THE ECOLOGY AND MANAGEMENT OF THE IDAHO RUFFED GROUSE

(BONASA UMBELLUS PHAIA)

by

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INTRODUCTION

The Ruffed Grouse (Bonasa umbellus) has been noteworthy in all American history as a source of food and more recently a source of sport. Early Rocky Mountain history, it is true, contains more frequent references to the grizzly bear, antelope and elk. However, when food was a problem to travelers in the forested mountains it was the ruffed grouse, among other native game birds, that sustained them. This important resource was recognized by C. Hart Merriam in a letter of transmittal attached to an economic study of grouse and wild turkey (Judd 1905). Merriam states that the "great economic consequence" of grouse was recognized and that their food value played an important part in "furnishing the pioneers with no small part of their fare."

In tracing the ruffed grouse through American history it is important to recognize the various common names and their sources. Generally the name partridge or variations of this name originated in New England while the name pheasant or mountain pheasant originated in the southern states (Judd 1905). Variations of both names are found in the Rocky Mountain country. The terms originating in the south, particularly "mountain pheasant," "brush pheasant" and "native pheasant," are most commonly used in northern Idaho in addition to the name ruffed grouse. For many years the seasons and bag limit regulations of the Idaho Fish and Game Department have specified "ruffed grouse or native pheasant."

At the present time the ruffed grouse in Idaho is sadly neglected with respect to management. Northern Idaho has a total land area of twelve and one-half million acres of which over 82 percent is covered with timber. Of this timbered area 6.9 million acres are classified as commercial forest land which is adaptable to ruffed grouse management. On the other hand

less than 17 percent of northern Idaho is cultivated land, pasture or grass. Considering these fundamental divisions of habitat the great pote tial for game management lies with the forest-wildlife species including the ruffed grouse. The ring-necked pheasant has dominated the game bird management program, however, since its first introduction in 1909 and its great popularity beginning about 1925. It was perhaps the game farm program that gave this bird its great popularity with the lure of quick production of high shootable populations. Sportsmen themselves have been instrumental in forcing the game department in this direction. Perhaps now that the management of ring-necked pheasants in Idaho has reached the stage of habitat improvement, grouse can compete with the pheasant as a game bird on its own merits. But, with more than seven years of closed seasons protecting grouse populations, many hunters had a chance to grow up without learning to appreciate another fine upland game resource which warrants their attention.

PURPOSE

The lack of fundamental knowledge of ruffed grouse populations in Idaho on which sound management procedure could be based, led to the initiation of this study. Ruffed grouse management is primarily a problem in forest land management and forest ecology. The primary purpose of this study was to determine the factors limiting grouse populations and how these factors could be controlled through management of timber, water and forage resources on forested areas in northern Idaho.

The following objectives were set up to guide the study.

1. To gain basic knowledge of the life history, food habits and habitat requirements of ruffed grouse in Idaho.
2. To investigate thoroughly the ecological factors operating on northern Idaho grouse ranges, including the vegetation and its relation to habitat, climate and its effect on grouse populations, and the relation of other animal life to grouse populations.
3. To develop a yardstick for measuring grouse populations and productivity.
4. To determine the effects of existing land management practices upon ruffed grouse populations and suggest practical management measures which may increase grouse production.

Here only one series of types is illustrated, that of the porous soil types on upland areas. The species would largely be the same on the non-porous soils and to some extent the same on the rock outcrops. For the marsh or flood plain series, of course, species would be much different and are not included in this study because such types are not necessary in the pattern of ruffed grouse cover use.

Brood Ranges as Limiting Factors

Vegetative Descriptions of Study Areas

Five study areas were chosen in northern Idaho to be representative of the grouse producing forests of this part of the state. The locations of these study tracts are shown on the map, Figure 24. The Flat Creek study area is within the University of Idaho Experimental Forest. The Priest River site is within the Priest River Experimental Forest administered by the Northern Rocky Mountain Forest and Range Experiment Station. The other study sites are within the St. Joe National Forest, the Clearwater National Forest and the Nez Perce National Forest.

From Figure 24, it can be seen that the Mannering Creek and Flat Creek study areas are close to the edge of the timbered section of northern Idaho. These were deliberately chosen as being representative of the more intensively used forest land and more typical of the many small forest areas managed or held as farm woodlots and private timberland. Perhaps the greatest potential for management of ruffed grouse lies within this area and likewise the greatest accessibility for hunting.

The Weitas Creek and Radcliffe Creek study sites were chosen to give a representative picture of the more remote forested land which

