MONTANA STATE UNIVERSITY

Structural characteristics and ecological relationships of male blue grouse (Dendragapus obscurus [Say]) territories in southwestern Montana

by Robert Rehm Martinka

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Fish and Wildlife Management

Montana State University

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Abstract:
Structural characteristics of male blue grouse (Dendragccpus obsGurus) territories and their relationship to land-use practices and forest succession were .studied from 1967-1969 on a 700-acre area of the Sapphire Mountains in southwestern Montana. A description of the physiography and vegetation was given. The area has been selectively logged periodically since 1948. During 130 observation trips, . 1,010 sightings of males on 40 territories were made. About 60 percent of the males were leg-banded for individual identification.¦ Vegetative and physical characteristics were recorded for 27 territories where males were observed 14 or more times; Territory size averaged 1.99 acres. Thickets of-coniferous trees, which were the major vegetational component of territories, averaged .211 acres and provided about 675 feet of edge. . The density of thickets averaged about 1200 -trees per acre. Average thicket tree diameter was 4.9 inches. Most trees in thickets were from 10 to 60 years old Territory thickets composed mostly of Douglas-fir were generally of greater density and smaller total area than those composed mostly of ponderosa pine. The longevity of thickets used by males was apparently about 40 to 50 years. Territories that- were occupied intermittently during an eight-year known history averaged 2.33 acres while those occupied continuously averaged 1.79 acres. Discriminant function analysis indicated that territories could be distinguished from unused areas with a high degree of success (96 percent) when ten variables were used. As the. number of variables was reduced, the quality of the results decreased. Selective logging may be beneficial because it opens up the canopy which allows the regeneration of trees in the form of scattered thickets. Clear-cut- logging might also be beneficial if used on small blocks of timber (10 to 60 acres). - Silvicultural practices such as mistletoe control, terracing on clear-cut areas, and thinning were discouraged in multiple-use management where blue grouse breeding habitat is paramount. Breeding habitat was associated with a ponderosa pine fire successional stage in the Douglas-fir vegetational zone, or with immature climax stages in both the ponderosa pine and Douglas-fir vegetational zones. With the curtailment of uncontrolled fires, logging is probably necessary if blue grouse breeding habitat is to be maintained or created. Male territories tended to be evenly spaced which was possibly initially a result of habitat requirements and/or selection and secondarily of territorial behavior. Longevity of males did not seem to be related to habitat type.

STRUCTURAL CHARACTERISTICS AND ECOLOGICAL RELATIONSHIPS OF MALE BLUE GROUSE (*DENDRAGAPUS OBSCURUS* [SAY]) TERRITORIES IN SOUTHWESTERN MONTANA

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES
(continued)

ABSTRACT

Structural characteristics of male blue grouse *(Dendragapus obscurus)* territories and their relationship to land-use practices and forest succession were studied from 1967-1969 on a 700-acre area of the Sapphire Mountains in southwestern Montana. A description of the physiography and vegetation was given. The area has been selectively logged periodically since 1948. During 130 observation trips, 1,010 sightings of males on 40 territories were made. About 60 percent of the males were leg-banded for individual identification. Vegetative and physical characteristics were recorded for 27 territories where males were observed 14 or more times. Territory size averaged 1.99 acres. Thickets of coniferous trees, which were the major vegetational component of territories, averaged .211 acres and provided about 675 feet of edge. The density of thickets averaged about 1200 trees per acre. Average thicket tree diameter was 4.9 inches. Most trees in thickets were from 10 to 60 years old. Territory thickets composed mostly of Douglas-fir were generally of greater density and smaller total area than those composed mostly of ponderosa pine. The longevity of thickets used by males was apparently about 40 to 50 years. Territories that were occupied intermittantly during an eight-year known history averaged 2.33 acres while those occupied continuously averaged 1.79 acres. Discriminant function analysis indicated that territories could be distinguished from unused areas with a high degree of success (96 percent) when ten variables were used. As the number of variables was reduced, the quality of the results decreased. Selective logging may be beneficial because it opens up the canopy which allows the regeneration of trees in the form of scattered thickets. Clear-cut logging might also be beneficial if used on small blocks of timber (10 to 60 acres). Silvicultural practices such as mistletoe control, terracing on clear-cut areas, and thinning were discouraged in multiple-use management where blue grouse breeding habitat is paramount. Breeding habitat was associated with a ponderosa pine fire successional stage in the Douglas-fir vegetational zone, or with immature climax stages in both the ponderosa pine and Douglas-fir vegetational zones. With the curtailment of uncontrolled fires, logging is probably necessary if blue grouse breeding habitat is to be maintained or created. Male territories tended to be evenly spaced which was possibly initially a result of habitat requirements and/or selection and secondarily of territorial behavior. Longevity of males did not seem to be related to habitat type.

INTRODUCTION

Most blue grouse *(Dendragapus obscurus)* populations exhibit a seasonal, altitudinal migration. After spending fall and winter in coniferous forests on the higher mountain ridges, the males migrate in late March and early April to relatively open forests in lower mountain areas where they establish and defend breeding territories. Females arrive shortly after the males and nest in the same general areas (Bendell and Elliott 1967).

Structural characteristics of the vegetation found at male blue grouse territories have been discussed by several authors; however, no one has described them in a quantitative manner. Bendell and Elliott (1966 and 1967) noted that the position of territories in dense cover may depend on the location of openings, and other authors (Blackford 1958 and Mussehl 1962) have described territories in open areas as being associated with thickets of coniferous vegetation. Forest succession, following fire or logging activities, undoubtedly acts as a control on the density and positioning of territories (Bendell and Elliott 1966; Mussehl 1962). Breeding blue grouse accept a variety of different forest types, from moist forests in the Pacific Northwest to relatively dry forests of the interior Rocky Mountain region.

Personnel of the Montana Fish and Game Department have been conducting blue grouse population and pesticide studies (Mussehl and Finley 1967) since 1962 on a small area of the Sapphire Mountains in southwestern Montana. This area was chosen for a quantitative study of the vegetational characteristics of male blue grouse territories because of the known history of approximately 40 different territories. Also, a large proportion of the territorial males had been leg-banded for individual identification. Objectives of the study were to determine the structural makeup of male breeding territories and to evaluate the effects of forest succession in relation to silvicultural practices on blue grouse breeding habitat in ponderosa pine *(Pinus ponderosa)* and Douglas-fir *(Pseudotsuga menziesii)* vegetation zones.

Full time field studies were conducted from late July to late August, 1967, from mid-April to mid-September, 1968, and from early April to early September, 1969. Approximately 130 trips to the study area were made for the purpose of locating male grouse, and about 200 were made for the purpose of vegetation analysis.

DESCRIPTION OF THE STUDY AREA

The study area (Figure 1), located 10 miles southeast of Hamilton, Montana, contains about 700 acres of Bitterroot National Forest land near Skalkaho Creek. According to Perry (1962), this area is composed of granitic rock of the late Cretaceous to early Tertiary periods. Elevations range from approximately 4550 to 5750 feet mean sea level.

Steep, open, south-facing slopes intermingled with heavily wooded draws characterize the area (Figure 2). Numerous logging roads traverse the hillsides providing excellent accessibility. Logging was begun in 1947 and has continued until the present.

