FOREST, WILDLIFE AND RANGE EXPERIMENT STATION

COLLEGE OF FORESTRY

UNIVERSITY OF IDAHO

Moscow, Idaho

THIRTEENTH ANNUAL REPORT

For the Fiscal Year 1960-1961

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INTRODUCTION

Of the 41 projects listed, 37 were active during the year, 2 were completed and 4 new projects were started.

The Station staff consisted of 18 members, of whom three were on full-time research. Two staff vacancies were filled by the appointment of Dr. John Schenk (Forest Entomology) replacing Dr. Clark and Dr. C. W. Wang (Forest Genetics) replacing Dr. Inman. One authorized position created by the death of Professor Slipp remained unfilled.

Professor L. A. Sharp was on leave for one quarter at Oregon State University to complete the course requirements for his doctorate program.

Twelve graduate Research Fellows were on appointment during the year, with three finishing their theses in June, 1961. For the first time this year, a Research Fellow was enrolled on a doctorate program.

Support for research in the form of funds, facilities, and other assistance was received from an increasing number of organizations. Those making major contributions are listed in Appendix B of this report. Overall support for research from both University and outside sources continued to increase over previous years. Research productivity as indicated by publications increased considerably during the current year.

Ernest Wohletz, Director

E. W. Tisdale, Associate Director

WORK ACCOMPLISHMENTS

I. Forest Management and Utilization

Project E.S. 2. White Pine Blister Rust.

The records of more than 20 years' research have been gathered together and sorted for analyses which will be completed by December 1966.

Project E.S. 3. White Pine Stem Anatomy.

This project was inactive during the past year.

Project E.S. 6. Diseases of Idaho Tree Species.

Numerous specimens of injured and diseased trees were received. Agricultural chemicals and various physical agencies were responsible in most instances. No serious epiphytotics were recorded except localized outbreaks of "larch needle cast".

Further study of an unexplained dieback of ponderosa pines in certain areas indicated that this condition was caused by a scale insect. This condition will be described in a Station Research Note now in preparation.

Injury and a Fusarium sp. were found causing a deterioration of locust seedlings in storage. Attempts at control by chemical treatment (i.e. pH variation, and various concentrations of cycloheximide) yielded no useful results.

Project E.S. 19. Christmas Tree Test Plantings.

Field work on this project has been completed and the results will be reported in a publication now in preparation.

Project E.S. 20. Mortality of Young Western White Pine (Pole Blight).

This project has been all but suspended, although some maintenance work is being done on some of the permanent sample plots. The two spread plots on the St. Joe National Forest were checked and since the disease has spread beyond the original plot limits, some of the radii have been extended. Pole blight is active in both plots.

One item of interest other than the spread was noted; former intermediate crown position trees are now showing symptoms of pole blight. The pole blight disease usually is confined to dominant and codominant crown position trees. On both of the spread plots and on several of the smaller progress plots virtually the entire population of dominant and codominant white pines have been killed by pole blight. Stand openings thus formed are quickly occupied by intermediate white pine, larch and Douglas-fir. The white pine intermediates respond by larger crowns, and greater height growth. After several years they might be reclassified as occupying a codominant stand position. It is these trees, former healthy intermediates, that are now coming down with pole blight.

Strangulation plots were visited and rings replaced where necessary, but since no external crown symptoms were visible, no detailed tree records were taken.

Several of the more useful progress plots were checked and individual tree records were made.

Project E.S. 23 (WM-42). Marketing Practices and Prices for Timber from Small Woodlands.

One-hundred forty-three mills, all but four of those operating north of the Salmon River as commercial enterprises between 1955 and 1959, were contacted and information secured regarding milling history, mill facilities, log source, method of marketing, product marketed, and volumes processed. Part of the material has been processed through the Statistical Service Center and the remainder is now being processed.

The mills have been broken into the following groups by production per 8-hour day and counties in which located:

Counties	0-9 M	10-19 M	20-39 M	40-59 M	60-99 M	Over 100 M
Bonner-Boundary	15	11	10	5	0	1
Kootenai-Shoshone-Benewah	8	13	10	2	6	2
Latah-Nez Perce-Lewis-Clearwater-Idaho	7	7	23	13	7	3

The six mills reporting a cut of 100 M or more per 8-hour shift were all established in 1927 or earlier.

Conventional mills (those not adapted to special product or special type head rig) are averaging slightly over three thousand board feet per man per 8-hour day in rough green lumber pulled at the green chain. Non-conventional mills are averaging approximately five and a half thousand board feet of rough green lumber to the same or relative position.

There is a high degree of competition for nearly all areas in the securing of logs. High degree of competition was listed as the major difficulty in obtaining logs by most mills. An indication of degree of competition is shown by a map listing the number of mills purchasing logs in various townships. One township has 22 mills purchasing logs from it. The range is from 22 down to one with an average of eight mills purchasing logs per township. As might be expected, the greater competition is occuring where there is more private forest land ownership and the greater concentration of mills.

Project E.S. 24. Forest Tree Breeding in Idaho.

The forest geretics research program of the University of Idaho was conducted

in cooperation with private wood-using industries and federal and state forestry agencies. A cooperative agreement was concluded on July 1, 1961 between the University, the U.S. Forest Service Regions 1 and 4, U.S. Bureau of Land Management, Idaho State Office, Southern Idaho Forestry Association and Idaho State Division of Forestry. The cooperating agencies agreed to make available to the University forest stands and facilities at their forest stations and nurseries and to provide personnel for help in conducting forest genetic studies and in establishment and protection of field plantations and experimental plots.

Since the fall of 1960 the following studies and experiments have been undertaken:

1. Hereditary differences in wood properties of seed sources of ponderosa pine growing in Idaho.

   Wood samples were obtained from 21 different seed sources of ponderosa pine growing in the experiment plantation of the Priest River Experimental Forest in northern Idaho. This plantation was established between 1911 and 1917. It includes living representatives of the following 21 seed sources: Plumas, Colville, Black Hills, Siskiyou, Bitterroot (4000), Bitterroot (5000), Bitterroot (7200), Kaniksu, Lolo, Pecos, Coconino, Ashley, Custer, Medicine Bow, Boise, Whitman, Umatilla, San Isabel, Helena, Coeur d'Alene and Payette. The purpose of this study is to investigate the extent of genetic control of wood properties, such as specific gravity, early-wood--late-wood development, and fiber length. This study is being made in close collaboration with Professor Howe and Professor Hofstrand and is complementary to their investigations on environmental influences upon wood properties. The preliminary results will be published as a Research Note of the Forest, Wildlife and Range Experiment Station.

2. Idaho ponderosa pine seed sources test.

   One hundred 1-0 ponderosa pine seedlings of each of 24 seed sources from various parts of Idaho and adjacent areas were planted in the nursery in 10 replicates. Idaho seed sources included in this study are Benewah, Boise County, Boise National Forest D-3, D-6, D-7 and D-9, Bonner, Boundary, Idaho City, Kaniksu, Kootenai, Latah, Payette, Salmon and St. Joe.

   The objective is to evaluate the differences in juvenile characters and range of variation between trees from different Idaho seed sources. Among the characters examined are: frost resistance, breaking of dormancy, period of maximum stem elongation, and cessation of height growth. Results from the first year's observation were presented at the 1961 annual meeting of the Western Forest Genetics Association, Spokane, Washington.

3. Variation and inheritance of seed characters.

   Open pollinated ponderosa pine seeds from several hundred individual seed trees were examined and classified according to their size, weight, seed coat color and texture. Seed trees of distinct seed

characters were selected for controlled reciprocal crosses in the study of the inheritance of seed and cone characters and the effect of cytoplasm.

Seeds selected in this study were used in the experiments described in sections 4 and 5 of this report.

4. Seed characters and survival in direct seeding experiment.

Ponderosa pine seeds of different sizes, from individual trees and from bulk seeds of different geographic origins were used in a direct seeding experiment conducted in collaboration with Professor Pitkin. Seeds were planted within a rodent proof fence on a severe site in southern Idaho. Provisions have been made for this experiment to be repeated in the next two years.

5. Studies on root growth and its photoperiodic responses.

This is an exploratory study on genetic variation in root growth and its relationship to drought resistance. Seeds of uniform size and weight were used. In replicated design, seeds from selected seed trees and from different geographic seed sources were planted in glass-windowed root boxes. Because a wide geographic range is represented in this study, part of the experiment was exposed to controlled day-period to investigate the possible photoperiod responses. This experiment is made in collaboration with Professor Pitkin.

6. Progeny testing of selected ponderosa pine.

Considerable variation has been observed among the seedlings raised from open pollinated seeds collected from 433 trees from approximately one-fourth of a square mile near Idaho City (see F.W.R. Experiment Station Annual Report for 1958-1959, p. 8). The progeny test plantings were made in collaboration with the Idaho State Forestry Department and the Boise National Forest. Plantations were established near Idaho City, Heyburn Park and on the University Forest near Moscow.

7. Intra-specific hybridization and the study of inheritance of morphological characters.

Controlled pollination has been made between ponderosa pines of different morphological characters. Trees with distinct branching and crown forms were selected for this purpose. This is to study the extent of genetic control of certain morphological characters as a basis for tree selection and improvement.

Project E.S. 27. Soil Nutrient--White Pine Site Quality Study.

Due to the press of other project work, little was done on this investigation during the year. Data obtained from the analysis of samples from 26 white pine sites during the previous year show that there do exist wide variations in soil fertility from area to area. For instance, depending on site, nitrogen in the top few inches of soil ranged from 0.279 to 0.10 percent. Comparable differences were noted for other plant nutrients and

other soil horizons.

Site indexes for these white pine stands show a considerable spread. However, because of interactions of many factors in the field, it is difficult to ascertain whether fertility of soil is an important contributing variable to this spread. It is believed that at the start, at least, significant information in regard to soil fertility as it affects the growth of white pine can be obtained in the greenhouse.

Soil from white pine sites supporting either good or poor stands of white pine will be placed in plastic pots with soil moisture maintained at field capacity for several weeks. During this period white pine seedlings will be germinated in mesh bottomed containers of sand. When the roots of the seedlings have reached the mesh at the bottom of the sand containers, these containers will be placed on the moist soil of the plastic pots. The roots will then grow through the mesh and into the soil where they will extract nutrients. After several weeks, the tops of the seedlings will be harvested, analyzed, and comparisons made of the nutrient supplying power of the various soils.

Concurrently with the above research, a greenhouse investigation will be conducted to determine the nutrient levels at which optimum growth of white pine can be obtained. With the results of these two experiments, fertility studies of white pine soils <u>in situ</u> will be more meaningful.

Project E.S. 28. Nursery Soil Fertility Studies.

Greenhouse studies of the nursery soils were continued during the year. A bark fertilizer product, containing nitrogen, phosphorus, and potassium, was tested against standard commercial fertilizer in one experiment, which utilized glass front root observation boxes. Two coniferous species and two hardwoods were utilized in the tests. The bark was applied either as a mulch or mixed in the top several inches of soil. It is believed that most of the beneficial effects of the bark, where noted, were due to improvement of the physical condition of the soil, which is heavy and is liable to impede water and air movement.