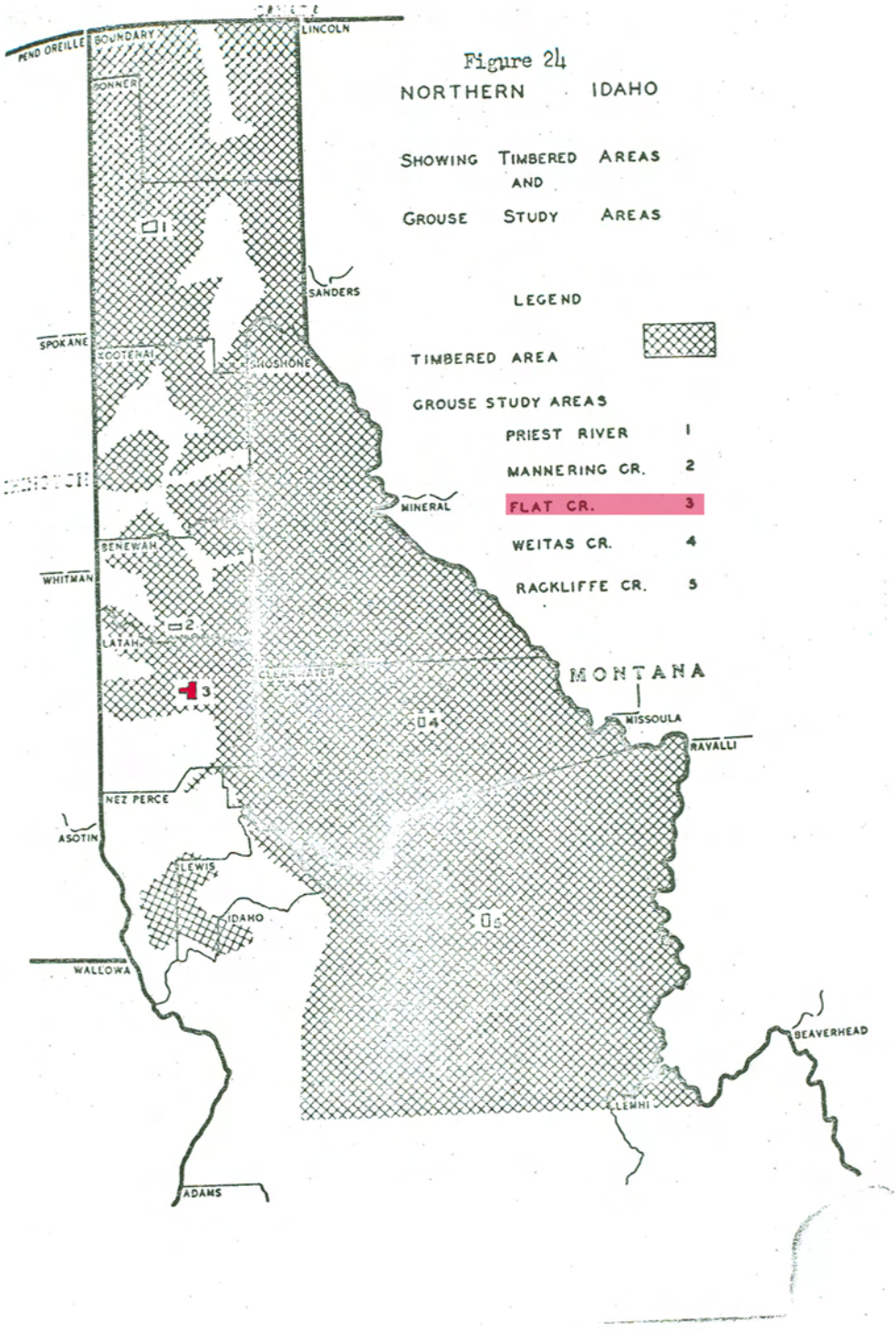


Figure 24
NORTHERN IDAHO
SHOWING TIMBERED AREAS
AND
GROUSE STUDY AREAS
LEGEND
TIMBERED AREA
GROUSE STUDY AREAS
PRIEST RIVER 1
MANNERING CR. 2
FLAT CR. 3
WEITAS CR. 4
RACKLIFFE CR. 5
PEND OREILLE
BOUNDARY
LINCOLN
BONNER
SANDERS
SPOKANE
KOOTENAI
SHOSHONE
MINERAL
BENEWAH
WHITMAN
LATAH
CLEARWATER
MONTANA
MISSOULA
RAVALLI
NEZ PERCE
ASOTIN
LEWIS
IDAHO
WALLOWA
BEAVERHEAD
LEMHI
ADAMS

receives less hunting pressure. The Priest River section is midway between these two extremes.

All five study tracts are within the cedar-hemlock zone, but the Priest River, Flat Creek and Weitas Creek areas also are represented by the Douglas fir zone or a transition of this zone with the cedar-hemlock vegetation. In several of the study sites, there are downward extensions of the spruce-fir zone present. It is within these associations that the ruffed grouse is ordinarily found and certainly where it reaches its best population development.

The Flat Creek study area comprising 2,200 acres is the site on which most of the present work has been done. The other four study sites have been used during the brood seasons to check population trends and cover use. The food habits work, the ecological studies, and the microclimate investigations have all been done on the Flat Creek tract. Figure 26 shows a general view of the Flat Creek study area. The most detailed vegetative description of this area is given to provide the information necessary for ecology and management applications. Figure 25 shows a type map of the Flat Creek area. The type classification follows the system described above using the prefix number for the zone, and following the successional stages as listed in Tables 12 and 13. The area is uniformly timbered without any great variation in timber density. Timber volumes vary from little or no merchantable timber to a maximum of about 10,000 board feet per acre. The greatest volume is on some of the ridges where old growth ponderosa pine remains which was too poor in form to be cut during the last logging operation. The details of cutting history are given in the section under forest management.

UNIVERSITY of IDAHO

EXPERIMENTAL FOREST

Flat Creek
Block

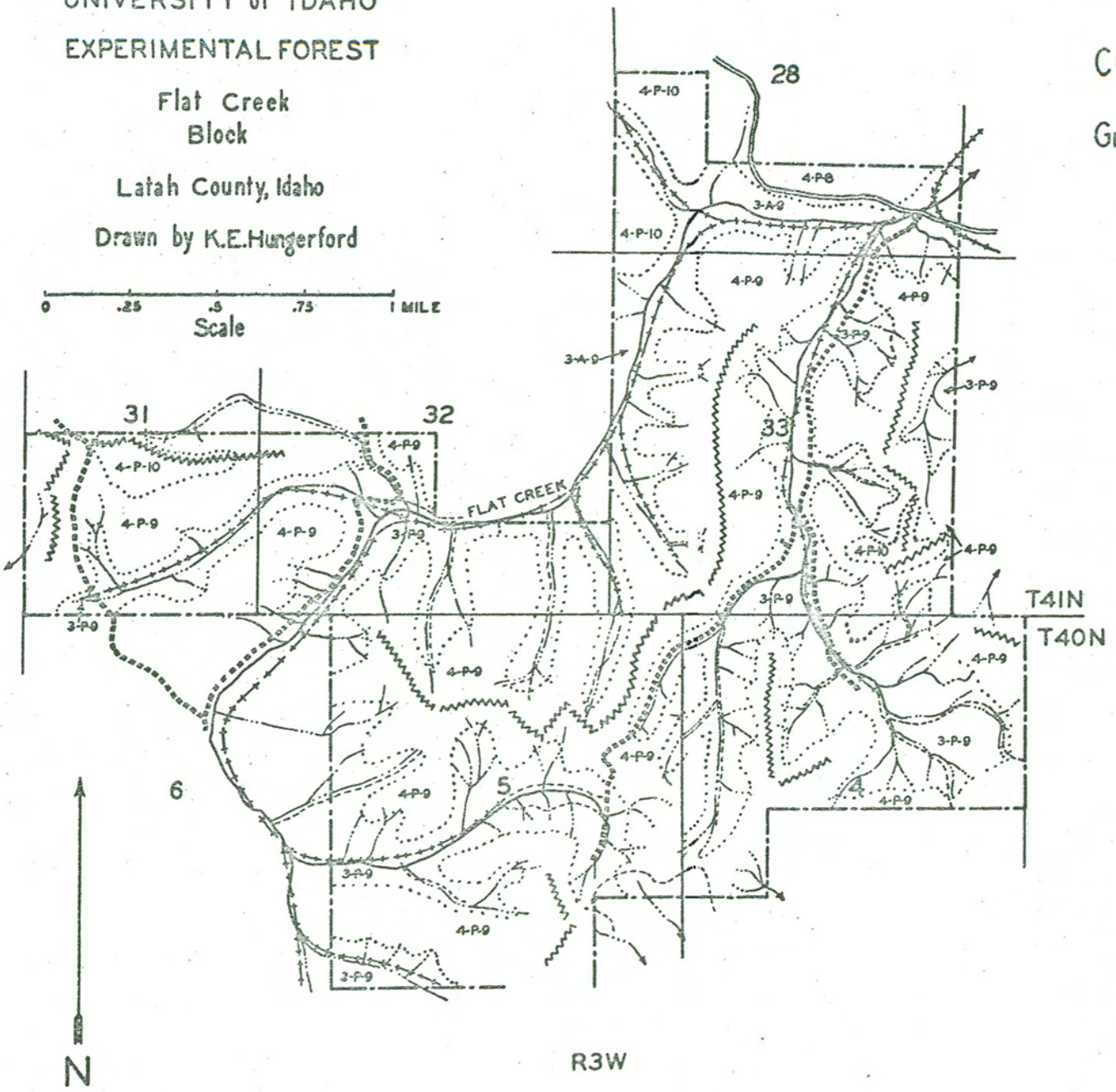
Latah County, Idaho

Drawn by K.E.Hungerford

Figure 25

COVER TYPE MAP

Grouse Study Area



Legend

- Type line
- Stream
- Intermittent stream
- Ridge
- Railroad
- Old railroad grade
- Skid trail
- Highway
- Forest road
- Forest boundary
- Section line

