Movements and habitat use of ruffed grouse in the Bridger Mountains, Montana
by Suvi Annikki Lehtinen

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
Ruffed grouse (Bonasa umbellus) movements and habitat use were studied in the Bridger Mountain Range, in southwestern Montana, from April 1982 through mid-June 1983. Cloverleaf-trapped or mirror-trapped birds were marked with leg bands and radio-transmitter packages. Radiotelemetry equipment was used to locate each marked grouse several times per week to determine movements and habitat being used. Some radio locations were made at night during winter to ascertain roosting habitat. The line intercept . method was used to measure the amount and types of vegetational cover in 3 habitat layers. Similar data were obtained from random locations in each major habitat type, so that grouse habitat preference could be determined. The mean summer and winter home ranges of grouse were 12.4 and 18.0 hectares (ha), respectively, while the mean annual home range size was 22.2 ha. Grouse ranges overlapped considerably. During the summer birds preferred the aspen, hardwood-conifer, and hawthorn habitat types, while avoiding the coniferous forest and meadow/opening types. A preference was shown for mixed forests as drumming sites, while conifers also were used. Obstacle and immediate overhead cover layers were less dense when grouse were found in conifers, meadow/opening, riparian zones, and aspens than in random vegetation samples. In the mixed forest type, shrub cover was more dense and tree canopy cover more open at grouse locations. In open habitats, grouse used areas with significantly higher canopy coverage. Combining all habitat types, grouse preferred higher tree densities for every tree species except willow. During winter, ruffed grouse preferred conifer, hardwood-conifer, and hawthorn habitat types and avoided meadow/ opening habitats. Grouse showed some shifts in habitat usage from summer to winter. Tree-roosting grouse preferred the coniferous forest habitat type. Snow-roosting grouse avoided mixed forests and showed a shift from daytime to nighttime habitat. The birds preferred slopes year-round which were steeper than random slopes. Preferred aspects were south and west. Major foods consumed by grouse during summer were hawthorn berry, huckleberry and strawberry fruits, and dandelion and clover leaves, while the winter diet mainly consisted of snowberry and huckleberry buds.

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APPROVAL

of a thesis submitted by

Suvi Annikki Lehtinen

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

Ruffed grouse (Bonasa umbellus) movements and habitat use were studied in the Bridger Mountain Range, in southwestern Montana, from April 1982 through mid-June 1983. Cloverleaf-trapped or mirror-trapped birds were marked with leg bands and radio-transmitter packages. Radiotelemetry equipment was used to locate each marked grouse several times per week to determine movements and habitat being used. Some radio locations were made at night during winter to ascertain roosting habitat. The line intercept method was used to measure the amount and types of vegetational cover in 3 habitat layers. Similar data were obtained from random locations in each major habitat type, so that grouse habitat preference could be determined. The mean summer and winter home ranges of grouse were 12.4 and 18.0 hectares (ha), respectively, while the mean annual home range size was 22.2 ha. Grouse ranges overlapped considerably. During the summer birds preferred the aspen, hardwood-conifer, and hawthorn habitat types, while avoiding the coniferous forest and meadow/opening types. A preference was shown for mixed forests as drumming sites, while conifers also were used. Obstacle and immediate overhead cover layers were less dense when grouse were found in conifers, meadow/opening, riparian zones, and aspens than in random vegetation samples. In the mixed forest type, shrub cover was more dense and tree canopy cover more open at grouse locations. In open habitats, grouse used areas with significantly higher canopy coverage. Combining all habitat types, grouse preferred higher tree densities for every tree species except willow. During winter, ruffed grouse preferred conifer, hardwood-conifer, and hawthorn habitat types and avoided meadow/opening habitats. Grouse showed some shifts in habitat usage from summer to winter. Tree-roosting grouse preferred the coniferous forest habitat type. Snow-roosting grouse avoided mixed forests and showed a shift from daytime to nighttime habitat. The birds preferred slopes year-round which were steeper than random slopes. Preferred aspects were south and west. Major foods consumed by grouse during summer were hawthorn berry, huckleberry and strawberry fruits, and dandelion and clover leaves, while the winter diet mainly consisted of snowberry and huckleberry buds.

INTRODUCTION

The ruffed grouse (Bonasa umbellus) is the most widely distributed tetraonid in North America (Aldrich 1963), occurring in 38 states and 13 Canadian provinces (Gullion 1977). In 1977, ruffed grouse were hunted in 46 states and provinces. The estimated total North American harvest for that year was 5,046,000 birds, although the number may have been 0.5-1.0 million birds higher (Gullion 1977).

Due to its popularity as a game bird and its wide distribution, the ruffed grouse has been studied intensively, particularly in eastern and midwestern states. Major monographs from this research in the East and Midwest include Bump et al. (1947), Edminster (1947) and Gullion (1972).

Although ruffed grouse occur widely over western North America (Aldrich 1963), they have received less research attention, possibly because they share the limelight with several other grouse species which are unique to the western states and provinces. Western studies to date include work on food habits by Hungerford (1957) in Idaho and Doerr et al. (1974) in Alberta. Habitat needs and movements were analyzed by Marshall (1946) in Idaho, Bakke (1980) in North Dakota and Stauffer (1983) in Idaho. Drumming sites were

studied by Sumanik (1966), Boag and Sumanik (1969), and by Salo (1976, 1978) in Washington. General ecology has been described by Hungerford (1951a, 1951b, 1953a) and Erickson (1961) in Idaho and by Rusch and Keith (1971a, 1971b) in Alberta. Hungerford (1953b, 1953c, 1969) also studied census methods and suitable management techniques for ruffed grouse in Idaho.

In Montana, the ruffed grouse occurs along stream courses in mountain valleys of the western half of the state (Mussehl et al. 1971). Between 1958 and 1969 an average of 53,000 were harvested annually by hunters. In spite of the species' geographic and numerical importance in the state, no published research has been undertaken.

This study investigated the ecology of ruffed grouse in the Bridger Mountains of southwestern Montana, with primary emphasis on movements and habitat use. My results were compared with those of other studies in the Northwest, Midwest and East. Field studies were completed during April 1982 through June 1983.

STUDY AREA

The study area, located approximately 25 kilometers (km) northeast of Bozeman, Montana, was a 289 ha block of private land in Bridger Canyon, a north-south oriented valley in the Bridger Mountains (Figure 1). Slopes in the area generally ranged up to 20%, with isolated hillsides to 30%. The elevation ranged from 1760-1880 meters (m) above mean sea level. Soils were heavy clays, with occasional rock outcrops, and often were poorly drained. The area contained numerous small springs and streams which formed the headwaters of Brackett, Bridger and Maynard Creeks.

The study area could be characterized as a subalpine fir (Abies lasiocarpa) and Douglas fir (Pseudotsuga menziesii) climax forest, as described by Ross and Hunter (1976:34). Vegetational cover was mainly coniferous forest, with lodgepole pine (Pinus contorta), subalpine fir, Douglas fir and Engelmann spruce (Picea engelmannii) being the dominant species. The understory vegetation was characterized by shrubs in the genera Symphoriocarpos, Vaccinium, and Amelanchier. Riparian zones were dominated by willow (Salix spp.), alder (Alnus spp.) and hawthorn (Crataegus spp.). Drier upland sites were in the Douglas fir/snowberry (PSME/SYAL) habitat type series of Pfister et al. (1977:45). More

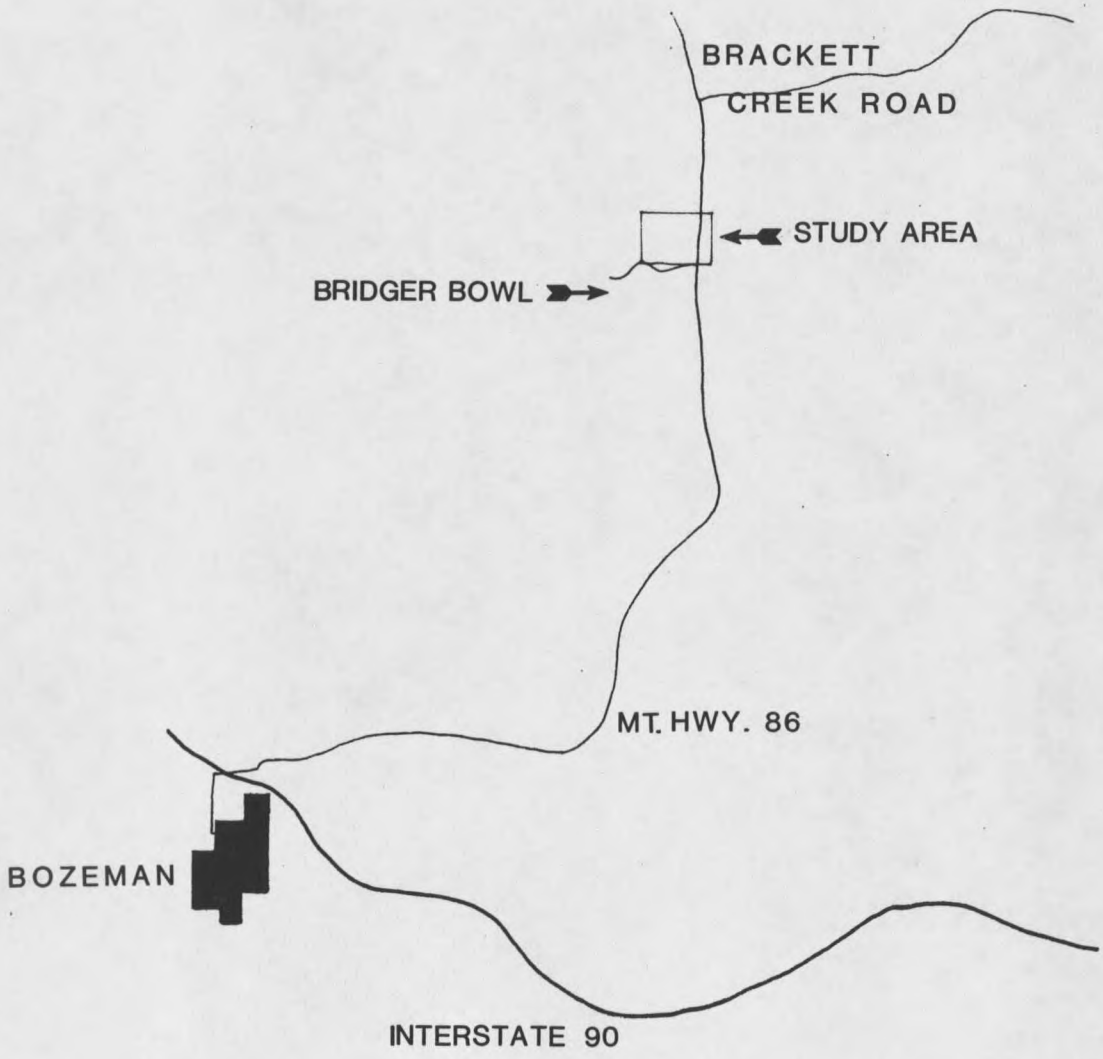


Figure 1. Location of the study area.

moist sites were classified in the subalpine fir/blue huckleberry (Vaccinium globulare) (ABLA/VAGL) series, while wet spring seep sites were classified in the subalpine fir/bluejoint (Calamagrostis canadeusis) (ABLA/CACA) series described by Pfister et al. (1977:97,88).

Forest cover was interspersed with numerous small meadows dominated by Idaho fescue (Festuca idahoensis) and introduced timothy (Phleum pratnse). Small stands of aspen (Populus tremuloides) were present in the meadows. This vegetation closely resembled the Festuca idahoensis/ Agropyron caninum (= Agropyron subsecundum) mountain grassland type described by Mueggler and Handel (1974:27).

Numerous man-made structures including 25 occupied dwellings, 1 state highway, and several trails created by a commercial cross-country skiing operation were present on the area.

The 29-year mean annual precipitation in the area was 70.5 centimeters (cm) with an average annual snowfall of 596 cm (Jane Forsythe, personal comm. 1983). Temperatures ranged from lows of -35 degrees Celsius (C) in winter up to 35 C in summer, with wind velocities reaching 100 km/hour (hr) during frequent winter and summer storms. Only two seasons - winter and summer - were used in describing habitat use by grouse. The start of the winter was set as 1 November. By this time, snow had accumulated on a permanent basis to depths exceeding 10 cm, covering most of

the forbs and grasses available to ruffed grouse during summer. The beginning of summer was set at 1 May. By this time, only the larger winter snowbanks remained, and snow free areas with those forbs and grasses which could be used as grouse food and cover were rapidly "greening up."

METHODS

Attempts were made to trap and mark ruffed grouse year-round. During May-early June of 1982 and 1983, the entire study area was walked in a grid pattern (at 200 m intervals) to locate drumming males. Annually, six 3-to-4 hr searches were made, each starting at sunrise. Mirror traps (Dorney and Mattison 1956) were used in trapping drumming males during the 1982 breeding season. Cloverleaf traps (Liscinsky and Bailey 1955), baited with mountain-ash berries (Sorbus spp.), were set out next to drumming logs during October and November of 1982, since males often attend their logs during the fall (Palmer 1956, Eng 1959).

On one occasion (22 June 1982), a mist net was used to capture a breeding male. The net was placed downhill from the log and the bird was flushed into it.

During late summer (4 September to 3 November) 2 cloverleaf traps baited with mountain-ash berries were set out in open meadows where females and broods had been seen feeding. These traps were equipped with two 25 m long chicken wire leads.

In the winter months of 3 November to 4 April 1982-83, cloverleaf traps were set beneath the canopy of large conifers. Because of snow intercept and melt, such areas

were often snow free and were used as feeding and loafing areas by grouse.

Following capture, birds were weighed, sexed and aged. The most important criterion used in sexing was the length of the central rectrix (Hale et al. 1954). The amount of spots on rump feathers and the terminal band (Gullion 1972) were also considered. The grouse were classified as juveniles or adults by the condition of the tips of the 9th and 10th primaries (Bump et al. 1947). Trapped birds were marked with colored and numbered plastic leg bands, and most were equipped with radio transmitter packages.

Transmitters (AVM Instrument Co., Dublin, CA) operated in the 149-152 megahertz frequency range, and were of 2 types. The "standard" transmitter package weighed from 9.8 to 21.3 grams (g), and was powered by a mercury battery. These had an expected life of 4 to 7 months, and a range of 0.5 to 1.5 km. The other type was powered by a solar panel, which recharged a mercury battery when exposed to sunlight (Figure 2). The range of this 9 g package was from 0.05 to 0.5 km, and life was indefinite.

Transmitters were placed on the bird as described by Amstrup (1980) with minor size modifications. A 2.6 cm diameter hole was cut, the assembly slipped over the head, and feathers in the neck region pulled over the entire package, so that the only part visible from above or behind

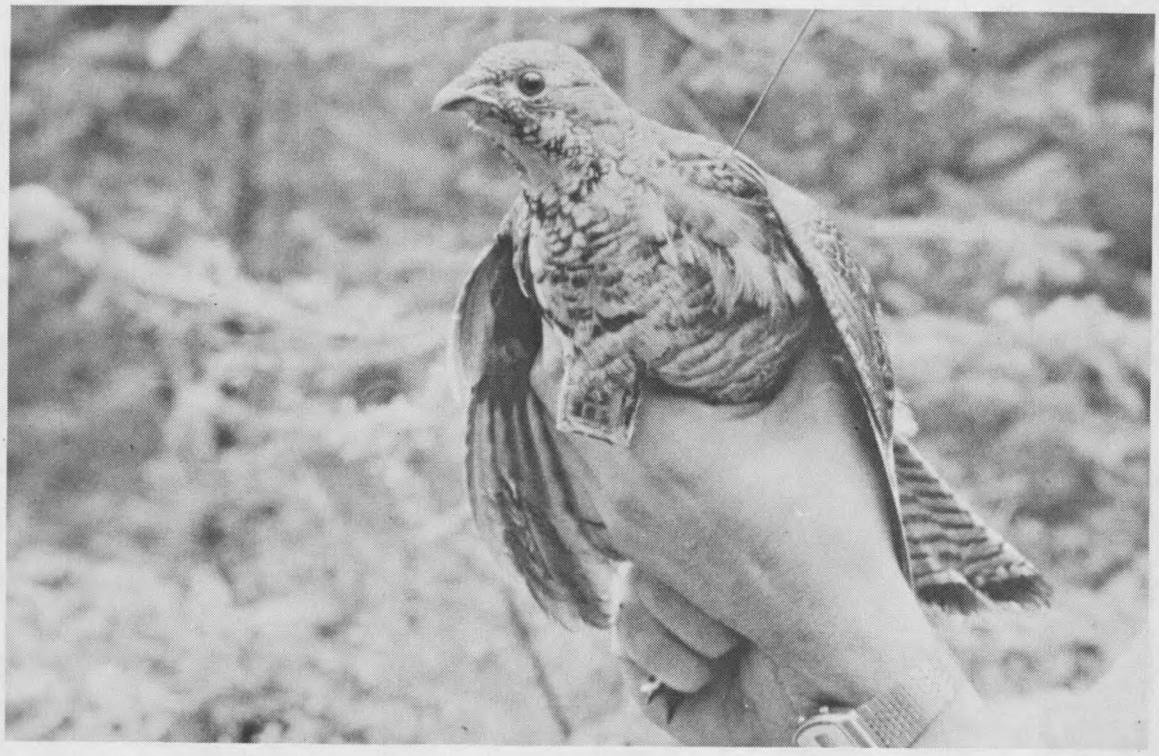


Figure 2. Solar powered transmitter fitted on a grouse.

the bird was a 0.5 cm diameter antenna wire, 32-35 cm in length. Portable receivers used in locating birds were equipped with a hand-held directional 3-element yagi antenna.

