FOREST, WILDLIFE AND RANGE EXPERIMENT STATION

COLLEGE OF FORESTRY

UNIVERSITY OF IDAHO

Moscow, Idaho

E L E V E N T H A N N U A L R E P O R T

For the Fiscal Year 1958-1959

Ernest Wohletz, Director

E. W. Tisdale, Associate Director

December 1959

TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION

Of the 40 projects active during the year, 3 were completed or discontinued. Nine new and continuing studies were begun during the year.

The Station staff numbered 19 with 4 on full-time research. The resignations of Dr. R. L. Gilbertson and Mr. George Frazier at the end of the year left open positions in Forest Pathology and Forest Economics. Arrangements were made to fill the vacant position in Wood Utilization early in the next fiscal year.

Dr. E. W. Tisdale was on leave of absence from September 15 to June 15 to accept a National Science Foundation Senior Postdoctoral Fellowship at the University of California. About one-third of his time during this period was spent on Project E.S. 13, Ecotypic variation in range plants, with current emphasis on native fescues, particularly Idaho fescue.

Mr. Minoru Hironaka of the Range Management staff was also on leave of absence during the same period, studying for his doctorate degree in Plant Ecology at the University of Wisconsin.

Eight graduate research fellows were included in the Station program during the year, and 3 research fellows completed their theses by June, 1959.

The Station program continued to be supported mainly by University funds, supplemented by contributions from other state, federal and private sources.

A list of publications prepared during the year and a roster of staff members and research fellows are appended to this report.

Respectfully submitted,

E Wohletz

Ernest Wohletz, Director

E. W. Tisdale

E. W. Tisdale, Associate Director

WORK ACCOMPLISHMENTS

I. Forest Management and Utilization

A. Projects completed during the year:

Project E.S. 25. Idaho Wood-Rotting Fungi.

Due to the resignation of Dr. Gilbertson, this project was terminated. A publication based on a portion of the work done will be prepared.

B. Continuing projects:

Project E.S. 1. Wood preservation Service Tests.

No work was done on this project during the year. Some treated materials remain for observation in future years.

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

The ten plots on which data collection was required were given their annual inspection in the period August 5 to 14, 1958. The last living canker on Sands Creek plot, C series, inoculated in 1940, died in 1958 terminating annual inspection of that plot.

Plot maintenance, consisting of repainting all identification numbers on trees for which records are continuing, and others required for location purposes was done on the six plots where the work was most necessary. The two plots on the Kaniksu and the two on the Coeur d'Alene were painted when inspected. Two of the St. Joe plots were done on August 21 and 23.

Photographic records in color and black-and-white were continued for cankers in these series that were still active. This work was done on June 18, 30; July 6; August 22; November 9, and 22, 1958. Site photographs were taken on Hobbs Creek plot, D series, inoculated 1941, on August 23. These were taken from the same camera setup positions from which the original site photographs were made in 1941, and illustrate stand changes in the intervening seventeen years.

It is of interest to note that a control crew applying Actidione BR accidentally treated one of the project's trunk cankers approximately two months before the 1958 inspection. This is canker C363, Ames Creek plot. The method used was to paint a solution of the antibiotic on axe-cuts made in the canker margin. After two months there was no evidence of killing of the canker, which was then continuing vigorous growth and spore production. Thirteen and one-half months after treatment this canker was still developing, continuing growth at both ends, and at points between most of the bark cuts so that it is progressing toward encirclement of the trunk. At time of treatment it was 26.2 inches long, and had grown 63.5 per cent around the 6.3-inch diameter trunk. After 13½ months it was 30.3 inches long, and had encircled 81.2 percent of the trunk. Five cuts had been made on one side and 8 on the other when the canker was 26.2 inches long. Much of the canker margin was dead around

the cuts after 13½ months. Both ends were still growing, as were both lateral margins at the center-line. As noted, there were living sections of the margin between most of the cuts. One such area produced aecia over a length of 7 inches, beyond which fresh pycnia appeared. One short vertical bark cut was almost exactly on the advancing margin. Although this cut was surrounded by a narrow region of dead bark, aecia were produced within one inch of it, and fresh pycnia within one-half inch. Inspection of this canker will be continued to follow future development.

Essential to the survival probability phase of the study, presented in interim form as F.W.R. Experiment Station Research Note 7 (1953), is the final status of each infected branch in the inoculated population. Of the 453 branches employed for that paper, cankers on 65 had neither reached trunk nor died enroute at the time data were compiled. Thus, prediction of final status of these cases was undertaken (1952) and the predictions included in the data, as discussed in the Station report for 1956-1957. Predictions were strictly subjective, based upon detailed records of each case independently. The Station report for 1957-1958 stated that, although 18 percent of the predictions were then in error, the errors were virtually compensating. The percentage given should read 14 percent. At this time it is necessary to report that 12 cases have failed to satisfy predictions, and that 1 and possibly 2 dubious cases may also fail to do so. Thus, 18.5 percent of 1952 predictions are now in error, compared with 14 percent at the end of the 1957 field season. When all data are in hand it is probable that 20 percent, and possible that 21.5 percent will be in error. Unfortunately, the errors are no longer compensating, and can only remain unchanged or become somewhat less so than at present. This is because, of the 2 alternatives, cases predicted to die that have actually reached trunk have increased in number, while there has been no increase in those predicted to reach trunk but have died enroute.

Of the 65 predicted cases, the 60 that have now reached final status comprise 23 that have reached trunk and 37 that have died enroute. Only 3 predicted to reach trunk died, but 9 predicted to die have actually reached trunk. Five branch cankers have not yet reached final status and must be inspected until they do so. Of these 2 are probably dead, 1 possibly dead, and 2 still active. Two are the dubious cases mentioned above. Present indications are that one will be in error, the other not. The remaining 3 will almost certainly satisfy predictions. Thus, based upon these latter assumptions, final status for the 65 predicted cases will show 24 reaching trunk and 41 dying enroute. The 1952 predictions indicated these cases as 19 and 46 respectively. The effect of distribution of these errors upon the survival probability percentages presented in Research Note 7 for the various classes of distance of canker from trunk must await analysis.

During the period June 22 to 30, 1959, further negotiations concerned with final analysis of data of the study were undertaken with the statistical staffs of the University of California's Statistical Laboratory, Public Health Department, and others suggested by them as prospects for statistical consultation. After conference with Professor Jerzy Neyman, a group of distinguished visitors and two senior staff members, and further personal interviews with Professor Neyman, several suggestions were made. Arrangements for consideration of the consultation work were made with one of the senior staff members of the Statistical Laboratory who was present

at the initial conference, and with another broadly experienced statistician. Final decisions have not as yet been forthcoming.

Through the courteous cooperation of Supervisor George F. Weyerman, the St. Joe National Forest provided two field assistants for the period August 4 to 15, 1958. Richard Ogle and James Dungan of the Avery district were assigned to the project through the Clarkia Blister Rust Control headquarters. Plot Maintenance and photography were assisted by Lowell Dubbles, assigned for August 21 to 23 from the Station's Pole Blight Project, E.S. 20, by courtesy of Dr. R. L. Gilbertson. Time contributed to assist canker photography by Mrs. A. W. Slipp, Vinai Bhandhaburana, Somphong Pachotikarn, and Clifford Flewwelling is gratefully acknowledged.

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

Data was compiled for 38 samples during the year. Present data indicates that the trend toward environmental influence of phloem structure is not as strong as previously reported. As the sampled population becomes larger and more plant associations are sampled, variation within associations in different geographical areas seems to be almost as great as between associations. This might suggest stronger geographical influence than was anticipated.

Further sampling was done in the central Sierra Nevada of California on the Lassen and the Stanislaus National Forests; this will greatly help to fill out the sample range which will eventually include the entire botanical distribution of western white pine.

Compilation of data and analyses will continue next year as time permits.

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

Climatic conditions during the spring of 1958 were again favorable to a build-up in the incidence of needle and leaf diseases. Most of the inquiries dealt with this year from northern and central Idaho concerned needle diseases of conifers. Needle casts caused by several members of the Hypodermataceae were very common as were a number of needle rusts not often seen in any quantity.

A short list of tree disease inquiries follows. The numerous needle diseases on many hosts are included under one heading for convenience:

1. Needle diseases of Douglas-fir, lodgepole, ponderosa and western white pines, western larch, and grand fir.
2. Winter dying of Engelmann and blue spruce.
3. Cedar-apple rust.
4. Pole-blight of western white pine.
5. Western gall-rust.
6. Decay of telephone pole insulation pins.

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

This project remains active, but no detailed data were obtained this year.

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

Work on this project was very much restricted during the past year due to two factors. First, the Graduate Fellowship position connected with this project was not filled; compilation of data are normally the duty of this person. Second, the project leader resigned and his successor was not appointed during the time covered by this report.

During the 1958 field season both progress and spread plots were checked and other plots were examined on a less detailed basis.

A manuscript entitled "Field identification of roots of western conifers in the Inland Empire" is in the final stages of preparation and will be sent to the publisher shortly.

The summary of the mycorrhizal work connected with the Pole Blight Project will be included under the discussion of Project S.R. 11-B, which is cooperating in this phase of research.

Project E.S. 21. Study of Idaho Small Tree Farms.

The small woodland owners in northern Idaho are of two occupational types: farm woodland owners and non-farm woodland owners. These two groups are different in several important respects. The farm woodland owners have a larger sized ownership and a larger woodland. They are more likely to be resident on their property than are non-farm owners. The objectives of ownership are essentially different between the two groups. In general, the farm woodland owners have as their primary objective of ownership the derivation of income. The non-farm woodland owner is less interested in the income possibilities of his ownership and more interested in values of rural living and recreation. He may be interested in income possibilities as well, but in general this is less important to him than other values.

