GLM (SAS Inst. 1987) to run multivariate analysis to test the null hypothesis that the difference between the proportions of habitat categories on the study area and the proportion within the home ranges, weighted by size, equaled zero. The same procedure was used to test the null hypothesis that the difference between the expected proportions of locations in habitat categories within home ranges and the observed proportion of locations within home range habitats equaled zero. Comparisons of habitat use and composition within home ranges were done between years by study area with the GLM procedure.
RESULTS

The habitat classification differed by less than 2% between years. In 1990-91, KSA was comprised mainly of STUBBLE (84.3%), with GRASS (11.6%), WOODY (1.9%), and OTHER (2.2%) comprising the remainder. STUBBLE was also the major habitat on PSA but comprised only 56.5% of the total area, whereas GRASS (25.4%) was more important than on KSA. WETLAND (6.7%), WOODY (3.7%), and OTHER (7.7%, lakes/water 7.3%) comprised the remainder. Crop fields were larger on KSA where there were 84 STUBBLE fields greater than 30 ha and 14 fields greater than 60 ha. PSA had 41 fields greater than 30 ha, but none greater than 60 ha. Only 4 GRASS fields greater than 30 ha and 1 greater than 60 ha occurred on KSA. On PSA there were 27 GRASS fields greater than 30 ha and 15 greater than 60 ha. There were no WOODY patches greater than 5 ha on KSA, but 7 occurred on PSA.

The number of days with measurable snow cover and total snow fall were less in 1989-90 than 1990-91 (Table 2). Mean monthly temperatures (December-March) were similar (within 3°C) between years except for January (1989-90, $\bar{x} = 28.6^\circ$C; 1990-91, $\bar{x} = 11.7^\circ$C).
Table 2. Weather information, published by the National Oceanic and Atmospheric Administration, for the Kossuth and Palo Alto/Clay study areas, 27 November-01 April, 1989-91

<table>
<thead>
<tr>
<th></th>
<th>KSA</th>
<th>PSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1989-90</td>
<td>1990-91</td>
</tr>
<tr>
<td>Days with measurable snow cover</td>
<td>15</td>
<td>101</td>
</tr>
<tr>
<td>Days with measurable snow cover</td>
<td>24</td>
<td>95</td>
</tr>
<tr>
<td>Total snow fall, cm</td>
<td>35.56</td>
<td>87.63</td>
</tr>
<tr>
<td>Mean average monthly temperature, °C</td>
<td>-2.81</td>
<td>-3.36</td>
</tr>
<tr>
<td>Mean average monthly temperature, °C</td>
<td>-2.51</td>
<td>-3.04</td>
</tr>
</tbody>
</table>
 Movements

I analyzed the daily movements of 25 hens on KSA and 60 on PSA in 1989-90 and 33 hens on KSA and 63 on PSA in 1990-91. The range of movements throughout the winter averaged 292-407 m in 1989-90 and 185-323 m in 1990-91, and the differences were not significant (1989-90, $F = 1.88, 5, 5$ df, $P = 0.253$; 1990-91, $F = 1.86, 6, 6$ df, $P = 0.235$). The range of movements by activity period was 307-314 m in 1989-90, and the differences were not significant ($F = 0.07, 2, 10$ df, $P = 0.935$). In 1990-91, movements in the morning period ($\bar{x} = 221$ m, SE = 13) were smaller than the midday period ($\bar{x} = 256$ m, SE = 13, $t = -3.263, 12$ df, $P = 0.007$) and the afternoon period ($\bar{x} = 248$ m, SE = 13, $t = -2.509, 12$ df, $P = 0.027$).

No differences were detected between the mean daily movements of hens on the 2 areas in 1989-90 (KSA, $\bar{x} = 330$ m, SE = 31; PSA, $\bar{x} = 289$ m, SE = 34, $F = 0.78, 1, 83$ df, $P = 0.380$). However, there was significant variation among individuals within each area ($F = 1.42, 83, 649$ df, $P = 0.012$). In contrast in 1990-91, the mean movement on KSA ($\bar{x} = 215$ m, SE = 22) was smaller than on PSA ($\bar{x} = 268$ m, SE = 18, $F = 3.41, 1, 94$ df, $P = 0.068$). The difference was not significant but it may be important. Significant variation among individuals within areas was also present in 1990-91 ($F = 2.24, 94, 1633$ df, $P < 0.001$). The decrease in daily movements
on KSA from 330 m to 215 m was significant between 1989-90 and 1990-91 ($F = 7.98, 1,5 \text{ df}, P = 0.037$), but the increase between means on PSA was not significant ($F = 2.33, 1,5 \text{ df}, P = 0.187$).

The range in distances between roost locations in 1989-90 was 60-139 m and in 1990-91 was 47-75 m, but the differences were not significant (1989-90, $F = 4.36, 5,5 \text{ df}, P = 0.066$; 1990-91, $F = 2.04, 6,6 \text{ df}, P = 0.204$). The mean distance between roosts on KSA (1989-90, $\bar{x} = 113 \text{ m, SE = 12}$; 1990-91, $\bar{x} = 78 \text{ m, SE = 9}$) was higher than PSA in both years (1989-90, $\bar{x} = 68 \text{ m, SE = 15}, F = 5.34, 1,68 \text{ df}, P = 0.020$; 1990-91, $\bar{x} = 43 \text{ m, SE = 8}, F = 7.78, 1,85 \text{ df}, P = 0.006$). There was significant variation in distances within areas in both years (1989-90, $F = 1.76, 68,597 \text{ df}, P < 0.001$; 1990-91, $F = 1.29, 85,755 \text{ df}, P = 0.045$). No differences in distances between roosts were detected between years on either area (KSA, $F = 0.75, 1,5 \text{ df}, P = 0.425$; PSA, $F = 3.88, 1,5 \text{ df}, P = 0.106$).

