5-1972

Blue Grouse Ecology and Habitat Requirements in North Central Utah

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BLUE GROUSE ECOLOGY AND HABITAT REQUIREMENTS IN NORTH CENTRAL UTAH

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Wildlife Biology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1972

ACKNOWLEDGMENTS

I would like to express my sincere appreciation to Dr. J. B. Low, leader of the Utah Cooperative Wildlife Research Unit, for giving me the opportunity to work on this project and for his continuing guidance and patience during the study.

I would also like to thank the members of my graduate committee: Dr. Donald Davis, Dr. Arthur Holmgren, and Dr. William Sigler for their advice and assistance in many ways during the two years of the research.

Frank Gunnell and Bruce Reese of the U. S. Forest Service deserve special thanks for many hours of help in the field and for continuing constructive criticism. Jack Rensel, Clair Huff, and John Kimball of the Utah Division of Wildlife Resources also provided field assistance and suggestions during the course of the study.

I very much appreciate the help and advice of my co-worker during 1971, Barry Barnes, and wish him well in his continuing studies of the blue grouse.

David A. Weber

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ABSTRACT

Blue Grouse Ecology and Habitat Requirements

In North Central Utah

by

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Utah State University, 1972

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Department: Wildlife Resources

The ecology and habitat requirements of a population of blue grouse were studied during 1970 and 1971 on the Cache National Forest 25 miles south of Logan, Utah.

Baseline data concerning numbers of blue grouse, vegetative composition, and insect abundance on the study area were gathered. These data were to be compared to similar measurements made following a herbicidal spraying of the area during 1972.

Information concerning the breeding, nesting, brood rearing, and wintering habits of the grouse was also collected. Male blue grouse migrated to the study area in early April to set up territories. These were located on open tree-shrub hillsides. Seven nests were located under sagebrush bushes. About 18 to 20 broods were on the study area during 1971. Young grouse consumed insects primarily during the summer. Males migrated from the area by July and females and broods moved off in late August and early September.

(83 pages)

INTRODUCTION

The blue grouse, Dendragapus obscurus, is a common resident of the mountainous forest country of western North America. It is important as a game bird over much of its range and is particularly interesting because of its colorful mating displays and unusual "reversed" migration. Blue grouse usually move to higher elevations during the fall months where they spend the winters, subsisting primarily on the needles of conifers, mainly firs. They migrate downward in elevation in the spring to breed and raise their young in the foothills. Good blue grouse populations are present on the Cache National Forest of northern Utah and southern Idaho.

Little is known of the life history or specific habitat requirements of the blue grouse in Utah. Because of this lack of basic information, it has to date been impossible to consider the effects on blue grouse of various land uses when formulating management plans. Therefore, part of the reason this research was undertaken was to gather general information about the habits of the blue grouse in Utah. More important, however, was the opportunity to study the effects of a specific range management practice, herbicidal spraying, on a population of blue grouse. Herbicidal spraying to remove or reduce certain plants, most commonly sagebrush (Artemisia spp.), is a frequently used habitat manipulation technique in the western United States. The United States Forest Service has planned to spray certain parts of the Cache National Forest in Utah to reduce stands of mule ears (Wyethia amplexicaulis), a common forb of western ranges. The purpose of the spraying is to encourage grass growth, thereby improving potential for livestock grazing, creating better watershed characteristics, and hopefully improving the area for wildlife.

One of the locations designated for spraying was heavily used by blue grouse for breeding, nesting, and brood-rearing. It was decided to make a study of the blue grouse on this area to determine the long and short term

effects of the spraying and vegetation change on their use of the area. The present study is a pre-spraying evaluation of the blue grouse on the study area. Herbicidal spraying with 2-4 D (2, 4-dichlorophenoxy acetic acid) is to take place during June of 1972. The research reported here began in April of 1970 and the field portion of the work was completed in October of 1971. Further research on the effects of the spray treatment will be made by other investigators during and after the actual treatment in 1972. A follow up study several years later will reveal any long term effects of the treatment on blue grouse use of the treated area. A portion of the study area will be left unsprayed as a control for the experiment.

The general goals of this study are to: 1) obtain prespraying data concerning the blue grouse use of the study area for eventual comparison to post-spraying data gathered by other investigators; and 2) gather as much basic information as possible about the ecology and habitat requirements of the blue grouse under study.

When the long term results are obtained from the study of effects of herbicide spraying on blue grouse it will be possible to make recommendations when future spray operations are being considered in areas used by blue grouse. General information on the ecology of Utah blue grouse obtained from this research has been translated into management recommendations and suggestions for further study which are reported in the latter part of this paper.

The blue grouse is worthy of study because it is a game bird which is probably being underharvested in Utah at the present time. In the future, with increasing demand for recreation in the form of hunting, the blue grouse could provide much sport. Blue grouse populations have to date withstood the pressures of civilization fairly well. This is primarily because the bird's habitat consists of areas which have not been desirable for human use. With rapidly expanding human populations, however, the

pressures for use of even more remote areas will mount. It seems wise, then, to learn as much as possible about the blue grouse and its requirements for survival now and act appropriately to maintain its numbers in the future.

Literature Review

Two studies of limited scope have been made on blue grouse in Utah. Nygren (1962) reported briefly on the blue grouse of the west slope of the Bear River Range in northern Utah. He described mating behavior, various calls made by chicks and adults, general habitat, and local movements. Maestro (1971), working in the same area, more thoroughly described general habitat requirements, trying to quantify various factors affecting the location of blue grouse. He also presented some observations of blue grouse breeding behavior.

Some blue grouse research has been done in the states nearest to Utah. Rogers (1968) reported on the blue grouse in Colorado. He found them at elevations from 6,000 to 12,700 feet in areas where brush or trees were present. The peak of hatch for Colorado occurred during the latter part of June. Broods were active in the early morning and late evening. They were observed only in areas where shrubs were present.

Marshall (1946), working in southern Idaho, reported that the birds remain on high ridges from October through March, using conifers for both food and cover. In May, June, and July, they moved to lower elevations and used the flowering parts of various plants for food. In late July and August, broods and females were encountered along streams, while males had moved to higher timber types. The food of the broods at this time was insects, berries, fruits, and leaves of various shrubs. By mid-September the females and broods had joined the males on higher ridges.

Blackford (1958, 1963) described male territoriality and breeding behavior in northwest Montana. He found that the males had well established

territories in the spring and that the females were attracted by male "hooting." He described in detail many vocal calls and "wing notes" used by both sexes during courtship rituals.

Mussehl (1960) studied Montana blue grouse during 1957 and 1958. He observed a minimum of 7 males on a 17 acre area during the breeding season. He located and described 3 nest sites. Hatching dates ranged from May 25 to July 14 with a peak of hatch during the third week of June. Broods stayed within a 1/2 square mile area on the summer brood range. Dispersal from the summer brood-rearing area began in late August and was well under way by mid-September. Movements of up to 3.4 miles were recorded. Seven and 12 percent of the birds he banded showed up in hunter's bags during the two years of the study respectively. Hunting was considered to be a minor influence on the population. Mussehl (1963) also studied cover selection by broods during the summer. Broods were found in herbaceous cover with consistent characteristics of height, canopy cover, and plant interspersion. Mussehl's work would seem to be the most comparable to the present study because of the similarity of the study areas and the similar nature of the investigations.

More extensive research has been conducted in Washington state and British Columbia by Bendell (1955a, 1955b), Bendell and Elliott (1966, 1967), Zwickel and Bendell (1967a), and Zwickel, Buss, and Brigham (1968). These studies are probably of less relevance to the present study because: 1) different subspecies of blue grouse were involved; 2) the habits of the coastal subspecies differ substantially from the subspecies in Utah; and 3) the topography, weather, and vegetation of the coastal study areas differ considerably from Utah conditions.

Food habits of the blue grouse have been studied by Beer (1943), Stewart (1944), and Boag (1963). They found that the winter diet consisted of from 90 to 100 percent conifer needles, mainly fir. The summer diet,

on the other hand, was quite varied. The adult birds consumed berries, seeds, leaves, insects, fruits, needles, and flowers. Young grouse ate insects almost exclusively during the first weeks after hatching but gradually added more berries and other plant foods during the late summer and early fall. By winter their diet was, like their parents, made up of conifer needles.

Methods for determining sex and age of blue grouse have been well documented. Sex of adult birds in the hand can be determined by plumage color alone. Juvenile sex may be determined by examining the cervical region for underlying white feathers which surround the air sacs of males (Caswell 1954). Age of juvenile blue grouse may be determined by the molt and growth pattern of the innermost eight primaries (Zwickel and Lance 1966, Schladweiler, Mussehl and Greene 1970). Yearling birds may be distinguished from adults since they retain the two outermost primaries to their second fall (Buss and Schottelius 1954) and since the average length of the outer pair of rectrices is shorter in yearlings than adults (Bendell 1955c).

Numerous methods for capturing blue grouse alive have been attempted. The most successful have been: noosing grouse with a long pole (Zwickel and Bendell 1967b), driving broods into a net trap equipped with long wings to funnel the grouse (Tomlinson 1963), and hand netting individual birds (Mussehl 1960). Stirling and Bendell (1966) used recorded calls of females and chick distress calls to aid in capturing and censusing blue grouse. Mussehl and Schladweiler (1969) used mist nets to trap radio-equipped blue grouse in Montana.

Several authors have studied or made observations on the migration habits of blue grouse. Fowle (1960) stated that the grouse descend to the lowlands in late March or early April in British Columbia. He said that most of the adult males returned to higher elevations by the end of July and that the females and broods had left the lowlands by the end of September.

Zwickel, Buss and Brigham (1968) reported that autumn migrations of blue grouse may be much longer in distance than was previously believed. The longest movement recorded was 31 miles. Half of the birds recovered were over 5 miles from the point of original capture. Most of the band recoveries during this Washington study were from elevations between 3,000 and 5,000 feet above sea level. Wing, Beer and Tidyman (1944) presented impressions of the fall migration in Washington and discuss brood breakup in late summer. Wing (1947) discussed the literature concerning blue grouse migration. The data presented were mostly sketchy, with little numerical data and many individual observations.

OBJECTIVES

The three general objectives of the study were:

1) To determine the numbers and distribution of the blue grouse on the study area. Obviously, to compare the use of the study area by blue grouse after the herbicidal spraying takes place to pre-spray conditions requires data on the total number of blue grouse present before the spraying and some knowledge of where the grouse were located on the study area. This information is also useful in comparing the population under study to other populations from the standpoint of density per unit area or relative quality of habitats as measured by population density.

2) To obtain numerical descriptions of the pre-spraying vegetative composition and insect populations on the study area. Knowledge of the vegetative characteristics before spraying is important because the effects on the spray on the vegetation can be monitored over time using these data as a starting point. Measurements of the vegetation after spraying will indicate which plant species have been reduced or increased by the treatment. This information will be important in trying to determine the causes of any changes in grouse use of the sprayed area. During the summer, blue grouse, especially the young of the year, depend heavily on insects for food. The spraying should not effect the insects directly, but changes in the vegetational composition may cause insect numbers or species composition to change. Such changes could be important as factors in explaining any post-spray changes in blue grouse numbers or reproductive success. Therefore, studies of the insect life on the study area were made.

3) To collect data concerning the breeding, nesting, brood-rearing, and wintering habits of the blue grouse on the study area. General ecological information is important and necessary so that any post-spray changes in the habits or behavior of the blue grouse may be detected and described. It is also valuable in making management recommendations for better management of blue grouse in general in the state.

DESCRIPTION OF THE STUDY AREA

The study area was located 23 miles south of Logan in Cache County, Utah (Figure 1). A semi-improved road, Utah Rt. 162, ran through the center of the area. The entire study area was within sections 20, 21, 28, and 29; T. 8 N, R. 1 E. Most of the area was on federal land as a part of the Cache National Forest, but the eastern edge of the area was privately owned.