The physical productivity of these small woodland ownerships varied from 6 to 8.6 percent compound interest based upon the present physical status of the woodland. This would seem to indicate that the small woodland owners are receiving a reasonable rate of return on their investment in woodlands.

The age classes represented in this ownership are not well distributed either between ownerships or within ownerships. In general, the age of these woodland ownerships is in the lower range-usually those age classes considered to be below merchantability. Basal area is below normal. It varied from 10 to 67 percent of the basal area of a normal stand. Site indexes of these ownerships tended to be concentrated in the higher site qualities.

Species composition of individual woodland ownerships was quite variable. Practically all of the commercially important softwood species in the re-

gion are found on these ownerships. In general, these ownerships are of two types--white pine and ponderosa pine. The samples surveyed were mostly ponderosa pine.

Equipment suitable for management and harvesting is generally available on the farm woodland ownerships. In general, the labor would seem to be available to small woodland ownerships, especially the farm woodland ownerships. Capital for intensive woodland improvement is not available.

The limited evaluation of woodland owners' attitudes would indicate that they are at least partially aware of the potentials of their woodlands. They are willing to devote some time and effort in the woodlands if they can foresee a reasonable return on their investment. They do have an interest in their woodlands--primarily as a source of income and home consumption.

Project E.S. 23 (WM-42). Marketing Practices and Price Analysis of Idaho Non-Industrial Logs and Stumpage.

This study has been carried on by Mr. George D. Frazier under the leadership of Professor R. H. Seale, during the fiscal years 1956-1959 as the Idaho Agricultural Experiment Station contribution to Regional Cooperative Marketing Research Project WM-42. Other contributing studies were conducted by the California, Colorado and Oregon Agricultural Experiment Stations with Washington State, the Forest Service and other U.S.D.A. research agencies cooperating.

Mr. Frazier submitted a thesis reporting the Idaho project in partial fulfillment of the requirements for the M.S. (For.) degree which he received in June, 1959. There has also been submitted a manuscript concerning the project for eventual publication by the Agricultural Experiment Station.

Some of the more salient findings of the study are enumerated below:

1. There are approximately 8500 small non-industrial woodland ownerships in the ten northern counties of Idaho. They own an estimated 1.5 million acres of woodland comprising about 14 percent of the total forest land resource in the region. These findings are based on 1842 questionnaires returned from a mailing of 6914.

2. Thirty-seven percent of small woodland owners are farmers; they own 53 percent of the total acreage in this class. The farm ownerships average 210 acres, the non-farm 120 acres. (The average size for all such ownerships in the United States is only 66 acres.) Fifty percent of the respondents were resident on their property. Over two-thirds have owned their property less than twenty years.

   Eighty-five percent owned less than 500 acres of woodland and they own only 55 percent of the total. In general, 80 percent of the land owned by these respondents is woodland. Only 10 percent purchased their properties for purposes of forest production. The largest groups, 38 percent, gave farming or grazing as their purpose. Thirty-five percent reported that their forest land "was not being used" at the present time. However, there is a significant trend away from "non-use" toward forest production, recreation and homesites.

3. Of reasons given for not marketing timber products, the principal one, by 31 percent of the owners, was that either the timber or the ownership was too small. Unfamiliarity with the market was not a common reason.

4. Forty percent of the respondents had made sales of products from their woodlands in the six years 1952-1957. Principal reasons given for making sales were: harvest of mature timber, land-clearing operations, and supplementary or emergency income. Forty-five percent of the sellers were farm owners. Sellers were generally holders of larger woodlands, averaging 219 acres as contrasted with 112 acres for non-sellers.

   Distance to market is not a major problem for woodland owners. Buyers were located within 20 miles of 80 percent of the sellers and within 10 miles of 52 percent. Sellers established contact with the buyers in half the sales, the reverse was true of one-quarter of the cases; various intermediaries entered into the remaining sales contacts. Forty-four percent of the sales consisted of stumpage, 38 percent of logs delivered to the mill.

5. Only a small fraction of owners received technical assistance in making their sales or marked the trees for harvesting. In four-fifths of the sales payment was based on volume as determined by log scaling. Half of the sellers did their own logging. Only one-fifth of the sales was price determined on the basis of more than one offer. About 40 percent of the sellers entered into written contracts with the buyers. Verbal agreements covered the remainder of the sales.

6. Statistical analysis disclosed no significant effect of any of the owner characteristics upon prices received. Of owner attitudes, only "expected future use of woodlands" was found to have a relationship to price.

7. Some of the marketing practices seemed to have significant effects. Prices were higher in those cases where seller contacted buyer. Prices were higher when they were based on offers from more than one buyer.

A number of recommendations to the woodland owner and to those concerned with woodland program and policy decisions have been derived from the study. These will be presented in the forthcoming bulletin.

As an outgrowth of this initial study, a sequel is now under way continuing the investigation of small woodland marketing practices and the price and volume stability of that market. Regional Cooperative Marketing Research Project WM-42 is looking into the market structure and practices of the initial processors of small woodland products with a view to discovering the influence which that market has upon the small woodland owners marketing situation.

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

The broad objective of this long range project is to find the most profitable combination of hereditary and environmental improvement for the for-

ests of southern Idaho. Plant breeding methods will be applied for the improvement of forest species in respect to cost of production, yield, and quality of forest products. This cooperative forest tree breeding project is sponsored by the University of Idaho, the Idaho State Forest Service, the Intermountain Forest and Range Experiment Station, and the Southern Idaho Forestry Association.

The second year has been devoted to the development of seed stands and the establishment of progeny tests. Seed stands, that appear to be typical of three ecotypes, have been selected at Centerville, Council and Cascade. These three stands are only a start toward the selection of sufficient seed stands throughout the range of ponderosa pine in southern Idaho to meet the local requirements for seed.

About 20 percent of the trees in the Centerville seed stand have been selected on the basis of their appearnace for further evaluation by progeny testing. Open pollinated seed for the progeny tests was collected the summer of 1958 from 433 of the 973 selected trees in the stand.

The spring of 1959 progeny tests were seeded in the Clarke-McNary Nursery near Moscow to observe the progeny's performance under typical commercial nursery conditions, and to produce planting stock for the field progeny test. The seed from each tree was planted separately with two replications in four foot rows of 35 seeds. The field trials will consist of single row plots of 18 trees with two replications. Due to environmental variation from year to year, the progeny tests will be replicated three years.

Two replications of 35 seeds from each tree were direct seeded in four foot rows on the Granite Creek Burn in the Boise Basin to select for seedling survival under field condition. The stratified seed was planted during the cold wet week of the 18th, 19th, and 20th of May. This experiment has been seriously damaged by rodents and an exceptionally hot, dry year.

A third lot of seed, for 800 plots of 12 seeds with 2 replications for each tree, was planted in trays against a slanted glass for the observation and selection of lines with fast seedling root growth. It is assumed that the seedlings with the most rapid root growth during favorable conditions are more likely to develop roots below the depth that the soil dries out during the summer. The seedling root growth can be observed readily through the slanted glass. From casual observation it was apparent that the clipping of the seedling needles by rodents seriously reduced the rate of seedling root growth. Seedling drought resistance is considered to be one of the most important characters of ponderosa pine that can be evaluated at an early age.

Work has been continued on the development of techniques for the adaptation of the basic methods of plant breeding for the hereditary improvement of ponderosa pine. Parchment paper corn ear bags were used for hand pollination to prevent contamination of the female flowers with foreign pollen. A bow and arrow technique was developed to climb large trees. A fish line from a spinning reel was shot over a large limb and used to pull up a sash cord and then a rope with a block so that a man could be hoisted up into the tree. Strips of hard tempered aluminum foil 3/1000 of an inch thick and 18 inches wide were used for rodent barriers.

Climbing ropes were found to facilitate the safety and speed of seed collection. By means of a rope a seed collector can work with short handled tools out on the branches with both hands free, and by sliding down a rope with the use of a taut line hitch to control the rate of descent, climbing time is reduced about a half. The seed collection crew of the Lowman District of the Boise National Forest adopted the use of climbing ropes for seed collection and developed a climbing harness. They had the best seed collection record on the Boise Forest.

One paper was published, "The Divergent Points of View of Forest Genetics and of Agronomic and Horticultural Crop Breeders." Journal of Forestry 57:375-377. 1958.

Project E.S. 26. Evaluation of Tree Plantings in Northern Idaho Forests.

The first phase of this project, involving the identification of coniferous tree seedlings was completed and the results presented in Station Research Note No. 15. This publication describes and illustrates the important characteristics of conifer seedlings and presents a key for the identification of all the major coniferous species of the northern Rocky Mountain region.

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

In a soil-site study, an attempt is made to correlate one, two, or many soil factors with the growth of a specific species. The soil features must be examined on a variety of sites on which the species in question exhibits growth characteristics ranging from poor to excellent. If correlations are found to exist, they can be used either to judge the potential productivity of burned or cut-over land, or in management of existing stands. Thus far most such investigations have dealt with physical soil properties. There is, however, increasing awareness that the nutrient status of the soil may significantly affect the development of trees. Little or no information is presently available relating the level of soil nutrients to growth of any Idaho tree species.

In the course of a Pole Blight study, the Inland Empire Research Center of the Forest Service collected soil samples from 26 white pine sites. These samples were kindly made available for the present soil-site investigation, together with site index and other growth data for each plot.