Commercial fertilizer seriously inhibited germination of seedlings of all test species, especially when applied at a high rate. In general, though some growth improvement of surviving plants was noted, bark fertilizer or plain bark were more efficient. As noted above, the physical effects of the bark probably played a major role.

It is expected that fertility studies of the nursery soil will be expanded in the coming year, as facilities and equipment for chemical analysis of soil and plant tissue are being provided in the College of Forestry.

Project E.S. 29. Studies of the Engelmann Spruce Weevil.

Field studies have been completed and work begun on a publication reporting the results.

Project E.S. 30. A Study of the Relationships Between the Farm Unit, the Farm Forest, and Off-Farm Employment Opportunities in Northern Idaho.

Over half the farms in Boundary, Bonner, Kootenai, and Benewah Counties have less than 100 acres of total land with 81 percent having less than 100 acres of crop land. Incomes from farming these small acreages are low and farmers often have to work off the farm to make a living for their families. Most of the land owned by people listed as farmers in the Bureau of Census figures is forest land. Historically, this forest land has been used as a source of fuel, grazing and emergency cash. Little has been accomplished toward integrating the farm forest into the total farming enterprise so that it contributes a steady source of income.

A number of projects similar to this one have been undertaken in recent years in similar areas. The project in Price County, Wisconsin has probably been the most intense. This project, plus similar projects in Stevens County, Washington and Ravalli County, Montana, will give useful information.

Unemployment in the study area has been as high as over half the working force in one of the counties in the study area this past winter.

The objectives of this project are:

1. Determine the scope of the problem in terms of the number of farm families involved, their income levels, and the resources they control.

2. Appraise the opportunities for increasing farm incomes through more efficient combinations of farm resources and through fuller utilization of all resources, especially the farm woodlands.

3. Determine what off-farm employment opportunities exist in the area and examine possibilities for the development of industries which would provide employment for part-time farmers.

4. Determine if a complementary relationship could be developed between agriculture and the forest industry to their mutual advantages.

An initial study of the area and review of census and other relative data will be made. Study of various aspects of the problem will then be made. It is anticipated that Progress Reports will be released covering the various phases of the problem. Some phases to be studied are economic size units of forest land, new products, possible new industires using the present resources, and possible recreational developments. The Department of Agricultural Economics of the Agricultural Experiment Station is cooperating in this project.

Project S.R. 11-C. Forest Tree Physiology.

Synthesis of mycorrhizal fungi on western white pine was finally successful, but still very sporadic. Six cases of ectotrophic mycorrhizal formation were confirmed by microsections. However, in each case there were variables which prevented duplication of results in any of the six successful

syntheses.

Fungus	Media	pH	Nutrients
Suillus granulatus	Terralite	5.0	Hacskaylo's
Suillus brevipes	Terralite	5.0	Hacskaylo's
Suillus subluteus	Terralite	5.0	Hacskaylo's
Suillus granulatus	Terralite and sponge rock	5.0	Hacskaylo's
Suillus granulatus	Terralite and sponge rock	5.0	Hacskaylo's and duff
Suillus subluteus	Terralite and sponge rock	4.5	Hacskaylo's and duff

Some indications of proper techniques can be gained from these results. The contamination problem still remains small. Photoperiod is still in question. Temperature is probably the most obvious difficulty still untested to any degree. Most of the experiments have been run at room temperature in a cool room at about 68 degrees F. Next year plants will be grown at lower temperatures since the young trees seem spindly and abnormal compared to field grown stock.

Some work was done with gaseous sterilization of media by use of propylene oxide. Addition of forest soil or duff to artificial media has been found by some workers to stimulate growth of certain mycorrhizal fungus cultures. However, steam sterilization materially alters the chemical composition of such additives; in fact, autoclaved duff has had an inhibitory effect in some reports. Gaseous sterilization was thought to hold some promise, especially in the use of duff/Terralite or duff/sponge-rock mixtures as a rooting medium for mycorrhizal synthesis. The efficiency and effect of such sterilization was tested by adding soil and duff to Hagem's agar. Soil was from the upper A, and lower humus layer from a stand of healthy, pole-sized white pine on the St. Joe Forest. This layer was chosen since earlier work showed that most of the feeding roots (thus mycorrhizal roots) of our native conifers occur in the upper few inches of the soil. Quantities of chopped duff-soil varying from 0.5 gram to 5.0 gram per standard Petri plate were added to Hagem's agar (Hagem's agar consists of the basic inorganic nutrients plus glucose and malt). Sterilization was done in a museum jar sealed with rubber cement. Sterilization was effected by adding 2 ml. of propylene oxide per liter of volume in the sterilization chamber; this is a fairly standard rate. Sterilization times were 24, 48 and 72 hours. Three representative Bolete cultures were used as test fungi--they not only represented three genera but also three different growth rates. Briefly, these are the results of the gaseous sterilization work:

1. Duff/soil samples would be incubated at room temperatures and high humidities for several days to allow dormant spores to germinate.

2. Twenty-four hour sterilization is effective with 0.5 gm. duff additives and 48 hours with the 5.0 gm. additives.

3. At least 3 days must elapse after removal from the chamber before any fungus growth will occur. Seven days was determined to be the waiting period necessary before normal growth could be expected.

4. Duff/soil additions of all magnitudes caused very little growth stimulation when combined with Hagem's agar. However, almost normal growth was obtained for short periods when duff/soil additives were made to water agar.

It was concluded that gaseous sterilization will work; it may be adapted to rooting media when suitable large sterilization chambers are available and that more work along this line will be done in the future.

Field collections of Boletaceae continue; each year several new records for the northern Rockies have been collected. Last year Boletus eastwoodiae, a red-pored Pacific coastal fungus, was collected in a mature white pine stand. This is another new collection record for Idaho.

A punch card system has been developed and is now in use for cross-indexing Boletes with tree species associations and ecological type. As more and more sightings and collection data are accumulated, a rather good idea of Bolete host and site preference will be gained. Some intensive plot work was done on this problem by Slipp (1944) but extensive sampling has enlarged not only the fungus species range but also sampled many more ecological types. Host preference and stand age and condition also will be better known. Thus far several fungi appear in healthy stands that have not been collected in pole blighted stands. While this could be coincidence, more collections will lower the chance of coincidence. If fungus cultures can be obtained, next year's work may concentrate on these Boletes not found thus far in pole blight stands.

Early work on mycorrhizal white pine roots and pole blighted roots has led to a root key for conifers of the northern Rocky Mountains. It will be published in Forest Science in the winter of 1961.

Project S.R. 54. Influence of Forest Site on the Wood Properties of Inland-Type Douglas-Fir.

Last summer field sampling was continued in the northern Rocky Mountain area. Twenty-two additional sample areas were selected and a plot in each of these areas was sampled. This summer one man will again be sampling full-time in the field. Almost all of the field sampling for this project should be completed by the end of this summer.

Last winter laboratory analysis of field samples continued. Soil samples were tested for mechanical analysis, fineness, pH, bulk density and wilting point or field capacity. Increment cores were analyzed for rate of growth and per cent summerwood. A research assistant will continue this laboratory work during the summer.

Although this work is not far enough along for a formal report, a progress report of this work was presented in Spokane on April 12, 1961, at the combined meeting of the Northwest Wood Products Clinic and the Inland Empire Section of the Forest Products Research Society. This will appear in the 16th Annual Proceedings of the Northwest Wood Products Clinic as well as in a F.W.R. Experiment Station Research Note in June, 1961.

Project S.R. 55. The Identification and Biology of the Insects Affecting Cones and Seeds of Commercial Forest Trees in Idaho.

A study, "The Biology of Conophthorus monticolae Hopk. in Northern Idaho", initiated in July, 1959 and completed in early 1961, was submitted by D. L. Williamson in partial fulfillment of the Master of Science degree. A summary of his study follows.

The life history of this forest pest is completed in one year. The adults overwinter in blighted cones that have fallen from the trees during the fall. They emerge from early May to early July and attack the second year cones of western white pine. From one and a half to two months are required to pass through the egg stage to the new adult stage. The immediate effect of the feeding damage is to prohibit all further growth of the immature cones, and the development of seeds. Losses to seed crops due to infestations of this cone beetle often seriously affect natural and artificial regeneration of western white pine. In addition, C. monticolae must be recognized as a threat to the successful maintenance of western white pine seed orchards and cone production areas in northern Idaho.

Preliminary data and observations on the life history of Dioryctria abietella D. & S. in western white pine cones also were recorded during the study of Conophthorus monticolae. This information has indicated that D. abietella is second in importance only to the cone beetle in destructiveness to the cones and seeds of this host tree species. For this reason, a study tentatively entitled "The Biology of Dioryctria abietella D.& S. with an Appraisal of its Damage to Western White Pine Cones" has been initiated as a continuation of S.R. 55.

Project S.R. 63. Mass Production of Lodgepole and Jack Pine Hybrids.

This project was initiated to determine the feasibility of producing lodgepole-jack pine hybrids for pulpwood plantations.

Because of weather conditions and poor flower counts last year on lodgepole pine, no pollination was done at that time. The absence of flowers induced a study to stimulate flower production by the use of commercial nitrogen as reported favorably by several research workers. The treatments which were applied include:

1. Three 1/10 acre plots installed in our previously thinned seed production area. 264 pounds per acre nitrogen was applied as ammonium nitrate. Three 1/10 acre plots were installed with no treatment and served as a control.

2. Six 1/10 acre plots were installed in an unthinned natural area. Three of the plots were treated with 264 pounds of nitrogen per acre and three plots served as a control.

The thinned seed production area comprises two acres with trees spaced at approximately 25 foot intervals. A border swath of 30 feet was cleared around the area. The seed trees averaged 22 years in age, 47 feet in height and had a D. B.H. of 9.2 inches.

Data from the fertilizer trial, along with the number of pollination bags installed on lodgepole plot #1, are shown in Table 1.

Table 1. Lodgepole Pine Plot #1.

Tree Numbers	Number of Pollination Bags Installed	Number Flowers on 10 Limbs *
Thinned Area		
-28	19	34
-27	23	52
- 3	23	39
-19	23	79
F. -11 **	25	94
F. -21 **	32	37
-24	23	119
- 7	25	46
- 9	31	188
- 2	50	158
-13	23	143
-22	24	120
-20	23	82
-12	21	71
-26	24	44
F. -25 **	25	84
-23	87	71
Unthinned Area		
F. -39 **	25	43
F. -40 **	25	87
-31	25	52
F. -29 **	25	50
-30	25	97
-32	25	12
TOTAL	651	1802

* Taken 6 whorls down, tip included.
** F. = fertilized tree

The pollination bags were installed on May 24; pollination occurred on May 2 and the bags were removed on June 13.

The data indicate no significant difference between the fertilized and the non-fertilized trees in either the thinned or unthinned area. There was, however, a significant increase in flower production in the thinned area as compared to the unthinned area. This increase in flower induction due to thinning was also repeated in an adjacent grand fir plot where thinned trees produced three times as many flowers as unthinned trees. The increase of flower production and subsequent cone production in the grand

fir plot was so great that many of the tree tops were broken because of the added weight. It will be interesting to follow future seed yield as a result of the natural topping of seed trees.