Climatological data for Hamilton (elevation 3529 feet) show a mean annual temperature of 46.1 F. January is the coldest month and July is the warmest with average temperatures of 24.1 F and 67.9 F, respectively. Average annual precipitation is 12.74 inches. The only months with average precipitation exceeding 1.20 inches are May and June which average 1.67 and 2.04 inches, respectively. Because precipitation generally increases with elevation in this region, the study area undoubtedly receives more moisture than Hamilton. On April 1, 1969, portions of the study area had 18 inches of snow remaining on the ground while Hamilton had none.

In addition to the influence of logging operations on the area, heavy summer grazing pressure was exerted by domestic livestock,

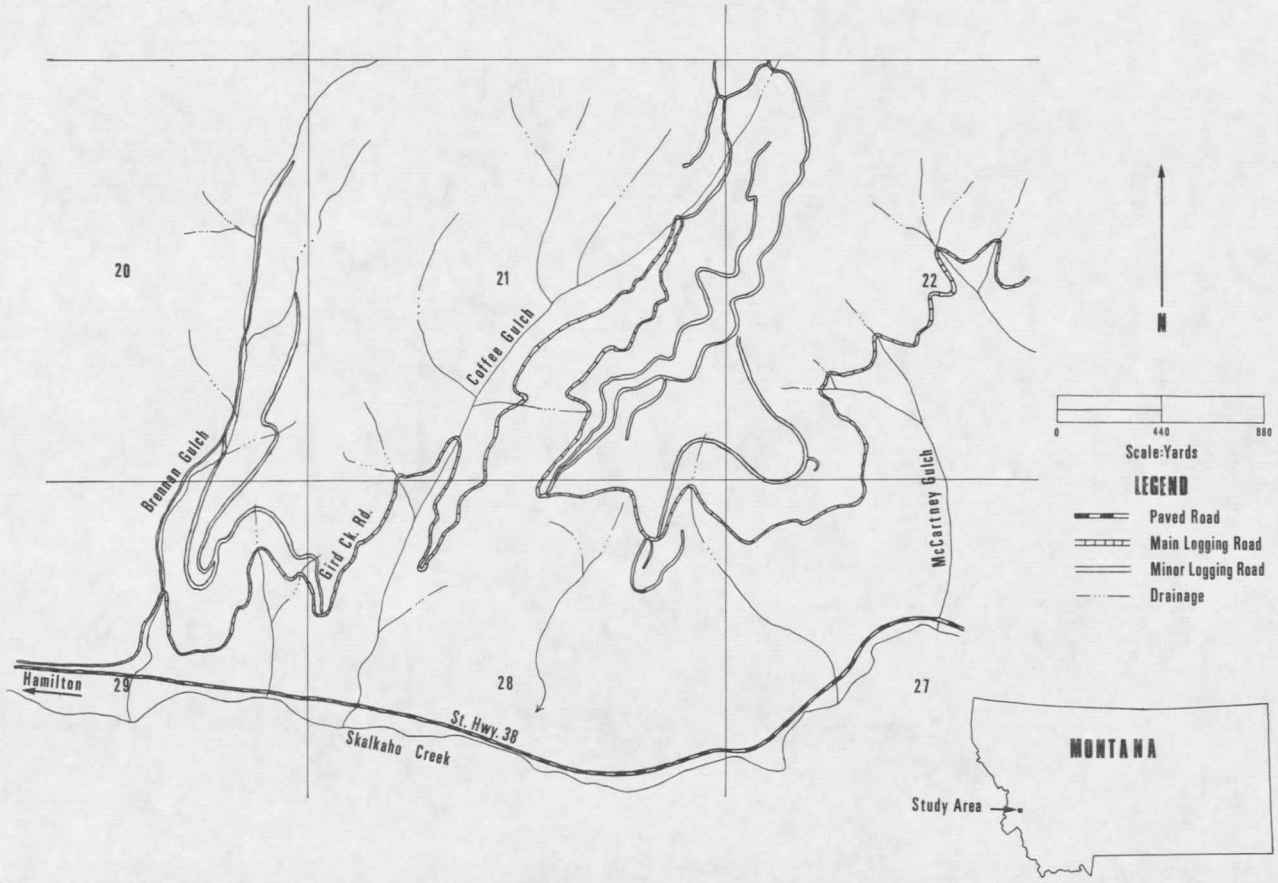

Figure 1. Map of the study area showing network of logging roads.

Figure 2. A view of the open slopes with heavily wooded draws.

particularly on creek bottoms and other moist sites. Mule deer *(Odocoileus hemionus)* and elk *(Cervus canadensis)* use the open, south-facing slopes as winter range.

The study area included portions of both the ponderosa pine and Douglas-fir zones as described by Daubenmire (1953). Semi-open stands of ponderosa pine dominated the lower elevations while stands of pine with Douglas-fir interspersed were found at higher elevations. The heavily wooded draws consisted mostly of Douglas-fir. The pine has been selectively cut on much of the area and is apparently being replaced by Douglas-fir at the higher elevations. Average crown cover of the study area as determined from aerial photographs was about 30 percent.

The unforested portions of the area consisted of three different vegetation types. Two herbaceous types were dominant while a shrubby type was of minor importance. Canopy coverage and frequency of occurrence of the principal plant species present in the two herbaceous types are presented in Table 1.

The dryer portions of the area supported a bunchgrass vegetation type in which bluebunch wheatgrass *(Agropyron spicatum)*, Junegrass *(Koeleria cristata)*, and Idaho fescue *(Festuca idahoensis)* were the major grasses and arrowleaf balsamroot *(Balsamorhiza sagittata)*, silky lupine *(Lupinus sericeus)*, yarrow *(Achillea millefolium)*, and field chickweed *(Cerastium arvense)* were the major forbs.

TABLE 1. CANOPY COVERAGE AND FREQUENCY OF TAXA FOR THE TWO HERBACEOUS TYPES AS DETERMINED BY EXAMINATION OF TWENTY 2 X 5 DECIMETER PLOTS ON EACH OF 16 SITES.

Taxa[1]	Vegetation Type			
	Bunchgrass (10 sites)		Pinegrass (6 sites)	
	Coverage	Frequency	Coverage	Frequency
GRASS AND GRASS-LIKE PLANTS	13	100	35	100
Agropyron spicatum	3.0	46	X[2]	X
Bromus tectorum	1.4	35	X	X
Calamagrostis purpurescens	X	X	1.6	19
Calamagrostis rubescens	X	X	25.0	92
Carex geyeri	X	X	5.0	50
Festuca idahoensis	2.6	31	0.8	16
Koeleria cristata	3.3	58	-	-
Poa spp.	1.4	52	3.9	33
FORBS	16	99	19	100
Achillea millefolium	1.7	53	1.4	49
Anaphalis margaritacea	-	-	0.3	12
Antennaria racemosa	-	-	0.9	10
Arenaria congesta	0.4	14	-	-
Arnica cordifolia	-	-	1.5	43
Balsamorhiza sagittata	8.0	48	X	X
Cerastium arvense	1.2	36	X	X
Erigeron spp.	0.6	12	-	-
Fragaria virginiana	X	X	5.6	55
Gayophytum nuttallii	0.7	27	X	X
Lupinus sericeus	2.4	25	8.2	51
Sedum stenopetalum	X	X	0.5	14
Silene noctiflora	-	-	0.8	15
Taraxicum officinale	X	X	0.5	10
Tragapogon dubius	0.4	15	X	X
Unidentified forbs	0.8	25	X	X
SHRUBS				
Symphoricarpus albus	0.7	10	-	-

1/ Includes taxa with at least 10 percent frequency of occurrence or one percent canopy coverage in at least one vegetation type.