Type Symbols

Douglas fir zone	4-
Cedar hemlock zone	3-
Porous soil	-P-
Non-porous soil	-A-
Mid-tolerant trees	-9
Tolerant trees	-10

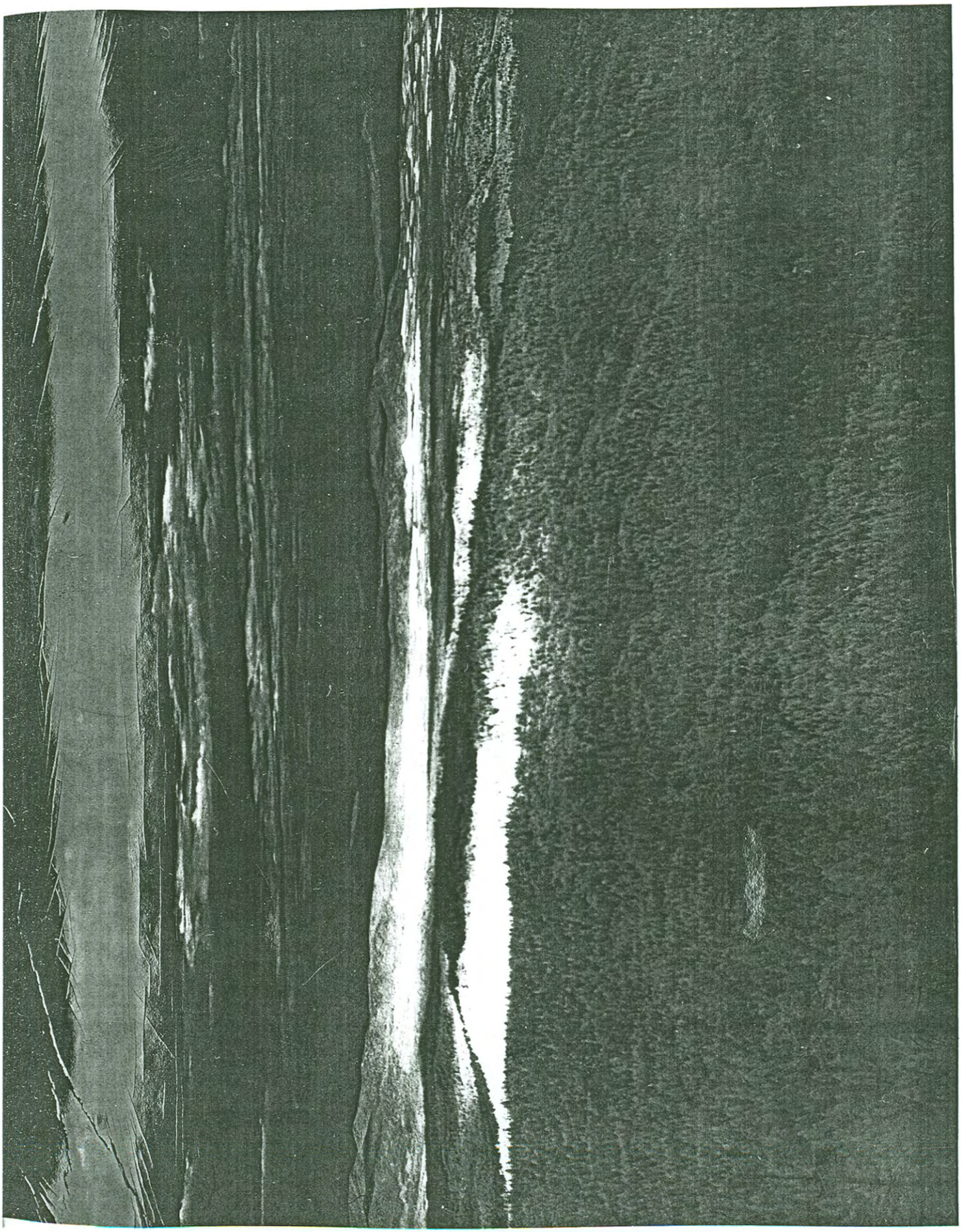
The Douglas fir zone present on the ridges on the Flat Creek site is well illustrated by the photographs in Figures 7, 13, and 14. Figures 15 and 16 illustrate an intermediate stage of the cedar-hemlock zone in a mixture of Douglas fir and grand fir. Another intermediate stage of this zone is illustrated in Figure 18 where a stand of predominantly western white pine is shown. Figure 17 illustrates a cedar-hemlock zone which is close to the climax stage although the pattern has been changed by recent cutting. An early stage of the Douglas fir zone is shown in Figure 19. Here logging followed by fire has caused the succession to revert to lodgepole pine, making a type designated as 4-P-8.

Ecological Study Plot

To study in detail the ecological factors affecting ruffed grouse abundance, a forty acre study plot was established near the center of the Flat Creek study area. The area was chosen with care to provide a representation of the main vegetative types, aspect, slope and amount of stream course and roadways. A stream divides the forty-acre square plot diagonally and the two halves of the plot represent the two most important general types. A type map of the forty-acre study plot is illustrated in Figure 27. The plot was originally surveyed and marked with a grid line every two chains (132 feet), and these marking stakes have been maintained during the three years that the brood studies have been conducted.

Figure 26

General view of the Flat Creek study area in Latah County, Idaho, and surrounding country. The study area is along the ridge in the edge of the shadow at the left of the picture. Cultivated lands begin at the far right in the picture near Deary, Idaho. The photograph was taken from East Moscow Mountain lookout facing east. Infra-red photograph taken August, 1949.