In addition to the 651 pollination bags which were installed as reported in Table 1, 200 pollination bags were also put on 4 different parents in lodgepole pine #2. The seed trees in plot #2 will average 70 feet in height with a D.B.H. of 22 inches. The elevation is 5000 feet compared to 2500 feet for plot #1.

Project S.R. 65. Fertilization of Forest Plantations and Natural Stands.

Nitrogen analysis of needles produced during the 1960 growing season revealed that ponderosa pine at Lone Mountain and on the College Forest were not absorbing much of the applied fertilizer. The very great stimulation of grasses and other ground cover on the fertilized plots indicated that these plants were taking the nitrogen at the expense of the trees. During the spring of 1961 the ponderosa pine experimental areas were sprayed with Dowpon in an effort to eliminate this competition for the fertilizer.

A marked increase in nitrogen content of young white pine and grand fir and definite stimulation of growth occurred on fertilized plots in the Ramskull Creek area of the St. Joe National Forest. Here ground cover competition was not serious. Ponderosa pine was originally planted on this site in 1939. Because of poor growth, white pine was planted under the older trees in 1949. These trees, also, had failed to show vigor. The grand fir on the plots have seeded in naturally, and are about the same age as the white pine. Grand fir needles on nitrogen fertilized plots contained an average of 0.16 percent nitrogen, as compared to 0.07 percent nitrogen on control plots. White pine needles showed similar trends. Both species produced needles on fertilized plots which were considerably longer and thicker than those produced on controls. These trees will be measured for height growth after the 1961 growing season.

New fertilizer plots were installed in a ponderosa pine plantation near Bovill. Nitrogen was applied at a rate of 300 pounds per acre in this area, as contrasted to 150 pounds per acre applied on the plots at Lone Mountain and the College Forest. A new series of plots were also prepared adjacent to those of the original Lone Mountain project. Here, too, the nitrogen was applied at the 300 pound per acre rate.

Project S.R. 66. Effects of Tree Seedling Fertilization.

This project was initiated to obtain information on the feasibility of fertilizing tree seedlings as they are field planted to increase survival and growth.

Tests made at Athol this year were a duplication of plots set out in 1959 and 1960.

In each test plot there were a total of 200 seedlings which were planted along with a mora tree feed pellet. An additional 200 plants were set out as a control. The pellets were inserted directly under each seedling

tested. A randomized planting design was used with 25 plants in each block replicated four times in both cultivated and non-cultivated soil.

Data, although not completely analyzed at this time, indicated that there is no significant increase in survival due to the fertilizer pellets at the Athol planting. Test so far has shown that soil moisture regulated by competing vegetation is the main factor in controlling survival.

Foliage samples have been collected for analysis to compare nutrient levels in the test plots. Growth may be stimulated with the continuation of the release of elements incorporated in the pellets.

Project S.R. 70. Seedling Growth and Survival as Conditioned by Variation in Climate, Soil, Competing Vegetation, Site Preparation and Planting Stock.

The first series of experimental plots concerned with this project were established in the spring of 1960 on a poor site near Athol in northern Idaho. A variety of treatments, including summer fallowing, cultivation, fertilization, scalping, mulching, and irrigation were employed. Details of treatments and methods of observation can be obtained from the 1959-1960 Annual Report of the Station. Douglas-fir seedlings were planted, and survival, soil moisture, and surface soil temperature observed frequently. Results after the first growing season may be briefly outlined as follows:

1. Differences in survival occurred which were highly significant.

2. The New Multiple Range Test indicated that these highly significant differences were between treatments employing cultivation or irrigation without cultivation and uncultivated, unirrigated plots.

3. Within the two broad groups mentioned above, no significant differences in survival occurred, regardless of any additional treatment such as mulching or scalping.

4. Survival on all plots where cultivation was included in treatment averaged 87 percent at the end of the growing season. Survival of seedlings on uncultivated plots averaged 36 percent.

5. Fertilization had no significant effect on seedling development.

6. While near or above field capacity at the beginning of the growing season, soil moisture on uncultivated plots (8 inch depth) fell rapidly and approached the wilting point before the middle of July. Moisture percentage on cultivated plots remained at adequate levels throughout the growing season.

7. Mulching and scalping both failed as moisture conserving agents under the conditions of this experiment.

8. Soil moisture levels at 18 and 24 inch depths followed patterns similar to those found at 8 inches.

9. A correlation coefficient of 0.89 was found when comparing the two

variables--survival at the end of the growing season and average soil moisture for the period July 13-August 30.

10. From limited data, it appears that the temperature of the soil surface did not exceed 162 degrees F on any plot, but for a 5-week period temperatures between 150 degrees and 162 degrees F were reached.

A Station Research Note covering the results summarized above has been prepared.

During the spring of 1961, a duplicate series of plots were installed on the Athol experimental area. New plots, similar in nature, were installed on a problem area near Cavandish, Idaho. This land had formerly been in farm crops, as had the Athol site. In order to test survival of forest type plantings, experimental areas were developed near Spirit Lake, Idaho, and on the College Forest. Comparisons of machine vs. hand planting, and 9 vs. 12-inch roots will be made on these sites, as well as tests of the effect of evaporation retardants. Observations to be made are similar to those employed on the plots at Athol.

In another phase of seedling survival investigations, a graduate student will study the relation of nutrient level of soil and plant as it affects drought resistance. This work will be conducted both in the greenhouse and in the field.

II. Range Management

Project E.S. 7. Evaluation of Salt-Desert Ranges.
Project E.S. 15. The Ecology and Control of Halogeton.

Three years of dry weather conditions along with other factors are producing changes in salt-desert vegetation on sites that have been studied for ten years. Shadscale stands, which were showing improvement after release from grazing pressure, have declined in the last two years. A poor condition stand of winterfat which was fenced in 1958 continues to show improvement as regards vigor of the remaining winterfat plants despite the dry years. Another stand of winterfat, south of Malta, Idaho, which was deteriorating rapidly, was fenced against rabbit and livestock use in the late summer of 1960. A comparison of plants inside and outside the exclosure in the spring of 1961 indicates an increased vigor of winterfat within the exclosure during the short period that the area has been fenced.

Army cut worm damage was noted on a small area of good condition saltsage in 1960. This area in 1961 showed an almost complete cover of halogeton. Sites containing annual plants, mainly halogeton, that were attacked by the cut worm in 1960 showed a reduction of annual plant cover in 1961.

Two large scale crested wheatgrass seedings that were planted in 1948 and 1951 have shown a marked decline in productivity and an increase in the amount of halogeton during the last two years.

Halogeton seed buried for six years is still capable of germinating in the laboratory. Seeds that germinate are entirely of the brown form as the black form either germinates in the field or deteriorates.

The studies on the ecology of Indian ricegrass, squirreltail grass, desert molly, winterfat, saltsage and shadscale initiated in 1958 were continued. Transplants of the various species to other plant communities, where they are not presently found growing, indicate that a number of them may be adapted for artificial vegetation on several site conditions. Few small scale seedings using native and introduced species have been successful. Of these saltsage has shown the most promise to date.

A number of shadscale, winterfat and saltsage seedlings were marked for observation in 1959. Of these, 29 percent of the shadscale seedlings were alive in 1960 and 19 percent in 1961. Sixty-four percent of the saltsage seedlings survived in 1960 and 62 percent were alive in 1961. Counts of winterfat seedling survival showed 79 percent in 1960. Counts for 1961 had not been taken at the time of writing of this report.

Project E.S. 8. (S.R. 27-D). Ecology and Control of Medusahead.

Emphasis during the past year was placed on studies of the life history and requirements of medusahead in relation to associated annual and perennial grasses. The principal studies included seed germination and dormancy, the regeneration of clipped plants, and the effect of medusahead litter on seedling establishment of several species. The effects of discing and fertilizers on two perennial grasses in the field and the relative response to nitrogen of annual and perennials in the greenhouse was studied also.

Seed studies included determining the length of the dormant period for medusahead and cheatgrass under laboratory conditions. The viability of medusahead seed after various periods of submergence in water and the amount of cheatgrass and medusahead seed that carries over for at least one year were also investigated.

Fresh medusahead seed maintained strict dormancy until the seed was over 100 days old and did not reach peak germination until about four and a half months after date of collection. Cheatgrass seed began to germinate slightly under 100 days from collection date and reached a peak at about four months.

Fresh medusahead seed gradually lost its viability with increasing time of submergence in water, but after 4 weeks of complete immersion as much as 19 percent of the seed was still viable and produced vigorous seedlings. Apparently water could be an important method of seed dispersal.

The amount of medusahead seed that is carried over for at least one year on 5 sites in Gem and Washington Counties ranged from 3.6 plants per square foot on a burned site to 227 plants per square foot on a site that has been protected from grazing for several years. Cheatgrass carryover ranged from 0.6 plants per square foot on a burned site that had been heavily grazed to 36 plants per square foot on a protected site.

The regenerative ability of medusahead plants clipped below the growing point proved to be directly related to phenological development of the plant at time of clipping and to soil moisture. Only 46 of 100 plants survived and produced seed after having been clipped on May 11 when they were in the early sheath stage. Similar treatment on May 19 when the plants were in the mid-sheath stage of development left only 5 surviving plants. Plants clipped at later dates and developmental stages died without producing any regrowth.

Four grass species, medusahead, cheatgrass, squirreltail (Sitanion hystrix) and desert wheatgrass (Agropyron desertorum) were seeded in sterilized medusahead litter that had been placed over soil. The litter ranged in depth from $\frac{1}{4}$ to 3 inches. The survival of all species was adversely affected by increasing depth of litter with the greatest mortality occurring in medusahead and desert wheatgrass. At the 3 inch litter depth the number of surviving desert wheatgrass plants was reduced more than 50 percent. Although the cheatgrass survived slightly better than the squirreltail, the plants were small and lacked vigor. Squirreltail plants were more vigorous and of greater height than any of the other species under all conditions of the experiment.

Seeding studies on burned medusahead sites included the effects of discing and time of application of nitrogen on the establishment of perennial grasses. Discing in late fall after germination of annual grasses was compared to no discing. Nitrogen was applied both spring and fall.

On a site (#1) that receives about 13 inches of precipitation, discing increased frequency of perennial species slightly, but had little effect on plant height (Table 1). Nitrogen applied in the fall significantly increased plant numbers and frequency. Height was not influenced by any of the treatments. On site 2, with about 18 inches of precipitation, discing

prior to seeding more than doubled plant numbers. Discing followed by spring applied nitrogen slightly increased plant number, height and frequency over discing followed by nitrogen applied in the fall.

Table 1. Effect of time of application of nitrogen and fall discing on density, height, and frequency of desert and intermediate wheatgrass.