During the past year, the soil from each site was analyzed for total nitrogen, available phosphorus, and exchangeable potassium, calcium, and magnesium. As the horizons of each profile were tested separately, approximately 150 samples were involved in the analysis. To procure an added indication of the soil fertility, it is planned to collect foliage from leading trees on each plot. These samples will be analyzed for the nutrients mentioned above. Soil and foliar nutrient levels will be compared with tree growth on each site. Should correlations be found, similar studies may be made with other species of commercial importance.

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

In order to improve the quality of growing stock, an investigation concerning the fertility of the soil in both the Clarke-McNary and Soil Bank nurseries has been instituted. Thus far the work has been confined to greenhouse studies, in which ponderosa pine and Russian olive are being used as test species. Nitrogen, potassium, and phosphorus were added to the potted nursery soils, either singly or in combination. After one year the plants will be harvested, and weights and nutrient contents determined. The root system development will be examined, and the overall quality of the plants rated. Field fertilizer trials are also planned for this project.

Project E.S. 28(a). Evaluation of Bark-Base Fertilizer.

Potlatch Forests, Inc. has developed a fertilizer and soil conditioner which consists of bark impregnated with nitrogen, phosphorus, and potassium. The College of Forestry and the Agronomy Department of the College of Agriculture were requested to test this material and report on its potential value.

The College of Forestry phase of the testing program has involved both greenhouse and nursery trials. In the greenhouse soil and bark were mixed in ratios ranging from 1:1 to 23:1. Seeds of five species were planted, ponderosa pine, lodgepole pine, blue spruce, Siberian pea, and Russian olive. The conifers failed to thrive or even to germinate at any of the above mentioned ratios. On the other hand, a dramatic stimulation of pea and olive occurred where soil was mixed with bark at ratios ranging from 5:1 to 23:1. Only at the more concentrated ratios did these species suffer.

Seedbed and transplant bed trials followed the greenhouse work. In these trials bark-base fertilizer was applied at the rates of 2 tons/acre and 7 tons/acre. This latter rate is equivalent to the 23:1 greenhouse ratio. The material was compared with untreated bark and with commercial fertilizer which contained nitrogen equivalent to that in the bark-base fertilizer. The plots were installed in July, well after the start of the growing season. Observations in early September indicated that there had been some growth stimulation of both Siberian pea and Russian olive by the bark-base fertilizer, though not as striking as that occurring in the greenhouse. Commercial fertilizer had almost as beneficial effect, whereas untreated bark produced no stimulation. A pronounced color improvement was noted on ponderosa pine treated with bark-base fertilizer; no effect was seen on plots of Douglas fir and grand fir.

The effect of bark-base fertilizer on seedling root development, a very important consideration, will be studied with the aid of glass front root observation boxes. The investigation will involve several rates of application and several methods of bark placement.

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

The weevil genus Pissodes includes a fairly large number of North American species, many of which are destructive to conifer reproduction. Two well known examples are Pissodes strobi attacking white pine in the north-eastern

Project E.S. 29. Nursery soil fertility studies.

In order to improve the quality of growing stock, an investigation concerning the fertility of the soil in both the Clarke-Mabry and Cliff Lawn nurseries has been instituted. To-date the work has been confined to preliminary studies. In virgin nurseries alum and Ammolan clay are being used as peat organics, although potassium, and phosphorus are added to the general nursery soils, either singly or in combination. After one year the significance of treatments will be expressed, and the overall quality of the plants rated. Field fertilizer trials are also planned for this project.

Project E.S. 29(a). Evaluation of bark-dust fertilizers.

Potash Forests, Inc. has developed a fertilizer and soil conditioner which contains ground bark, nitrogen, phosphorus, and potash. The College of Forestry and the Forestry Department of the College of Agriculture were requested to test this material and report on its fertilizer value.

The College of Forestry phase of the testing program has involved both greenhouse and nursery trials. In the greenhouse soil and bark were mixed in various ratios (Parts 1 to 25). Beds of live species were planted, ponderosa pine, Douglas fir, blue spruce, Siberian elm, and Russian olive. The fertilizer called 10-10-10 was used as directed at one of the above mentioned rates. On the other bed, a strange situation of pure and alive coconut grove soil was mixed with bark to rate nearly 1 part to 25 parts. Only at the more concentrated ratios did these species suffer.

Seeded and transplant soil trials followed the greenhouse work. In these trials bark-base fertilizer was applied at the rate of 2 tons/acre and 4 tons/acre. This latter rate is equivalent to the 25:1 recommended ratio. The material was applied with untreated bark and with commercial fertilizer for which complete directions were followed to the letter in the bark-base fertilizer. The plots were installed in July, well after the start of the growing season. Observations in early September indicated that there had been some growth stimulation of both Siberian elm and Russian olive by the bark-base fertilizer, though not as startling as that occurring in the greenhouse. Commercial fertilizer behaved in identical fashion, whereas untreated bark produced no stimulation. A pronounced color improvement was noted on potatoes plots treated with bark-base fertilizer as opposed to either bare soil or plots of Douglas fir and grand fir.

The effect of bark-base fertilizer on seedling root development, a very important consideration, will be studied with the aid of glass front observation boxes. The investigation will involve several types of application and several rates of bark-base.

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

The weevil genus Pissodes includes a fairly large number of forest insects, many of which are destructive to conifer reproduction. Two weevil species are Pissodes Sitchensis and Pissodes Strobi which are the most destructive

United States and Pissodes sitchensis attacking sitka spruce on the west coast. Both of these insects are sufficiently destructive to be the overriding problems in the silviculture of the host species. The type of damage of the two insects is the same. The larvae work downward in the cambium of the leaders and kill one, two, or more years growth. Height growth is lost and a crook in the bole results when a lateral assumes the terminal function. Under severe weeviling, no tree at all is produced.

In the northern Rockies, the same ecological niche is filled by the engelmann spruce weevil, Pissodes engelmanni Hopk., which attacks all spruce in its range. The insect has been collected in all spruce areas in Idaho, from Valley County north. In some sites of dense spruce reproduction, it has occurred extremely heavily. There is a definite need to obtain some quantitative description of the destructiveness of this weevil. A clear estimation of the degree of reduction of efficiency of engelmann spruce by the spruce weevil is necessary for an adequate evaluation of engelmann spruce as a planting species.

Field observations suggest that there may be an economically significant difference in the damage caused by the beetle between the two ecological occurrences in spruce. Road surveys to date indicate that low elevation, "cold-pocket" spruce stands are much more susceptible to the insect than the high elevation stands in sites of good air-drainage. This indication, which has been obtained from road surveys and observations, requires substantiation by controlled sampling.

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

This project is closely correlated with the Pole Blight Project (E.S. 20) and mycorrhizal work for both projects is summarized here. The initial phases of mycorrhizal research on this project are of necessity the same as those connected with the Pole Blight work. Briefly these phases include the identification and associations of the mycorrhizal fungi of western white pine. This involves collection of mycorrhizal roots and of sporophores of suspect mycorrhizal fungi. Subsequent culture and synthesis will establish basic information on white pine mycorrhizae. With these facts the Pole Blight Project hopes to develop a classification of mycorrhizae and determine which mycorrhizae may be peculiar to various white pine site and stand categories. Such information could then be integrated with existing knowledge in the attempt to explain the cause or causes of the pole blight disease. The Forest Tree Physiology Project, utilizing the basic information from the work outlined above, plans to examine the relative efficiencies of mineral uptake of mycorrhizae connected with western white pine. Should some difference in the mycorrhizal populations of pole blight and healthy stands appear, the fungi involved would be the first to be investigated.

Project 11-B originally was designed to investigate the mineral nutrition of pole blighted and healthy western white pine and was especially adapted to the use of radioisotopes as an investigative tool. There has been a gradual switch in emphasis from mineral nutrition using isotopes to work on the physiology of mycorrhizae which does not involve any use of isotopes. This change, coupled with the aims of the Pole Blight Project, has led to the establishment of a new project. Next year the mycorrhizal work

of both projects will be combined under Project 11-C.

A summary of mycorrhizal investigations during the past year can be divided into three segments:

I. Collection of possible mycorrhizal fungi.

The 1958 field season was marked by scanty late season rainfall, consequently the production of sporophores of fungi suspected of being mycorrhizal on western white pine was very poor. Extensive collecting trips were made to both pole blighted and healthy stands but few collections made. In August, several days were spent in the McCall area with Dr. A. H. Smith of the University of Michigan; Dr. Smith is one of the world's authorities on the taxonomy of the Agarics and the Boletes. Most of the mycorrhizae of western white pine will probably be found to be in these two groups of fungi. Collections of possible mycorrhizal fungi were made from the McCall area; while there is no western white pine in this location, several associated tree species are found there, and a knowledge of fungi associated with these trees will aid us in the finding which fungi, if any, may be restricted to white pine. The McCall collections added 48 fungi to our mycorrhizal herbarium in addition to 12 new cultures for experimentation. Of the new cultures, 9 are Boletes and three of these are new to our work. Fungi in the mycorrhizal herbarium now number over 300 while 46 of these are maintained in pure culture.

II. Mycorrhizal synthesis.

The attempted snythesis of mycorrhizae of western white pine is proceeding, but we have yet to report any great success. Experimentation with media and nutrient solutions as well as inoculation methods is continuing. This year the medium tested was Sponge-Rok, an inorganic, exploded, volcanic rock (perlite). It was hoped that the better aeration provided by this material would aid in the formation of mycorrhizae.

