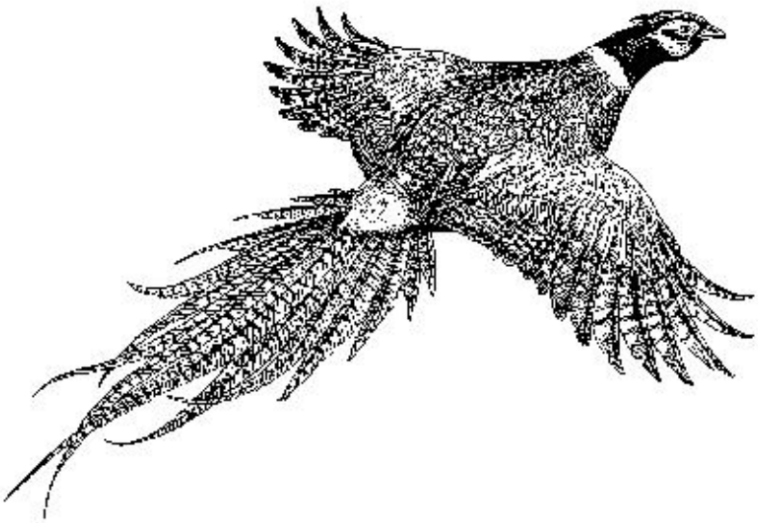
GAME REPORT

Survival, Spatial Ecology and Habitat Use of Male Ring-necked Pheasants in South Dakota

Anthony P. Leif



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Survival, Spatial Ecology and Habitat Use of Male Ring-necked Pheasants in South Dakota

Completion Report

by

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Abstract

Survival, Spatial Ecology and Habitat Use of Male Ring-necked Pheasants in South Dakota

Survival and habitat selection by breeding male pheasants (*Phasianus colchicus*) has received little attention in research and management of North American populations. In contrast, European pheasant managers focus on creating and enhancing habitats for breeding males and associated harems of female pheasants. Also, estimates of annual and time-specific survival and dispersal of male pheasants in North America are lacking in recent scientific literature. To evaluate these parameters, I radiomarked 95 male pheasants over 5 years (1997-2001) on 2 study areas in eastern South Dakota.

Annual survival of male pheasants varied from 0.125 to 0.417. Predators and pheasant hunters were responsible for all pheasant mortality except 1 death that resulted from a vehicular collision. Mammalian predators were responsible for a higher proportion (80%) of male pheasant deaths than raptors (20%) during the breeding period (15 March – 15 June), whereas avian predators were the only documented source of predation during winter. Survival during the breeding period was lower following severe winters (0.707 ± 0.077) than after relatively mild winters (0.875 ± 0.043). This difference may be related to a reduction of available habitat from snow flattening idle herbaceous cover and wetlands filling with melting snow. Pheasant hunters harvested between 45 and 57% of radiomarked pheasants that were alive upon initiation of hunting seasons. Approximately one-half of this harvest occurred in the first 9 days of pheasant hunting seasons.

Winter severity also influenced spring dispersal of radiomarked pheasants. A higher proportion of male pheasants dispersed following severe winters (93%) than following winters with below average precipitation and above average temperatures (60%). In addition, ambient temperatures in March influenced the timing of spring dispersal. When March weather was relatively warm, all dispersing males completed spring movements by 24 March, whereas spring dispersal continued well into April during years when March temperatures were relatively cold. The mean dispersal distance (3.2 ± 0.3 km [SE]) of male pheasants in South Dakota was >10x further than published mean dispersal distances of male pheasants in Europe.

Home range sizes for breeding male pheasants were bimodally distributed. One group of male pheasants exhibited localized movements and had relatively small (18.4 ± 0.9 ha) home ranges. A second group exhibited ephemeral movement patterns that were intermittently sedentary and mobile. These males had relatively large (45.4 ± 2.9 ha) home ranges. Defense of territories likely influenced the documented spatial distribution of breeding male pheasants. Home range size for ephemeral males was not related to proportional distributions of habitats comprising home ranges. However, 2 of 5 habitats effected home ranges sizes of localized males. The proportional abundance of woody cover decreased the size of localized male home ranges while higher proportions of cropland resulted in larger home ranges.

Both ephemeral and localized males established home ranges in areas with perennial herbaceous and woody cover. Perennial cover in home ranges of localized males typically included grasses and forbs that had not been mowed or grazed the previous growing season. However, ephemeral males used mowed or grazed perennial cover more frequently than localized males. Both ephemeral and localized males preferred woody cover to other habitats

available in their home ranges. Breeding males (both types) selected unobstructed habitats (cropland, mowed and grazed perennial plants) in mornings that enhanced their visibility for courtship displays but preferred woody habitat and idle grasslands during midday periods, presumably for enhanced protection from predators. Pheasant use of perennial cover that was mowed or grazed the previous year increased when new growth produced sufficient foliage to provide concealment and protection from predators. Correspondingly, pheasant use of woody and idle herbaceous cover declined as the breeding period progressed.

The spatial dynamics (movements and sizes of home ranges) of male pheasants in this study indicate that previously documented patterns in Europe are not applicable to pheasant populations in South Dakota. While subjugated males in Europe assumed sedentary, submissive roles in breeding populations, male pheasants in South Dakota sought unoccupied space on landscapes to establish territories. Survival of breeding male pheasants appears to improve with increased use of idled herbaceous cover and may be further benefited by the availability of woody cover having high stem density near the ground. Complexes of undisturbed herbaceous and woody cover will maximize the capacity of landscapes to support male pheasant territories. In turn, these complexes will concentrate breeding female pheasants in areas that provide protection from predators and secure locations to establish nests.

Preface

This report summarizes results of data collected by South Dakota Department of Game, Fish and Parks personnel from January, 1997 through December, 2001 on the survival, spatial ecology and habitat use of male ring-necked pheasants in eastern South Dakota under Pittman-Robertson Project W-75-R-36, 37, and 38.

This study was initiated to evaluate population parameters and habitat selection of male pheasants in South Dakota. These objectives were accomplished by tracking the locations and fates of radiomarked pheasants. Results of this study will be used to manage pheasant populations and make recommendations to landowners interested in managing their property for pheasants.

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Survival, Spatial Ecology and Habitat Use of Male Ring-necked Pheasants in South Dakota

Anthony P. Leif

Management of ring-necked pheasants (*Phasianus colchicus*) in North America has focused on 2 management objectives: enhancing reproduction by establishing and maintaining grass or grass/forb plantings, and enhancing winter survival by establishing and maintaining herbaceous or woody cover near unharvested stands of agricultural crops. These management philosophies are supported by documented increases in pheasant densities in association with herbaceous habitat plantings (Warner and Joselyn 1986, Berner 1988, Riley 1995) and locations of pheasants in winter (Gates and Hale 1974, Sather-Blair and Linder 1980, Larson et al. 1994, Gabbert 1999).

In contrast, management of pheasants in Europe focuses on establishing and maintaining shrubby habitat adjacent to small grain fields for male pheasants to establish crowing territories and attract breeding females (Robertson et al. 1993, Robertson 1996). Robertson (1996) postulated that availability of suitable breeding territories limited local abundance of breeding males which in turn could limit densities of breeding females. Minimizing dispersal of breeding pheasants is important to European managers since ownership of pheasants resides with landowners. Due to public ownership laws in North America, dispersal is perceived by wildlife management agencies as of lesser importance than survival and reproduction. However, dispersal of breeding pheasants could impact pheasant populations if breeding pheasants selected territories that reduced rates of survival and reproduction.

Female pheasants in North America have relatively low survival in spring compared with other seasons (Snyder 1985, Riley et al. 1994, Leif 1996). In South Dakota, 50% of annual hen pheasant mortality (all the result of predation) occurred during April and May (Leif 1996). This period coincides with activities associated with mate selection, nest-site selection, and egg laying. The time between breakup of winter flocks and initiation of clutch incubation was the period of highest female pheasant mortality in Colorado (Snyder 1985). Implications of not actively managing for breeding territories in North America are unknown. Research is needed to better understand relationships of habitats selected and susceptibility of pheasants to predation. Before managers can understand the dynamics of survival and habitats selected by breeding female pheasants, knowledge of these variables for male pheasants is prerequisite since male habitat selection influences habitat selection by breeding female pheasants (Gates and Hales 1974, Ridley 1983).

OBJECTIVES

1. Estimate home range size and quantify habitats selected by male pheasants during the breeding season.
2. Estimate the proportion of male pheasants that establish breeding territories.
3. Estimate dispersal distances of breeding male pheasants from wintering areas to breeding territories.
4. Estimate annual and periodic survival of male pheasants and compare survival probability with habitats selected.
5. Determine rates of exploitation of male ring-necked pheasants during pheasant hunting seasons.

STUDY AREA

Data were collected in Beadle County in east central South Dakota. Topography of the region varies from flat to slightly rolling. Climate of this region is characterized by distinct seasons (US National Climatic Data Center, Asheville, North Carolina). Winter conditions are typically cold (mean January temperature, -9 C) and generally

dry although annual snowfall for the past 107 years has ranged from 23 to 190 cm. Approximately one-third of the annual precipitation total (51 cm) falls during the spring. Summers are generally hot (mean July temperature, 23 C) with precipitation coming primarily from thundershowers (US National Climatic Data Center, Asheville, North Carolina).

Two 2332-ha (9 square mile) study areas were located 14 km southwest (Bauder study area) and 5 km southeast (Derksen study area) of Huron, SD. Study sites were selected for having a diversity of available pheasant habitats. All property on both study areas was privately owned. The dominant land-use in both study areas was row-crop agriculture (corn and soybeans) or cattle-forage production (pasture and hayland). Interspersed among cropland, hayfields and pastures were linear plantings of trees and shrubs, wetlands, field-border fencelines, road rights-of-way, and idled fields of herbaceous cover enrolled in USDA's Conservation Reserve Program.

METHODS

From January through mid-March, male pheasants were captured using walk-in funnel traps or rocket-propelled nets on sites baited with grain. Additional males were captured with a decoy trap using pen-reared male pheasants and recorded pheasant crows during the breeding season (Smith et al. 2002). I measured body mass, tail length, spur and tarsus length, and bursa of Fabricius depth of captured males. Bursa depth and spur length were used to classify male pheasants as juveniles (<1 year) or adults (>1.5 years) (Trautman 1982). Captured pheasants were marked with 19-gram necklace transmitters equipped with mortality sensors (4-hour delay) and released at capture locations within 24 hours of capture.

Marked pheasants were located 5 days/week from 15 March through 15 June by triangulation and 3-4 days/week during the remainder of the year. Triangulated locations were taken from a vehicle-mounted directional antenna parked at known locations. On alternating days, birds were located during morning (<2 hours after sunrise) or midday (>3 hours after sunrise to 4 p.m.). I defined the period of 15 March – 15 June as the breeding period and focused on this interval because it was during this period that pre-nesting female pheasants experience high rates of predation (Leif 1996). Also, the period concluded before row crops on study areas obtained sufficient growth to offer pheasants cover and potentially alter habitat selection patterns.

Survival

When radios transmitted mortality signals, we investigated radio recovery locations for the cause of death. Predators were identified with the aid of tracks, scat, marks on the transmitters, and trauma and foraging patterns on carcasses. I estimated survival using the Kaplan-Meier product-limit method with the staggered entry design (Kaplan and Meier 1958, Pollock et al. 1989) and compared survival estimates with program CONTRAST (Sauer and Williams 1989). For multiple comparisons, I adjusted significance levels by dividing alpha (0.05) by the number of comparisons (Neter and Wasserman 1974:480). Pheasants that did not survive at least 10 days following release were censored from analyses. Radio-marked samples were censored the day following last radio contact when we lost and never found radio signals or when transmitter-mounting harnesses broke.

Dispersal

Dispersal distances were determined by measuring the distance between winter capture locations and the approximate center of breeding period locations. Only those male pheasants that moved >500 m from their capture location to breeding ranges were considered to have dispersed. The proportion of males dispersing and directions in which they dispersed were compared using Chi-square, whereas dispersal distances were ranked to normalize a skewed distribution and compared using analysis of variance. Because of site fidelity, dispersal distances of radiomarked males that were monitored during a second field season were censored from analyses.

Home Range and Habitat Use

I digitized land-use of the study areas from 1:6336 (10 inches/mile) aerial photographs using PC ARC/INFO; a vector-based Geographic Information System (Environmental Systems Research Institute, Redlands, CA). After initial cover mapping, study area maps were modified each year to account for temporal changes in cover types. Land covers were classified as wood, crop, pasture, hay, idle, wetland, road, road ditch, fenceline, farmstead, and other. For analyses, land-uses were grouped into:

- Wood: shrubs and/or trees that provided ground-level cover to pheasants. Herbaceous plants were commonly a secondary component of this habitat type.
- Crop: land cultivated annually for agricultural production. Crops planted on study areas were corn, soybeans and wheat.
- Open: perennial herbaceous cover that had been mowed or grazed to the extent of having minimal residual cover from the previous year. Roads were included in this habitat type.
- Idle: herbaceous cover left undisturbed by farming activities and livestock grazing which included land enrolled in USDA's Conservation Reserve Program, fencelines, and portions of uncultivated wetlands that were predominantly dry during the breeding period.
- Water: portions of wetland basins that contained water for the majority of the breeding period.

Pheasant locations were calculated by triangulation using the location generating code (LOCATE) included with program CALHOME (Kie et al. 1996). Similar to Gabbert et al. (1999), I calculated breeding home range polygons for males with at least 20 radiolocations with PC ARC/INFO by buffering pheasant locations with a 2-ha (80-m radius) circle and merging overlapping contours. I used the *k*-means procedure to examine the distribution of home range sizes. I overlaid home range polygons on study area maps to extract land-use composition. To estimate habitat selection within each pheasant home range, I buffered each point individually with a 0.25 ha (28-m radius) circle, overlaid study area maps, and extracted land-use. A 28-m radius was equal to the mean error distance of locations as determined by locating transmitters placed at known locations that represented typical locations of radiomarked pheasants.

All radiolocations from non-dispersing males were included in home range and daily habitat selection analyses beginning on 15 March. Only post-dispersal radiolocations were included for males that dispersed after 15 March. Whereas all marked males were monitored for survival, I suspended recording radiolocations of males that departed digitized study areas but continued to record radiolocations of males that were intermittently on and off digitized areas. I appended land-uses of areas used by these males in order to have a complete composition of the habitats selected. However, these males with home ranges partially off originally digitized boundaries were censored from analyses of home range selection.

I examined preferential selection of habitats by breeding male pheasants on 2 availability (selection) levels (Johnson 1980) using compositional analysis (Aebischer et al. 1993). The first level of selection tested was for habitat composition of home ranges versus those habitats available on the study areas. Second, daily selection (28-m buffer) of habitats was evaluated among habitats available within each male's home range. I used analysis of variance to evaluate the effects of home range class and study area on compositional analysis habitat scores. I tested the relationship between the proportional composition of home range habitats with sizes of home ranges using forward stepwise regression with entry and removal P = 0.05. I compared morning and midday selection of habitats within 2450-m^2 daily use ellipses with univariate repeated measures analysis for each male with $\geq$10 observations per repeated measure. I examined temporal changes in use of habitats by modeling day of the breeding period with mean daily habitat use. I compared daily habitat use of predated pheasants for the week immediately preceding deaths with a pooled estimate of daily habitat use of all pheasants that survived that same weekly period with Friedman tests.

Table 1. Numbers and origin of radiomarked male pheasants used to estimate annual, breeding period and hunting season survival in eastern South Dakota, 1997-2001.

Year	Study Area	Annual			Breeding Period			Hunting
		Winter Capture	Previous Year	Spring Capture	Winter Capture	Previous Year	Spring Capture	(Total)
1997	Bauder	7	0	0	5	0	0	1
	Derksen	6	0	0	5	0	0	2
1998	Bauder	7	0	2	7	0	2	6
	Derksen	1	1	5	1	1	5	7
1999	Bauder	14	2	0	12	1	0	9
	Derksen	13	3	0	11	2	0	8
2000	Bauder	2	2	5	2	2	5	5
	Derksen	9	3	0	9	3	0	7
2001	Bauder	12	2	0	12	2	0	6
	Derksen	12	4	0	11	3	0	8
All	Both	83	17	12	75	14	12	59

RESULTS

Over the 5 years of the study I captured 95 male pheasants. Of those captured in the first 4 years, 17 survived until 1 January and were consequently reentered as samples in a second year. Of these 17, 14 survived long enough (past 15 March) to contribute data in a second breeding period. Sample sizes and origin of samples for survival estimates are in Table 1.

Availability of pheasant habitat on study areas was related to variations in precipitation amounts (Figure 1). Higher than average precipitation in 1997 and 2001 resulted in higher portions of the study areas to be inundated with water. Other than differing amounts of freestanding water on study areas, proportions of land-uses shifted little over the course of the 5-year project (see Appendix Figures 1-10).

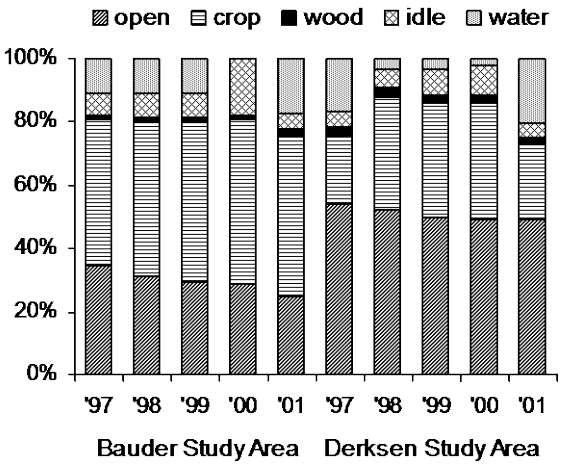

Figure 1. Proportional composition of habitats available to breeding pheasants on 2 study areas in eastern South Dakota, 1997-2001.

Survival

Of 112 radiomarked samples, 22 male pheasants survived to the end of the calendar year, 64 died, and 26 were censored from survival analyses. Of the 26 censored observations, 7 radio transmitters either lost battery power or malfunctioned, 8 radio signals were lost for unknown reasons, 6 radios became detached from pheasants when harnesses broke, and 5 pheasants survived less than 10 days following capture.

Predators accounted for 36 (56%) male pheasant deaths. Mammals accounted for 18 pheasant deaths and avian predators took 11 radiomarked pheasants (Figure 2). Predator identification in the remaining 7 depredated deaths was inconclusive. Predators identified and number of pheasant deaths attributed to each were coyote (*Canis latrans*) (4), red fox (*Vulpes fulva*) (2), mink (*Mustela vison*) (3), raccoon (*Procyon lotor*) (2), badger (*Taxidea taxus*) (1), and great horned owl (*Bubo virginianus*) (2). Reported deaths by predation should be considered minimums because recovery site evidence of many radiomarked

Table 2. Annual survival of male pheasants in eastern South Dakota, 1997-2001.

Year	*n*	Survival	SE
1997	13	0.125	0.083
1998	16	0.337	0.112
1999	32	0.359	0.109
2000	21	0.417	0.120
2001	30	0.284	0.108
ALL	112	0.307	0.054

pheasant deaths was insufficient to identify predators with confidence. Other sources of pheasant deaths were hunting (24), vehicular collision (1) and unidentified causes (3). Annual survival estimates did not differ (χ^2 = 5.58, df = 4, *P* = 0.233) with year (Table 2).

All mortality during the breeding period was the result of predation. Of 18 deaths, mammals killed 12 males, raptors killed 3 and unidentified predators killed the remaining 3. The proportion of male pheasants killed by mammals (versus avian predators) was higher (χ^2 = 4.24, df = 1, *P* = 0.039) during the breeding period (80%) than during the rest of the year (42%). However, from December through the start of the breeding period, 5 of 6 depredations were caused by raptors (Figure 2). The one remaining death had insufficient evidence to identify the predator.