	Not Disced			Disced		
Treatment	Average Number Plants per Row	Average Plant Height (cm.)	Freq. %	Average Number Plants per Row	Average Plant Height (cm.)	Freq. %
Site 1. Desert wheatgrass						
Control	48	11.31	58	56	10.76	74
Fall N.	66	11.26	80	92	11.96	88
Spring N.	50	11.23	68	56	11.28	72
Site 2. Intermediate wheatgrass						
Control	94.5	9.50	90	214	12.69	94
Fall N.	108.0	10.25	95	239	14.85	98
Spring N.	100.0	10.90	95	242	16.30	100

The relative response of 3 grasses to 5 nitrogen levels (20, 50, 100, 200 and 400 ppm.) was tested in the greenhouse using sand culture as a medium. The grasses were medusahead, cheatgrass and desert wheatgrass. The yield of the latter two species was closely correlated with increasing nitrogen. At the highest nitrogen rate medusahead exhibited an inverse relationship and yield decreased to less than that recorded for the plants that had received 100 ppm. Growth differences between the three species from 20 through 100 ppm. of nitrogen were slight. At the 100 ppm. level the yield curve of desert wheatgrass and of medusahead began to flatten with increasing nitrogen, but the curve of cheatgrass continued to climb.

The nitrogen concentration in harvested plant material was not in keeping with yield results. The medusahead plants increased in nitrogen content at rates beyond the 200 ppm. mark although yield dropped sharply after this point. The nitrogen content of cheatgrass was the lowest of the three species and desert wheatgrass was the highest.

Project E.S. 9. (R-287). Ecology of Sagebrush-Grass Ranges.

This project is conducted jointly with the Soils staff of the Department of Agronomy as the Idaho contributing project to Regional Project W-25.

Thirteen new study sites were sampled, bringing to 83 the total of full-fledged sites done to date. The sites added this year belong to associations dominated by Artemisia tridentata, A. tripartita and A. arbuscula, along with herbaceous understories consisting primarily of Agropyron spicatum and Festuca idahoensis. Most of these sites are located in the

eastern third of the state on parent material derived primarily from limestone. Differences between these communities and comparable ones located on basaltic, rhyolitic and loessial materials indicate an influence by the limestone which warrants further study. For example, F. idahoensis is restricted to definitely higher and apparently more mesic climatic areas on limestone than on any of the other parent materials mentioned above.

Additional sites selected for study in 1961 were not sampled because of early curing of the herbaceous vegetation. This was the third year of drought over much of the study area.

Observations were continued on the sagebrush thinning study begun in 1960, and partial re-sampling of the plant cover was done. In this experiment, conducted on a site dominated by A. tridentata and a thin stand of perennial grasses, three treatments involving removal of sufficient sagebrush plants to produce foliage, cover means of 0, 2-3 percent and 7-8 percent on an area where the undisturbed cover averaged 14 percent. Sampling of the herbaceous understory in 1961 revealed no significant response to any of the treatments. While this result may reflect in part a need for more intensive sampling, it also seems related to the effects of the severe drought which prevailed in the study area during 1961 and the previous year. Growth of sagebrush did seem to be stimulated in the partially thinned plots, but no sampling of the shrubby vegetation was done. Both herbaceous and shrub strata will be sampled again next year, with increased sampling intensity.

Re-sampling of the vegetation in a 40-acre exclosure located in south central Idaho was done in order to continue successional studies initiated by Dr. R. L. Piemeisel of the U. S. Bureau of Plant Industry. This exclosure was established in 1932 on abandoned farm land situated in a sagebrush-grass region with mean annual precipitation of about 10 inches. The vegetation at the time the area was fenced consisted of annuals, mainly Salsola and Sisymbrium. The rabbit population was sufficient to prevent appreciable plant succession until 1938, when the area was fenced against these pests and a continuing program of rabbit extermination was initiated. The succession which occurred from that time was studied by Dr. Piemeisel until his retirement in 1954. This exclosure and two similar ones, along with all the original plant data, were turned over to the University at this time.

The changes in annual vegetation on this and the other two exclosures have been reported in a series of papers (Piemeisel 1938, 1945, 1951), but virtually nothing has been published on the development of perennial vegetation. In 1961 the remaining 175 of an original 182 permanently located frequency plots (25 x 25 cms. in size) were re-sampled. These data were combined with those obtained earlier by Dr. Piemeisel to determine what changes in plant cover had occurred.

While this analysis has not been completed, enough has been done to indicate the trends for the principal species. The dominant grass, and the quickest to increase, was Sitanion hystrix. This species increased from a frequency of 1.6 percent in 1938 to 42.8 percent in 1941 and reached a peak of 77 percent in 1945. Comparative stability has prevailed since that time, with a rating of 66 percent in the 1961 sampling. Agropyron riparium, the other major grass, increased more slowly to a peak of 23.6

percent in 1954 and stabilized thereafter as indicated by the 1961 figure of 21 percent. Stipa thurberiana and Poa secunda, the two major climax grasses of the region, have increased very slowly and are still far from exerting dominance on the site.

A study of distribution patterns for major species of the sagebrush region and their relation to certain major soil characters was continued by Hironaka. Part of this study will be used as a Ph.D. thesis in Plant Ecology at the University of Wisconsin.

The methodology developed for the first phase of this project was described in a paper by C. E. Poulton and E. W. Tisdale entitled "A Quantitative Method for the Description and Classification of Range Vegetation" in the January 1961 issue of the Journal of Range Management.

Project E.S. 13. Ecotypic Variation in Idaho Range Species.

The study of native species of perennial fescues was continued in the uniform nursery plantings made in the spring of 1959 on the University of Idaho campus and at Stanford University. Emphasis has continued to be placed on Festuca idahoensis which constitutes about 75 percent of the plantings. Due to the heavy mortality in most lots at Stanford, it was decided to consider this test completed and to plow up the remnants of all but two lots after final field data for the 1961 season were obtained in June. Two to four potted plants of each of the 25 collections planted at Stanford have been retained in the Carnegie Institution of Washington greenhouses for future use.

The principal data obtained from the nursery plantings include measurements of survival, basal diameter, height of leaf and culm, and dates of flowering. In the following summary, all references are to F. idahoensis except when noted otherwise.

Survival. Mortality for most lots has been low at Moscow and high at Stanford. At Moscow, only two lots, from high elevations in Montana and Wyoming, had survival rates less than 80 percent by the end of the 1960 season. At Stanford, only seven lots out of 25 showed more than 50 percent survival by the end of 1960, and much additional killing had occurred by June of 1961. It is evident that F. idahoensis and F. scabrella are both reasonably well adapted to the environment at Moscow, while the opposite is true at Stanford. While the Stanford site is the drier, drought does not appear to be the principal factor causing low survival at that station. Several of the collections of F. idahoensis from the sagebrush-grass region of Idaho and Oregon are well adapted to drought, yet these suffered as severely as lots from more mesic sites. On the other hand, a collection from a highly mesic site in the Coast Range of Oregon was the best adapted of all lots at Stanford.

Basal Diameter. By 1960 the plants at Moscow were definitely larger than those at Stanford, with an average difference of 50 percent. Differences among lots at Moscow were relatively small with the exception of the two high elevation lots mentioned above for poor survival.

Leaf and Culm Height. Height of basal leafage varied greatly among lots

and averaged slightly higher at Moscow than at Stanford. At Moscow the lots with the greatest mean leaf height were all from northern Idaho, while the shortest included collections from high elevations in western Montana and Wyoming and one from the sagebrush zone in eastern Oregon.

Mean culm heights varied much less than those of basal leafage, but followed much the same pattern as described for foliage height measurements.

Time of First Anthesis. Dates varied as much as 37 days among different lots of F. idahoensis, and averaged much earlier at Stanford than at Moscow. The earliest lots at both stations included those from western Montana, Wyoming and a high sagebrush area at Dubois, Idaho. The latest materials were from northern Idaho, central Oregon (Sisters) and northeastern California (Susanville).

Individual plants of several lots were photographed in the Moscow nursery. In addition, vouchers were taken from each of 5 plants in 14 lots of the Moscow-grown material.

During the coming year a study will be made of morphological characters of vouchers collected from the two nurseries. The data on field performance for the three seasons will be summarized and an attempt made to obtain the chromosome numbers for the lots studied.

Project E.S. 14. Investigations of Harvester Ants on Southern Idaho Rangelands.

The size and number of harvester ant clearings was determined on the three areas under study during the 1960 field season. There was no significant change in the results reported in the last annual report. The number and total area cleared is still greater on depleted sites than those in good condition.

Project E.S. 26. Evaluation of Range Reseeding.

Five years of grazing studies were completed at the Point Springs experimental area at the conclusion of the 1959 trials. At the close of these trials the experimental design was modified to include a greater number of treatments. The six original 160-acre pastures were divided in half so as to provide twelve fields for comparative grazing studies.

The original treatments provided for three intensities of use: light, moderate, and heavy, in each of two seasons--spring and fall. The expanded design provides for maintaining these treatments on one-half of each original 160-acre pastures and adding an additional season and intensity treatment on the other half of the pasture. All combinations of four intensities (including 0 intensity) and two seasons are used with the exception of any combination with heavy spring use. The combination no use in spring and fall is also excluded. The treatments currently being used are presented below:

	No Use Fall	Light Fall	Moderate Fall	Heavy Fall
0 Spring	No	X	X	X
Light Spring	X	X	X	X
Moderate Spring	X	X	X	X
Heavy Spring	X	No	No	No

The pasture arrangement and experimental design used in the first five years of the study, and after subdivision, are shown in Figure 1.

1960 Trials

Production and utilization were determined in a similar manner to previous trials except that three transects per line were used instead of five. This represents an increased intensity of sampling, however, due to decreased pasture size.

Growth measurements were obtained in a similar manner to that used in 1959. Cages measuring 9.6 square feet in area were located in all the spring use pastures for this determination.

Spring Grazing Trial

Sampling of the pastures to determine forage production was completed on April 27 and the animals were weighed and distributed to the pastures on April 30.

Lack of anticipated growth during this trial made it necessary to reduce the number of animals grazing some of the pastures at the time of the 28-day weighing. The number of animals grazing the pastures is given below:

Pasture Number	Intensity of Use	No. of Animals First 28 Days	No. of Animals Last 18 Days
02	Light Spring	35	35
05	Moderate Spring	47	41
03	Heavy Spring	44	36
10	Moderate Spring--Heavy Fall	44	44
20	Light Spring--Light Fall	32	32
30	Moderate Spring--Moderate Fall	38	32
40	Light Spring--Heavy Fall	22	12
50	Moderate Spring--Light Fall	35	30
60	Light Spring--Moderate Fall	29	23
	Total	326	285

Production and utilization values are given in Table 1 and livestock weight data are given in Table 2.