Instrumented birds were initially located by triangulation and carefully stalked with the aid of the receiver to ascertain the exact type of habitat used. Telemetry-aided searches for grouse were made from 22 June in 1982 to 21 May in 1983. Each instrumented grouse was located no more than 2-3 times per week to reduce, if not prevent, disturbance-induced changes in its normal habitat use. Some of the weekly locations during the winter season were made at night to ascertain roosting habitat.

Home ranges were plotted by connecting outermost locations on area maps. Sizes were then measured by use of a polar planimeter and statistically compared between summer and winter seasons.

Other methods and situations providing locations of and habitat types used by non-instrumented grouse included:

a. walking a pre-determined route 2-3 times/week
b. walking randomly, when doing vegetation sampling
c. walking randomly with 2 trained dogs
d. when locating instrumented birds
e. when locating drumming logs
f. when checking traps

g. by using tape recorded ruffed grouse chick distress calls (as described by Healy et al. 1980)

Color aerial photographs (scale = 1:16,000) taken by the U. S. Forest Service in 1971, were supplemented by 35 millimeter color photos taken in July 1982. These photographs, coupled with ground checks, revealed 6 broad habitat types on the study area:

a. coniferous forest
b. mixed hardwood-conifer forest
c. pure aspen stands
d. riparian vegetation
e. mountain meadow/openings
f. hawthorn thickets

For each habitat type, all stands greater than 0.1 ha were outlined on a map of the study area and measured using a compensating polar planimeter.

Summer habitat type preference was statistically determined by comparing the total number of summer bird sightings (except those within 10 m of a drumming log) in each habitat type to the percent of the area covered by that type. Selection of habitat for drumming log sites was similarly determined by recording the broad habitat type surrounding each drumming log and comparing the number of logs in each type to the relative availability of that habitat type.

The vegetational characteristics of the broad habitat types being used by grouse during summer were analyzed by measurements centered on the location of every grouse sighting during summer. Two lines, each 20 m long, were laid out so that they intersected each other at right angles at the point of the bird sighting. By random selection the lines were oriented either on the N-S, E-W major compass coordinates, or on the NW-SE, NE-SW minor coordinates. The amount of cover along the two 20 m lines was then measured by the line intercept method (Canfield 1941) at each of 3 levels. The levels and cover types sampled at each are as follows: the obstacle layer (0-25 cm height) included bare soil, rock, litter, sticks, logs, stream, standing water, moss, grass, forbs, shrubs and trees. In the immediate overhead cover layer (25.1-150 cm height) sticks, logs, grass, forbs, shrubs and trees were sampled. The overstory cover layer (151+ cm height) consisted of forbs, shrubs and trees.

The density of the dominant tree species (over 10 cm Diameter at Breast Height) was determined by the point-centered quarter (P.C.Q.) method (Cottam and Curtis 1956), again using the sightings of the birds as the center points. The Diameter at Breast Height (DBH) was recorded for each tree that was sampled by this method, so that an index to overstory dominance might be obtained.

Comparable vegetational data were gathered at random locations in each broad habitat type, except hawthorn thickets; sample points were determined by walking in random compass directions in the habitat types and stopping at predetermined random distances. Sampling in each habitat type was stratified for the P.C.Q. method, in that the number of center points sampled in each type was proportional to the total area covered by that type on the study area.

Analyses involved the following comparisons between the location-centered and random vegetation samples.

1. Comparisons within each broad habitat type
   a. total amount of obstacle layer covered by vegetation
   b. total amount of immediate overhead layer covered by vegetation
   c. total amount of tree canopy cover
   d. total amount covered by grass and forbs
   e. total amount covered by different shrubs
   f. total tree density
   g. total density of each tree species
2. Comparisons combining all habitat types
   a. total tree density
   b. total density of each tree species
   c. size (DBH) of each tree species

Winter habitat type preference was statistically determined by comparing the number of grouse sightings in

each habitat type to the percent of area covered by that type. Additionally, the number of sightings in each habitat type during winter and summer were compared, to see if a significant shift occurred in habitat usage between the 2 seasons.

Relative use of snow and tree roosts was determined from periodic locations of grouse at night in winter season. The major habitat type in which roosts were located was compared to the amount of that habitat type available.

Food habits data were gathered by direct observation and crop analysis. Actual feeding on definite species of plants was observed occasionally when instrumented grouse were located during the summer. During winter, grouse were easily tracked to shrubs in fresh snow. When feeding was evident from recently clipped buds, dry leaves or fruits, this was recorded. Crops collected from hunters in the late summer period were analyzed for their contents by net weight and volume.

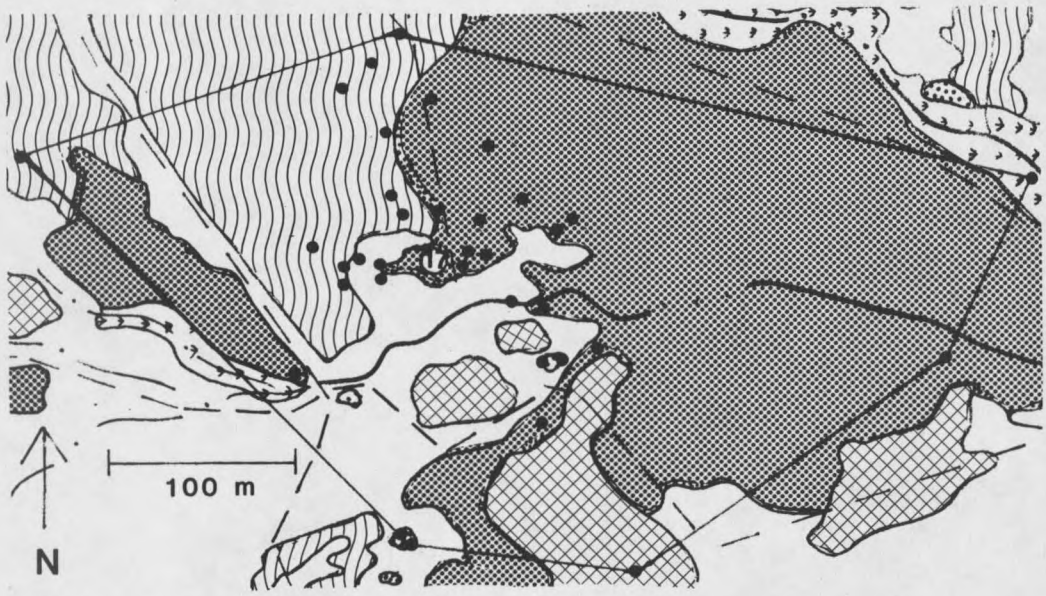
The major aspect (N-NE-E-SE-S-SW-W-NW) and slope, in degrees (if any), were recorded at all grouse sightings, and random vegetation sampling points, in all the broad habitat types. For both slope and aspect, random versus centered sightings were compared, for both seasons.

RESULTS

A total of 9 ruffed grouse were trapped and marked on the study area between 1 June 1982 and 15 June 1983 (Table 21). Although more grouse were trapped during fall and winter with cloverleaf traps, the catch per trap-day was highest with mirror traps (1 grouse/10 trap-days versus 1 grouse/65 trap-days, respectively).

Two hundred and twenty-six radio locations were made of 7 instrumented grouse, 6 of which were located more than 5 times in a season so home ranges could be estimated. The summer home ranges are shown in Figures 3-5 and winter ranges in Figures 6-11.

Summer home ranges were smaller than winter ranges (Table 1), although not significantly so, probably due to the small sample size and large variability in home range size ($\bar{x}_1$ = 12.38 ha, $\bar{x}_2$ = 17.95 ha, $n_1 = 3$, $n_2 = 6$, $t = 0.71$.) (Student's t-test, Snedecor and Cochran, 1967:59). The sex and age structure of instrumented birds for both seasons was roughly similar. Inadequate sample sizes prevented a statistical comparison of home ranges by sex and age class. The mean annual home range size used by ruffed grouse on the study area was 22.18 ha ± 35.55 ha (2 sd).



CONIFEROUS FOREST
HARDWOOD-CONIFERS
ASPEN GROVE
RIPARIAN VEGETATION
HAWTHORN THICKET
MEADOW OPENING
POND
PERENNIAL STREAM
INTERMITTENT STREAM
TRAIL
GROUSE SIGHTING
(7) DRUMMING LOG & # OF SIGHTINGS WITHIN 10m

BUILDING
MT. HWY. NO. 86
GRAVEL ROAD

Figure 3. Summer home range of grouse no. 1, 8.9 ha.

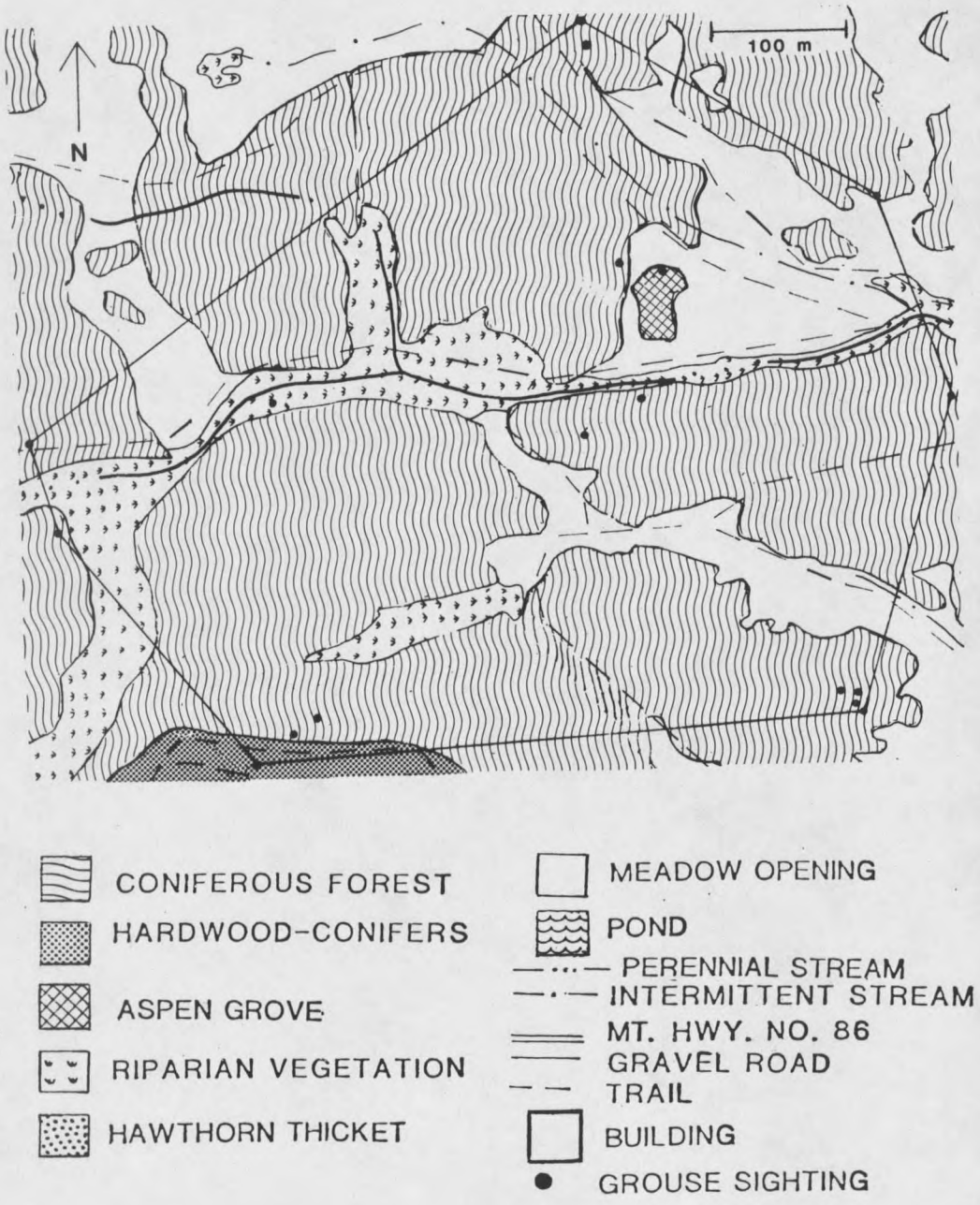
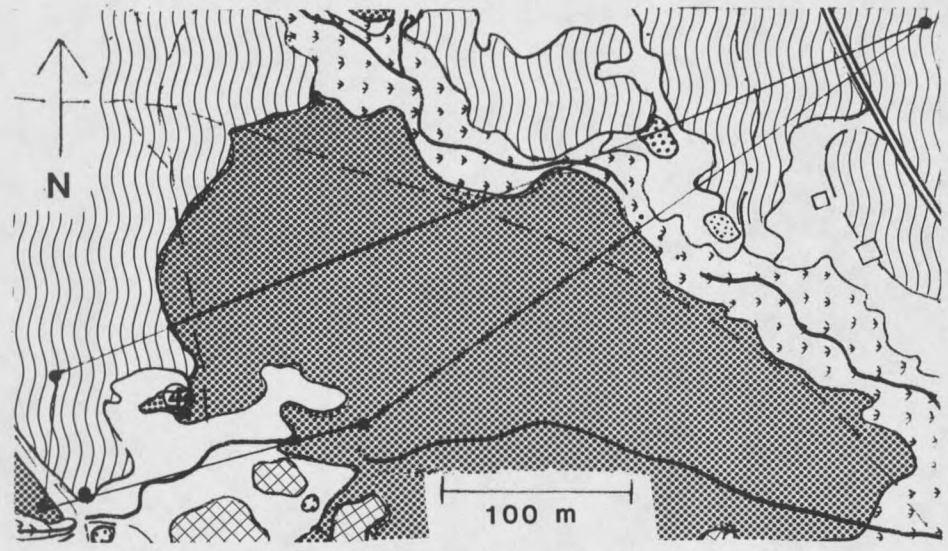


Figure 4. Summer home range of grouse no. 32, 25.61 ha.



CONIFEROUS FOREST
HARDWOOD-CONIFERS
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RIPARIAN VEGETATION
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POND
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INTERMITTENT STREAM
TRAIL
GROUSE SIGHTING
(7) DRUMMING LOG & # OF SIGHTINGS WITHIN 10m

BUILDING
MT. HWY. NO. 86
GRAVEL ROAD

Figure 5. Summer home range of grouse no. 46, 2.62 ha.

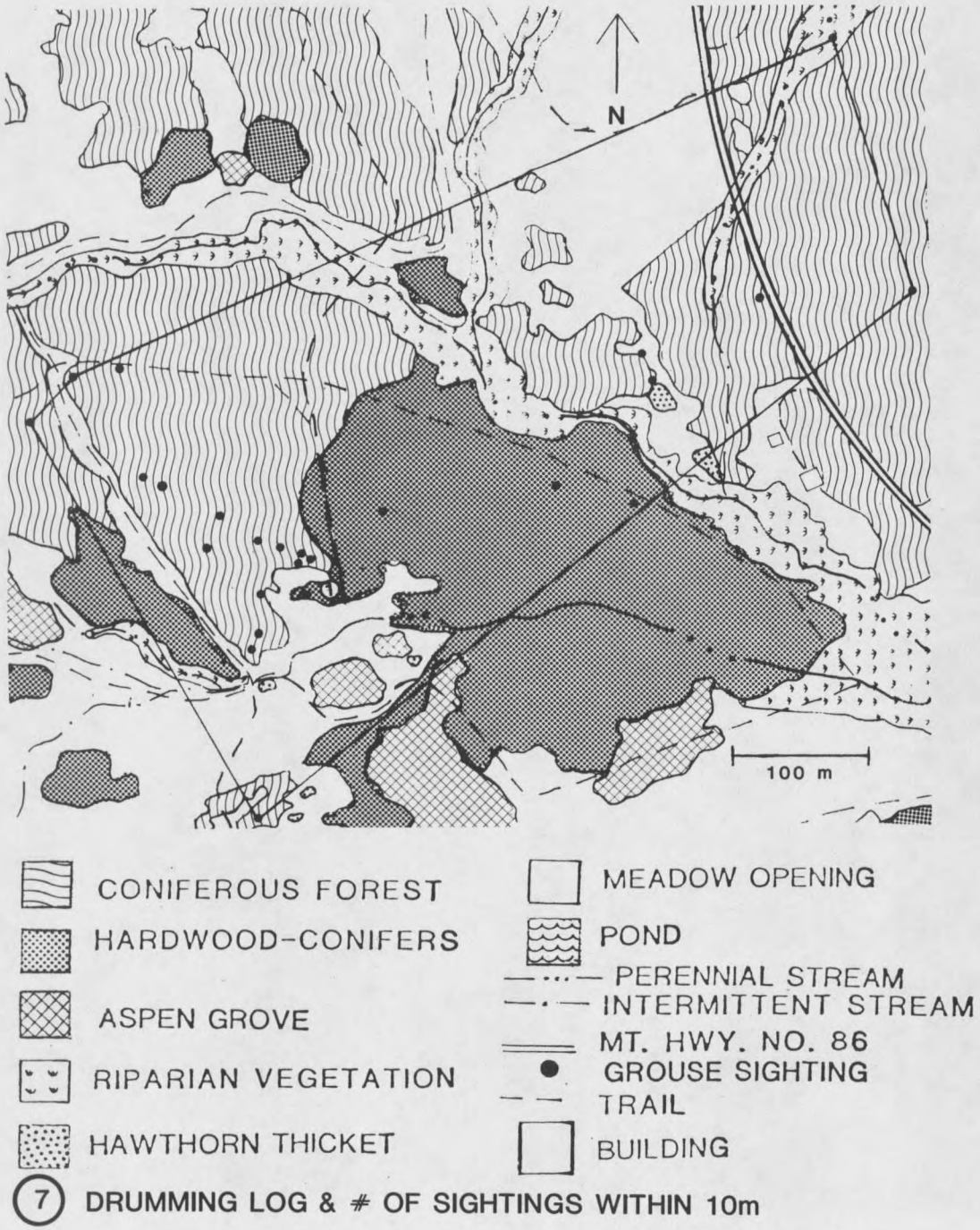

Figure 6. Winter home range of grouse no. 1, 16.86 ha.