Survival estimates for the 93-day breeding period of 15 March - 15 June varied from 0.53 on Bauder in 1997 to 1.0 on both study areas in

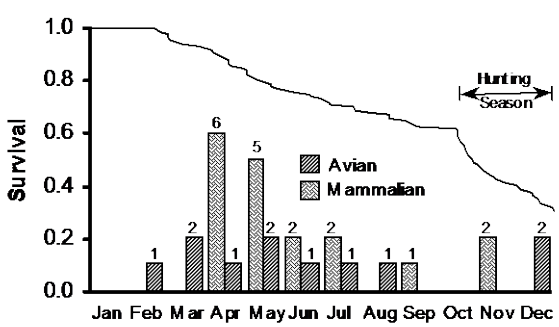

Figure 2. Annual survival distribution and number of depredations attributable to mammalian and avian predators by months in eastern South Dakota, 1997-2001.

Table 3. Survival of male pheasants during the breeding period (15 March – 15 June) in eastern South Dakota, 1997-2001.

Year	Study Area	*n*	Survival	SE
1997	Bauder	5	0.533	0.210
	Derksen	5	0.600	0.190
1998	Bauder	9	1.000	0.000
	Derksen	7	1.000	0.000
1999	Bauder	13	0.923	0.071
	Derksen	13	0.769	0.117
2000	Bauder	9	0.875	0.109
	Derksen	12	0.825	0.109
2001	Bauder	14	0.643	0.121
	Derksen	14	0.857	0.094
ALL	BOTH	101	0.808	0.040

1998 (Table 3, Figure 3). Survival estimates were similar (χ^2 = 0.04, df = 1, *P* = 0.840) between study areas but differed among years (χ^2 = 28.83, df = 4, *P* < 0.001). Survival during the breeding period in 1998 was higher than in 1997 (χ^2 = 9.36, df = 1, *P* = 0.002) and 2001 (χ^2 = 10.64, df =1, *P* = 0.001). Remaining comparisons among years did not differ (*P* > 0.005). Pooled breeding period survival following severe winters (1997 and 2001) was 0.707 ± 0.077 whereas that following the 3 mild winters (1998, 1999 and 2000) was 0.875 ± 0.043.

Of 59 male pheasants that were alive at the beginning of the 5 hunting season openers, 23

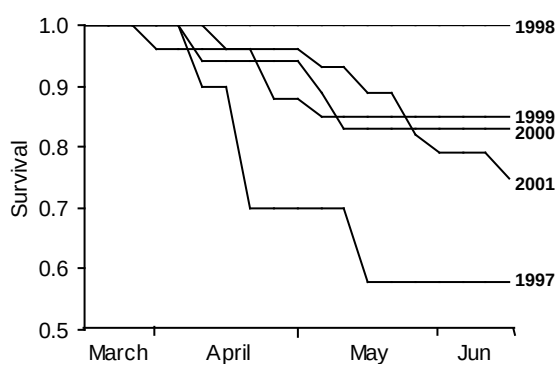

Figure 3. Survival distributions during the breeding period (15 March through 15 June) in eastern South Dakota, 1997-2001.

were harvested and 1 male was found dead of apparent shotgun wounds. Predators consumed 4 males during the hunting season and another 4 were lost without any indication that the radio was malfunctioning or exhausting battery power. Radio transmitters on 4 males transmitted erratic signals prior to the loss of radio contact during the hunting season and were assumed lost due to radio failure. The transmitter of 1 radiomarked male was recovered after the harness broke and the remaining 22 males survived hunting seasons.

Years pooled, minimum annual hunting mortality of adult male pheasants was 0.446 ± 0.077 (Figure 4). However, an additional 8 deaths (those consumed by predators or lost without warning) could potentially be related to the hunting season. The 4 males that were fed upon by predators may have been scavenged or captured following shotgun injury. Also, the 4 radios that we lost contact without warning could have been destroyed by shotgun pellets and/or harvested but not reported. Consequently, maximum annual hunting mortality of male pheasants was 0.565 ± 0.068 if all 8 of these pheasant deaths or disappearances were associated with the hunting season.

Hunting mortality was highest in the first 9 days of hunting seasons when 52% of all harvested males were shot. The rate of hunting mortality then declined and continued at a steady rate until the close of hunting seasons (Figure 4).

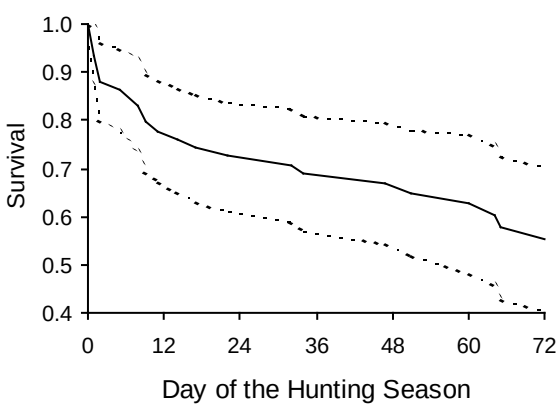

Figure 4. Survival distribution and 95% confidence intervals for adult male pheasants during the hunting season in eastern South Dakota, 1997-2001.

Dispersal

Of 74 male pheasants included in dispersal distance analyses, 27% (9 on Bauder and 11 on Derksen) remained within 500 m of their winter capture location and 73% (27 on each study area) dispersed (Table 4). The proportion of radiomarked males that dispersed varied (χ^2 = 12.76, df = 4, P = 0.012) among years. A larger proportion of males dispersed in 2001 than in 1998 (χ^2 = 8.72, df = 1, P = 0.003), 1999 (χ^2 = 5.38, df = 1, P = 0.020), and 2000 (χ^2 = 10.97, df = 1, P < 0.001). A high proportion of males (6 of 7) also dispersed following the 1997 winter although the small sample precluded statistical differences with other years.

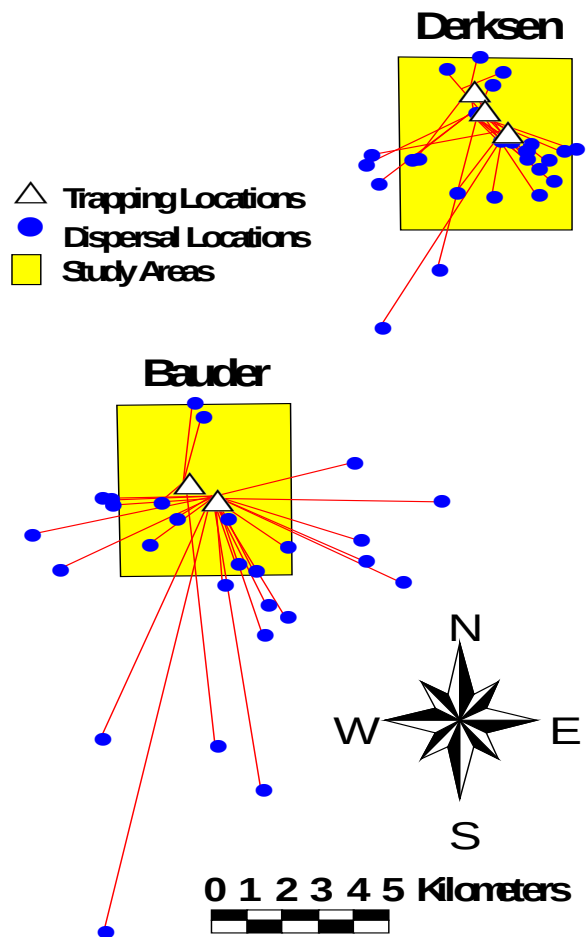

Figure 5. Distances and directions of spring dispersal for male pheasants in eastern South Dakota, 1997-2001.

Table 4. Spring dispersal of male pheasants by years in eastern South Dakota 1997-2001.

Year	*n*	*n* dispersed	%	Dispersal distance (km)	SE
1997	7	6	86	4.65	1.87
1998	8	4	50	3.55	1.67
1999	26	18	69	2.95	0.49
2000	11	5	45	1.92	0.56
2001	22	21	95	3.17	0.28
ALL	74	54	73	3.17	0.31

Distances that male pheasants dispersed did not vary among years (F = 0.837, df = 4, 44, P = 0.509) nor between pheasant age classes (F = 0.29, df = 1, 44, P = 0.596). The maximum observed dispersal distance was 12.6 km (1997). Combining all birds, dispersing male pheasants moved an average of 3.2 ± 0.3 km (median = 2.5 km) from capture locations to breeding ranges (Figure 5).

Dispersing birds did not move in random directions (χ^2 = 33.56, df = 3, P < 0.001) from capture locations to breeding ranges (Figure 5). Only 6 of 54 males dispersed in a direction from north to east (0° - 90°) and only 1 dispersed from west to north (270° - 360°). Over half of dispersing males (28 of 54) moved in a direction from east to south (90° - 180°) and another 19 moved south to west (180° - 270°) (Figure 5).

The timing of the dispersal of male pheasants from winter flocks to breeding ranges varied among years (Figure 6). All radiomarked male pheasants dispersed from winter flocks by 17 March in 1999 (median date <15 March) and 24 March in 2000 (median date = 23 March). However, the median dispersal date of radiomarked pheasants was 1 April in 2001 and 4 April in 1997 and 1998.

Home Range and Habitat Use

The distribution of home range sizes was clearly bimodal (Figure 7) and the *k*-means procedure distinctively partitioned (F = 161.1, df = 1, 59, P < 0.001) male pheasants into 2 groups based upon the size of their home ranges, hereafter classified as localized (<30.1 ha) or ephemeral (>31.5 ha). Home ranges for localized males averaged 18.4 ± 0.9 (SE) ha while those for ephemeral males averaged approximately 2.5 times larger at 45.4 ± 2.9 ha. Morning radiolocations alone encompassed 76 ± 2% of the area of localized and 64 ± 3% of ephemeral home ranges, whereas midday radiolocations covered 75 ± 2% (localized) and 65 ± 2% (ephemeral) of whole home ranges.

Of 62 home ranges described in this study, 38 (61%) were classified as localized and 24 (39%) as ephemeral. The proportion of localized and ephemeral home ranges differed between age

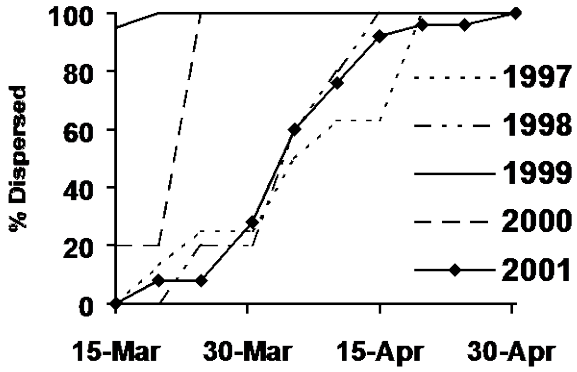

Figure 6. Dates of spring dispersal for male pheasants in eastern South Dakota, 1997-2001.

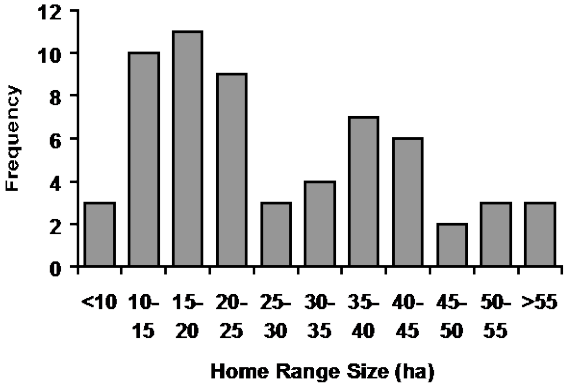

Figure 7. Histogram of the size of home ranges of male pheasants during the breeding season in eastern South Dakota, 1997-2001.

classes (χ^2 = 8.36, df = 1, P = 0.004). Seventy-three percent of 44 adult males maintained localized home ranges, whereas 67% of 18 juveniles had ephemeral home ranges. Of 9 males tracked through 2 breeding periods, 3 (all adults) were classified as localized both years, 5 (1 juvenile and 4 adults) were classified as ephemeral in the first year and localized in the second, and 1 adult male had an ephemeral range the year after being localized. Seven of 11 male pheasants captured in spring using territorial encroachment as a lure had localized home ranges, 2 had ephemeral home ranges, and 2 males were undetermined for lack of enough radiolocations.

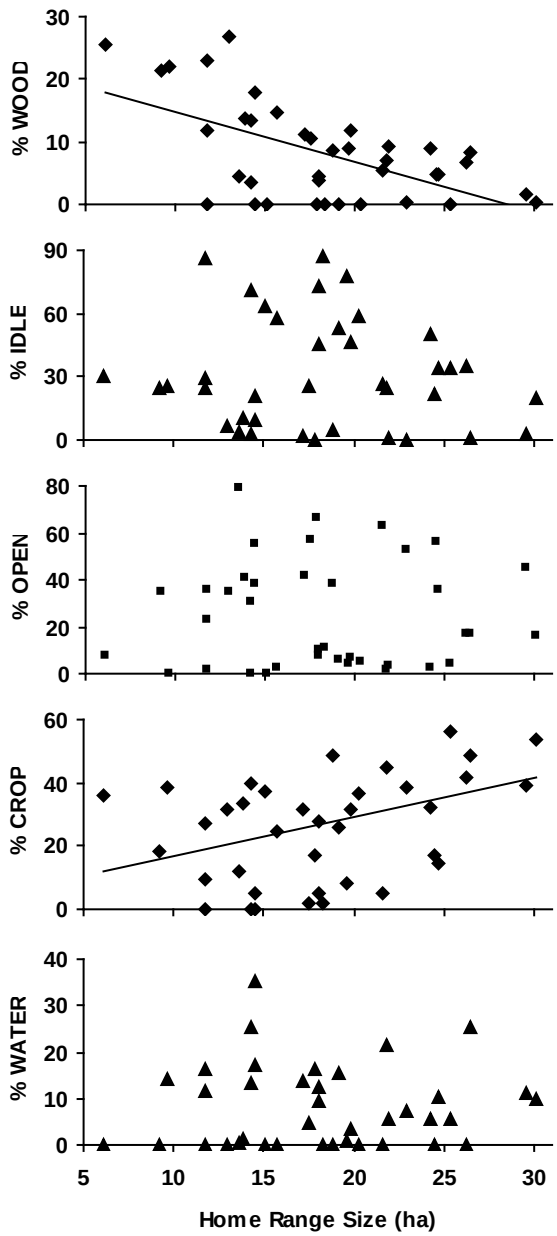

Figure 8. Relationship of the proportional composition of habitats with sizes of home ranges for localized male pheasants during the breeding season in eastern South Dakota, 1997-2001.

Size of ephemeral home ranges was not associated (F < 0.89, df = 1, 18, P > 0.358) with habitat composition. However, size of localized home ranges was inversely related the proportion of wood (F = 25.10, df = 1, 32, r^2 = 0.338, P < 0.001) and positively related the proportion of cropland (F = 11.37, df = 1, 32, r^2 = 0.162, P = 0.002) in home ranges (Figure 8).

When establishing home ranges in study areas, localized and ephemeral males selected wood (F = 0.17, df = 1, 55, P = 0.682), crop (F = 1.61, df = 1, 55, P = 0.210), and water (F = 0.61, df = 1, 55, P = 0.440) at similar preference levels (Figure 9). However, localized males were more (F = 5.89, df = 1, 55, P = 0.019) selective for idle herbaceous cover and less (F = 8.83, df = 1, 55, P = 0.004) selective for open habitats than ephemeral males when establishing home ranges. Open and crop were the only 2 cover types to be selected at differing rates between the 2 study areas. Localized and ephemeral males used open habitats more (F = 4.02, df = 1, 55, P = 0.050) readily on the Derksen (-0.321 ± 0.249) than on the Bauder (-1.107 ± 0.248) study area. Use of crop by breeding male pheasants ranked higher (F = 4.53, df = 1, 55, P = 0.038) on Bauder (-0.123 ± 0.175) than on Derksen (-0.799 ± 0.217) study area.

Home range habitat scores differed for both localized (F = 15.481, df = 4, 175, P < 0.001) and ephemeral (F = 5.960, df = 4, 110, P < 0.001) males. Wood and idle herbaceous habitats ranked higher (P < 0.001) than open, crop and water on sites selected by localized males for home ranges (Figure 9). For ephemeral males, wood and idle also ranked highest but only wood ranked statistically higher than open (P = 0.048), crop (P = 0.003) and water (P < 0.001). Water also ranked statistically lower than idle (P = 0.002) and open (P = 0.012) in the home ranges of ephemeral

males. Mean composition of localized home ranges was 7% wood, 31% idle, 29% cropland, 25% open, and 8% water, whereas ephemeral male home ranges were comprised of an average of 6% wood, 17% idle, 29% cropland, 44% open and 4% water.

Daily use of habitats available within home ranges did not differ (F < 2.30, df = 1, 58, P > 0.13) between localized and ephemeral males (Figure 9). Daily habitat selection also did not differ (F < 2.80, df = 1, 58, P > 0.10) between study areas. However, the habitats used by breeding pheasants (home range types pooled) compared to those available in home ranges differed (F = 11.094, df = 4, 305, P < 0.001). Wood ranked higher (P < 0.003) than all other habitats in the daily use of home range habitats. Daily use of idle, the 2nd ranking habitat, was higher than water (P = 0.003) and approached statistically higher use than open (P = 0.070) and crop (P = 0.066).

Both localized and ephemeral males selected wood ($\Delta\chi$ = 174 m^2, F = 42.47, df = 1, 60, P < 0.001), and idle ($\Delta\chi$ = 61 m^2, F = 4.66, df = 1, 60, P = 0.035) more frequently and crop less ($\Delta\chi$ =

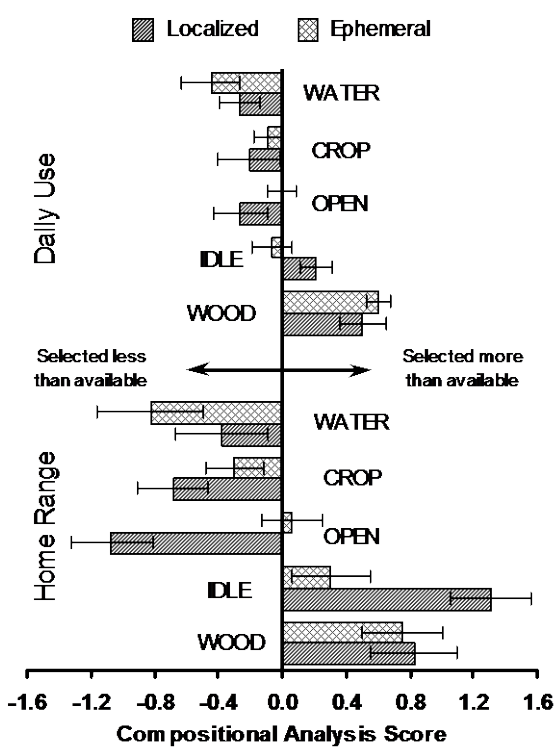

Figure 9. Mean scores and standard errors for habitats selected by male pheasants for home ranges in relation to habitats available on study areas and daily selection of habitats in relation to habitats available within home ranges during the breeding season in eastern South Dakota, 1997-2001.

