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

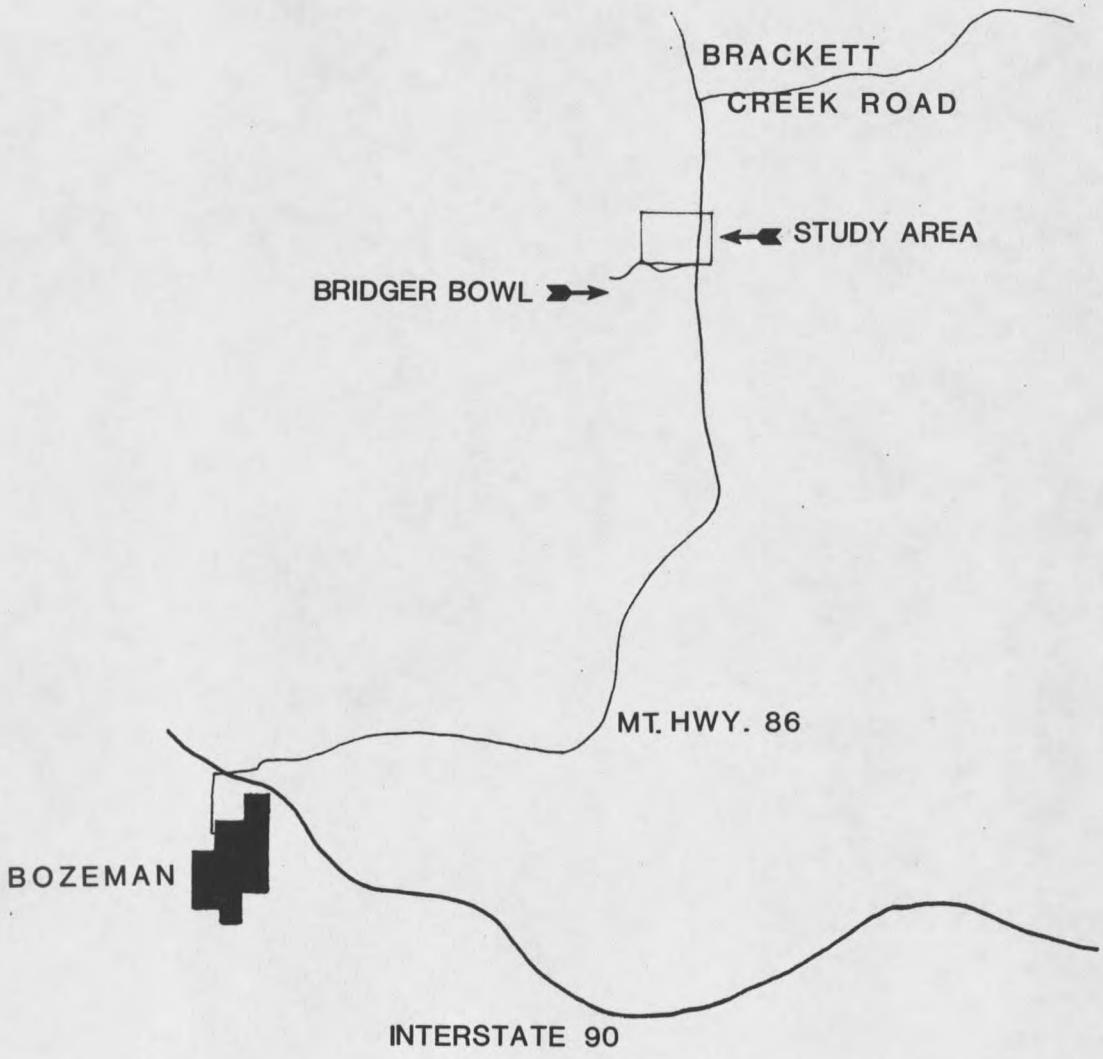


Figure 1. Location of the study area.

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

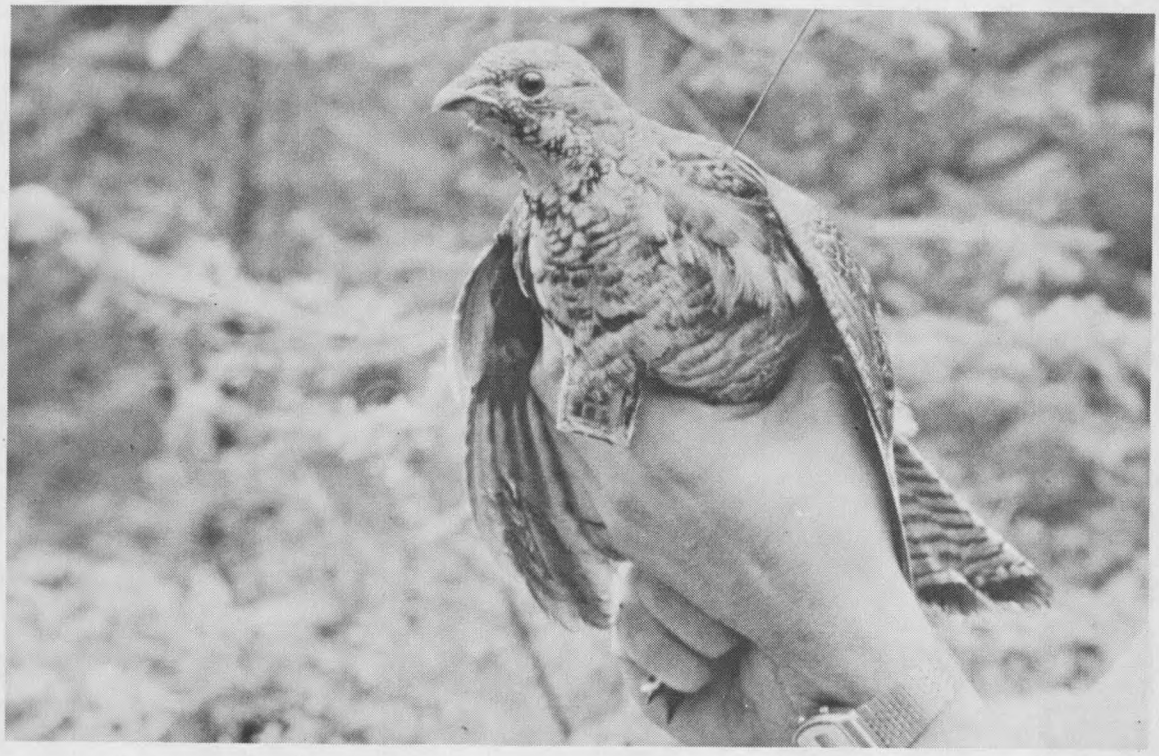


Figure 2. Solar powered transmitter fitted on a grouse.

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.