The research on breeding, nesting, and brood-rearing was done on a 1 1/2 square mile tract of rolling to hilly land lying in a low spot. James Peak, a 9400 foot high mountain, was just to the east of the area and a low ridge borders the area on the west. The elevation of the study area itself varied from 6200 to 6600 feet above sea level.

Summer weather on the study area was mild. Summer daytime temperatures seldom rose out of the 80's and on summer evenings the temperature usually dropped only to the 40's or 50's. The area was under snow cover from late November to April. Snow depth was 3 to 4 feet over most of the terrain. Summer precipitation was rather low, inclement weather almost never occurred for more than a day at a time. Occasional light showers were caused by clouds rising rapidly over nearby James Peak.

The dominant vegetation on the study area during spring and summer was mule ears, black sagebrush (Artemisia nova), and big sagebrush (Artemisia tridentata). Many grasses were present, the most common being various species of the needle grasses (Stipa spp.), bluegrasses (Poa spp.), and wheatgrasses (Agropyron spp.). Some of the most common forbs on the study area were: wild onion (Allium spp.), lupine (Lupinus spp.), yarrow (Achillea millefolium), tarweed (Madia glomerata), knotweed (Polygonum douglasii), microseris (Microseris nutans), and ground smoke (Gayophytum diffusum). Some ephemeral forbs which were present in the spring but soon disappeared were: buttercup (Ranunculus spp.), collinsia (Collinsia

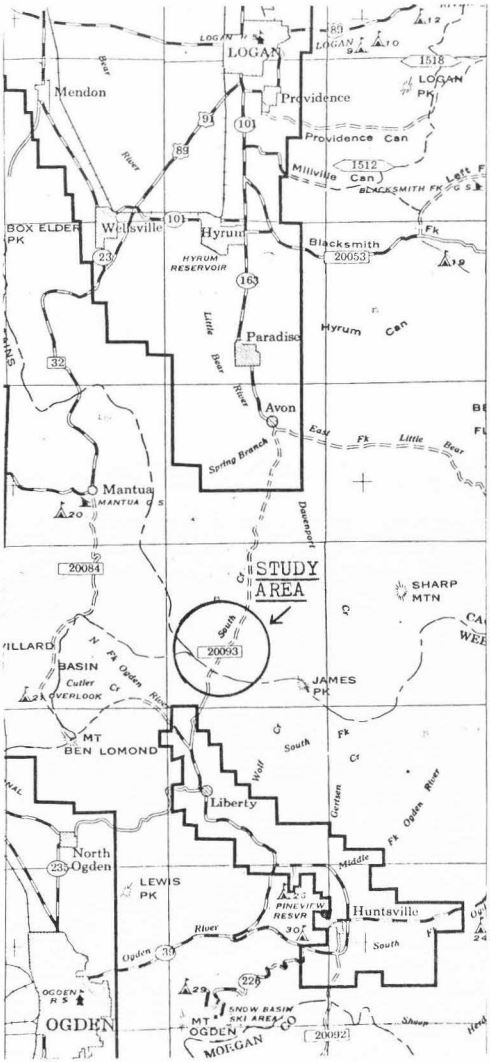


Figure 1. General location of the blue grouse study area 23 miles south of Logan, Utah.

parviflora), spring beauty (Claytonia lanceolata), groundsel (Senecio spp.), and false mermaid (Floerkea prosperpinacoides).

Some of the tree species present as islands on the study area proper and as stands on the surrounding hillsides were: quaking aspen (Populus tremuloides), Rocky Mountain Juniper (Juniperus scopulorum), curlleaf mahogany (Cercocarpus ledifolius), bigtooth maple (Acer grandidentatum), and Gambel's oak (Quercus gambelii). At higher elevations on slopes surrounding the study area conifer forest, primarily Douglas fir (Pseudotsuga menziesii), was present. The most common shrub species on the area were: chokecherry (Prunus virginianus), snowberry (Symphoricarpos oreophilus), and wild rose (Rosa woodsii).

A rather wide variety of birds and animals were present on the study area during the spring and summer. Some of the birds which were spring nesters are the mourning dove (Zenaidura macroura), Brewer's blackbird (Euphagus cyanocephalus), a sparrow (probably the vesper sparrow, Pooecetes gramineus), killdeer (Charadruis vociferus), common snipe (Capella gallinago), red-shafted flicker (Colaptes cafer), and the mallard duck (Anas platyrhynchos). Ruffed grouse (Bonasa umbellus) and sage grouse (Centrocercus urophasianus) were present in small numbers. Hawks were rather common on the study area, many different kinds being identified. A group of several sparrow hawks (Falco sparvarius) took up residence on the area for a few weeks during the summer of 1971. At least one male ring-necked pheasant (Phasianus colchicus) was present during the spring of 1971.

Small mammals were common on the study area. Some of the frequently encountered species were the northern pocket gopher (Thomomys talpoides), deer mouse (Peromyscus maniculatus), vole (Microtus spp.), porcupine (Erethizon dorsatum), striped skunk (Mephitis mephitis), yellow-belly marmot (Marmota flaviventris), whitetail jackrabbit (Lepus townsendi), cottontail (Sylvilagus spp.), and various chipmunks and squirrels.

The only large mammals seen on the area, and these only rarely, were the mule deer (Odocoileus h. hemionus) and the coyote (Canis latrans).

Leopard frogs (Rana pipiens) were common along the waterways on the study area and some unidentified salamanders were present in some of the cattle ponds in the vicinity. Several species of snakes were observed, but to the relief of this observer rattlesnakes were not among them. Some trout were residents of the streams crossing the area, but were not observed closely enough for positive identification as to species.

Numerous small streams, springs, and seeps provided the area with water well into the summer. One of the larger springs was the origin of the south fork of the Little Bear River.

Several Indian artifacts were found near one of the springs on the area. These were identified by Dr. Gordon Keller, Utah State University anthropologist, as being several thousand years old and rather unusual because of their extreme age.

At the time of this study, the study area was mainly important as a watershed and recreational area. It was comparatively heavily used during the summer by campers, sightseers, and motorbike enthusiasts. It was hunted in the fall, mainly for grouse, and was heavily used for snowmobiling during the winter, The privately owned land just east of the study area was grazed extensively by sheep all summer. Cattle grazing was technically not allowed on the study area but cattle wandering from nearby grazing allotments commonly used the area.

The general topography and vegetation types present are detailed in Figure 2 and 3. Mule ears, the plant for which the area will be herbicidally sprayed occurred in dense stands (Figure 4). Big sagebrush was a common plant on the area (Figure 5). This species was important, along with the lower black sagebrush, as feeding and nesting cover for the blue grouse.

Figure 2. A view of the south end of the study area showing general topography and vegetation types. (Photo by Dr. J. B. Low)

Figure 3. The center of the study area. The aspen trees in the l. background were heavily used by grouse. (Photo by Dr. J. B. Low)

Figure 4. A dense stand of mule ears, the most common plant species on the study area. (Photo by Dr. J. B. Low)

Figure 5. Big sagebrush, a common species on the study area, was important to grouse as cover. (Photo by Dr. J. B. Low)

METHODS

Determining the numbers and distribution of blue grouse on the study area

Two separate population size estimates were obtained during this study, number of territorial males and the number of broods on the study area.

Locating territorial males. Two methods were used in locating territorial male blue grouse. First was the technique of searching likely areas on foot, snowshoe, or horseback until a male was flushed. Dogs were usually used during these searches. When a male was flushed, its location was plotted on an aerial photograph of the area. Continued flushing of male blue grouse from a locality was taken to indicate a territory located there. The second technique used was one described by Stirling and Bendell (1966) in which the recorded call of a female grouse is played by portable tape recorder near likely male territories. This technique was used during both years of the study with moderate success. The male blue grouse, upon hearing the recorded female call, often left his protective cover and walked into view of the observer in full mating display. The colorful display posture made it possible to see the male grouse, which would ordinarily be nearly impossible. The recorder can obviously be used in combination with searching with dogs. Several of the male territories were found or confirmed with the help of the recording. By noting the locations where male blue grouse were flushed during random searching, and taking into consideration males which responded to the recording, the locations of male blue grouse territories were plotted on aerial photos.

Searches for territorial males were carried out from mid-May through June of 1970 and from late March through June during 1971.

Determining the number of broods. Obtaining an estimate of the number of blue grouse broods on the study area was a greater problem than determining the number of territorial males. This was true because

the broods do not remain in the same general locality as do the territorial males. The broods continually move from place to place and it is therefore difficult for an observer to determine whether he is seeing one brood repeatedly or several broods. Some broods can be distinguished from others by noting the number of young in the brood or by the comparative age of the young. These factors are not very reliable, however, since the number of young in a brood may change as a result of mortality and because age determination using relative size as a parameter is rather subjective to begin with.

It was determined that the only practical method for obtaining an estimate of brood numbers was to capture and color-mark hens or young grouse from various broods. This technique was worked out during 1970 and successfully put into practice during 1971.

The first step in capturing blue grouse hens or young is to locate broods. Searches of likely areas on foot or horseback using dogs were moderately successful in locating broods. Success in finding broods was very poor during the first part of the 1970 season until, through experience, areas used most frequently by the broods were delineated. Broods consisting of chicks less than 3 weeks old were especially hard to find during both years of the study. Dogs helped in locating broods by scenting. It was discovered that the broods, especially those with chicks under 3 weeks old, often hold without flushing even upon extremely close approach by an observer. Since it is all but impossible to spot an immobile blue grouse, even in low cover, many broods are easily overlooked without the aid of a dog.

Usually, a brood was located when some or all of its members flushed. The technique in cases where only part of a brood flushed was to walk slowly through the area in order to visually locate other members of the brood which had not flushed. If this proved unsuccessful, or if it was felt that the entire brood had flushed at first, the procedure was to move in the direction that most of the flushing grouse had flown. It was often possible to locate, by

careful searching, young grouse hiding in the ground cover or perched in trees.

Once the location of a grouse was known, a noosing pole was used in the actual capture operation. The poles used during this study were 15 foot long telescoping fishing poles. A noose of about three inches in diameter was attached to the narrow end of the pole. The technique consisted of getting within 15 feet of the grouse, lowering the noose over its head, tugging the pole to tighten the noose around the neck of the bird, releasing the pole, and capturing the snared bird by hand to quickly remove the noose in order to prevent injury. This is the technique described by Zwickel and Bendell (1967b). Grouse were captured on the ground and from trees using this method (Figure 6).

Once the grouse were in hand, they were banded with aluminum leg bands obtained from the Utah Division of Wildlife Resources. During 1970, silver bands only were used. In 1971, combinations of colored and silver bands were used in an attempt to allow identification of birds at a distance. Juvenile grouse were color-marked by safety pinning colored streamers through the skin at the back of their necks. During 1970, these streamers were made of plastic mending tape and were about 5 inches long. It was discovered that these tags did not remain on the grouse well, and in 1971 3 inch long tags made of flexible vinyl material were used with success. Both the 3 inch and 5 inch long tags were about 1/2 inch wide. The streamers were readily visible from some distance when the young grouse flushed. Different color combinations were used so that individuals could be recognized on the wing.

At the suggestion of my co-worker, Barry Barnes, we placed plastic tape on the tail feathers of many of the grouse captured during 1971. The tail feathers are spread in flight and the colored tape, applied in various patterns on the tail, helps in recognizing individual birds. The tape is lost, of course, during the fall molt of tail feathers but provides a good aid to identification during the summer.