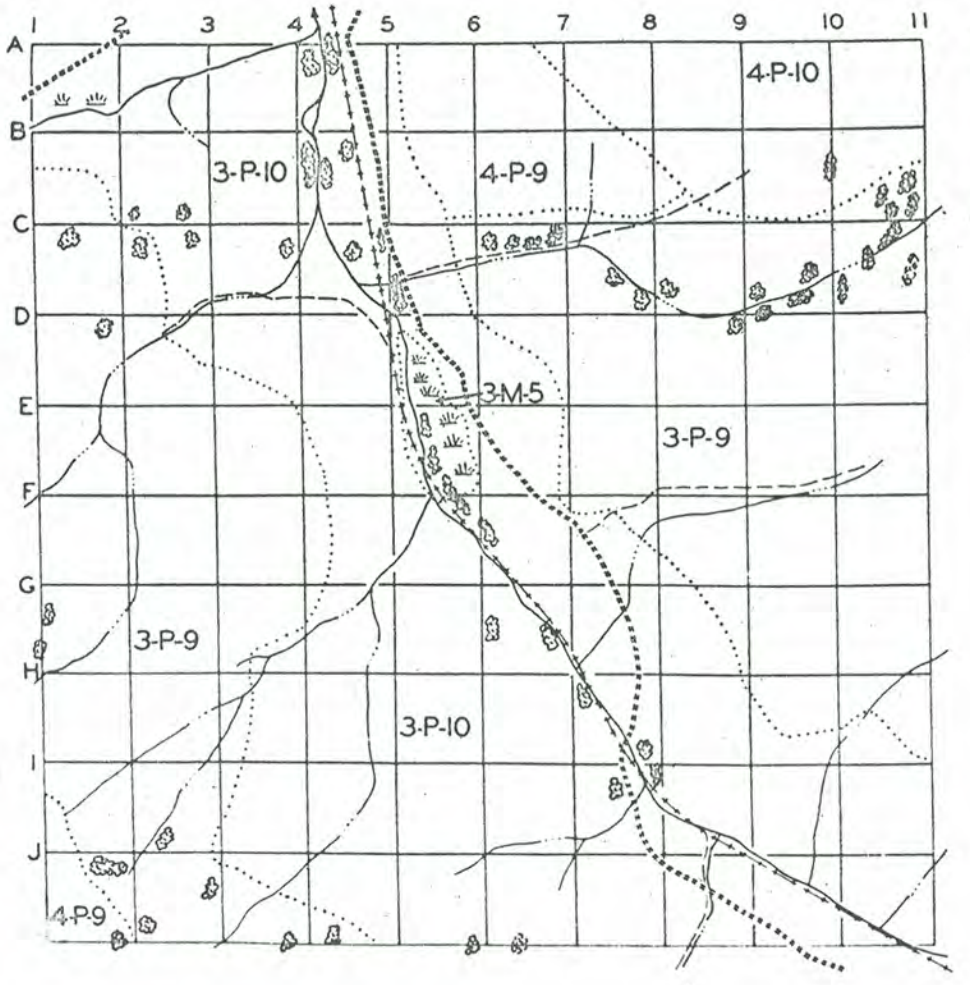


Figure 27

COVER TYPE

MAP

40 ACRE STUDY PLOT

Sections 33, 4

T40N, T41N R3W

Scale 1 square = 132 ft. = 2 chains

Legend

Old skid trail

Type line

Stream

Dry ravine

Forest road

Old railroad grade

Hardwood tree

Marshy area

For type symbols see text.

Table 14

Stand Table Showing Numbers of Trees by Diameter Classes on a Ten Percent Sample of the South One Half of the Forty Acre Study Plot on the Flat Creek Study Area

Tree Species	Number of Trees by D. B. H. Classes											
D. B. H. Class	2	4	6	8	10	12	14	16	18	20	22	24
Ponderosa Pine	8	2	1		1			3			1	
Douglas Fir	9	6	2	3	1	4	4		1	3	3	2
Grand Fir	36	12	10	2		4	5	2				
Western Larch	1			1			4	8	3	3		
Lodgepole Pine		2	2			2	1					
Western White Pine	1	1				2	4					
Western Red Cedar	15	5	4	1	8	8	5	5	1	2		

Cover Types. The cover type classification used on the forty acre study plot is the same as described for the Flat Creek study area. Table 13 lists the details of the system. In addition to the cover type classification each hardwood tree has been located. In the upland areas the only hardwood species present are mountain maple (Acer glabrum) while along the main stream, mountain alder (Alnus tenuifolia), willow (Salix spp) and red osier dogwood (Cornus stolonifera) are present.

Distribution of the species of trees by sizes is shown in the stand table (Table 14) for the south one half of the study plot. Data for this table were obtained from a ten percent sample of the 3-P-9 and 3-P-10 types using one-fifth acre circular sample plots systematically located. A further distribution of tree species was undertaken at the time a series of mil-acre plots was run through the forty acre study plot, in order to study ground cover vegetation. Records were kept of the number of tree

seedlings per mil-acre by cover types. The series of mil-acre plots was spaced at one chain intervals along line six of the forty acre plot. Table 15 lists the numbers of seedlings by cover types. This table shows rather definitely the predominance of seedlings of western red cedar and grand fir in the 3-P-10 cover type which is the climax stage of the cedar-hemlock zone. The subclimax stage of the cedar-hemlock zone, indicated as type 3-P-9, also shows a large number of seedlings of the seral Douglas fir. The 4-P-9 cover type located on a south-facing slope in a drier site has a notable lack of tree reproduction when compared with the other types. However, even the low abundance of seedlings in this type can be considered as adequate stocking from the forester's standpoint since only one tree per mil-acre need reach maturity in order to give a fully stocked forest.

Table 15

Abundance of Tree Seedlings by Cover Type on the Forty-Acre Study Plot

Species	Numbers of Trees per Mil-Acre by Cover Types		
	4-P-9	3-P-9	3-P-10
Pseudotsuga taxifolia	1.3	13.5	0.9
Abies grandis	3.5	16.5	10.7
Pinus monticola	0.7	1.0	1.4
Thuja plicata		8.0	28.6
Larix occidentalis		1.0	0.2
Picea engelmannii		0.5	0.2

A further study of the abundance of tree seedlings was made on the south one half of the forty acre study plot. Table 16 shows the results of a series of 80 mil-acre plots established here. These data also bring out the fact that western red cedar and associated tree species of the cedar-hemlock zone are dominant among the seedlings present on the forty acre study plot.