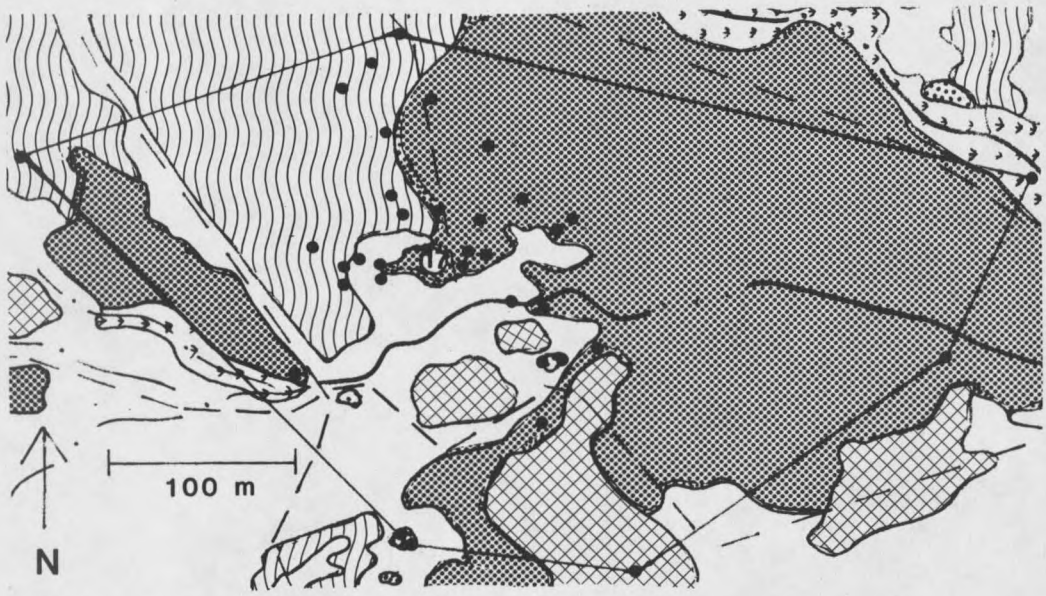
The major aspect (N-NE-E-SE-S-SW-W-NW) and slope, in degrees (if any), were recorded at all grouse sightings, and random vegetation sampling points, in all the broad habitat types. For both slope and aspect, random versus centered sightings were compared, for both seasons.

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.

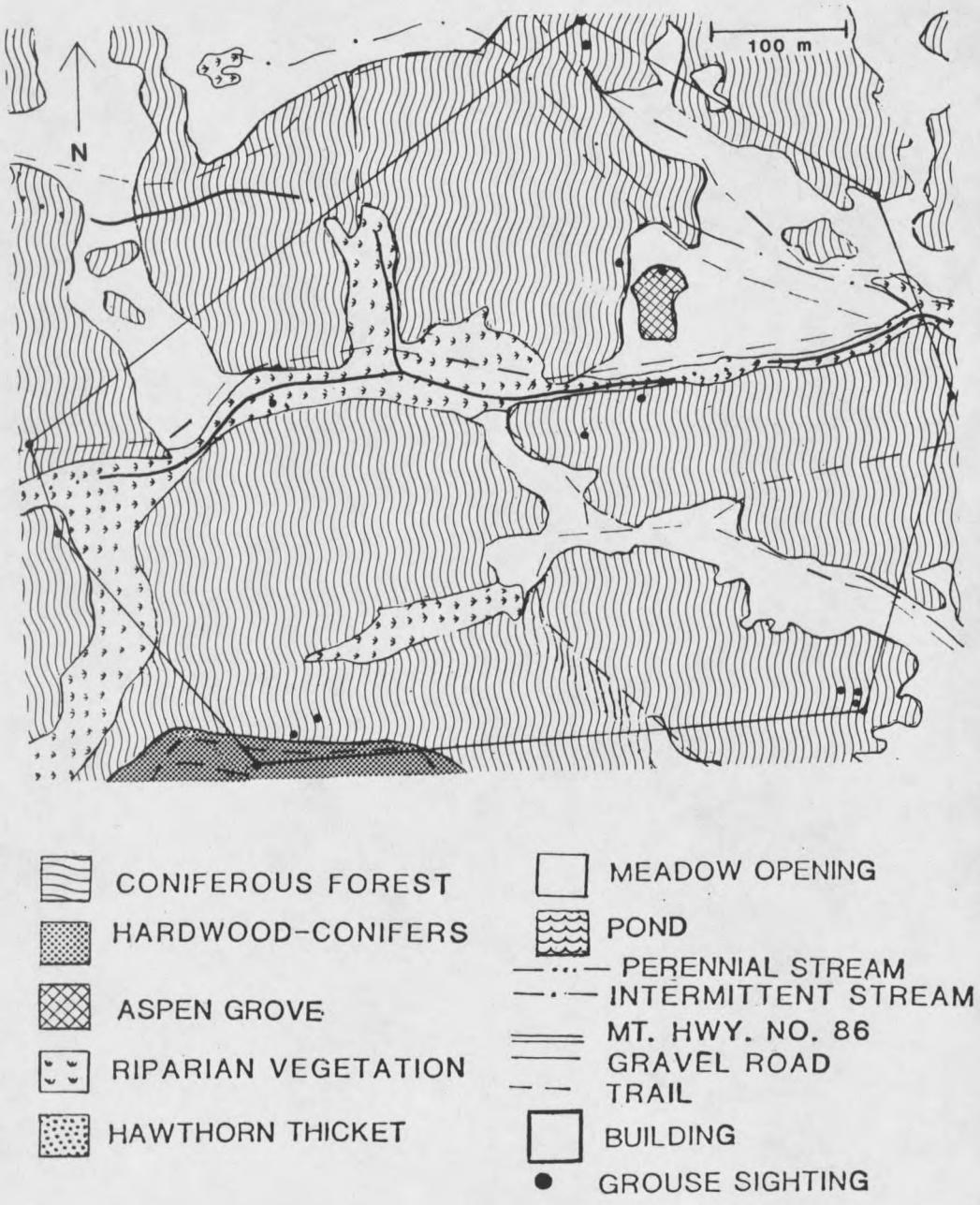
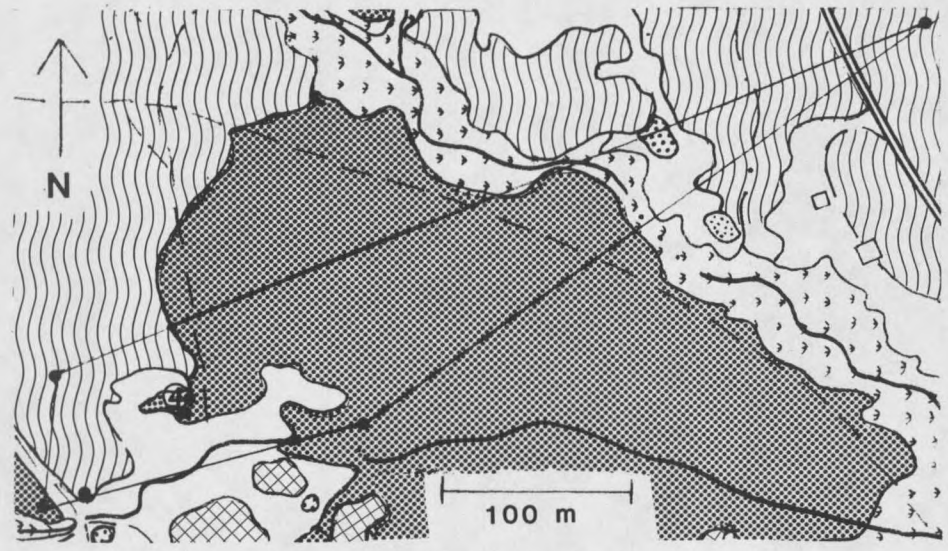


Figure 4. Summer home range of grouse no. 32, 25.61 ha.



CONIFEROUS FOREST
HARDWOOD-CONIFERS
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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.