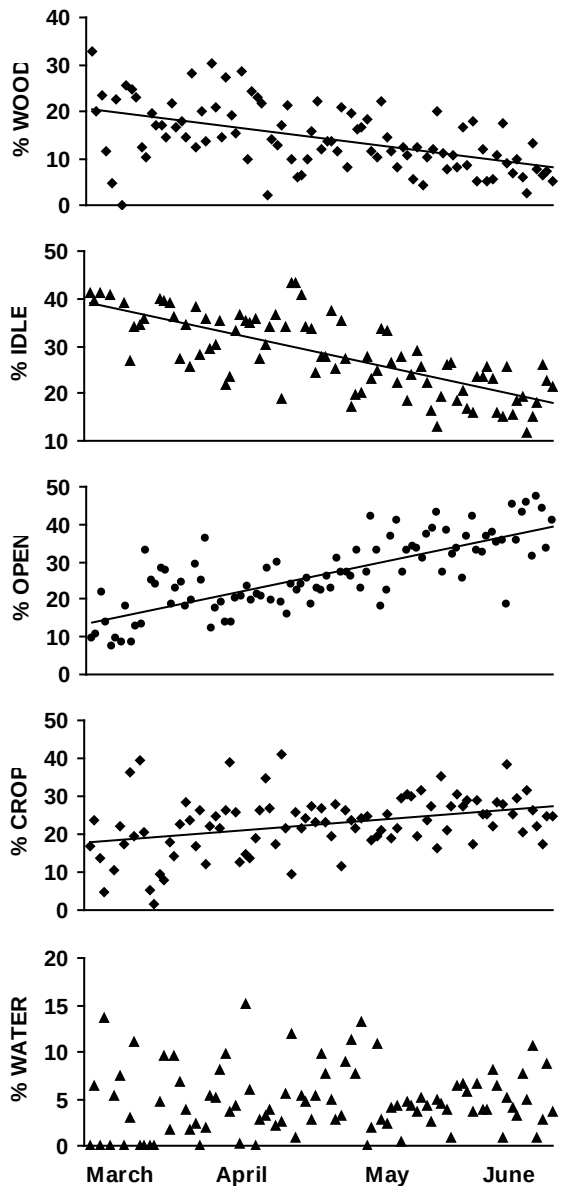

Figure 10. Relationship of habitats selected by breeding male pheasants (% of 28-m ellipses) with day of the reproductive period (15 March – 15 June) in eastern South Dakota, 1997-2001.

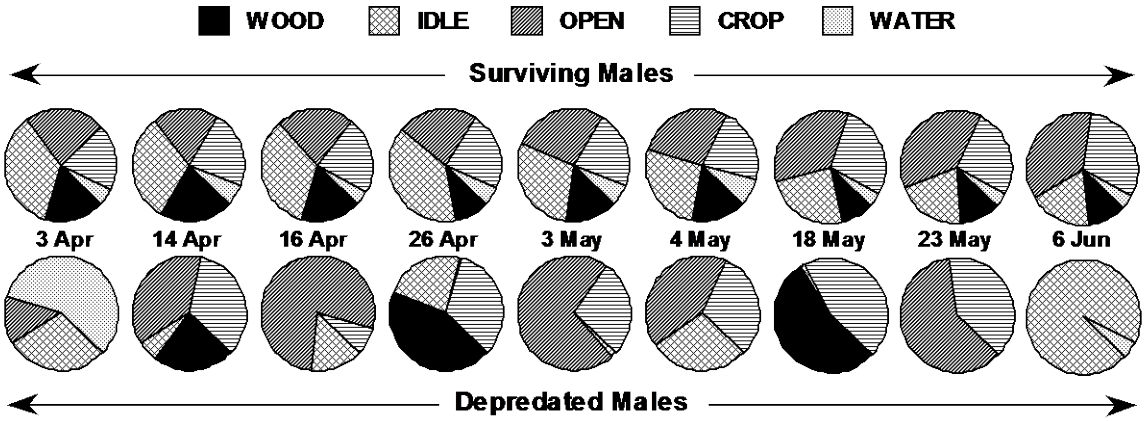

Figure 11. Mean composition of habitats selected by breeding male pheasants in the week prior being depredated and by all males surviving the same weekly periods in eastern South Dakota, 1997-2001.

171 m^2, F = 12.76, df = 1, 60, P = 0.001) frequently in the midday than morning. Use of open habitat in the morning versus midday interacted (F = 5.18, df = 1,60, P = 0.027) with pheasant home range type. Localized males exhibited no differential use ($\Delta\chi$ = 7 m^2, F = 0.02, df = 1, 37, P = 0.897) of open habitats between morning and midday, whereas ephemeral males selected open cover more ($\Delta\chi$ = 201 m^2, F = 10.71, df = 1, 23, P = 0.003) frequently in the morning than midday.

Male pheasants expressed temporal variation in habitat selection (Figure 10). Selection of wood (F = 53.7, df = 1, 85, adjusted r^2 = 0.380, P <0.001) and idle (F = 100.1, df = 1, 85, adjusted r^2 = 0.535, P <0.001) declined whereas open (F = 111.4, df = 1, 85, adjusted r^2 = 0.562, P <0.001) and crop (F = 53.7, df = 1, 85, adjusted r^2 = 0.058, P <0.001) use increased as the reproductive period progressed.

Over 5 years, 9 male pheasants (5 localized, 1 ephemeral and 3 unclassified) were depredated on digitized study areas during the reproductive period. Habitats used by these males in the week prior to their deaths did not differ (wood [χ^2 = 1.00, df = 1, P = 0.317], idle [χ^2 = 2.78, df = 1, P = 0.096], open [χ^2 = 0.111, df = 1, P = 0.739], crop [χ^2 = 1.00, df = 1, P = 0.317]) from males surviving the same weekly periods (Figure 11). While 33% of predated males used woody habitats in the week prior to their deaths, 55% of surviving males used woody habitats during the same weekly periods.

DISCUSSION

Dispersal

Most (73%) male pheasants dispersed >500 m from their capture locations to spring breeding ranges. The timing of this dispersal was related to ambient temperatures in March. During the relatively warm March weather in 1999 (15th warmest in 100 years) and 2000 (5th warmest in 100 years), all male pheasant dispersal occurred prior to 24 March. In contrast, the median date of spring dispersal was in early April following the relatively cool March weather in 1997 (45th warmest), 1998 (81st warmest) and 2001 (62nd warmest in the last 100 years). These dates of male pheasant dispersal are very similar to those reported by Gates and Hales (1974).

The proportion of males that dispersed was related to winter severity. Ninety-three percent of males dispersed in 1997 and 2001 when the amount of winter (December, January and February) snowfall ranked among the highest (1996-97:1st, 2000-01: 6th) and winter temperatures ranked (1996-97: 20th, 2000-01: 26th) among the coldest in the last 100 years. Only 58% of males dispersed following the relatively mild winters of 1997-98 (snowfall rank: 54th, temperature rank: 95th), 1998-99 (snowfall rank: 83rd, temperature rank: 93rd) and 1999-2000 (snowfall rank: 54th, temperature rank: 97th). Gates and Hale (1974) observed a similar relationship between winter severity and spring dispersal in Wisconsin. As Gates and Hale

Male pheasants dispersed from winter flocks earlier when March temperatures where above average.

(1974) also postulated, amplified spring movements subsequent to cold, snowy winters may have been partially attributable to reciprocated movements of immigrated males that had relocated on to study areas in search of secure winter habitat. Additional dispersal stimulation likely resulted from male seeking solitary breeding territories away from high densities of pheasants wintering on trapping sites. Lastly, males may have extended spring movements following severe winters as a result of breeding habitat degradation from snow-pack (mated herbaceous cover and wetlands filled with water).

Distances traveled by dispersing males in South Dakota indicate these populations are proficient in distributing themselves upon landscapes. However, the direction of dispersal had a southerly bias. It is unclear whether the similar dispersal pattern observed on my 2 study areas was related to the distribution of breeding habitats in relation to winter habitats because I did not map habitats outside study areas. Gates and Hale (1974) observed relatively uniform distribution of dispersal directions and concluded that males tended to return to the vicinity of their natal ranges.

Distances traveled by dispersing males are the first indication of a distinct difference in the spatial dynamics of breeding male pheasants in South Dakota and Great Britain (Hill and Ridley 1987). Mean dispersal distances of breeding males in Great Britain (149 and 248 m on 2 study areas) would not have even constituted dispersal by the protocol of this study. Differences between populations in this study and those in Great Britain may be the result of genetic and behavioral influence of artificial propagation. Pen-reared pheasants were relatively sedentary in both Great Britain (Hill and Ridley 1987) and North America (Krause et al. 1987, Leif 1994) compared to wild counterparts. Raising and releasing pheasants is central to management of estates for pheasant shooting in Great Britain (Hill and Ridley 1987). These authors found that the social structure of 2 separate pheasant populations was similar despite one being comprised of 60% pen-reared birds. While they interpreted this similarity as adaptation of pen-reared birds to the wild, it's equally plausible that the population comprised of wild-reared pheasants still retained many of the behavioral characteristics of their artificially propagated ancestors. Male pheasants in this study also dispersed farther than wild-trapped males in Wisconsin (700 – 1100 m, Gates and Hale 1974) and translocated wild hens in Missouri (1134 m, Wilson et al. 1992) but the magnitude of the difference was substantially less than with Great Britain pheasant populations.

Home Range

A second sharp contrast between this and previous research is the size of areas used by breeding male pheasants. Breeding territories of males (predominately pen-reared) on a shooting preserve in Wisconsin averaged 1.7 ha (Burger 1966) which was comparable to mean territory sizes reported by Lachlan and Bray (1976) (1.8 ha) and Ridley (1983) (2.0 ha) for breeding males in Great Britain. The smallest home range documented in my study was 6.2 ha and the mean of localized males was 18.4 ha. Because previous studies used visual observations of males in mornings, a portion of this difference in areas of use can be attributed to methodology. Morning radiolocations of localized males accounted for all but 24% of their entire home ranges. Censoring afternoon radiolocations would result in a mean home range size of 14 ha which is still 7-8x larger than previously reported means. While my home range estimates would further decline if I

included only visual observations of radiomarked males, a portion of the difference from my study and previous research on this topic was likely related to differences in male pheasant mobility.

The distribution of breeding male pheasants on study areas was likely influenced by territorial defense of spaces on the landscape. Previous research that used visual observations of male pheasants during spring described breeding male pheasants as territorial and non-territorial (Burger 1966, Ridley 1983, Ridley and Hill 1987). These classifications were based upon observed crowing and displaying behavior and aggression towards other males (Ridley 1983). Data from my study, the first to document the spatial ecology of breeding male pheasants using radio telemetry, supports the assertion that 2 types of male pheasants exist in breeding populations. Most if not all males in this study classified as localized were likely also territorial. Ocular examination of the distribution of home ranges revealed some overlap but home ranges of localized males were predominately spatially exclusive of each other (Appendix Figures 11-20). This spatial distribution is likely a result of territorial behavior.

My observations of ephemeral male home ranges are likely associated with observations of non-territorial males in Great Britain (Ridley 1983, Robertson et al. 1993) and on a shooting preserve in Wisconsin (Burger 1966). Based on the sedentary nature of periodic radiolocations,

Sixty-one percent of radiomarked male pheasants concentrated their movements in a restricted area and appeared to be territorial.

Male pheasants established home ranges in association with habitats that contained residual protective cover.

ephemeral males in South Dakota appeared to remain localized periodically and possibly territorial for short periods during the breeding period. Consequently, I believe that a more accurate description of the springtime areas of use for these males is temporarily territorial or ephemeral in nature. Support for this theory can be found in the fact that I captured ephemeral males in spring using territorial encroachment as a lure. Burger (1966) reported that 40% of male territories “shifted” during the breeding season, which is similar to the proportion of males (39%) classified as ephemeral in my study. Ridley (1983) reported that males classified as non-territorial performed courtship displays, instigated antagonistic behavior with other males and participated in the breeding effort.

The occurrence of non-territorial males may be related to the sedentary nature of pen-reared pheasants and those populations with lineage to artificially propagated ancestors. Of 5 males classified by Burger (1966) as non-territorial, 4 had been raised in a pen and the remaining male was described to be in poor physical condition. In Great Britain, densities of non-territorial males increased while densities of territorial males remained constant following releases of pen-reared pheasants (Hill and Robertson 1988, Robertson et al. 1993). Wild pheasants in South Dakota that were presumably subjugated by more dominant males apparently had the impetus to seek alternate breeding home ranges rather than assuming

Presence of woody habitat reduced sizes of breeding male pheasant home ranges. Woody habitat was also the most preferred cover type of the habitats available in pheasant home ranges.

sedentary submissive roles in the breeding population.

Habitat Selection

Home ranges of both localized and ephemeral males were not randomly distributed on the landscape but rather, they were established in association with habitats that provided protective cover. Localized males selected sites for home range with preference for woody cover and idle herbaceous habitats. Ephemeral males also expressed preference for woody and idle cover, but their home ranges contained less idle and more open habitat than localized males. This difference in home range composition was likely controlled in part by territorial behavior. The disproportionate composition of idle and open habitats in home ranges of localized and ephemeral males was the likely result of displacement of ephemeral males from idle habitats by localized males. The only alternate source of herbaceous cover for ephemeral males was in open habitats. Lower habitat suitability of open habitats in comparison to idle cover likely contributed to the enlarged home ranges of ephemeral males.

While some woody habitat selected by ephemeral males overlapped home ranges of localized males, most woody habitat used by ephemeral males was unused by localized males. Woody habitats used by ephemeral males were not positioned near blocks of idled herbaceous cover but rather adjacent to pastures and mowed herbaceous cover. Consequently, I believe that the first order of habitat selection for male pheasant home ranges is for blocks of idled herbaceous habitats. In substitute, open habitats appear to fulfill the herbaceous cover component for males with ephemeral home ranges. The protective cover provided by woody habitats served to reduce home range sizes and likely enhanced home range suitability for breeding male pheasants.

Habitats selected by breeding male pheasants in this study were similar to those described previously (Burger 1966, Lachlan and Bray 1976, Robertson et al. 1993). However, methodology (visual observations) employed previously likely contributed to an overemphasis of edges between protective and unobstructed habitats. Restricting my data to only visual observations would have resulted in overestimations of the value of open and crop habitats. Although male pheasants used unobstructed habitats (pastures, crop and hay fields) more frequently during early morning (the primary display period) than midday, they expressed highest preference for woody and idle cover. Accordingly, male pheasants established home ranges in alignment with the spatial distribution of habitats that offered protective cover (Appendix Figures 11-20).

Pheasants selected open areas more frequently in mornings than midday and their use of pastures and hayfields increased as the breeding period progressed.

While habitat composition of home ranges differed among breeding male pheasants with localized and ephemeral ranges, the daily selection of these habitats within their respective home ranges was similar. Both types exhibited preferential selection of woody habitats over all other habitat types available in home ranges. Breeding pheasants used woody habitats and idle herbaceous cover more frequently during midday hours and selected open and cropland more frequently in early morning. These patterns of habitat selection are consistent with previous research (Taber 1949, Burger 1966, Ridley 1983, Ridley and Hill 1987). Breeding male pheasants appear to seek pastures, mowed cover and crop fields in mornings to optimize their chances of being seen and heard by potential mates. However, during midday, their preference shifts to habitats that provide concealment and escape cover.

Woody and idle herbaceous habitats (CRP fields, fencelines, and dry wetlands) provided predator-avoidance escape habitat to breeding pheasants throughout the breeding period. Hayfields and pastures provided minimal protective cover in March and April but new growth in these predominately cool-season habitats reached a sufficient height to conceal pheasants and pheasant use correspondingly increased as the breeding period progressed. In contrast, use of woody and idle herbaceous habitats (CRP fields, fencelines and dry, uncultivated wetlands) by breeding male pheasants was high in early spring and then declined throughout the breeding period.

Predation of male pheasants was highest during the spring breeding period.

Pheasants used crop fields at relatively low levels throughout the breeding period. Fields were predominately planted to soybeans and corn and crop residue from the previous growing season provided negligible ground cover for pheasants during the breeding period. Additionally, growth of planted crops did not reach sufficient height and density to provide protective cover until after 15 June. Unlike small grain fields in Great Britain (Robertson et al. 1993), row crop fields in this study did not provide a source of green forage for breeding pheasants.

Survival

As a partial result of observing only 9 pheasant deaths on digitized study areas, I was unable to statistically relate pheasant survival with habitats selected. Nonetheless, trends within these data indicate that the amount of idle and the presence/absence of woody cover may have influenced male pheasant survival. The lack of statistical significance in the test of idle cover was the result of 1 male pheasant death with a high proportion of idle in its pre-death habitat use profile (Figure 11). Aside from this observation, predated pheasants used a lesser amount of idle cover in the week prior to their deaths than pheasants that survived these same weekly periods. While the amount of woody habitat used by pheasants does not appear to affect survival, the simple presence of some woody cover may improve pheasant survival. Only 3 of 9 males depredated on study areas used woody cover in the week preceding their death whereas over half of surviving males used woody cover in these same weekly periods. It is plausible that some combination of herbaceous and/or woody cover served to enhance pheasant survival and although supporting data is inconclusive, it appears that male pheasant survival improved with increased amounts of idle cover and the presence of at least some woody cover.

Survival of male pheasants during the breeding period (15 March – 15 June) was related to the severity of the preceding winter. Following the

Pheasant survival was higher in springs following mild winters due in part to the increased availability of protective herbaceous habitats in dry wetlands.

severe (relatively high snowfall and cold temperatures) winters of 1996-97 and 2000-01, spring survival was lower (71%) than that following relatively mild winters (88%). Severe winters likely affected spring survival through habitat degradation from heavy snow pack flattening idle herbaceous cover and melting snow filling wetland basins. Spring rains exacerbated flooding of wetlands when soils are saturated from snowmelt. Filled wetlands reduce the availability of protective cover to breeding pheasants at a time of year when cover availability is at a minimum. This reduction in available cover in combination with exclusionary behavior of territorial males likely reduces the seasonal carrying capacity of these landscapes. However, the presence of wetland basins actually enhances long-term pheasant densities by providing wintering habitat (Sather-Blair and Linder 1980, Gabbert et al. 1999) and breeding habitat during dry springs. Regardless of precipitation patterns, wetland basins with altered hydrology cease to intermittently afford habitat for breeding pheasants. Drained wetlands would be incorporated into agricultural fields and would no longer support perennial cover that typifies unaltered prairie wetlands (Johnson and Higgins 1997).

In all documented instances but 1, predation or hunter-harvest caused male pheasant deaths. The distribution of deaths attributable to avian or mammalian predators differed with the time of year. Mammalian predators killed disproportionately more male pheasants than avian predators during the breeding period but raptors were the agent in all documented winter depredations (1 December – 15 March). Distribution and rates of depredation of male pheasant are consistent with past work on female pheasants in South Dakota (Leif 1996).

Although only the adult segment of the male pheasant population was radiomarked each autumn, it appears that the rates of exploitation approximated harvest distributions from hunter surveys. In 2000, 56% of pheasants harvested statewide in South Dakota were shot in the first 11 days of the pheasant season (Gigliotti 2001). Over the 5 years of this study, 57% of harvested pheasants were shot in the first 11 days of the hunting season. During the 2001 season, 22% of the season-long harvest occurred (Smith and Leif 2002) on the opening weekend, while in my study, 30% of the harvest occurred during the first 2 days of hunting seasons. This difference would be in contrast to a presumed higher susceptibility of juvenile males than adult males to harvest. Finally, the statewide harvest rate as calculated from preseason population estimates (Trautman 1982) and reported harvest for the 5 years of this study was 52% (SD Game, Fish and Parks, unpublished data). If one assumes that the 4 transmitters lost during the hunting season were actually harvested but not reported, mortality attributable to harvest in this study would be 50%. Consequently, although only adults were marked, it appears that rates of exploitation and harvest distribution documented in this research are representative of populations of male pheasants in South Dakota but are considerably lower than those reported by Wagner et al. (1965) for Wisconsin during 1940-61 (73%).

As in most states, South Dakota experiences an initial surge of hunting pressure during the opening weekend of the pheasant season and to a lesser degree during the following 7 days. These first 9 days typically account for slightly more than half of the season-long pheasant harvest. After this period, the daily harvest rate appears to approximate a constant daily rate (Figure 4) of 0.00582 for reported harvests and 0.00695 if lost transmitters were assumed harvested but not reported. Applying these

Fifty-two percent of the season-long pheasant harvest occurred in the first 9 days of the hunting season.

rates to the average (1997 through 2001) statewide preseason population of 2,400,000 male pheasants (SD Game Fish and Parks, unpublished data), 49,000 to 58,000 male pheasants were harvested for each week that the hunting season was open after the initial 9 days (second weekend).

MANAGEMENT IMPLICATIONS

To be most effective, pheasant managers must focus efforts on practices that enhance pheasant survival and reproduction. With this in mind, this study was initiated to identify important habitats of pheasants during the breeding season. Whether woody or herbaceous, some type of cover with vertical structure is necessary to conceal pheasants from predators and provide escape habitat if detected. Habitat manipulation intended to enhance pheasant densities though reduced mortality must focus on reducing predator-pheasant encounters (Petersen 1979).