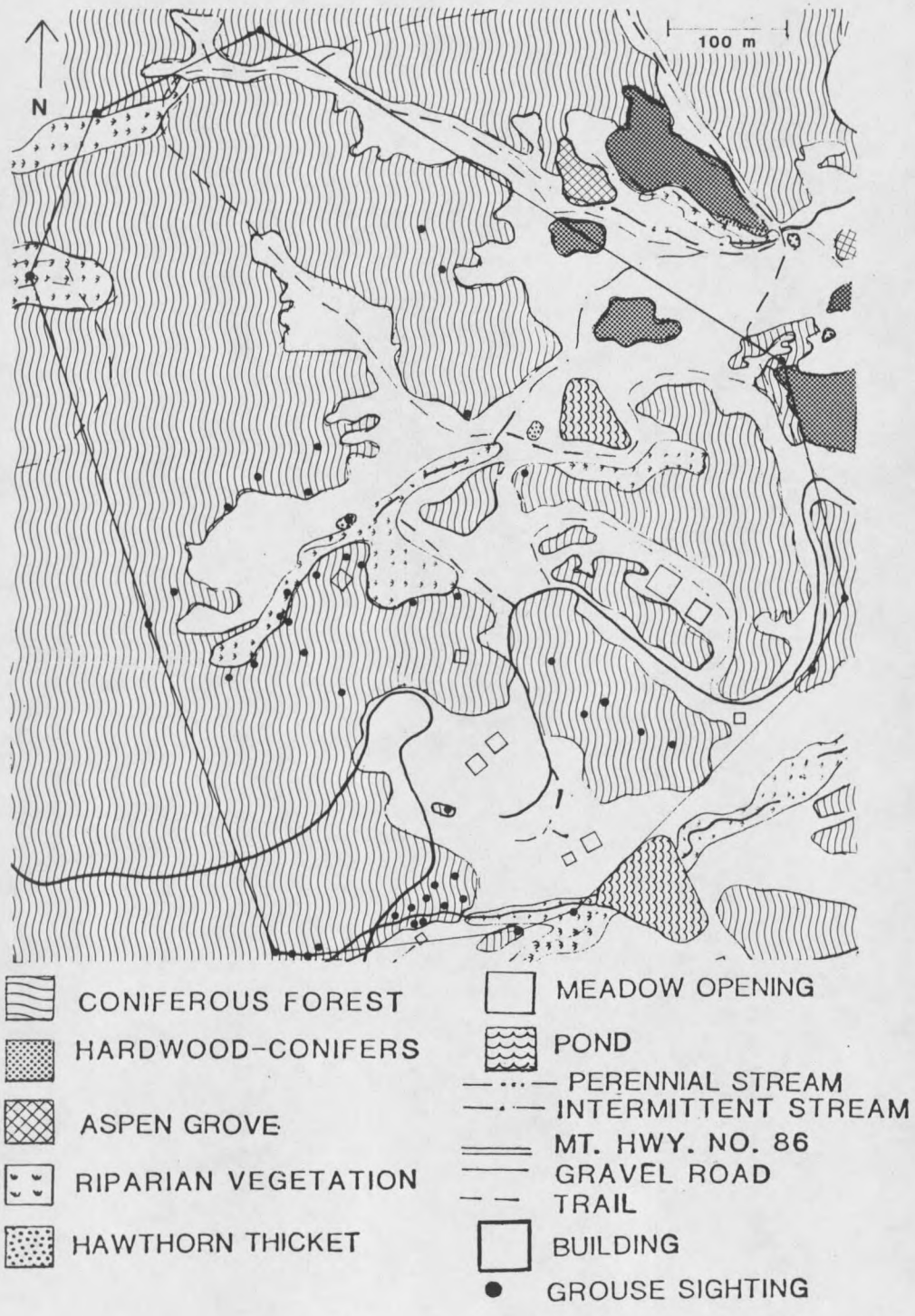

Figure 7. Winter home range of grouse no. 32, 33.76 ha.

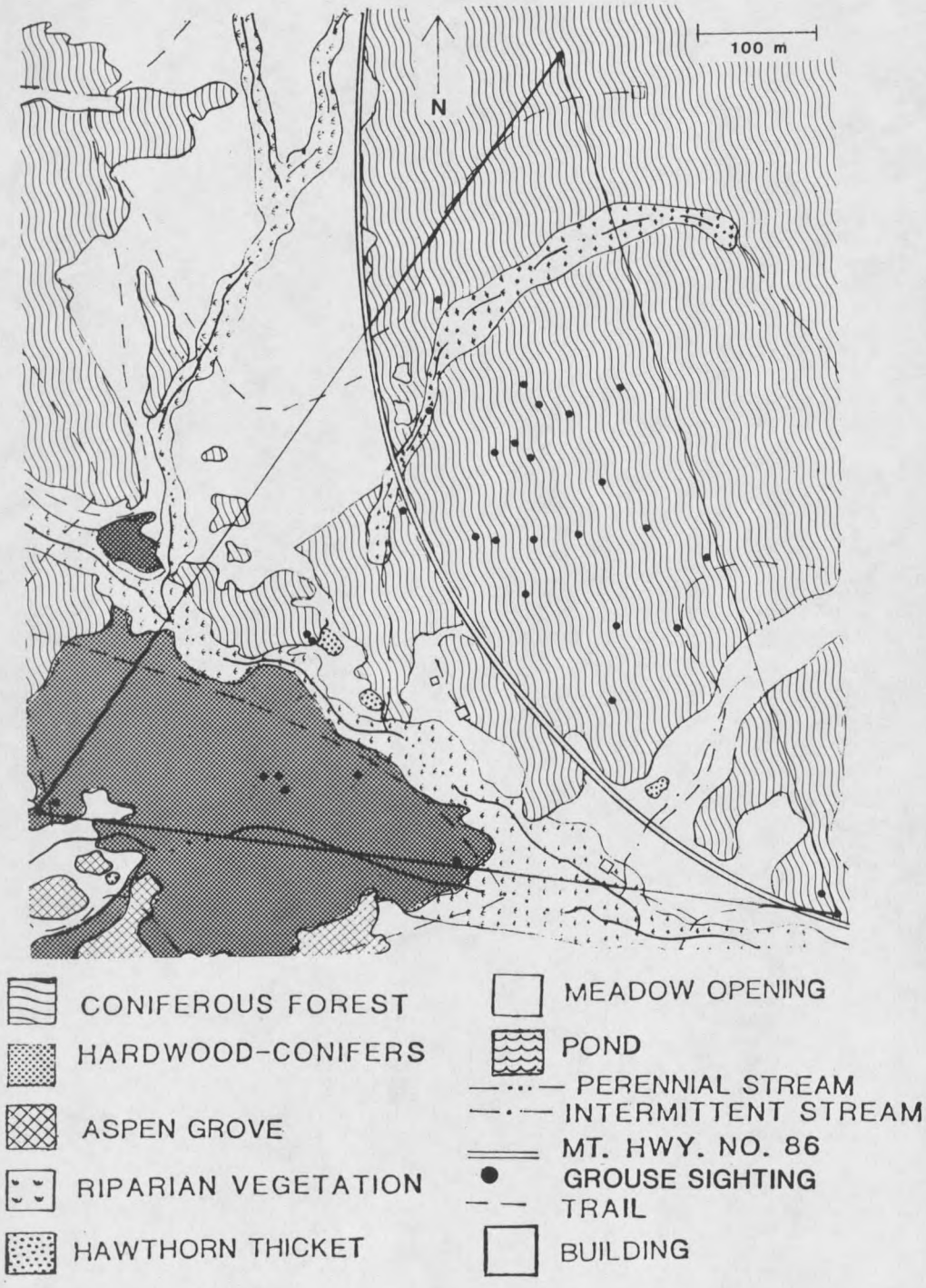

Figure 8. Winter home range of grouse no. 46, 22.69 ha.

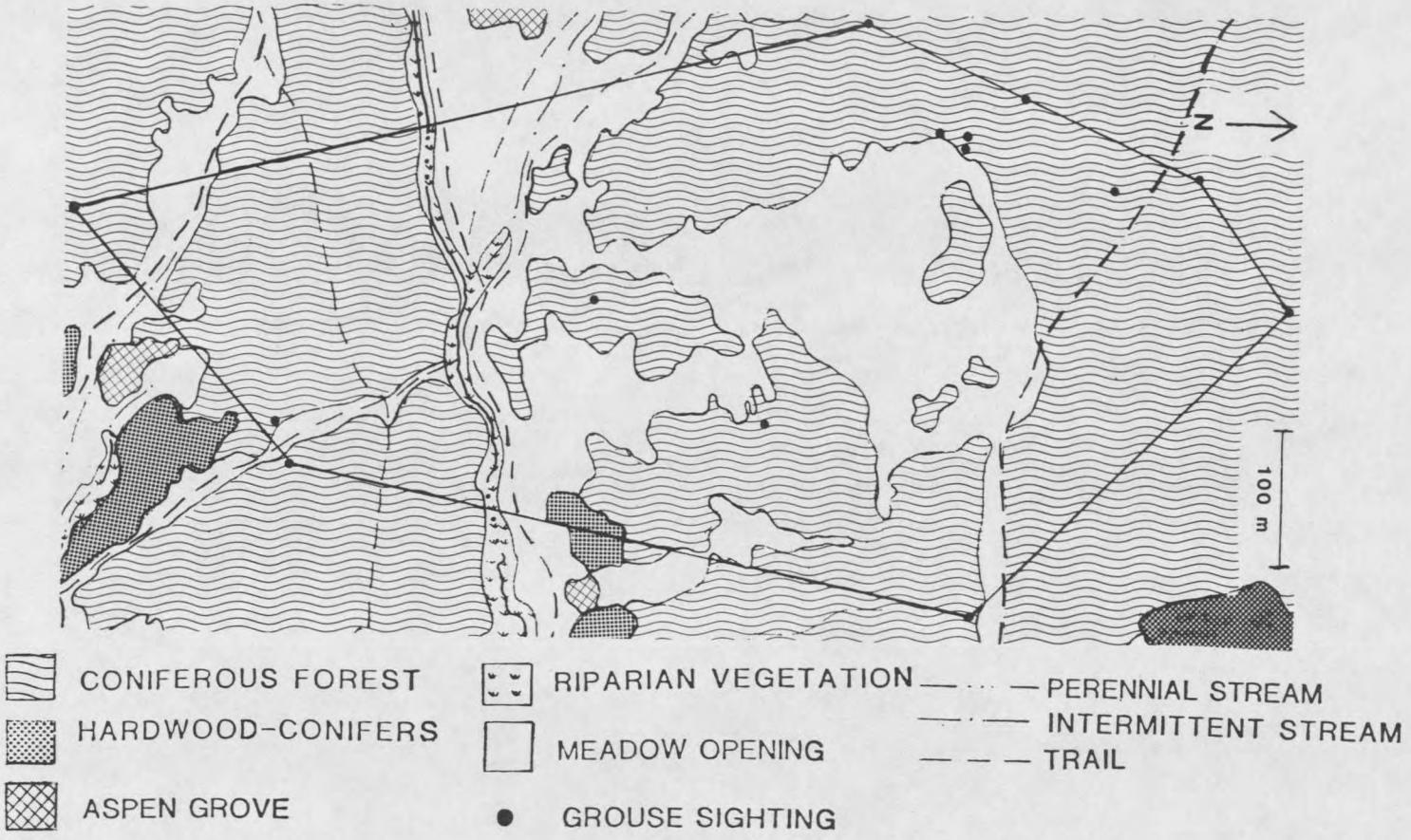

Figure 9. Winter home range of grouse no. 56, 21.50 ha.

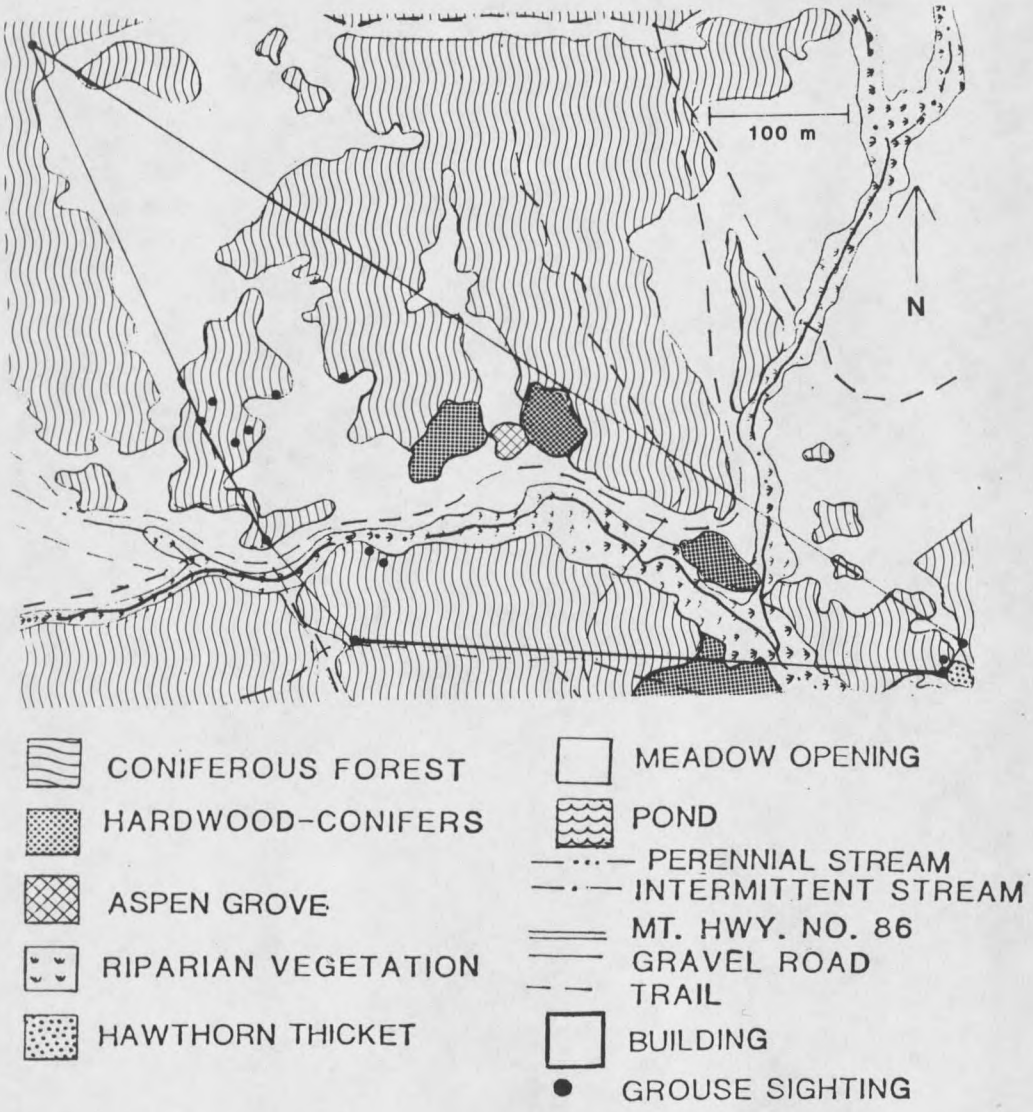

Figure 10. Winter home range of grouse no. 75, 9.77 ha.