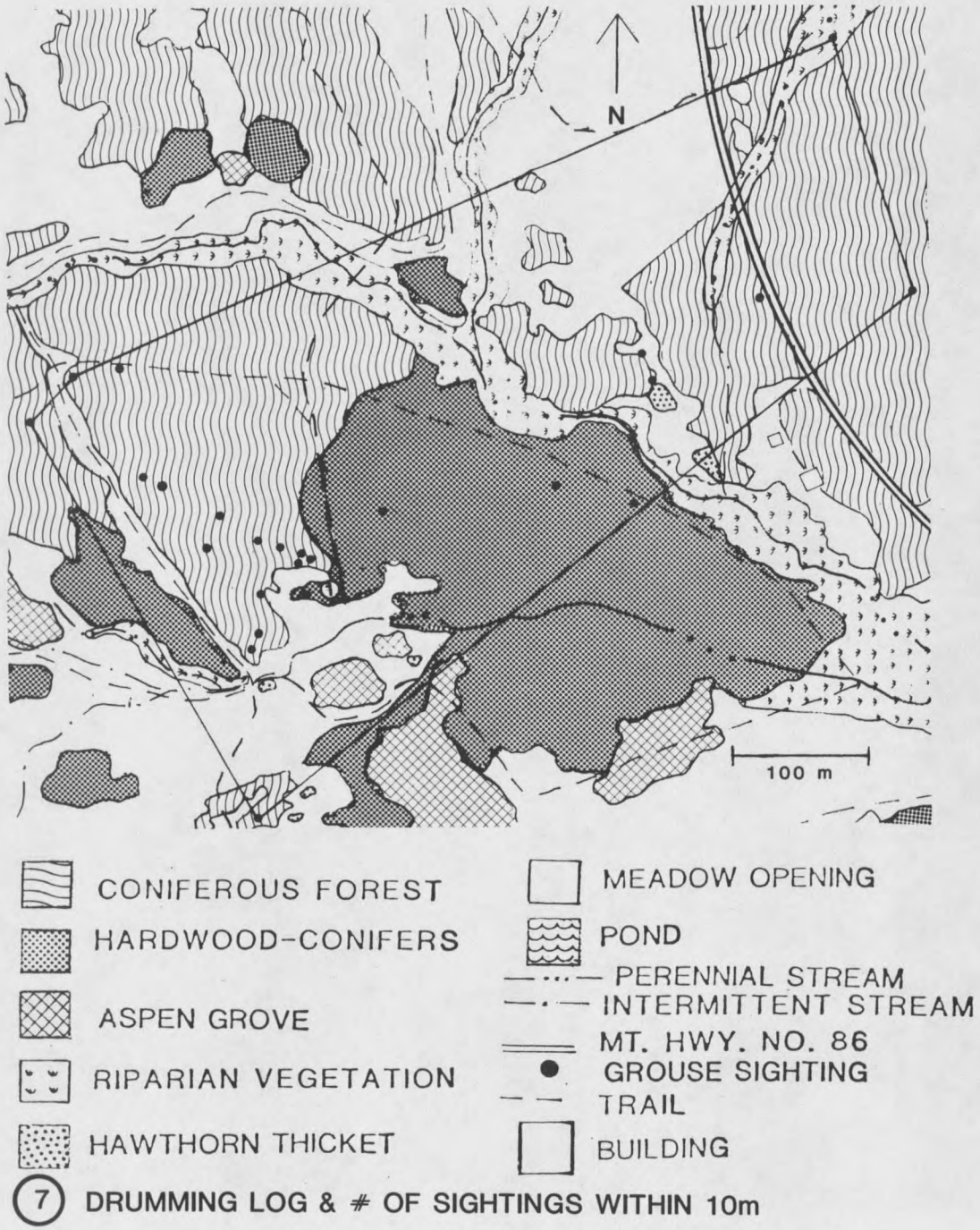

Figure 6. Winter home range of grouse no. 1, 16.86 ha.

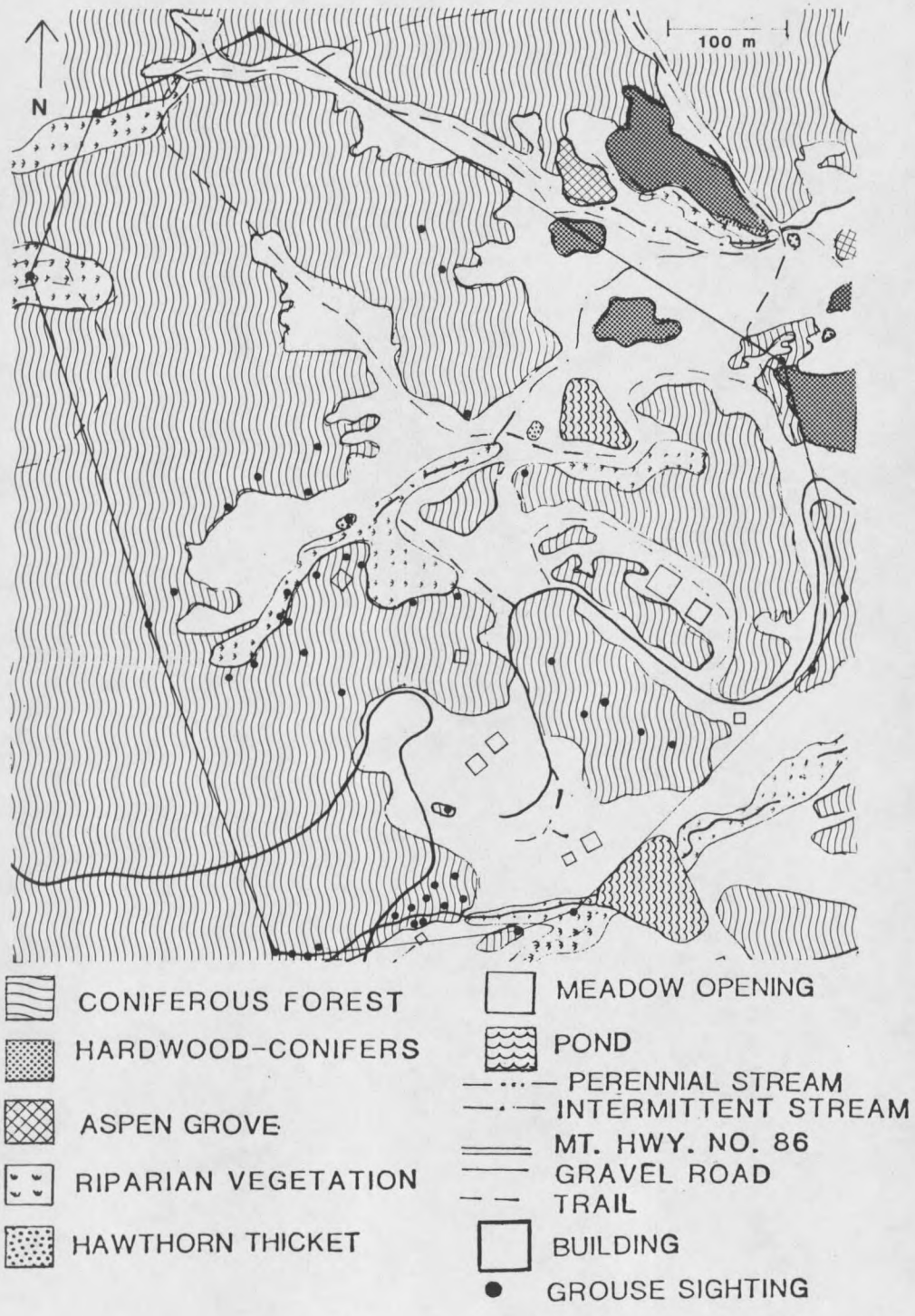

Figure 7. Winter home range of grouse no. 32, 33.76 ha.