Figure 6. The author uses a 15 foot long noosing pole to capture blue grouse for banding and color-marking. (Photo by Dr. J. B. Low)

Poncho markers, as described for sage grouse by Pyrah (1970) were used to mark two yearling grouse which were captured and released. These tags were rectangular vinyl strips, 2 inches wide by 7 inches long. A circular hole just big enough to fit over the head of a blue grouse is cut in the center of the strip. The head of the captured grouse is pushed through the hole and the tag is worked down around the neck of the grouse and is held in place by the neck feathers above the tag. One flap of the tag extends down in front of the bird and the other end is on the bird's back. The tags were numbered with permanent black ink, and the numbers were visible when the birds were flushed.

All of the information used in estimating the number of broods on the study area was obtained during the 1971 season of research. As the grouse were captured, marked, released and resighted records were kept of the number of broods from which at least one bird had been marked. A number of sightings of marked birds were made during the last half of the summer. From the data on the number of broods containing marked grouse and observations of marked and unmarked broods during the latter half of the summer, an estimate of the total number of blue grouse broods using the study area was made. The location of each brood sighting was noted at the time of flushing in order to form a picture of the distribution of the broods and to learn which habitat types were preferred by them.

Obtaining numerical descriptions of the pre-spraying vegetative composition and insect populations on the study area

Vegetational analysis. In order to allow for continuous monitoring of changes in the vegetation on the study area, six line transects were established on the study area. The transects were placed with the objective of obtaining representative sampling of the portions of the study area to be herbicidally sprayed. The transects were thus all established in the open

sage-mule ears flats rather than the wooded parts of the study area because the forested portion will not be sprayed with the herbicide. Two of the six transects were placed on the control portion of the area, which will remain unsprayed. Figure 7 is a map of the study area showing the location of the control portion of the area and the location of the six transects. The transects are numbered 1 through 6 for convenience.

Each of the six transects was 400 yards long. The vegetation along the transect lines was sampled utilizing a method developed by Daubenmire (1959). A 20 by 50 cm metal frame was placed along the transect line at 10 yard intervals. A ten yard long rope was used to determine the spot to be sampled. Position on the transect line was maintained by visually sighting in on the end marker of the transect and walking toward it. The metal frame was placed on the ground alongside the end of the measuring rope every ten yards. The vegetation within the rectangular frame was viewed from above (Figure 8). The observer estimated the total canopy coverage of each plant species within the frame. Rather than estimating exact percentages for each species, six percentage classes were used: 0-5%, 6-25%, 26-50%, 51-75% 76-95%, and 96-100%. Thus, a single tiny yarrow plant within the frame would be rated class 1, 0-5%, while the rating for mule ears nearly covering up the frame would be class 5 (76-95%) or class 6 (96-100%). An estimate of percentage canopy coverage was made for each species of plant within the frame. Forty plots made up a transect line, so that at the end of each transect an average canopy coverage figure for each species present could be calculated. In addition to plant canopy coverage, ground cover percentages of litter, bare ground, and rock were also calculated. In figuring average canopy coverage for a transect for one species of plant, the midpoints of each percentage class were used. For instance, a plant which was rated class 3 (26-50%) would be considered to have a density of 37.5% for purposes of calculation of average percent canopy coverage. For example, suppose a transect was run and 40 class

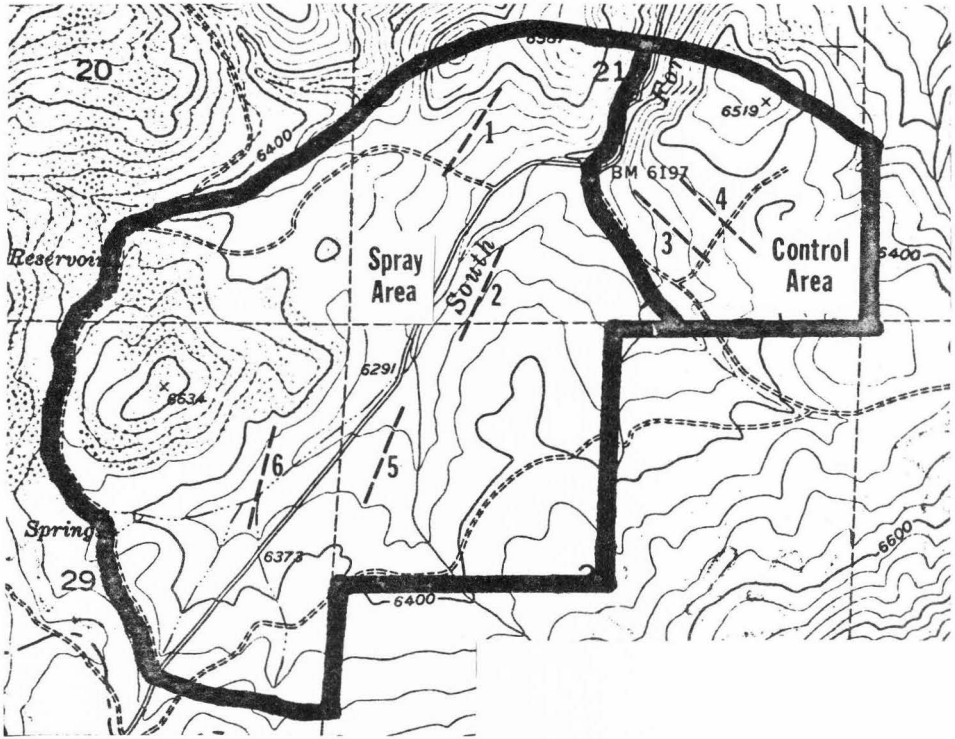


Figure 7. Control and spray portion of the study area on the sampling transects. 4 inches = 1 mile

estimates were obtained for mule ears, one for each plot read by the observer. The estimates would be distributed thusly:

Class	Range	Midpoint	No. of Observations in Class
1	0-5%	2.5%	2
2	6-25%	15.0%	5
3	26-50%	37.5%	11
4	51-75%	62.5%	12
5	76-95%	85.0%	8
6	96-100%	97.5%	2

Total samples = 40

To determine average percent canopy coverage for mule ears in this example, first the number of estimates in each class is multiplied by the midpoint of the class:

2 x 2.5%	=	5.0
5 x 15.0%	=	75.0
11 x 37.5%	=	412.5
12 x 62.5%	=	750.0
8 x 85.0%	=	680.0
2 x 97.5%	= +	195.0
Total		2117.5

The total percentage figure, 2117.5 is divided by the sample size (40) to obtain the overall percentage canopy coverage for mule ears on this particular transect:

$$\frac{2117.5}{40} = 52.9\%$$

Confidence limits at the 95 percent level were placed on the average canopy cover figures using the formula:

$$\bar{X} \pm t_{(n-1,\ 1-\alpha/2)} \times s.d./\sqrt{n}$$

Using these methods, average percent canopy coverage values were obtained for all the significant plant species encountered on the six transect lines. The vegetation transects were read only once during 1970 when the

technique was being perfected and plant identification was sometimes uncertain. During 1971, a regular schedule for reading the transects was established. The transects were read three times, during the first weeks of May, June and July.

Analysis of insect populations. Analysis of insect populations on the study area was divided into three components: 1) collection and classification of small insects during the period just after the peak of hatching for the blue grouse; 2) determination of the number of grasshoppers on the study area during August; and 3) monitoring of changes in the activity of mound ants on the study area.

Collection of small insects was made during the period immediately following the peak of hatch because of the fact that young blue grouse rely heavily on small insects such as ants, beetles, and larvae. It was felt that by sampling during this period, those insects which were most important to the diet of the young grouse would be obtained. Samples were taken during two periods of 1971, June 29-30 and July 13-14. Sampling was done along the same transects used for the vegetation analysis. Insects were collected using a backpack vacuum insect sampler, trade name D-VAC (Figure 9). A gasoline motor is carried on the back of the investigator. It powers a vacuum pump which pulls insects and debris into an extendable funnel and captures them in a net. The size of the circular funnel opening used during all of our sampling was one square foot.

To take the samples, the machine operator placed the net in the funnel, started the motor, and paced off 50 yards to the first sampling point. At the sampling point, the operator stopped and took ten square foot samples by placing the funnel down on top of the vegetation ten times in a semi-circle in front of him. When this was completed, the bag of insects and debris was removed from the machine, placed briefly in a large jar containing carbon tetrachloride fumes, and the contents were then transferred to a

Figure 9. The author using a backpack insect sampler to make small insect collections. (Photo by Dr. J. B. Low)

plastic bag for storage. The operator then started the machine and moved on 50 yards to the next sampling point.

Eight samples were taken at 50 yard intervals along each of the six transect lines. Thus, a total of 48 samples was taken during each of the sampling periods. The 96 samples were frozen until they were examined. The first step in the examination consisted of removing the insects from the litter in each sample. The insects were placed in plastic vials, one vial for each sample. The insects from each sample were then classified and counted. The total weight of insects from each sample was determined using an analytical balance. The average number of insects from each group on each transect was calculated, as was the average weight of insects per sample on each transect.

Grasshoppers played an important part in the diet of both adult and juvenile blue grouse on the study area, especially during the latter part of the summer. Because of this, it was decided to make a determination of grasshopper numbers apart from the small insect counts made in early summer. To accomplish this, a grasshopper sampling method developed by the U. S. Department of Agriculture (U.S.D.A., 1969) was used. Mr. Jack Judd of the U. S. Department of Agriculture, Plant Pest Control Division introduced the method to us and demonstrated its use on the study area so that we could become proficient enough to produce reliable results. The method revolved around being able to visualize a square foot of ground on the area to be sampled for grasshoppers. The observer moved through the sample area and visually located a particular square foot of ground a few yards in front of him. Keeping his eyes on the square foot decided upon, the observer walked toward it and simply counted the number of grasshoppers which hopped into or out of the square foot as he approached. The method sounds rather difficult at first, but with practice is simple and quick to apply. The grasshopper counts, like the small insect counts, were made along the six transect lines previously established. Thirty-six square

foot plots were counted on each of the six transects. The investigators walked from one end of the transect toward the other and counted the grasshoppers in square foot plots at about ten yard intervals. A total count for each transect was obtained and a grasshopper per square yard average obtained for each transect as follows:

$$\frac{\text{Total Count on Transect}}{4} = \text{grasshoppers/square yard}$$

Two counts of grasshoppers were made, August 11 and 17, 1971.

Mound building ants are common on many parts of the study area. Since young blue grouse are known to eat ants to some extent, it was decided that the mound building ants might be of some importance in the survival of young grouse. In order to test the effects of the herbicidal spray on the mound ants, fifty active ant mounds were marked with numbered wooden stakes. Ten of the marked mounds were on the control slope and forty on the spray portion of the study area. The idea behind this procedure was to check the mounds periodically to determine if they were still in active use by the ants. Since the same mound is usually used by ant colonies for several years (Dr. Donald Davis, personal communication) it was felt that the marked mounds would naturally become inactive at a slow, steady rate. This being the case, any sudden drop in activity following the herbicide spray could be attributed to the effects of the spray. The mounds were staked out on June 8, 1971 and checked for activity on August 12, 1971 and September 20, 1971.

The obvious disadvantage to this ant mound monitoring system is that if the spray causes an increase in ant mounds it will not be detected by this system. Only deterimental effects are determined.

Collecting data concerning the breeding, nesting, brood-rearing, and wintering habits of the blue grouse on the study area

Much of the general information obtained for this objective was collected in the course of working on the first two objectives. Some of the work was, however, independent of the population studies.

Breeding habits. All of the information obtained concerning the breeding habits of blue grouse was obtained during the searches for territorial males previously described.

Nesting habits. Searches for nests were conducted soon after the breeding season during both years of the study. Search methods were identical to the methods used for brood searches except for the fact that the searchers were always on the alert for the signs of eggs or eggshells in likely nesting areas. Nests proved very difficult to locate because of the well hidden locations chosen by the nesting hens and because of the fact that hens on nests hold extremely tightly. In two cases, it was literally necessary to step on the female before she flushed from the nest. When nests were located, all pertinent information concerning the nesting site was collected. Nests which were active when discovered were revisited at intervals and data collected concerning clutch size, length of incubation, nesting success, and date of hatch. All eggs from blue grouse nests which did not hatch were collected and measured using standard egg measurement techniques.