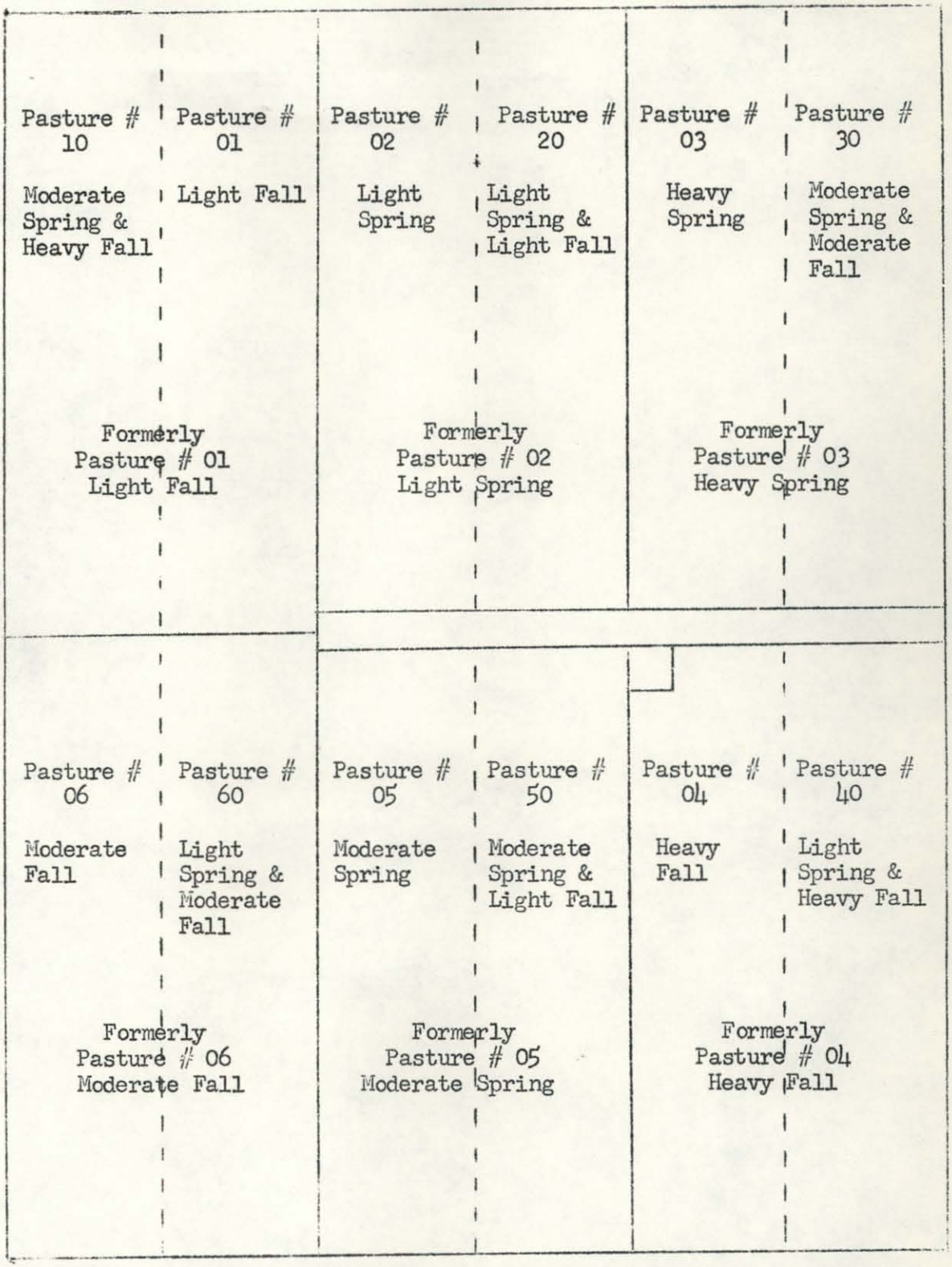

Figure 1. Pasture arrangement at Point Springs experimental area with season and intensity of use for the first five years of the study, 1955 through 1959, and after subdivision.

_____ Boundary of original pastures.
\- - - - - - - Boundary of present pasture arrangement.

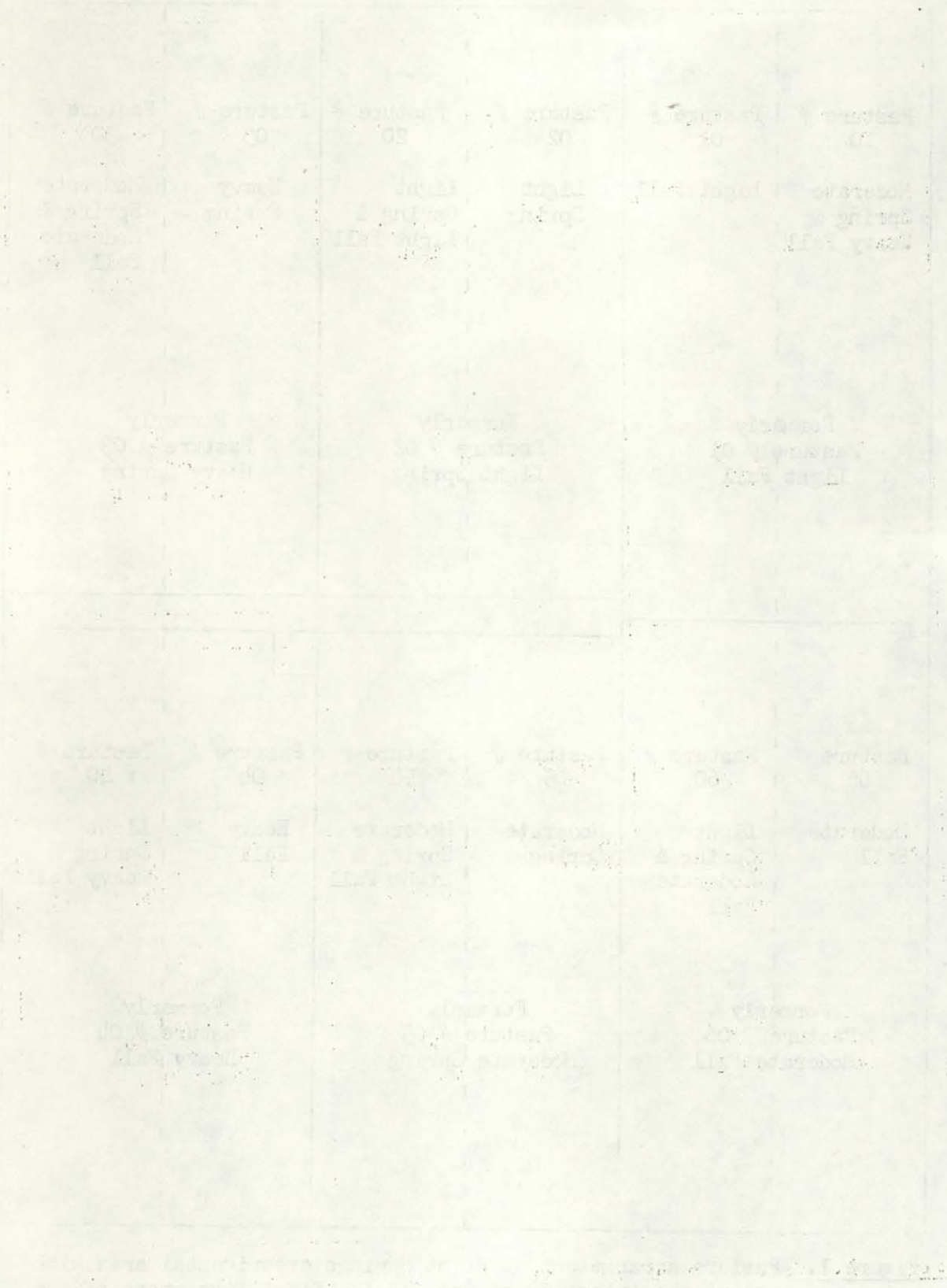

Table 1. Production of forage in pounds per acre and the percent of this production utilized by animals grazing at three intensities in two seasons during 1960.

Pasture Number	Season	Intensity	Initial Production*	Percent Utilization
Spring Use Only				
02	Spring	Light	302	44
05	Spring	Moderate	320	83
03	Spring	Heavy	264	81
Fall Use Only				
01	Fall	Light	444	73
06	Fall	Moderate	287	59
04	Fall	Heavy	186	62
Combined Spring and Fall Use				
10	Spring	Moderate	310	44
	Fall	Heavy	173	72
	Total			82
20	Spring	Light	311	53
	Fall	Light	146	23
	Total			64
30	Spring	Moderate	267	67
	Fall	Moderate	88	35
	Total			78
40	Spring	Light	205	56
	Fall	Heavy	90	62
	Total			83
50	Spring	Moderate	228	66
	Fall	Light	78	12
	Total			70
60	Spring	Light	294	73
	Fall	Moderate	80	44
	Total			85

* Includes growth increment for pastures used during the spring trial.

Table 2. Livestock weights and gains by pasture and season during 1960.

Pasture Number	Season	Intensity	Average Initial Weight	Avg. Total Gain Per Animal	Avg. Daily Gain Per Animal	Gain Per Acre
Spring Use Only						
02	Spring	Light	507.8	65.1	1.42	27.3
05	Spring	Moderate	504.5	55.9	1.22	32.1
03	Spring	Heavy	408.3	76.5	1.66	40.5
Fall Use Only						
01	Fall	Light	565.8	21.5	0.48	6.7
06	Fall	Moderate	541.5	43.2	0.96	10.8
04	Fall	Heavy	554.7	40.3	0.89	7.7
Combined Spring and Fall Use						
10	Spring	Moderate	456.9	60.1	1.31	33.07
	Fall	Heavy	554.9	28.1	0.62	3.51
		Total				36.58
20	Spring	Light	518.3	60.7	1.32	24.26
	Fall	Light	511.3	35.9	0.80	3.14
		Total				27.40
30	Spring	Moderate	410.3	74.9	1.63	35.32
	Fall	Moderate	493.8	7.8	0.17	0.49
		Total				35.81
40	Spring	Light	456.2	97.1	2.11	22.94
	Fall	Heavy	520.0	36.0	0.80	3.13
		Total				26.07
50	Spring	Moderate	467.2	72.5	1.58	30.66
	Fall	Light	540.0	36.4	0.81	2.28
		Total				32.94
60	Spring	Light	523.1	76.0	1.65	26.96
	Fall	Moderate	501.1	11.0	0.24	0.82
		Total				27.78

Fall Grazing Trial

The pastures were sampled to determine production from September 8 to September 12 and the animals were weighed on September 15 and distributed to the pastures as shown below:

Pasture Number	Intensity of Use	Number of Animals
01	Light Fall	25
06	Moderate Fall	20
04	Heavy Fall	15
10	Moderate Spring--Heavy Fall	10
20	Light Spring--Light Fall	7
30	Moderate Spring--Moderate Fall	5
40	Light Spring--Heavy Fall	7
50	Moderate Spring--Heavy Fall	5
60	Light Spring--Moderate Fall	6
	Total	100

Miscellaneous Data

Salt consumption records were continued during the 1959 and 1960 trials. Average daily and monthly consumption by pastures and season for the two years is shown in Table 3.

Water consumption records obtained in the spring of 1959 and in the fall of 1959 and 1960 are summarized in Table 4. The meters for recording water consumption were not installed during the spring of 1960.