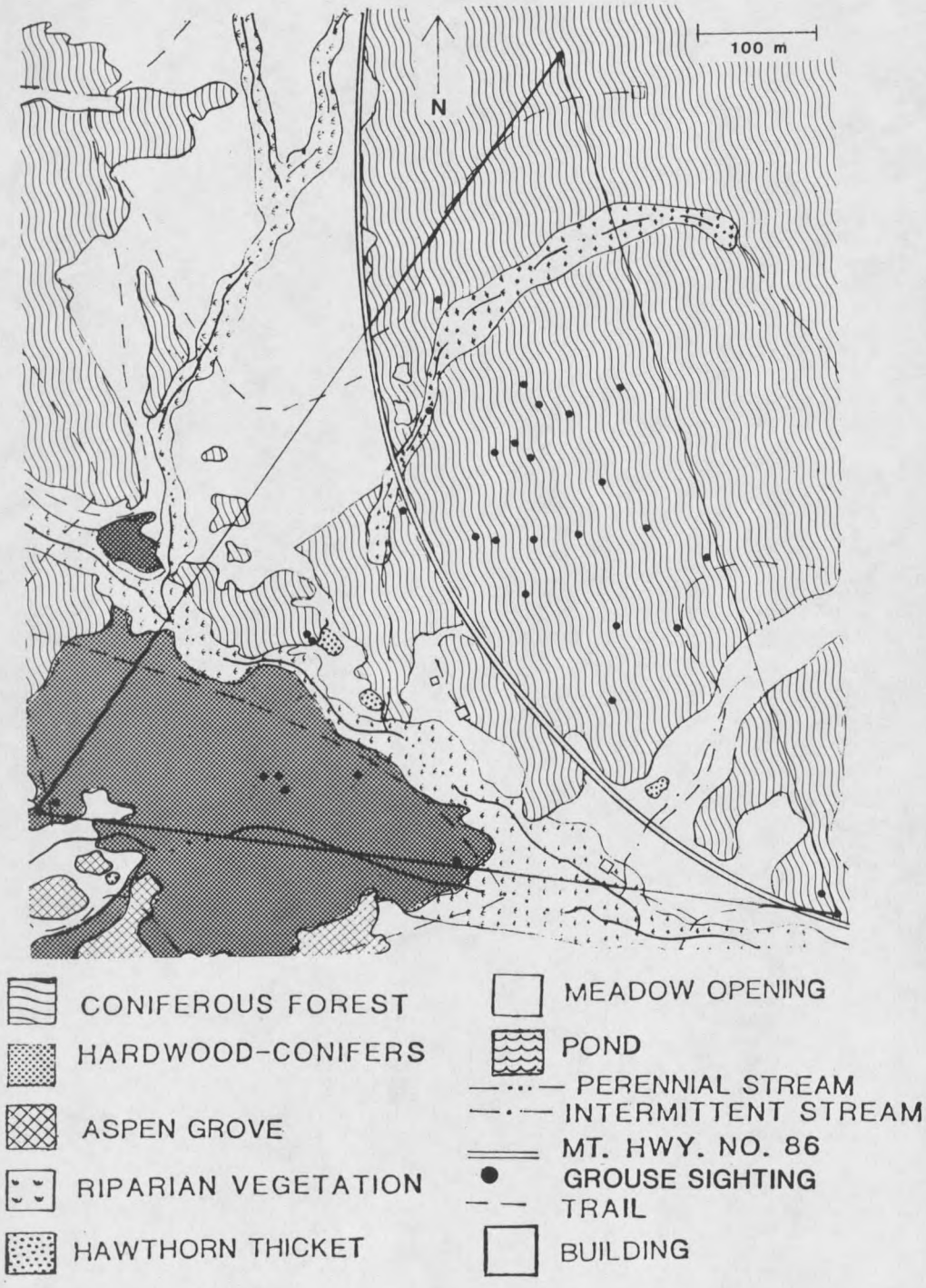

Figure 8. Winter home range of grouse no. 46, 22.69 ha.

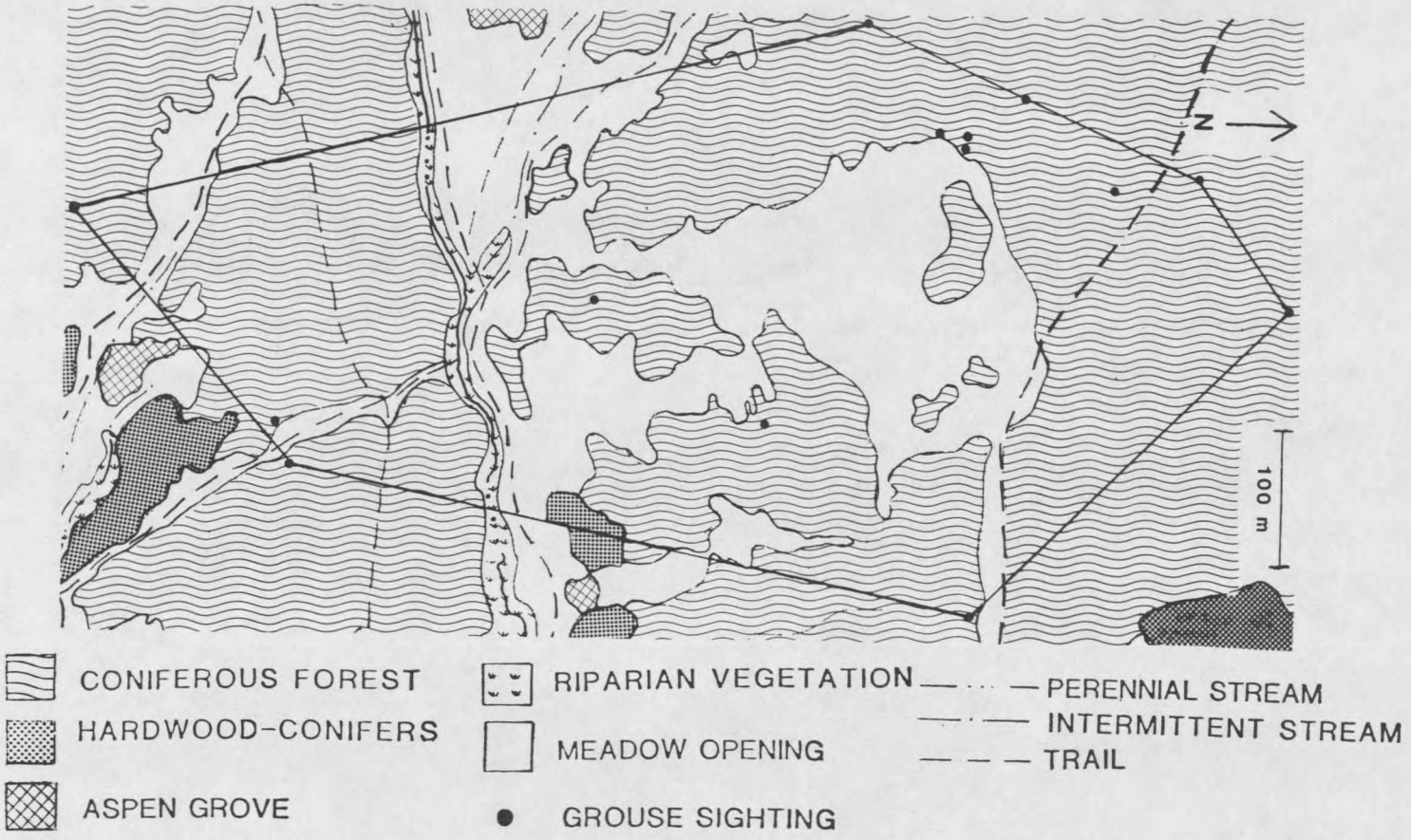

Figure 9. Winter home range of grouse no. 56, 21.50 ha.