Woody cover was a preferred habitat of breeding male pheasants, but not an essential prerequisite for establishment of home ranges. An important feature of woody habitats used by pheasants in this study was high stem density near ground level. However, alternate forms of woody vegetation were present in study areas but absent from study area maps. I could not spatially account for intermittent trees that were present in and immediately adjacent to some wetlands. Cover maps of study areas were 2 dimensional and focussed on the dominant vegetation within 2 meters above ground level. Isolated trees constituted minimal space within this focus area and were consequently omitted from these maps. Pheasants in Colorado experienced higher rates of avian depredation on an area with trees than sites without trees (Snyder 1985) and this habitat type appeared to reduce survival of mallard (*Anas platyrhynchos*) broods in eastern South Dakota (Stafford et al. 2002). Petersen (1979) estimated that great-horned owls and red-tailed hawks (*Buteo jamaicensis*) together removed 36% of the springtime pheasant population and recommended the removal of all trees that could be used as pheasant hunting perches. Likewise, trees probably enhanced predatory opportunity by providing perch sites for raptors in my study. Consequently, managers should remove trees that are potentially deleterious to pheasant survival and do not serve to meet an alternate management objective.

Although solitary tall trees likely enhance susceptibility of pheasants to predation, woody habitat dominated by shrubs, especially those that provided a high density of stems near ground level, probably enhance pheasant survival. This observation is anecdotal since I was not able to statistically relate any habitat type to pheasant survival. However, Ridley (1983) and Petersen (1979) postulated that woody habitat provided the cover for pheasants to avoid predation. In my study, woody habitat was the most preferred habitat of breeding male pheasants and served to reduce sizes of pheasant territories. In addition, male pheasants without access to woody habitat appeared to experience higher rates of depredation than pheasants using areas that included woody cover. Yet breeding pheasants neither need nor prefer landscapes with high proportions of woody habitat. Rather, managers will be most effective by maximizing amounts of idle herbaceous cover. Placement of narrow bands of shrubs (2-3 rows) along idle cover edges will consume minimal space yet provide an attractive and likely beneficial habitat component to pheasant breeding ranges.

Petersen (1979) also recommended that shrub borders be planted adjacent to herbaceous cover to provide loafing and escape cover to pheasants.

Although large woody plantings are not essential to breeding pheasants, wide shelterbelts are necessary to insure pheasant survival during harsh winters in South Dakota (Gabbert et al. 1999). Male pheasants in this study were highly mobile, especially following severe winters. With a median winter to spring dispersal distance of 2.5 km, a 5 km spacing between shelterbelts would provide secure winter cover in the travelling radius of male pheasants although closer placement would facilitate better distributions of breeding pheasants. Additionally, shelterbelts should be placed near idle herbaceous cover (wetlands with emergent cover or CRP plantings) and food sources (Gabbert et al. 1999). Shelterbelts placed near idle cover will also serve as effective pheasant breeding habitat.

Suitable space for pheasant breeding territories will increase and male pheasant survival will likely improve as the quantity of idle cover on landscapes increases. Both male and female pheasants in Wisconsin were also highly selective for idle grass cover in dry wetlands and unharvested hayfields in spring (Gates and Hale 1974). Grass species with residual stems that retain their vertical structure in the spring likely offer superior protective cover to those prone to lodge under snow. As a general rule, warm-season grasses have a more rigid stalk and retain more of this residual vertical structure through winter and into spring than cool-season grasses. However, cool-season plants provide both a direct food source similar to cereal grain fields in Great Britain (Robertson 1996) and a substrate for invertebrate production, an important food of breeding pheasants (Trautman 1982). Data from the first year of a study comparing nest densities in warm-season grasses vs. cool seasons indicate that hen pheasants prefer cool season fields for nesting (unpublished data, South Dakota State University). Although levels of benefits may differ, both warm- and cool-season grasses meet similar pheasant habitat requirements and managers will be most effective by establishing fields of both types within management units.

Woody cover with high stem density at ground level is an attractive and likely beneficial component of pheasant breeding areas.

Open spaces are another habitat feature important to breeding male pheasants. Homogenous blocks of dense grasses, such as monocultural switchgrass (*Panicum virgatum*) fields, may inhibit territory establishment in interior sections due to the lack of available displaying areas. While the same might be true for extensive woodlands, the linear nature of woody habitat in perspective to sizes of pheasant home ranges in my study provided an adequate amount of edge to allow full utilization.

The spatial requirements of breeding male pheasants in South Dakota are different than pheasant populations in Europe. Furthermore, the application of disparate habitat requirements (Robertson et al. 1993) and the categorization of pheasant habitats as need-specific (nesting cover versus territory cover) led Robertson (1996) to erroneously postulate that idle herbaceous cover was unimportant to North American pheasant abundance. This study and previous work in Wisconsin (Gates and Hale 1974) clearly demonstrate the importance of idle herbaceous cover to breeding male pheasants. Additionally, numerous studies have demonstrated the value of idle herbaceous cover to female pheasants for reproduction (Gates and Hale 1974, Warner and Joselyn 1986, Berner 1988, Riley 1995, Clark and Bogenschutz 1999).

An important management implication of this study and previous research in both Europe and

North America is the effect of the breeding season chronology on male and female pheasant distribution. Median dates of male pheasant dispersal from winter flocks was 3 to 4 weeks earlier than female pheasants on these same study areas (Schilowsky 2003). Consequently, the distribution of female pheasants is at least partially dictated by the distribution of breeding males. Gates and Hale (1974) reported a similar conclusion for pheasants in Wisconsin and stressed the importance of attracting breeding males to habitats that are beneficial for nesting. Accordingly, managers should create habitat complexes that are attractive to both male and female pheasants. In addition to alluring appeal, habitats must also protect breeding pheasants from predators and enhance reproductive success to enhance pheasant abundance.

Idle herbaceous cover is the only habitat type that can singly fulfill male and female breeding pheasant habitat requirements in South Dakota. However, woody cover with high ground-level stem density will enhance habitat suitability for breeding pheasants. Managers concerned with the potential effect of woody habitat on grassland obligate birds may opt to refrain from planting shrubs near grasslands. However, densities of breeding male pheasants will increase and susceptibility of pheasants to predation may decrease if idle herbaceous habitats are coupled with shrubs.

Undisturbed herbaceous cover was a critical component of breeding male pheasant home ranges. Idled grasslands reduce susceptibility of pheasants to predation and provide a secure place for nesting.

The capacity of landscapes to support breeding pheasants will be maximized where complexes of idle herbaceous cover and shrubs are established.

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Appendix Table 1. Capture and release dates and fates of radiomarked male pheasants captured in eastern South Dakota, 1997-2001.

Bird	Study Area	Year	Release Date	Fate Date	Exposure Days	Fate
1023A	Bauder	1997	11 Feb	20 Feb	9	Depredated – unidentified
1044A	Bauder	1997	11 Feb	20 Dec	312	Hunter harvested
1104A	Bauder	1997	11 Feb	22 Apr	70	Lost radio contact
1303A	Bauder	1997	11 Feb	24 Aug	194	Unidentified death
1124A	Bauder	1997	14 Feb	4 Mar	18	Depredated – owl
1164A	Bauder	1997	14 Feb	7 May	82	Depredated – fox
1323A	Bauder	1997	7 Mar	19 Apr	43	Depredated – unidentified
1113A	Derksen	1997	14 Jan	21 Dec	341	Hunter harvested
1293A	Derksen	1997	17 Jan	16 Apr	89	Depredated – coyote
1453A	Derksen	1997	17 Jan	18 Jan	1	Depredated – cat
1023B	Derksen	1997	14 Mar		293	Survived to 31 Dec
1124B	Derksen	1997	17 Mar	6 Apr	20	Depredated – mink
1402A	Derksen	1997	17 Mar	8 Jun	83	Lost radio contact
1063D	Bauder	1998	3 Mar	24 Oct	235	Hunter harvested
1323D	Bauder	1998	3 Mar	25 Oct	236	Hunter harvested
1203D	Bauder	1998	4 Mar	25 Sep	205	Lost radio contact
1223D	Bauder	1998	9 Mar	21 Jun	104	Depredated – raptor
1442D	Bauder	1998	10 Mar		297	Survived to 31 Dec
1283D	Bauder	1998	12 Mar		295	Survived to 31 Dec
1362D	Bauder	1998	13 Mar	15 Dec	277	Hunter harvested
1142D	Bauder	1998	6 May	15 Dec	223	Depredated – raptor
1253D	Bauder	1998	21 May	7 Jul	47	Depredated – mink
1023B	Derksen	1998	reentry	24 Oct	296	Hunter harvested
1152D	Derksen	1998	13 Mar	18 Oct	219	Hunter harvested
1073D	Derksen	1998	14 Apr	17 Oct	186	Hunter harvested
1133D	Derksen	1998	16 Apr		260	Survived to 31 Dec
1293D	Derksen	1998	20 Apr		256	Survived to 31 Dec
1053D	Derksen	1998	28 Apr	2 Dec	218	Hunter harvested
1472D	Derksen	1998	28 Apr		248	Survived to 31 Dec
1283D	Bauder	1999	reentry	11 Dec	344	Radio ceased transmitting
1442D	Bauder	1999	reentry	2 Mar	60	Depredated – raptor
1243F	Bauder	1999	6 Jan	11 Jan	5	Depredated – canid
1263F	Bauder	1999	6 Jan	16 Nov	314	Hunter harvested
1383F	Bauder	1999	6 Jan		360	Survived to 31 Dec
1425F	Bauder	1999	6 Jan	14 Mar	67	Depredated – unidentified
1463F	Bauder	1999	6 Jan	28 Jul	203	Depredated – raccoon
1503F	Bauder	1999	6 Jan	5 Sep	242	Depredated – unidentified
1183F	Bauder	1999	7 Jan		359	Survived to 31 Dec
1494G	Bauder	1999	12 Jan	17 Oct	278	Hunter harvested
1082F	Bauder	1999	13 Jan	10 Dec	331	Lost radio contact
1124F	Bauder	1999	13 Jan	4 May	111	Depredated – canid
1323F	Bauder	1999	13 Jan	17 Oct	277	Hunter harvested
1243G	Bauder	1999	14 Jan		352	Survived to 31 Dec
1343F	Bauder	1999	14 Jan	17 Jan	3	Unidentified death
1343G	Bauder	1999	12 Feb	16 Oct	246	Hunter harvested
1133D	Derksen	1999	reentry	2 Dec	335	Radio ceased transmitting
1293D	Derksen	1999	reentry	5 Mar	63	Radio ceased transmitting
1472D	Derksen	1999	reentry	6 May	125	Radio harness broke
1092F	Derksen	1999	6 Jan	22 Apr	106	Depredated – fox

1233F	Derksen	1999	6 Jan	29 Oct	296	Hunter harvested
1334F	Derksen	1999	6 Jan	22 Oct	289	Lost radio contact
1355F	Derksen	1999	6 Jan		360	Survived to 31 Dec
1372F	Derksen	1999	6 Jan		360	Survived to 31 Dec
1392F	Derksen	1999	6 Jan	27 Mar	80	Depredated – unidentified
1412F	Derksen	1999	6 Jan	16 Sep	253	Depredated – raccoon
1034F	Derksen	1999	7 Jan	5 Dec	332	Hunter harvested
1192F	Derksen	1999	7 Jan		359	Survived to 31 Dec
1313F	Derksen	1999	7 Jan	20 Apr	103	Depredated – mink
1433F	Derksen	1999	7 Jan	8 Aug	213	Depredated – raptor
1494F	Derksen	1999	7 Jan	10 Jan	3	Depredated – cat
1483F	Derksen	1999	12 Jan	6 Nov	298	Hunter harvested
1183F	Bauder	2000	reentry	15 Apr	105	Radio ceased transmitting
1383F	Bauder	2000	reentry	29 Nov	333	Radio ceased transmitting
2012K	Bauder	2000	7 Jan	21 Oct	288	Hunter harvested
2403K	Bauder	2000	21 Jan	23 Aug	215	Depredated – unidentified
2375K	Bauder	2000	18 Apr	7 Jul	80	Depredated – unidentified
2583K	Bauder	2000	18 Apr	9 May	21	Depredated – coyote
2133K	Bauder	2000	19 Apr		257	Survived to 31 Dec
2793K	Bauder	2000	19 Apr	25 Oct	189	Hunter harvested
2703K	Bauder	2000	26 Apr		250	Survived to 31 Dec
1192F	Derksen	2000	reentry	22 Sep	265	Radio ceased transmitting
1355F	Derksen	2000	reentry	18 Apr	108	Radio harness broke
1372F	Derksen	2000	reentry	6 Apr	96	Depredated – owl
2224K	Derksen	2000	7 Jan		360	Survived to 31 Dec
2673K	Derksen	2000	7 Jan	31 Oct	298	Shot but not retrieved
2192K	Derksen	2000	13 Jan		354	Survived to 31 Dec
2765K	Derksen	2000	13 Jan	18 Sep	249	Radio harness broke
2494K	Derksen	2000	21 Jan	30 Apr	100	Depredated – coyote
2825K	Derksen	2000	21 Jan		346	Survived to 31 Dec
2313K	Derksen	2000	19 Feb	31 Dec	316	Depredated – raptor
2883K	Derksen	2000	19 Feb		317	Survived to 31 Dec
2044K	Derksen	2000	11 Mar	23 Nov	257	Hunter harvested
2133K	Bauder	2001	reentry	23 May	142	Depredated – badger
2703K	Bauder	2001	reentry	28 Oct	300	Hunter harvested
2343P	Bauder	2001	17 Jan	13 May	116	Depredated – raptor
2614P	Bauder	2001	17 Jan	27 Jul	191	Vehicular collision
2102P	Bauder	2001	18 Jan	27 May	129	Depredated – canid
2163P	Bauder	2001	18 Jan	12 Nov	298	Depredated – mammal
2313P	Bauder	2001	18 Jan	4 May	106	Depredated – raptor
2375P	Bauder	2001	18 Jan	1 Dec	317	Lost radio contact
2403P	Bauder	2001	18 Jan	23 May	125	Depredated – unidentified
2583P	Bauder	2001	18 Jan	9 Sep	234	Unidentified death
2644P	Bauder	2001	18 Jan		348	Survived to 31 Dec
2673P	Bauder	2001	18 Jan	10 Dec	326	Lost radio contact
2522P	Bauder	2001	19 Jan	31 Jul	193	Lost radio contact
2554P	Bauder	2001	19 Jan	20 Oct	274	Hunter harvested
2192K	Derksen	2001	reentry	3 Mar	61	Unidentified death
2224K	Derksen	2001	reentry	7 Dec	340	Radio ceased transmitting
2825K	Derksen	2001	reentry	13 Jun	163	Radio harness broke
2883K	Derksen	2001	reentry	19 Aug	230	Radio harness broke
2044P	Derksen	2001	17 Jan		349	Survived to 31 Dec
2073P	Derksen	2001	17 Jan	5 Nov	292	Hunter harvested

2253P	Derksen	2001	17 Jan		349	Survived to 31 Dec
2283P	Derksen	2001	17 Jan	1 Jul	165	Depredated – raptor
2433P	Derksen	2001	17 Jan	25 Feb	39	Depredated – raptor
2462P	Derksen	2001	17 Jan	15 Dec	332	Radio harness broke
2494P	Derksen	2001	17 Jan	10 Apr	83	Depredated – mammal
2732P	Derksen	2001	17 Jan	30 Dec	347	Hunter harvested
2764P	Derksen	2001	17 Jan	15 Nov	302	Depredated – mammal
2853P	Derksen	2001	17 Jan	10 Jun	144	Depredated – coyote
2433Q	Derksen	2001	14 Mar		293	Survived to 31 Dec
2192Q	Derksen	2001	15 Mar	23 Jun	100	Depredated – canid

Appendix Table 2. Characteristics of radiomarked male pheasants captured in eastern South Dakota, 1997-2001.

Bird	Study area	Year	Age	Number of points	Number of HR polygons	Type of home range	Home range size (hectares)
1164A	Bauder	1997	Juvenile	48	4	Localized	29.6
1113A	Derksen	1997	Adult	98	2	Localized	14.5
1293A	Derksen	1997	Juvenile			Unknown	
1402A	Derksen	1997	Adult	88	5	Ephemeral	49.7
1063D	Bauder	1998	Juvenile			Unknown	
1142D	Bauder	1998	Juvenile			Unknown	
1223D	Bauder	1998	Adult	45	1	Localized	19.8
1253D	Bauder	1998	Adult			Unknown	
1283D	Bauder	1998	Adult	31	4	Localized	18.0
1323D	Bauder	1998	Juvenile	46	1	Localized	19.1
1362D	Bauder	1998	Adult	59	1	Localized	19.6
1053D	Derksen	1998	Adult	27	1	Localized	14.5
1073D	Derksen	1998	Juvenile	36	9	Ephemeral	43.2
1133D	Derksen	1998	Adult	36	2	Localized	24.5
1152D	Derksen	1998	Adult	59	1	Localized	11.7
1293D	Derksen	1998	Adult	33	2	Localized	13.9
1472D	Derksen	1998	Adult	28	1	Localized	6.2
1082F	Bauder	1999	Juvenile	53	3	Localized	21.8
1183F	Bauder	1999	Juvenile	52	11	Ephemeral	62.6
1243G	Bauder	1999	Juvenile	57	4	Localized	24.2
1263F	Bauder	1999	Adult			Unknown	
1283D	Bauder	1999	Adult	67	5	Ephemeral	33.6
1323F	Bauder	1999	Adult	61	3	Ephemeral	40.3
1383F	Bauder	1999	Juvenile	52	6	Ephemeral	31.5
1463F	Bauder	1999	Adult	65	4	Ephemeral	40.8
1034F	Derksen	1999	Adult	40	11	Ephemeral	67.0
1133D	Derksen	1999	Adult	46	1	Localized	21.6
1192F	Derksen	1999	Adult	48	9	Ephemeral	49.3
1233F	Derksen	1999	Juvenile	55	5	Ephemeral	37.4
1313F	Derksen	1999	Adult	26	13	Ephemeral	41.1
1334F	Derksen	1999	Adult	60	6	Ephemeral	36.3
1372F	Derksen	1999	Adult	56	1	Localized	24.7
1412F	Derksen	1999	Adult	65	2	Localized	18.1
1433F	Derksen	1999	Adult	62	4	Ephemeral	35.4
1472D	Derksen	1999	Adult	31	1	Localized	11.7
1183F	Bauder	2000	Adult	22	1	Localized	15.1
1383F	Bauder	2000	Adult	66	3	Localized	23.5
2012K	Bauder	2000	Juvenile	32	2	Localized	15.7
2133K	Bauder	2000	Juvenile	41	10	Ephemeral	53.0
2375K	Bauder	2000	Adult	42	2	Localized	25.4
2403K	Bauder	2000	Adult	26	5	Ephemeral	36.5
2583K	Bauder	2000	Juvenile			Unknown	
2703K	Bauder	2000	Adult	36	4	Localized	26.3
2793K	Bauder	2000	Adult	41	2	Localized	20.3
1192F	Derksen	2000	Adult	65	1	Localized	14.5
1372F	Derksen	2000	Adult			Unknown	
2044K	Derksen	2000	Adult	53	2	Localized	30.1
2192K	Derksen	2000	Juvenile	57	3	Ephemeral	33.3
2313K	Derksen	2000	Adult	59	3	Localized	18.3

2494K	Derksen	2000	Adult	22	1	Localized	9.2
2673K	Derksen	2000	Juvenile	53	3	Ephemeral	37.3
2765K	Derksen	2000	Adult	64	25	Ephemeral	97.3
2825K	Derksen	2000	Adult	64	4	Ephemeral	41.0
2883K	Derksen	2000	Juvenile	66	5	Ephemeral	52.9
2102P	Bauder	2001	Adult	25	2	Localized	22.9
2133K	Bauder	2001	Adult	34	1	Localized	21.9
2583P	Bauder	2001	Juvenile	36	5	Ephemeral	36.6
2703K	Bauder	2001	Adult	47	3	Localized	26.6
2044P	Derksen	2001	Juvenile	54	9	Ephemeral	53.8
2073P	Derksen	2001	Adult	49	1	Localized	11.8
2192Q	Derksen	2001	Adult	53	1	Localized	13.6
2253P	Derksen	2001	Juvenile	50	3	Ephemeral	36.3
2283P	Derksen	2001	Adult	52	1	Localized	17.2
2433Q	Derksen	2001	Adult	51	1	Localized	14.2
2462P	Derksen	2001	Juvenile	39	1	Localized	18.0
2764P	Derksen	2001	Juvenile	48	3	Ephemeral	43.7
2825K	Derksen	2001	Adult	40	2	Localized	17.6
2853P	Derksen	2001	Adult	48	1	Localized	14.3
2883P	Derksen	2001	Adult	50	1	Localized	9.6

Appendix Table 3. Compositional analysis scores for habitats selected by breeding male pheasants that were classified as having localized home ranges in eastern South Dakota, 1997-2001.