2/ Indicates taxon present but less than 10 percent frequency of occurrence or one percent canopy coverage.

The more moist portions of the area supported a pinegrass *(Calamagrostis rubescens)* vegetation type in which scattered pine and Douglas-fir were usually present. Pinegrass, elk sedge *(Carex geyeri)*, and blue grass *(Poa* spp.*)* were the major grasses and grass-like species, and silky lupine, Virginia strawberry *(Fragaria virginiana)*, yarrow, and heart-leafed arnica *(Arnica cordifolia)* were the major forbs.

A shrub vegetation type occurred on some of the more moist sites and in creek bottoms. The major shrub species present were common snowberry *(Symphoricarpus albus)*, ninebark *(Physocarpus malvaceous)*, mockorange *(Philadelphis lewisii)*, chokecherry *(Prunus virginiana)*, white spiraea *(Spiraea betulifolia)*, and red dogwood *(Cornus stolonifera)*.

A comprehensive listing of the plants occurring on the study area is presented in Table 2 in the appendix. Plant nomenclature is according to Booth (1950) and Booth and Wright (1966).

METHODS

Each year field work was divided into two major phases. From April through mid-June, a concerted effort was made to locate territorial males and plot their locations on aerial photographs. Mid-June to September was devoted to vegetation measurements. The severe decline in male breeding activity by mid-June created a natural division for the two phases.

Observational Procedures

A 4-wheel drive vehicle was used to travel an 8.8 mile route through the study area while conducting morning and evening observations. Morning observations were of three to four hours duration beginning about one-half hour before sunrise. Evening observations were begun about three hours before sunset and continued until visibility was impaired. These periods coincided with times of greatest breeding activity (Blackford 1963; Wing 1946; and Bendell 1954). During the seasonal breeding peak, the large number of observations prevented covering the entire area during a single morning or evening activity period. Some observations were made on foot. Observations from vehicles were probably more indicative of normal behavior because many males were more disturbed by persons on foot than they were of vehicles.

An attempt was made to capture and band all territorial males. They were captured with a plastic-covered wire noose attached to the end of a 24-foot telescoping fiberglass pole (Zwickel and Bendell 1967). Birds were marked for individual field identification with a combination of numbered, plastic and aluminum bands of various colors (Figure 3). Different color combinations were used each year.

When a banded territorial male was sighted, a 15x-60x spotting scope or a 7X50 binocular aided in checking the band number and/or color. If the bird was wary or too far away, a recorded female call (Stirling and Bendell 1966) was used to coax it closer. The call was also useful in locating males that were not readily observable. At least some gave multiple hoots in response or came out in the open.

Each male observation was plotted on colored aerial photographs taken during a low level flight in 1967. Territorial boundaries were then delimited from the plotted observation points.

The projected size of a territory varies with the number of observations until a point is reached where more observations will not add greatly to the size (Odum and Kuenzler, 1955). In order to determine this approximate point, the number of observations of each male was plotted against the size of its territory. Once this point was determined, emphasis could be placed on locating males which had been observed less than the desired number of times.

Figure 3. Leg band combination on a blue grouse for individual identification.

Territory Structure Analysis

Overall territory size was determined from aerial photos by measuring all the area included in boundaries formed by connecting the outermost observation points. To reduce the error in acreage determination caused by radial distortion in the photos, territorial boundaries were transferred to a sheet of paper using a method described by Meyer, et al. (1970). Area was then determined by using a dot grid. Most other measurements were made in the field with emphasis placed upon coniferous thickets in the territories. A thicket was defined as an area having a density of 300 or more trees per acre.

Among the variables measured were the number and total size of thicket(s) in use, tree species composition of thickets, average age of oldest trees, and the amount of edge formed by the perimeter of thickets and open areas. Tree age was determined with the use of an increment borer, and other quantitative measurements were made with the use of a 100-foot steel tape. Crown cover of each of the territories was determined from aerial photographs using a dot grid.

All trees in the thickets were measured with a diameter tape and placed in diameter categories of 1-3, 4-8, and greater than 8 inches. From these data, the number of trees per acre in each diameter category was determined. Where thickets were too large for all trees to be measured, ten randomly placed one-hundreth acre plots were used. Also measured was the height to the lowest live branches under 10 feet high.

The percent slope was measured with an Abney level, exposure was determined with a compass, and the average altitude with an altimeter. Other characteristics that were recorded were the amount of shrub cover, and the distance from the center of one territory to the center of the nearest neighbor territory. The activity center rather than the geometric center was used in determining this distance.

A vegetation density profile of each territory was determined using a technique modified from that proposed by Wight (1938). By this method, a board 6 feet in length with each foot marked off and numbered from one to six was used. The board was placed upright in the approximate center of the territory, and an observer standing 50 feet from it estimated and recorded the amount of cover obstruction at each one foot interval (Figure 4). Estimations of obstruction were made in categories of 0-5, 5-25, 25-50, 50-75, 75-95, and 95-100 percent. An average percent obstruction for each one foot interval was obtained by adding the midpoints of all obstruction estimates for that interval and dividing by the number of observations. Eight readings were made in each territory, one at each of eight major compass directions.

To permit a statistical analysis of the vegetational characteristics, a series of measurements similar to those described above were made on an equal number of areas designated as "non-territories". They were selected at random from portions of the study area that had coniferous vegetation present but no history of use by territorial male

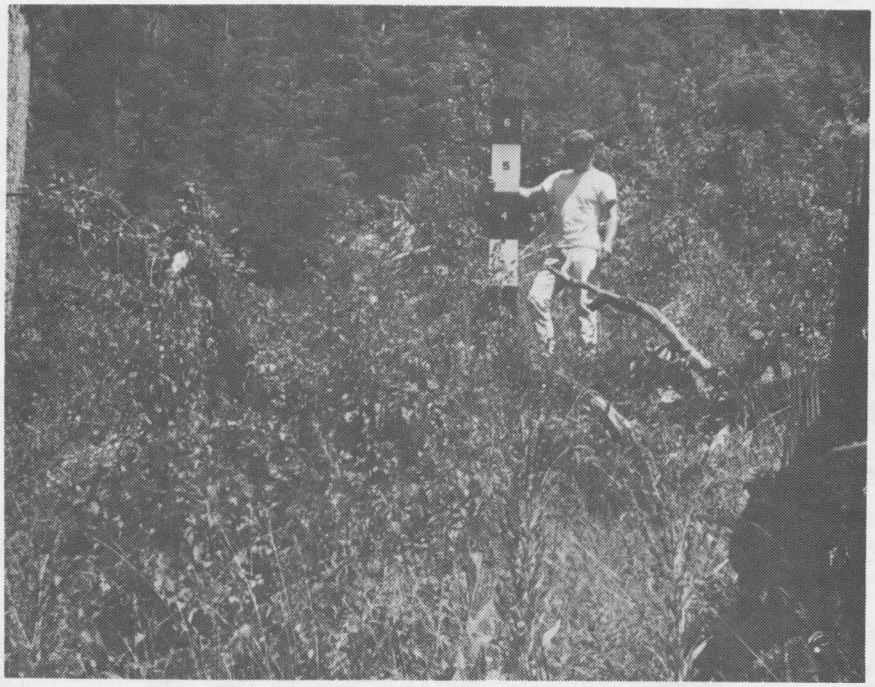

Figure 4. Vegetation density board used to determine shrubby vegetation density profile.

blue grouse.