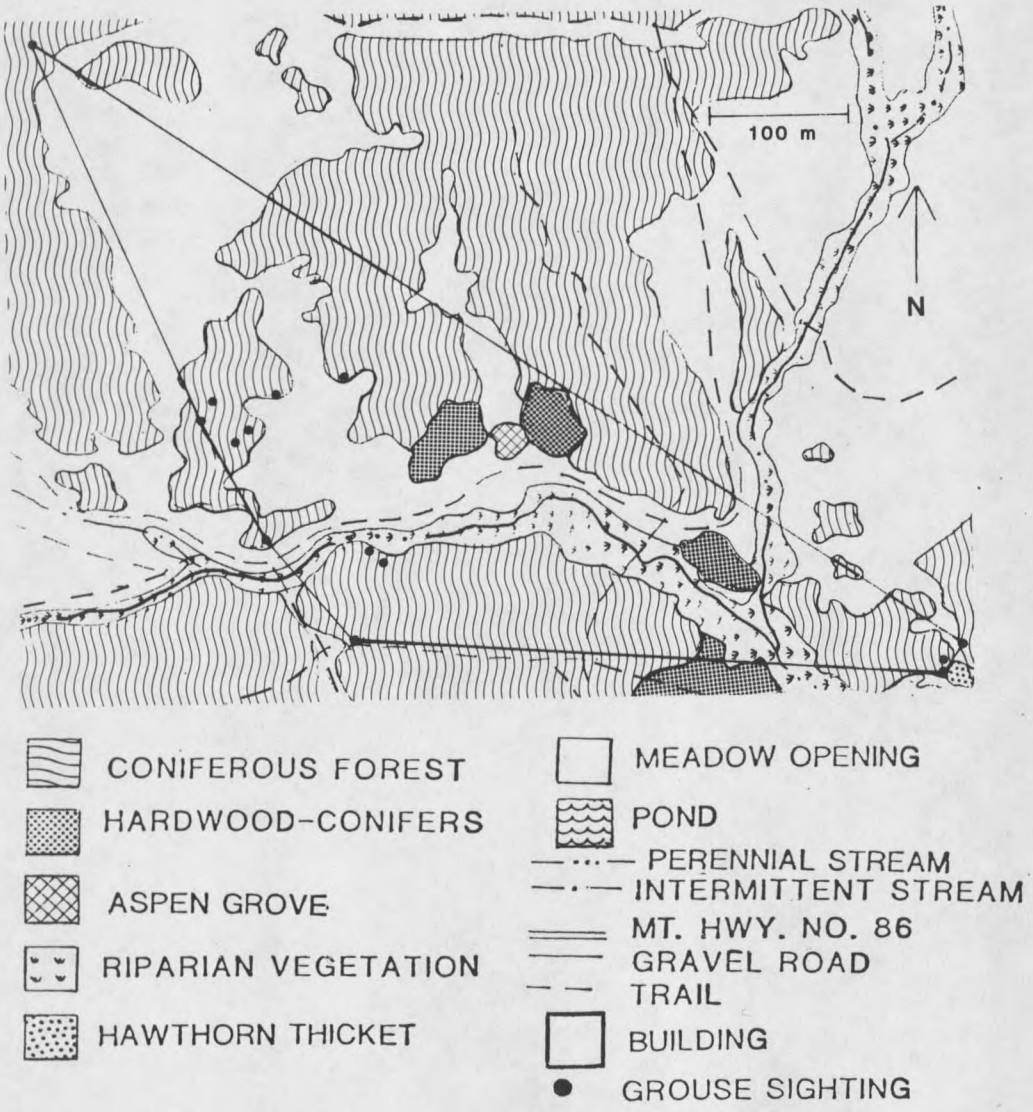

Figure 10. Winter home range of grouse no. 75, 9.77 ha.

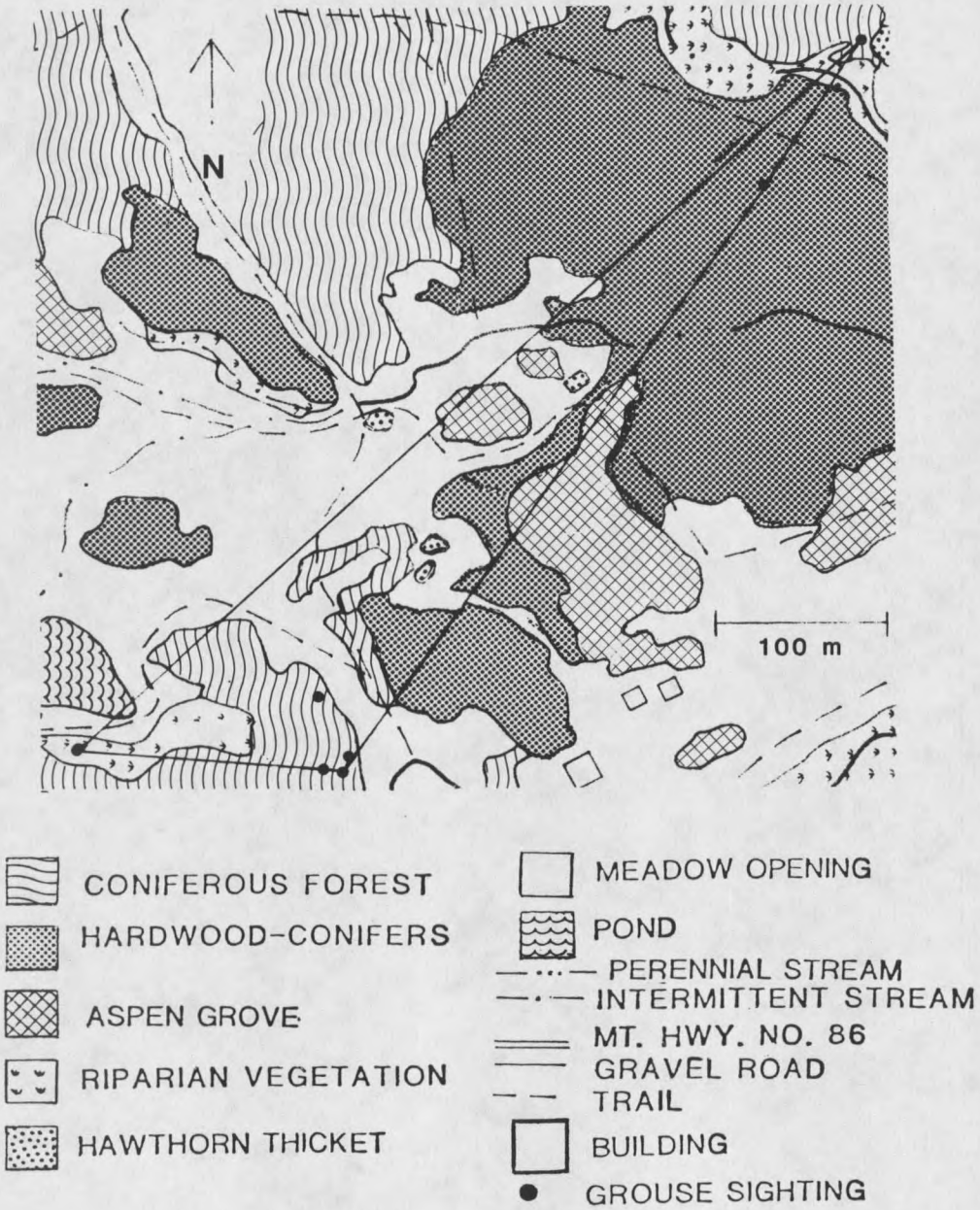

Figure 11. Winter home range of grouse no. 38, 3.13 ha.