The mean home range size on KSA in 1989-90 was 72 ha (SE = 16); not significantly different from the 1990-91 estimate ($\bar{x} = 122 \text{ ha, SE = 28}, F = 2.32, 1,39 \text{ df}, P = 0.136$). The mean home range size on PSA in 1989-90 was 43 ha (SE = 13), not significantly different than the estimate in 1990-91 ($\bar{x} = 46 \text{ ha, SE = 7}, F = 0.06, 1,35 \text{ df}, P = 0.815$). In 1989-90 the home range estimate on KSA was not significantly different from that on PSA ($F = 1.23, 1,26 \text{ df}, P = 0.278$); however, in
1990-91, the estimate on KSA was significantly larger than on PSA ($F = 8.99, 1,48 \text{ df}, P = 0.004$).

Habitat Use

**Study area scale**

On KSA, GRASS habitats were present within home ranges in greater proportions than on the study area in both years (1989-90, $F = 9.70, 1,19 \text{ df}, P = 0.006$; 1990-91, $F = 9.97, 1,16 \text{ df}, P = 0.006$), and STUBBLE habitats were present in smaller proportions (1989-90, $F = 9.64, 1,19 \text{ df}, P = 0.006$; 1990-91, $F = 8.66, 1,16 \text{ df}, P = 0.010$). In 1989-90 only, OTHER was present in home ranges in smaller proportions than on KSA as a whole ($F = 4.62, 1,19 \text{ df}, P = 0.045$).

On PSA, GRASS (1989-90, $F = 8.30, 1,7 \text{ df}, P = 0.024$; 1990-91, $F = 123.28, 1,27 \text{ df}, P = 0.0001$) and STUBBLE (1989-90, $F = 87.22, 1,7 \text{ df}, P = 0.0001$; 1990-91, $F = 144.91, 1,27 \text{ df}, P = 0.0001$) habitats were also selected and avoided, respectively, in both years relative to the study area. In 1990-91 only, proportions of WETLAND habitats ($F = 11.81, 1,27 \text{ df}, P = 0.002$) were larger and proportions of OTHER habitats ($F = 28.63, 1,27 \text{ df}, P = 0.0001$) were smaller in home ranges relative to the study area.

Larger mean proportions of WOODY habitats were contained in home ranges on both areas in 1990-91 compared to 1989-90
(KSA, $F = 7.81, 1,35 \text{ df}, P = 0.008$, Table 3; PSA, $F = 4.51, 1,34 \text{ df}, P = 0.041$, Table 4). Also, the mean proportion of GRASS was significantly lower on PSA in 1990-91 ($F = 5.93, 1,34 \text{ df}, P = 0.020$).

**Home range scale**

On KSA, more locations were found in GRASS habitats ($1989-90, F = 67.31, 1,19 \text{ df}, P = 0.0001; 1990-91, F = 9.09, 1,16 \text{ df}, P = 0.008$) and less in STUBBLE habitats ($1989-90, F = 53.56, 1,19 \text{ df}, P = 0.0001; 1990-91, F = 31.22, 1,16 \text{ df}, P = 0.0001$) than expected in both years. In 1990-91 only, locations in OTHER ($F = 33.09, 1,16 \text{ df}, P = 0.0001$), as well as in WOODY ($F = 6.87, 1,16 \text{ df}, P = 0.018$) were greater than expected.

On PSA, the proportion of locations in GRASS was greater than expected ($1989-90, F = 8.47, 1,7 \text{ df}, P = 0.023; 1990-91, F = 7.88, 1,27 \text{ df}, P = 0.009$), and the proportion in STUBBLE was less ($1989-90, F = 6.215, 1,7 \text{ df}, P = 0.042; 1990-91, F = 12.93, 1,27 \text{ df}, P = 0.001$) in both years.

On KSA, the mean proportion of locations within OTHER ($F = 9.81, 1,35 \text{ df}, P = 0.003$), STUBBLE ($F = 9.16, 1,35 \text{ df}, P = 0.005$), and WOODY ($F = 10.14, 1,35 \text{ df}, P = 0.003$) increased significantly from 1989-90 to 1990-91 (Table 3). The mean locations in GRASS decreased significantly on KSA ($F = 21.52, 1,35 \text{ df}, P = 0.0001$).
Table 3. Total proportion of habitat in study area, proportion of habitats in home range, and proportion of locations in habitats within home range, Kossuth study area, 1989-91

<table>
<thead>
<tr>
<th>Habitat categories</th>
<th>Area totals</th>
<th>Study area scale</th>
<th>Home range scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990-91*</td>
<td>(\bar{x}) SE</td>
<td>(\bar{x}) SE</td>
</tr>
<tr>
<td>GRASS</td>
<td>0.1015</td>
<td>0.378 0.600</td>
<td>0.252 0.045</td>
</tr>
<tr>
<td>WOODY</td>
<td>0.0194</td>
<td>0.021(^a) 0.003</td>
<td>0.042(^a) 0.007</td>
</tr>
<tr>
<td>WETLAND</td>
<td>0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>STUBBLE</td>
<td>0.8573</td>
<td>0.588 0.058</td>
<td>0.689 0.047</td>
</tr>
<tr>
<td>OTHER</td>
<td>0.0218</td>
<td>0.010 0.004</td>
<td>0.017 0.006</td>
</tr>
</tbody>
</table>