	Home Range					**Daily Use**				
Bird	Wood	Idle	Open	Crop	Water	Wood	Idle	Open	Crop	Water
1053D	-2.10	1.66	1.31	-4.63	3.75	-0.79	-0.83	-0.72	3.51	-1.16
1082F	1.40	1.07	-2.77	-0.25	0.54	0.45	-0.14	0.45	-0.14	-0.62
1113A	1.65	1.09	-0.66	-1.81	-0.27	1.94	1.59	0.53	-3.47	-0.59
1133D	0.96	1.70	0.53	-0.29	-2.91	0.73	-0.76	0.05	0.01	-0.03
1133D	1.30	1.82	0.90	-1.26	-2.76	1.96	0.28	0.58	-3.45	0.62
1152D	1.46	0.90	-1.46	-1.99	1.09	0.72	0.29	-1.52	-0.09	0.60
1164A	0.26	-0.70	0.37	-0.05	0.11	0.90	0.05	0.44	0.00	-1.39
1183F	-1.08	2.91	-4.04	1.28	0.94	0.07	0.30	0.07	-0.51	0.07
1192F	2.53	-0.13	-0.05	0.15	-2.51	0.97	0.46	-1.84	0.19	0.22
1223D	2.01	1.67	-1.75	-0.61	-1.32	0.63	0.32	0.92	-0.21	-1.66
1243G	1.74	1.89	-2.42	-0.47	-0.74	0.63	0.01	0.42	-0.71	-0.35
1283D	1.25	2.36	-1.34	-2.15	-0.11	-2.52	1.46	0.01	0.35	0.69
1293D	1.37	0.32	-0.44	-0.28	-0.97	1.99	-0.38	0.25	0.06	-1.92
1323D	-2.08	2.47	-1.10	-0.13	0.84	-0.03	-0.01	0.50	-0.07	-0.38
1362D	2.33	2.79	-1.52	-1.32	-2.29	1.06	0.61	-0.61	0.31	-1.38
1372F	0.13	1.05	-0.71	-1.30	0.82	-0.34	0.88	-0.24	-1.07	0.77
1383F	1.74	-1.29	0.29	-0.07	-0.68	1.07	-0.37	0.01	-0.63	-0.08
1412F	-0.01	1.40	-1.92	-0.56	1.10	-0.30	1.16	-1.83	1.53	-0.57
1472D	2.50	1.88	-1.63	0.31	-3.07	0.71	0.70	-3.46	1.21	0.85
1472D	1.73	1.40	-0.03	0.03	-3.13	0.67	0.57	-1.01	-0.25	0.01
2012K	2.35	1.26	-2.30	-0.69	-0.62	0.52	-0.24	-0.07	-0.15	-0.06
2044K	-1.86	0.70	-1.08	0.41	1.83	-1.14	0.43	-0.62	0.30	1.03
2073P	-1.24	4.96	-1.47	-3.58	1.34	0.60	0.65	-2.22	0.60	0.36
2102P	.	.	.	.	.	0.76	-0.17	-0.16	-0.23	-0.20
2133K	2.26	-0.95	-1.61	0.94	-0.65	1.45	0.53	-1.45	0.08	-0.61
2192Q	1.31	0.71	1.16	-0.03	-3.15	-0.15	0.14	1.00	-0.34	-0.65
2283P	1.47	-0.90	-0.26	0.18	-0.49	1.20	-0.29	0.17	0.41	-1.50
2313K	-2.31	4.03	0.32	-1.09	-0.95	1.93	1.26	-2.48	-1.84	1.13
2375K	-2.58	0.80	-1.89	0.21	3.46	0.08	-0.02	0.54	0.16	-0.76
2433Q	1.58	-0.65	-0.65	0.33	-0.61	1.32	-1.49	-0.33	1.20	-0.70
2462P	.	.	.	.	.	0.17	0.07	0.28	-0.91	0.38
2494K	2.19	1.11	-0.17	-0.50	-2.63	0.72	-0.32	-0.60	0.17	0.03
2703K	1.35	0.55	-0.69	-0.38	-0.83	0.41	-0.06	0.51	-0.77	-0.10
2703K	1.66	-1.63	-0.36	-0.05	0.37	0.53	-0.01	-0.06	-0.56	0.09
2793K	-1.85	2.06	-0.88	0.50	0.17	-0.19	-0.36	1.02	-0.27	-0.19
2825K	1.64	1.97	0.27	-2.56	-1.31	0.36	1.07	1.35	-1.66	-1.13
2853P	2.02	4.51	-4.55	-3.84	1.86	-0.28	0.44	0.24	0.24	-0.63
2883P	2.65	2.23	-5.79	0.88	0.04	0.51	0.43	0.05	-0.79	-0.20

Appendix Table 4. Compositional analysis scores for habitats selected by breeding male pheasants that were classified as having ephemeral home ranges in eastern South Dakota, 1997-2001.

	Home Range					**Daily Use**				
Bird	Wood	Idle	Open	Crop	Water	Wood	Idle	Open	Crop	Water
1034F	1.13	-0.62	-0.12	0.09	-0.47	0.21	0.07	0.41	-0.04	-0.66
1073D	0.67	0.52	-0.06	-1.80	0.66	0.19	-0.55	-0.22	0.77	-0.19
1183F	1.13	0.11	0.06	0.36	-1.67	0.58	-0.29	0.13	-0.28	-0.14
1192F	1.38	-0.17	-0.05	0.17	-1.33	0.58	-0.28	-0.52	-0.24	0.47
1233F	0.08	-0.43	0.31	-0.59	0.63	0.97	-0.55	0.61	-0.08	-0.95
1283D	-2.09	2.59	-1.26	0.12	0.64	0.28	0.60	0.60	-0.25	-1.23
1313F	0.48	0.73	-0.11	-0.98	-0.12	1.10	0.39	0.19	-0.06	-1.61
1323F	1.49	-2.19	0.41	0.08	0.20	1.22	0.14	-0.47	0.14	-1.03
1334F	1.38	-0.34	0.12	-0.19	-0.98	0.59	0.01	0.54	0.70	-1.84
1383F	1.82	1.07	-0.25	0.93	-3.57	1.36	-0.32	0.26	-0.59	-0.71
1402A	1.93	0.40	0.58	1.42	-4.34	0.65	-0.59	-0.49	0.36	0.06
1433F	0.68	-0.35	0.17	-0.88	0.39	0.99	0.00	-0.44	0.43	-0.98
1463F	-2.22	1.06	-0.43	0.60	0.99	0.00	-0.42	0.20	-0.07	0.29
2044P	1.38	0.94	-1.03	-0.26	-1.02	0.63	0.43	-0.52	-0.40	-0.15
2133K	-0.22	0.53	0.48	-0.26	-0.52	0.65	0.11	-0.02	-0.60	-0.13
2192K	1.63	1.29	0.12	-0.50	-2.55	0.66	0.20	-0.71	-0.09	-0.07
2253P	.	.	.	.	.	0.42	1.20	0.03	-0.50	-1.15
2403K	0.94	0.96	-2.38	-1.90	2.38	0.14	-0.11	-0.09	-0.26	0.33
2583P	1.32	-1.06	-0.09	0.49	-0.66	0.64	0.07	-0.38	0.08	-0.41
2673K	-1.67	-0.48	2.34	-0.56	0.37	0.23	-2.22	0.23	-0.31	2.07
2764P	1.41	-2.15	1.55	0.38	-1.20	1.17	0.19	0.76	0.25	-2.38
2765K	0.96	1.33	0.42	-0.76	-1.95	0.82	0.04	-0.12	-0.20	-0.54
2825K	2.02	1.94	0.23	-1.85	-2.34	0.03	0.30	0.53	-1.21	0.34
2883K	1.74	1.38	0.37	-1.02	-2.46	0.42	-0.03	-0.50	0.24	-0.13

Appendix Table 5. Results of analysis of variance tests on the selection of home range habitats by breeding male pheasants in relation to the habitats available within two 9 square-mile study areas in eastern South Dakota, 1997-2001.

Variable	Source of Variation	df	Mean-Square	*F*-ratio	*P*-level
Wood	Home Range Type[1]	1	0.370	0.170	0.682
	Study Area	1	2.809	1.288	0.261
	HR Type∗Study Area	1	1.010	0.463	0.499
	Error	55	2.180		
Idle	Home Range Type	1	11.555	5.892	0.019
	Study Area	1	0.469	0.239	0.627
	HR Type∗Study Area	1	1.225	0.624	0.433
	Error	55	1.961		
Open	Home Range Type	1	14.937	8.829	0.004
	Study Area	1	6.793	4.015	0.050
	HR Type∗Study Area	1	0.015	0.009	0.925
	Error	55	1.692		
Crop	Home Range Type	1	2.104	1.607	0.210
	Study Area	1	5.924	4.525	0.038
	HR Type∗Study Area	1	0.228	0.174	0.678
	Error	55	1.309		
Water	Home Range Type	1	1.710	0.606	0.440
	Study Area	1	6.416	2.272	0.137
	HR Type∗Study Area	1	0.250	0.088	0.767
	Error	55	2.824		

[1] Home ranges were segregated into 2 groups based upon their size using k-means ($F = 161.1$, $df = 1, 59$, $P < 0.001$).

Appendix Table 6. Results of analysis of variance tests on the daily use of habitats by breeding male pheasants in relation to habitats available within their respective home ranges in eastern South Dakota, 1997-2001.

Variable	Source of Variation	df	Mean-Square	*F*-ratio	*P*-level
Wood	Home Range Type[1]	1	0.185	0.338	0.563
	Study Area	1	0.203	0.371	0.545
	HR Type∗Study Area	1	0.222	0.405	0.527
	Error	58	0.548		
Idle	Home Range Type	1	0.921	2.295	0.135
	Study Area	1	0.042	0.105	0.747
	HR Type∗Study Area	1	0.177	0.442	0.509
	Error	58	0.401		
Open	Home Range Type	1	0.596	0.841	0.363
	Study Area	1	1.975	2.789	0.100
	HR Type∗Study Area	1	1.570	2.218	0.142
	Error	58	0.708		
Crop	Home Range Type	1	0.083	0.085	0.771
	Study Area	1	0.156	0.161	0.690
	HR Type∗Study Area	1	0.133	0.137	0.713
	Error	58	0.968		
Water	Home Range Type	1	0.281	0.412	0.523
	Study Area	1	0.125	0.184	0.670
	HR Type∗Study Area	1	0.526	0.771	0.383
	Error	58	0.682		

[1] Home ranges were segregated into 2 groups based upon their size using k-means ($F = 161.1$, $df = 1, 59$, $P < 0.001$).

Appendix Table 7. Results of Fisher's Least Significant Difference (LSD) mean separation tests on the compositional analysis rankings for the composition of home ranges and daily use of habitats of breeding male pheasants in eastern South Dakota, 1997-2001.

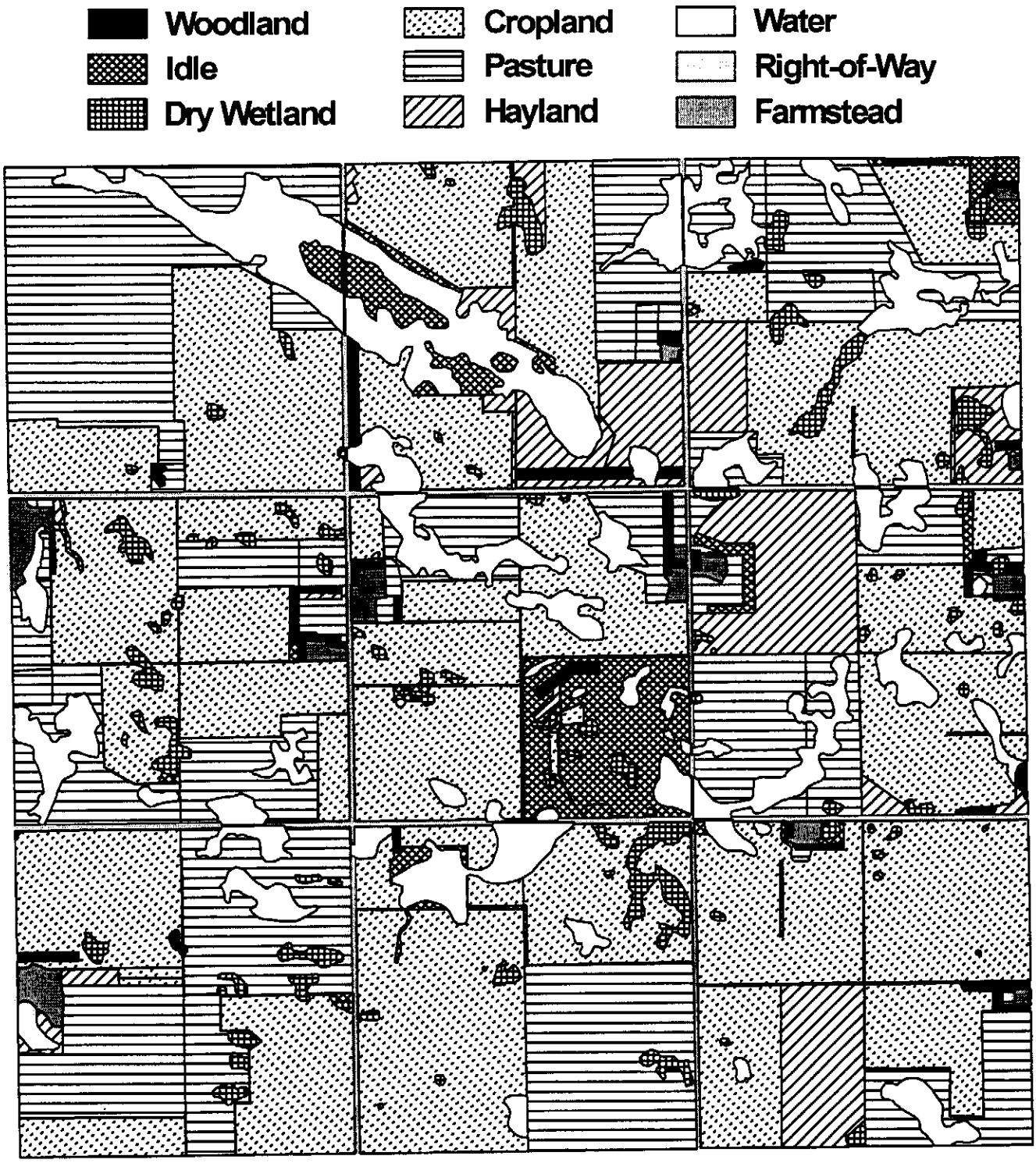
Level of selection	Home range classification	Habitat	Wood	Idle	Open	Crop	Water
Home range	Localized	Wood	1.000				
		Idle	0.192	1.000			
		Open	0.000	0.000	1.000		
		Crop	0.000	0.000	0.300	1.000	
		Water	0.001	0.000	0.063	0.406	1.000
Home range	Ephemeral	Wood	1.000				
		Idle	0.199	1.000			
		Open	0.048	0.478	1.000		
		Crop	0.003	0.083	0.302	1.000	
		Water	0.000	0.002	0.012	0.135	1.000
Daily Use	Both types Combined	Wood	1.000				
		Idle	0.003	1.000			
		Open	0.000	0.070	1.000		
		Crop	0.000	0.066	0.978	1.000	
		Water	0.000	0.003	0.228	0.239	1.000

[1] Home ranges were segregated into 2 groups based upon their size using k-means ($F = 161.1$, $df = 1, 59$, $P < 0.001$).

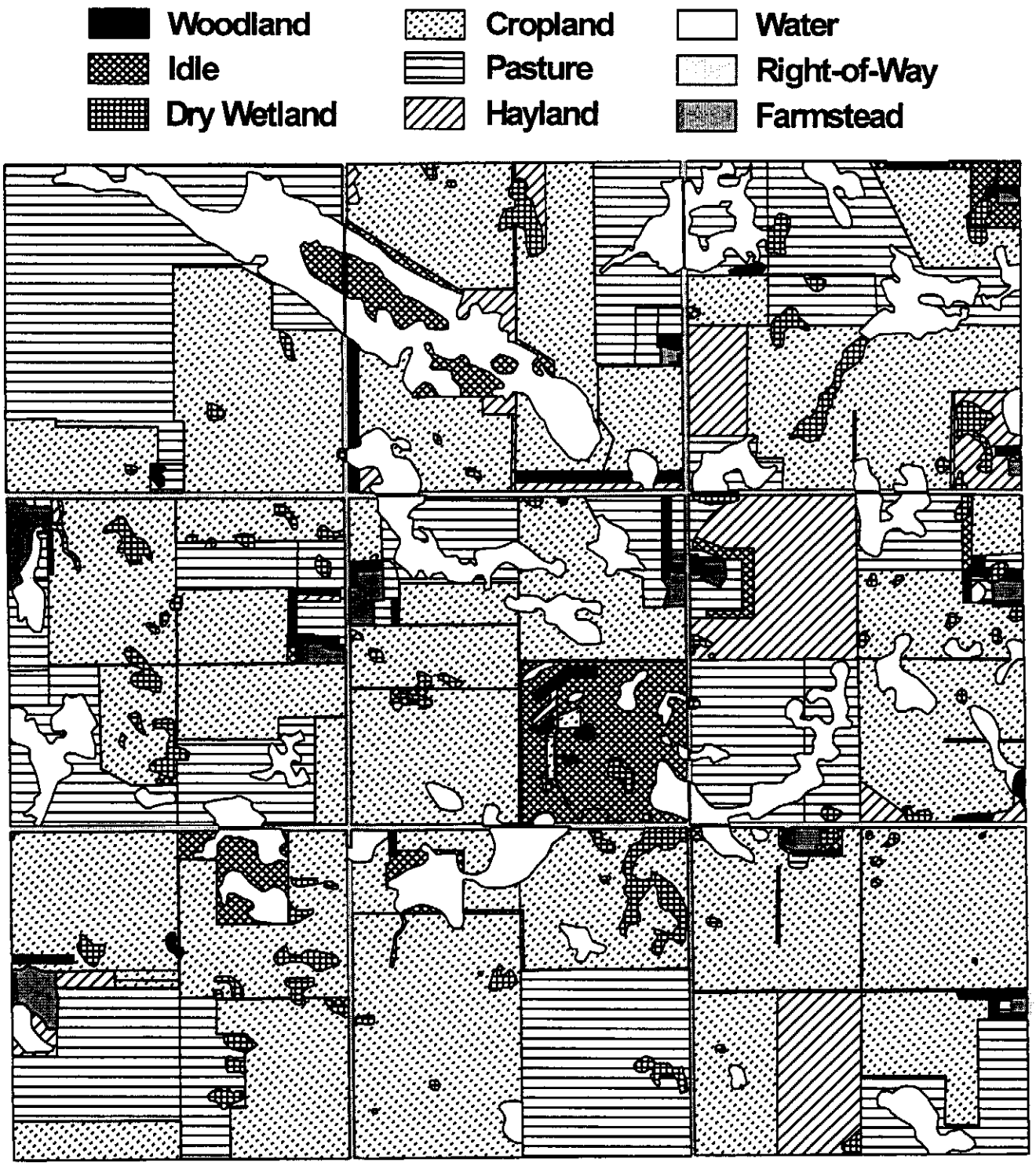
Appendix Table 8. Results of repeated measures analysis of variance tests on the effect of time of day on the daily use of habitats by breeding male pheasants in eastern South Dakota, 1997-2001.