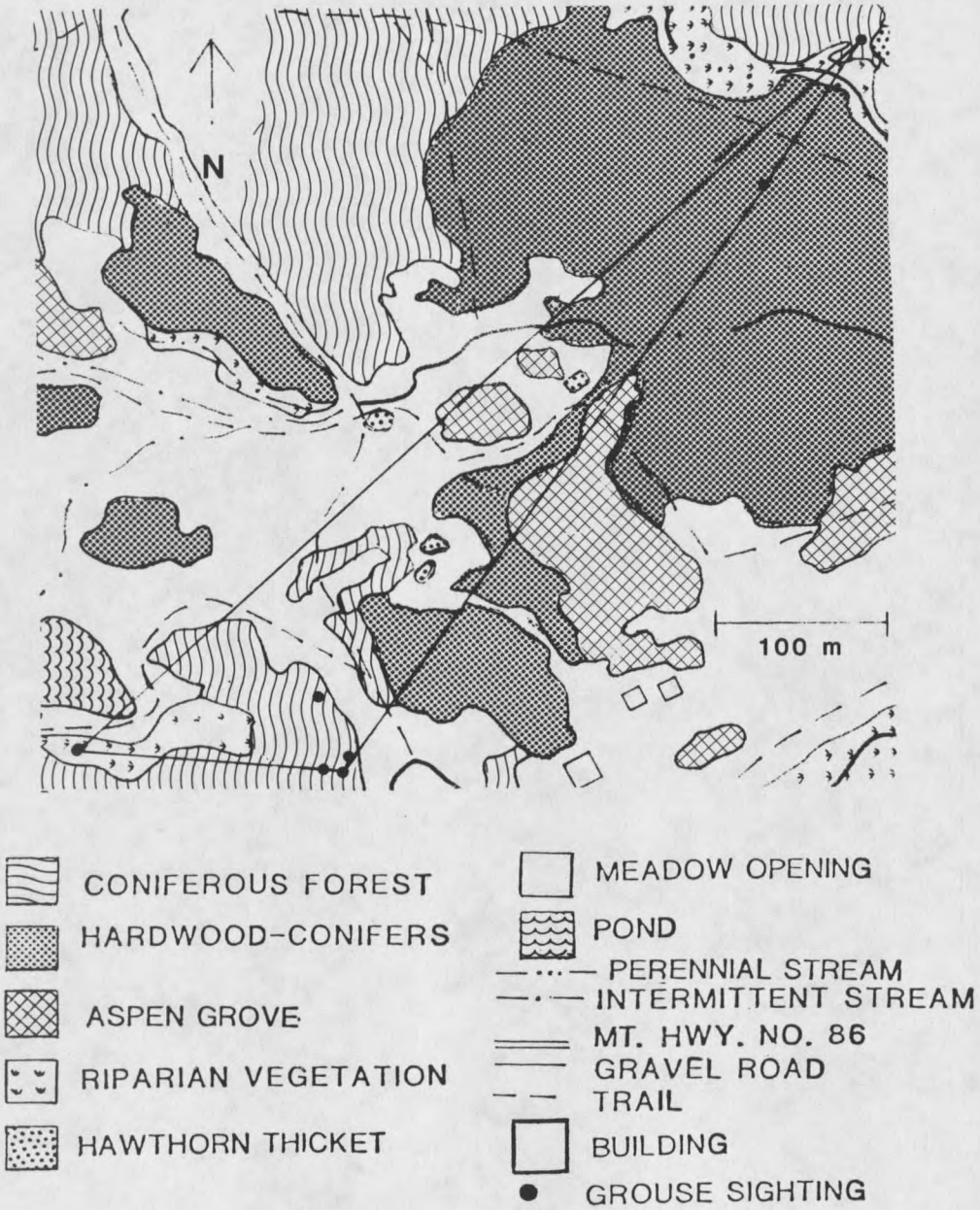

Figure 11. Winter home range of grouse no. 38, 3.13 ha.

Table 1. Home ranges of radio-instrumented ruffed grouse.

Grouse #	Sex	Age	Summer (ha)	n	Winter (ha)	n	Total (ha)	n
1	M	A	8.90	52	16.86	26	20.24	78
32	M	J	25.61	18	33.76	50	54.67	68
46	M	J	2.62	7	22.69	33	23.79	40
56	M	J	--		21.50	14	21.50	14
75	F	J	--		9.77	14	9.77	14
38	F	J	--		3.13	7	3.13	7
Mean			12.38		17.95		22.18	
2 sd			23.77		21.40		35.55	

As shown in Figures 12, 13 and 14, considerable overlap among individuals in both winter and annual home ranges of ruffed grouse was present on this study area. A total of 94.8 ha was included within all the ranges, of which 10.6 ha (11.2%) were areas of overlap between individual grouse. If the isolated range of bird no. 32 is omitted, the remaining 50.2 ha had 21.1% (10.6 ha) area of overlap. Further overlap in ranges can be seen from examining the summer and winter distribution of unmarked grouse (Figures 15 and 16). Unmarked birds were observed within the home ranges of every radio-instrumented grouse.

At least part of the observed overlap in home ranges was a result of a moderate degree of sociability or the gregarious nature of the birds, especially in winter. On 24 occasions, 2 to 4 grouse were observed within a few feet of each other at feeding (n=20) and roosting sites (n=4). These groups were observed during most months of the study. Such groups did not include known broods seen 3 times in August, 1982.

Two or more male grouse were observed simultaneously near drumming logs. Such sites are the center of activity for established males during most of the year (see Figures 3, 5 and 6). On 17 occasions during October-December 1982, 2 juvenile male grouse were observed near 5 drumming logs occupied by adult males (Table 2). In 13 instances, the resident adult was present. After visiting several occupied

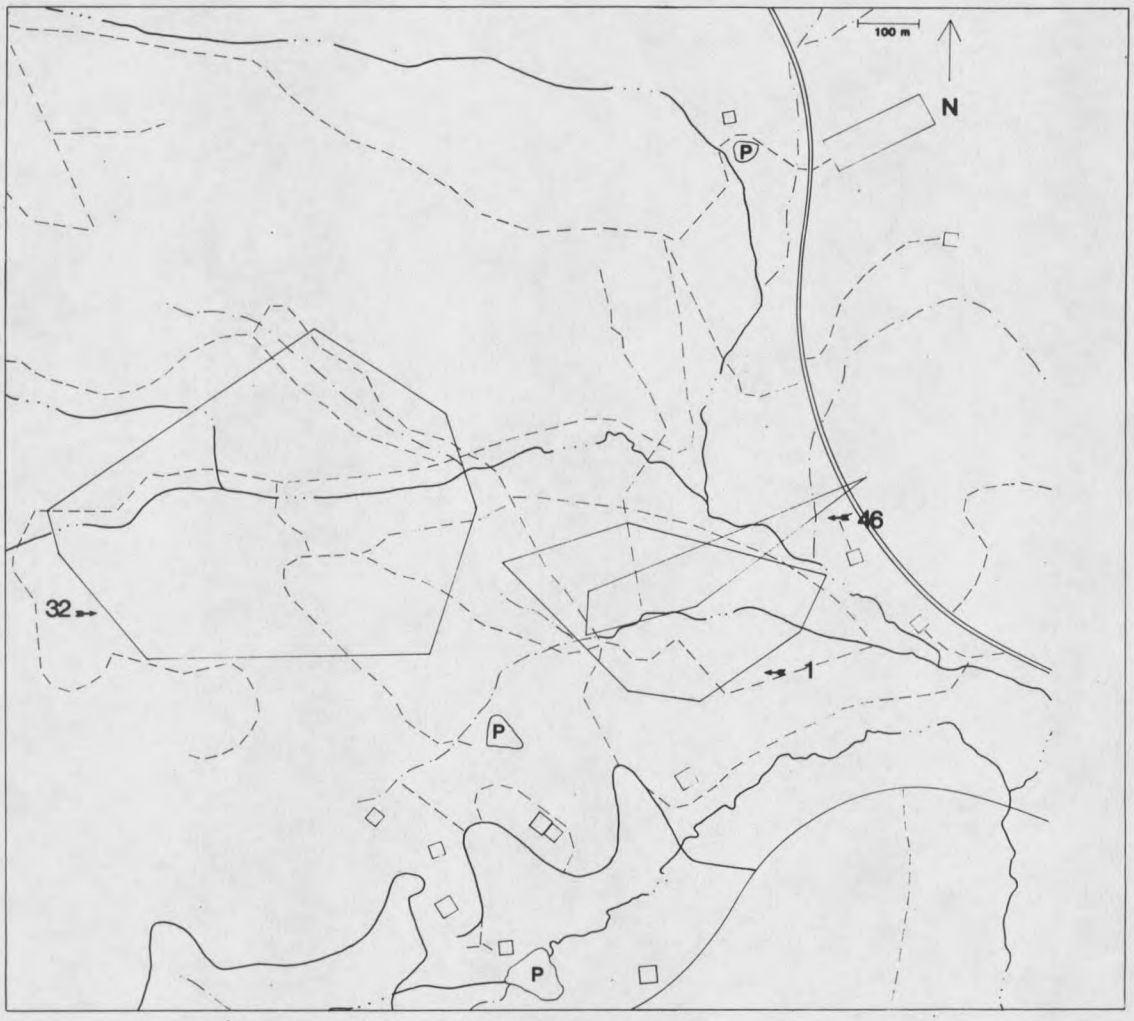

Figure 12. Summer home ranges of all radio-instrumented grouse. Grouse no. 1 and 32 (1982) and grouse no. 46 (1983).

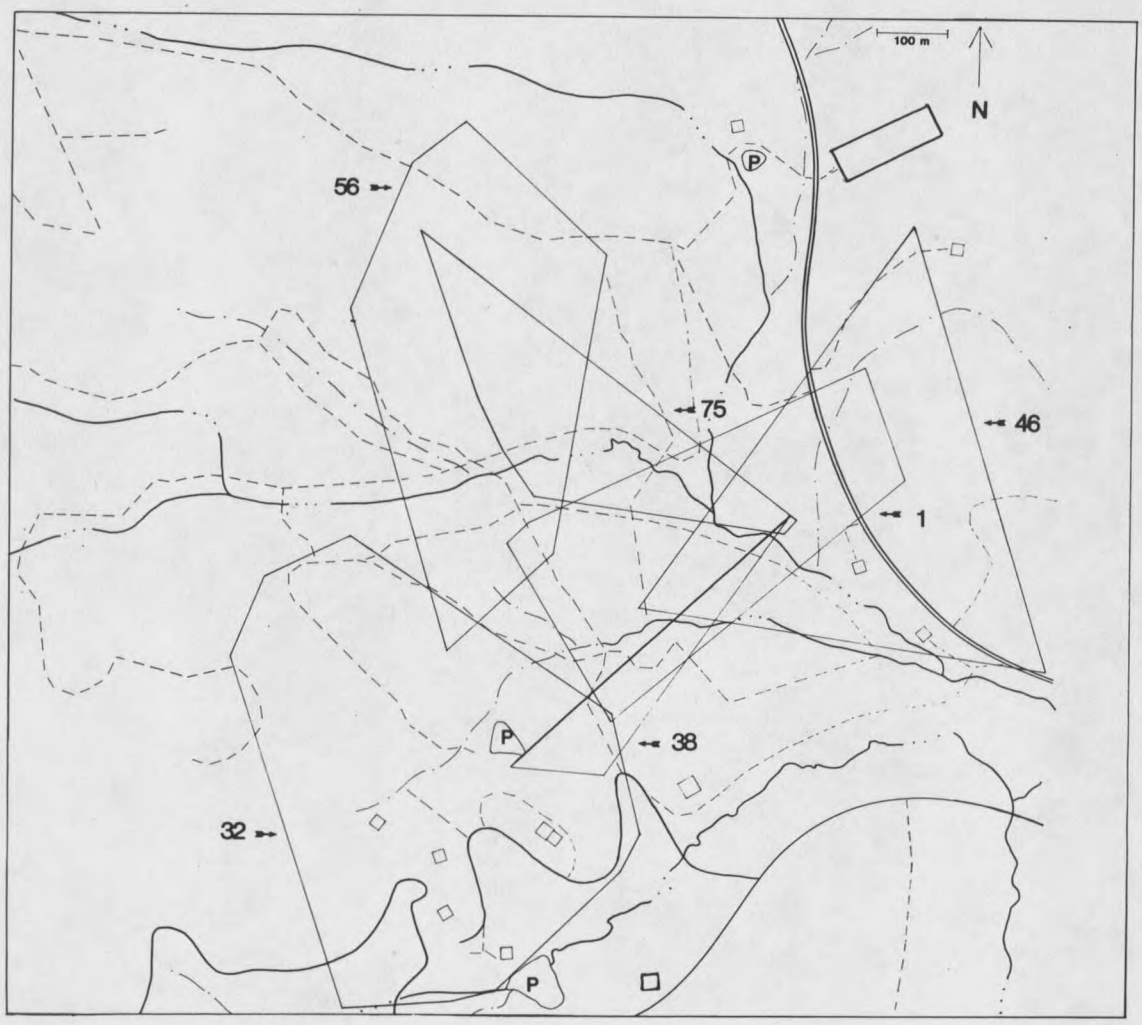

Figure 13. Winter home ranges of all radio-instrumented grouse.

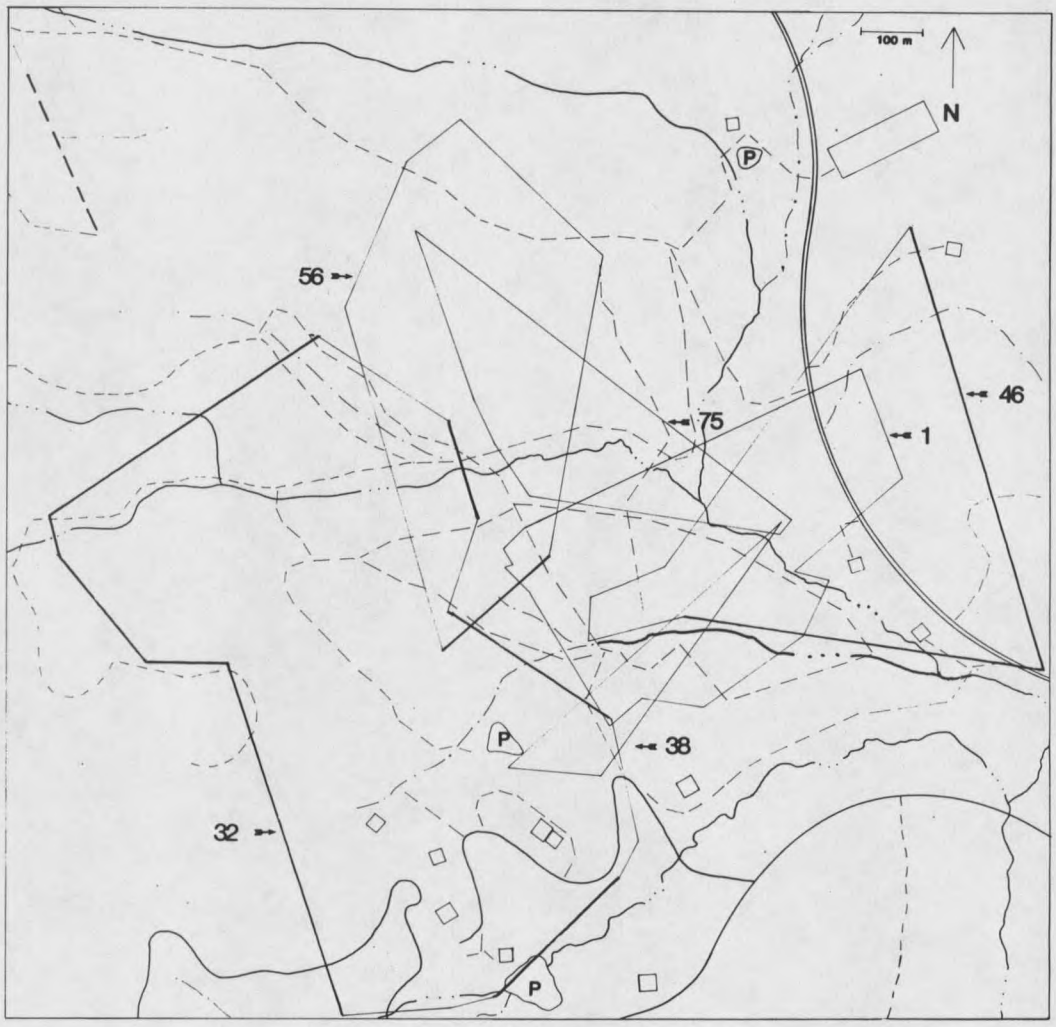

Figure 14. Total home ranges of all radio-instrumented grouse.