Table 3. Average salt consumption in pounds per head per day and per month in 1959 and 1960.

	Pasture	Intensity of Use	Average Consumption per Animal Daily (pounds)	Monthly (pounds)
Spring 1959				
	02	Light	.042	1.26
	05	Moderate	.034	1.03
	03	Heavy	.042	1.25
Fall 1959				
	01	Light	.048	1.46
	06	Moderate	.032	0.96
	04	Heavy	.027	0.81
Spring Use Only 1960				
	02	Light	.059	1.76
	05	Moderate	.047	1.42
	03	Heavy	.041	1.22
Fall Use Only 1960				
	01	Light	.082	2.46
	06	Moderate	.050	1.49
	04	Heavy	.047	1.41

Table 4. Average daily water consumption for the spring and fall periods of 1959 and the fall of 1960.

Pasture	Intensity of Use	Average Daily Consumption (Gallons) 1959	1960
Spring			
02	Light	4.80	---
05	Moderate	4.92	---
03	Heavy	4.51	---
Fall			
01	Light	5.15	5.34
06	Moderate	6.32	5.74
04	Heavy	7.31*	5.19

* Includes some leakage from the trough.

Project E.S. 32. (Formerly S.R. 27-C) Ecology and Control of Goatweed (Hypericum perforatum).

Work on this project was maintained at a minimum level, primarily to follow the trends in Hypericum populations already much reduced by Chrysolina beetles. This involved detailed study of two sites (Spalding and Webb) which have been under close observation for several years, along with general observations of four other sites.

Numbers of Hypericum plants beyond the seedling stage remained at a low level during 1961 at both detailed study sites. Numbers of Hypericum seedlings increased from the zero levels found in 1959 and 1960, but not enough to indicate any major upsurge of the species.

An important feature of the 1961 data is the increase shown in frequency of Elymus caput-medusae on both portions of the Spalding site, situated in the Clearwater River drainage near Spalding. This species is also present in significant amounts at the Webb site, but is not increasing so rapidly. The phenomenon of invasion by this highly undesirable grass into sites where Hypericum has been much reduced indicates the complexity of the weed problem on ranges whose natural cover of perennial bunchgrasses and forbs has been largely destroyed.

Less detailed observations on four other sites indicated conditions fairly similar to those reported for the two detailed study areas. No Hypericum plants were observed at two of the sites, only a thin stand on one portion of a third, and a fair stand on the fourth. There was evidence of much beetle activity at this latter site, so that its Hypericum population is probably on a downward trend.

III. Wildlife and Fisheries Management

A. Projects completed during the year:

Project W.U. 15. The Movements, Productivity and Management of Sage Grouse in Clark and Fremont Counties, Idaho.

The last of four investigators completed the project in September, 1960 with the submission of a Master's thesis entitled "Productivity and Movements of a Population of Sage Grouse in Southeastern Idaho" by Edward F. Schlatterer.

The summary and conclusions of this last segment of the study are as follows:

1. Two hundred and fifty-one sage grouse were trapped, banded and released over a two-year period from 1958 to 1960 in southeastern Idaho. These birds provided information on strutting behavior, inter-strutting-ground and seasonal movements, and the age composition of the spring populations.

2. The cannon net trap was highly efficient in trapping sage grouse on the strutting grounds, but unfortunately resulted in considerable mortality and tended to disrupt the strutting activities. A little over 50 percent of the males banded were re-observed on the strutting grounds. In two strutting seasons, about 30 percent of all banded males re-observed on the strutting grounds were involved in inter-strutting-ground movements at least once in the season.

3. In 1960, the number of inter-strutting-ground movements was high enough to cause one to suspect that fluctuations in daily male counts on the strutting grounds may in part be caused by inter-strutting-ground movements.

4. The sub-adult males in the 1959 strutting season appeared in large numbers prior to and during the peak mating period. These males exhibited almost full adult plumage development and were difficult to distinguish from the full adults except when in the hand. An early and very successful hatching period and good juvenile survival in 1958 was the probable cause of the early appearance of sub-adult males on the strutting grounds.

5. The sub-adult male population in 1960 on the strutting grounds appeared to be below normal as a result of relatively poor juvenile survival in 1959.

6. The strutting ground census is adequate under the present intensity of management practiced by the Idaho Fish and Game Department, if the highest single day total count of males for the entire Red Road strutting complex is used as a census figure rather than high counts on individual strutting grounds. The factor of inter-strutting-ground movements will thus be minimized.

7. Indications based on one year's observations are that strutting

ground improvement by clearing the invading sagebrush had some management value.

8. The peak of mating in 1959 extended over a period of ten days, from April 10 to April 20. Adult females tended to be mated earlier during the peak period than the sub-adults. The peak of mating in 1960 encompassed a period of less than five days, from April 11 to April 13. There was no difference between the mating periods of the adult and sub-adult females.

9. The determination of the age ratio between adult and sub-adult females on the strutting grounds may be of considerably more importance in the estimation of the productivity potential than the strutting male counts.

10. Ovulated follicle counts when compared to the age ratio data collected on the strutting grounds, seemed to support the contention that the productivity potential in 1959 was lower than that in 1958, in spite of higher male counts on the strutting grounds in 1959.

11. The presence of a considerable number of atretic follicles on the ovaries of incubating females, in addition to the ovulated follicles, tended to invalidate the use of ovulated follicle counts taken in the fall to determine the number of eggs laid.

12. Ovulated follicle counts made of fall-collected sage grouse ovaries revealed that adult females are stimulated to a much greater extent than sub-adult females.

13. The winter range of the sage grouse utilizing the Red Road strutting grounds was found to be in the vicinity of the Rexburg-Sage Junction area.

14. The winter range of the sage grouse populations tends to fluctuate with the severity of the winter season, being closer to the strutting grounds in mild winters and farther away in severe winters. The date of arrival of the first birds in the vicinity of the strutting grounds varies considerably with the earliness or lateness of the spring break-up.

15. Movement across the lower Red Road strutting grounds early in the strutting season, by the birds that utilize the strutting areas east of the Red Road, cause highly erratic male counts early in the strutting season, often higher than at any time later in the strutting season.

B. Continuing projects:

Project W.U. 18c. Productivity of Ruffed Grouse on Idaho Forests.

This project has been active only a portion of last year. Mr. David Erickson completed his work in the middle of the school year and his Master's thesis was submitted and approved.

During late June and early July ruffed grouse were found in both Cedar

Hemlock and Douglas-fir zones. As the summer advanced broods moved to the ravines and occupied the Cedar Hemlock zone, primarily the Thuja/Pachistima habitat type. Broods used cover in the ravines during the day. Logging roads and railroad grades were used as evening feeding areas from about mid-August until at least mid-November. This confirms some of the original results of Project W.U. 1.

In the summer and fall of 1959, 24 grouse were banded. Six of 20 grouse checked during the hunting season on the Flat Creek area were banded. The total known kill represented about 13 percent of the fall population on the area. The banded juvenile grouse moved a maximum distance of 0.29 miles and a minimum distance of 0.04 miles in fall dispersal. The short period of time from the date of banding to the date the bird was subsequently killed or observed suggested that the dispersal distances could have been greater. Although sufficient data are lacking, juvenile females moved farther than males. In addition, there was a tendency of the birds to move in a southerly direction up the major drainage system of the area.

Grouse were found using the spur ridges, slopes, and ravines for their winter habitat. Very few birds were found wintering on the main ridges, in contrast to the finding in Project W.U. 1. Most of the grouse were observed in the Thuja/Pachistima and Abies grandis/Pachistima habitat types. Grouse were found on all aspects during the winter. This led to the conclusion that the wintering habitat of grouse overlaps the summer brood habitat during the period of investigation.

The habitat of the drumming males was on the spur ridges and slopes as opposed to the more extensive winter habitat. The cover in the Abies grandis/Pachistima habitat type was preferred by male grouse, although the use of more than one habitat type was indicated. Males showed no preference for one aspect over others. Cocks selected large, rotten, moss-covered logs for drumming, and they commonly used more than one log during the drumming season.

Thirty-eight drumming males were located on the Flat Creek area. A spring density of 5.4 drumming males per hundred acres was estimated for this area. Fifteen males were captured with mirror-traps and marked. The age composition of the trapped cocks consisted of about twice as many juveniles (one-year olds) as adults (two years or older). Although the sample size is small, these data indicated that the ruffed grouse population on the Flat Creek area is reproducing well.

Project W.U. 19. Ruffed Grouse Populations and Census Methods.

This project was inactive during the year.

Project W.U. 23b. Census, Habitat Use, and Productivity of White-Tailed Deer in the Hatter Creek Enclosure.

The objectives of this phase of the Hatter Creek study are as follows:

1. To develop census techniques suitable for use in the habitat types

represented in the Hatter Creek Deer Enclosure which is typical of much of northern Idaho forested areas.

2. To determine the habitat use of the Hatter Creek deer herd during different seasons of the year.

3. To gather information concerning the age class, sex ratio, and productivity of various classes of does within the enclosure area.

A graduate student, Mr. Harley Shaw, has been on this project throughout the current school year. He was in course work during the fall semester, but spent most of the spring semester in the field on this Hatter Creek study. The pellet group count technique was emphasized during the spring field season and counts were made in five cover types and in some cleared areas in the forest within the enclosure. Pellet group densities were closely correlated with deer feeding habits and browse availability. This could indicate that food availability is a major factor affecting deer habitat use or merely that deer tend to defecate more while feeding than at other times. It has not yet been determined whether the pellet density is a good index of total use of the area by deer and future plans for the project will include an attempt at evaluation.

In addition, direct observation of deer habitat use was attempted; however little definite information was obtained. Work is underway to develop several further techniques of determining deer habitat use because of the limitations of direct observation and the possible limitation of the pellet group method. The project will be continued throughout the summer but the next spring field season will be emphasized to complete this project.

Project W.U. 26. Salt in the Management of Elk and Other Wildlife in the Lower Selway River Area, Idaho County, Idaho.

Tom Williams, research fellow, was employed by the Idaho Fish and Game Department prior to completion of the thesis. The first and second drafts of the thesis were reviewed. The final copy has not yet been submitted.

Project W.U. 28. A Study of the Influence of Logging on Trout Streams in Northern Idaho.

During the summer of 1960 three collections of fish samples and limnological data were made on the four streams selected for this project. The sample stations and techniques used in analysis of data were similar to those utilized in previous years. The data collected were analyzed and tabulated for inclusion in a final report.

Project W.U. 36. Plant Succession and Utilization by Livestock and Big Game in a Sand Dune Area in Fremont County, Idaho.

Larry D. Wing, research fellow, entered the field on June 15, 1961, on the second phase of this project.

A. Objectives

1. To determine forage utilization by big game.

2. To determine forage competition, if any, between big game and livestock.

3. To determine the condition of the range under present use.

4. To determine what effect the present level of utilization has upon re-establishment of burned-over bitterbrush.

5. To determine as closely as possible winter range carrying capacity for big game.

B. Procedures

1. Pre-sample cover types to determine adequate sample for permanent transects.

2. Establish randomly located transects to sample density and utilization.

   a. Bitterbrush shrubs selected by nearest shrub in each quadrant at each one hundred foot intervals on transect line. One hundred inches measured on four major stems in the four quadrants of each shrub. New shrubs used for utilization studies each year.