* category totals differed less than 2% between years

\(^a\) yearly means with the same superscript letter are significantly different (\(P \leq 0.05\))
Table 4. Total proportion of habitat in study area, proportion of habitats in home range, and proportion of locations in habitats within home range, Palo Alto/Clay study area, 1989-91

<table>
<thead>
<tr>
<th>Habitat Categories</th>
<th>Area Totals</th>
<th>Study Area Scale 1989-90</th>
<th>1990-91</th>
<th>Home Range Scale 1989-90</th>
<th>1990-91</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990-91</td>
<td>x</td>
<td>SE</td>
<td>x</td>
<td>SE</td>
</tr>
<tr>
<td>GRASS</td>
<td>0.2478</td>
<td>0.690</td>
<td>0.080</td>
<td>0.509</td>
<td>0.033</td>
</tr>
<tr>
<td>WOODY</td>
<td>0.0386</td>
<td>0.021</td>
<td>0.007</td>
<td>0.052</td>
<td>0.007</td>
</tr>
<tr>
<td>WETLAND</td>
<td>0.0624</td>
<td>0.097</td>
<td>0.049</td>
<td>0.225</td>
<td>0.042</td>
</tr>
<tr>
<td>STUBBLE</td>
<td>0.5700</td>
<td>0.162</td>
<td>0.042</td>
<td>0.189</td>
<td>0.034</td>
</tr>
<tr>
<td>OTHER</td>
<td>0.0812</td>
<td>0.029</td>
<td>0.019</td>
<td>0.026</td>
<td>0.010</td>
</tr>
</tbody>
</table>

* Category totals differed less than 2% between years

* means significantly different (P ≤ 0.05)
DISCUSSION

Daily movements on both KSA and PSA were smaller than similar movement estimates reported in the literature, though caution must be used when making comparisons due to methodological differences. Grondahl (1953) observed marked pheasant hens in Winnebago County, Iowa, and reported a mean daily cruising radius during the period 21 December to 25 February of 627 m. Gates and Hale (1974) reported of a backtagged Wisconsin population that day-to-day winter movements were rarely over 402 m with 804 m the upper limit, and mean movements for years, ages, and sexes combined was 644 m.

I found no seasonal variation of daily movements because I concentrated on the winter season exclusively, after pheasants disperse into winter habitats in the fall. Variations in movements by activity periods occurred only in 1990-91. Hens fed close to roost in the mornings and traveled further to loaf and to feed in the afternoons.

Home range estimates on both areas were not different between years, but the variation was large. The estimates were considerably larger than others reported in the literature (Penrod et al. 1987). For example, in southern Iowa, Wooley and Rybarczyk (1981) calculated the area of convex polygons (Mohr 1947) and estimated mean size of winter
home ranges (01 January-31 March) as 28 ha (SD = 18, n = 83).

The variation in movements and home ranges within areas may be due to the habitat variations within areas. Birds that concentrated their activity around "quality" habitat, such as larger blocks of CRP, may have smaller movements while birds that used food plots or smaller idle areas may range further.

The major difference I detected between the winters of 1989-90 and 1990-91 was weather. More snow fell over a longer time span in 1990-91. Daily movements were smaller on KSA, but not on PSA, in 1990-91. Thus it appears that snow cover reduced movements on the sparse landscape and that snow was a bigger influence to hens on KSA. Other studies have reported changes in pheasant behavior related to snow cover.

In northern Iowa, Weston (1954) observed that presence of snow cover was associated with more limited pheasant activity. His study area contained managed lands that provided feeding, loafing, and roosting cover in close proximity. However, Grondahl (1953) reported increased movements related to snow cover as roost habitat quality decreased and as birds dispersed into other cover areas. Gates and Hale (1974) calculated the average distances of movements between 01 January and winter break-up (approximately mid-March) for 7 winters. The 2 largest means occurred in the most severe winters, and the authors attributed the greater distances to changes in "residence" and not simply increased day-to-day
movements. Wooley and Rybarczyk (1981) reported annual variation, though not significant, in home range areas from 3 winters. The largest mean occurred in the most severe winter. However, Gatti et al. (1989) reported that monthly home ranges from a Wisconsin population were negatively related to depth of snow.

The decrease in movements between years was not reflected in home range sizes, and the smaller daily movements in 1990-91 is not consistent with the similar or larger home range estimates of 1990-91. There are reports in the literature of both increased and decreased activity during winter. Daily movements appear to be smaller when snow is present until protective cover becomes inadequate and then movements were increased in the search for adequate cover (Grondahl 1953, Weston 1954, Gates and Hale 1974). Gatti et al. (1989) reported that variation in home range estimates in their study was due to shifts in centers of activity. Perhaps, in my study, there were more changes in centers of activity due to reduced quality of cover related to snow. Snow accumulation can reduce available cover by compressing vegetation and filling in or drifting in of vegetation. May (1978) studied windbreaks and reported that the amount of snow drifting in patches was related to their size and shape.