Brood-rearing habits. Broods were located using the methods previously described. When a brood was flushed, data were recorded concerning the location, topography, vegetation, and other aspects of the sighting point. During 1971, these data were recorded on the blue grouse observation form shown below:

Blue Grouse Observation Record U.C.W.R.U. No. 70 5-27-71

Bird No._____ L. Leg Band No. _____ R. Leg Band No. _____

Pancho: Color_____ No. _____ Tail Mk.: L_____ R_____

Juv. Mark _____ Observer _____

Date_____ Time _____ Weather _____

AdM YM AF YF B Ch Found by: Dog Observer Brood Size:_____

Juv. Age: 1 2 3 4 5 6 7 8 9 10 11+ Drop. Coll.:_____

Flush: Dist. _____ Dir._____ Captured:_____ Blood:_____

Weight:_____ % slope _____ aspect_____ elev._____

Gen. Loc.: _____ Veg. Type:_____ Dist. from trees: _____

Grid No._____ Specific Loc.: _____ Actual Location:_____

_____

_____

To obtain information on the food habits of the young blue grouse, collections of crop samples were made by shooting young grouse during both years of the study. Crops were also collected from hunters during the hunting season. Some of the collections were made off of the study area proper in order to avoid unnecessary mortality to the birds under study or disturbance of grouse on the study area caused by shooting. The crop samples were analyzed in the laboratory. The volumes of all food items was measured and recorded.

During 1971, blue grouse droppings from both adults and juveniles were collected in order to supplement the crops as indicators of food habits of the grouse. The droppings were examined microscopically in the laboratory in an attempt to obtain some impressions of food habits.

In order to test for blood diseases among the grouse under study, blood smears were made from ten of the grouse captured alive. These smears

were microscopically examined for blood diseases or parasites by Dr. Smart of the Veterinary Science Department of Utah State University.

Age of the juvenile blue grouse captured or shot was estimated using the method of Zwickel and Lance (1966) during 1970 and the updated method of Schladweiler, Mussehl and Greene (1970) during the 1971 season of study. Back dating was used to obtain estimated hatching dates for the broods so that a peak of hatch could be determined.

Records were kept of the number of young per brood over the two years of the study. These were totaled by month of the year and average brood sizes for each month obtained. This information was useful in estimating production.

Wintering habits. Searches were made of the fir forest areas nearest to the study area during late fall and early spring of 1970-71. Snowmobiles and snowshoes were used to gain access to the snowbound hillsides.

RESULTS

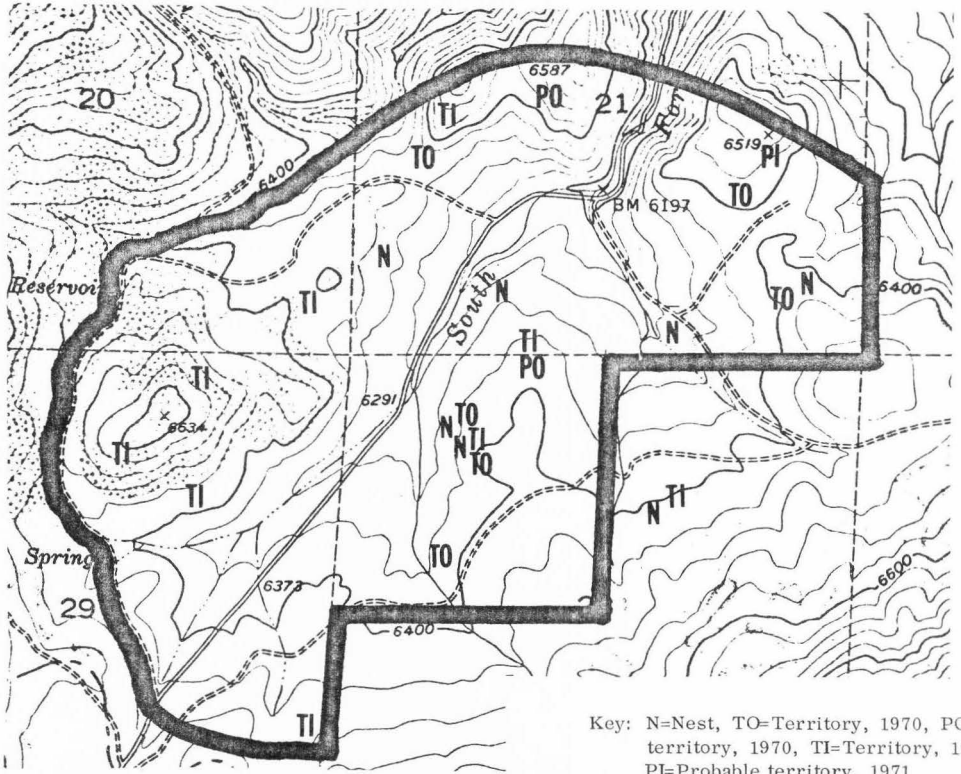
Numbers and distribution of blue grouse

Male territories. During 1970, six definite male territories were located. In addition, two locations which may have been territories, but for which inconclusive data were available, were located. It was felt that the six territories located were by no means all the male territories on the study area. Because of the late start of field work in the spring of 1970 and the initial lack of experience a good count was not obtained.

During the field work of 1971 a better count of male territories was made. Field work was begun early and the experience of 1970 was helpful in locating territorial males. A total of eight male territories and one possible territory was located on the study area during 1971. In addition, one male territory was located about 200 yards to the east of the study area proper. The locations of all the male territories and possible territories located during both years are plotted on Figure 10.

Of the fourteen definite territories located during the two years of the study, two were on the control portion of the area and twelve on the spray portion. Of the twelve, nine were located such that they might be affected by the herbicidal spray. The other three territories were located in wooded locations which will not be sprayed. The male territory to the east of the study area should not be effected by spraying of the study area.

The distribution of the male territories, as shown on Figure 10, is rather even over the entire study area. There was some indication during the spring of 1971 that males migrating onto the study area chose for territories those areas from which the snow melted first. Nine of the fourteen definite territories were located on or near south-facing slopes which became clear of snow earlier than most of the study area. This phenomenon has been documented experimentally for black grouse (Lyrurus tetrix) in Finland (Rakkolainen 1971). In that study, soot was experimentally placed on the snow to



Key: N=Nest, TO=Territory, 1970, PO=Probable territory, 1970, TI=Territory, 1971, PI=Probable territory, 1971

Figure 10. Locations of territories and nests on the study area during 1970 and 1971. 4 inches = 1 mile

melt particular portions sooner than others in the spring. Grouse and their nests were found to be appreciably more abundant in the experimental area than on control areas. It is possible that to some extent male blue grouse select early snow melt areas for their territories.

Brood numbers. The number of broods on the study area was estimated from observations of color-marked grouse during the summer of 1971. No firm estimate was possible during 1970 because the number of grouse caught and marked was too small. In addition, the colored tags used to mark the grouse during 1970 were inadequate.

During 1971, a total of fifteen blue grouse, two yearlings and thirteen juveniles, were captured. They were banded, color-marked and released. Twelve resightings of these marked birds, including two band returns from hunters, were made during late summer. It was felt that by marking these grouse approximately twelve different broods had at least one color-marked member. Twelve of the thirteen juvenile grouse were caught during the period July 7-28, 1971. Young grouse from four different broods were captured on one day, July 27. Using our twelve marked broods as a base for estimation, and adding unmarked broods observed during the period following most of the capturing and marking activities, Barry Barnes and I arrived at an estimate of 18 to 20 broods using our study area during the summer of 1971.

Our estimating techniques are subject to some areas of possible bias. One source of bias would arise if the blue grouse broods were continually moving onto and off of the study area during the summer. This was not the case, however, as was demonstrated by our resightings of color-marked broods. No brood was sighted more than one-half mile from its original location in any of our resightings. Mussehl (1960) supports this observation with his findings that most summer brood movements were restricted to one-half mile or less.

Another possible bias concerns the question of whether or not our color markings stayed on the birds throughout the summer. We believe that most

of our markings were permanent enough. One juvenile blue grouse shot on September 25, 1971, still had its colored neck tag which was applied on July 27, 1971. Many resightings were made of color-marked grouse at least a month following the application of the tags. In addition, some of the young were marked with both neck tags and colored tape on tail feathers. Even if one mark had been lost, the other would likely have remained. We believe that this source of bias was not important.

Mortality of marked grouse was not thought to be an important factor since many of the marked birds were seen repeatedly following the marking. At least three of the fifteen marked grouse survived to the hunting season since two bands were returned and I observed one marked grouse on opening day (September 25, 1971). As with most birds, mortality in young blue grouse is highest during the first two or three weeks of life. All the birds we captured were at least four weeks old and should not have suffered high mortality during the favorable conditions that prevailed on our study area during the last half of the summer.

Table 1 is a summary of the data on the marked grouse which were resighted or shot during 1970 and 1971.

Numerical descriptions of the vegetative composition and insect populations

Vegetative Composition. Composition of the portion of the study area to be sprayed was measured over four vegetation transects. Two additional transects were used to analyze the vegetation on the control area. Average percent canopy cover for each plant species present was measured for each transect. To summarize the data, average percent canopy cover figures were combined within the control and spray transects for each of the three sampling periods (Table 2). Because of the large number of plant species found on the transects, it was impractical to include all of them in the tables. Therefore, only those plant species which were present on at least 15 percent of all 240 plots during any one of the three sampling periods were included.

Table 1. Resightings of blue grouse captured and marked during 1970 and 1971 on the study area and nearby locations.

Grouse #	Date Caught	Age	Resightings	
			Date	Distance Moved[a]
1	9/ 9/70	Juv.	9/26/70	2-5 miles (BR)[b]
2	9/ 9/70	Juv.	9/26/70	less than 1 mile (BR)
3	5/26/71	Yearling	9/25/71	50 yards
4	6/ 9/71	Yearling	6/15/71	300 yards
5	7/ 7/71	Juv.	7/12/71	600 yards
			7/17/71	500 yards
			8/ 6/71	650 yards
6	7/19/71	Juv.	7/23/71	250 yards
			8/10/71	400 yards
			8/13/71	150 yards
			8/17/71	600 yards
7	7/22/71	Juv.	8/26/71	600 yards
			9/25/71	2-3 miles (BR)
8	7/27/71	Juv.	9/25/71	3/4 mile (BR)
9	7/28/71	Juv.	8/14/71	200 yards

[a]Refers to distance from the point of original capture.
[b]Band return.

Table 2. Average percent canopy cover of the more common plant species found on the vegetation transects used to sample the control and spray portions of the study area, 1971.