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

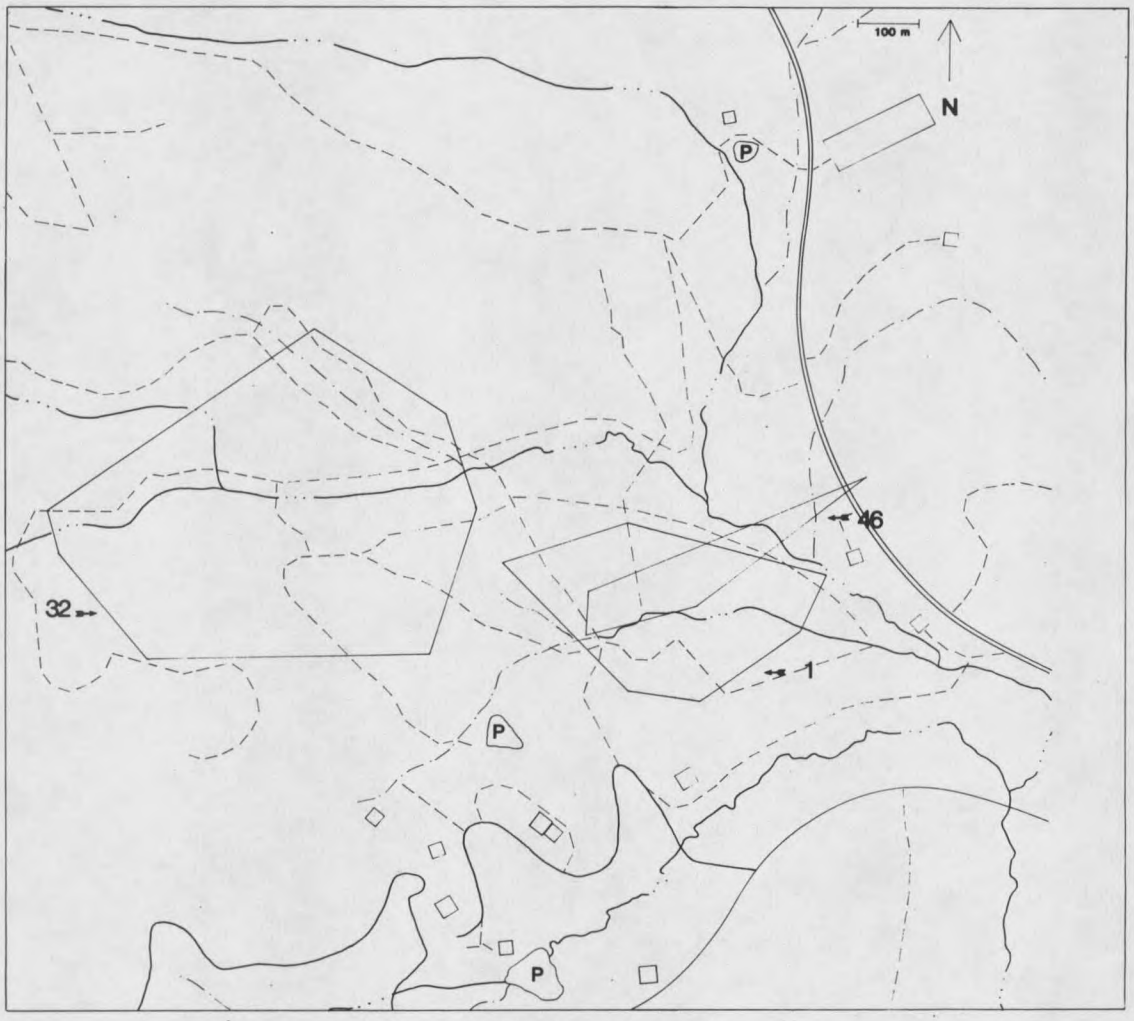

Figure 12. Summer home ranges of all radio-instrumented grouse. Grouse no. 1 and 32 (1982) and grouse no. 46 (1983).

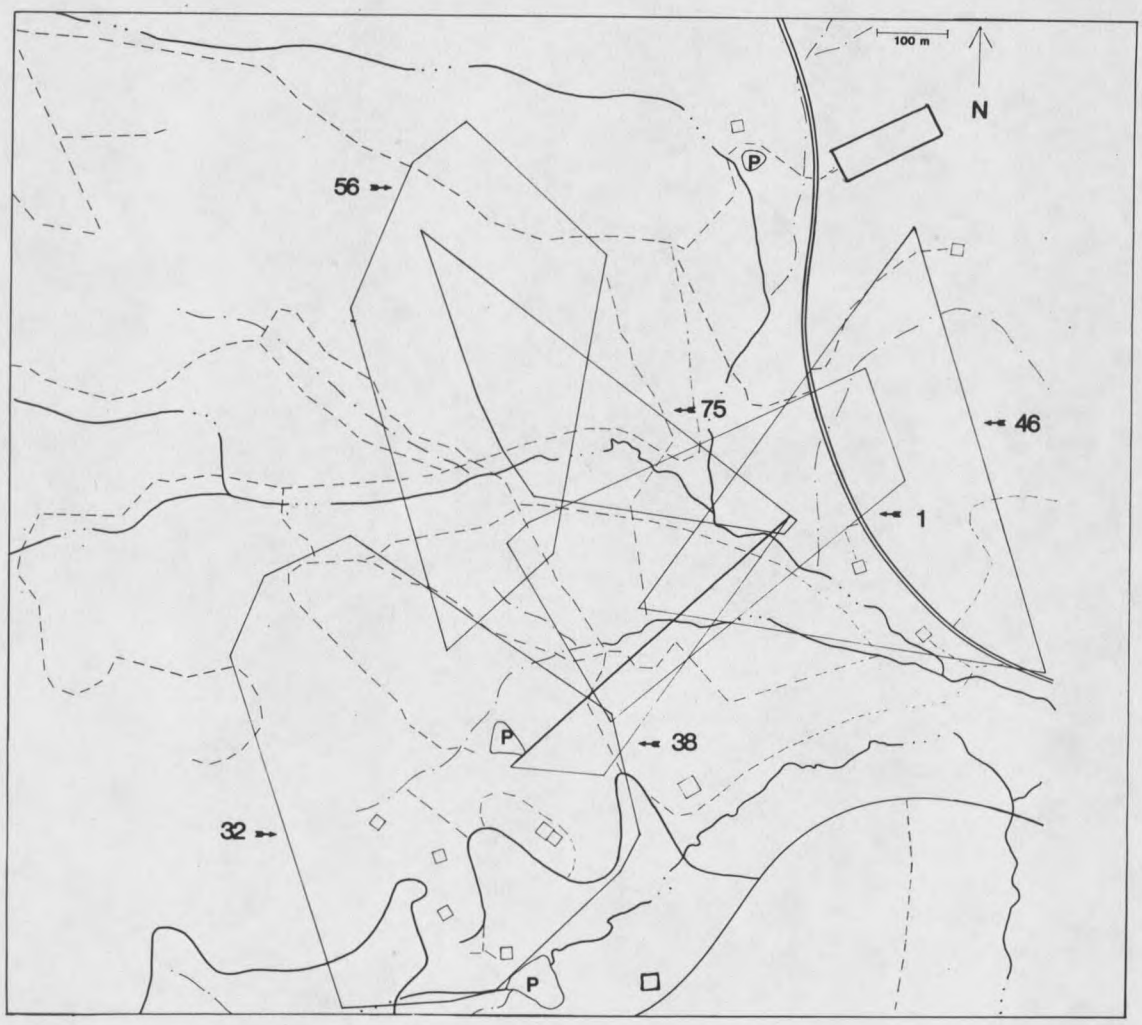

Figure 13. Winter home ranges of all radio-instrumented grouse.