Discriminant function analysis (Snedecor and Cochran 1967) was used to determine if measurable differences existed between areas selected by male grouse for territories and areas not used by males. The variables which showed no significance in the analysis were eliminated and the remaining judged the most significant territorial characteristics.

In this method, all of the vegetation measurement data are used to formulate an equation, the discriminant function. The data from each territory and non-territory are then inserted into this equation separately. The magnitude of the resulting figure indicates whether the variables and interaction between variables for the particular area are more closely related to those determined overall for the territories, or those determined overall for the non-territories. Thus the area, whether it is actually a territory or a non-territory, is classified as one or the other through the use of the discriminant function. The probability that the area was classified correctly was also determined.

Overall Vegetational Analysis

Vegetational measurements in the open areas were made with a modification of the method described by Daubenmire (1959). Canopy coverage and frequency of occurrence of grasses, forbs, and shrubs were determined with the use of twenty 2 X 5 decimeter plots placed at

10 foot intervals along each of 16 paced transects through representative sites. The percent canopy coverage of each species, and percentages of bare ground and rock were recorded for each plot. Percentage classes were the same as those used in the vegetation density profile readings and the midpoint of each class was the value used in data tabulations.

RESULTS

Territory Occupancy

Observations of banded male blue grouse indicate that some may be present on territories as early as the last week in March. Others may not be situated on a territory until the second or third week in April even though they have been present in the general area since the beginning of that month. Initiation of breeding behavior occurred during the first week in April.

Forty-three territories have been occupied on the study area at one time or another since 1962 as indicated by the present and previous studies (Schladweiler and Mussehl 1968). In the springs of 1968 and 1969, 39 and 40, respectively, of these territories were occupied. At least two territorial males were killed by predators in 1968 and four in 1969. In a minimum of three of these cases, other males took up occupancy after variable periods of time.

A total of 1,010 sightings of individual adult male blue grouse was made. The number of sightings per male over the two-year period ranged from 1 to 72. All sightings were plotted on aerial photographs. The number of plotted observations of a given male may be greater than the number of individual sightings due to extensive movement during a single sighting.

A comparison of the number of observations of a male and the size of its territory indicates that the territory size increased with the

number of observations until a male was observed about 14 times (Figure 5). Therefore, fourteen observations of an individual male were considered sufficient to indicate the approximate size and extent of a territory. Measurements of vegetational characteristics were limited to the 27 territories where males had been observed 14 or more times. The number of observations and minimum age of males on these territories is presented in Table 3.

In 1968, 58 percent of 36 and in 1969, 70 percent of 36 territorial males closely observed were banded. For the years 1968 and 1969, 81 and 68 percent, respectively, of the males having bands the previous year returned to their respective territories. Over the two-year period, the return rate averaged 74 percent. Two males banded in 1962 were still occupying the same territories in 1969. One disappeared later that spring. Ten adult and seven yearling males were banded during this study.

Results of the daily observational periods are presented in Table 4. There was an indicated difference between 1968 and 1969 in the peak of breeding activity, based on the number of adult male observations per hour (Figure 6). The data from 1969 compare more favorably with other studies than those from 1968. The number of female sightings per hour, which also may be indicative of the relative degree of breeding activity, generally supports the data on males pertaining to activity peaks. About 11 percent of the male observations were made on foot rather than

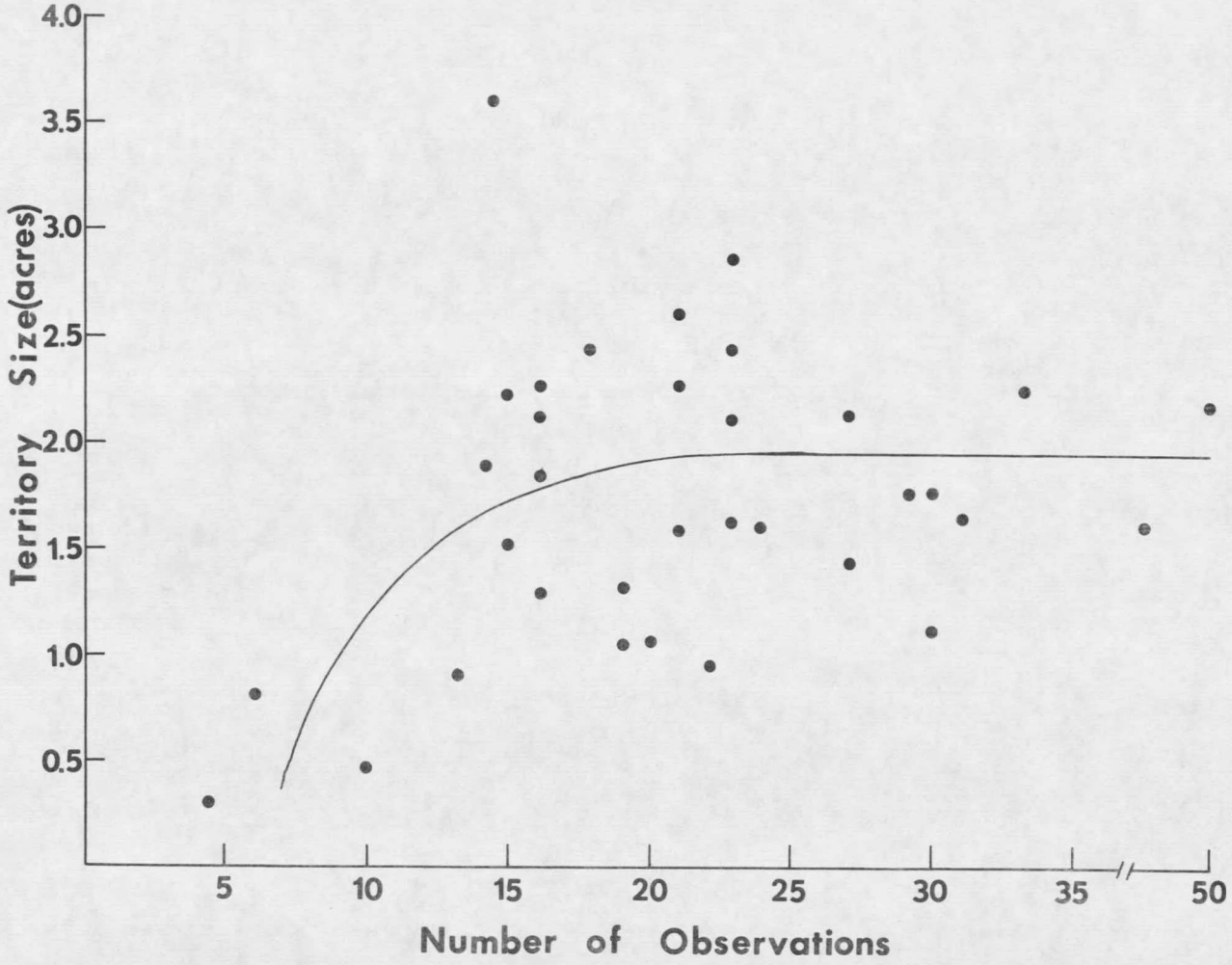

Figure 5. The relationship between the number of observations of males and territory size.