Plant Species	Percent Canopy Coverage					
	Spray Area			Control Area		
	May	June	July	May	June	July
Litter	64.3(3.8)[a]	59.0(3.8)	51.7(3.6)	62.9(5.4)	55.4(4.0)	55.7(5.8)
Bare Ground	15.6(2.3)	17.8(2.3)	22.9(2.8)	19.6(3.8)	30.2(4.7)	23.7(4.6)
Rock	15.5(2.2)	17.3(2.6)	19.8(2.8)	16.0(3.9)	15.1(4.1)	16.9(3.6)
Forbs						
Achillea millefolium	1.4(0.6)	3.9(1.3)	4.9(1.8)	3.6(1.8)	9.2(3.8)	7.6(2.8)
Allium spp.	11.3(2.2)	7.8(1.6)	5.4(1.2)	10.6(3.6)	6.1(2.0)	5.3(2.6)
Claytonia lanceolata	4.2(1.3)	0.4(0.3)	--	5.4(1.7)	--	--
Collinsia parviflora	1.9(0.6)	4.3(1.3)	--	3.0(1.2)	1.4(0.7)	--
Floerkea proserpinacoides	4.3(1.5)	6.3(2.2)	--	1.2(0.7)	1.2(1.2)	--
Gayophytum diffusum	--	1.8(1.2)	3.3(1.1)	0.8(0.3)	6.7(1.8)	4.3(1.4)
Lithophragma glabra	1.6(0.6)	0.8(0.4)	--	0.4(0.4)	0.3(0.4)	--
Lupinus spp.	1.7(0.8)	2.3(1.0)	2.9(1.5)	3.0(1.2)	4.1(1.0)	8.5(3.9)
Madia glomerata	0.9(0.5)	3.8(1.2)	3.5(1.1)	1.4(1.1)	3.8(1.6)	6.2(2.3)

Table 2. Continued

Plant Species	Percent Canopy Coverage					
	Spray Area			Control Area		
	May	June	July	May	June	July
Microseris nutans	1.9(0.7)	3.5(1.2)	--	1.2(0.9)	2.1(1.0)	--
Polygonum douglasii	--	2.2(0.8)	2.4(0.6)	--	3.5(1.1)	2.7(0.8)
Ranunculus spp.	1.0(0.6)	--	--	2.7(1.2)	--	--
Senecio spp.	4.3(1.2)	4.0(1.4)	--	2.5(1.4)	6.0(2.8)	--
Viola purpurea	1.6(0.7)	2.8(1.1)	1.2(0.6)	1.7(0.9)	1.4(0.9)	1.2(1.1)
Wyethia amplexicaulis	9.7(1.7)	44.2(4.8)	56.4(5.4)	22.6(4.4)	45.2(7.3)	57.5(7.8)
Grasses						
Agropyron spp.	2.4(1.2)	2.3(1.0)	6.3(1.9)	2.8(1.7)	3.7(2.2)	10.1(3.5)
Poa spp.	4.1(1.6)	12.0(2.6)	7.8(2.5)	--	10.1(3.5)	5.9(3.3)
Stipa spp.	1.7(0.6)	5.2(1.2)	10.0(2.2)	2.2(2.2)	3.7(1.7)	5.4(2.8)
Shrubs						
Artemisia nova	18.2(3.7)	19.9(3.9)	24.8(4.6)	26.1(5.7)	34.1(6.6)	31.7(7.1)

[a]The figure in parentheses is the 95% confidence interval for the mean. In this case, the percentage for litter would read: "Sixty-four point three plus or minus three point eight."

Those plant species which did not make up the 15 percent on at least one sampling period were very scarce and their possible importance to the study is minimal. Table 3 indicates percent occurrence of the more common plant species on the spray and control areas during the three sampling periods. Percent occurrence was defined as the percent of sample plots in which the species occurred at least once. Thus, a species which occurred in 80 of 160 plots on the spray transects would have a percent occurrence of 50.

It was obvious that the most common plants on the study area, judging both by percent canopy cover and percent occurrence, were mule ears and black sagebrush. Mule ears had a canopy cover average of over 50 percent during the July sampling on both the control and spray transects. No other plant species approaches this figure in percent canopy cover. Black sagebrush was the species with the second highest canopy cover figures, reaching 25 percent during July on the spray transects and 34 percent during June on the control transects. No other plant species had a canopy cover percentage over 15 percent during any of the sampling periods. As for percent occurrence, mule ears consistently occurred on over 80 percent of the plots on all the transects. Black sagebrush was also second highest in occurrence, being observed on at least 60 percent of the plots on all transects.

Few of the other plant species approached the above-mentioned two in either canopy cover or occurrence. Allium spp. (wild onion) occurred on over 50 percent of the plots on the spray transects during all three sampling periods. Its canopy cover percentage ranged from 5.4 to 11.3 percent over the three periods. Collinsia parviflora (collinsia) occurred on over 50 percent of the plots during the May and June sampling periods on the spray area, but because of the small size of the plant made up only 1.9 and 4.3 percent canopy cover respectively. Lupinus spp. (lupine) did not occur in a high percentage of the plots but because it is a rather large plant, its canopy cover percentages were fairly high over all the transects and sampling periods. Some species, such as Claytonia lanceolata (spring beauty) and Ranunculus

Table 3. Percent occurrence of the more common plant species found on the transects used to sample the spray and control portions of study area, 1971

Plant Species	Percent Occurrence					
	Spray			Control		
	May	June	July	May	June	July
Litter	100	100	100	100	100	100
Bare Ground	95	96	97	99	98	91
Rock	96	93	98	96	96	96
Forbs						
Achillea millefolium	30	31	34	30	38	46
Allium spp.	66	59	57	41	41	40
Claytonia lanceolata	39	10	--	48	--	--
Collinsia parviflora	56	52	--	64	44	--
Floerkea proserpinacoides	36	30	--	21	6	--
Gayophytum diffusum	--	22	49	34	76	68
Lithophragma glabra	28	15	--	10	6	--
Lupinus spp.	28	21	19	45	41	40
Madia glomerata	16	37	32	26	46	46
Microseris nutans	28	32	--	12	26	--
Polygonum douglasii	--	37	54	--	71	75
Ranunculus spp.	11	--	--	31	--	--
Senecio spp.	39	24	--	26	32	--
Viola purpurea	22	26	15	22	19	11
Wyethia amplexicaulis	75	89	91	81	84	84
Grasses						
Agropyron spp.	17	17	39	15	21	56
Poa spp.	29	48	35	--	55	24
Stipa spp.	26	49	56	11	30	40
Shrubs						
Artemisia nova	65	74	68	79	84	71

Table 4. Average number of insects per sample on the spray and control transects during two sampling periods, 1971

Classification	Spray Area		Control Area	
	June 29-30	July 13-14	June 29-30	July 13-14
Order Hymenoptera				
Family Formicidae (ants)	13.47(3.95)[a]	9.53(3.69)	7.06(2.38)	2.38(1.26)
Superfamily Chalcidoidea	.12(0.20)	.16(0.13)	.06(0.13)	.12(0.18)
Unidentified Hymenoptera	.22(0.18)	.62(0.13)	.12(0.18)	.56(0.48)
Order Homoptera				
Family Cicadellidae (leaf hoppers)	5.03(1.56)	1.84(0.69)	2.25(0.98)	2.19(0.89)
Family Membracidae (tree hoppers)	.03(0.06)	1.00(0.91)	--	2.38(0.53)
Family Ortheziidae (ensign coccids)	.16(0.26)	.97(1.37)	.06(0.13)	--
Unidentified Homoptera	--	--	.06(0.13)	--
Order Orthoptera				
Family Gryllidae (crickets)	--	.34(0.70)	--	.81(0.51)
1st Instar Grasshoppers	.12(0.12)	.81(0.62)	.25(0.36)	.31(0.42)
Grasshoppers past 1st Instar	1.31(0.52)	.75(0.32)	.88(0.47)	.62(0.23)
Order Hemiptera				
Nabis spp.	.50(0.29)	.59(0.32)	1.31(0.77)	.75(0.36)
Family Miridae (plant bugs)	--	--	--	.12(0.18)
Unidentified Hemiptera	.50(0.35)	.53(0.37)	.56(0.64)	.25(0.31)

Table 4. Continued

Classification	Spray Area		Control Area	
	June 29-30	July 13-14	June 29-30	July 13-14
Order Coleoptera				
Family Curculionidae (weevils)	.50(0.37)	.56(0.37)	.12(0.18)	.38(0.33)
Unidentified Coleoptera	.62(0.36)	.44(0.29)	.69(0.82)	.19(0.21)
Order Lepidoptera				
Lepidoptera larvae	--	.03(0.06)	--	.06(0.13)
Unidentified moths	.59(0.39)	.19(0.15)	.38(0.26)	.06(0.13)
Order Diptera				
Unidentified Diptera	1.66(0.56)	.38(0.24)	.94(0.71)	.12(0.18)
Order Thysanura				
Family Machilidae (jumping bristletails)	.25(0.24)	.50(0.39)	--	.62(0.93)
Order Araneida				
Spiders	.62(0.34)	.62(0.35)	1.00(0.51)	.75(0.36)
Unidentified Insects	.53(0.30)	.47(0.27)	.44(0.22)	.62(0.39)

[a]The figure in parentheses is the 95 percent confidence interval for the mean. In this case, the figure would be read: "13.47 plus or minus 3.95 insects per sample."

spp. (buttercup), grew and bloomed early in the spring but went to seed and dried up quickly afterward. This is reflected by the fact that few or none of these species were recorded on the June or July samplings. Other species, like Gayophytum diffusum and Polygonum douglasii, were late to begin growth and, therefore, did not show up significantly during the May sampling.

The three genera of grasses, Agropyron, Poa, and Stipa, were well and evenly distributed over the entire study area. None of them, however, made up more than 12 percent canopy cover during any of the sampling periods.

The herbicidal spray will remove a large percentage of the mule ears and black sagebrush on the transects. It will also reduce those forbs which are prominent during the spray operation in early June. Some of the forbs likely to be damaged by the spray are: yarrow, collinsia, tar weed, lupine, and ground smoke. Some of the early spring ephemeral plants should be unaffected by the spray. The removal of the competition from many broad-leaved plants should allow the grasses of the area to become more abundant.

Insect populations. Insect populations were sampled in three ways: small insect transects, grasshopper transects, and ant mound activity monitoring.

Two factors were measured during the small insect sampling. These were the average number of insects/sample and the weight of insects/sample over six transects during two sampling periods, June 29-30, and July 13-14, 1971. Table 4 is a tabulation of the number of insects/sample from the many groups of insects present on the area. Table 5 indicates the weight of insects/sample on the six transects. It is apparent from Table 4 that in terms of numbers of organisms, ants were the most common insect on the transects. The number of ants/sample ranged from 2.38 to 13.47 on the two areas during the two sampling periods. The second most abundant group, leaf hoppers, ranged from 1.84 to 5.03 insects/sample. Some of the other more frequently found insects were tree hoppers, adult grasshoppers,

Table 5. Average oven dry weight of insects per sample for six transects on the study area during the two sampling periods, 1971.

Transect Number	Weight of Insects per Sample (mg)	
	June 29-30	July 13-14
Spray Transects		
1	21.75(17.45)[a]	27.84(10.90)
2	26.69(23.92)	30.51(25.47)
5	29.89(13.45)	33.15(16.86)
6	31.69(3.48)	23.41(5.79)
Control Transects		
3	15.15(7.66)	15.49(7.50)
4	17.76(5.66)	21.91(10.60)
All Six Transects	23.82(5.07)	25.39(5.05)

[a]The figure in parentheses is the 95 percent confidence interval for the mean. In this case, the mean would read: "21.75 plus or minus 17.45 mg."

damsel bugs (Nabis spp.), and various spiders. It should be remembered that this sampling was intended to collect only the smaller insects which would presumably be most likely to be used by the blue grouse chicks for food at the time of year of sampling. Larger insects were not collected by the vacuum sampling machine used. The oven dry weight of insects/sample (Table 5) was rather uniform on all the transects, although the control transects had slightly lower average weights than the spray transects. The average weight/sample values ranged from 15.15 to 33.15 mg. In simpler terms, the oven dry weight of insects ranged from 1/6 lb. to 1/3 lb/acre. The overall average for the two sampling periods incidated that the weights of insects on the transects had not changed significantly during the two week period between samples.