Variable	Source of Variation	df	Mean-Square	F-ratio	P-level
Wood	Home range type	1	240018	1.120	0.294
	Error	60	214297		
	Morning – Afternoon	1	926414	42.468	0.000
	M-A∗Home range type	1	7735	0.355	0.554
	Error	60	21814		
Idle	Home range type	1	3237954	3.574	0.064
	Error	60	906101		
	Morning – Afternoon	1	110439	4.655	0.035
	M-A∗Home range type	1	1	0.000	0.994
	Error	60	23723		
Open	Home range type	1	4560146	5.938	0.018
	Error	60	767914		
	Morning – Afternoon	1	319611	5.977	0.017
	M-A∗Home range type	1	276705	5.175	0.027
	Error	60	53469		
Crop	Home range type	1	269104	0.609	0.438
	Error	60	442005		
	Morning – Afternoon	1	719107	12.756	0.001
	M-A∗Home range type	1	124211	2.203	0.143
	Error	60	56373		
Water	Home Range Type	1	139606	2.230	0.141
	Error	60	62592		
	Morning – Afternoon	1	33	0.002	0.963
	M-A∗Home range type	1	7625	0.498	0.483
	Error	60	15313		

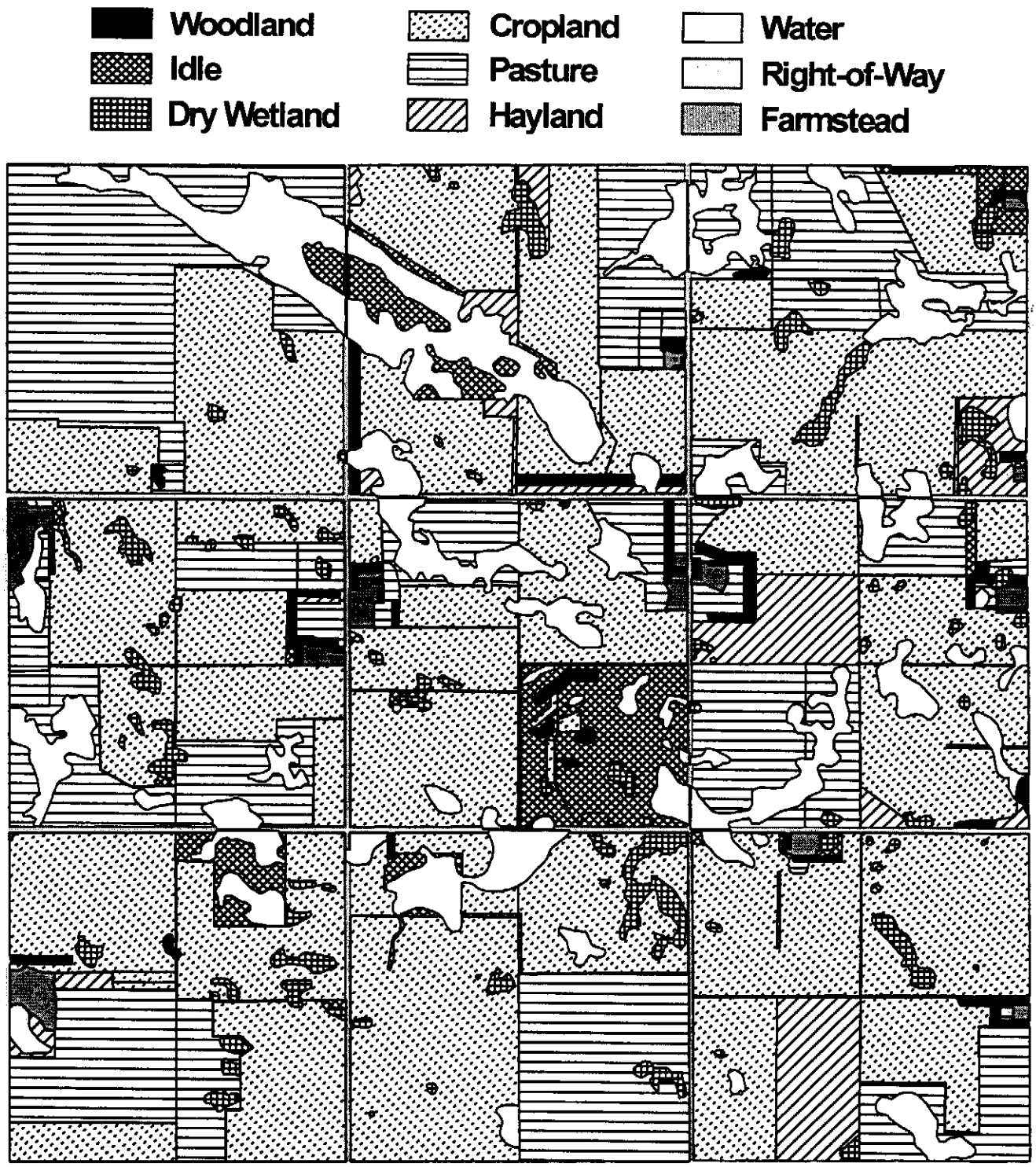
[1] Home ranges were segregated into 2 groups based upon their size using k-means ($F = 161.1$, $df = 1, 59$, $P < 0.001$).



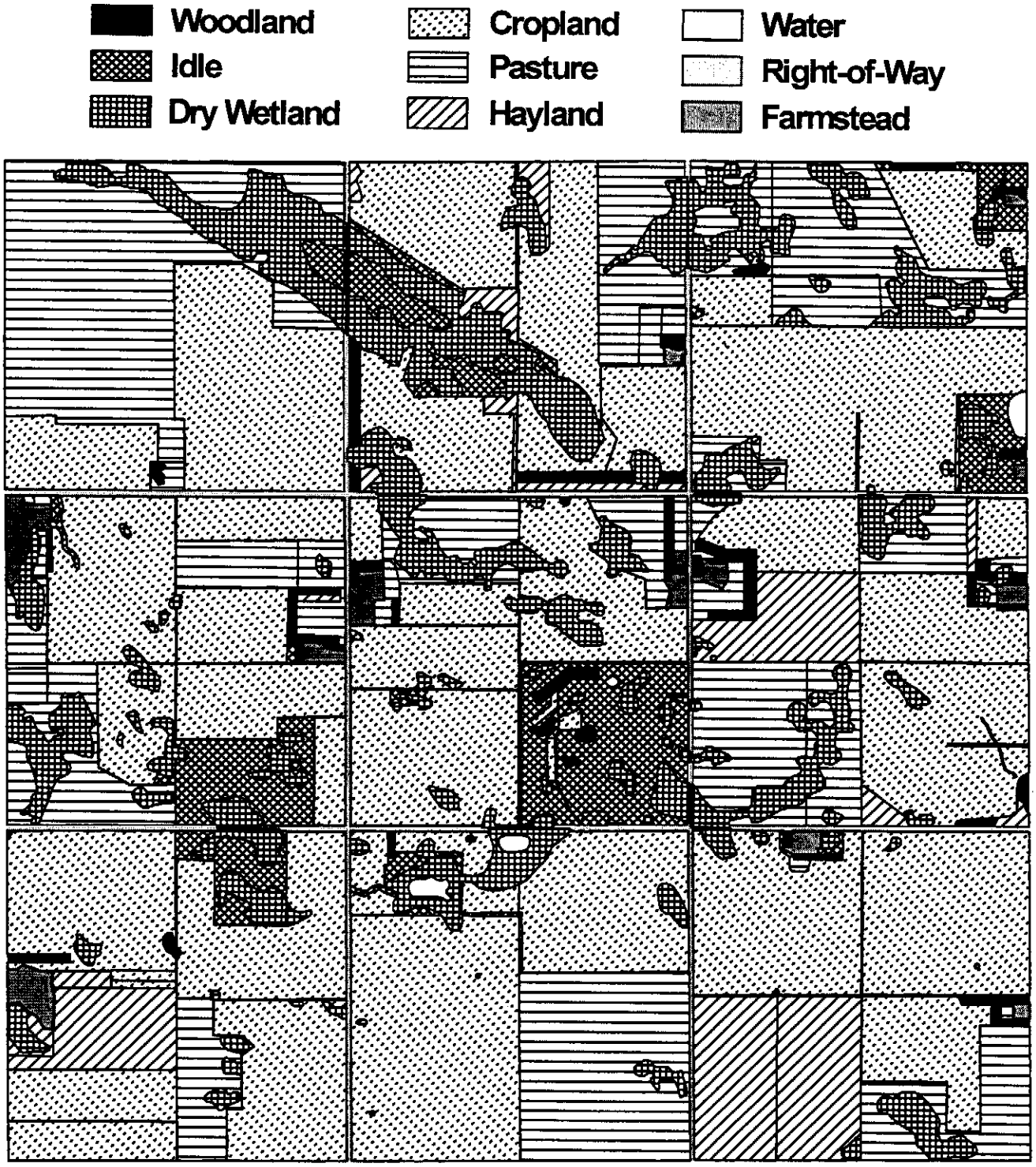
Appendix Figure 1. Cover types on the Bauder Study area in 1997.



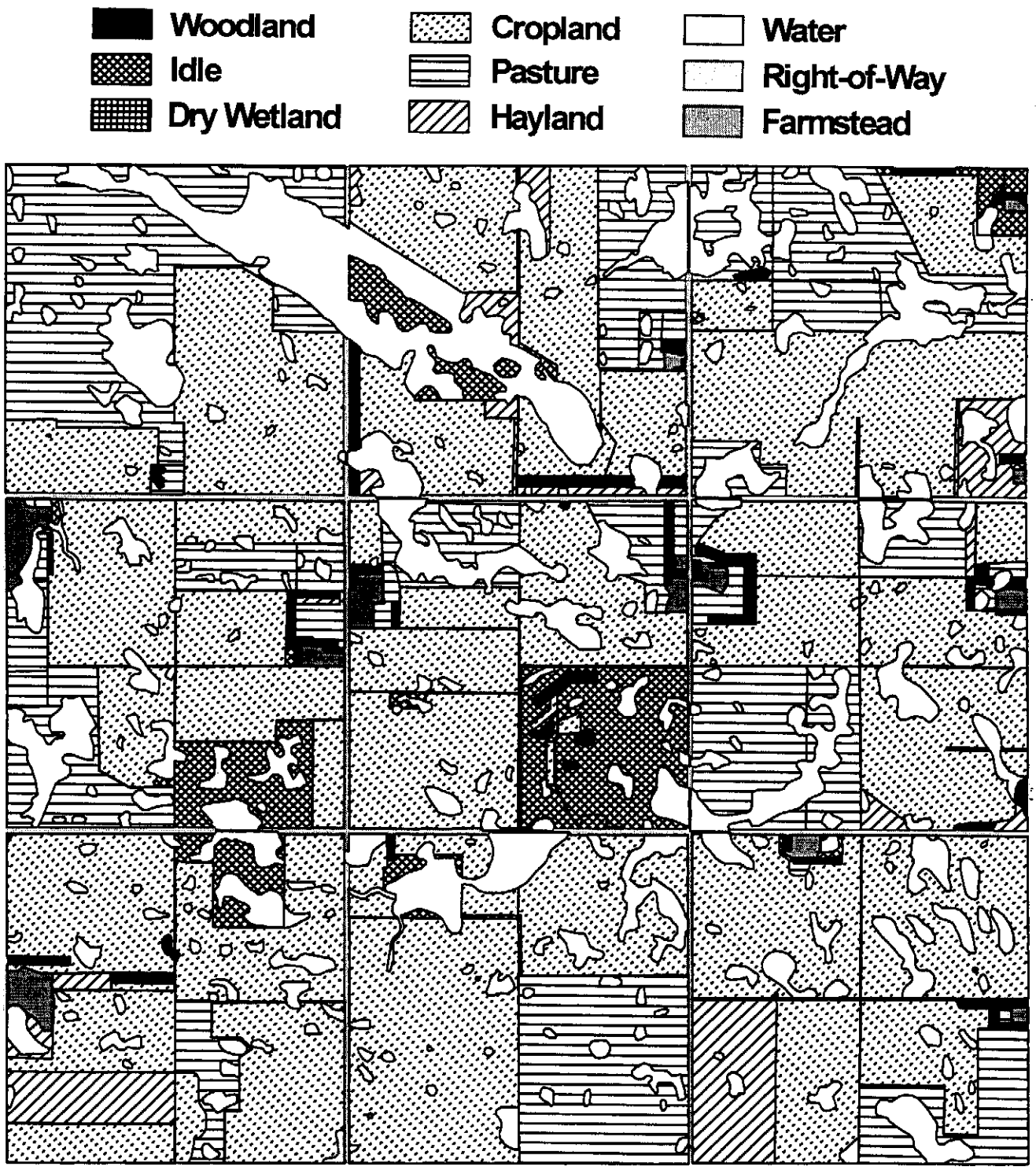
Appendix Figure 2. Cover types on the Bauder Study area in 1998.



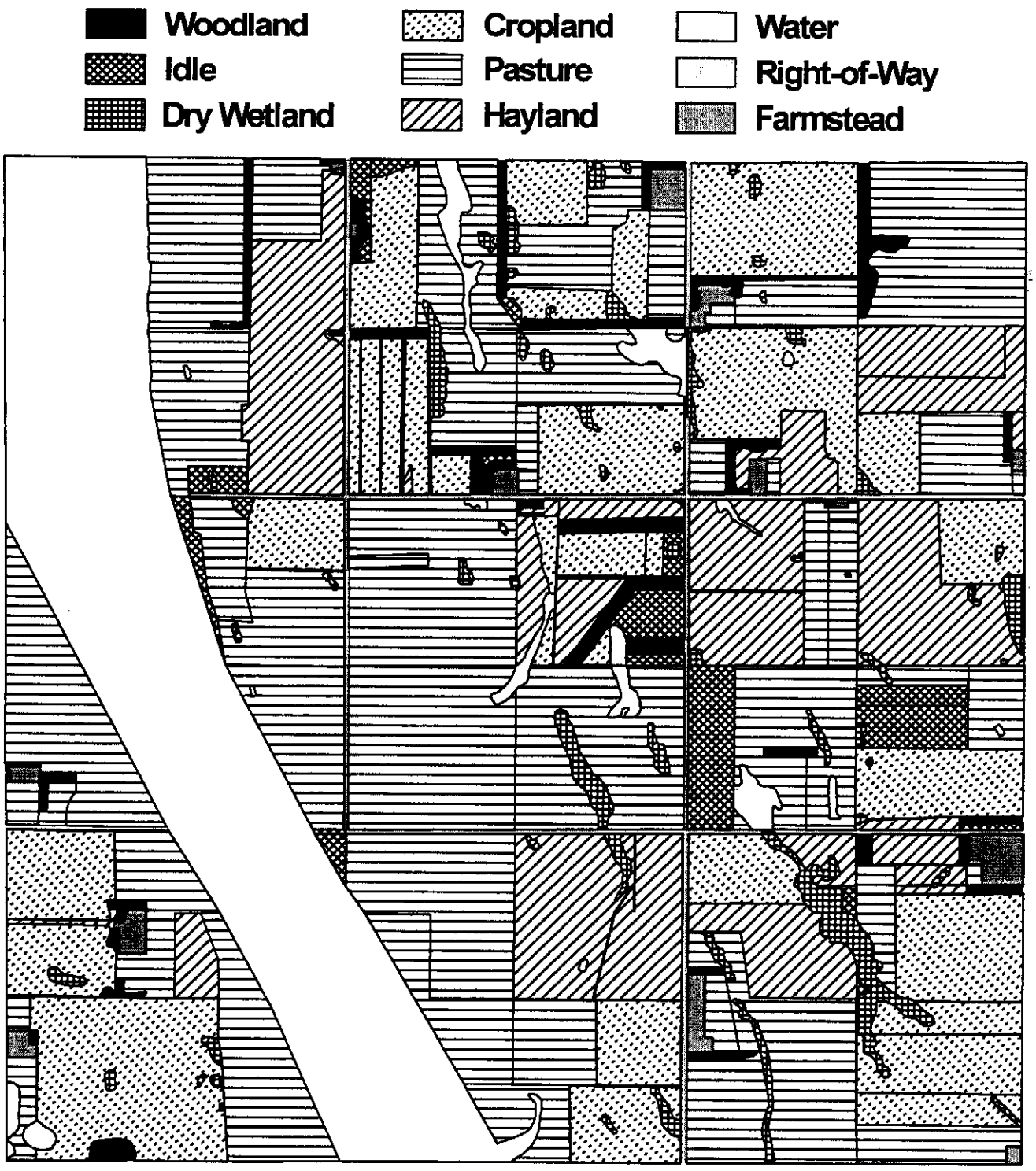
Appendix Figure 3. Cover types on the Bauder Study area in 1999.



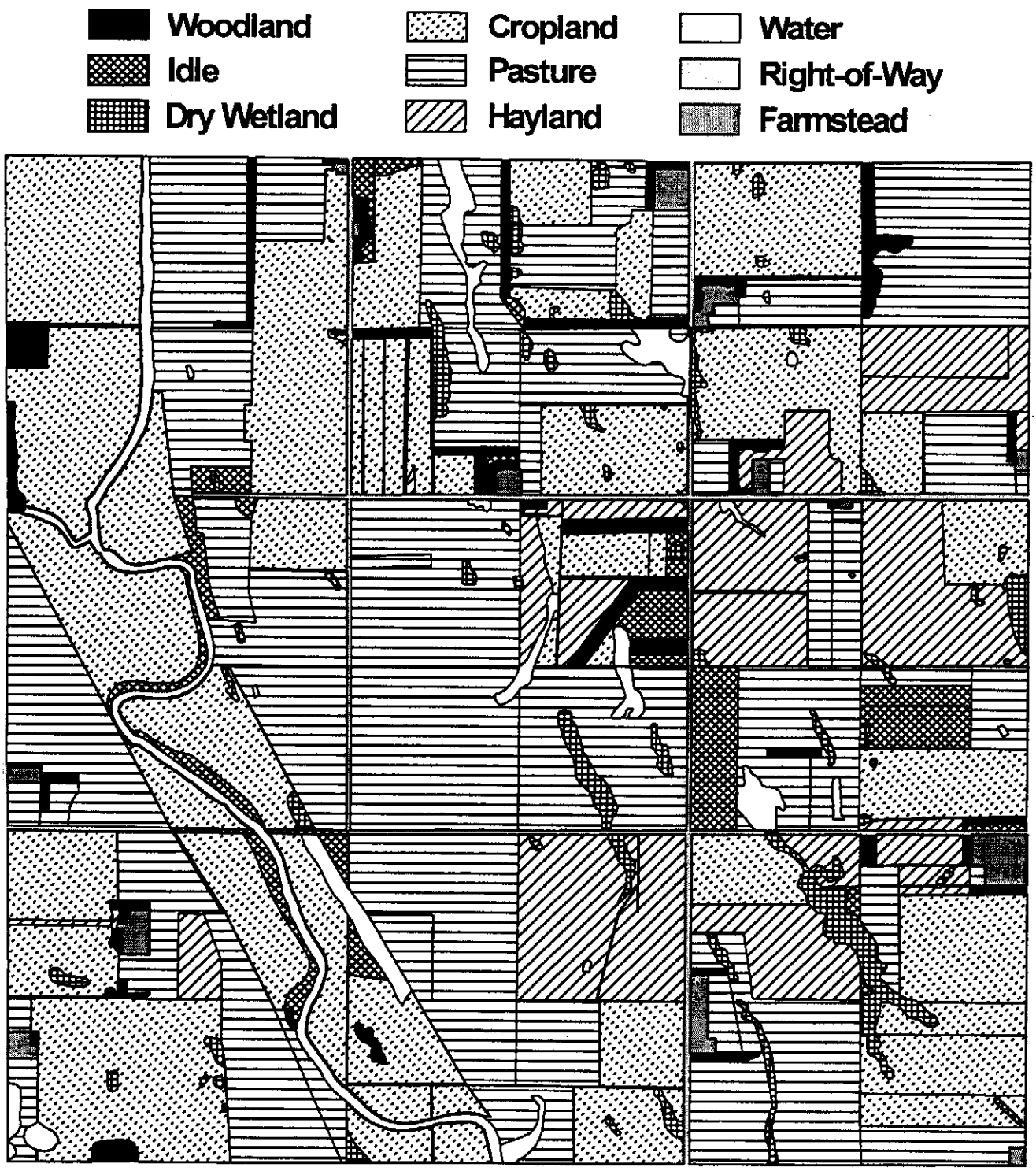
Appendix Figure 4. Cover types on the Bauder Study area in 2000.