Home range estimates tended to be larger on KSA than on PSA, even in the mild winter, therefore, it appeared hens were
using the landscape differently. Hens might spend more time searching for cover which results in shifts in centers of activity and increases in home range sizes. There was no evidence that the home range size on PSA was influenced by snow. Survival of hens on KSA was found to be significantly lower than PSA in 1990-91 (Perkins 1992), and other studies reported that larger home ranges were related to reduced survival (Penrod et al. 1987, Gatti et al. 1989).

On KSA STUBBLE habitats were avoided and GRASS habitats were important in both years at both levels of selection. However, WOODY habitats increased in importance in the second year. The proportion of WOODY habitat in home ranges increased significantly between years though not enough to be greater than the available habitat. Within the home ranges, use of WOODY habitat was greater than expected, and the proportions of locations in that habitat increased from 1989-90 to 1990-91.

On PSA STUBBLE and GRASS were also important in both years at both scales. However, in 1990-91 WETLANDS were also selected within home ranges relative to the study area.

Gatti et al. (1989) compared habitat in home ranges to habitat on the study area of radioed hens in Wisconsin. The study area was 52% "active croplands", 14% "marshes", and 5% "retired croplands". Monthly home ranges (January-March) showed strong hen preference for marshes, strong avoidance of
active croplands, and weak avoidance of active pastures. However, when they compared habitat at locations with home range habitat, marshes were avoided. In Iowa, Wooley and Rybarczyk (1981) investigated habitat use by comparing the percentage of locations in habitats to the percentage of habitat on the study area. In winter, "idle areas" and "waterways" were used more than available while "cropland" and "hay-pasture" were avoided.

As with movements, habitat use changed between years concurrent with weather changes. Penrod et al. (1986) also reported habitat use change in relation to weather; less use of grass and more use of woods in a winter rated twice as severe as the previous winter. In 1990-91 birds on KSA, where there was more marginal habitat, selected more habitats within home ranges than on PSA. However, the decrease on KSA of locations in GRASS and the increase of locations in STUBBLE was unexpected. The difference in proportions between years may be related to the larger home ranges in 1990-91. KSA contained a large amount of STUBBLE and little GRASS and an increase in the calculated home range size would enclose a larger relative amount of STUBBLE and a smaller amount of GRASS in the home ranges. Therefore the increase in amount of STUBBLE would increase the chance that a random location would be found in STUBBLE.

Home range estimates were consistently larger on the area
(KSA) with a less diverse landscape, even in the mild winter. Habitat use was also more variable between years on KSA. The differences in landscape did not appear detrimental to the KSA population in the mild winter of 1989-90 but the interaction of the more severe weather and poor landscape structure in 1990-91 significantly reduced the survival on KSA relative to PSA (Perkins 1992).
LITERATURE CITED


SECTION 2. OVERWINTER SURVIVAL OF RING-NECKED PHEASANT HENS
ABSTRACT

I used the Kaplan-Meier (KM) product limit method to estimate survival of 219 pheasant hens (*Phasianus colchicus*) marked with radio transmitters on 2 areas in north central Iowa. Survival was contrasted between the Kossuth Study Area (KSA), chosen to represent landscapes dominated by intensive rowcrop agriculture, and the Palo Alto/Clay Study Area (PSA), representing a more diverse landscape. Hens captured by nightlighting or baittrapping were relocated at night roost locations and at 3 daytime activity periods during the winters of 1989–91. Cox's proportional hazards model was used to examine habitat and movement variables that influenced survival. In winter 1989–90 only 4 of 98 pheasant hens died, 3 by predation, and survival estimates did not differ between study areas (KSA \( \hat{S} = 0.90 \), PSA \( \hat{S} = 0.96 \), \( p = 0.47 \)). However, in winter 1990–91, 44 of 143 pheasant hens died, 84% by predation, and survival was significantly lower on KSA (KSA \( \hat{S} = 0.43 \), PSA \( \hat{S} = 0.62 \), \( p = 0.0002 \)). Average distance between a night roost location and a morning location, type of capture method used, and number of days with snow cover prior to date of death were related to the hazard function. Both winter weather and landscape structure appeared to influence survival of pheasant hens.
Historically, Iowa ring-necked pheasant (Phasianus colchicus) populations were greatest in the north central part of the state (Farris et al. 1977), but more recent roadside counts indicate a reduction in numbers (Suchy et al. 1991). Winter storms in 1965 and 1975 apparently caused reductions, but the pheasant populations have not returned to former densities (Fig. 1). Landscape level changes in habitat are blamed for decreases in pheasant numbers around the United States (Nomsen 1969, Labisky 1976, Dahlgren 1988), but the specific influences of habitat change on demographics are not well understood.

Survival of pheasant hens is critical to population sizes (Jarvis and Simpson 1978), and much research has focused on winter because of suspected high hen mortality. Studies by Dumke and Pils (1973), Gates and Hale (1974), and Penrod et al. (1987) found winter losses ranging from 35% to 89% to be significant in hen population fluctuations.

Extreme cold temperatures are apparently not as limiting to pheasant populations as snow (Weston 1954, Klonglan 1971, Penrod et al. 1987). There are anecdotal reports of huge population losses due to severe winter storms, but most estimates of losses are not accurate. They were determined from casual observations, spring roadside counts, or spring
Figure 1. Pheasant population trends in the 33 county Cash Grain region of north central Iowa, 1962-1990, based on August roadside surveys by the Iowa Department of Natural Resources
cock-call counts (Klonglan 1971, Farris et al. 1977, Warner and David 1982). Klonglan (1971) reviewed data from several Iowa winters and suggested that the timing of winter storms influenced mortality rates. The 1940 Armistice Day storm and the 1965 St. Patrick's Day blizzard, with mortality estimates of 50-90% and 50-75% respectively, both began in the pheasant morning feeding period. A storm in March 1966, rated more extreme than the 1965 blizzard, hit in the evening and caused minimal loss to pheasant populations.