TABLE 3. THE NUMBER OF OBSERVATIONS AND MINIMUM AGE OF INDIVIDUAL MALES ON DIFFERENT TERRITORIES FOR 1968 and 1969.

Territory No.	Min. Age of Male (1969)	Number of Observations		
		1968	1969	Total
103A	5	22	43	65
104	5	5	23	28
105	4	9	30	39
42	unk.[1]	4	16(NB)[2]	20
32A	8	7	27	34
32B	unk.	4	16(NB)	20
30	3	3	14	17
30A	5	20	52	72
65	9	11	(21)[3]	32
73A	2	7	(21)	28
54	9	9	19	28
94	4	9	23	32
94A	8	7	21	28
62	unk.	12	14(NB)	26
38	2	15	(23)	38
38A	2	12	27(NB)	39
72	2	19	(29)	48
27	unk.	6	16(NB)	22
47	3	3	19	22
48	unk.	13	30(NB)	43
51	unk.	6	(16)	22
53	4	22	31	53
52	2	7	(24)	31
82	2	6	(23)	29
115	2	12	15(NB)	27
116	unk.	10	18(NB)	28
78	unk.	20	(33)	53

1/ Age unknown

2/ Indicates that the male was not banded in 1968 so individual identification was not permitted for both years.

3/ Parentheses indicates that the territory was occupied by different males in 1968 and 1969.

TABLE 4. DAILY OBSERVATIONAL DATA FOR 1968 and 1969.

Period	Adult Males	Others	Total	Hours of Search	Miles of Search	Males/ Hour	Birds/ Hour
1968							
4-14	4	2	6	2.5	10.5	1.60	2.40
4-19 to 4-22	47	11	58	26.5	72.2	1.77	2.19
4-27 to 4-30	58	13	71	25.3	73.4	2.30	2.81
5- 3 to 5- 6	59	19	78	20.5	47.0	2.88	3.80
5-10 to 5-13	73	33	106	24.6	78.9	2.96	4.30
5-16 to 5-19	50	18	68	15.4	48.4	3.18	4.35
5-25 to 6-13	21	8	29	16.3	89.1	1.29	1.78
Sub-totals	312	104	416	131.1	419.5	2.38	3.17
1969							
3-29 to 5- 3	36	18	54	23.3	84.9	1.54	1.97
4- 6 to 4-12	127	72	199	40.4	167.2	3.14	4.93
4-17 to 4-19	52	36	88	15.2	72.2	3.41	5.77
4-20 to 4-26	140	84	224	38.1	167.0	3.68	5.88
4-27 to 5- 3	111	51	162	25.4	118.2	4.37	6.38
5- 4 to 5- 9	146	78	224	30.1	136.1	4.85	7.45
5-12 to 5-16	65	36	101	21.1	118.3	3.09	4.80
5-25 to 5-29	21	6	27	8.5	57.6	2.47	3.18
Sub-totals	698	381	1079	202.1	921.5	3.45	5.34
Totals	1010	485	1495	333.2	1341.0	3.03	4.49

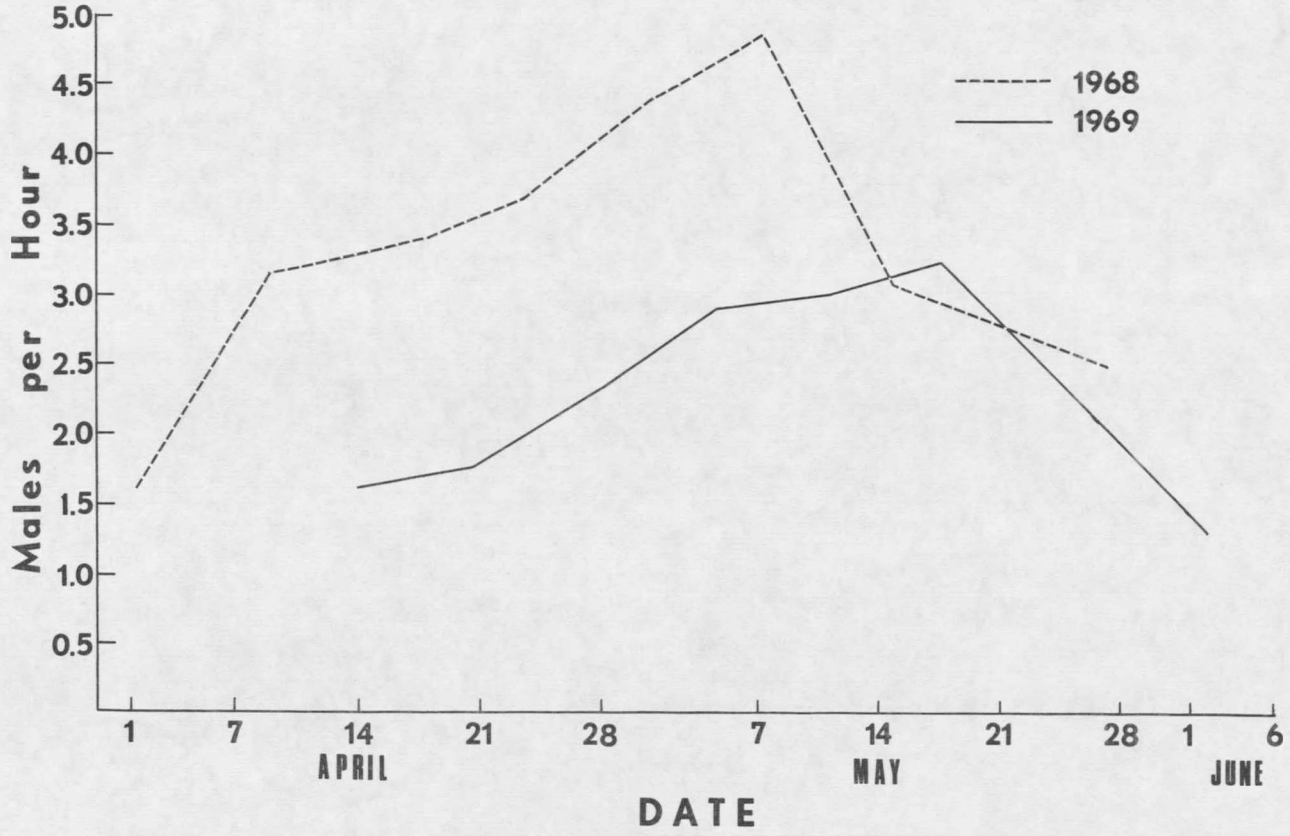

Figure 6. Seasonal distribution of the number of territorial male observations per hour in 1968 and 1969.

from a vehicle but have been included in the total.