Grasshopper counts were made on August 11 and 17 of 1971. Grasshoppers were sampled on all six of the transects. The results of the grasshopper counts are presented in Table 6. The figures in the table are grasshoppers/square yard. Grasshopper density was rather uniform over five of the transects, ranging from three to six grasshoppers/square yard over both sampling periods. Transect number 4, a control transect, held a lower population of grasshoppers than any of the other transects, 2.50 and 1.75 grasshoppers/square yard for the

two sampling dates respectively. It should be noted that, from the vegetation analysis, transect 4 had the highest percentage canopy cover of black sagebrush. It is possible that the grasshoppers do not prefer sagebrush as a food species and were therefore less common on transect 4. The total average counts for all six transects combined were 4.52 and 4.25 grasshoppers/square yard for the two sampling periods. There is no statistical difference between these two means.

Grasshoppers are an important food item for juvenile and adult blue grouse on the study area during July, August, and early September. The transect data and field observations indicate to me that the grasshopper numbers were not a limiting factor to the blue grouse during either year of the study. Should the herbicidal spray change the vegetation type to one inhabited by few grasshoppers, an important food source would be reduced.

Table 6. Average number of grasshoppers per square yard on the study area for the six transects on August 11 and 17, 1971.

Transect Number	Number of Grasshoppers/Square Yard	
	August 11	August 17
Spray Transects		
1	3.25(1.62)[a]	3.00(1.62)
2	4.50(2.34)	5.25(1.89)
5	5.00(2.07)	6.00(2.07)
6	5.62(2.52)	5.25(1.98)
Control Transects		
3	6.25(2.70)	4.25(2.16)
4	2.50(1.35)	1.75(1.26)
All Six Transects	4.52(0.90)	4.25(0.72)

[a]The figure in parentheses indicates the 95 percent confidence interval for the mean. In this case the mean would read: "3.25 plus or minus 1.62 grasshoppers/square yard."

The third insect sampling technique was a continual monitoring of fifty ant mounds marked with wooden stakes on June 8, 1971. The mounds were all actively being used by ants at the time they were chosen and marked. Several

species of ants were found to inhabit the mounds, mostly species of the genus Formica. Formica subnitens and Formica altipetens were the most common mound builders, but Formica fusca and Formica neogagates were also present. Some other ants obtained during a random collection, not necessarily mound builders, were Aphaenogaster occidentalis, Solenopsis molesta, and Lasius spp. The fifty mounds were checked for activity on August 12, 1971 and it was discovered that one mound had become inactive since the original marking on June 8. Another check was made on September 20, 1971 and at that time two more mounds had become inactive. Active mounds were found to replace those which became inactive in order to keep the sample size at fifty. By following the success of the ant mounds before and after spraying, the detrimental effects, if any, of the vegetation change on the mound ants will be measured.

Breeding, nesting, brood-rearing, and wintering habits of the blue grouse

Breeding habits. Male blue grouse migrate early in the spring from their winter homes in high fir stands down to the breeding grounds such as our study area. The females migrate down soon afterward and are attracted to the males, which have set up territories, by male vocal "hooting" and visual displays.

During 1970, not much information was gathered concerning the breeding habits of the grouse because of the late start of field work. During 1971 field work was conducted throughout the breeding season. Male blue grouse arrived on our study area during the first week of April. As previously discussed, the area was mostly still covered by snow and the males tended to congregate on or near the parts of the area (mostly south facing slopes) from which the snow had begun to melt. The males apparently set up their territories very soon after arriving on the area. The typical territory site chosen by the male grouse was on the edge of the wooded slopes surrounding the sage-mule ears flatland. The males preferred open timber and brush rather than more dense brush or timber. Nearly all of the territories were in open timber near open sage-mule ears flats. I believe that the males prefer more open habitat so that their visual displays may be more readily seen by females. A male whose territory was

located in dense brush would have no way of being seen by females. Examples of rather typical territory sites are presented as Figure 11 and Figure 12. These two photographs show open, bushy hillsides bordering sage- mule ears flatland. A typical male territory was located on the border between the brush and open area.

Some of the male territories were located in patches of big sagebrush far from any tree or brush cover. In these cases, I believe that the sagebrush (which grew up to three feet high) provided ample cover and protection from predators for the grouse, while having the advantage of being open enough for visual displays to be effective.

No breeding behavior was observed except for the response of some male grouse to the recorded female call. The call caused the males to go into their full mating display. Their air sacs puffed out and were surrounded by white feathers, the comb over their eyes became brightly colored orange or yellow, and their tails fanned out while they performed a strutting type of dance. In at least two cases, the recorded female call also caused the males to hoot. This consisted of a very soft buzzing sound which was emitted for a second or two, stopped, then repeated again. The hooting was almost inaudible if one was further than about 15 yards from the grouse, and even at that distance a little wind would cover up the sound completely.

In responding to the recording, males usually walked toward the recorder, often leaving cover and coming into the open to do so. On some occasions the male moved a certain distance and then refused to come any closer. It is possible that in these cases the male had reached the edge of his territory and did not wish to leave it.

Judging from hatching dates of nests, most mating activities took place during late April and May. The males became less territorial during June and migrated off the area, presumably to high ridges, by the first part of July. During 1971, no adult males were seen on the study area after July 2 and only one male remained on the area past early July in 1971.

There was some indication that adult males came together into groups just before migrating off the area following the breeding season. On at least two

Figure 11. Typical site for a male blue grouse territory on the blue grouse study area. (Photo by the author)

Figure 12. Male blue grouse territory site, located on the edge of a brushy hillside near the open sage mule ears flat in the foreground. (Photo by the author)

occasions during 1970, groups of at least three males were observed just before all the males disappeared.

Nesting habits. Seven blue grouse nests were located during the two years of the study, four in 1970 and three in 1971. Three of the seven nests were active when they were located. The three hens successfully brought off young grouse. All seven of the nests were located under or next to sagebrush bushes, six under big sagebrush and one next to a black sagebrush bush. None of the nests were located in tree cover. Figure 13 shows a nesting site typical of those located during the study. The sagebrush cover usually was used to great advantage in concealing the nests from predators. Concealment of the nests was so good, in fact, that we felt very lucky to find the number of nests which we did.

The nests consisted of a shallow (1-2 inches) depression in the ground about 4-5 inches in diameter. Most of the nests were lined with a few twigs and some had feathers as added lining material. In general, though, nest construction was simple. Figure 14 shows a typical blue grouse nest.

Blue grouse eggs are light cream colored with scattered brown speckles. Seventeen unbroken eggs were collected from deserted or partially hatched nests during 1970 and 1971. Length and width measurements were made with calipers of all seventeen and they were broken open to observe the stage of development of the embryos. These data are summarized in Table 7. The longest egg was 55.7 mm long and the shortest 46.6 mm. The widest egg was 36.8 mm wide and the narrowest 33.1 mm. It was interesting to note that three eggs (all from the same nest) were all longer than the maximum length for blue grouse eggs reported by Bent (1932) which was 53.0 mm. The three eggs were 53.2, 54.2, and 55.7 mm long.

Four complete clutches were observed, three from active nests and one from a deserted nest. The clutch sizes were 6, 7, 8, and 9. Average clutch size was 7.5 eggs. Data concerning hatching dates and success are presented in Table 8.

Figure 13. Typical blue grouse nest site on the study area, under sagebrush bush as pointed out by Bob Maestro. (Photo by the author)

Figure 14. Typical blue grouse nest, shallow depression in the ground with lining of twigs and feathers. Two eggs in the foreground are beginning to hatch. (Photo by the author)

Table 7. Summary of the measurement and examination of 17 blue grouse eggs collected from the study area during 1970-71

Egg Number	Egg Length (mm)	Egg Width (mm)	Condition of Embryo
Nest 1			
1	53.2	35.0	Undeveloped - yolk only
2	54.2	35.8	" " "
3	55.7	35.2	" " "
Nest 2			
4	51.6	35.4	Mostly yolk - beak & eyes visible
5	50.3	35.8	" " "
6	49.6	36.0	" " "
7	50.0	36.2	" " "
8	50.0	35.6	" " "
9	49.8	35.4	" " "
10	50.5	36.0	" " "
11	46.6	34.7	" " "
12	50.4	35.2	" " "
Nest 3			
13	50.2	34.4	Some yolk, but beak, eyes, and small feathers present
Nest 4			
14	51.4	34.7	Undeveloped - yolk only
15	49.3	33.2	Entirely developed, ready to hatch
Nest 5			
16	48.7	36.8	Undeveloped - yolk only
17	52.6	36.7	" " "
Mean =	50.9	35.2	

Table 8. Hatching dates and success of three blue grouse nests located during 1970 on the blue grouse study area

Nest Number	Date Located	Hatching Date	Total # Eggs	# Eggs Hatched	Percent Success
1	6/ 2/70	6/16/70	6	3	50.0
2	6/16/70	6/15/70	8	7	87.5
3	6/19/70	6/22/70	7	4	66.7[a]
		Total Hatching Success:	21	14	70.0[a]

[a]These percent figures take into account that one egg in nest number 3 was broken when a horse stepped on it. Percent success was therefore figured considering only a total of 6 eggs in nest 3.

All of the nest sites were near one or more male territories. The location of the seven nests are plotted on Figure 10. It seems possible that females do not move far from the site of their mating to build their nests. Female blue grouse on the three active nests held tightly to the nest without flushing. This tendency seemed to increase as the date of hatch drew nearer in the case of one female grouse who was observed for two weeks before her clutch hatched. The other two females on active nests held so tightly to the nest that one was discovered when a horse actually stepped on her tail while she was on the nest, pulling out all her tail feathers. The other female allowed me to step within a foot of her on the nest before she moved a few steps and revealed her presence. One female, whose eggs were in the process of hatching, allowed me to put my foot within six inches of her head as she sat on the nest. I believe that I could have picked her up if I had so desired. Female blue grouse appear to be very faithful mothers. Although we disturbed the nesting females many times during the spring, they always returned to their nests.

Table 9 is a representation of the peak of hatch as compiled from nest observations and back-dating from the wing feathers of juvenile grouse shot or captured alive on our study area or at Dips Hollow, another blue grouse area 1 1/2 miles to the north. The peak of hatch was obviously during the third week of June during both years of the study if we can assume that the back-dating

techniques used on the grouse were accurate. Even if there was some error in the application of age determination techniques developed elsewhere to Utah blue grouse, the error would likely be within a week or so either way. All three of the actual nest observation dates were during the third week of June.

Table 9. Hatching dates for blue grouse nests as determined by nest observations and back-dating from young grouse shot or caught alive.

Time Interval	Number of Nests Hatching During Period		
	1970	1971	Both Years
May 24-31	0	1	1
June 1-7	0	1	1
June 8-14	2	5	7
June 15-22	7	13	20
June 23-30	3	6	9
July 1-7	1	2	3
Total	13	28	41

Brood-rearing habits. Blue grouse chicks left the nest within a few hours after hatching and remained with the mother as a group during all of the summer and in some cases into the hunting season. At first the chicks remained very close to their mother most of the time. Later, when they were 3-4 weeks old, they wandered further from the hen to feed. The behavior of the chicks when the brood was flushed changed as they got older. One or two week old chicks were capable of weak flight, but when the hen of the brood was flushed, the young usually froze in place until the danger was past. During this period it was possible to capture young chicks by hand when they were "frozen". They were, however, very difficult to see if much cover was present. Chicks over three weeks old usually flew rather than froze when the hen was flushed.

During the process of locating and flushing broods, patterns of habitat use became evident. Most broods were observed in two broad classifications of habitat: open sage mule-ears flats and deciduous thickets consisting of maple, aspen, oakbrush, and various low shrubs. As a rule, most of the broods were located either in or near the edge of the thickets rather than far out in the open

vegetation. This factor may very well depend on the time of day during which the broods were observed. Some literature references state that blue grouse broods make feeding trips into open vegetation and to water in the early morning and late evening hours. Few of our observations of broods were made at these times. It is possible that the broods on our study area did spend more time in the open sage-mule ears flats feeding in the early morning and late evening. Perhaps we more frequently flushed them during the main part of the day when they had retreated to woody thickets for cover or shade during the warm summer.