In addition, the distribution and quality of cover has been implicated in such losses. Narrow shelterbelts or other cover types, regardless of storm timing, do not provide adequate protection in storms with high winds because they do not prevent internal snow drifts (May 1978, Linder 1984). If storms strike during feeding periods, the distance between feeding habitats and protective cover can be important. Gates and Hale (1974) observed that the distribution of winter cover had a greater influence on population distributions than did food sites.

A landscape may have what appears to be an abundance of quality cover, but if it is not spatially associated with feeding areas, its actual quality may be reduced. Mohlis (1974) stated that reduced winter cover quality in north central Iowa was due to increased distances between cover and feeding areas. Some food patches in Ohio were not utilized
due to lack of protective travel lanes in the vicinity, which suggests landscape structure influence (Leite 1971).

In a review of Wisconsin pheasant research, Petersen et al. (1988) suggested that low survival resulted from habitat loss and operated through increased predation. In South Dakota, predation rates have increased, according to a review of research by Trautman (1982), due to loss of quality winter cover. A Wisconsin study (Dumke and Pils 1973) using radio telemetry attributed 78.6% of mortality from 1 October to 31 March to predation. From 19 February to 14 April, predation was the only discernable cause of death.

Movement patterns and mortality appear related and influenced by landscape structure. Telemetry studies by Penrod et al. (1987) and Gatti et al. (1989) in New York and Wisconsin respectively, found that, as a group, hens that died had larger home ranges than hens that survived. In the New York study, hens that died had a higher percentage of openland and grasses within their home ranges. During winter in Wisconsin the percentage of home range area in food patches was inversely related to home range size (Gatti et al. 1989).

The evidence suggests that survival of pheasants is related to winter weather and to landscape structure. This study addressed winter pheasant hen survival on 2 areas in north central Iowa with different landscapes. My objectives were to estimate and compare survival between an area that
represented an intensive agricultural landscape with sparse habitat and an area with a more diverse landscape. Weather conditions, habitat use, and movements were also related to survival. I expected survival to be poorer on the sparse agricultural landscape.
METHODS

I conducted this study on 2 areas in north central Iowa (Perkins 1992). The Kossuth Study Area (KSA), predominated by rowcrop agriculture, is a 93.2 km$^2$ area located in northeastern Kossuth County. The Palo Alto Study Area (PSA) is a 124.3 km$^2$ area, larger to compensate for lakes, located in northwestern Palo Alto County and adjoining Clay County. Land use on PSA includes row crops but also set aside and idle fields as well as areas, especially wetlands, managed for wildlife by public agencies.

Pheasant hens were captured at each site by nightlighting (Labisky 1968), primarily in the fall (25 September-24 October, 1989; 17 September-16 October, 1990), and later by bait trapping when snow cover allowed. I weighed each hen to the nearest 10 g, measured the wing length (mm) as the distance from wrist to most distal tip of primaries, collected the proximal (first) primary feather, and measured the bursa of Fabricius (mm) until January (Linduska 1943, Wishart 1969). Hens were marked with leg bands and 12 g necklace-type (Riley and Fistler 1992) radio transmitters (Holohill Systems, Ltd., Woodlawn, Ontario, Canada$^1$) with mortality switches that doubled the pulse rate when motionless for 4 hours. A

$^1$ Mention does not constitute endorsement.
condition index was calculated as the ratio of body weight to wing length cubed (Owen and Cook 1977).

Feather shaft diameters and bursa depth measurements were used to age hens as hatch-year (HY) or after-hatch-year (AHY). The bursa depth method is useful only until midwinter as the bursa of juveniles decreases (Wishart 1969), therefore, the feather diameter method was used to supplement the bursa method. Proximal primaries were dried following Greenberg et al. (1972) and measured with a calipers to the nearest 0.01 mm in the plane of the vane at the superior umbilicus. I assumed the bursa measurement was an accurate indicator of age and used it in discriminate analysis using PROC DISCRIM (SAS Inst. 1987) to develop a classification function for feather diameter.

Climatological data were taken from records published for Iowa by the National Oceanic and Atmospheric Administration. The reporting station for PSA was Emmetsberg, approximately 16 km southeast of the study area. For KSA the reporting station for snow fall was Titonka, approximately 16 km south, and for temperatures was Swea City, approximately 16 km west of the study area.

Each hen was monitored with a receiver and vehicle-mounted antenna system at least 2 times per week to determine survival status. A search by airplane was made for hens missing 2 weeks or more. When a bird died, the carcass and
transmitter were located when possible and examined to
determine approximate cause of death (Einarsen 1956, Dumke and
Pils 1973). The date of death was considered the midpoint
between the last date an individual was known alive and the
first date it was known dead for intervals 14 days or less.