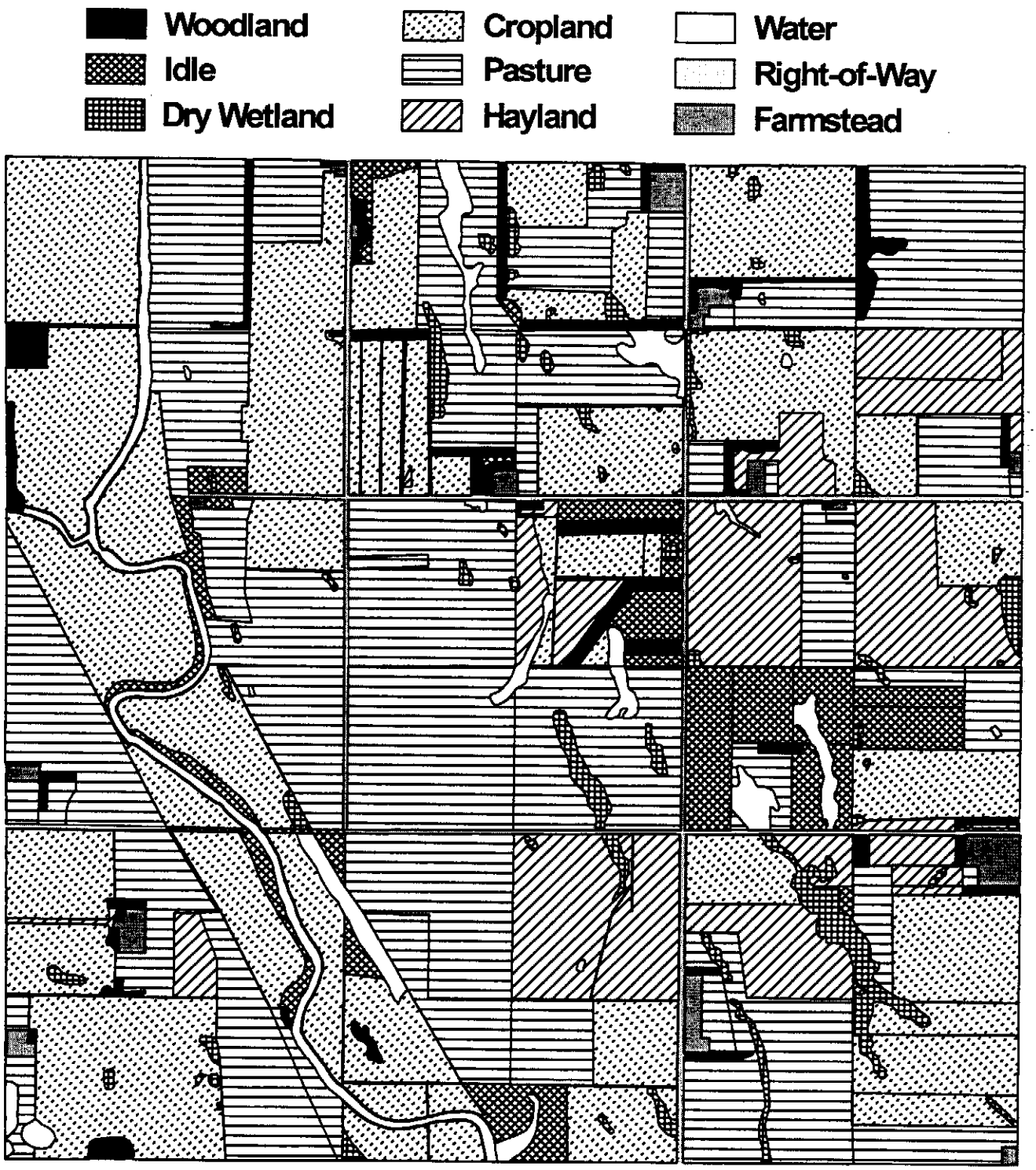
Appendix Figure 5. Cover types on the Bauder Study area in 2001.



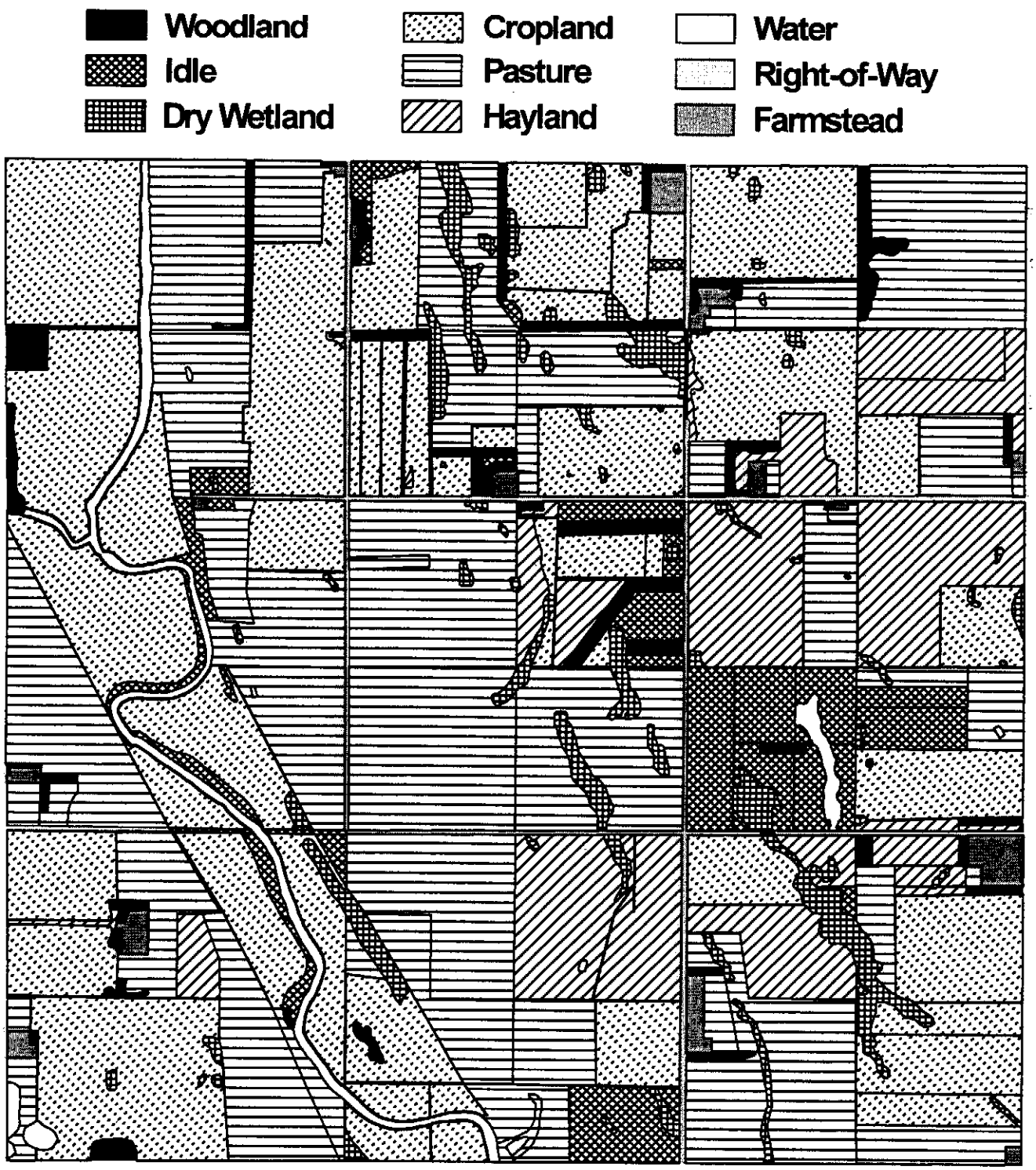
Appendix Figure 6. Cover types on the Derksen Study area in 1997.



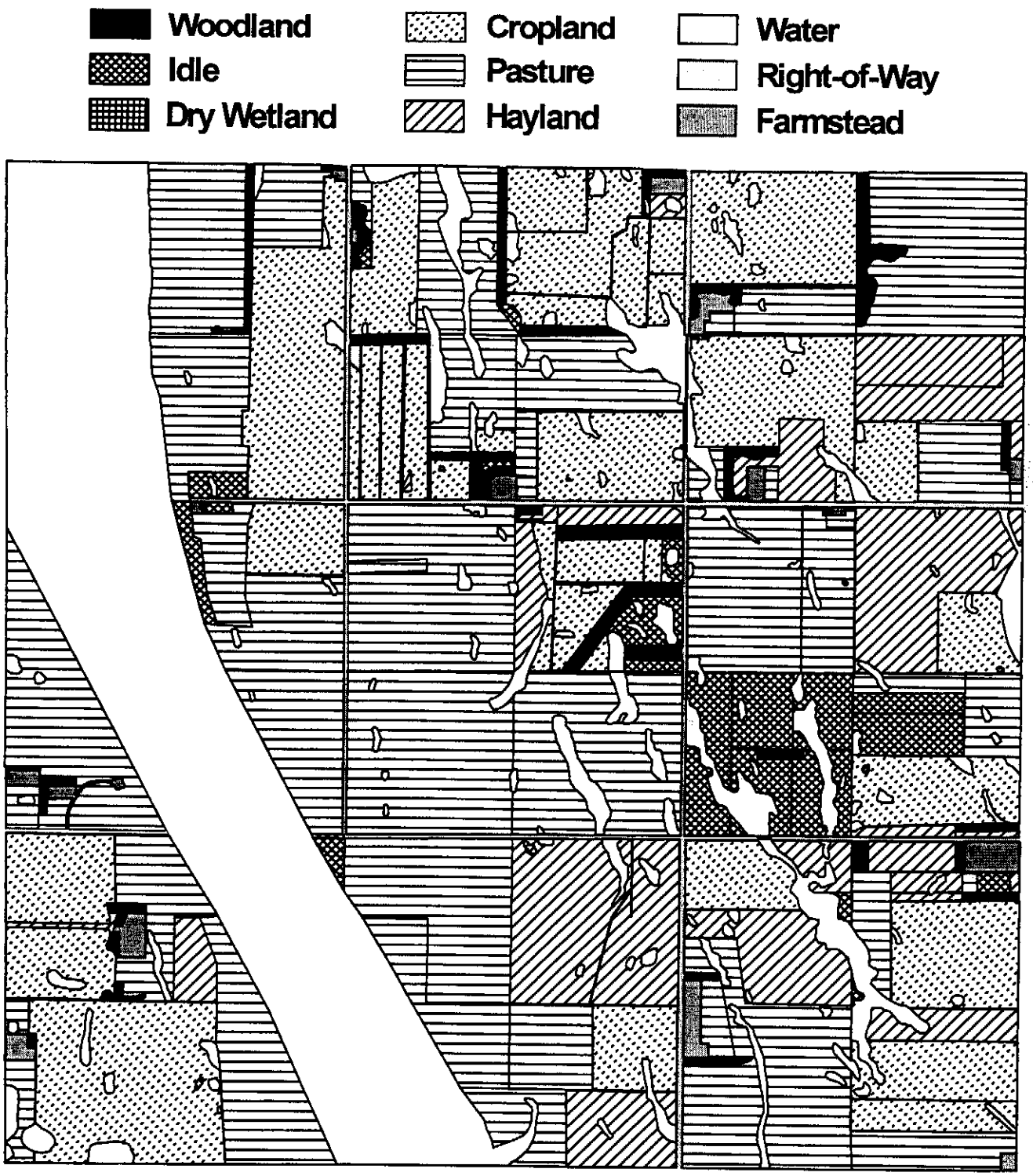
Appendix Figure 7. Cover types on the Derksen Study area in 1998.



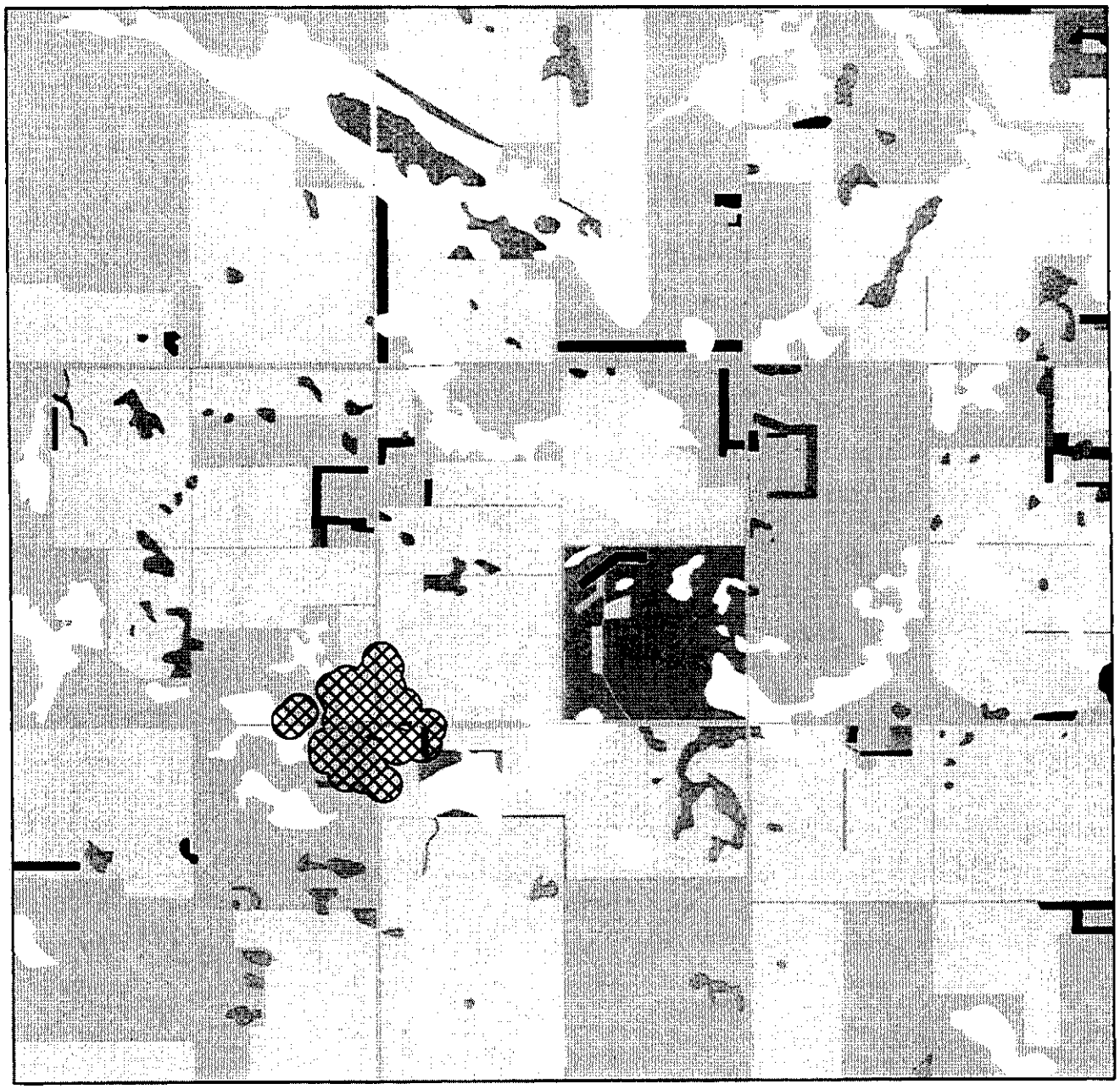
Appendix Figure 8. Cover types on the Derksen Study area in 1999.



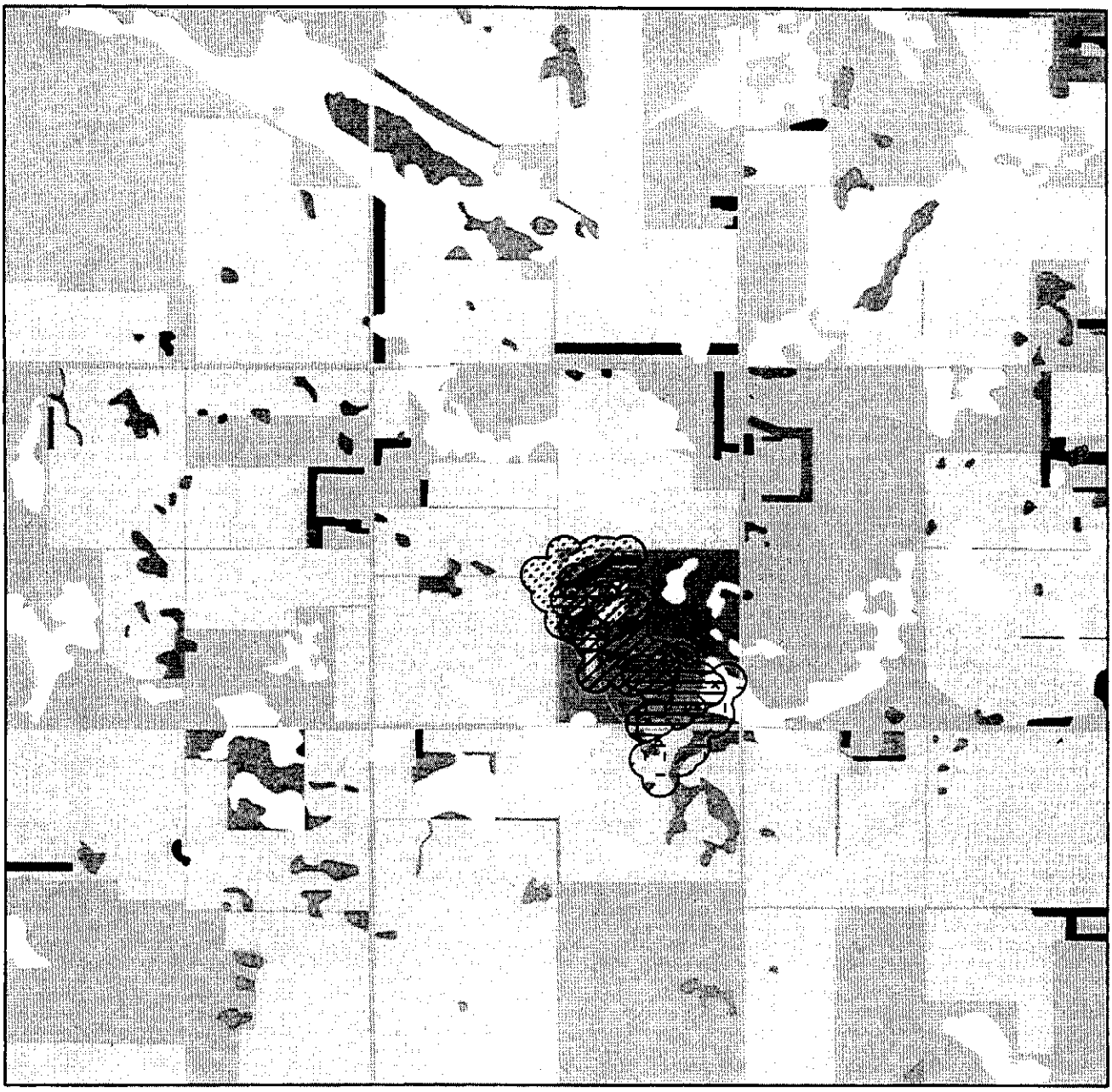
Appendix Figure 9. Cover types on the Derksen Study area in 2000.



Appendix Figure 10. Cover types on the Derksen Study area in 2001.