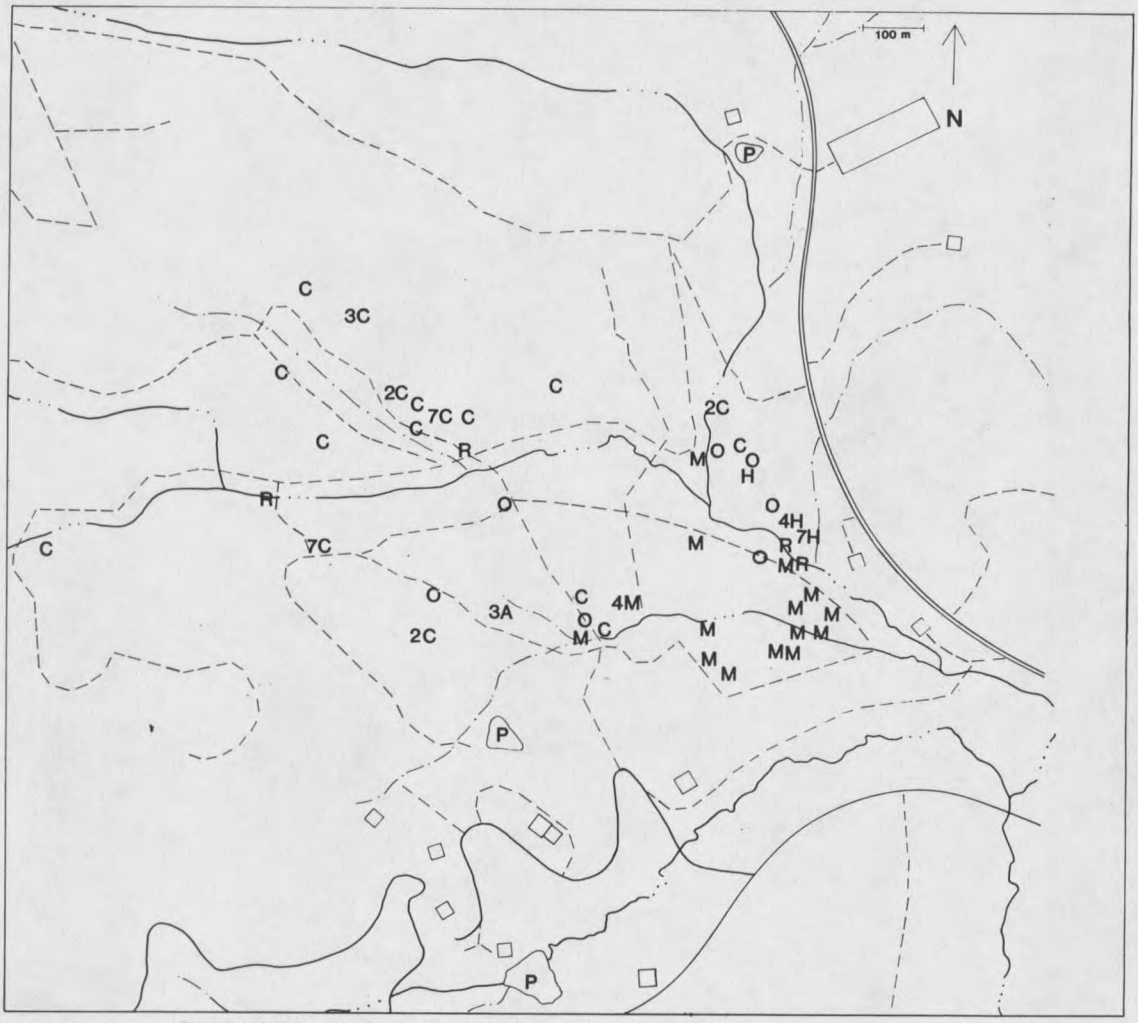

Figure 15. Unmarked ruffed grouse sightings during summer and habitat type at sighting location.

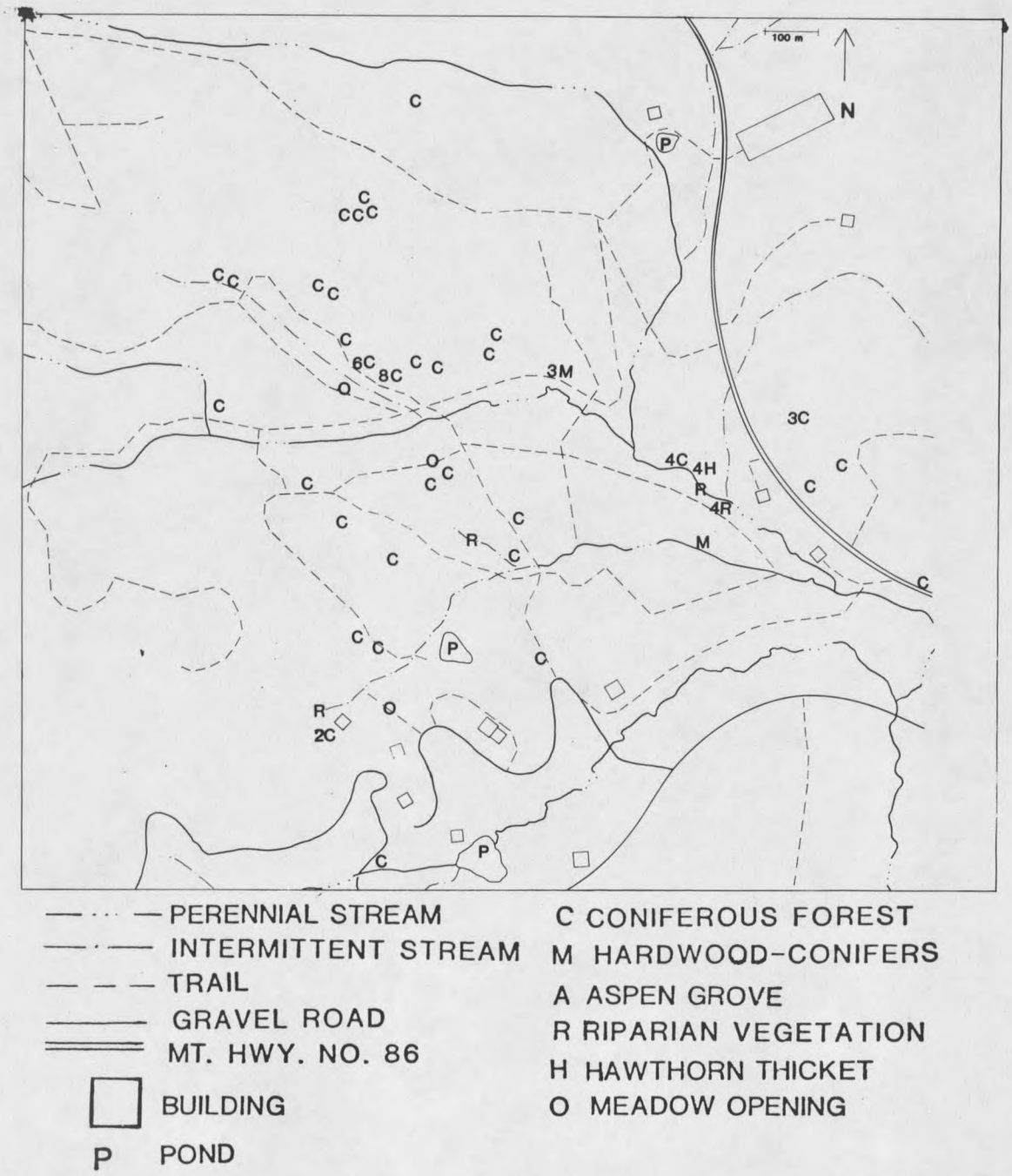

Figure 16. Unmarked ruffed grouse sightings during winter and habitat type at sighting location.

Table 2. Number of times and dates that juvenile grouse visited established drumming logs of adults.

# of bird visiting log	# of bird established on log	Log simultaneously occupied by adult yes/no	Date
32	5	yes	2 Oct. 82
32	5	no	4 Oct. 82
32	6	no	9 Oct. 82
32	8	no	10 Oct. 82
32	2	yes	11 Oct. 82
32	2	yes	13 Oct. 82
32	5	no	22 Oct. 82
32	6	yes	29 Oct. 82
32	5	yes	4 Nov. 82
32	6	yes	5 Nov. 82
56	5	yes	4 Nov. 82
56	1	yes	7 Nov. 82
56	2	yes	18 Nov. 82
56	8	yes	27 Nov. 82
56	8	yes	28 Nov. 82
56	8	yes	3 Dec. 82
56	8	yes	4 Dec. 82

logs, grouse no. 32 established a new drumming log outside the home ranges of known adult males. The other juvenile male, no. 56, was killed before becoming established on a log.

The availability of replacement males for a drumming log throughout the winter and early spring was evidenced by the fact that a log was successively used by 3 different males (Figure 17). The first male, grouse no. 1, occupied the log from spring, 1982, when trapped and radio-tagged until December, 1982, when killed. Juvenile male, no. 46, was trapped in January, 1983. The next day he was located less than 20 m from the above mentioned log and, by spring, he was an established drummer on the log. He was killed in late May, 1983. An unmarked grouse was drumming on the log the next morning.

Population and Mortality Estimates

On 4 different dates, an attempt was made to strip census, with the help of trained dogs, all grouse on the 289 ha study area. The highest number of birds, 11, was counted on 20 January 1983, while the lowest, 9, was counted on 3 different dates (Table 3). The highest number of birds observed equaled a density of 1 bird per 26.3 ha. This density is conservative since some birds undoubtedly were missed in each census. At least 1 brood (6 young) was present on the area in autumn, 1982.

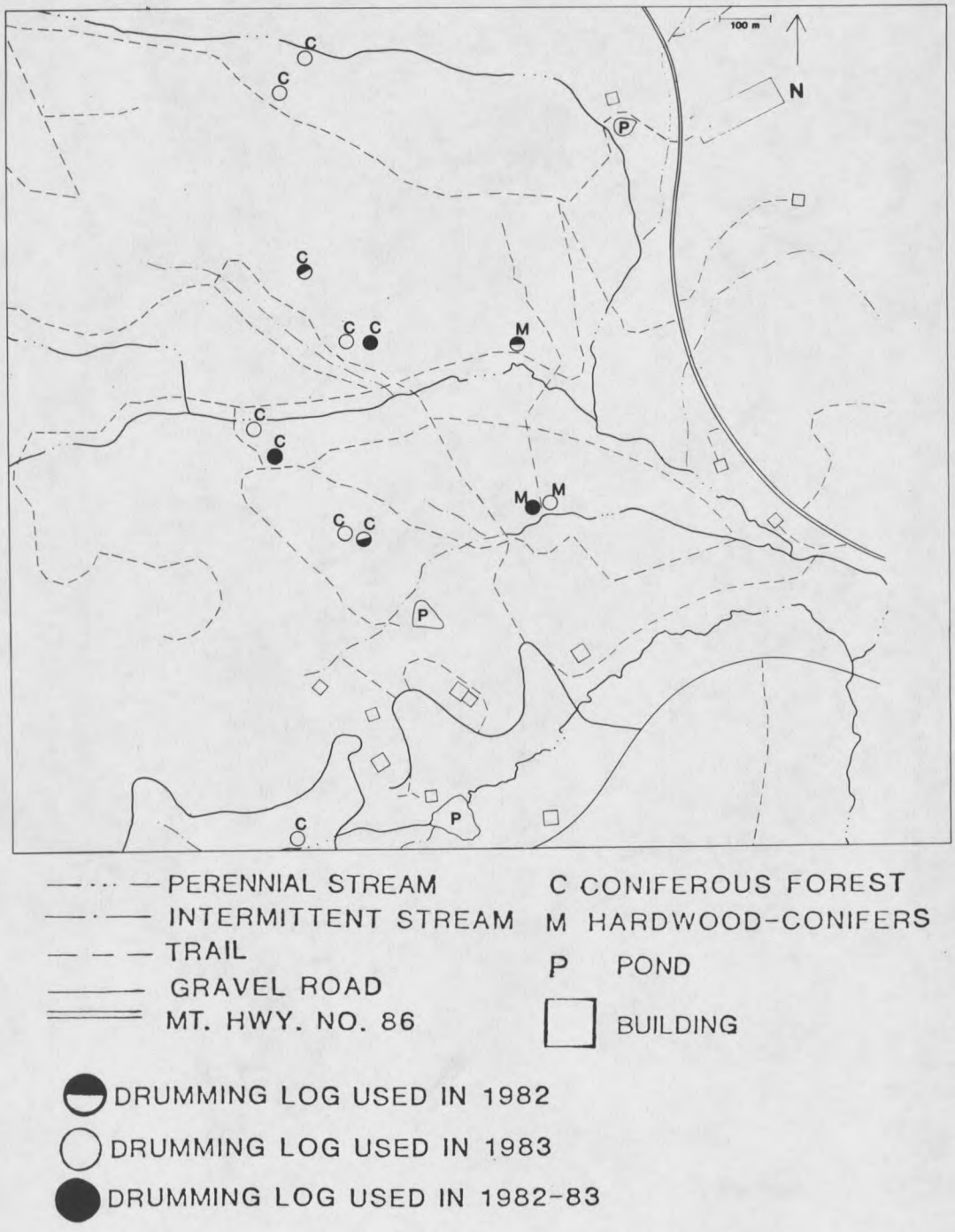

Figure 17. Habitat types and data of occupation of drumming logs.

Table 3. Ruffed grouse population estimates for entire 289 ha study area.

# of instrumented birds alive	# of unmarked birds seen	Total	Date
2	7	9	19 Aug. 82
4	5	9	5 Nov. 82
4	7	11	20 Jan. 83
2	7	9	27 April 83

Predation by goshawks (Accipiter gentilis) was the major observed cause of mortality on ruffed grouse in the area. Mortality data were obtained from 7 instrumented birds, 4 of which were probably killed by goshawks, as deduced from examining the kill sites. One young male was killed by a mammal while on his newly established drumming log. A female grouse suffocated when she became entangled by the antenna of her radio when landing in a tree roost. The seventh died during the winter from an unknown cause.

Daytime Habitat Use During Summer

Sightings of grouse during the summer are summarized by the major habitat types in Table 4. The birds were located more often than expected in mixed hardwood-conifer forests (Figure 18), aspen growths and hawthorn thickets ($\chi^2_1 = 154.4$, $\chi^2_2 = 5.69$, $\chi^2_3 = 3720.1$, $n_1 = 35$, $n_2 = 4$, $n_3 = 15$, respectively, Snedecor and Cochran 1967:20-26). They

Table 4. Major summer habitat use by instrumented and unmarked ruffed grouse.

Habitat type	ha	Number of grouse observations			%	Significance
		Instrumented	Random	Total		
Coniferous forest	171.9	33	34	67	49.3	$p<.1$ **
Hardwood-conifer	11.9	17	18	35	25.7	$p<.005$ *
Aspen growth	2.7	2	2	4	2.9	$p<.05$ *
Riparian vegetation	20.1	2	4	6	4.4	not sig.
Hawthorn thicket	0.1	3	12	15	11.1	$p<.005$ *
Meadow/openings	78.3	2	7	9	6.6	$p<.005$ **
Total	285	59	77	136	100.0	

* Significantly greater use of the habitat type in proportion to availability.

** Significantly less use of the habitat type in proportion to availability.

Figure 18. Mixed hardwood-conifer forest habitat typical of the Bridger Canyon study area in summer.

avoided coniferous forests and meadow openings ($\chi^2_1 = 2.74$, $\chi^2_2 = 21.57$, $n_1 = 67$, $n_2 = 9$, respectively).

Drumming logs were found in only 2 of the major habitat types. A significant preference was shown for hardwood-conifer forests (4 of 14 total) as drumming sites, while the coniferous forest type (Figure 19) was used in proportion to availability (10 of 14 total) ($\chi^2_1 = 18.51$, $\chi^2_2 = 0.1$, $n_1 = 4$, $n_2 = 10$).

Vegetation Analysis within Broad Summer Habitat Types

The characteristics of vegetational cover in the immediate area of grouse sightings are compared in Table 5 to random samples taken within the same habitat type using Student's t-test. Ruffed grouse appeared to select coniferous forest that had significantly less obstacle cover (0-25 cm high) and less immediate overhead cover (26-150 cm high). On the mixed hardwood-conifer forest type, sites with significantly less tree canopy and more total shrub cover in the obstacle layer were preferred. When meadows (including forest openings > 20 m diameter) were used, grouse were more often associated with significantly less total obstacle and immediate overhead cover and less grass-forb cover than expected. However, when grouse were found on meadows and open sites, the locations had more tree canopy cover than was randomly available, reflecting the fact that birds

Figure 19. A perennial drumming log in coniferous forest habitat on the Bridger Canyon study area.

Table 5. Vegetational cover surrounding grouse-centered sightings versus random vegetation sampling, as measured by mean total length in m on 40 m line intercepts.