Table 16

Rate of Stocking of Tree Seedlings Determined by a Series of 80 Mil-Acre Plots on the Forty-Acre Study Plot

Plot Series Number	Percentage of Plots Adequately Stocked	Species of Seedlings Present
1	40	Pinus monticola, Abies grandis
2	80	Thuja plicata, Pinus monticola, Abies grandis
3	60	Thuja plicata, Pinus monticola, Abies grandis
4	100	Pinus monticola, Abies grandis, Thuja plicata
5	20	Abies grandis, Pseudotsuga taxifolia
6	100	Thuja plicata, Pinus monticola, Abies grandis
7	100	Pseudotsuga taxifolia, Abies grandis, Larix occidentalis
8	50	Thuja plicata, Abies grandis, Pseudotsuga taxifolia

The shrub cover present on the forty acre study plot has been determined through the establishment of a line intercept directly through the center of a plot on line number 6, running from north to south. The line intercept method was applied as described by Canfield (1941). The results

of the line intercept study are presented in Table 17. For the purposes of comparison the line intercept was recorded in two parts. The north part of the line intercept recording the vegetation on a south facing

Table 17

Shrub Composition on the Forty-Acre Study Plot as Determined by the Line Intercept Method. Intercept of the line by species is shown in feet and tenths. The line intercept was run the complete length of Line 6 on the forty acre plot illustrated in Figure 27.

North Side Line Intercept

Species	Total Line in Feet	Percent of Shrub Composition	No. of Plants Intercepted
Symphoricarpos albus	16.5	15.5	17
Pachistima myrsenites	15.0	14.1	27
Rubus parviflorus	13.7	12.9	17
Spiraea lucida	4.6	4.3	7
Salix spp	15.4	14.5	9
Vaccinium membranaceum	11.0	10.3	19
Rosa gymnocarpa	11.8	11.1	18
Amelanchier florida	3.3	3.1	2
Mahonia aquifolium	3.2	3.0	5
Arctostaphylos uva-ursi	8.4	7.9	6
Lonicera utahensis	3.1	2.9	9
Populus tremuloides	.2	Tr.	1
	106.2	99.6	137

South Side Line Intercept

Rosa gymnocarpa	16.9	14.2	22
Pachistima myrsenites	9.0	7.6	14
Symphoricarpos albus	1.8	1.5	31
Salix spp	10.9	9.2	14
Rubus parviflorus	23.6	20.0	24
Vaccinium membranaceum	15.4	13.0	12
Amelanchier florida	1.6	1.3	3
Arctostaphylos uva-ursi	4.4	3.7	4
Ribes viscocissimum	1.5	1.3	2
Acer glabrum	8.7	7.3	3
Menziesia ferruginea	6.5	5.5	4
Holodiscus discolor	1.3	1.1	1
Lonicera utahensis	4.9	4.1	4
Physocarpos malvaceus	8.0	6.7	4
Ceanothus sanguineus	1.5	1.3	1
Cornus stolonifera	2.7	2.3	2
	118.7	100.1	145

slope was recorded separately from the south side of the forty acre study plot in which the slope was facing north. The line intercept study shows some interesting relationships in the habitat within which the various shrubs are growing. For instance, dogwood (Cornus stolonifera), fool's huckleberry (Menziesia ferruginea), mountain maple (Acer glabrum), and gooseberry (Ribes viscocissimum) appear only on the south one half of the line intercept. Spiraea and Mahonia aquifolium are species of importance that occur only on the north one half of the line. Aspen (Populus tremuloides) is a very infrequent species in this area. Many of the shrub species occur in both halves of the line, as might be expected. For instance, willow (Salix spp), Rubus parviflorus, huckleberry (Vaccinium membranaceum), and myrtle boxleaf (Pachistima myrsenites) are among the species that might be expected on either slope. Several species of shrubs, however, occur on the south one half of the line where they would not ordinarily be expected. Ninebark (Physocarpus malvaceus) and ocean spray (Holodiscus discolor) are examples of these. These shrub species occur more characteristically on the ridges within the Douglas fir zone. Red-stem ceanothus (Ceanothus sanguineus) and bearberry (Arctostaphylos uva-ursi) might also be expected to occur more frequently on a south facing slope. It should be indicated that all shrubs listed in Table 17 furnish either food or cover for the Idaho ruffed grouse.

Table 18 shows a further breakdown of the abundance of ruffed grouse food plants by cover types on the forty acre study plots. Included here are some of the more important shrub species as well as some herbaceous species that are important as ruffed grouse foods. It should be pointed out that the 4-P-9 type is a relatively dry south-facing slope. The 3-P-9

Table 18

Abundance of Grouse Food Plants by Cover Types on the Forty Acre Study Plot

Food Species	Numbers of Plants per Mil-Acre* by Cover Type		
	4-P-9	3-P-9	3-P-10
Rosa gymnocarpa	1.0	3.0	3.1
Fragaria bracteata	1.3	2.0	1.6
Vaccinium membranaceum	4.5	4.0	1.9
Mahonia aquifolium	9.7	1.5	-
Amelanchier florida	1.3	1.5	-
Cornus canadensis	-	57.0	22.4
Clintonia uniflora	-	28.5	18.7
Rubus parviflorus	-	-	1.6

* Abundance may be converted to plants per acre by multiplying by 1000.

type is also on a generally south facing slope but includes several small drainages or ravines. It is within these small drainages with somewhat better moisture conditions where the excellent growth of Cornus canadensis and Clintonia uniflora has appeared. It is also within the plots located in the 3-P-9 types where the best light conditions prevail. From 70 to 100 percent of the full light is available on the plots in this type. Table A in the Appendix gives a full summary of the light conditions over the forty acre plot as a whole. Abundance of plants on the 3-P-10 types, that is, the climax stage of the cedar-hemlock zone, is somewhat less than for the same species growing within the seral stage. This is largely due to the light conditions prevailing. Light conditions checked at five stations on the south one half of the forty acre plot along which the mil-acre

plots were taken all showed less than 12 percent of the full light available at the ground level. The absence of the Amelanchier florida in the 3-P-10 type is believed to be quite important, since this is one of the key winter food plants on the Flat Creek area.

Light Conditions. Light conditions on the forty acre study plot were studied with the aid of a General Electric number PR-1 exposure meter with an incident light attachment. Before use in this study, the G.E. meter was tested carefully by comparing it with an accurate micro-ammeter connected to a pair of Weston photronic cells. After making comparative measurements, it was determined that the exposure meter method would be satisfactory for use in obtaining light measurements in the field. On a given reading the value might vary as much as 5 percent of the amount of full light available when compared with the more accurate measurement. However, repeated measurements with the more accurate means using the micro-ammeter and the Weston photronic cells might vary as much as 5 or 10 percent in light reading for a given station. The General Electric exposure meter has the advantage that it is portable and readings are taken much more rapidly in the course of field work. For the basic information in preparing the calibration chart for use with the General Electric meter the writer is indebted to the G. E. Research Laboratory at Schenectady, New York.

In actual field use it is necessary only to take two readings in the field with the photo-electric meter. One reading taken under full sunlight is compared with a series of readings taken later at various stations under the forest canopy. The difference in the reading is translated directly into the percent of full light with the aid of a chart. Light measurements were made only between 10:00 A.M. and 3:00 P.M. on days when

there were no clouds in the sky. Under uniform light conditions it is necessary to make the full light reading for comparison only once every half hour or three quarters of an hour. The calibration chart used for determining the percent of full light at any given station is reproduced on Figure A in the Appendix.