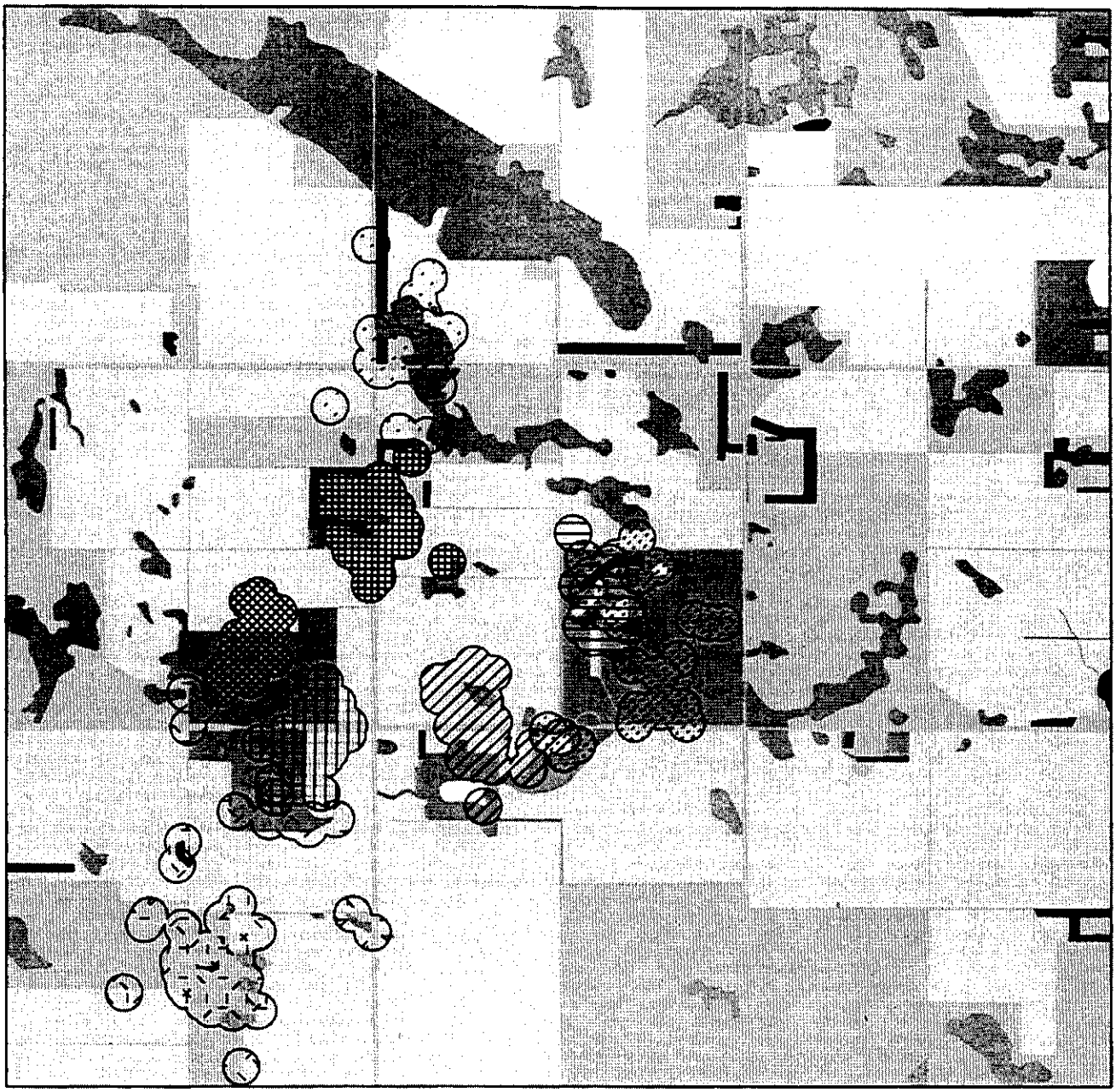


Appendix Figure 11. Home ranges of breeding male pheasants on the Bauder study area in 1997. Each shading pattern represents a different radiomarked pheasant.

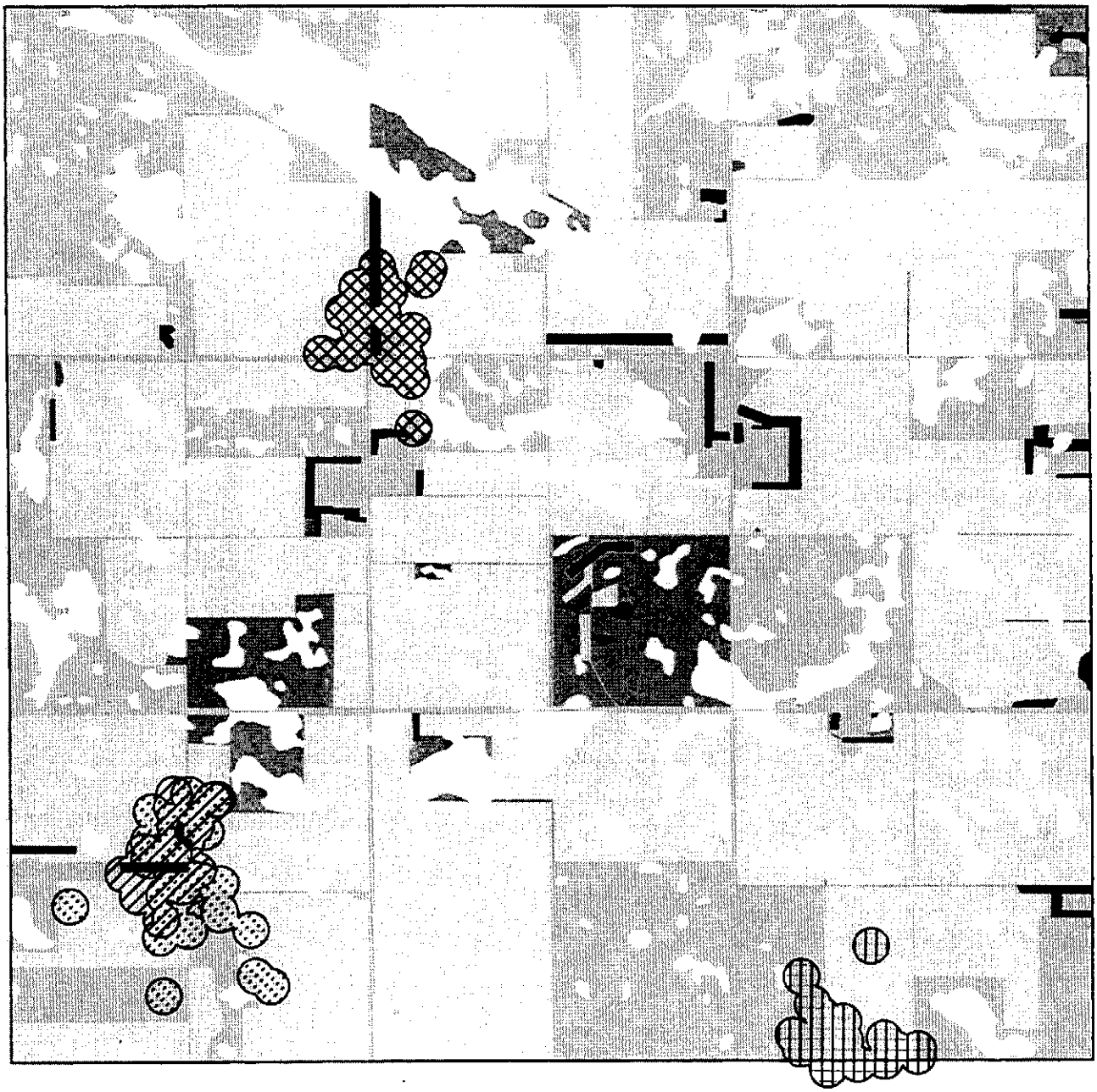


Appendix Figure 12. Home ranges of breeding male pheasants on the Bauder study area in 1998. Each shading pattern represents a different radiomarked pheasant.

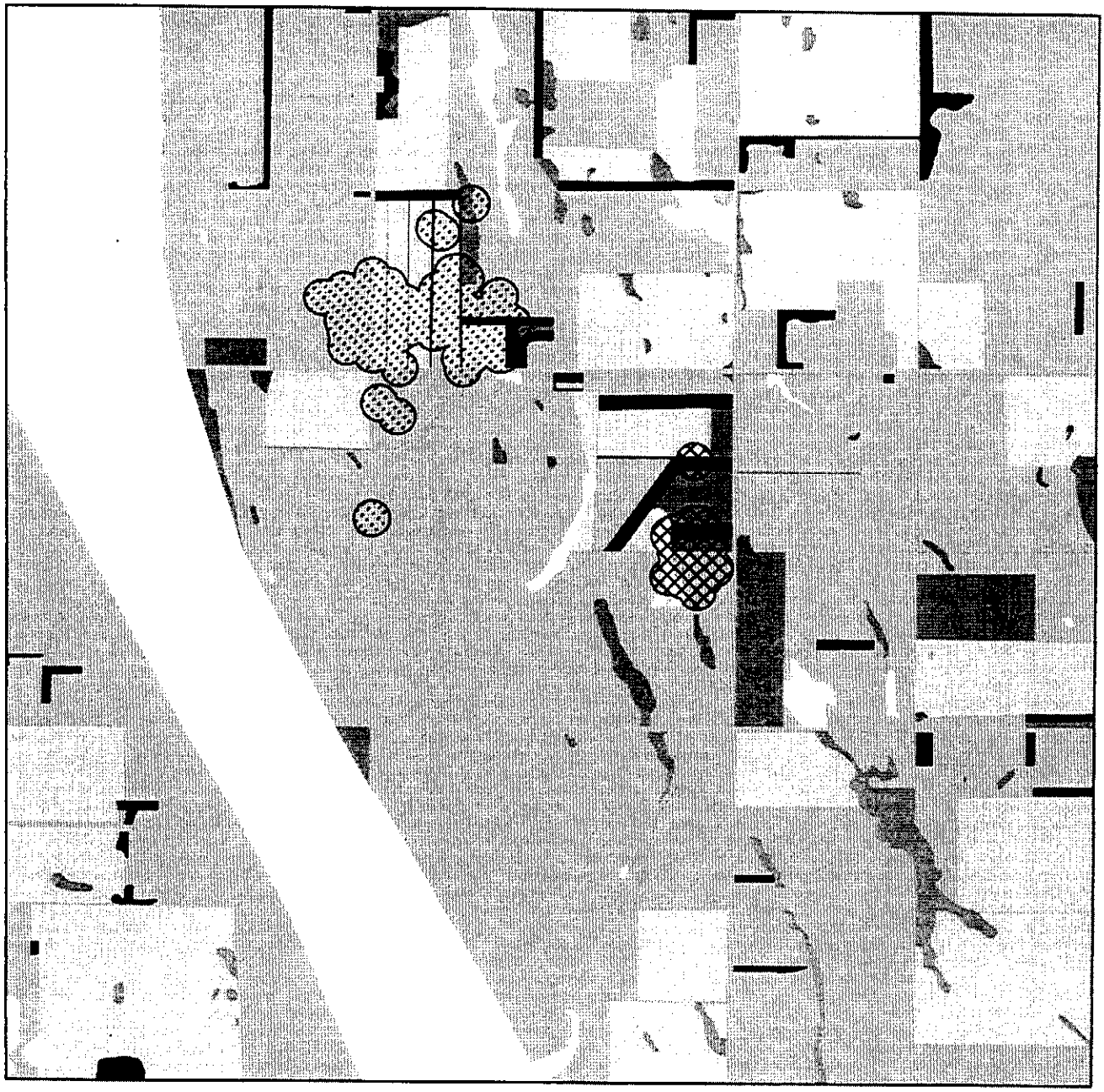
Appendix Figure 13. Home ranges of breeding male pheasants on the Bauder study area in 1999. Each shading pattern represents a different radiomarked pheasant.



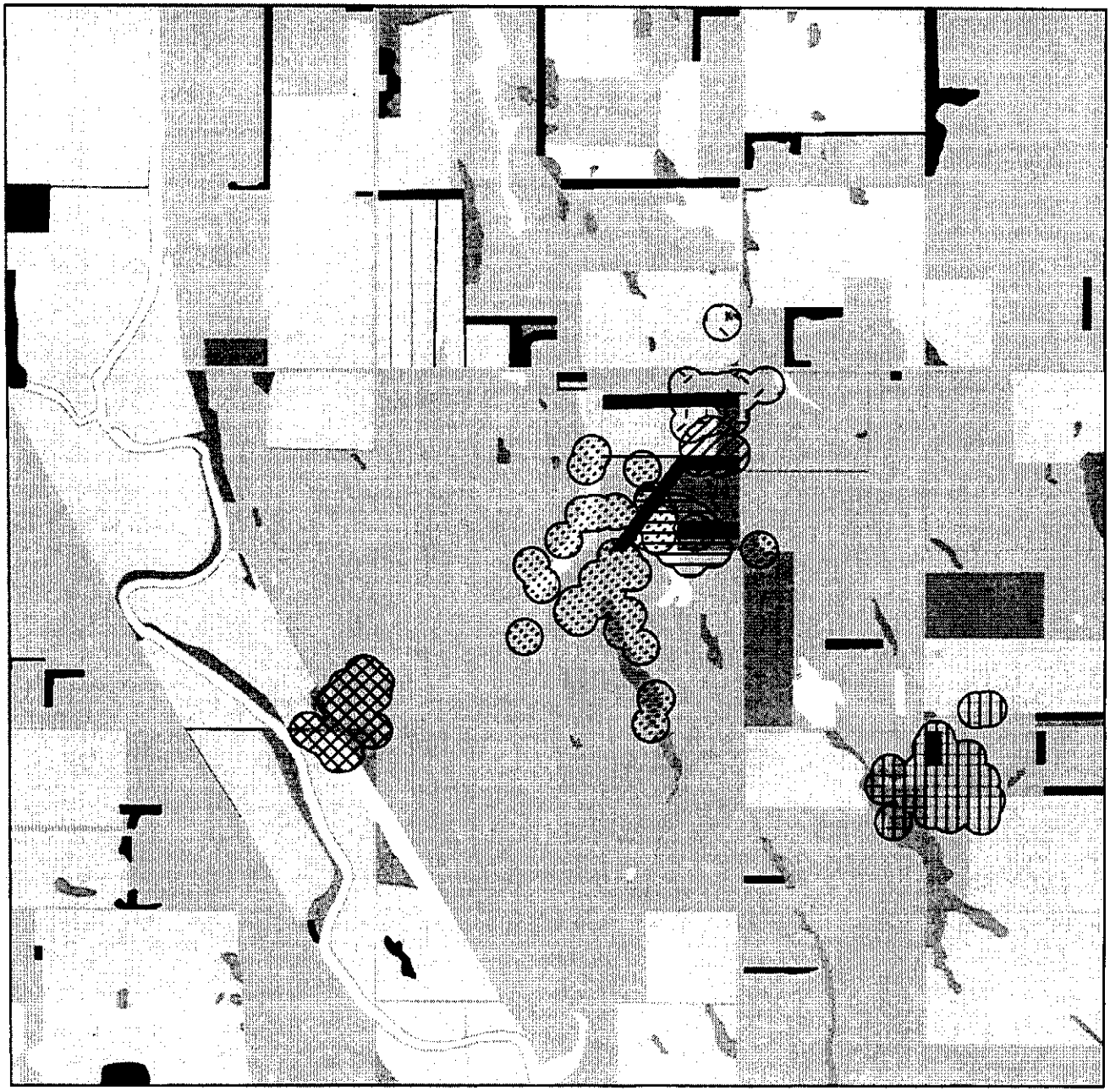
Appendix Figure 14. Home ranges of breeding male pheasants on the Bauder study area in 2000. Each shading pattern represents a different radiomarked pheasant.



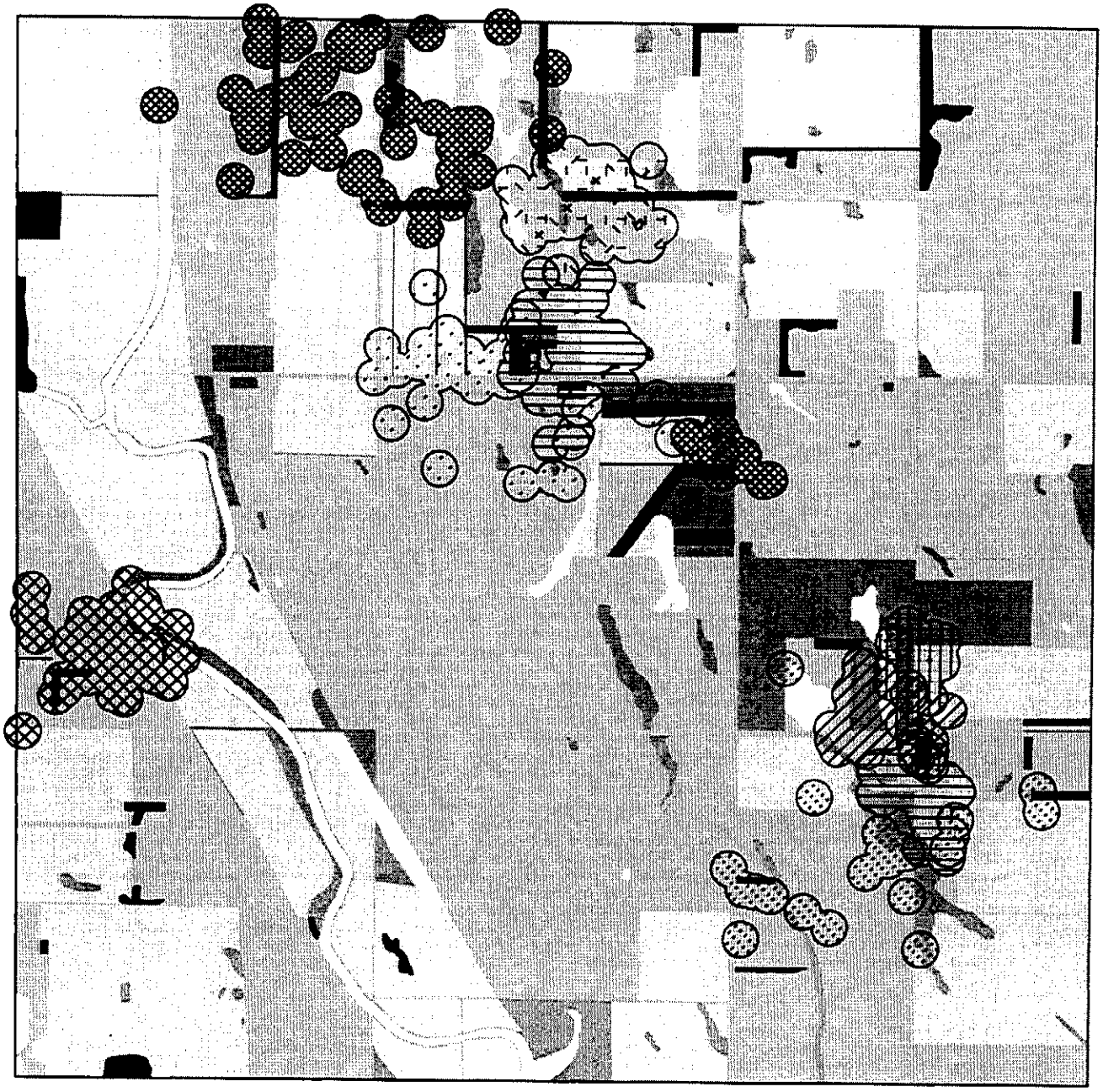
Appendix Figure 15. Home ranges of breeding male pheasants on the Bauder study area in 2001. Each shading pattern represents a different radiomarked pheasant.



Appendix Figure 16. Home ranges of breeding male pheasants on the Derksen study area in 1997. Each shading pattern represents a different radiomarked pheasant.



Appendix Figure 17. Home ranges of breeding male pheasants on the Derksen study area in 1998. Each shading pattern represents a different radiomarked pheasant.



Appendix Figure 18. Home ranges of breeding male pheasants on the Derksen study area in 1999. Each shading pattern represents a different radiomarked pheasant.

Appendix Figure 19. Home ranges of breeding male pheasants on the Derksen study area in 2000. Each shading pattern represents a different radiomarked pheasant.

Appendix Figure 20. Home ranges of breeding male pheasants on the Derksen study area in 2001. Each shading pattern represents a different radiomarked pheasant.