Approximately 1.33 miles were driven for each adult male sighted and 0.90 for each blue grouse sighted. This latter figure is considerably better than the one grouse per 26.07 miles of travel recorded by Rodgers (1968) over a three-year period in Colorado. Bendell and Elliott (1967) recorded a high of .81 hooting males per hour of foot search during the peak of breeding activity (May 1 to 14) on Vancouver Island. During the present study, as many as 4.85 males per hour of vehicle search were recorded. Although differences in physiography and habitat types between the areas are considerable, the densities of territorial males were similar. Thus, it appears that search by vehicle, when feasible, may be more efficient than search on foot.

About 68 percent of all blue grouse observed were adult males. The high percentage of birds in this category is attributed to the fact that adult males are much more conspicuous, especially when displaying, than are females or yearling males. Also, the observer probably biased these results by concentrating the search mostly to known territories, where females and yearling males would not necessarily be found.

Eighty-six percent of the adult males observed were either "hooting" or displaying. Of these, 88 percent were in open areas. During rainy or windy weather, males were most often observed hooting in thickets or under trees (Figure 7). Twenty-eight percent of the males observed hooting in the open were on roads. These figures are undoubtedly

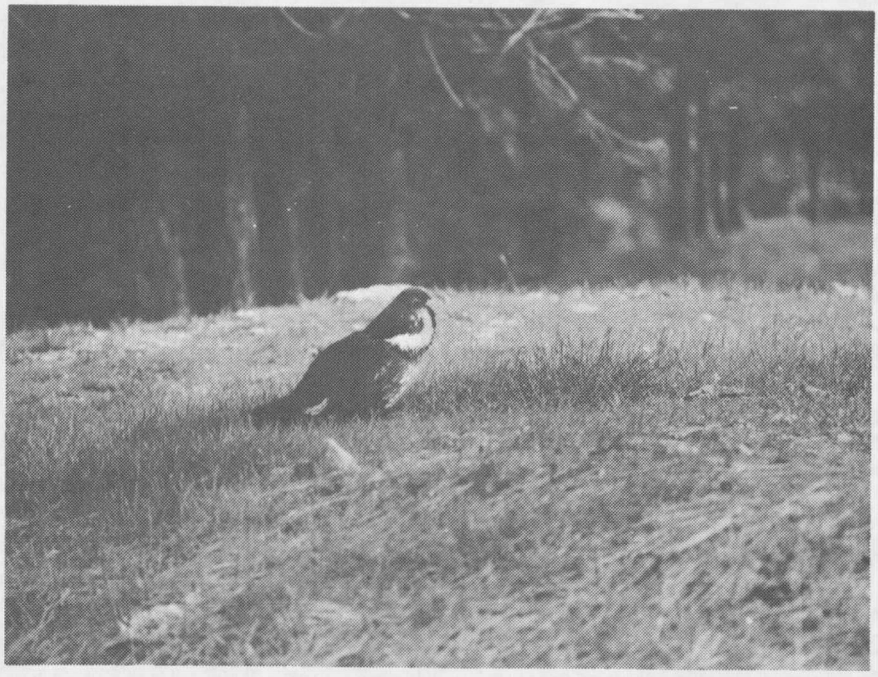

Figure 7. Blue grouse displaying under a ponderosa pine during rainy weather.

influenced by observational bias, but they probably reflect somewhat the tendency of males to display in open areas, particularly on roads (when available), where visibility is least restricted.

Vegetation Measurements

Thickets of coniferous trees which were probably used for resting and escape cover appeared to be a major vegetational component of each male blue grouse territory (Figure 8). Therefore, various measurements were made on the thickets and the trees of which they were comprised (Table 5). Similar measurements were made on 27 randomly selected areas designated as non-territories which corresponded in size to the territories (Table 6).

The least variable of all vegetational characteristics measured was the amount of edge provided by the thicket(s). The territories contained an average of .211 acres of thicket and an average of 677 feet of edge. Numerous small thickets often provided as much edge as one large one. For example, Territory 52 contained six thickets totaling .089 acres with 577 feet of edge, while Territory 105 had one thicket totaling .294 acres but only 570 feet of edge. In the non-territories, an average of .055 acres of thicket provided an average of 278 feet of edge, both of which were significantly different ($p<.01$) from the territories.

Figure 8. A thicket of ponderosa pine and Douglas-fir used by a territorial male blue grouse.

TABLE 5. CHARACTERISTICS OF CONIFEROUS THICKETS USED BY TERRITORIAL MALE BLUE GROUSE.

Terr. No.	Terr. Size[1]	Thicket Area[1]	Thicket Edge[2]	Trees Ave. DBH[3]	Trees Branch Ht.[2]	%PP[4]	%DF[5]	Trees per Acre All	1-3"	4-8"	> 8"
103A	1.60	.254	599	5.4	4.9	93	7	1074	241	574	259
104	2.44	.366	897	8.7	5.3	88	12	434	46	153	235
105	1.14	.294	570	5.5	5.3	98	2	1123	395	633	95
42	1.82	.402	874	4.6	5.9	67	33	309	127	162	20
32A	1.42	.187	576	5.1	5.8	52	48	471	176	225	70
32B	2.26	.313	608	4.5	4.4	31	69	361	176	166	19
30	3.60	.152	573	4.7	5.4	17	83	1092	375	592	125
30A	2.16	.174	581	4.6	5.6	53	47	1288	437	730	121
65	1.58	.256	580	3.9	6.0	87	13	790	340	438	12
73A	2.61	.189	850	5.7	5.5	24	76	937	217	540	180
54	1.30	.148	584	4.0	4.6	2	98	1628	824	750	54
94	2.10	.156	665	3.7	4.4	4	96	1923	1064	814	45
94A	2.24	.174	697	4.4	5.0	5	95	1339	494	759	86
62	1.86	.235	787	2.7	5.1	8	92	1803	1244	513	46
38	1.60	.211	520	3.3	5.3	4	96	1341	744	597	0
38A	2.12	.276	795	4.3	5.3	9	91	1210	533	583	94
72	1.74	.197	697	3.7	5.3	1	99	1955	919	985	51
27	2.11	.123	625	4.6	4.5	9	91	1235	463	707	65
47	1.96	.143	660	4.9	4.8	11	89	1594	524	986	84
48	1.74	.196	598	5.2	5.0	10	90	918	291	490	138
51	1.29	.158	770	4.8	5.7	15	85	2323	842	1354	127
53	1.63	.208	923	4.2	6.7	18	82	1800	790	989	77
52	1.56	.089	577	6.5	6.3	99	1	1663	371	955	337
82	2.82	.117	614	9.3	6.3	100	0	778	60	410	308
115	2.27	.248	825	3.7	6.0	31	69	1298	802	468	28
116	2.43	.255	617	3.7	5.2	90	10	1263	710	510	43
78	2.22	.177	625	5.6	5.3	53	47	610	175	328	107
Average	1.99	.211	677	4.9	5.4	40	60	1205	496	608	105

1/ Territory size and thicket area are in acres.
2/ Edge and branch height are in feet.
3/ DBH is in inches.
4/ Ponderosa pine.
5/ Douglas-fir.