As can be seen from Table A in the Appendix, the light readings from one station to another on the forty acre plot are highly variable. Where a trace is indicated this means that less than 5 percent was measured at the station. Where 100 percent of full light is recorded, this indicates no shade whatsoever from the tree canopy. All measurements were taken at a height four and one-half feet above the ground over the grid stake indicated.

Use by Ruffed Grouse of Various Cover Types

The wintering habitat on the forty acre plot is located on spur ridges at 7-D and also at 11-E as well as in the 4-P-10 type from 8 to 11-E. A number of grouse have been found wintering within these areas during the three years in which the plot has been observed. Only one or two grouse have been observed on the south one half of the plot wintering adjacent to 4-P-9 type on the southwest corner. During one winter, grouse were found using the spur ridge between 9-H and 11-G as winter habitat. These lower portions of the spur ridges, that is, the portions more closely adjacent to the ravine, are used only during the late winter or during periods of fair weather when the grouse range farther from the slopes. The only drumming territory found within the forty acre plot was on the small spur ridge adjacent to 10-E or 11-E. Three logs were found within this drumming territory, one of which is illustrated in Figure 9. The only nesting location found on the forty acre

study plot was at 6-K. The nest was located on the north side of a western red cedar tree about eight inches in diameter. One small shrub was the only cover within four or five feet of the nest other than the cedar tree itself. The broods during the early season used several clearings on the forty-acre plot. A clearing between 1-J and 3-J was used only during the early part of the season. Also a clearing at 9-B was used during the early brood season. It can be seen that both of these areas are at the heads of the small drainages which originate on the forty-acre plot. As the brood season progressed, broods moved to lower elevations apparently in search of water and an adequate food supply. During the latter part of the brood season, most broods were concentrated along the main stream course which flows diagonally across the center of the forty-acre plot. Broods used as evening feeding grounds the section of the main drainage 9-J to 10-K and from 5-C to 7-F. Also, the small ravine from 4-C to 3-D was used as a late summer brood range. During dry summers up to three broods used the area from 6-F to 4-A along the main stream course as an evening feeding area and as resting cover during the day. On a dry season the only original source of water on the forty acre plot is a spring at the upper edge of the marsh area near 6-F. During the dry parts of the season the stream above this point is dry. By fall, there is a general shuffle of the population, but even at this season most of the grouse are found associated with the main stream course or with the small ravines, such as those from 1-F to 4-C, from 11-C to 5-D, and also the small ravine from 2-J to 5-F.

The shift in seasonal use of various kinds of cover on the forty-acre plot is well illustrated by a series of census operations taken within the plot. During the year 1947, three complete census operations were

conducted on this plot; one in late summer, one during the fall, and one during the following winter. On the first census taken from August 27 through 29, the complete forty-acre plot was covered systematically by one observer. Nine ruffed grouse were observed. On October 25, 1947, a complete census was made of the forty-acre plot, using a crew of eighteen men. The eighteen man crew executed a complete drive of the forty-acre plot, moving on parallel lines one chain apart from west to east, and then from north to south. The average flushing distance observed was .69 chains, well over the half chain interval between each observer. The final tally after duplications were eliminated was a total of twenty-three grouse on the forty-acre study plot. On December 13, 1947, another drive census was conducted using a crew of five men. This entailed a longer time in completing the census, but it was organized on the same basis as the fall census drive. A total of two grouse was observed on the plot on the December census.

The cover types within which the grouse were found on these three consecutive census operations are explained above in seasonal cover use. However, it is interesting to note that the general movement of the birds was upward toward a higher elevation as the season progressed from August into December. During the August date of the census, relatively few birds were observed on the plot because many broods were then located at lower elevations on the main drainage below the plot. At the late October date when the fall census was made, many of these broods had moved upward and were then located on the forty-acre plot area, particularly along the small ravines. By the time of the December census the birds had moved still further up the ridges to the normal winter ranges. It is undoubtedly true that predation, accidents and other factors

causing loss, had some effect in reducing the population throughout the fall and early winter, affecting particularly the winter census. It should be indicated, however, that during 1947, the year in which these studies were made, there was no regular hunting season and no poaching losses were detected on this area.

In summarizing the use of various cover types by ruffed grouse on the forty acre study plot, it is apparent that during the winter, grouse use the 4-P-9 or 4-P-10 types on the ridge almost exclusively. In some cases, the 3-P-9 type along the spur ridges were used during early winter. The ridges used as winter habitat are from 60 to 200 feet in elevation above the adjacent ravines. The only drumming observed within the forty acre plot has been in the edge of a 3-P-9 type near a transition with a 4-P-9 type. The only nest located was within the 3-P-10 type. However, this also was adjacent to a transition with the 3-P-9 and 4-P-9 types. During the early part of the season the broods used 3-P-9 or 4-P-9 types almost exclusively. As the season progressed, usually coinciding with the drying of the seeps and springs at the heads of the smaller ravines, the broods moved to the lower elevations and into the 3-P-10 or 3-P-9 types along the ravines which they used almost exclusively during the latter part of the brood season. During the fall there was considerable shuffling of the population and a more or less general movement of the grouse back to the higher elevations where, by early December, they were back on the winter habitat along the ridges.

Analysis of Brood Ranges

For three brood seasons the brood ranges on the Flat Creek study area were studied in detail. During 1948, 1949, and 1950 all brood ranges were located, mapped and analyzed to determine the essential factors