	Major habitat types									
	Coniferous forest		Hardwood-Conifer		Aspen growth		Riparian		Meadow/openings	
Parameter	Centered (n=29) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=19) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=2) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=4) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=19) $\bar{x}$	Random (n=16) $\bar{x}$
Obstacle layer (0-25 cm ht.)	16.3**(e	20.0	24.1	25.5	21.7**(e	36.3	27.9**(d	32.9	31.4**(f	36.7
Immediate overhead cover (26-150 cm ht.)	8.1**(e	10.8	8.1	12.6	1.6**(f	25.2	15.5**(e	27.1	15.4**(f	26.1
Tree canopy (150+ ht.)	18.8	19.6	22.6**(a	26.4	27.0	31.6	13.8	7.7	11.5*(f	1.9
Total grass-forb cover (0-25 cm)	9.9	13.1	19.8	17.0	21.7**(d	35.3	25.2**(d	32.2	29.3**(d	35.3
Total grass-forb cover (26-150 cm)	0.2	0.8	2.4	2.2	0	21.8	7.3**(f	19.9	7.0	24.2
Total shrub cover (0-25 cm)	2.6	6.2	1.5*(a	1.2	0	0.1	0.5*(d	0.1	0.9	0.6
Total shrub cover (26-150 cm)	.9	2.1	1.2	2.4	0	1.1	0 4	1.4	2.2	1.2

* = more vegetation in centered samples ** = less vegetation in centered samples

(a = p<.09 (b = p<.08 (c = p<.07 (d = p<.05 (e = p<.01 (f = p<.001

usually used those portions of openings that were near to forest edges.

When grouse used riparian and aspen habitat types, they usually selected locations that had less cover than randomly selected sites. However, the sample size for sightings in these 2 habitat types was small.

The abundance of certain shrub genera was measured in areas of use by ruffed grouse (Student's t-test, Table 6). In coniferous forest the birds were often present in sites that had significantly fewer shrubs in the genera Vaccinium, Symphoriocarpos, and Amelanchier. In hardwood-conifer forest, the birds evidently preferred sites that had more Rosa and Crataegus shrubs but fewer Amelanchier plants.

Combining all major habitat types, ruffed grouse favored areas with higher tree densities compared to what was available at randomly selected sites (χ^2-test, Table 7). Within coniferous forest, riparian and meadow/opening habitats birds were observed in areas having higher tree densities than would have been expected. Grouse were more often associated with hardwood (aspen)-conifer and aspen stands that had lower tree densities than similar habitats which were randomly sampled.

Some preference was shown by grouse for certain sizes or densities of the major tree species. Lodgepole pine trees were significantly smaller near grouse sightings than at randomly selected sites (Student's t-test, Table 8).

Table 6. Vegetational cover of 5 shrub genera at grouse-centered sightings versus random sampling of those genera, as measured by mean total length in m on 40 m line intercepts.

	Major habitat types									
	Coniferous forest		Hardwood-Conifer		Aspen growth		Riparian		Meadow/openings	
Shrub genera	Centered (n=29) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=19) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=2) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=4) $\bar{x}$	Random (n=16) $\bar{x}$	Centered (n=19) $\bar{x}$	Random (n=16) $\bar{x}$
Vaccinium (0-25 cm)	1.60**(d	3.5	0.3	0.40	0	0	0.50	0.01	0.40	0.40
Vaccinium (26-150 cm)	0.50	0.9	0.1	0.30	0	0	0	0	0.04	0.60
Symphoriocarpos (0-25 cm)	0.04**(e	0.3	0.2	0.20	0	0.05	0	0.30	0.10	0.08
Symphoriocarpos (26-150 cm)	0.06**(e	0.6	0.4	0.70	0	0.60	0.05	0.60	1.30	0.50
Amelanchier (0-25 cm)	0.08**(f	1.1	0.4	0.80	0	0	0	0	0.07	0.04
Amelanchier (26-150 cm)	0.08**(e	0.5	0.3**(e	1.20	0	0.10	0	0.01	0.10	0.10
Rosa (0-25 cm)	0.30	.2	0.3*(a	0.10	0	0.08	0	0.01	0.08	0.10
Rosa (26-150 cm)	0.02	.07	0.3	0.10	0	0.05	0.03	0.05	0.10	0.04
Crataegus (0-25 cm)	0.30	0	0.3*(c	0.01	0	0	0	0	0.02	0
Crataegus (26-150 cm)	0.20	0	0.3*(b	0.02	0	0.30	0	0.30	0.20	0

* = more shrubs in centered samples ** = less shrubs in centered samples

(a = p<.09 (b = p<.08 (c = p<.07 (d = p<.05 (e = p<.01 (f = p<.001

Table 7. Tree density (over 10 cm DBH) in each major habitat type and the total tree density for all habitats combined, for grouse-centered sightings versus random tree samples.

Habitat type	Centered density (Trees/ha)	n	Random density (Trees/ha)	n(a	χ^2	Significance
Coniferous forest	2,039	121	1,629	64	45.74	p<.005 *
Hardwood-conifer	2,154	76	3.125	4	178.56	p<.005 **
Aspen growth	1,478	8	2,475	1	251.62	p<.005 **
Riparian vegetation	2,072	15	1,172	8	249.48	p<.005 *
Meadow/openings	502	70	70	29	326.03	p<.005 *
Total density	1,345	290	559	106	324.57	p<.005 *

* Significantly higher tree density in centered samples.

** Significantly lower tree density in centered samples.

(a Stratified sample.

Table 8. Mean diameter of each tree species (cm DBH), for grouse centered sightings versus random samples, for all habitat types combined.

Tree species	Centered	n	Random	n	Significance
Lodgepole pine	16.4	73	24.1	55	p<.001 **
Douglas fir	11.9	89	15.4	19	not sig.
Spruce	13.5	17	16.5	7	not sig.
Subalpine fir	10.0	84	10.1	80	not sig.
Aspen	10.1	15	10.2	104	not sig.

** Significantly smaller DBH for centered sample.

With the exception of willows, every major tree species sampled had a significantly higher density around grouse sightings, compared to random densities (χ^2-test, Table 9). Douglas fir showed the highest difference in density, while aspen had the lowest significant difference in density for grouse sightings versus random samples. The density of each tree species within each habitat type was also compared between grouse observations and random samples (Table 9). In coniferous forest, all tree species present, except subalpine fir, had higher densities at bird sightings. Ruffed grouse were associated with higher densities of lodgepole pine, Douglas fir, alder and spruce and lower densities of aspen, subalpine fir and willow in the mixed hardwood-conifer habitat type. In aspen growths the birds were sighted in higher densities of Douglas fir and alder, whereas the density of aspens around them was lower than in random sites. When grouse used the riparian zones they selected areas with higher densities of all major conifers except lodgepole pine, the density of which was lower at these sites. The density of each major tree species, with the exception of aspen and willow, was higher around bird sightings than in random samples in meadow/openings.

Daytime Habitat Use During Winter

During the winter months, ruffed grouse were found to use coniferous forest (Figure 20), mixed hardwood-conifer

Table 9. Total density of each tree species (per ha) in each major habitat type and all habitat types combined at grouse-centered sightings versus random locations.

	Major habitat type											
	Coniferous forest				Hardwood-conifer				Aspen growth			
Tree species	Centered	n	Random	n	Centered	n	Random	n	Centered	n	Random	n
Lodgepole pine	742.1	44	636.9*	25	312.3	11	0	0*	0	0	0	0
Douglas fir	607.5	36	231.3*	9	680.7	24	0	0*	369.5	2	0	0*
Spruce	83.6	5	26.1*	1	170.2	6	0	0*	0	0	0	0
Subalpine fir	572.8	34	734.7**	29	624.7	22	781.3	1**	0	0	0	0
Aspen	0	0	0	0	226.2	8	1562.5	2**	923.7	5	2475.3	1**
Alder	16.3	1	0*	0	114.2	4	0	0*	184.7	1	0	0*
Willow	16.3	1	0*	0	16.3	1	781.3	1**	0	3	0	3

Table 9 (Continued).

	Major habitat type											
	Riparian vegetation				Meadow/openings				All types combined			
Tree species	Centered	n	Random	n	Centered	n	Random	n	Centered	n	Random	n
Lodgepole pine	0	0	146.5	1**	114.9	16	26.6	11*	329.6	71	195.1	37*
Douglas fir	553.2	4	0	0*	136.0	19	0	0*	394.1	85	47.5	9*
Spruce	138.8	1	0	0*	35.6	5	0	0*	79.4	17	5.0	1*
Subalpine fir	138.8	1	0	0*	165.1	23	26.6	11*	371.0	80	216.3	41*
Aspen	0	0	0	0	14.6	2	14.5	6	69.0	15	47.5	9+
Alder	828.8	6	586.2	4*	28.6	4	0	0*	74.0	16	21.2	4*
Willow	414.4	0	439.6	0	7.0	1	2.5	1	28.3	6	26.3	5

* Density of the species greater in centered samples ($p<.005$).

+ Density of the species greater in centered samples ($p<.05$).

** Density of the species lower in centered samples ($p<.005$).

Figure 20. The coniferous forest habitat in winter.

forest, and hawthorn thickets to a greater degree than would be indicated by their overall availability (χ^2-test, Table 10). They avoided the meadow/opening habitat type (χ^2=40.33, $p<.005$).

The birds showed some shifts in their major habitat usage from summer to winter (χ^2-test, Table 11). Coniferous forest was used significantly more in winter than in summer, while hardwood-conifers, aspens, hawthorns, and meadow/openings were used less. However, hardwood-conifers and hawthorns were still associated with grouse more often than expected (Table 10).

Nighttime Roosting Habitat Use During Winter

Eight snow roosts and 38 tree roosts of radioed birds were found during the winter of 1982-83 (χ^2-test, Table 12). The birds avoided hardwood-conifer forest for snow roosting, and they avoided aspen, riparian, and meadow/openings for tree roosting. Coniferous forest was preferred for tree roosting during the winter.

As shown in Table 13, using χ^2-test, the birds moved from their normal daytime habitat to snow roosts in riparian vegetation or meadow/opening habitats. When the ruffed grouse tree roosted, no significant change in habitat selection was observed, compared to normal daytime winter habitat that was used.

Table 10. Major daytime winter habitat use by instrumented and unmarked ruffed grouse.

Habitat type	ha	No. of grouse observations			%	Significance
		Instrumented	Unmarked	Total		
Coniferous forest	171.9	84	51	135	80.4	p<.005 *
Hardwood-conifer	11.9	10	5	15	8.9	p<.005 *
Aspen growth	2.7	0	0	0	0	not sig.
Riparian vegetation	20.1	3	7	10	6	not sig.
Hawthorn thicket	0.1	0	5	5	3	p<.005 *
Meadow/openings	78.3	0	3	3	1.8	p<.005 **
Total	285	97	71	168		

* Significantly greater use of the habitat type over random availability.

** Significantly less use of the habitat type over random availability.

Table 11. Comparison between summer and winter habitat use by instrumented and unmarked ruffed grouse.

	Summer				Winter				
Habitat type	Instr.	Unm.	Total	%	Instr.	Unm.	Total	%	Significance
Coniferous forest	33	34	67	49.3	84	51	135	80.0	$p<.005$ **
Hardwood-conifer	17	18	35	25.7	10	5	15	9.0	$p<.005$ *
Aspen growth	2	2	4	2.9	0	0	0	0	$p<.05$ *
Riparian vegetation	2	4	6	4.4	3	7	10	6.1	not sig.
Hawthorn thicket	3	12	15	11.1	0	5	5	3.0	$p<.01$ *
Meadow/openings	2	7	9	6.6	0	3	3	1.9	$p<.05$ *
Total	59	77	136	100.0	97	71	168	100.0	

* Significantly more use in summer.

** Significantly less use in summer.

Table 12. Ruffed grouse snow and tree roost habitat preference in the Bridger Mountains.

Habitat type	Area		Snow roosts		Tree roosts		Significance	
	ha	%	No.	%	No.	%	Snow	Tree
Coniferous forest	171.9	60	5	63	35	92	not sig.	p<.05 *
Hardwood-conifer	11.9	4	0	0	3	8	p<.04 **	not sig.
Aspen growth	2.7	1	0	0	0	0	not sig.	p<.05 **
Riparian vegetation	20.1	7	2	25	0	0	not sig.	p<.1 **
Hawthorn thicket	.1	0	0	0	0	0	not sig.	not sig.
Meadow/openings	78.3	28	1	13	0	0	not sig.	p<.005 **
Total	285.0	100	8	100	38	100		

* Used significantly more for roosting.

** Used significantly less for roosting.

Table 13. A comparison of major habitats used by ruffed grouse during the day and for night roosts.

Habitat type	Daytime Sightings		Roosts				Significance	
			Snow		Tree			
	No.	%	No.	%	No.	%	Snow	Tree
Coniferous forest	135	80	5	63	35	92	not sig.	not sig.
Hardwood-conifer	15	9	0	0	3	8	not sig.	not sig.
Aspen growth	0	0	0	0	0	0	not sig.	not sig.
Riparian vegetation	10	6	2	25	0	0	$p<.05$ *	not sig.
Hawthorn thicket	5	3	0	0	0	0	not sig.	not sig.
Meadow openings	3	2	1	13	0	0	$p<.05$ *	not sig.
Total	168	100	8	100	38	100		

* Significantly greater use for roosting.

Topographic Preferences

During the summer season, birds preferred south-facing aspects, while they avoided southwest aspects (χ^2-test, Table 14). The mean slope birds used (9.68°) in summer was significantly steeper than the mean slope of the study area (6.84°, Student's t-test).

In winter, grouse preferred south and west aspects, while avoiding aspects facing southeast, north, and southwest (χ^2-test, Table 15.) The mean slope used during this season was significantly greater than the mean slope of the area (9.63° versus 6.84°, Student's t-test).

In comparing aspect and slope use by ruffed grouse during the summer and winter seasons (χ^2-test, Table 16), no significant shifts were seen. Likewise, the mean slope used by the birds in the two seasons was nearly identical (Student's t-test).

Feeding Habits

The most common foods seen to be consumed by ruffed grouse in summer were hawthorn berries, dandelion leaves, huckleberry fruits, and strawberry fruits (Table 17).

Winter feeding observations for ruffed grouse are compiled in Table 18. Fruits and buds of snowberry and huckleberry were by far the most commonly eaten foods when grouse were followed (36.1% and 22.1%, respectively). One

Table 14. Use of slopes and aspects by ruffed grouse during summer compared to random availability.

	Random		Observed		Significance	
Aspect	n	%	n	%	χ^2	
S	16	20	37	42.5	22.08	p<.005 *
SE	24	30	18	20.7	2.51	not sig.
E	14	18	13	14.9	.32	not sig.
NE	5	6	4	4.6	.36	not sig.
N	4	5	3	3.5	.45	not sig.
NW	0	0	0	0	0	not sig.
W	4	5	5	5.7	.08	not sig.
SW	13	16	7	8.1	3.58	p<.04 **
Total	80	100	87	100.0		

	$\bar{x}$	n	$\bar{x}$	n		
Slope	6.84	80	9.68	87	t = 3.5	*** p<.001

* Significantly more use by grouse than randomly expected.

** Significantly less use by grouse than randomly expected.

*** Grouse favored significantly steeper hillsides.

Table 15. Use of slopes and aspects by ruffed grouse during winter compared to random availability.

	Random		Observed		Significance	
Aspect	n	%	n	%	χ^2	
S	16	20	64	41	35.13	p<.005 *
SE	24	30	24	16	10.81	p<.005 **
E	14	18	28	18	0.03	not sig.
NE	5	6	12	8	0.55	not sig.
N	4	5	2	1	4.31	p<.05 **
NW	0	0	0	0	0	not sig.
W	4	5	18	12	13.34	p<.005 *
SW	13	16	7	4	13.14	p<.005 **
Total	80	100	155	100		

	$\bar{x}$	n	$\bar{x}$	n		
Slope	6.84	80	9.63	155	t = 1.83	*** p<.03

* Significantly more use by grouse than randomly expected.

** Significantly less use by grouse than randomly expected.

*** Grouse favored significantly steeper hillsides.

Table 16. Comparison of aspects and slopes used by ruffed grouse in summer and winter.

	Summer		Winter		Significance	
Aspect	n	%	n	%	χ^2	
S	37	43	64	41	0.02	not sig.
SE	18	21	24	16	0.86	not sig.
E	13	15	28	18	0.33	not sig.
NE	4	4	12	8	0.84	not sig.
N	3	3	2	1	1.25	not sig.
NW	0	0	0	0	0	not sig.
W	5	6	18	12	2.03	not sig.
SW	7	8	7	4	1.19	not sig.
Total	87	100	155	100		
	$\bar{x}$	n	$\bar{x}$	n		
Slope	9.68	87	9.63	155	$t<0.60$	not sig.

Table 17. Observed use of various plant foods by instrumented and unmarked ruffed grouse during summer.

Bird type	Snowberry berries	Huckleberry berries	Serviceberry berries	Mtn. ash berries	Hawthorn berries	Strawberry berries	Dandelion leaves	Clover leaves
Unknown		2		1	8	2	6	1
Adult male		2	1		4			1
Juvenile male	1			2				
Brood						2		
Total	1	4	1	3	12	4	6	2

Table 18. Observed use of various plant foods by instrumented and unmarked ruffed grouse during winter.