Two fungi were extensively tested under different conditions; these were Boletus subluteus and B. granulatus. Tests included the following variables: light, heat, age of seedling at inoculation, medium/nutrient ratio, and inoculation techniques. Macroscopic examination of 45 inoculated seedlings has shown no obvious mycorrhizal formation. While this examination is reliable for ectotrophic mycorrhizae, endotrophic mycorrhizae, if present, can only be confirmed by microscopic examination. Roots of these 45 seedlings will be sectioned and examined in the near future. If precedents in the genus Pinus and P. strobis in particular are followed, we can expect very few endotrophic mycorrhizae on P. monticola, western white pine.

III. Cultural studies of mycorrhizal fungi.

In the maintenance of a number of pure cultures of mycorrhizal fungi, many of them of the same species of fungus, an ideal opportunity for the observation of cultural characteristics is presented. No new work was started on this phase of the project. A preliminary draft of a

paper describing the cultural characteristics of Boletus subluteus has been completed.

Project S.R. 24. Slash Disposal Studies.

1. Full tree skidding to remove slash from the woods. During the past year, an exploratory study was made to test the feasibility of skidding entire cedar trees to a central point for pole making. The U. S. Forest Service made this study possible by providing a timber sale of 300 poles subject to all the requirements of the study; furnishing a portable wood chipper for slash disposal and assigning a man to obtain data during the operation. The results of this study recently have been reported in Research Note No. 16, 1959. A few of the highlights from this study are:

Entire trees, from stump height to crown trip, were skidded to the landings without difficulty. Two trees could be taken out at a time, either top first or butt first. Some of these trees were large enough to yield 80 and 90 foot finished poles.

Because the branches of cedar are tough and resiliant, very little branchwood broke from the tree while skidding and the crown served to cushion both the pole and residual trees against damage.

Limbing, peeling and trimming operations went faster on the level landings than in the woods.

A two-man crew with a portable chipper can dispose of the slash at the landing for about half the cost of cedar slash disposal in the woods and do a better job of it, provided the pole operation is large enough to keep the chipper busy 75 percent of the time.

By skidding entire trees to landings, it is often economically feasible to salvage material formerly left in the woods, such as long butts, trimmings and round posts.

While it is recognized that this one operation is not an adequate test for the various logging conditions found in the western white pine type, it does indicate the possibilities of using these methods under similar or more favorable conditions, of which there are many in this region. More important, perhaps, this study has removed some of the questions that had been deterrents to trying these methods on a more comprehensive scale.

2. Inflammability of logging slash. In the early 1950's, this Station started simple exploratory tests to determine the degree of inflammability in logging slash of the various timber species of this region, as measured by rate of fire spread. The U. S. Forest Service became interested in the study and offered to take over this phase of slash disposal research, placing a full time man (George R. Fahnestock) with ample technical and financial help to handle the work on a comprehensive scale. This Station continued work on the study to a limited extent.

Since 1956, when Fahnestock was transferred to the Southern Experiment Station, the inflammability study has been on a "stand by" basis. There remains one series of 45 plots, which will be burned in 1960. These plots

contain slash that was left to age for 5 years.

A publication by Fahnestock will be out soon, reporting some of the results obtained from the inflammability study, particularly those dealing with rate of fire spread and heat radiation.

3. Rate of decay. The new technique used for measuring rate of decay in logging slash appears to be satisfactory after two years of trials. It was feared that over-winter compaction and slippage might result in losing the identity of the cut-out samples in the mass of fuels, but as yet this has not occurred. To date all species show a substantial loss in weight. Much of this is accounted for in needle cast and disintegration of needles. However, a significant amount of weight loss is also occurring in branchwood through the activity of decay organisms.

Project S.R. 54. Investigation of Log Grading Standards for Important Idaho Tree Species.

Log grades are influenced by wood quality. Therefore this investigation is especially concerned with fundamental relationships between environmental factors and wood quality.

Since inland Douglas-fir is Idaho's leading species both in quantity of manufacture and in volume of growing stock, at present this investigation is concerned with a study of Douglas-fir.

To date, sample plots have been established on the following National Forests: Kaniksu, Coeur d'Alene, Payette and Boise. Soil and wood samples have been taken and will be tested in the laboratory this winter. Additional samples will be taken next summer.

Knowledge regarding the relationship of environment to wood quality should be of great value to forest management in growing wood of maximum economic value.

Project S.R. 55. Identification and Ecology of Insects Affecting Cones and Seeds of Forest Trees.

Work under this project centered on determining relative importance among the several insect species involved. Due to seed demands and relatively high seed loss, the concentration of the work was primarily on Douglas-fir. In addition, the experimental insecticide treatments of 1958 were analyzed, and further tests made with insecticides in 1959. Neither series of tests resulted in adequate control.

The three most commonly encountered pest species of Douglas-fir in the Inland Empire during 1957 and 1958 were the cone moths Barbara colfaxiana (Kearf.) and Dioryctria abietella D. & S. and the seed chalcid Megastigmus spermotrophus Wachtl. Additionally the damage typical of the gall midges was found, but identity of the species involved is not yet certain.

Barbara colfaxiana proved to be the paramount insect problem in the Inland Empire during 1957 and 1958. The insect infested Douglas-fir cones at a

high level during these years, and, considering the absence of such artificial population determinants as insecticide treatments, was remarkably uniform in occurrence throughout the large region involved. General collections and observations were supported by sampling of eight collections of cones, randomly drawn from the shipments of various collectors with the Forest Nursery at Moscow. Table 1 shows the rates of infestation determined from these samples.

Table 1. Rate of infestation by Barbara colfaxiana (Kearf.) in Douglas-fir cones. Samples represent different collection sites in each of 4 general areas.

Area	Number Cones Examined	Number Infested	Percent Infested
Moscow	250	178	71.2
Moscow	250	124	48.0
St. Maries	250	64	25.6
St. Maries	250	69	27.6
Sandpoint	250	61	24.4
Sagle	250	92	36.8
Sagle	250	101	40.4

An intensive examination of the rate of infestation and uniformity of infestation on a single 320 acre area was made in 1958. The purpose was to determine whether infestation occurred approximately uniformly over a small area or whether infestation occurred as small localized populations separated by areas of non-infestation. Sampling was carried out by pre-selecting from an aerial photo sub-areas within the 320 acre unit. All cones in Douglas-fir within the sub-areas were removed and examined. Cones were rated as infested or not infested, with no attempt made to determine the the number of cone moth pupae in the infested cones. Results are shown in Table 2.

Table 3. Rate of infestation of Douglas-fir cones by Barbara colfaxiana in various sub-areas in a 320 acre plot.

Sub-area	Number Trees	Number Cones Examined	Number Cones Infested	Percent Cones Infested
1	3	623	224	36
2	5	944	269	28
3	4	1107	376	34
4	7	1388	813	59
5	4	370	141	38
6	8	708	143	20
7	7	1122	159	14
8	5	128	30	23
9	2	720	151	21
10	3	943	459	49
11	3	724	142	20
12	5	1393	438	31

Results of the study to date have shown that Barbara colfaxiana has been consistently and fairly uniformly present in northern Idaho Douglas-fir stands during the two year study. Actual seed loss caused by this insect has probably been in the order of 30 to 60 percent. There are reasons to believe that this order of infestation is persistent and normal in the Inland Empire. This idea is in agreement with the experience of seed and cone handlers over the past several years; it agrees with an earlier report (1908) of the persistence of this insect in an area in Montana; and the uniformly high occurrence over the region in any single year suggests that populations of Barbara colfaxiana do not behave in the sporadic pattern of most forest insects. The pattern of population occurrence appears more like that of infestations of fruit insects in orchard areas.

Although further study may require modification, the information at hand warrants certain tentative conclusions to guide the further development of the research project.

1. It is very unlikely that cone-collectors may avoid the loss caused by this insect by searching for areas of no infestation.
2. If an economic control method can be developed, it might well become a routine procedure in the collection of Douglas-fir seeds.
3. An area chosen for cone collection can be assumed to be infested with B. colfaxiana with little actual preliminary measurement of the insect population.
4. Douglas-fir seed orchards, if and when developed, will probably require annual treatment.
5. If it is determined that some of the other species are occasionally distributive, methods developed to control them will also have to include control of B. colfaxiana.

In anticipation of further insecticide testing, preliminary data on the phenology of the insect for northern Idaho were collected in 1959. The objectives of the study were to determine the periods of adult emergence and oviposition and to show an approximate relation to flower development on the host tree.

Data on adult emergence were collected by periodic observation of infested cones that were enclosed in fine mesh plastic screen and hung on the drown of the host tree. The observation of free flying adults at about the same time as emergence within the plastic sacks indicated that temperatures within the sacks were not significantly altered.

Oviposition was measured by drawing a sample of 50 new cones at periodic intervals and rating each as carrying one or more eggs or no eggs. The results are shown in Figure 1.

Following successful tests of insecticides applied by ground equipment in 1957, two tests of application by air have been made. Application was directed at the larvae just before hatch in 1958 and the emerging adults in 1959. Neither was successful. These tests included the application of 1 to 2 pounds of DDT and Sevin per acre in from 3 to 10 gallons of water. These dosages and volumes are comparable with the commonly used forest sprays, but far below that used in typical orchard production. It is possible that these rates of application may be much too low to control B. colfaxiana on Douglas-fir cones.