The Kaplan-Meier product limit estimator with staggered
entry was used to estimate survival by age, study site, and
year (Pollock et al. 1989a). The method assumes that survival
times are independent between animals, that the censoring
mechanism is random, and that newly tagged animals have the
same survival function as previously tagged animals (Pollock
et al. 1989b). I censored hens because of transmitter failure
before death, emigration from study area, survival past study
period, or when an interval for determining date of death was
greater than 14 days (Pollock et al. 1989a). I modified SAS
code (SAS Inst. 1987), originally written by White and Garrott
(1990:236-239), to calculate survival estimates with left­
truncation. I compared survival functions with log rank tests
to identify whether the functions came from a common
underlying function (Pollock et al. 1989b).

I used the Cox proportional hazards model to examine
variables potentially related to the probability of dying at a
particular time (Pollock et al. 1989a). The major assumption
of the model is that the functions of the covariates have a
multiplicative or proportional relationship to the underlying
hazard function (Hopkins 1988, White and Garrott 1990). Covariates may be either discrete or continuous variables associated with individual animals (White and Garrott 1990). Covariates with positive coefficients increase the hazard and decrease survival while negative coefficients decrease the hazard and the magnitude of the coefficient indicates its relative importance to survival.

I used the program P2L in the BMDP statistical software package (Hopkins 1988) to run Cox's model. Covariates are entered into the model in a forward stepwise procedure, and after a new covariate is added all the variables in the model are tested and nonsignificant variables removed (Sievert and Keith 1985). Initially I used an entry limit of \( P < 0.25 \) and removal limit of \( P > 0.30 \) and subsequently refined models using an entry limit of \( P < 0.10 \) and a removal limit of \( P > 0.10 \). I included 18 variables in the analysis: YEAR (1990, 1991), SITE (KSA, PSA), AGE (HY, AHY), COND (condition index), CAPTYPE (nightlight, baittrap). The weather variables were SNOW, total snow fall (in) in 7 days previous to date of death, and SNDAYS, number of the 7 days with measurable snow on the ground. Four movement variables (Perkins 1992) were used: DIST1, DIST2, and DIST3 represented the average linear distance (m) between night roost locations and locations in each of 3 daytime activity periods. The fourth movement variable, ROOST, was the average distance (m) between
sequential roost locations adjusted for the number of days between locations. Habitat variables (Perkins 1992) included: GRASS, STUBBLE, WOODY, WETLAND and were the proportion of an animal's locations in each of those habitat categories. NUMHAB was the number of habitats used by an individual bird, CAPHAB was the type of habitat where the bird was captured, and ENDHAB was the type of habitat where the bird was recovered.

I looked at 3 different criteria to evaluate the resulting models. I checked for evidence of multicolinearity by examining the covariate correlation matrix. Covariates with $r > 0.45$ were considered to provide redundant information (Sievert and Keith 1985). To check the proportional hazards assumption, I plotted the log minus log survivor function against time (Kalbfleisch and Prentice 1980, Hopkins 1988). The plot should show constant differences between curves if the assumption has been met, and covariates that did not meet the assumption were specified as a stratum. Program P2L allows the hazard function to be different for each stratum while the regression coefficients remain the same across strata (Hopkins 1988). I also examined the results of the likelihood ratio test with the null hypothesis that all regression coefficients were 0 (Hopkins 1988).
I put radio transmitters on 98 pheasant hens during 1989-90 and on 143 hens during 1990-91 that I used in survival analysis. The study period was 27 November to 01 April during both years.

Snowfall and temperature information was examined for each study area (Perkins 1992). The number of days with measurable snow cover was much less in 1989-90 ($\bar{x} = 19$ days) than 1990-91 ($\bar{x} = 98$ days). The total snow fall was also much less in 1989-90 ($\bar{x} = 38$ cm; 1990-91, $\bar{x} = 184$ cm). The mean monthly temperatures (December-March) were similar (within 3°C) between years except for January (1989-90 $\bar{x} = 28.6^\circ C$, 1990-91 $\bar{x} = 11.7^\circ C$).

Information was available from 90 hens for use in discriminate analysis. I used a quadratic function, due to unequal variances between the feather measurements by age. The resulting diameter for the cutoff between HY and AHY was 2.806 mm with AHY greater than that value. This criterion resulted in 95 hens assigned to HY and 90 to AHY of the 219 birds that I used in survival analysis. For HY individuals the mean shaft diameter was 2.647 mm (SE = 0.015) and the mean bursa measurement was 24.60 mm (SE = 1.02, n = 58). For AHY individuals the mean shaft diameter was 2.999 mm (SE = 0.015), and the mean bursa measurement was 5.69 mm (SE = 1.65, n = 32).
Censoring occurred to 13% of radioed individuals in 1989-90 (5 radio problems, 4 date-of-death intervals too large, 3 off area, 1 lost) and to 17% of individuals in 1990-91 (11 intervals too large, 7 dispersed off area, 3 lost, 3 radio problems, 1 other).

Of the marked individuals in 1989-90, there were only 4 mortalities: 2 attributed to mammalian predation, 1 to avian predation, and 1 unknown. Three of the censored individuals were also known to have died of predation, 2 mammalian and 1 avian, but an accurate estimate of date-of-death was not possible. In 1990-91, 44 mortalities were documented with 33 (75%) mammalian predation, 4 (9%) avian, and 7 (16%) unknown. The cause of death for censored birds for which date of death was not known included 17 by mammalian and 1 by avian predators.