Bird type	Snow-berry	Huckle-berry	Service-berry	Mountain ash	Hawthorn	Rose	Juniper	Willow	Aspen	Other
Unknown	4 buds	6 buds		1 berries	5 berries	2 buds	1 berries	6 buds		
Unknown						1 berries				
Adult male				1 berries					1 buds	
Juvenile male	21 buds	12 buds	4 buds	2 berries		2 buds		1 buds	1 buds	1* buds
Juvenile male	3 berries					4 berries				1** buds
Juvenile male	3 buds	1 buds	1 buds					2 buds		
Total	31	19	5	4	5	9	1	9	2	2

* = thimbleberry
** = subalpine fir

female grouse, no. 75, which was killed by an entangled antenna in March, 1983, had a crop entirely filled with 27.8 g of snowberry buds. Rose hips and buds, as well as willow buds, were secondarily important foods (10.5% each).

During the late summer period, crops were collected from 1 grouse chick that was found dead, and 5 birds shot by hunters or hit by vehicles. The crop contents were tabulated by wet weight and volume (Table 19). The most common food items, both by weight and volume, were clover leaves, serviceberry fruits, and rose hips. Clover leaves, strawberry fruits and snowberry leaves, huckleberry buds, and grasses were found in crops of at least 2 different grouse.

A comparison of crop and body weights for all late-summer-killed birds is presented in Table 20. Ruffed grouse crops contained up to 9.5% of the birds' total weight.

Some birds were trapped and weighed more than once, enabling trends to be observed. Grouse no. 1 was caught as a young male in spring, 1982. When first instrumented his weight was 435.7 g. When caught in October 1982, he weighed 492.5 g. He was located 53 days later, badly scalped, and had lost 63.9 g, weighing only 423.2 g. The other grouse weighed twice was female no. 75. She gained 22.3 g in 40 days during mid-winter.

Table 19. Summary of crop contents of 6 ruffed grouse killed during late summer season, 1982.

Food item	Consumed by	Wet weight (g)			% of total	Volume (cc)			% of total
	n birds	max.	min.	mean	weight	max.	min.	mean	volume
Clover leaves	5	34.4	4.2	18.2	63.9	34.1	4.5	15.7	63.4
Serviceberries	1	23.7	23.7	23.7	16.7	25.4	25.4	25.4	17.1
Rose hips	1	19.2	19.2	19.2	13.5	20.0	20.0	20.0	13.5
Strawberries	1	2.7	2.7	2.7	1.9				0
Strawberry leaves	2	0.2	0.2	0.2	0.3	1.0	0.4	0.7	0.9
Huckleberry leaves	2	1.5	0.7	1.1	1.6	2.0	0.2	1.1	1.5
Huckleberries	1	0.3	0.3	0.3	0.2	0.5	0.5	0.5	0.3
Dandelion leaves	1	0.6	0.6	0.6	0.4	1.0	1.0	1.0	0.8
Lepidoptera larvae	1	0.5	0.5	0.5	0.4				0
Grasses	2	0.3	0.5	0.2	0.3	1.0	0.1	0.6	0.7
Snowberries	1	0.4	0.4	0.4	0.3	0.6	0.6	0.6	0.4
Snowberry leaves	2	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2
Hawthorn leaves	1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Grass seeds	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Moss	1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.3
Wasp (Hymenoptera)	1	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.2

Table 20. Weight of grouse and crop contents for 6 birds.

Bird type	n	Total crop weight			Total bird weight less crop			Mean crop weight/ mean total weight less crop (%)
		max.	min.	mean	max.	min.	mean	
Chick	1	4.3	4.3	4.3	202.2	202.2	202.2	2.1
Juvenile	3	32.4	9.5	21.1	514.1	451.0	475.6	4.4
Adult	2	66.5	37.8	52.2	568.7	525.9	547.3	9.5
Male	2	37.8	9.5	23.7	525.9	514.1	520.0	4.5
Female	3	66.5	21.3	40.1	568.7	451.0	493.8	8.1

DISCUSSION AND CONCLUSIONS

Effects of Radio-Marking

One of the major concerns in a telemetry study is that the transmitter package may change the normal behavior or adversely affect survival of the study animal. To my knowledge, this was the first time the "bib-type" harness was used on the ruffed grouse. No obvious behavioral changes were observed which could have been attributed to radio-marking the birds. All of the marked males participated in drumming. No unusual movement patterns were noted, and 2 of the instrumented birds which were recaptured gained weight. Similar results were reported by several authors. Properly fitted transmitter harnesses had no noticeable effects on behavior of red grouse (Lagopus lagopus scoticus), ruffed grouse, or spruce grouse (Canachites canadensis franklinii) (Boag et al. 1973, Maxon 1977, Herzog 1979, respectively).

Solar powered radios were of questionable value in this study. Inadequate light apparently reached the panels to permit continuous use of the transmitter. Whether this was a function of the habitat or feathers being preened over the solar cells was not determined.

Home Ranges

In this study the mean grouse summer home range was 12.4 ha, which was consistent with most other studies. Bakke (1980) in North Dakota reported home range sizes for males at the onset of drumming to range from 0.4 to 1.8 ha and from 2.5 to 13.8 ha during the following 9 weeks. The only adult male followed throughout the summer in my study showed a pattern of increased movements as the summer progressed.

The mean grouse winter home range in this study was 18 ha, similar to that reported by Marshall (1965) in Minnesota. Eng (1959) found that adult male ruffed grouse in Minnesota moved the maximum distances from their logs in winter. In the northeastern states the winter ranges were also larger than those used in summer (Edminster 1947).

Most authors, including Chambers and Sharp (1958), Eng (1959), Hale and Dorney (1963), reported considerably more movements in the fall by juvenile males than by adults. Young males, following fall dispersal, limited their movements to an area within which the drumming log was established.

The 2 juvenile males trapped in the fall during my study followed the above pattern. Grouse no. 32 (Figure 4), which was trapped in early October, moved considerably more than no. 56 (Figure 9), caught a month later. No. 32 was

probably making dispersal movements, which peak in October (Chambers and Sharp 1958). However, both juveniles moved more than the adult male (grouse no. 1, Figure 6). Bird no. 32 continued moving for a large part of the winter (Figure 7). This could have been related to the presence of snowmobiles and downhill and cross-country skiers within his home range. The year-round mean home range (22.2 ha) was quite similar to that reported by Edminster (1947) for grouse in the northeast, 20 ha.

Social Behavior

The homes ranges of birds overlapped throughout the year in that unmarked grouse were seen within every home range in both seasons (Figures 15, 16). The overlap in summer ranges was, however, noticeably less than that during the winter, since the ranges of radio-marked grouse did not overlap during summer (Figures 12, 13).

In New York, adult grouse seldom formed flocks, although several birds could be seen roosting in the same clump of cover (Bump et al. 1947). Gullion (1972) believed that ruffed grouse were essentially solitary. However, in Alberta birds were often seen in groups of 2-9 during feeding periods in fall and winter and it was common for 2 or more grouse to snow roost within 20 feet of each other (Rush and Keith 1971a, Doerr et al. 1974).

The latter 2 studies support my findings. All groups were found during the late summer season (the fall months) and winter. Most of these birds were seen feeding and walking together, although grouse were found roosting together in trees 4 times. Snow-roosting birds were always solitary.

Male grouse are often considered territorial (Sumanik 1966, Aubin 1970). Archibald (1976) found drumming to be involved in maintenance of stable spatial relationships among males. He believed that this had 2 beneficial effects on the grouse population. First, after establishing territories, males could concentrate their efforts on drumming instead of fighting. Secondly, since the drumming sounds at 1 log could be heard at another and because the birds did not drum simultaneously, more females would be attracted. However, Gullion (1981a) stated that since no active defense of territory has been demonstrated for this species, areas which include the log and are occupied by a male should be called activity centers, not territories. He did state that drumming was involved in the spacing of males, which would make the male ruffed grouse at least partially territorial.

Since this study showed no overlap in summer home ranges of radio-marked males, and no sightings of other than resident males around the drumming logs during the breeding season, Archibald's theory seems valid. Drumming from 1 log

could in most cases be heard at 1 or more logs, but no fighting or evidence of it was observed.

Even spacing of drumming logs (usually 200-250 m apart according to Gullion 1981a) has been suggested by many authors (Rusch and Keith 1971b, Archibald 1976, Gullion 1981a). This was not evident during this study (Figure 17). Instead, while most logs were separated by 250-350 m, 1 pair was only 90 m apart, another 180 m and the log of grouse no. 32 was over 600 m away from the closest occupied log. This was not caused by scarcity of suitable drumming habitat, since coniferous forest, which covered over 60% of the area, was readily used. Rather, these mostly greater distances possibly reflected the comparatively low population density on my study area.

Gullion (1967) believed that the attendance of logs by adult males is nearly as common in fall as in spring. During the fall and throughout the winter non-established young males were observed in the vicinity of several logs occupied by adult males. The visiting of occupied logs during the fall shuffle by juvenile males has often been reported in the literature (Palmer 1963, Gullion and Marshall 1968). In Minnesota, the replacement of an absent drumming male on a particular site appeared to depend on the site being occupied during the fall drumming season (Eng 1959). Gullion (1967) also considered it likely that the activity of young males seeking to become established on

logs probably stimulated increased activity by older, established males. On some occasions male grouse used the same traditional sites even when there was no contact between the newly established bird and his predecessor (Gullion 1967, Boag and Sumanik 1969). The latter authors believed that, in these cases, the birds used environmental criteria in selecting the exact perennial log.

Results of this study support the theory that juvenile males learn the drumming sites of established males during the fall dispersal. It seems that while the juveniles mature during the fall, the adults start visiting their logs with increased frequency. Thus, a young male in the vicinity of an occupied log is aware of the attending male. This may attract the young birds, and the intrusion triggers the strutting and drumming behavior of the adult. At least on 1 occasion during the study an adult was known to have actually drummed while a young male was in the immediate vicinity of the log. Twice, wing marks were found on the snow by a log with at least 2 different sets of tracks. While this attendance of logs by adults reveals their locations to the juvenile birds, it may also acquaint them with the drumming behavior itself, and the characteristics of desirable habitat for a log.

One of the young males (no. 46) trapped during the winter spent the entire season approximately 400 m east of the log of grouse no. 1, which was killed almost a month

before no. 46 was caught. This bird made 2 brief visits to the above mentioned log during the winter and when the log became snow-free, he established himself on it. Evidently grouse no. 46 knew the location of this drumming site since it was occupied by no. 1 during the fall shuffle. Another observation seems to reinforce the above conclusion. The only known drumming log not attended in the fall 1982 was that of grouse no. 4. This log was also the only 1 which failed to show any signs of occupancy the following spring.

The selection of new logs in fall might also be triggered by the territorial behavior of adult grouse. Young males, after visiting several occupied logs, may select another log outside the territories of the adults, thus establishing home ranges in new, possibly less suitable, areas. This appeared to be the case with male no. 32, who was observed near almost all the occupied logs, most of them several times (Table 2) during the fall. Then, at the onset of winter, he moved to an unoccupied area, and established on a new drumming log, over 600 m from the closest occupied log.

That only a few of the juvenile males become established on logs during their first fall has been well documented (Eng 1959, Marshall 1965, Gullion 1967). The same was found in my study. Possibly, the 2 different behavioral reactions are triggered by difference in sexual maturity of the young birds. Those whose gonadal activity

is higher, called semi-sexually active by Eng (1959), establish themselves on a new log away from the home ranges of other grouse during their first fall. Birds which are not as mature evidently only visit the occupied logs during fall, becoming aware of their locations and the drumming behavior. The next spring they either find an unoccupied perennial log or establish a new one. This idea may explain why no. 32 was caught in early October in a trap near an occupied log, whereas no. 56 was trapped in the same place over a month later. Bird no. 32 may have been more mature than no. 56, and progressed to a point of log establishment during the first fall. Grouse no. 56 was not yet established by early December when he was killed.

Population Density and Mortality Estimates

The population estimate, based on the actual number of birds seen, was 1 bird per 26.3 ha. This may have been low. Several authors have concluded that the sex ratio among ruffed grouse is 1:1 during spring (Bump et al. 1947, Gullion and Marshall 1968, and Rusch and Keith 1971b). If this is true, the population density in this area would have been 1 bird per 20.6 ha, since 7 drumming males were located during each spring.

Ruffed grouse densities reported in the literature vary considerably. The highest was observed by King (1937) in Minnesota where the maximum during 7 years was 1 bird per

1.6 ha. The mean from 27 studies was 1 bird per 11.7 ha. The lowest reported densities for occupied habitat have been 1 or fewer birds per 40 ha in Michigan, Utah and Wisconsin (Palmer and Bennett 1963, Phillips 1964, and Kubisiak et al. 1980, respectively).

In the West, a high density of 1 bird per 1.9 ha was found in Idaho by Hungerford (1951b) and the lowest by Phillips (1964) in Utah. Rusch and Keith (1971b) reported a density of 1 bird per 6.3-9.3 ha in Alberta. In Washington, the number of hectares per bird varied from 7.1 to 10 (Salo 1978).

Compared to the mean density from all studies, mine was quite low. However, when the comparison is made between the densities reported from western states and provinces only, mine is closer to the mean (1 bird per 13.4 ha).

Bump et al. (1947) considered a 50% mortality of the fall population typical. They found that 80% of these birds succumbed to various predators. Several other authors believed various raptors to be the chief immediate cause of mortality among grouse in fall and winter (Eng and Gullion 1962, Gullion and Marshall 1968, Rusch and Keith 1971a). In Alberta, most of the losses occurred in October and November after the fall dispersal was completed (Doerr et al. 1974). Depending upon the area, predation accounted for 60-100% of the winter losses.

Goshawks were the major predators of ruffed grouse on my study area. The time of losses, however, differed from those reported in Alberta. Most of the birds (75%) were killed during the winter months of 1982-1983, and the remaining 25% at the onset of spring of 1983. One possible cause for this pattern was the winter influx of goshawks in 1982. One of these migrants may have taken up winter residence close to the study area sometime in early December and remained there after finding a generous food supply (snowshoe hares were common throughout the area). This is supported by the fact that all adult males made it through the breeding season in 1982, and all except 1 returned to their logs the next fall, indicating no mortality during spring and a low (14%) mortality among the adult males during summer. Ruffed grouse are known to be preyed upon by avian predators during the reproductive season (Eng and Gullion 1962, Gullion and Marshall 1968, Boag and Sumanik 1969). During the second spring one male was lost to a hawk near his drumming log. This would support the idea that goshawks were absent from the study area during the first spring and summer and appeared in the early part of the following winter.

Daytime Habitat Use During Summer

Ruffed grouse preferred mixed hardwood-conifer and, to a lesser degree, aspen types during summer. A very high degree of association was found between grouse and hawthorn thickets during late spring and throughout the fall months. Coniferous forests and meadow/openings were both avoided during summer.

It seems that most authors agree about the importance of hardwoods in ruffed grouse summer habitat (Chapman et al. 1952, Gullion 1970, Kubisiak 1978, Bakke 1980). In my study, grouse also showed a slight preference for aspen stands, although the preference for the mixed hardwood-conifer type was more apparent. The same was found in Michigan (Fisher 1939) and Idaho (Stauffer 1983). This was probably caused by the abundance of shrubs and herbaceous plants for food combined with high tree density for shade and shelter.

No one has commented on the preference for hawthorns, although Bump et al. (1947) stated that during fall grouse mostly used brushy patches bordering coniferous forests. In this study, grouse were found feeding on newly emerged green vegetation in hawthorn thickets in spring long before the leaves emerged on the shrubs. The thickets were very dense, however, thus protecting the bird from above. Also, the gray color of the grouse blended in with the gray of the

hawthorns, making them extremely hard to see. No use of this habitat type was found during the summer months of June, July and August. The fall use of the thickets was encouraged by the abundance of ripe fruit the shrubs produced. Even though the birds usually sat on the limbs of the hawthorns while feeding, they still were difficult to see, especially because they favored the inner parts of the thickets. No grouse remains were found around these feeding sites, confirming their relative safety.

Avoidance of coniferous forests was noted in most studies (Bump et al. 1947, Phillips 1964). The reason might have been lower density of tree canopy cover in this habitat type compared to the favored mixed hardwood-conifer habitat. Hungerford (1951b) also thought that grouse sought denser canopy cover in summer, and this was the case in Stauffer's (1983) study. Only in 2 studies in Idaho were conifers used year-round (Marshall 1946, Hungerford 1951b, 1953a). This might have been caused by scarcity of deciduous trees in these areas.

All authors agreed that ruffed grouse generally avoided large openings, whereas logging roads and small natural forest openings were used, mostly for feeding, which was also the case in my study.

Drumming Log Habitat

Hardwood-conifer forests were preferred as drumming sites and coniferous forests were used in proportion to their availability. No use of the other major habitat types was found.