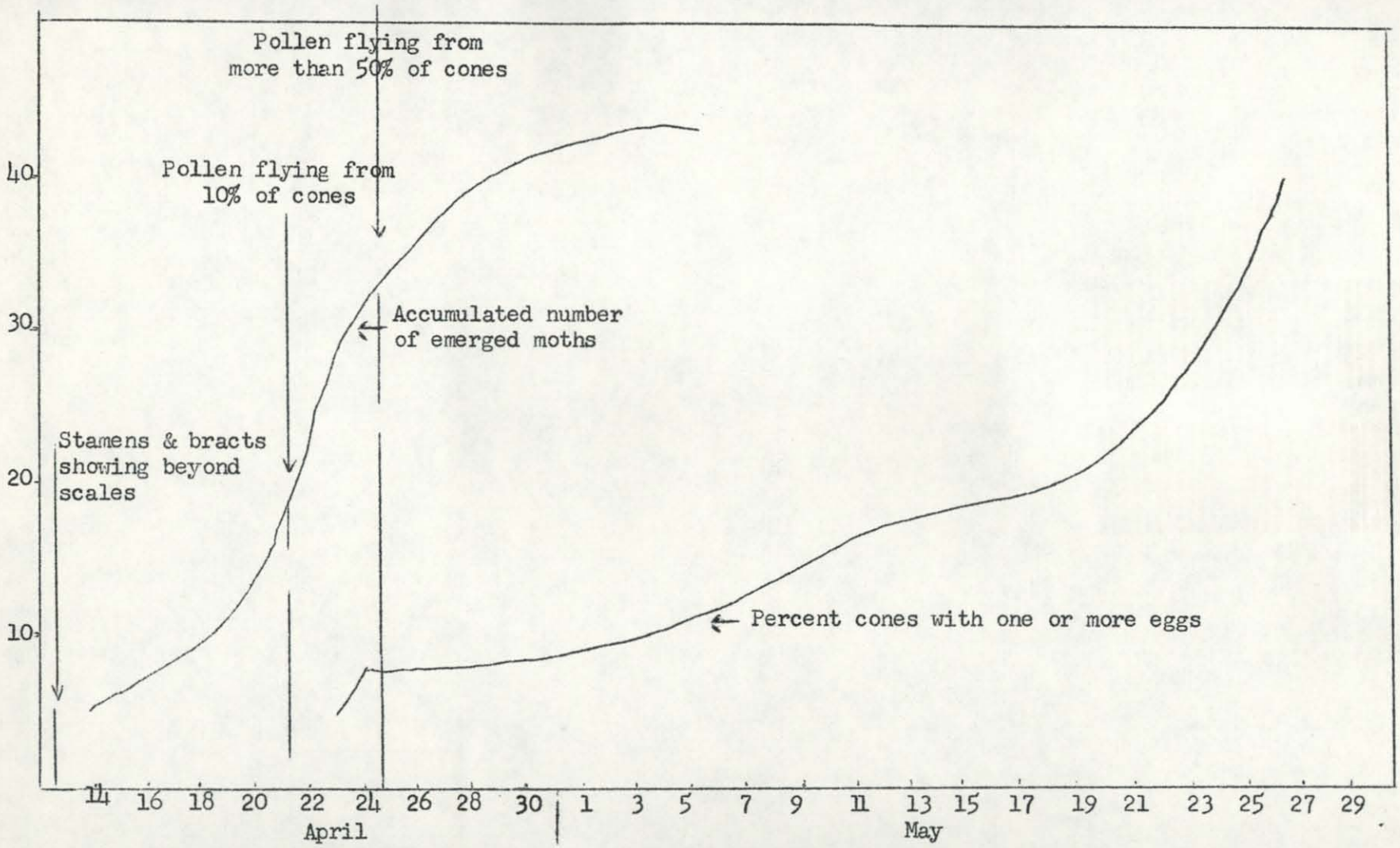
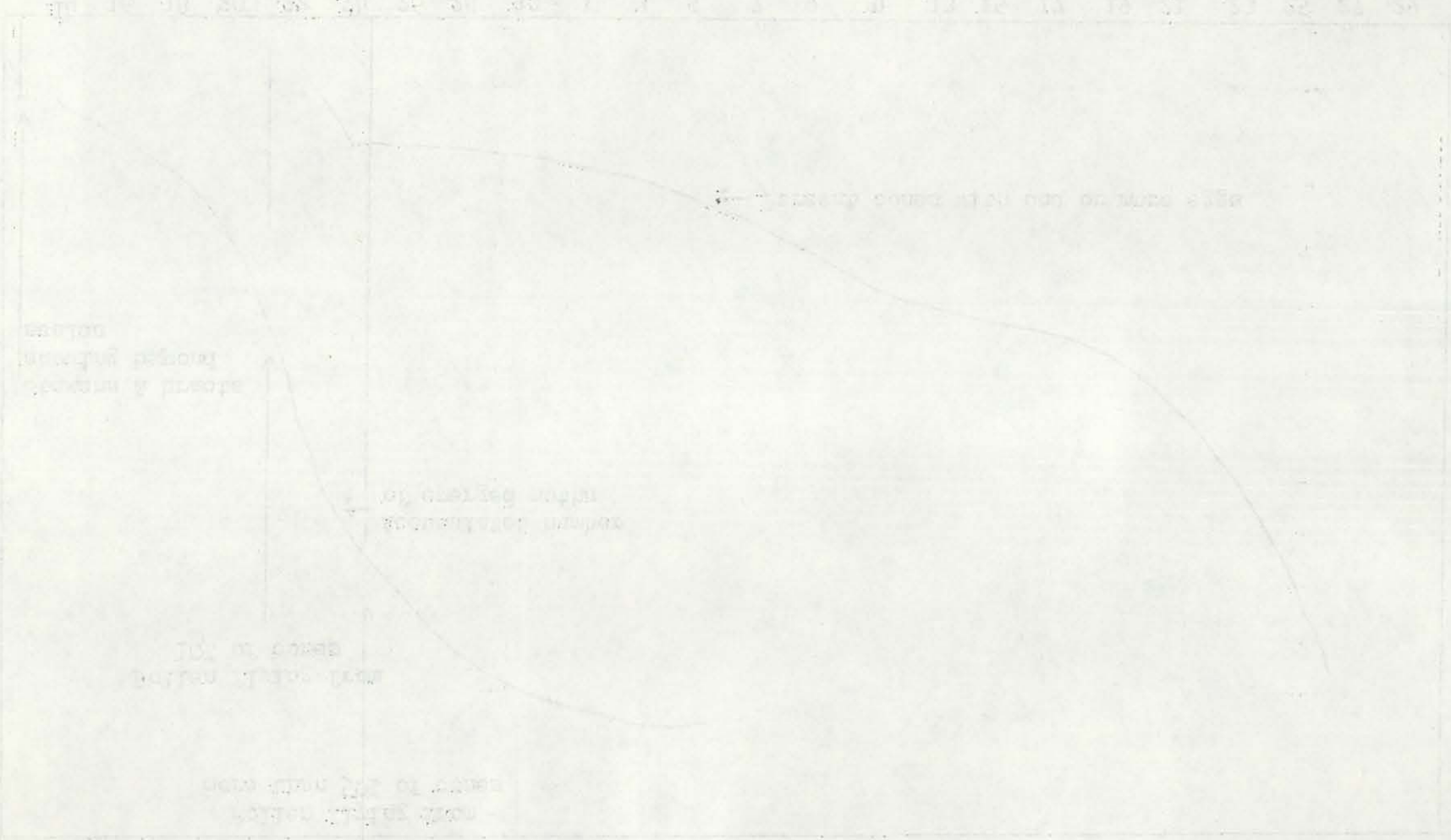


Figure 1. Phenology of adult emergence and oviposition of Barbara colfaxiana, Moscow, 1959.



The other two primary pests of Douglas-fir cones that are frequently encountered in northern Idaho, Dioryctria abietella D. & S. and Megastigmus spermotrophus Wachtl. were observed less intensively. Both occasionally occur at fairly destructive levels, but such occurrences appear as yet to be much more restricted and localized than those of B. colfaxiana. A more adequate sampling of these two species will be conducted in 1959.

In contrast to the experience with coastal Douglas-fir cone insects, the gall midges have not yet been found to reach a level of destruction comparable to that of B. colfaxiana. Gall damage has been observed, however. The midge species responsible has not yet been identified.

Initial observations directed toward assigning the five pests of ponderosa pine cones recovered thus far, Dioryctria auvanticella (Grobe), Laspeyresia piperana (Kearf.), L. miscitata Hein., Eucosma sp., and Conophthorus sp., to levels of relative importance were made in 1958. No conclusions are possible at this time, however.

Intensive work on the cone insects of western white pine is now started with the assignment of a graduate fellow, Mr. D. S. Williamson, to a study of this problem. The preliminary phases of determining what insect species are present and at what levels are being conducted in 1959. The work is now being concentrated in the Clarkia-Boville-Elk River areas with more extensive observations and collections being made elsewhere.

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

The objective of this long-range project is to determine the feasibility of producing lodgepole-jack pine hybrids for pulpwood plantations. Eighteen lodgepole parents were selected just south of Spirit Lake on which four hundred flowers were bagged and fertilized with jack pine pollen. A ten percent survey has been made which gives an indication there will be approximately 800 hybrid cones available for collection at maturity.

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

Fertilization of forest plantations and natural stands past the seedling stage is a relatively new and untried silvicultural tool. Only scattered experiments of this nature have been performed in this country, but these have, in the main, been encouraging. The results of fertilization have been noted in markedly increased growth and better tree quality. Moreover, nutrient additions have stimulated trees to produce seed earlier and in greater quantity than unfertilized specimens. The current project is designed to test the potentialities of fertilization of Idaho forest soils.

During the spring of 1959, forty-two 1/10 acre plots were installed. Ten of these were on a ponderosa pine plantation on the Meadow Creek unit of the College Forest, and two were on a lodgepole pine plantation at the same site. Twenty plots were placed on the Forest Service Lone Mountain ponderosa pine plantation near Spirit Lake, Idaho, and ten were located in lodgepole pine thickets adjoining the plantation. In this latter instance it is hoped that the fertilization will stimulate the expression of natural dominance and thus overcome the present stagnation.