3. Transects laid out to include both outside and inside the take-down exclosure and the high fence exclosure.

4. Measure livestock use on shrubs before arrival of big game in fall and total use after departure of big game in spring.

5. Quantitative measure of resprouting of bitterbrush following the April 1960 fire.

6. Pellet group counts on one-hundredth acre plots at points of utilization measurements on transects to indicate the number of deer, elk, and moose days of use.

7. Rate of sand movement determined by measurement from previously set stakes.

8. Re-measurement of density in total exclosure using same methods established by Chadwick in first phase of the project.

Project W.U. 37. Ecology and Management of Browse on Elk Winter Range, Lower Selway River, Idaho.

This project, assigned to Dr. Dalke, has not been active during the past year except for establishment of utilization plots.

Project W.U. 41. Productivity of Mule Deer on an Over-Used Low Grade Range.

Robert E. Wood, research fellow, is assigned to this study in the lower Middle Fork of the Salmon River. The field work was started on June 15, 1961.

A. Objectives

1. To determine the population composition and trend of mule deer on sample units of the winter range.

2. To determine mortality factors.

3. To determine the fawn crop and over-all productivity of all age classes of does.

4. To determine movements into and away from winter range.

B. Procedures

1. Age composition of the herd will be accomplished through direct observation, trapped deer, hunter kills and winter mortality.

2. Herd mortality on two winter range segments--Sheep and Brushy Creek drainages.

3. Fertility and fecundity determined by embryo and ovarian analysis. Embryo counts to be secured from collected deer, late hunting season kills, winter and spring mortality.

4. Population estimates will be based upon both direct counts and pellet group counts.

5. Movements of deer will be determined from animals trapped and marked. Twenty portable traps are available for project use.

Project W.U. 42. Life History of the Salmon River Cutthroat Trout.

Material for this project was provided by the State of Idaho, Department of Fish and Game. This project is being written as a thesis for the M.S. degree and as a Dingell-Johnson report.

Project W.U. 43. A Limnological Survey of the Backwater of the Lower St. Joe River, Idaho.

The St. Joe River backwater in northern Idaho is essentially a twenty-six mile transition zone between the lotic environment of Coeur d'Alene Lake and the lentic environment of the St. Joe River fastwater. Since the backwater is transitional between a lake and river environment, it readily lends itself to a study of linear succession of plankton and bottom fauna.

A limnological survey of the backwater was begun April, 1960, and con-

tinued through February, 1961. The project was undertaken to observe the linear succession of plankton and bottom fauna from the lower to upper reaches of the backwater; to ascertain the productivity of the backwater with special reference to fish food organisms; and to measure seasonal variation in physical, chemical and biological features.

Sample stations numbering 1 to 6 were located about equal distances apart from the lower to upper reaches of the backwater respectively. At each station, the following limnological data were taken: physical measurements of width, average depth, air and water temperatures and surface turbidities; chemical factors including dissolved oxygen, hydrogen ion concentrations and methyl orange alkalinity; biological measures of bottom fauna, plankton and periphyton.

Observations of the backwater demonstrate that it more closely resembles a lotic or river unit than a lentic or lake environment. Simultaneous records of top and bottom temperature and dissolved oxygen concentrations never ranged more than 1.4 degrees C. and 1.7 ppm. Water velocity varied from a maximum of 0.73 miles per hour during spring runoff to a minimum of 0.07 miles per hour in the fall when hydrographic conditions were most stable.

Bottom fauna production in the backwater is considered poor by the food grade standard in Lagler, 1956.

Inshore samples were six times more productive by number and 10 times more productive by weight than mid-channel samples. This contrast in productivity is attributed to a difference of bottom type at inshore and mid-channel stations.

Two taxonomic groups, the Chironomidae and Oligochaeta, formed 84 percent by number of the benthic organism population. Chironomid larvae contributed 61 percent of the total number and oligochaetes 23 percent; whereas amphipods, leeches, caddisfly larvae, beetle larvae and mayfly nymphs were present in relatively small amounts.

A definite seasonal trend in the quantity of bottom fauna was evident. From a July minimum, the population developed through August, underwent a marked increase in September and reached a maximum in December, 1960. Numbers decreased in February 1961.

Abundance of benthic organisms was inversely related to water discharge. The population was lowest after the spring floods. Thereafter, population increase was greatest during periods of stable water flow from September through December 1960. There is no correlation in seasonal fluctuations of water temperatures and chemistry and the seasonal trend in bottom organism production.

The greatest production of benthic organisms was in the middle section of the backwater. Low production in the upper extremity is attributed to a sandy bottom which is generally accepted as the least productive type of substratum.

A linear succession of benthic fauna was evident from the lower to upper reaches of the backwater. Amphipods occurred in greatest numbers at the

lower extremity near Lake Chatcolet (Station 1). They decreased in numbers as the distance upstream from the lake increased. Leeches exhibited a population peak at Station 2, oligochaetes at Station 3, chironomids at Station 4 and caddisfly larvae at Station 5 respectively. Coleoptera larvae also exhibited the greatest density at Station 5. The number of taxonomic groups were least in the upper reaches at Station 6.

A paucity of plankton in the backwater is attributed to soft water; current; young water age; lack of associated lentic environments; and fluctuation in hydrographic conditions.

Three main taxonomic groups (Copepoda, Cladocera and Rotatoria) and nine genera made up the zooplankton population. The mean percentages by numbers were 61 percent copepods, 37 percent cladocerans and only 2 percent rotifers.

Zooplankton abundance was directly related to water temperature. The vernal pulse of animal plankton was accompanied by a corresponding rise in water temperature until a peak occurred during August at a mean water temperature of 19.2 degrees C. Thereafter it subsided during the following months to a minimum in December 1960, when water temperature was lowest.

Plankton density was greatest in the lower section of the backwater. The lower part average 55 times more zooplankton and 1.7 times more phytoplankton than the upper extremity.

Phytoplankton outnumbered zooplankton at a ratio of 240:1.

Five phyla and 39 genera of phytoplankton were represented in the backwater. Filamentous algae contributed 43 percent, Dinobryon 21 percent and diatoms 34 percent by number of the total population.

There were two major peaks in the standing crop of phytoplankton. The first bloom occurred in June at a mean water temperature of 3.5 degrees C. and the second in September, one month later than the zooplankton pulse, at a mean water temperature of 16.6 degrees C.

In April, June, August and October, gill-net samples were taken at four stations in the backwater of the St. Joe River. The smallest weight of both largescale suckers and northern squawfish were obtained in June. This was attributed to an emigration to upstream sites for spawning purposes. Maximum numbers of suckers occurred in the fall at which time bottom organisms became most abundant. The center of concentration of suckers was associated with that part of the backwater in which bottom fauna was most plentiful.

Project W.U. 44. Ecology of Mule Deer Winter Range, Middle Fork, Salmon River.

Richard C. Presby, research fellow, is assigned to this study in the lower Middle Fork of the Salmon River. The field work started June 15, 1961.

A. Objectives

1. To determine composition, density and plant vigor of the perennial

plant cover.

2. To determine soil stability in relation to existing cover and per cent of slope.

3. To determine soil moisture and soil temperature as factors in plant growth and regeneration.

4. To determine degree of browse utilization and availability and periods of use.

5. To determine food habits of deer on the winter range. Correlate available food with physical condition of animals.

B. Procedures

1. Establish two weather instrument stations on two typical bitterbrush sites, one at 5400 feet, south facing slope, Sheep Creek; the other east facing slope along Middle Fork at 4200 feet.

2. Develop habitat-type maps from aerial photographs using ecological classification of vegetation as previously used in the Wildlife Research Unit based upon Daubenmire's zonal plant classification and Hungerford's adaptations.

3. Pre-sample cover types to determine adequate sample for permanent transects.

4. Establish randomly located permanent transects to sample density and utilization.

5. Utilization of shrubs will be determined by linear twig measurement before and after deer use with progressive use determined on selected high population density sites.

6. Pellet group counts will be made on 100 square foot circular plots established in conjunction with the utilization transects and in additional areas as determined from previous winter trend count sites.

7. Food habit material will be collected from all deer taken from productivity study as well as from hunter-killed deer and winter mortality specimens.

Project W.U. 45. Occurrence and Significance of Dew on Selected Sites in Northern Idaho.

This project is an outgrowth of W.U. 18 in which the microclimate became recognized as an important part of the environment in determining productivity of ruffed grouse. Mr. Paul Edgerton, National Defense Fellow working towards a Ph.D., has been working on this project but during the past year he has been occupied almost entirely with course work. Some work was done during the 1960 field season on the measurement of dew on selected micro-sites in the Hatter Creek Enclosure,

the development of a better method of measuring dew moisture, and a collection of data on micro-sites to help define the overall micro-climate picture.

At the end of the year we received word that the U.S. Weather Bureau had agreed to provide a two-year research grant to carry on this study, beginning July 1, 1961. A number of instruments for recording microclimatic factors, the summer salary for the graduate student, and a field assistant, and the summer field expenses will be provided by the grant.

Objectives of this project are as follows:

1. To perfect a dew measurement procedure that would give values approximating amounts of dew deposited on the vegetation of the study area.

2. To determine the amounts and pattern of distribution of dew on these selected sites.

3. To study the influence of microclimatic factors, specifically temperature, wind movements, air drainage, rainfall, humidity, and solar radiation upon dew deposition.

4. To study the effects of forest cover and forest clearings upon these microclimatic variables during the summer season of dew deposition.

5. To briefly investigate possible functions of dew in the moisture relations of certain herbaceous plants.

6. To briefly investigate possible correlations between the microclimatic variables, including dew, and the food preferences and habitat preferences of Idaho ruffed grouse and white-tailed deer on the study area.

Project W.U. 46. Life History of the North Idaho Cutthroat Trout.

The objective of this study is to investigate the life history of a cutthroat trout race that lives in the complex of lakes at the south end of Lake Coeur d'Alene, and migrates up the St. Joe River system to spawn.

Preliminary examination of scales from migrating cutthroat trout of the St. Joe River system indicates that they spend the early part of their life in a stream environment, and move down to the lake environment sometime during the first or second year of life. Anglers report catching these cutthroat trout from early May until mid-June, in the lower reaches of the St. Joe River. These fish, taken by anglers, are generally sexually mature, indicating that they are on a spawning migration.

Cutthroat trout in the St. Joe River system have survived the introduction of other game fish (rainbow trout and eastern brook trout), in-

creased numbers of non-game fish (squawfish and yellow perch), increased angling pressure, logging and forest fires which increase stream siltation, and water drawdown when tributary streams are diverted for irrigation.

Because the cutthroat trout is native to Idaho, and has survived these limiting factors, it has become an important and much sought-after sport fish. However, its survival and production is not unlimited, and its effective management depends upon knowing more about its habits and distribution.