When a brood was flushed during our searches, the hen of the brood seldom flew far. Often she lighted in a nearby tree and clucked softly as a warning to the hidden chicks that intruders were still in the area. On some occasions, in attempting to capture hens, we hid ourselves after flushing a brood. The hen usually returned within 5-15 minutes to the original flushing site to call in the scattered chicks. The chicks issued a "lost" call consisting of a high pitched "peeeeeep," which helped the hens locate them. We attempted to locate young grouse by listening for this lost call but the chicks usually became aware of our presence and stopped calling before we got close enough to pinpoint their locations.

Counts were made during both 1970 and 1971 of the number of young grouse in each brood observed. The results of these counts are presented in Table 10. Average brood size over both years of the study during July was 4.88 and during August 3.60 young. This represents a loss on the average of just over one young per brood from July to August. This seems to be a rather low mortality rate.

Attempts were made to determine the food habits of adult and juvenile grouse by analysis of droppings and crop contents. Droppings were collected during April, May, and June of 1971 from adult blue grouse. No crops were collected during this period so all conclusions about adult food habits during these months must come from dropping analyses. A summary of the results of microscopic examination of the droppings is presented in Table 11. The results are reported by time period, so that droppings within a certain period are pooled and examined together. The percentage figures for relative amounts of

plant and insect content of the droppings are simply my visual estimates. Differential digestion makes drawing conclusions about food habits from dropping contents risky. It would seem to be that insect exoskeletons would pass through undigested more readily than any plant material. Therefore, the percentage of insect material present in droppings may be greater than the actual percentage intake of insects. I would conclude that the amount of insect material consumed by adult blue grouse during April, May and June was minimal. Identification of specific plants from dropping material is generally impossible without examination of cell structure. It was possible to separate flower parts, leaves, and twigs however. About half of the plant material in the droppings was flower parts. I noted flowers of Ranunculus spp. in some fresh adult male droppings examined in the field. The grouse probably take many different flowers during the spring. Leaves and twigs made up the rest of the plant material in the droppings. Some grass leaves were present in some of the droppings but it was not possible to estimate a percentage. Beetle larvae, adult beetles, ants, spiders, and grasshoppers were eaten in very small quantities by adult grouse during the spring.

Crop analysis was a much better indicator of food habits because there is no differential digestion and it was much simpler to identify food items. Crops from 30 blue grouse, 28 juveniles and 2 adult females, were collected on the study area. These crops were opened and the contents identified and measured for volume. A summary of the results of this analysis is presented as Table 12.

It is obvious from Table 12 that juvenile blue grouse subsist primarily on insects during July and August and gradually take more vegetable food in September as insects become scarce. Grasshoppers were by far the most important food item during the summer. Various berries were the most important item during September, particularly serviceberries (Amelanchier alnifolia).

The ten blood smears taken from blue grouse on the study area were examined microscopically for blood diseases or parasites. No evidence of any abnormality was found in any of the ten.

During August of both years of the study it became apparant that the broods were beginning to mix and, to some extent, break up. On several occasions large numbers of young grouse, obviously making up two or three broods, were flushed from the same spot. During this period we also began to observe chicks without any hens nearby. This could be the result of mortality to the hen, but seems more likely to be a consequence of the young grouse, nearly full grown at that point, leaving the hen to migrate on their own or with other chicks which had left their brood hen.

The broods and lone juveniles began to leave the study area, presumably for their upward migration to the wintering areas, during late August and early September of both years. By the start of the hunting season at the end of September very few blue grouse were present on the study area.

Table 10. Average blue grouse brood size by month for 1970 and 1971 on the blue grouse study area, 23 miles south of Logan, Utah

Month	Mean Number of Young/Brood	Sample Size
1970		
July	5.11(1.19)[a]	9
August	4.37(1.05)	16
September	4.00(--)	1
1971		
June	8.00(--)	1
July	4.78(0.94)	32
August	3.12(0.77)	26
Both Years		
June	8.00(--)	1
July	4.85(0.76)	41
August	3.60(0.63)	42
September	4.00(--)	1

[a]The figure in parentheses is the 95 percent confidence interval for the mean. In this case, the mean would be read: "5.11 plus or minus 1.19 young/brood."

Table 11. Results of the microscopic analysis of adult blue grouse droppings collected during the spring of 1971 on the study area.

Dates Collected	Sex of Grouse	Percent Plant[a] Material	Description	Percent Insects	Description
April 5-8	3M, 1U[b]	92	Flowers, leaves	8	beetle larvae
May 10-13	4M, 2U	98	Flowers, leaves	2	ants, beetles
May 14-26	3M, 1F, 4U	99	Flowers, leaves, twigs	1	beetles, grasshopper, spider
June 7-9	1M, 2F, 1U	95	Leaves, flowers	5	beetle larvae, adult beetles, ants
June 16-24	1M, 2F	98	Flowers, leaves grass	2	beetles

[a]Percentages are visual estimates of volume.
[b]M = Male, F = Female, U = Unknown sex

Table 12. Results of the analysis of the contents of 28 juvenile blue grouse crops collected on the study area during the summer and fall of 1970 and 1971

Food Category	July (n=11)		August (n=11)		September (n=6)	
	Percent[a] Total Volume	Percent[b] Occurrence	Percent Total Volume	Percent Occurrence	Percent Total Volume	Percent Occurrence
Animal Food						
Order Orthoptera						
Grasshoppers past 1st Instar	74.84	63.6	56.02	81.8	26.72	33.3
1st Instar Grasshoppers	.07	9.1	--	--	--	--
Family Gryllidae (Crickets)	--	--	--	--	.49	16.7
Order Hymenoptera						
Family Formicidae (Ants)	1.01	81.8	.19	27.3	.02	16.7
Unidentified Hymenoptera	.30	18.2	.01	9.1	--	--
Order Coleoptera						
Family Tenebrionidae	4.04	54.5	.05	9.1	--	--
Family Curculionidae	.37	27.3	--	--	--	--
Unidentified Coleoptera Adults	.11	18.2	.02	9.1	.01	16.7
Coleoptera Larvae	1.21	36.4	--	--	--	--
Order Hemiptera						
Family Scutelleridae	--	--	.11	9.1	--	--
Family Pentatomidae	--	--	--	--	7.4	16.7
Nabis spp. (damsel bugs)	.11	9.1	--	--	--	--
Unidentified Hemiptera	.05	9.1	--	--	--	--

Table 12. continued

Food Category	July (n=11) Percent Total Volume	July (n=11) Percent Occurrence	August (n=11) Percent Total Volume	August (n=11) Percent Occurrence	September (n=6) Percent Total Volume	September (n=6) Percent Occurrence
Order Lepidoptera						
Lepidoptera Larvae	3.06	45.4	--	--	--	--
Microlepidoptera adults	.05	9.1	--	--	--	--
Order Homoptera						
Family Cicadellidae (leafhoppers)	.02	9.1	--	--	--	--
Family Membracidae (treehoppers)	.14	27.3	--	--	--	--
Order Neuroptera						
Family Raphidiidae	.27	27.3	--	--	--	--
Order Araneida						
Spiders	.59	36.7	.01	9.1	.02	16.7
Class Chilopoda						
Centipedes	--	--	.02	9.1	.06	16.7
Unidentified Arthropoda	.87	36.4	--	--	--	--
Total Animal Food	88.41	100.0	56.43	81.8	28.06	50.0
Plant Food						
prickly lettuce-seed heads (Lactuca serriola)	--	--	11.57	27.3	--	--
prickly lettuce-leaves	1.30	9.1	.11	9.1	--	--

Table 12. continued

Food Category	July (n=11) Percent Total Volume	July (n=11) Percent Occurrence	August (n=11) Percent Total Volume	August (n=11) Percent Occurrence	September (n=6) Percent Total Volume	September (n=6) Percent Occurrence
Plant Food (cont.)						
rose hips (Rosa woodsii)	--	--	10.37	36.4	--	--
snowberries (Symphoricarpos oreophilus)	--	--	3.28	9.1	2.72	16.7
serviceberries (Amelanchier alnifolia	--	--	3.17	9.1	57.23	50.0
snowberry leaves	--	--	.22	9.1	--	--
serviceberry leaves	--	--	.22	9.1	.12	16.7
chokecherries (Prunus virginiana)	--	--	2.51	9.1	--	--
salsify-flower heads (Tragopogon spp.)	--	--	1.97	9.1	--	--
acorns (Quercus gambelii)	--	--	1.53	9.1	--	--
curlleaf mahogany leaves (Cercocarpus ledifolis)	--	--	.87	18.2	5.32	33.3
willow leaves (Salix spp.)	--	--	.76	9.1	--	--
mountain dandelion flower heads (Agoseris glauca)	--	--	--	--	1.11	16.7
unidentified grass	--	--	.22	18.2	.62	33.3
unidentified seeds	4.26	45.4	.76	27.3	--	--

Table 12. continued

Food Category	July(n=11) Percent Total Volume	July(n=11) Percent Occurrence	August (n=11) Percent Total Volume	August (n=11) Percent Occurrence	September N=6; Percent Total Volume	September N=6; Percent Occurrence
unidentified leaves	--	--	1.20	9.1	2.72	33.3
unidentified plant material	6.03	54.5	4.80	81.8	2.10	66.7
Total Plant Food	11.59	63.6	43.57	90.9	71.94	100.0

[a]Percent of the total volume of food found in all the crops examined during the specified time period.
[b]Percent of the crops examined in which the food item was found.

In an attempt to determine in what direction the migrating grouse were moving, we searched the slopes on the east and west sides of the study area in the hope of sighting some of the color-marked grouse from our study area. These searches were carried out in late August and early September. We sighted some grouse, but none that had color marks.

A total of 31 grouse were captured by noosing during the two years of the study. These consisted of 1 adult female, 1 yearling male, 1 yearling female, and 28 juveniles. Two birds, the adult female and one juvenile, died as a result of being captured. This is a mortality rate of 6 percent. Zwickel and Bendell (1967b) reported a mortality rate of about 1-2 percent during the capture of over 1200 blue grouse by noosing. Four bands which we had applied to the grouse were turned in by hunters who shot the grouse. Two were returned in 1970 and two more in 1971. One of the banded birds, not from our study area, was shot at approximately the point of banding. Two of the banded grouse from our study area had moved half way up the slopes of James Peak, a distance of about 2-3 miles where they were shot. The fourth grouse from our study area had moved about 1 mile to the southwest of our study area where it was shot. I sighted a yearling male banded April 26, 1971 on September 25, 1971 about 50 yards from the banding point on the study area. It had not migrated at all for some unexplained reason. It was the last blue grouse which we saw on the study area during 1971. During 1970, at least one group of blue grouse remained on the study area during the start of the hunting season. These may have been grouse from our study area which had not migrated or they may have been grouse from a lower elevation migrating through our area on their way to higher points.

Wintering habits. The two band returns from the slopes of James Peak suggest that it may be a wintering area for the grouse on our study area. The summit of James Peak is covered with fir trees and it certainly appears to be a suitable wintering area for blue grouse. Searches were made during the fall of 1970 and early spring of 1971 of possible blue grouse wintering areas near the study area. No blue grouse or blue grouse sign were seen during any of the searches. It is possible that blue grouse were present but not seen since a

grouse in the dark branches of a fir tree would be all but invisible from the ground.

DISCUSSION AND RECOMMENDATIONS

The most significant aspect of this project to date is the foundation laid for the continuing study of the effects of the proposed 1972 herbicidal spraying on the blue grouse of the study area. The information presented here, along with continuing reports on the status of the population of blue grouse before and after the herbicidal spraying should give a good idea of the short and long term effects of vegetation change on blue grouse in similar habitats when future spray projects are planned. Using this information, land managers can consider the effects of herbicide spraying on blue grouse while still in the planning stages of land management. Recommendations may be made to spray or not to spray areas particularly well suited to blue grouse. If the long term results of this study indicate that one type of vegetation is particularly important to the grouse, such as big sagebrush for nesting cover, it will then be possible to spray selectively, leaving areas unsprayed which are most important to the grouse for one reason or another.