Most researchers believed that hardwoods were essential as drumming log habitat (Dorney 1959, Porath and Vohs 1972, Stoll et al. 1979). Several studies have stressed the role of aspens in the selection of a drumming log. Gullion (1972) said that male ruffed grouse select logs within a site of a clone of male aspens. Sumanik (1966), Boag (1976), Salo (1978), and Theberge and Gauthier (1982) all found drumming sites in mixed hardwood-conifer forests. Salo (1978) commented about the lack of aspens in his study area and said that 70% of drumming logs were instead associated with cottonwood trees (Populus trichocarpa). He also believed that dense conifer stands were least attractive to male ruffed grouse. Only Frank (1947) considered drumming logs to be usually in dense coniferous cover.

The preference for hardwood-conifer forests as drumming sites could have been expected in Montana, since most studies in the northwestern states and provinces reported similar findings. The reason might have been the relatively low tree canopy coverage in this habitat type before the foliage of the deciduous trees developed. One fact that

also increased the amount of logs in this type was the use of 1 perennial log by 2 different males and the temporary establishment of a young male less than 20 m from the above-mentioned log. Thus, 3 out of 4 sites in this habitat type were one and the same. All logs in this habitat type were less than 10 m from aspens, even though on 1 occasion the trees were only saplings. At all sites conifers constituted the major canopy coverage.

The usage of conifers to such a high degree and the complete avoidance of pure aspen stands differed markedly from the results of other studies. This could have been caused by the amount of tree canopy coverage provided by conifers (less than that of mixed hardwood-conifers in summer but more than other types in spring) and the almost complete lack of canopy coverage in aspens, which in this area leaf out after the breeding season. The extensive lack of shrubs in the aspen habitat type (Table 5) may also have made it less desirable for grouse. Several authors have stressed the importance of canopy coverage above the drumming site (Dorney 1959, Eng 1959, Boag and Sumanik 1969, and Stauffer 1983), although Gullion et al. (1962) in Minnesota reported shrubby cover being preferred over forest canopy cover. Furthermore, stands with closed canopy were avoided in their study. Generally, it has been agreed that the tree canopy cover is necessary for screening off the drumming grouse from avian predators. All logs in this study

evidently had the necessary coverage since no birds were killed while drumming.

Vegetation Analysis within Broad Summer Habitat Types

Ruffed grouse selected coniferous forests with less cover in obstacle and immediate overhead layers than occurred randomly in this habitat type. Within the mixed hardwood-conifer type, sites with more total shrub cover in the obstacle layer and less tree canopy cover were preferred. When using meadow/openings birds avoided thick cover in both lower layers and favored higher tree canopy coverage. Locations used by grouse in riparian and aspen habitat types showed less cover than was randomly available.

In conifers, grouse selected sites with fewer shrubs in the genera Vaccinium, Symphoriocarpos and Amelanchier. In hardwood-conifers they were more often associated with shrubs in genera Rosa and Crataegus than expected, and less often with Amelanchier.

When all major habitat types were taken into consideration, birds preferred areas with higher tree densities. Grouse sightings in coniferous forests, riparian vegetation and meadow/openings had higher tree densities, while those in hardwood-conifers and aspen stands had lower densities than randomly available.

Lodgepole pines were smaller near grouse sightings than at randomly selected sites. All individual tree species for

all combined habitat types, except willow, had higher densities around grouse sightings. Douglas fir was the most sought after species, and aspen the least. In the conifer habitat type, the birds preferred higher densities of all species, except subalpine fir, over random availability. In the mixed forest type, aspen, subalpine fir and willow were less often associated with grouse, while other conifers and alder were more often found near bird sightings. Aspen densities were also lower than expected in aspen growths around sightings, and those of Douglas fir and alder, higher. All conifers, except lodgepole pine, had higher densities at grouse locations in riparian zones. In meadow/openings the densities of all other tree species, except aspen and willow, were higher near the sightings.

In the literature comparative data defining the specific characteristics of sites selected by ruffed grouse are scarce. In Idaho, chokecherry, snowberry and serviceberry were shrubs most frequently associated with grouse (Stauffer 1983). He believed this to be due to the importance of these species as cover and food. In his study huckleberry was preferred for only a short period in fall. He found Douglas fir to be the most important coniferous tree for grouse in summer, whereas aspen was most commonly associated with grouse from all available tree species. Stauffer believed that aspen stands in late successional stages (having higher conifer-cover and tree density, and

fewer shrubs and small stems) had the lowest numbers of grouse, while the seral stages of deciduous hardwoods (10-20 yrs) contained the highest levels. This opinion was shared by Sharp (1963, 1970) and Gullion (1970, 1977).

The reasons for selection of sites with less than expected cover in both lower layers in coniferous habitat could have been selection for greater visibility as it relates to security. The same reason could account for the greater amount of shrubs associated with bird sightings in hardwood-conifers. The importance of a thick shrub layer to quality grouse habitat has been reported several times (Palmer 1963, Rusch and Keith 1971a, Gullion 1972, Bakke 1980 and Stauffer 1983). The brush provides some protection from avian predators and an open forest floor with a minimum of concealment for mammalian predators. The lower tree densities in sites favored by grouse could have been related to the greater development of an understory of desirable density in stands with higher light penetration. The use of meadow/openings with less cover in lower layers reflects the need for an open obstacle layer for ease of movements. Since most of the vegetation in this habitat type was composed of various grasses, the characteristics of the immediate overhead cover layer automatically resembled those of the lower layer. The significantly higher tree density associated with grouse sightings made in openings reduced the thickness of the understory by shading and also offered

overhead protection to the birds while they used this habitat type.

The reason that grouse were at sites with lower than expected densities of huckleberries, snowberries and serviceberries in coniferous forests, and serviceberries in hardwood-conifers, could have been the high quantities of these plants available in this habitat type; grouse did not have to specifically search for them. It could also be that the birds preferred herbaceous plants (like dandelions and clover) over shrubs in the summer months. Grouse were found near huckleberries more during the early fall, when the fruits were ripening. The apparent selection for roses and hawthorns in mixed hardwood conifers could have been due to the scarcity of these shrubs. The fruits of both plants, especially those of hawthorn, were evidently preferred food items. Hawthorn also provided good protection from raptors.

The higher tree densities in conifers, riparian zones, and meadow/openings found around grouse locations may have been the result of grouse utilizing cover for protection from avian predators. The lower densities in the mixed hardwood-conifer type and in aspen stands might have been due to the relatively high tree densities randomly available in these habitats or sampling error due to small sample size in the aspen type. In both types, grouse were more often associated with conifers than was expected (in mixed forests 83% of trees around grouse locations were conifers compared

to 25% at randomly selected sites). All this might have resulted from the high preference for shrubs. After the foliage of deciduous trees is fully developed, the canopy coverage they provide is greater than that of conifers and possibly too closed for existence of a well developed understory.

Gullion and Marshall (1968) considered mature pine trees detrimental to grouse. This could have been the reason that birds selected sites where lodgepole pines were smaller than those randomly available. Small trees provided cover structure similar to hawthorns.

In my study, Douglas fir was the tree most commonly associated with ruffed grouse. In Idaho (Stauffer 1983) it was the most important coniferous tree. In Stauffer's (1983) study both aspen and willow were preferred by grouse. In mine aspen was found in all habitat types, where it occurred less often around bird sightings than expected. Willow was mostly avoided during summer.

Daytime Habitat Use During Winter

During the winter coniferous forest, mixed hardwood-conifer forest, and hawthorn thickets were preferred and meadow/openings avoided.

The birds showed a shift from summer to winter in the amount of use received by conifers, hardwood-conifers, aspens, hawthorns, and meadow/openings. Grouse sightings

were associated with coniferous forest more often during winter than summer, and less often with all the other habitat types.

The importance of coniferous cover during winter has been well documented in the literature (Marshall 1946, Hungerford 1951b, 1953a, and Pietz and Tester 1982). Gullion and Marshall (1968) and Gullion (1972, 1981b) expressed an opposite opinion. They considered clumps of pines, fir and spruce unnecessary as winter cover. They believed that whatever benefits grouse gained from using coniferous cover during severe weather in winter were temporary, whereas the evergreen cover served as a hiding place for the major predators upon grouse throughout the year. In Idaho, grouse also preferred aspens in winter, although use of mixed aspen-conifers and dense conifers was higher during this time than in other seasons (Stauffer 1983).

Hungerford (1953a) found a definite shift between summer and winter ranges used by grouse in Idaho. The birds moved from bottoms of ravines, preferred in summer, to coniferous ridge tops in winter.

In Montana, grouse preferred hawthorn thickets and mixed hardwood-conifer forests year-round, although to a lesser extent in winter than in summer. The decline in hawthorn use was evidently caused by the diminishing fruit supply in the bushes as winter progressed. Fewer sightings

in the mixed forest type might have been due to the relative flatness of this habitat (slopes ranged from 1° to 5°). The accumulating snow soon covered most fruit-bearing shrubs, which were the major food source for grouse, forcing birds to seek food elsewhere. This was possibly one reason for the shift to greater use of conifers, since most hillsides where shrubs remained at least partially exposed belonged to this habitat type. Conifers also provided better shelter both from weather and predators.

Gullion's (1972, 1977, 1981b) statements about aspen forest being relatively free of raptors, and the near obligatory relationship of grouse with aspen in states where snow covers the ground for at least 4 months of the year seem irrelevant in Montana. The slight importance of aspen stands during summer was lost in winter (Tables 4, 10, 11). Aspen may only indicate flat, moist habitats capable of producing useful cover and food for ruffed grouse in summer. The tree itself appears almost useless to the birds in this area as either cover or food.

Most of the predation by goshawks took place in winter. Two of the grouse were killed in mixed forest, and one in conifers. A fourth grouse killed by a hawk in early spring was also in hardwood-conifer forest. The major reason for the deaths did not seem to be the habitat itself, but rather newly established ski trails winding through the home ranges of the birds. Three of the grouse were caught while

crossing a trail. The fourth was killed 2 m after the crossing as judged from the tracks in the snow. One could argue that these birds were not accustomed to the new trails, and to the openness they created in the canopy coverage. This was supported by the absence of kills on several old logging roads within the home ranges.

Nighttime Roosting Habitat Use During Winter

Mixed forests were avoided by snow-roosting grouse. The birds moved from their normal daytime habitat to snow roosts in riparian and meadow/opening habitats.

Snow roosting is considered common, especially in bitter cold or stormy weather (Edminster 1947, Dorney 1959, and Gullion 1972). In Idaho all snow roosts were located in small openings in forest cover with logging roads receiving part of the use (Hungerford 1953). Gullion (1972) considered the quality of snow cover during winter as a major factor influencing grouse survival.

In Montana, riparian vegetation, formed mainly by alders around the roost sites, was associated with 25% of the snow roosts. The reason could have been the relative ease of diving into a roost inside an alder thicket and the protection of the shrub against raptors. The roost found in a meadow-opening was right at the edge of conifers, thus resembling those sites within the coniferous forest. The availability of soft snow did not seem to be very critical

to grouse. Tree roosting was more common, even though snow roosting would have been possible.

The shift to use riparian zones and meadow/openings for snow roosting could have been due to the scarcity of food and shelter in these areas, making them less preferable during the day, whereas their openness was favorable for snow roosting. Since snow-roosting birds must flush blindly when suddenly disturbed, they may select sites for such roosts so that when they flush, they will not inadvertently strike overhead cover.

Aspen stands, riparian vegetation, and meadow/openings were not used by tree-roosting birds. Ruffed grouse preferred coniferous forests for tree roosting (Table 12). No changes in habitat selection were observed between day and night by tree-roosting grouse. Most studies have shown that tree roosting usually occurs in conifers (Hungerford 1953a, Marshall 1965, Lewis et al. 1968, and Stauffer 1983).

The preference for dense coniferous cover as tree roosting sites could have been expected, since it offered better protection from inclement winter weather and predators than did the other habitats. All roosts found in mixed forests also occurred in evergreen trees. The avoidance of the other 3 habitat types reflected the importance of dense tree canopy coverage in winter tree roosting sites, since this was the major factor lacking in these mainly deciduous or open habitats.

Topographic Preferences

During summer grouse preferred south-facing and avoided southwestern aspects (Table 14), although they could be found on hillsides facing all available directions. The mean slope used was steeper than the mean slope of the study area. In winter the aspects most often associated with birds were south and west, while southeast, north, and southwest were all avoided. The mean slope used remained steeper than the mean slope of the area. No significant shifts were seen in use of either aspect or slope between the two major seasons.

Hungerford (1953a) found ruffed grouse on the upper parts of south-facing slopes during winter in Idaho. In Stauffer's (1983) study, higher elevations were preferred during winter. Grouse were always associated more with south and east aspects, although in summer and fall they could be found across all aspects. Slopes used were generally less than 20°, which he considered as gentle terrain.

Both of the above authors believed that the higher hillsides were warmer than areas below. This seems to be a likely explanation for the preference of hillsides. The solar radiation on those aspects that face the sun for the longest part of the day would cause snow to melt during sunny days, even in mid-winter, uncovering more shrubs for

feeding grouse. The density of fruit-bearing plants might also be higher on south-facing slopes than on those facing north. The mean slopes used by grouse in this study, although steeper than the mean slope of the area, were still more gentle than those used in Idaho (Stauffer 1983).

Feeding Habits

During summer, foods which grouse were most commonly seen eating were hawthorn berries, dandelion leaves, huckleberry fruits, and strawberry fruits. In winter, birds preferred most both fruits and buds of snowberry and huckleberry. Rose hips and buds, as well as willow buds, were secondarily important foods. Crop analysis during the fall months indicated clover leaves, serviceberry fruits, and rose hips as the most heavily used items.

Ruffed grouse are primarily plant-eaters (although they are omnivorous) and are known to utilize representatives from 65 families and over 334 plant species (Bump et al. 1947). Eastern food habit studies agreed that the bulk of the food is furnished by various fruits and seeds from shrubs in summer, and buds and twigs from shrubs and trees in winter (Bump et al. 1947, Edminster 1947, Bailey et al. 1955).

In Idaho, the preferred foods included clover leaves, sedge seeds, grasses, small ground cover plants, rose hips, and snowberry and huckleberry fruits during summer

(Hungerford 1953a, 1957). In fall, clover leaves were the most important food item. During winter months, serviceberry, huckleberry, snowberry, and willow buds, together with a variety of hardwood buds, were consumed. Marshall (1946) found grouse feeding on chokecherry, willow, serviceberry, and mountain ash buds in his study area in southern Idaho. Phillips (1967) recorded rose hips as the number 1 food item during fall in Utah; clover leaves, serviceberry and snowberry were also used by grouse. In winter, chokecherry buds had the highest preference value, although buds of aspen, maple, willow, and serviceberry were also desirable.

Some authors considered aspen buds (specifically flower buds and catkins from mature male aspen) as critical winter and spring food (Svoboda and Gullion 1972, Doerr et al. 1974). Svoboda and Gullion saw ruffed grouse as an example of a species narrowly adapted in its food requirements. Furthermore, since young birds gained weight while feeding almost exclusively on aspen flower buds in their study, this was considered indication that this food resource was adequate for the species. Doerr et al. (1974) found, however, that even though aspen buds were the major food source in Alberta, the willow buds also eaten had higher protein levels (14%) than those of aspen (12.9%). The quantities of carbohydrates were also higher in willow buds,

while their fat, fiber and ash contents were lower than those of aspen buds.

All the items used by ruffed grouse in Montana have been found in other studies, especially in the northwest. The definite preference for snowberry and huckleberry buds during winter may indicate that the food value of these plants is even higher than that of willows, or it might reflect the abundance of these shrubs on hillsides utilized by grouse. Only once was a bird seen budding in aspens, in late winter. The reason for avoidance of budding could not have been inadequate supply of aspens, but may have been due to the exposure to predators while sitting on the barren limbs as compared with the relative safety of ground feeding among shrubs.

Using Svoboda's and Gullion's (1972) assumption of weight gain as indicator of suitable food availability, buds of various shrubs seemed to provide an adequate winter diet for grouse in Montana.

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Table 21. Ruffed grouse trapped and marked on the Bridger Mountain study area.

Grouse #	Color phase	Sex	Age	Trap type	Marked with: Bands	Marked with: Radio	Marked with: Date trapped	Date disappeared or died	
1	Gray	M	A	Mirror	-	Solar	9 June 82	29 July 82	Radio failed
5	Gray	M	A	Mirror	x	Solar	13 June 82	17 June 82	Radio failed
6	Gray	M	J	Mirror	x	--	15 June 82	18 June 82	
4	Gray	M	J	Mist net	x	--	22 June 82	22 June 82	
32	Gray	M	J	Cloverleaf	x	Battery	2 Oct. 82	3 March 82	Broken antenna
1	Gray	M	A	Cloverleaf	x	Battery	5 Oct. 82	27 Nov. 82	Broken antenna
56	Gray	M	J	Cloverleaf	x	Battery	4 Nov. 82	9 Dec. 82	Died
1	Gray	M	A	Caught by dog	-	Battery	27 Nov. 82	20 Dec. 82	Died
38	Gray	F	J	Cloverleaf	x	Battery	20 Jan. 83	4 Feb. 83	Died
75	Gray	F	J	Cloverleaf	x	Battery	20 Jan. 83	1 March 83	Died
46	Gray	M	J	Cloverleaf	x	Battery	20 Jan. 83	21 May 83	Died