It was not a specific goal of this study to identify individual species of predators though occasionally enough evidence was available to make some generalizations. Fox were identified frequently by tracks, feces, and urine and I suspect they were the primary mammalian predator. On PSA there was also evidence of mink predation: 1 radio recovered from a mink den and 1 radio disappeared underground in proximity to a suspected mink den. There was no evidence of direct weather related or starvation mortalities.
Generally there were no differences in survival between HY and AHY birds. On KSA, the Kaplan-Meier (KM) survival estimates for HY ($\hat{S} = 0.88$, SE = 0.12, n = 11) and AHY ($\hat{S} = 0.91$, SE = 0.09, n = 14) individuals were not significantly different in 1989-90 ($\chi^2 = 0.01$, df = 1, $P = 0.94$). Survival estimates for each age were not significantly different on PSA in 1989-90 (HY, $\hat{S} = 0.96$, SE = 0.04, n = 24; AHY, $\hat{S} = 1.00$, SE = 0.00, n = 26, $\chi^2 = 1.50$, df = 1, $P = 0.22$). In 1990-91 the HY survival estimate ($\hat{S} = 0.45$, SE = 0.16, n = 8) on KSA was significantly larger ($\chi^2 = 12.89$, df = 1, $P = 0.0003$) than AHY ($\hat{S} = 0.40$, SE = 0.13, n = 20). The PSA estimates were not significantly different (HY, $\hat{S} = 0.53$, SE = 0.09, n = 27; AHY, $\hat{S} = 0.67$, SE = 0.08, n = 34, $\chi^2 = 0.18$, df = 1, $P = 0.67$).

Because there was only a single exception, I pooled ages and added unaged individuals to the sample.

Because 3 of the 4 above tests failed to reject the null hypothesis I computed chi-square values to calculate the power of the comparisons of survival by age group. However, in contrast to the tests I assumed binomial survival and included the censored birds with the birds that lived. In all of the cases the power of the binomial tests was less than 10%.

In 1989-90 the KM survival estimate for KSA was 0.90 (SE = 0.07, n = 28), not significantly different ($\chi^2 = 0.52$, df =
1, \( P = 0.47\), from the PSA estimate of 0.96 (SE = 0.02, n = 56, Fig. 2). In 1990-91 the survival estimate for KSA was 0.43 (SE = 0.08, n = 33), significantly less than \( \chi^2 = 9.34, \) df = 1, \( P = 0.002 \) the PSA estimate of 0.62 (SE = 0.06, n = 62, Fig. 3). On both areas the survival estimates were significantly larger in 1990-91 (PSA, \( \chi^2 = 23.4, \) df = 1, \( P < 0.001 \); KSA, \( \chi^2 = 23.9, \) df = 1, \( P < 0.001 \)).

### Proportional Hazards

Although I initially wished to consider the influence of age and condition in the proportional hazards analysis, missing values resulted in decreased sample size. Furthermore, the KM analysis above suggested no age difference. Of the 16 variables initially included \( (n = 118) \), 5 were considered important after screening at \( P < 0.25 \) and \( P > 0.30 \): DIST1, SNOW, SNDAYS, CAPHAB, and YEAR. The plot of the log minus log survivor function against time suggested that YEAR was not proportional, so it was subsequently used as a stratification variable.

A new covariate, CAPTYPE, was introduced in an attempt to condense the categories within the CAPHAB variable. Nightlighting was done in grass habitats, particularly Conservation Reserve Program fields, and most bait trapping was done around woody vegetation such as farm groves. CAPTYPE
Figure 2. Kaplan-Meier survival estimates for pheasant hens on 2 areas in north central Iowa, 1989-90
Figure 3. Kaplan-Meier survival estimates for pheasant hens on 2 areas in north central Iowa, 1990-91
was run with CAPHAB, DIST1, DIST2, ROOST, SITE, SNDAYS, and SNOW (n = 135) and indeed did replace CAPHAB in subsequent models.

CAPTYPE, DIST1, DIST2, SNDAYS, and SNOW were tested (n = 138) with an entry limit of $E < 0.10$ and removal limit of $E > 0.10$, and the resulting model contained CAPTYPE, DIST1, SNDAYS, and SNOW. CAPTYPE and DIST1 were found to be correlated ($r = 0.556$), and I removed DIST1 because it had a smaller coefficient. CAPTYPE, DIST2, SNDAYS, and SNOW (n = 154) were run together but the resulting model, SNDAYS and SNOW, contained correlated variables ($r = 0.512$).

Because DIST1, CAPTYPE, and SNDAYS appeared to be important covariates, they were specified to enter the model in the final run (n = 148). As the number of days with snow cover ($\hat{B} = 0.8700$, SE = 0.1667) and the average distance between a night roost location and a morning location ($\hat{B} = 0.0023$, SE = 0.0011) increased, survival decreased. Decreased survival was associated with the bait trap method relative to the nightlighting method ($\hat{B} = 0.9868$, SE = 0.5419). DIST1 and SNDAYS were correlated ($r = 0.529$).
DISCUSSION

The survival estimates in 1989-90 were high relative to other reported estimates of fall-to-spring survival (Petersen et al. 1988). However it is difficult to compare estimates from the literature because of differences in methodology, variety in definitions of seasonal periods among studies, and different landscapes. Of estimates from radio collared hens, average percent survival ranged from 50.1% to 86.2% for "fall-to-spring" periods (Dumke and Pils 1973, Wooley and Rybarczyk 1981, Austin et al. 1985). The highest estimate, 86.2%, was from a New York study (Austin et al. 1985) during winter only when snow cover was not complete.