TABLE 6. CHARACTERISTICS OF CONIFEROUS THICKETS NOT USED BY TERRITORIAL MALE BLUE GROUSE.

Non-terr. No.	Size[1]	Thicket Area[1]	Thicket Edge[2]	Trees Ave. DBH[3]	Trees Branch Ht.[2]	%PP[4]	%DF[5]	Trees per Acre All	1-3"	4-8"	> 8"
103A	1.60	.092	487	11.9	5.5	89	11	457	0	185	272
104	2.44	.052	266	5.8	7.5	89	11	635	19	481	135
105	1.14	.082	397	2.1	1.0	26	74	1549	1463	85	0
42	1.82	.039	350	3.4	4.2	0	100	2744	1641	1051	51
32A	1.42	.104	380	7.2	4.5	10	90	625	125	308	192
32B	2.26	.015	150	6.7	5.8	100	0	1000	67	800	133
30	3.60	.000	0	0.0	0.0	0	0	0	0	0	0
30A	2.16	.090	303	6.5	7.6	66	34	389	78	256	56
65	1.58	.039	240	7.1	5.8	98	2	1026	179	590	256
73A	2.61	.014	100	12.0	8.9	100	0	857	0	286	571
54	1.30	.032	220	9.6	5.5	100	0	688	0	250	438
94	2.10	.007	128	6.3	8.3	6	94	2430	290	1430	710
94A	2.24	.140	647	5.7	6.4	12	88	843	286	379	179
62	1.86	.048	354	4.0	6.1	54	46	1979	979	896	104
38	1.60	.020	158	8.7	5.6	82	18	850	0	500	350
38A	2.12	.012	100	5.3	6.0	100	0	1500	417	1000	83
72	1.74	.034	249	8.0	5.6	50	50	765	88	412	265
27	2.11	.076	372	8.2	4.9	46	54	947	132	395	421
47	1.96	.029	126	6.2	4.7	0	100	897	276	414	207
48	1.74	.299	730	6.0	5.3	26	74	690	140	345	205
51	1.29	.067	390	8.9	7.0	62	38	821	119	298	403
53	1.63	.065	188	9.9	8.0	89	11	292	15	92	185
52	1.56	.020	210	10.0	7.9	50	50	1250	100	250	900
82	2.82	.024	200	2.8	1.2	0	100	1667	1250	417	0
115	2.27	.037	240	6.7	10.0	26	74	1243	865	162	216
116	2.43	.055	220	5.4	5.4	5	95	1018	382	582	55
78	2.22	.065	298	5.9	4.4	97	3	1215	323	585	308
Average	1.99	.055	278	6.68	5.67	51	49	1051	342	461	248

1/ Non-territory size and thicket area are in acres.
2/ Edge and branch height are in feet.
3/ DBH is in inches.
4/ Ponderosa pine.
5/ Douglas-fir.

The average DBH (diameter breast high) of trees in the territory thickets was 4.9 inches which is significantly less ($p<.01$) than the 6.7 inch average occurring in the non-territory thickets, and the average number of trees per acre over 8 inches DBH was significantly less ($p<.01$) in the territory than in the non-territory thickets (105 trees per acre vs. 248 trees per acre). Thus, the males used thickets that were generally younger than those in non-territories.

Ages of the majority of trees contained in the territory thickets ranged from about 10 to 60 years with most of them in the 20 to 40 year range. Thickets with most trees younger than 10 or older than 60 years were seldom used except when they were of a growth form that provided protection without obscuring vision.

The species composition of thicket trees varied considerably with an increase in Douglas-fir as the elevation increased. There was no significant difference in species composition or overall densities of thicket trees between territories and non-territories.

The territories and non-territories were separated into three categories based on the species composition of thicket trees. The ponderosa pine type had thickets containing more than 75 percent pine, the Douglas-fir type had thickets containing more than 75 percent fir, and the mixed type had thickets in which neither species made up more than 75 percent of the total. A comparison of the results (Table 7) indicates that the Douglas-fir type territories contained less thicket

TABLE 7. THICKET CHARACTERISTICS OF TERRITORIES AND NON-TERRITORIES GROUPED ACCORDING TO TREE SPECIES COMPOSITION.

Type	Terr. Size[2]	Thicket Area[2]	Edge[3]	Ave. DBH[4]	Branch Ht.[3]	Trees per Acre All	1-3"	4-8"	>8"
				Territories					
Ponderosa Pine(7)[1]	1.94	.233	636	6.1	5.6	1018	309	525	184
Mixed(6)	2.03	.250	681	4.7	5.5	723	315	347	61
Douglas-fir(14)	1.99	.183	696	4.3	5.2	1507	666	761	84
				Non-territories					
Ponderosa Pine(10)	1.94	.041	221	8.3	6.3	852	102	442	286
Mixed(9)	1.76	.084	361	6.7	6.2	1070	440	344	286
Douglas-fir(8)	2.11	.057	293	5.3	5.0	1460	607	654	199

1/ The number of territories or non-territories in each group.
2/ Territory size and thicket area are in acres.
3/ Edge and branch height are in feet.
4/ Average DBH is in inches.

area than the other types. The greater tree density in these thickets could make them more secure and account for the smaller area. These higher densities could be due to the relative shade tolerance of Douglas-fir and the younger age of the thickets. The ponderosa pine thickets were less dense and contained, on the average, larger trees. The relative intolerance of pine to shade and the lack of young pine thickets in the area could account for this.

The open areas of territories contained mostly herbaceous vegetation with occasional areas of shrubby cover. The density profile of

the shrubby vegetation on territories and non-territories is presented in Figure 9. Since the growth of herbaceous vegetation occurs largely after the peak of grouse breeding activity, only the profile of the shrubby vegetation was determined. There is an indicated increase in the shrubby vegetation density in the territories from the ground level upward while the opposite is apparent in the non-territories. This difference is due to both the amount of shrub cover and its growth form. Only ten of the territories had significant amounts of shrub cover while 13 of the non-territories had significant amounts. In the 10 territories and 13 non-territories, shrub cover averaged 1400 and 6300 square feet, respectively.

Small amounts of shrub cover may be used for escape and resting cover as indicated by Bendell and Elliott (1967); however, large amounts probably cause too much vision obstruction and are thus avoided.

Large, mature ponderosa pine and/or Douglas-fir trees were present in most of the territories, but their presence is probably not necessary for territory occupancy. They were occasionally used for escape cover since the birds often flew into them when flushed. Bendell and Elliott (1967) noted that no large trees were present on the breeding areas they studied on Vancouver Island.

Physical Characteristics

Various physical characteristics of the 27 territories are recorded in Table 8. Overall territory size was included in Table 5.