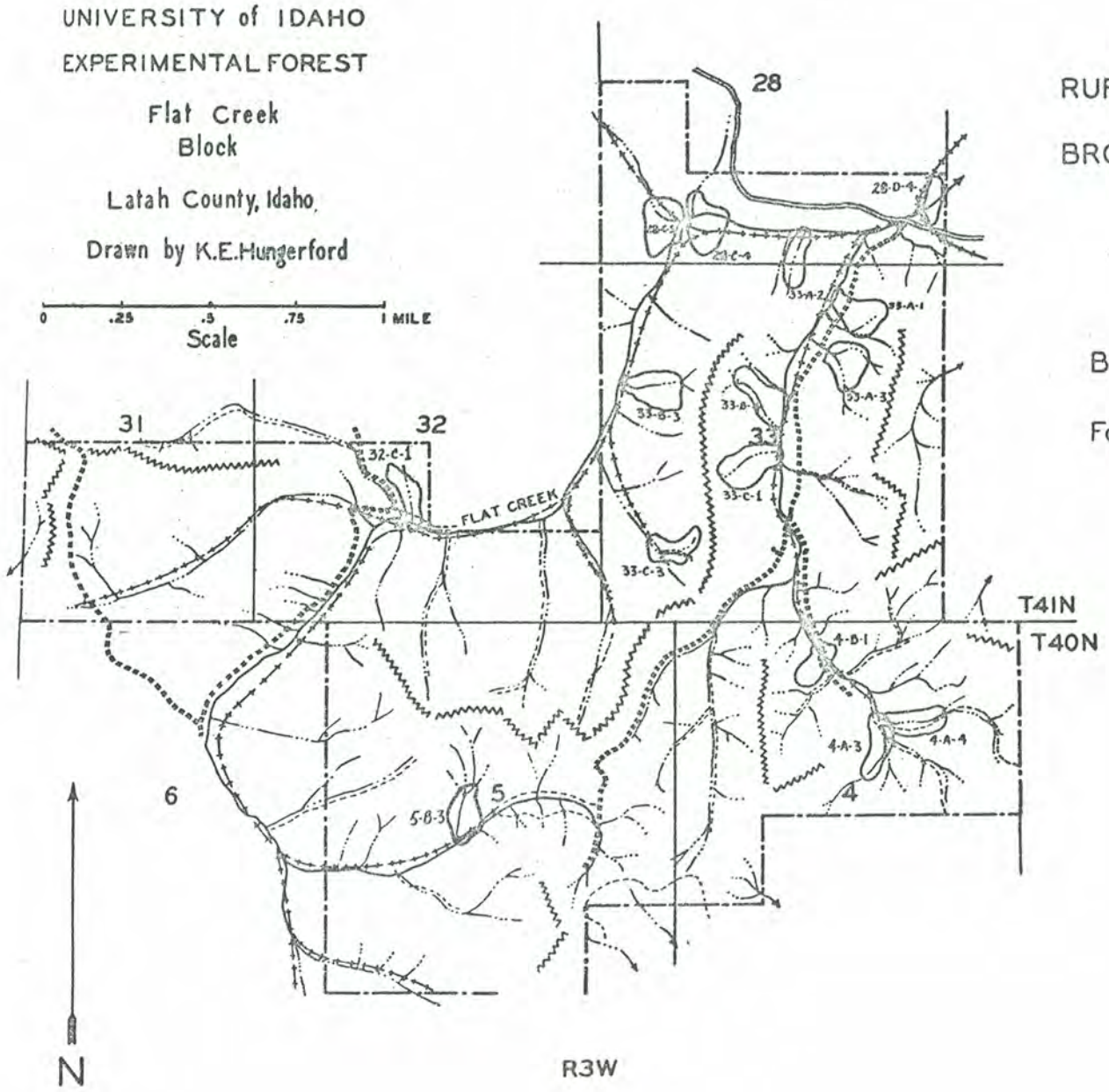


Figure 28

RUFFED GROUSE

BROOD RANGES

1948

Brood range 28-D-4

For legend see cover map.

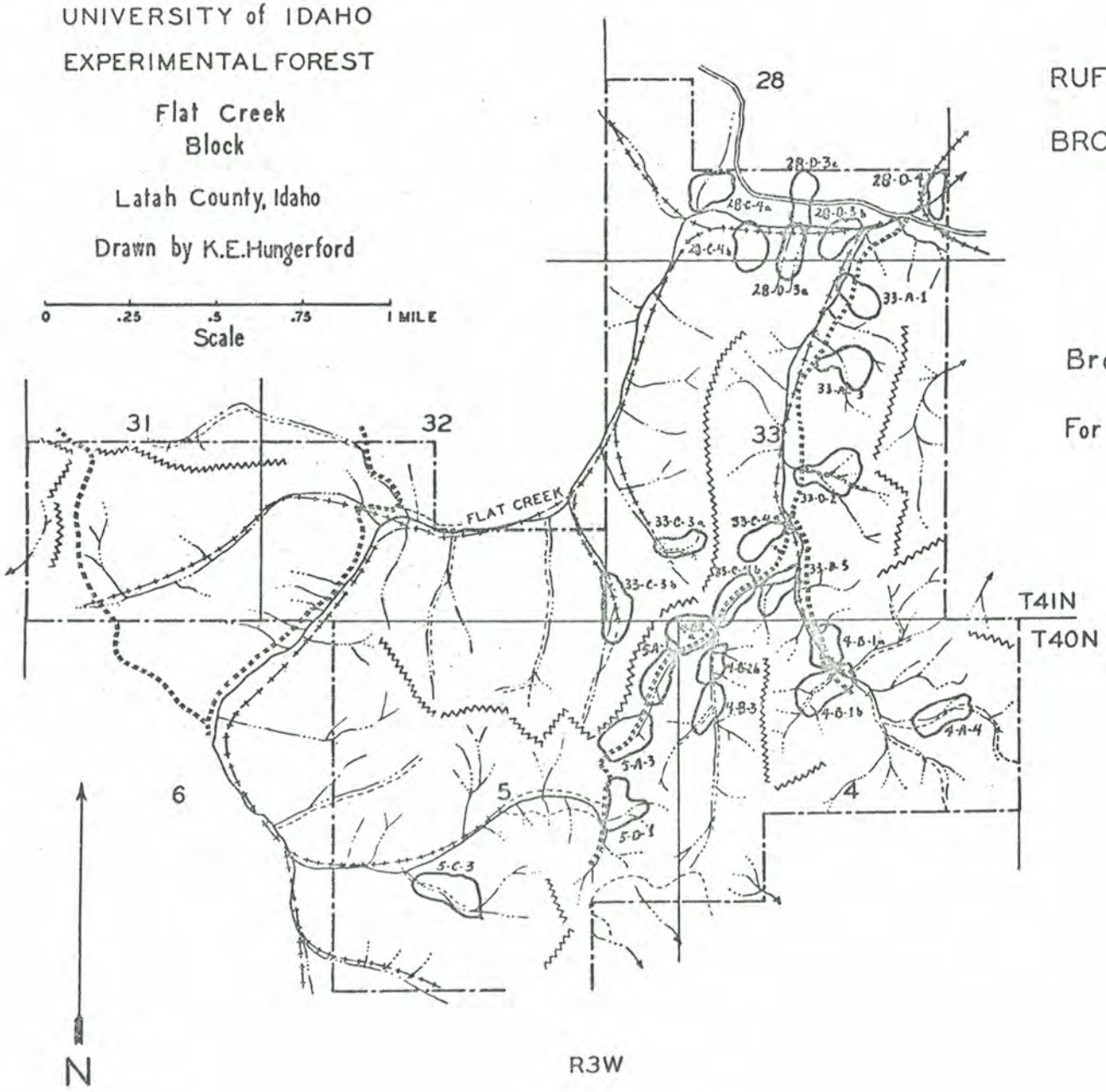


Figure 29

RUFFED GROUSE

BROOD RANGES

1949

Brood range 5-A-1

For legend see cover map.