An important phase of this study will be to determine if any meristic differences exist between resident cutthroat trout of the St. Joe River and tributaries, and the adfluvial race that lives in the lake complex near the mouth of the river. Other phases of the study are age and growth, chronology of the spawning run, the amount of time young adfluvial fish spend in the tributary streams before migrating to the lake system, and the determination of those tributary streams of the St. Joe River system that are used for spawning by adfluvial cutthroat trout. By determining the above factors management practices designed for increased production can be initiated, and more intensive studies can be conducted.

The first part of this study was begun during early July, 1961, and consisted of a general survey, and collecting fish in various streams tributary to the St. Joe River, and the St. Joe River mainstem.

SUMMARY OF F. W. R. EXPERIMENT STATION PROJECTS 1960-1961

No.	Title	Started	Present Status	Personnel
	I. FOREST MANAGEMENT			
E.S. 1	Wood Preservation Service Tests	1946	Discontinued	Howe, Burlison
E.S. 2	White Pine Blister Rust	1940	Cont. Active	Partridge
E.S. 3	White Pine Stem Anatomy	1953	Cont. Inactive	Johnson
E.S. 6	Idaho Tree Diseases	1950	Cont. Active	Partridge, Johnson
E.S. 19	Christmas Tree Test Plantings	1953	Cont. Active	Pitkin
E.S. 20	Mortality of Young White Pine	1948	Cont. Active	Johnson
E.S. 23 (WM 42)	Market Structure & Marketing Practices	1956	Cont. Active	Seale, Williams
E.S. 24	Forest Tree Breeding in Idaho	1957	Cont. Active	Wang, Reid
E.S. 27	Nutrients in White Pine Site Quality	1958	Cont. Active	Loewenstein
E.S. 28	Nursery Soil Fertility	1958	Cont. Active	Loewenstein,Pitkin
E.S. 29	Engelmann Spruce Weevil	1958	Cont. Active	Schenk
E.S. 30	Study of Relationships Between Farm Unit, Farm Forest & Off-Farm Employment Opportunities	1961	New	Williams
S.R. 11-C	Forest Tree Physiology	1951	Cont. Active	Johnson
S.R. 54	Forest Site Influences on Wood Properties of Inland Douglas-Fir	1957	Cont. Active	Howe, Hofstrand, Johnson, Maloney
S.R. 55	Cone and Seed Insects	1957	Cont. Active	Schenk,Williamson
S.R. 63	Lodgepole-Jackpine Hybrids	1958	Cont. Active	Pitkin
S.R. 65	Fertilizing of Forest Stands	1958	Cont. Active	Loewenstein,Pitkin
S.R. 66	Seedling Fertilization	1958	Cont. Active	Pitkin,Loewenstein
S.R. 70	Seedling Growth & Survival	1960	Cont. Active	Loewenstein,Pitkin
	II. RANGE MANAGEMENT			
E.S. 7	Evaluation of Salt-Desert Ranges	1951	Cont. Active	Sharp
E.S. 8 (S.R. 27-D)	Ecology & Control of Medusahead	1950	Cont. Active	Hironaka, Tisdale, Heller
E.S. 9 (R-287)	Ecology of Sagebrush Ranges	1949	Cont. Active	Hironaka, Tisdale
E.S. 13	Ecotypic Variation in Range Plants	1956	Cont. Active	Tisdale
E.S. 14	Harvester Ants on Idaho Ranges	1956	Cont. Active	Sharp
E.S. 15	Halogeton on Idaho Ranges	1950	Cont. Active	Sharp, Nelson
E.S. 26	Evaluation of Range Reseeding	1952	Cont. Active	Sharp, McIlvain
E.S. 32	Study of Goatweed (Hypericum) (Formerly S.R. 27-C)	1951	Cont. Active	Tisdale

No.	Title	Started	Present Status	Personnel
	III. WILDLIFE AND FISHERIES MANAGEMENT			
W.U. 15	Study of Sage Grouse	1952	Completed	Dalke, Schlatterer
W.U. 18c	Productivity of Ruffed Grouse	1952	Cont. Active	Hungerford, Erickson
W.U. 19	Ruffed Grouse Population Study	1951	Cont. Inactive	Hungerford
W.U. 23b	Census, Habitat Use & Productivity of White-Tailed Deer	1952	Cont. Active	Hungerford, Shaw
W.U. 26	Silt in Elk Management, Selway	1955	Cont. Inactive	Dalke, Williams
W.U. 28	Influence of Logging on Trout Streams in Northern Idaho	1955	Cont. Active	MacPhee
W.U. 36	Plant Succession & Utilization by Livestock and Big Game, Fremont County	1958	Cont. Active	Dalke, Wing
W.U. 37	Ecology & Management of Browse on Elk Winter Range, Lower Selway	1959	Cont. Active	Dalke
W.U. 41	Productivity of Mule Deer on Over-Used Low Grade Range	1961	New	Dalke, Wood
W.U. 42	Life History of Salmon River Cutthroat Trout	1959	Cont. Active	MacPhee
W.U. 43	Limnological Survey of Backwater of Lower St. Joe River	1960	Cont. Active	MacPhee, Davis
W.U. 44	Ecology of Mule Deer Winter Range, Middle Fork, Salmon R.	1961	New	Dalke, Presby
W.U. 45	Occurrence & Significance of Dew on Selected Sites in Northern Idaho	1960	New	Hungerford, Edgerton
W.U. 46	Life History of North Idaho Cutthroat Trout	1961	New	MacPhee, Averett

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I. Technical Publications

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II. Graduate Theses (M.S. June, 1961)

Erickson, D. L. Movements and seasonal habitat of ruffed grouse on the University of Idaho Experimental Forest.

Farmer, E. E. First-year establishment of aerially-sown coniferous tree seed on a burned area in northern Idaho.

Helle, J. H. Characteristics and structure of early and late spawning runs of chum salmon (Oncorhynchus keta Walbaum) in streams of Prince William Sound, Alaska.

Schlatterer, E. F. Productivity and movements of a population of sage grouse in southeastern Idaho.

III. Miscellaneous Publications

Hungerford, K. E. 1960. Review of "Wildlife of Mexico" by A. Starker Leopold. Northwest Sci. 34(3):110-111.

Johnson, F. D. 1961. Review of "The Biology of Mycorrhiza" by J. L. Harley. Northwest Sci. 35(1):32.

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APPENDIX A. F. W. R. EXPERIMENT STATION STAFF 1960-1961

I. Regular Staff Members

Ernest Wohletz, Director and Professor (Forest Management)
E. W. Tisdale, Associate Director and Professor (Range Management)
P. D. Dalke, Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Management)
M. E. Deters, Professor (Forest Management)
Minoru Hironaka, Assistant Range Ecologist
A. D. Hofstrand, Instructor (Wood Utilization)
J. P. Howe, Assistant Professor (Wood Utilization)
K. E. Hungerford, Professor (Wildlife Management)
F. D. Johnson, Assistant Professor (Forest Management)
Howard Loewenstein, Assistant Professor (Forest Management)
Craig MacPhee, Assistant Professor (Fishery Management)
Arthur Partridge, Assistant Professor (Forest Management)
F. H. Pitkin, Nurseryman and Instructor
R. H. Seale, Associate Professor (Forest Management
J. E. Schenk, Assistant Professor (Forest Entomology)
L. A. Sharp, Associate Professor (Range Management)
Chi-Wu Wang, Associate Professor (Forest Genetics)
E. L. Williams, Assistant Forest Economist, Jr.

II. Research Fellows

S. P. Davis--Fishery Management
E. E. Farmer--Forest Management
T. H. Heller--Range Management
J. L. Mallet--Fishery Management
R. B. Maloney--Forest Utilization
R. C. Presby--Wildlife and Range Management
R. G. Reid--Forest Genetics
Edward Schlatterer--Wildlife Management
H. G. Shaw--Wildlife Management
D. L. Williamson--Forest Entomology
L. D. Wing--Wildlife Management
R. E. Wood--Wildlife Management

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT 1960-1961

1. University of Idaho, Forest, Wildlife and Range Experiment Station, projects in Forest Management, Range Management, Wildlife Management, and Wood Utilization.

2. University of Idaho, Special Research Funds for Projects S.R. 11-C, 27-D, 54, 55, 63, 65, 66, 70 and 77.

3. Boise-Cascade Company. Assistance in forest genetics research.

4. Idaho State Department of Forestry. Support for forest genetics research.

5. Idaho State Fish and Game Department. Regular support for the Wildlife Research Unit.

6. Inland Paper Company. Labor, equipment and field accommodations for work on tree hybridization, seedling survival and forest fertilization.

7. Potlatch Forests, Inc. Potlatch Research Fellowship and a special grant for work on forest site influences on wood properties of inland Douglas-fir and for research on bark-base fertilizers.

8. Southern Idaho Forestry Association. Support for forest genetics research.

9. United States Bureau of Land Management. Funds for research on salt-desert shrub ranges, facilities and assistance for Point Springs grazing project, medusahead research and forest genetics studies.

10. United States Bureau of Sport Fisheries and Wildlife. Regular funds for Wildlife Research Unit.

11. United States Department of Agriculture. Funds from Regional Research Projects WM-42, W-25 and W-71. *

12. United States Forest Service. Office space at Boise Research Center, field living accommodations and assistance in collection of research material for several projects.

13. Wildlife Management Institute. Funds for wildlife research.

* Funds received through cooperation of Agricultural Experiment Station, University of Idaho.

APPENDIX B. SOURCES OF RESEARCH FUNDS AND COOPERATIVE SUPPORT 1960-1961

1. University of Idaho, Forest, Wildlife and Range Experiment Station. Projects in forest management, range management, wildlife management and wood utilization.

2. University of Idaho, Special Research Funds for Projects R.P. 11-0, 2[illegible], 3[illegible], 5[illegible], 6[illegible], 8[illegible], 9[illegible], and 7[illegible].

3. [illegible] Company. Assistance in forest genetics research.

4. Idaho State Department of Forestry. Support for forest genetics research.

5. Idaho State Fish and Game Department. Regular support for the Wildlife Research Unit.

6. Inland Paper Company. Labor, equipment and field accommodations for work on tree hybridization, seedling survival and forest fertilization.

7. Potlatch Forests, Inc. Potlatch Research Fellowship and a special grant for work on forest site influences on wood properties of inland Douglas-fir and for research on [illegible].

8. Southern Idaho Forestry Association. Support for forest genetics research.

9. United States Bureau of Land Management. Funds for research on salt-desert shrub ranges, facilities and personnel for Point Springs grazing project, mechanized research and forest [illegible] studies.

10. United States Bureau of Sport Fisheries and Wildlife. Regular funds for Wildlife Research Unit.

11. United States Department of Agriculture. Funds from Regional Research Projects [illegible], W-25 and [illegible].

12. United States Forest Service. Office space at Boise Research Center, field station accommodations and assistance in collection of research material for several projects.

13. Wildlife Management Institute. Funds for wildlife research.

[illegible] cooperation with the Agricultural Experiment Station, University of Idaho.