Plot treatments included:

1. 150 lbs/acre nitrogen as $(NH_4)_2SO_4$
2. 150 lbs/acre potassium as potash
3. 150 lbs/acre P_2O_5 as treble superphosphate
4. A combination of 1, 2, and 3.
5. Control--no fertilizer

The fertilizer was applied broadcast, spread evenly over the plot.

Effects of the fertilizer application on the trees will not be evident until the 1960 growing season. However, visual inspection of the plots during the summer of 1959 revealed that the ground cover vegetation had responded to nitrogen fertilization. On nitrogen treated plots the cover was much more luxuriant and of a deeper green color than on plots receiving no fertilizer or potassium or phosphorus alone.

At the close of the 1960 growing season, and at regular intervals thereafter, the trees will be measured for height and diameter increment. At the same time soil and foliage samples will be collected for analysis. The growth measurements and foliar analysis will indicate the possible beneficial effects of the various treatments on the trees. Soil studies should reveal if the soil properties themselves have been materially improved by the fertilization.

It is hoped that during the spring of 1960 fertilizer plots will be installed on plantations or natural stands of white pine and Douglas-fir.

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. Three thousand seedlings were planted and fertilized with mora tree feed pellets, along with controls in four different test plots. The plots in Kootenai and Bonner Counties will be duplicated in the spring of 1960 so that reliable data can be obtained. The extended drought conditions contributed to a very low survival on all seedlings planted, which makes it impossible to get a correlation of the effects of fertilization.

II. Range Management Research

A. Projects completed during the year: none.

B. Continuing projects:

Project E.S. 8 (S.R. 27-D). Study of Medusa-Head on Idaho Ranges.

Relatively little work was done on this project due to the absence of Mr. Hironaka who was on leave for graduate study from September, 1958 to June 15, 1959.

Arrangements were made for an expanded research program on the medusa-head problem, starting in July, 1959. Financial support for a graduate Research Fellow will be available from the Special Research fund of the University, thus increasing considerably the funds and manpower for this project. The Bureau of Land Management has offered assistance in the form of fencing experimental areas and providing heavy cultural equipment.

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

Twelve new study sites were established this year, and three others which had been burned were re-studied. The total of study sites is now sixty. While this number provides an approach to adequate sampling of the major communities in the western portion of the state, much remains to be done on this phase of the project in eastern Idaho.

Yield studies were begun on 2 sites this year, one in the Artemisia tridentata/Festuca/Agropyron community and the other in the A. tridentata/Agropyron/Poa. The layout provides for continuing the project for 5 years without re-clipping any of the plots. The plots are 2 x 0.5 meters, a size which appears adequate to sample the dominant species at least, and utilizes the working advantages of the elongated plot.

The replicates for any one year are clipped first for early-maturing species such as Poa secunda, and annuals, and again later for the major perennial grasses and forbs. Sagebrush is not clipped, nor are low, mat-forming species such as Phlox.

The results of this first year's work indicate that ten replicates are adequate to sample the yield of the dominant large bunchgrasses, also total forbs and total herbage on the Artemisia/Festuca/Agropyron. This number was not sufficient to sample the yield of Poa secunda or of the individual forb species (except Balsamorhiza) to the desired degree at this site.

At the drier site (Artemisia/Agropyron/Poa), ten plots were adequate for total herbage, and barely adequate for Poa secunda. This number was marginal for Agropyron spicatum (S.E. 19 percent) and 20 plots were required for a fully adequate sampling.

Due to exceptionally good growing conditions, followed by drought in late summer, the season of 1957 was noted for the number and size of fires in the sagebrush region of Idaho. As a result, three study sites were swept

by wildfire. In all cases the burning was severe, with all vegetation burned to ground level. Two of the burned sites are in the Artemisia tridentata/Stipa thurberiana types, the other in the Artemisia tridentata/Agropyron/Poa community. The re-study of these sites in 1958 revealed the following:

a. Agropyron spicatum showed little effect from the fire. The total basal area was the same in 1958 as when first recorded in 1956, and the plants showed only a slight reduction in vigor compared to those on adjacent unburned areas.

b. Stipa thurberiana showed severe damage, both at the two sites where it was the dominant grass, and at the other site where it was second to Agropyron. Average basal area was reduced from 2.5 percent to 0.45 percent. Many plants were completely destroyed, while almost all that survived lost their centers and appeared as whole or partial rings of growth. Seedlings of Stipa were found to be abundant and vigorous at the two Stipa-dominated sites, but not at the third site.

c. Other bunch grasses, including Poa secunda and Sitanion hystrix, were severely damaged at all sites, but not eliminated.

d. The scanty perennial forb cover was differentially affected. Of the two principal species, Phlox longifolia was not reduced in amount, while the low-growing Antennaria dimorpha was severely damaged. Lithophragma, an early spring-flowering perennial, increased greatly following the fire.

e. Annuals were little affected in abundance, but most species increased greatly in size of individual plants.

No major change in the tentative classification of communities shown in last year's report is indicated by the additional sites sampled in 1958. The increased number of samples available for certain types suggested the desirability of careful review of the classification basis being used, and an analysis which might further reveal the characters most useful in recognizing the communities. For this purpose only the groups of sites dominated by Artemisia tridentata were used. A total of 38 sites have been sampled in this category. An analysis based on all available vegetational and soil characters indicated a clear grouping into three major communities, namely the Artemisia tridentata/Festuca/Agropyron (No. 1), the A. tridentata/Agropyron/Poa (No. 2), and the A. tridentata/Stipa thurberiana (No. 3). Despite considerable variability within each community, the three are distinct when the whole complex of characters is considered. The greatest differences occur between No. 1 and the other two, while No. 3 may perhaps be considered as a localized variant of No. 2.

An evaluation of the value of different vegetational characters in the recognition of types yielded the following conclusions:

a. The presence of Festuca idahoensis is highly diagnostic. This species is rare or lacking in Types 2 and 3, and occurs in significant amounts in almost all sites of No. 1.

b. Agropyron spicatum is more widespread, and is diagnostic only by virtue of its absence in community No. 3.

c. Poa secunda is common in all three types, and although mean differences occur among them in this character, the internal variability is such as to render this difference of little consequence.

d. The total cover of all of the taller perennial grasses (Festuca, Agropyron, Sitanion, Stipa, etc.) is diagnostic, and decreases from Type 1 through 3.

e. The perennial forb component is highly diagnostic when considered as such, and gives clear-cut separations whether based on average number of species per site, average number occurring on a particular percentage of the sites, or on total accumulated frequencies. Individual forb species have little diagnostic value. This is due to the great variability in species from site to site within types. The diagnostic value lies in the life-form rather than the species.

f. The characteristics of the shrub cover appear to be of limited value classification-wise. Differences in average height and density and crown cover of Artemisia tridentata occur, but these are relatively small in view of the variability among sites.

A joint field trip was made in south central Idaho and northern Utah during mid-June, 1958. The main objective was to inspect sagebrush vegetation types in that part of Idaho not seen previously by the group, and to inspect adjacent areas in Utah. This latter was done with the cooperation of the Utah State range staff, and several areas of sagebrush-grass and Agropyron grassland were seen. Contact was also made with the S.C.S. soils-vegetation research team and a day spent examining some of their study sites in northern Utah. The sagebrush-grass vegetation seen in Utah corresponded in most cases with types occurring in adjacent portions of Idaho. The chief problem area appears to be in parts of Cache Valley where vegetation resembles the Agropyron/Festuca grasslands of the Palouse area. A few similar areas have been observed in Idaho, mainly along the eastern border. Further study is needed to determine the status of such areas, and the relation between the two major communities involved.

Project E.S. 10. Ecology and Grazing Relationships of the Douglas-Fir Zone in Interior British Columbia.

This study was inactive during the past year, but some future work is planned.

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

The study of ecotypic variation begun on a small scale in 1956 was expanded greatly, and some work done on other species of Festuca which occur in the same general region.

This work was started during the summer of 1958, and continued during the winter at Berkeley and Stanford by Dr. Tisdale as part of his program on a National Science Foundation Post-Doctoral Fellowship. This project is a study of intraspecific variability in Festuca idahoensis, an important perennial grass of western North America.

The objective is to determine the degree of variability within this species and to determine the ecological status of such races as may occur. This project was conceived and much of the work done with the full cooperation of Drs. Hiesey, Nobs and Clausen of the Carnegie Institute, Stanford.

Bulk collections of F. idahoensis seed from 20 different locations were obtained during the summer of 1958. These collections were designed to sample a good portion of the geographic range of the species as well as different habitats within this range. In addition, a few collections were made of closely related species. Herbarium specimens representing each population were also obtained at most of these collection sites.

Seedings of this material were made in the greenhouse of the Carnegie Institute at Stanford in November. The initial plantings were made in 8-inch pots and the seedlings later picked out and put in spaced plantings in greenhouse flats. Early in February, the flats were all placed outdoors in order to provide some semblance of the winter conditions. Ninety plants of each lot were put out in spaced plantings in the field late in March and watered to obtain establishment. Growth was slow at first, but by June 1 most plants were well established with leaves 10 to 20 centimeters tall. Mortality in most lots ranged from three to ten percent, but a few collections showed distinctly higher losses running to 30 percent, indicating differences in response even at this stage of the test.

A similar set of plantings was made by University of Idaho staff members, and field planted in April, 1959. This material was handled in the same way of that at Stanford, and between them, the two plantings should provide a valuable picture of the performance of different collections of this species in two widely differing environments. The location at Moscow is on a site where F. idahoensis was the principal native species prior to cultivation, and probably represents an optimal site for many of the collections. The site at Stanford represents an area outside the main range of the species, although a small amount of F. idahoensis occurs in the Coast Ranges as far south as the San Francisco Bay area.