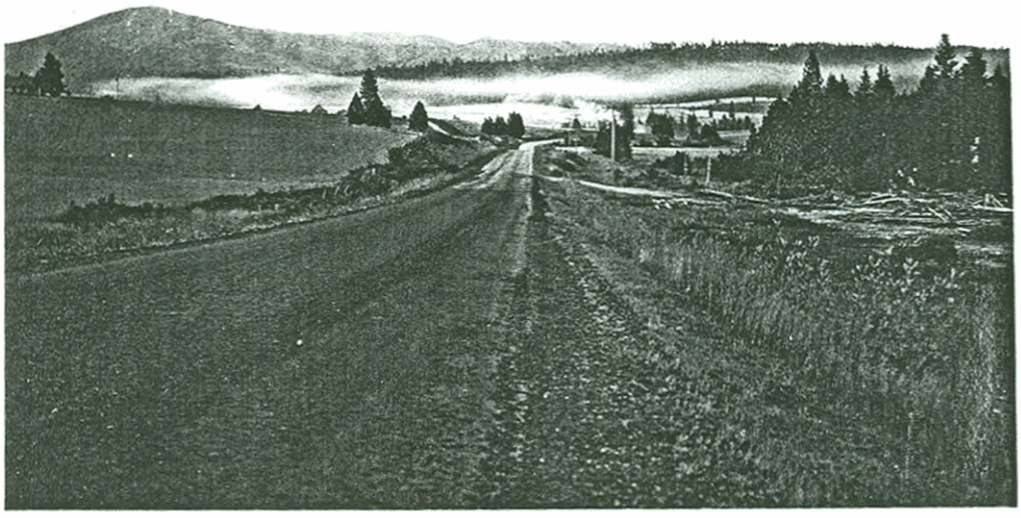
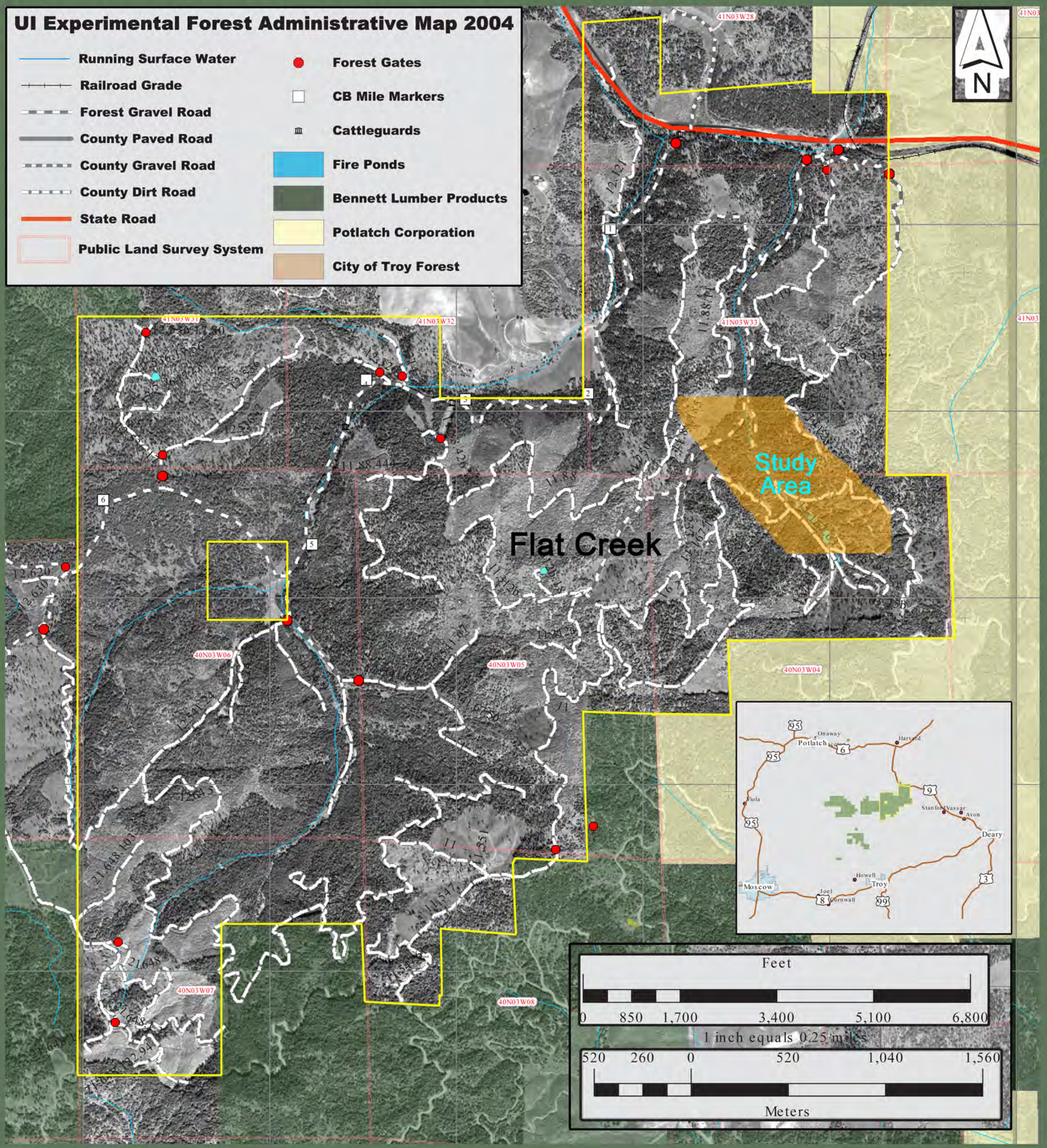


Figure 44

Visible evidence of evening air drainage in southern Benewah county, Idaho. The smoke from brush fires comes from up the valley at least a mile to the right. Height of the smoke layer defines the thermal belt.

Figure 45

Snow on Flat Creek Unit


UI Experimental Forest Administrative Map 2004
Running Surface Water
Railroad Grade
Forest Gravel Road
County Paved Road
County Gravel Road
County Dirt Road
State Road
Public Land Survey System
Forest Gates
CB Mile Markers
Cattleguards
Fire Ponds
Bennett Lumber Products
Potlatch Corporation
City of Troy Forest
N
41N03W28
41N03W31
41N03W32
41N03W33
40N03W06
40N03W05
40N03W04
40N03W07
40N03W08
Study Area
Flat Creek
Onaway
Potlatch
Harvard
Viola
Stanford
Vassar
Avon
Deary
Howell
Troy
Moscow
Joel
Cornwall
Feet
0 850 1,700 3,400 5,100 6,800
1 inch equals 0.25 miles
520 260 0 520 1,040 1,560
Meters

Flat Creek

Location of Complete Research:

Author & Title: Kenneth E. Hungerford

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University of Idaho Library:

Call Number- QL 696.G285H86 1951a
DAY-NW SK325.G&H84 (1951)

College of Natural Resources:

Department- Wildlife

Other Sources: University of Michigan