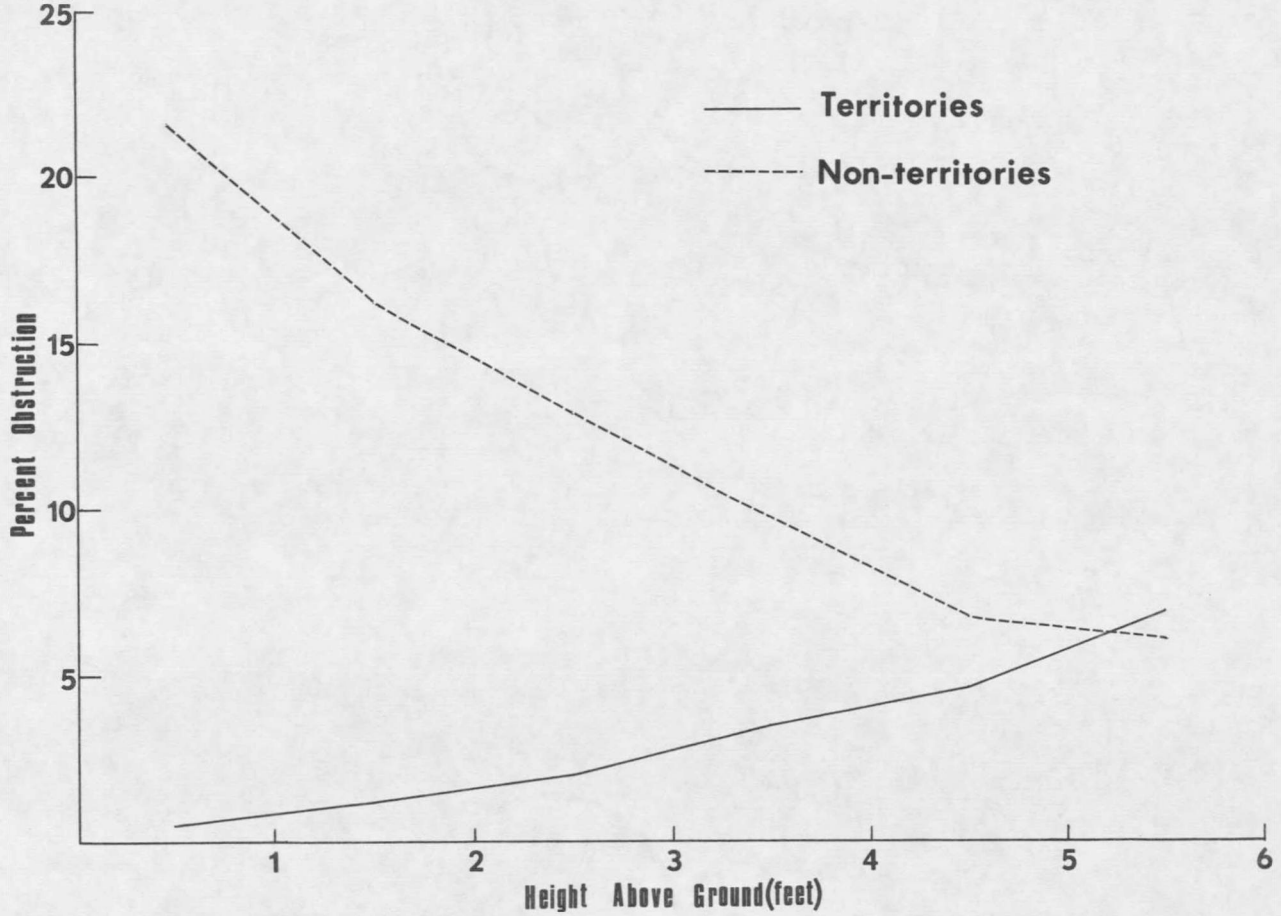

Figure 9. Shrubby vegetation density profile of territories and non-territories.

TABLE 8. PHYSICAL CHARACTERISTICS OF 27 MALE BLUE GROUSE TERRITORIES.

Terr. No.	Altitude	%Slope	%Crown Cover	No. of Thickets	Distance to Neighbor 1/	Exposure
103A	5420	18-35	18	4	460	NE,SW
104	5430	72	25	4	395	E-SE
105	5380	35-65	23	1	525	NE,SW
42	5400	65	19	3	395	SE
32A	5380	58	21	4	395	SE
32B	5460	65	27	2	525	S-E
30	5470	23-47	43	5	395	SE-SW
30A	5510	23-54	33	3	395	E-SW
65	5430	62	39	2	395	E
73A	5610	13-25	31	6	660	N,S
54	5490	57	29	4	460	W
94	5510	45-66	34	4	460	SW-NW
94A	5470	34-44	32	4	660	W-N
62	5400	44	32	4	460	E
38	5380	48	34	2	330	W
38A	5400	58	29	3	330	SW-NW
72	5410	58	28	5	525	W-NW
27	5120	27	25	5	810	SW
47	5000	65	26	6	595	W
48	4950	39-56	26	2	395	SW-NW
51	4910	60	65	5	460	NW
53	4820	59	37	9	460	NW
52	4670	56	30	6	725	W
82	4620	57	31	4	660	SW
115	4680	0-60	24	5	330	W,E
116	4650	20-34	23	4	330	SE-NW
78	4960	70 !	33	4	395	W
Average		46	30	4.1	478	

1/ Feet

Territory size ranged from 1.14 to 3.60 acres, but only one territory was larger than 2.82 acres. The average size was 1.99 acres which is slightly larger than the size determined by Bendell and Elliott (1967) who worked with several different population densities. From their studies, they concluded that territory size varies inversely with population density. No such conclusion could be drawn from this study since male density remained stable.

There appeared to be some relationship between the age of a male and the size of its territory. Nine territories that had been occupied by the same males for a maximum of two years averaged 2.25 acres, while ten territories that had been occupied by the same males for more than two years averaged 1.76 acres, but this difference was not statistically significant.

The altitudes of the territories ranged from 4620 feet to 5510 feet; however, territories are known to occur at considerably higher elevations in other nearby areas. Slopes of the territories located on ridge lines were relatively level, but most of the territories had rather steep slopes because of the general aspect of the terrain.

Tree crown cover on the territories averaged 30 percent which is the same crown cover figure arrived at for the entire study area. Mussehl (1962) reported that the average crown cover was 41 percent on 12 blue grouse territories in the Judith Mountains of Central Montana.

Exposure of the territories included all compass directions; however, the majority faced south or west. Several of the territories were located on ridgelines extending in northwest to southeast or west to east directions so that they contained portions of the heavily wooded north or northeast side of the ridge and the open, treeless, south or southwest side (Figure 10). In such territories, the males often used the ridgeline for displaying.

The distance from the center of one territory to the center of the nearest neighbor territory was measured on the aerial photographs (Table 8). In order to evaluate the significance of this spacing, the distance-to-the-nearest-neighbor method of Clark and Evans (1954) was used. This involves the calculation of a R value which is indicative of the degree to which the pattern of distribution deviates from random expectation. R ranges in value from 0 for maximum clumping to 2.1491 for an evenly spaced distribution. An R value of 1 represents a random distribution.

The calculated R value, determined by dividing the average distance between territories by a figure derived from the territorial male density on the area, was 1.32. This is a significant departure from a random distribution and indicates that the males are rather evenly spaced over the area.

The eight-year history of territories on the study area was used to separate them into three categories: those occupied intermittantly, those occupied continuously by different birds, and those occupied