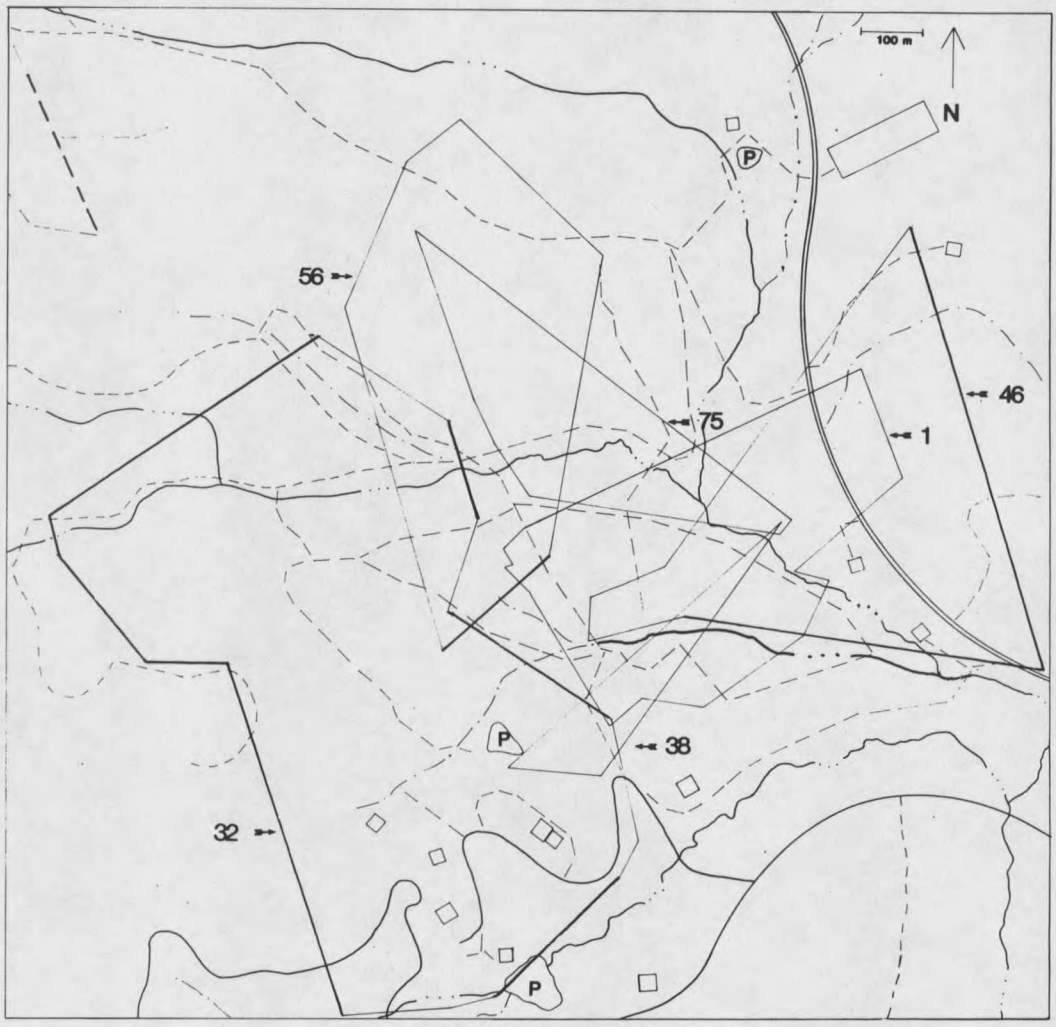

Figure 14. Total home ranges of all radio-instrumented grouse.

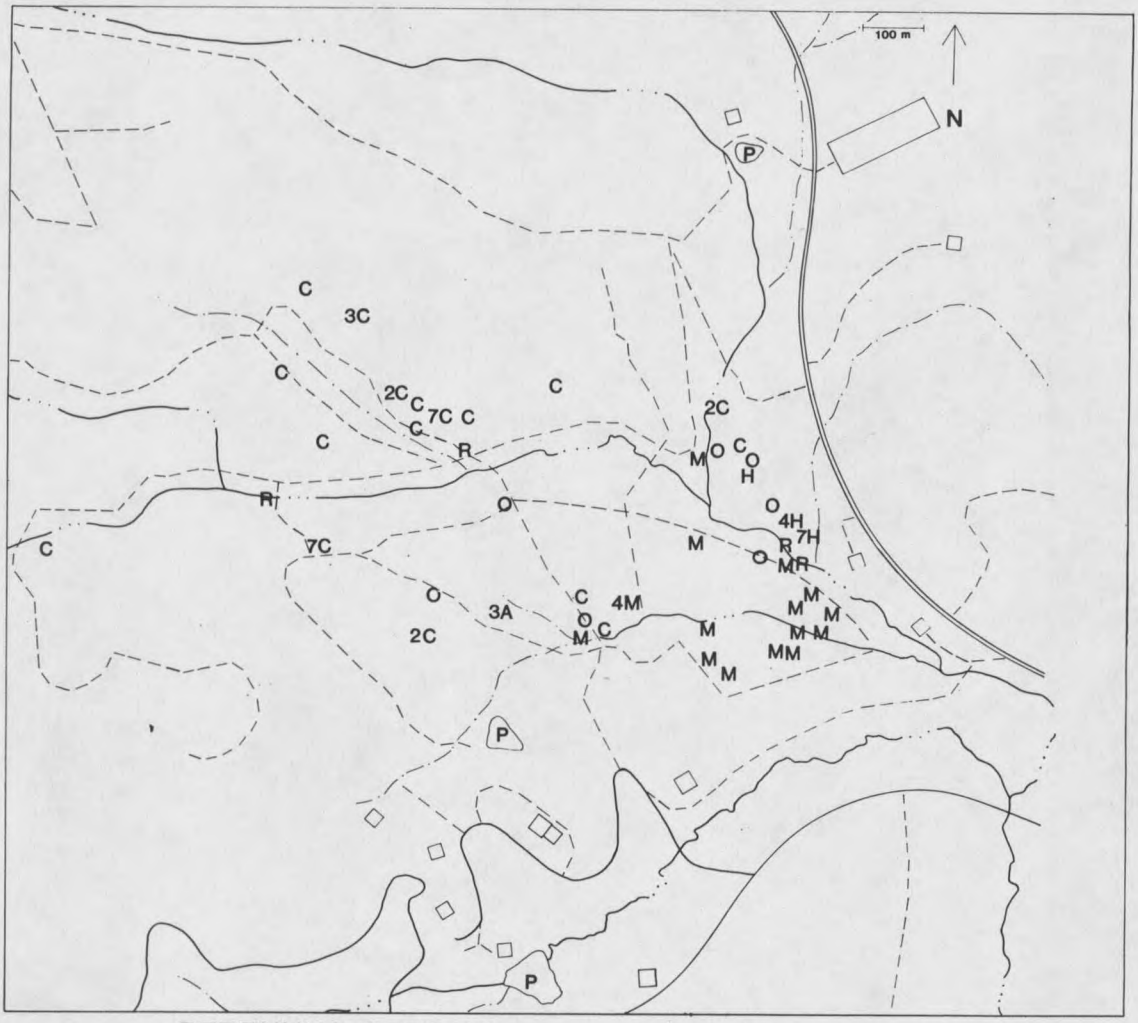

Figure 15. Unmarked ruffed grouse sightings during summer and habitat type at sighting location.