While the Festuca material is still only in leaf stage, differences are apparent both within and between many of the collections. Variability is shown in such characters as relative fineness, degree of erectness and color of foliage, in establishment success and in growth rate. In general, the material from the east side of the Rockies in Montana differs from all of the remaining collections in possession of relatively shorter, coarser and bluer foliage, and in the presence in most lots of a small percentage of what might be termed dwarf plants. In the material from west of the Rockies, the most clear-cut difference at the present time consists of the fine relatively low-growing foliage of the lots from dry sagebrush sites as compared to the material from the Pacific Northwest grasslands and from ponderosa pine sites. The evidence to date indicates that there is probably a considerable measure of ecotypic variation within Festuca idahoensis but the material cannot be properly evaluated until it has become more mature.

In addition to the greenhouse and field work, a check was made of the seed characteristics of the various collections including germination under laboratory conditions. In most cases, this germination paralleled that obtained in soil in the greenhouse with appreciable differences in rate and

amount of germination showing among different lots. The vouchers collected during 1958 were examined and compared with the material of F. idahoensis and related species in the herbaria of the University of California at Berkeley and at Davis. The herbarium material indicates the presence, in certain parts of the country, of forms intermediate between F. idahoensis and some of the related species. This seems true in the case of F. rubra and F. idahoensis in northwestern California and southwestern Oregon, and perhaps with F. occidentalis and F. idahoensis in western Oregon and Washington.

The literature regarding the taxonomy, ecology, genetics and cytology of F. idahoensis and related species was reviewed along with comparable studies of other perennial grasses which might be helpful in this project. Floras of all the states in which F. idahoensis and related species occur were checked, as were the herbaria mentioned above for distribution of these species.

Future work on this project will involve detailed observations of performance under field conditions at the two planting sites, studies of breeding behavior, chromosome counts, and morphological and anatomical studies of the nursery material as it comes to maturity.

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

The widespread occurrence of harvester ant (Pogonomyrmex occidentalis) clearings in southern Idaho ranges led to the initiation of cooperative research by entomology and range management on this insect.

Three study areas were selected in the Raft River Valley of Cassia County in the fall of 1956. Two of these were located in the Atriplex nuttallii zone. The vegetational cover of one of these areas consisted primarily of annuals, with halogeton, Halogeton glomeratus, predominating. The second area was occupied by a vigorous stand of saltsage. The third area of study was located in a shadscale, Atriplex confertifolia, community.

Six adjacent one-acre plots measuring 132 x 330 feet were laid out in the depleted saltsage and the saltsage areas. Twelve plots of the same size were located in the shadscale type. One-half of the plots at each location were treated with insecticides to control the ant colonies.

Only a slight variation in the average number of clearings has been found in the two areas with stands of perennial plants. A large difference in the number of clearings between the annual and perennial plant areas is evident. Each year the depleted saltsage plots had approximately three to four times as many clearings per acre as either the shadscale or saltsage plots. These data suggest that a stand of annual plants is more favorable to the establishment of a larger number of colonies than a perennial cover of saltsage or shadscale.

The saltsage stand exhibited the greatest stability in number of ant colonies. New clearings did not appear in this area in either 1957 or 1958. Moreover, the average survival of the 1956 colonies in the two following years was high. The number of clearings did not change in two of the three plots over the three-year period. The loss of two colonies in the third

plot in 1956 and 1957 was the only change that took place.

Numerous measurements of the diameter and area of harvester ant clearings were made in the saltsage and depleted saltsage plots. The average diameter of the clearings in the shadscale approximated that of depleted saltsage and the percentage of area cleared was estimated to be less than 1 percent.

The depleted saltsage generally had smaller clearing than the saltsage, whereas the reverse appears to be true in shadscale and depleted shadscale stands. The diameter of clearings in the saltsage averaged approximately one and one-half to nearly two times those in the depleted saltsage.

The ant clearing occupied about 3.5 percent of the area in saltsage and approximately 5 to 8 percent of the area in depleted saltsage during the three years of study. The size of the clearings in the saltsage area increased slightly each year. Perennial saltsage plants require a longer period to establish than the annual plants common in the depleted saltsage. Consequently, the ant was easily able to keep ahead of the encroaching vegetation in the saltsage area. The size of the clearings in the depleted saltsage fluctuated in both directions.

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

The data for these two projects are reported together.

Studies in the Raft River Valley of Cassia County, Idaho since 1950 indicate some important relationships between halogeton and perennial forms of vegetation. There is ample evidence that intact stands of perennial vegetation will not permit any appreciable amount of halogeton or any other annual to invade. An example of this is found in a saltsage (Atriplex nuttallii) stand of vegetation surrounded by areas where halogeton has been abundant since 1951. (Table 1.)

Table 1. Loop records obtained from a cluster of three transects in a good condition saltsage stand.

Species Index	1951	1952	1953	1954	1955	1956	1957	1958
				(Percent)				
Saltsage-basal	10.7	7.8	8.3	8.7	9.7	6.3	8.0	9.7
Saltsage seedlings-basal	0.0	32.7	7.7	5.0	0.0	0.3	6.3	6.0
Saltsage-foliage	36.0	52.3	49.3	39.3	45.0	59.3	80.0	49.7
Halogeton	0.0	0.0	0.0	0.3	0.0	3.0	1.0	0.7
Other annuals	1.7	4.0	15.0	0.7	0.0	0.7	1.3	4.3

Abuse of the perennial vegetation leads to a decline in forage productivity, a thinning of the perennial plants and the creation of space for invasion by any annual plant that may be in the vicinity. Such an example for a saltsage stand is presented in Table 2.

Table 2. Loop records obtained from a cluster of three transects in a poor to fair condition saltsage stand.

Species Index	1951	1953	1954	1955	1956	1957	1958
				(Percent)			
Saltsage-basal	3.7	5.3	4.3	3.6	2.3	2.3	2.3
Saltsage seedlings-basal	3.3	0.3	0.3	1.0			
Saltsage-foliage	13.7	19.3	14.0	14.0	8.7	9.7	7.0
Halogeton	0.0	0.0	2.7	21.3	62.7	42.3	54.7
Other annuals	32.0	3.7	5.3	0.0	0.0	0.3	2.7

Once the space is available for annual plant growth, the quantitative expression of that growth depends on favorable or non-favorable growing conditions for the annual plants. Similar examples for shadscale (Atriplex confertifolia) stands could be given.

Improvement of conditions for perennial plant growth after a stand has been decimated may result in a return to perennial vegetation within a reasonable length of time. Such a change is apparently going on in a shadscale stand of vegetation that appeared to have a minimum of vegetation, particularly perennial vegetation in the fall of 1950. A 100 square-foot plot was established in this area in 1950 and a complete count of the plot in 1951 showed no living shadscale plants, six budsage, 40 squirrel tail grass and 1,032 halogeton plants. A 1 by 10 foot subplot was established in 1953 and the counts in plants per square foot are shown in Table 3.

Table 3. Number of plants per square foot in a depleted shadscale stand.

Species	1953	1955	1956	1958
Shadscale	0.7	0.6	0.6	1.5
Bud sage	0.6	0.5	0.5	0.2
Squirrel tail grass	0.1	0.0	0.0	0.0
Halogeton	8.9	0.5	14.4	5.5
Other annuals	3.5	0.0	0.2	0.6

A similar area in which a cluster of three transects was established in 1951 shows a parrallel reaction (Table 4) to protection from grazing. Both of the areas mentioned were included in an area fenced in 1950 for halogeton studies.

The factors which produced the halogeton problem are still operating to some extent and are well illustrated by data gathered from a winterfat stand in the Raft River Valley. A cluster of three transects was located in this stand in 1951. The steady decline in the stand of winterfat is illustrated in Table 5.

Table 4. Loop record obtained from a cluster of three transects in a depleted shadscale stand.

Species	1951	1952	1953	1954	1955	1956	1957	1958
				(Percent)				
Basal Index								
Shadscale	0.3	0.0	0.0	0.3	0.3	0.3	0.3	0.0
Squirrel tail grass	0.7	0.7	1.7	0.3	0.3	0.7	1.0	1.0
Bluegrass	1.0	0.3	0.3	0.3	0.7	0.0	0.3	0.3
Opuntia	1.0	1.3	1.3	2.0	2.0	1.0	3.0	2.7
Halogeton	0.0	34.7	10.7	10.7	2.7	55.7	12.3	24.3
Other annuals	3.0	13.0	8.3	0.0	0.0	0.3	3.0	1.7
Foliage Index								
Shadscale	0.3	2.0	2.0	2.3	3.6	5.0	6.3	7.0
Budsage				0.3	0.3	0.3	0.0	0.0

Table 5. Loop record obtained from a cluster of three transects in a winterfat stand.

Species	1951	1954	1955	1956	1957	1958
Basal Index						
Winterfat	6.7	6.7	6.7	6.3	6.7	6.7
Sagebrush	0.3	0.3	0.0	0.0	0.3	0.0
Bluegrass	0.3	2.0	1.0	0.7	0.0	0.0
Halogeton	0.0	0.0	0.0	1.0	43.7	35.3
Other annuals	5.3	0.0	0.0	0.7	0.7	1.3
Foliage Index						
Winterfat	28.9	24.3	23.0	18.7	17.0	12.7
Sagebrush	1.0	4.3	5.3	9.3	14.3	11.3

Although the basal index of winterfat did not decrease over the period of study, the vigor of the plants was greatly reduced and is best shown by the foliage index. The lack of change in the basal index for winterfat indicates a high resistance to grazing. Halogeton had been in the vicinity of the cluster along a roadway since the time of establishment but did not invade the stand until 1956. An invasion of the big sagebrush also occurred as the vigor of the winterfat declined.