In 1990-91 the survival estimates were more similar to other studies. A 3-year study in southern Iowa by Wooley and Rybarczyk (1981) reported winter (01 January-31 March) estimates, products of 5-day survival estimates (Dumke and Pils 1973), ranging from 53.3% to 79.2%. The study site, in Lucas and Wayne counties, was 47.5% cropland and 23.5% hay-idle. Dumke and Pils (1973) in Wisconsin reported mean winter (15 December-14 April) survival estimates of radioed hens ranging from 31.2% to 67.9%.

The major difference between 1989-90 and 1990-91 appeared to be snow fall. Of other studies that have linked survival to winter weather (Dumke and Pils 1973, Gates and Hale 1974,
Wooley and Rybarczyk 1981), only Austin et al. (1985) related survival to specific conditions. They reported that winter mortality rates were positively correlated with both the total duration of winter and the duration of snow cover. My study showed that snow cover interacts with habitat to influence survival of hen pheasants.

PSA had a greater amount of potential winter habitat in larger size patches (Perkins 1992). The 2 landscapes did not appear to be functionally different in the mild first winter as shown by the similar high survival estimates in 1989-90. However, the differential survival during the more severe winter suggests important qualitative differences between the landscapes. Snow cover can indirectly influence pheasant survival by increasing risk of predation or other mortality factors. It can alter pheasant behavior by changing daily movements or habitat use (Gates and Hale 1974, Gatti et al. 1989, Perkins 1992), protect "buffer" species from predation (Wagner et al. 1965), and reduce quantity and quality of winter habitat (May 1978). My study found differences in movement and habitat use in 1990-91 in relation to snow cover (Perkins 1992). SNDAYS, rather than snow depth, was chosen of the 2 correlated snow variables for inclusion in the hazards model because snow cover seemed to be a more direct measure of the influence of snow on pheasant behavior.

The capture method (CAPTYPE) was negatively associated
with survival. Baittrapping decreased survival relative to nightlighting. Nightlighting occurred predominantly in grass fields during the fall, but baittrapping was done primarily in association with snow cover and woody vegetation. The birds that were caught in bait traps may have been in poorer condition than the birds captured by nightlighting. Also, the success of baittrapping was influenced by the amount of snow cover. This condition bias has been suggested for a variety of avian species. Decoy-trapped red-winged blackbirds had lower condition than mist-netted red-wings in a study by Weatherhead and Greenwood (1981). Weatherhead and Ankney (1984) suggested that a condition bias may influence waterfowl band-recovery analyses. Researchers should be aware of the possible biases associated with different capture methods and their effects on analyses.

The covariate DIST1 measured the average distance between a night roost location and a morning location likely to be during feeding times. Although the coefficient was small, it is not surprising that increased distances were associated with decreased survival. In Wisconsin, Gatti et al. (1989) found that home range size was negatively related to survival. Longer distances could increase exposure to predators, especially avian species. However fox, the main predator in my study, capture pheasants when they are on the roost. Increased distances may increase risk of exposure to mammalian
predators by putting birds in unfamiliar habitats. There could also be energetic costs to traveling longer distances that could indirectly influence survival. Gates and Hale (1974) suggested that pheasants remain on roost throughout cold winter days to reduce energetic costs.

I expected habitat covariates to be related to survival. GRASS was selected and STUBBLE was avoided by hens in my study (Perkins 1992). However, the survival was different between years and areas despite selection and avoidance occurring on both areas in both years. This discrepancy could have occurred because the habitat variables may have been too broadly defined to detect their influence on survival. Additionally, some habitat variables are difficult to utilize with the Cox model due to their time varying nature. Individuals that survived longer provided more information available about habitat use. For example, home range size have been suggested as a possible explanatory variable for survival (Penrod et al. 1987, Gatti et al. 1989), but an individual bird must live long enough to allow an adequate sample of locations to be collected for home range calculation.

Other studies have successfully used Cox proportional hazards to relate habitat variables to survival. Sievert and Keith (1985) reported that poor habitat quality reduced survival of snowshoe hares. In a study of raccoons (Judson
1990) the number of different habitats and den locations used by females had a positive influence on survival of young. The proportional hazards model may be an important tool in understanding the relationship between habitat and survival.

It is important to understand how pheasants interact with their surroundings on a landscape level. Future research should be designed to more specifically explore the relationship of the landscape configuration to pheasant ecology.
LITERATURE CITED


SUMMARY

I captured 219 ring-necked pheasant hens by nightlighting and baittrapping during the winters of 1989-91. Hens were marked with radio transmitters and monitored at night roosts and during 3 daytime activity periods.

In 1989-90 no study area differences were detected in daily movements, however, distances between roosts were larger on KSA. In 1990-91, a more severe winter, daily movements were smaller, distances between roost locations larger, and home range estimates larger on KSA.

Grass habitats were selected on both areas in both years at 2 scales. Crop stubble was likewise avoided. Woody cover on KSA was selected relative to the study area in 1989-90 and was selected relative to the home range in 1990-91. Wetlands were selected relative to the study area in both years on PSA.

Survival estimates were not different between age classes, so ages were pooled to compare estimates between study areas. In 1989-90 survival estimates were high but not different between areas. In 1990-91 PSA had a larger estimate and both estimates were lower than 1989-90. Proportional hazards analysis selected 3 potential explanatory variables: the average distance between a night roost and a morning location, the capture method used, and the number of days with snow cover out of the 7 prior to date of death.
ADDITIONAL LITERATURE CITED