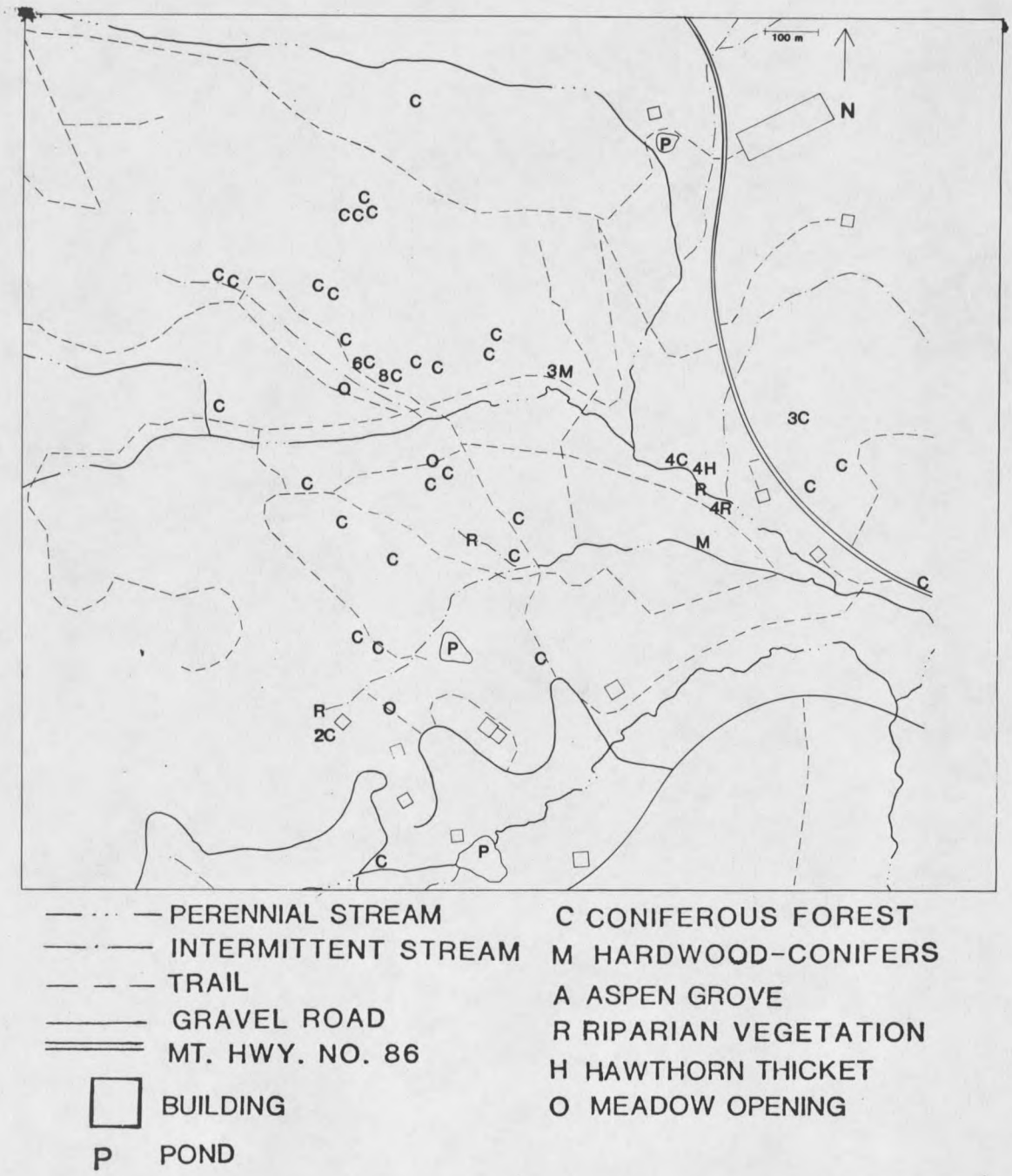

Figure 16. Unmarked ruffed grouse sightings during winter and habitat type at sighting location.

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.

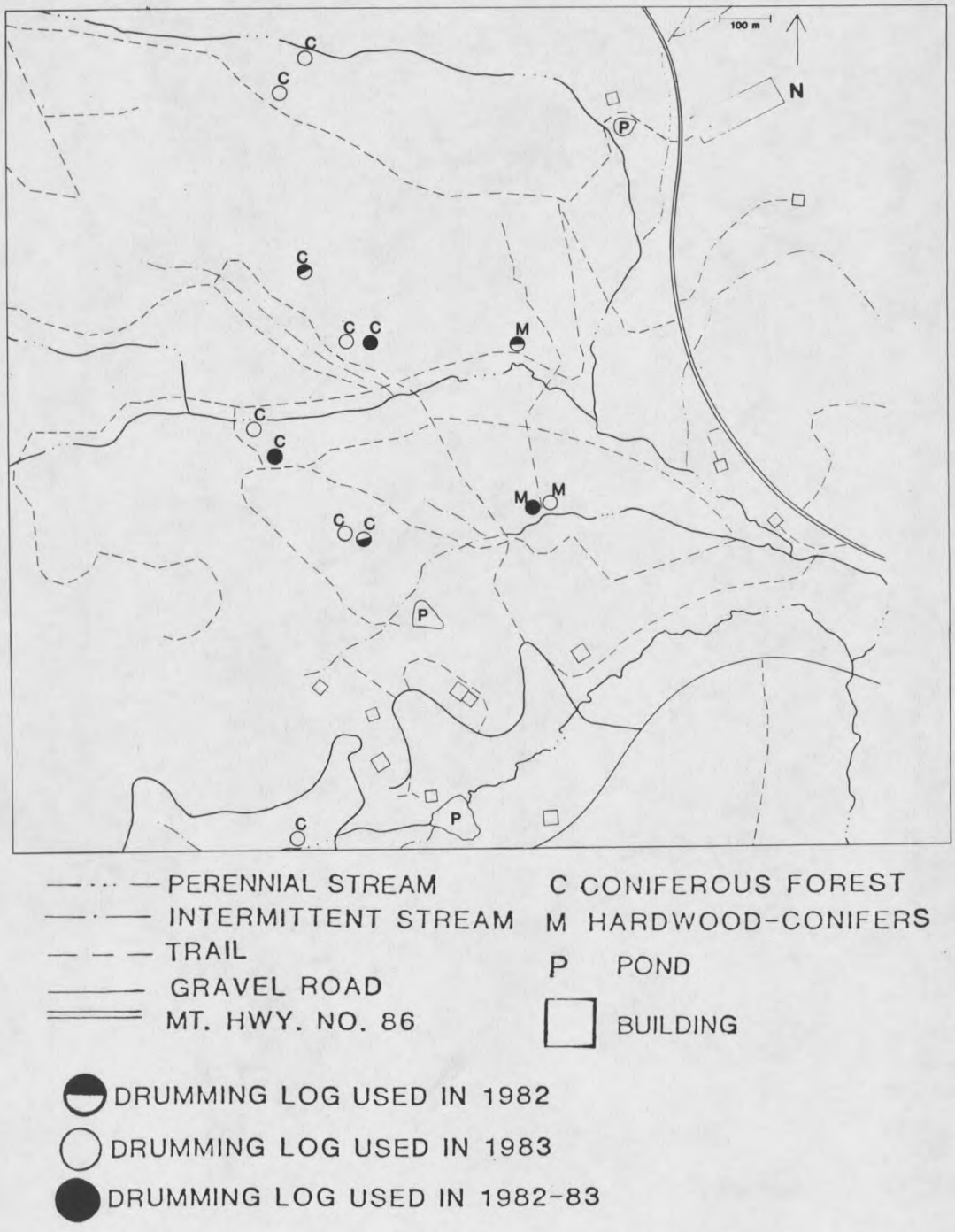

Figure 17. Habitat types and data of occupation of drumming logs.

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