I believe that a possible area for more research is the question of the effects of snow melt on the location of male territories. If, indeed, male blue grouse are attracted in the early spring to the first points from which snow melts and subsequently set up their territories at these spots, it may be possible to predict from snow melt patterns where the most likely locations for territories (and nests) are. This information will be of help in locating males in future blue grouse research studies and in formulating management plans. Perhaps logging north slopes in blue grouse range will have no affect on territorial males when logging south slopes would destroy their cover. The same idea might hold for grazing patterns. It might even be possible to manipulate the position of territorial males by spreading soot or other material to increase snow melt at a particular spot and thereby attract adult or yearling males to a desired area. This might be used as a technique for bringing blue grouse into suitable habitat which previously had none simply because they had not been introduced.

One finding of this study which seems to differ from other blue grouse research is the location of all the nests which were located away from trees in the open sagebrush. Practically all the reports of blue grouse nesting locations have described them as being in the timber or at least in partially wooded spots. No particular association of the blue grouse nests with sagebrush has been described to my knowledge. Yet all 7 of the nests we located were under sagebrush away from wooded areas. I believe that the blue grouse is an opportunistic nester in that it uses whatever nesting cover is available in the habitat in which it finds itself. On our study area, apparently one of the more desirable nesting sites was beneath sagebrush. Since the herbicidal spray is likely to remove most of the sagebrush, it would seem possible that there would be a loss of most of the nesting cover on the area. On the other hand, since the blue grouse seems to be a rather adaptable bird, perhaps the female grouse will simply nest in bunchgrass or under deciduous trees or shrubs when the sagebrush is gone.

Fall migration of blue grouse was the most significant factor affecting the success of hunters in the fall. Since the blue grouse on our study area and presumably over most of the bird's range migrated to high elevations before the hunting season, hunters were forced to make their way, usually on foot, to steep mountain slopes in order to find the grouse. Few hunters were willing or able to exert the effort necessary to find the migrating grouse, and consequently I believe that few blue grouse (in relation to the total population) were harvested yearly. With a better knowledge of migration patterns and schedules it would be possible to obtain practically any desired level of harvest on blue grouse. On our study area, if the hunting season were moved to the beginning of September or end of August from the present late September starting date, a much greater harvest could be accomplished. The young grouse are nearly full grown at that time and would make good table fare and be sporting at the same time. One complication, however, is the coordination of hunting seasons for ruffed and sage grouse with the blue grouse season. These species are less migratory and a concurrent earlier season might place undesirable pressures on them. From my experience in talking to hunters, I would say that a separate blue grouse season would not be

feasible because most hunters cannot tell one grouse from another. The idea of regulating blue grouse harvests through proper timing of the season remains one which deserves consideration in the future, however.

The results of the crop analysis of juvenile grouse on the study area during both summers revealed that their diet was overwhelmingly insects, mainly grasshoppers. Because this was the case on our study area, however, is no reason to assume that this diet is representative of all Utah blue grouse during the summer. Twelve crops from juvenile blue grouse collected during the summer of 1971 from an area only 1 1/2 miles from our study area held a high percentage of vegetable food and few grasshoppers. Whether this was a result of different foods being available or different food preferences of the grouse is unknown at this time.

Some question may be raised as to the validity of the entire before and after spraying study because of the lack of replication of the experiment. In order to confirm the final results of the experiment, the control portion of the study area could be sprayed a few years after the 1972 spraying. The grouse on the control portion should be effected in the same manner as those on the present spray area following spraying.

SUMMARY

The objectives of this study were to: 1) determine the numbers and distribution of blue grouse on the study area; 2) describe the vegetative composition and insect abundance; and 3) investigate the breeding, nesting, brood-rearing, and wintering habits of the blue grouse.

Field work to meet these objectives was begun in May, 1970 and concluded in September, 1971. Searches for territorial male blue grouse and capture and marking of juvenile grouse were used to estimate the number of grouse on the area. Transects were established on the study area and used to sample the vegetative composition and insect abundance. In the course of the above investigations and with additional efforts, general ecological information concerning the habits of the grouse was gathered.

During 1971, 8 male territories and 1 probable territory were located and mapped. It was estimated that 18 to 20 blue grouse broods were on the study area during 1971. Data from the vegetation transects indicated that mule ears and black sagebrush were the most common plant species on the area. Many other forbs and grasses were present on the transects.

Numbers of small insects were measured during late June and mid-July of 1971. Ants were the most numerous insect on the area. A wide variety of other insects was collected, none of which was particularly numerous. The oven dry weight of the insects collected on the transects varied from about 1/6 lb. to 1/3 lb. per acre. Grasshopper numbers in August ranged from 1.75 to 6.25 grasshoppers per square yard on the transects. Fifty ant mounds were marked in June, 1971 and checked for activity during the summer and fall. Three of these had become inactive by September 20, 1971.

Male blue grouse migrated to the study area and set up territories in early April of 1971. Most territories were established on open tree-shrub hillsides. Breeding took place in April and May and females began nesting in late May and

June. Most nests hatched during late June. Seven nests located during the study were all under sagebrush bushes.

Broods stayed within a 1/2 square mile area over most of the summer . Ants, beetles, and grasshoppers were common food items. Broods began to break up during late August and September and most grouse had migrated from the study area by mid-September.

The blue grouse is an adaptable bird in that it exists in a wide variety of habitat types and elevations. At the time of this study the blue grouse population on our study area was healthy and doing well. I believe that the herbicidal spraying will disrupt reproduction during the year of the spraying because hens on the nests at the time of spraying may desert or fall predators when their nesting cover is removed. By the following year the vegetation should be grown up enough to allow near normal reproduction although mortality to the young may be high because of poor cover conditions. Within 3 to 4 years, I believe that blue grouse numbers will have returned to present levels.

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APPENDIX

Table 13. Plant species not occuring on at least 15 percent of the plots on either the spray or control areas during any of the three sampling periods, 1971.

Species	Percent Occurrence[a]		
	May	June	July
Forbs			
pearl-everlasting (Anaphalis margaritacea)	--	0.4	--
rock cress (Arabis spp.)	7.1	2.9	0.8
locoweed (Astragalus spp.)	1.2	3.3	2.1
common camas (Camassia quamash)	7.5	5.0	1.2
camelina (Camelina microcarpa)	--	0.8	--
collomia (Collomia tenella)	--	10.4	--
Nelson larkspur (Delphinium nelsoni)	--	5.8	--
steershead bleeding-heart (Dicentra uniflora)	0.4	--	--
shooting star (Dodecatheon spp.)	--	--	0.4
dogtooth violet (Erythronium grandiflorum)	2.9	1.7	--
catchweed bedstraw (Galium aparine)	--	14.2	0.8
Fremont geranium (Geranium fremontii)	--	0.4	0.8
curlycup gumweed (Grindelia squarrosa)	--	1.7	5.8
yellow fritillary (Fritillaria pudica)	0.8	--	--
ballhead waterleaf (Hydrophyllum capitatum)	2.5	1.7	--
least lewisia (Lewisia pygmaea)	--	0.4	--
desert parsley (Lomatium grayi)	1.2	2.1	0.8
naverretia (Navarretia intertexta)	--	5.8	14.2
purplewhite owlclover (Orthocarpus purpureo-albus)	--	--	10.4
penstemon (Penstemon spp.)	0.8	4.6	1.2
polemonium (Polemonium spp.)	7.1	3.3	2.5
arctic pearlwort (Sagina saginoides)	--	--	3.3
dandelion (Taraxacum spp.)	--	0.8	--
speedwell (Veronica campylopoda)	--	9.2	0.4
foothill death camas (Zigadenus paniculatus)	4.6	5.0	0.8
Grasses and Grasslike			
sedge (Carex spp.)	2.1	1.7	1.7
oatgrass (Danthonia spp.)	0.4	10.8	12.1
(Melica bulbosa)	--	10.4	8.7

Table 13. (cont.)

Species	Percent Occurrence		
	May	June	July
Grasses and Grasslike (cont.)			
foxtail (Hordeum jubatum)	--	--	2.9
junegrass (Koeleria cristata)	--	0.8	3.8
Shrubs			
big sagebrush (Artemisia tridentata)	0.4	--	--

[a]Occurrence on the spray and control areas combined.

Table 14. Record of blue grouse banded or color-marked during the two years of the study.

Date Captured	Age	Sex	Band #	Other Marks
7/29/70	8 weeks	U[a]	S-1700-LL[b]	None
7/31/70	10 weeks	U	S-1699-LL	None
7/31/70	7 weeks	U	S-1698-LL	None
8/ 5/70	8 weeks	U	S-1697-LL	None
8/ 7/70	8 weeks	U	S-1696-LL	Yellow Neck Tag
8/12/70	9 weeks	U	S-1695-LL	White Neck Tag
8/12/70	7 weeks	U	S-1694-LL	Red Neck Tag
8/12/70	7 weeks	U	S-1693-LL	Blue Neck Tag
8/12/70	7 weeks	U	S-1691-LL	Green Neck Tag
8/12/70	Adult	F	Died after being noosed	
8/26/70	10 weeks	M	S-1692-LL	Yellow-White Neck Tag
8/26/70	10 weeks	M	S-1690-LL	Red-White Neck Tag
8/26/70	10 weeks	M	S-1689-LL	Yellow-Red Neck Tag
9/ 9/70	10 weeks	F	Shot by hunter	
9/ 9/70	11 weeks	F	Shot by hunter	
5/26/71	Yearling	M	G-A31215-RL	White Poncho - "0"
			S-1686-LL	Yellow Tape on Tail
6/ 9/71	Yearling	F	S-1684-RL	Red Tape on Tail
			B-A31383-LL	White Poncho - "4"
7/ 7/71	4 weeks	U	None	Yellow Neck Tag
7/ 8/71	4 weeks	U	S-1685-RL	Red Neck Tag
			G-A31225-LL	
7/13/71	5 weeks	U	Go-A31407-RL	Yellow-Blue Neck Tag
			B-A31348-LL	
			S-1608-LL	
7/13/71	5 weeks	U	S-1602-RL	Yellow-Blue Neck Tag
			B-A31326-RL	
			Go-A31403-LL	
7/19/71	5 weeks	U	B-A31374-RL	Red-White Neck Tag
7/22/71	5 weeks	U	Shot by hunter	
7/27/71	6 weeks	U	Shot by hunter	
7/27/71	7 weeks	U	B-A31313-RL	White Neck Tag
			S-1606-LL	
			Go-A31402-LL	
7/27/71	8 weeks	U	S-1604-RL	White-Blue-Red Neck
			Go-A31405-RL	Tag
			B-A31385-LL	Red Tape on Tail
7/27/71	6 weeks	U	Go-A31408-RL	Red Neck Tag
			S-1607-LL	Red Tape on Tail

Table 14. (cont.)

Date Captured	Age	Sex	Band #	Other Marks
			B-A31317-LL	
7/27/71	6 weeks	U	Died after being noosed	
7/28/71	8 weeks	U	Go-A31401-RL	Yellow-Red Neck Tag
			S-1605-RL	Red Tape on Tail
			B-A31373-LL	
7/16/71	5 weeks	U	None	Yellow-Red Neck Tag
8/11/71	7 weeks	U	Go-A31401-RL	Blue Neck Tag
			G-A31253-LL	Yellow Tape on Tail
			S-1617-LL	

[a]U=Unknown Sex, F=Female, M=Male

[b]S=Silver, G=Green, Go=Gold, B=Blue, RL=Right Leg, LL=Left Leg.

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