As a comparison of the results that could be obtained with a lessening of grazing pressure (in this case none), a small exclosure was constructed near the cluster of transects in 1953. Plots were established within the exclosure in 1953 and on the outside in 1955. The data from these plots are shown in Table 6.

Table 6. Number of plants per square foot from plots inside and outside the winterfat exclosure.

Species	1953	1954	1955	1956	1957	1958
Inside						
Winterfat	3.33	3.33	3.00	2.80	2.93	3.00
Bluegrass	0.07	0.07	0.07	0.07	0.13	0.20
Halogeton	0.00	0.00	0.27	233.31	28.64	5.93
Other annuals	49.95	26.97	0.00	1.19	0.27	1.33
Outside						
Winterfat			2.67	2.06	1.40	0.93
Bluegrass			0.07	0.20	0.00	0.07
Halogeton			0.33	339.67	114.55	29.00
Other annuals			0.07	0.73	0.60	1.47

Restoration of a perennial plant cover to areas where halogeton occurs is an effective means of solving the halogeton problem. Seeding of adapted species on large areas has proven to be successful in correcting the basic problem of poor range condition and consequently the attending halogeton problem. Even though halogeton may not be completely banished from such areas by the successful establishment of a perennial cover, there is little reason to fear the plant as a menace to livestock production.

Project E.S. 22. Beef Cattle Nutrition on Seeded and Native Forage in Idaho.
Project S.R. 38. Evaluation of Range Reseeding.

Since much of the work on these two projects is conducted jointly on the Point Springs Grazing Site, work on both projects is included herewith.

The 1958 spring and fall grazing studies on the Point Springs experimental area are summarized below.

Spring Grazing Trial

The pastures to be used for spring grazing were sampled between April 25 and April 28. Due to favorable climatic conditions in February and March, new growth of crested wheatgrass was well along at the beginning of the grazing trial, averaging approximately 7 inches on May 2. The rain gauge established on the area in 1957 showed a total precipitation of 6.20 inches accumulating from November 18, 1957 to May 12, 1958. Precipitation during the month of May was 0.51 inches this year in contrast to 4.8 inches during the same period in 1957. Total June precipitation was approximately the same in the two years but a larger portion of the June, 1957 precipitation fell in the early part of the month. The amount and distribution of precipitation in 1957 was much more favorable for plant growth than in 1958.

Aggravating the lower moisture conditions in 1958 was the higher temperatures prevailing during May of 1958. Maximum-minimum thermometers established on the area showed 21 days in May, 1958 in which the maximum daily temperature was or exceeded 80 degrees F. and 5 days in which it was or

exceeded 90 degrees F. The maximum reading in 1957 for the same period was 79 degrees F.

Production and Utilization: Sampling to determine production at the beginning of the trial was completed four days before the animals were weighed and distributed to the pastures. Production and utilization data are presented in Table 1.

Table 1 Forage production and utilization by blocks within pastures as determined from clippings and count of plants grazed for the spring grazing period.

Pasture	Block	Initial Production Per Acre (Pounds)	Initial Production Per Acre Plus Growth (Pounds)	Forage Per Acre Remaining at End of Grazing Season (Pounds)	Utilization (Percent)	No. of Plants Grazed in Clipped Samples (Percent)
Light (East)	A	385	676	226	67	94
	B	625	935	810	13	91
	C	687	971	448	54	89
	Average	566	861	495	42	91
Moderate (West)	A	508	835	251	70	100
	B	799	1276	246	81	99
	C	789	1266	244	81	98
	Average	699	1126	247	78	99
Heavy (South east)	A	432	776	62	92	100
	B	588	990	214	78	100
	C	620	1008	209	79	99
	Average	598	925	162	82	100

Growth made during the spring grazing trial was calculated to be 193 percent of the initial production and utilization was determined on this basis.

Livestock Gains: A summary of the livestock gains made during the spring trial period are presented in Table 2.

Table 2. Summary of cattle gains during the spring grazing trials of 1958.

Grazing Intensity	Average Initial Weight (Pounds)	Average Final Weight (Pounds)	Average Total Gain (Pounds)	Average Daily Gain (Pounds)
Light (East)	422	518	96	2.13
Moderate (West)	407	502	95	2.11
Heavy (Southeast)	407	491	84	1.87

Fall Grazing Trials

Sampling to obtain production for the fall grazing trials was accomplished during the early part of September (September 2). Animals for the fall trial arrived on September 29 and on September 30, 242 yearlings were weighed and distributed to the fall pastures. The cattle were weighed off after the 45-day trial on November 15.

Production and Utilization: Forage production and utilization are presented in Table 3. A lower production in this year resulted from both less favorable growing conditions and grazing by rabbits within the experimental pasture area.

Table 3. Forage production and utilization by blocks within pastures as determined from clippings and count of grazed plants for the fall grazing period 1958.

Pasture	Block	Initial Production Per Acre (Pounds)	Forage Per Acre Remaining At End of Grazing Season (Pounds)	Utilization (Pounds)	No. of Plants Grazed In Clipped Samples (Percent)
Light (Northeast)	A	562	126	78	95.5
	B	624	364	42	89.7
	C	507	233	54	88.9
	Average	564	241	57	91.5
Moderate (Northwest)	A	428	76	82	98.1
	B	520	195	62	96.1
	C	526	81	85	96.7
	Average	491	117	76	96.9
Heavy (Southwest)	A	215	137	36	98.6
	B	379	103	73	95.5
	C	372	20	94	100.0
	Average	322	87	73	97.8

Livestock Gains: There was insufficient moisture during the late summer and fall of this year to initiate new growth on the crested wheatgrass until late in the trial period. The smaller animal gains (Table 4) that were obtained in contrast to 1957 gains reflect in part this lateness of crested wheatgrass regrowth.

Table 4. Summary of cattle gains during the fall grazing trials of 1958.

Grazing Intensity	Average Initial Weight (Pounds)	Average Final Weight (Pounds)	Average Total Gain (Pounds)	Average Daily Gain (Pounds)
Light (Northeast)	571	587	16	0.36
Moderate (Northwest)	586	601	15	0.33
Heavy (Southwest)	589	600	11	0.24

Salt and Water Consumption

Measured amounts of iodized block salt were placed in each pasture at the beginning of each grazing trial period during the four years of the study. Consumption rates are shown in Table 5.

Table 5. Average daily and monthly salt consumption per animal for pastures grazed during the two seasons for the years 1955 through 1958.

Average Consumption Per Animal (Pounds)	Year	Season	
		Spring	Fall
Daily	1955	.023	.022
	1956	.014	.018
	1957	.021	.013
	1958	.026	.054
Monthly	1955	.678	.651
	1956	.408	.537
	1957	.618	.384
	1958	.768	1.608

These results show consumption to be greatest in the fall for two of the four years of the study. Ample salt was provided in all seasons except the fall of 1957 when the supply was exhausted and not replenished near the end of the trial.

The average daily water consumption was determined in 1958 by measurements obtained from a meter located on the outlet of the storage tank. Consumption during the spring averaged 3.68 gallons per head per day and 3.74 gallons in the fall period.

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

Studies in this project were conducted by Mr. Joe Oppe, a graduate student in Botany under the guidance of the project leader. Almost all of the study sites were re-sampled, and additional plots established at 2 sites. In addition, laboratory studies were made of the effect of extracts of Hypericum perforatum on the germination of its own seed and that of certain grasses.

Re-sampling of the vegetation on 19 permanent study sites provided another set in a series of observations which extend in most cases to 1951 or 1952. The results of this phase of the project may be summarized as follows:

1. On sites formerly occupied by grassland or ponderosa pine savannah, the stands of Hypericum show marked reduction from the amounts present at the time of release of Chrysolina beetles. A typical site where beetles were released in 1951 shows populations of Hypericum stalks averaging 106 per M^2 in 1952, with 78 in 1953, and none in 1955 through 1958.

2. Some evidence of resurgence of Hypericum is evident in the data for

1958, particularly in the form of relatively large populations of seedlings of this species. For example, on the site mentioned above, Hypericum seedlings average 97 per square meter. Much smaller populations of seedlings observed occasionally during the course of the project invariably suffered heavy mortality from drought, or else from beetles if they did survive the first year. Limited observations made in June, 1959 indicate that many of the seedlings observed in 1958 have survived and thus may provide for a definite increase in the population of the weed. This trend, similar to that reported in parts of northern California, appears most pronounced on sites where beetles were released 5-10 years ago, and from which formerly dense stands of Hypericum had been almost eliminated.

3. On sites in Idaho north of the natural grassland areas, as in the vicinity of Coeur d'Alene and Priest Lake, Chrysolina beetles have been much less effective in controlling Hypericum. This is now the only part of the state in which extensive and fairly dense stands of Hypericum can be found. These stands are mainly on clearings in ponderosa pine or Douglas-fir forest, where climate, soil and vegetation differ considerably from that found in the grassland areas further south in the state.

The experiments with exudates of Hypericum involved the effect of hot water extracts of both capsule and leaf-stem tissue on germination. Seeds of Hypericum perforatum, Agropyron spicatum and Bromus tectorum in Petri dishes were watered with concentrations of exudate ranging from 0 to 10 percent. Extracts of 1-1.5 percent tended to stimulate germination of Hypericum and Agropyron, but concentrations of 3 percent or over reduced the germination almost to nil for Hypericum, but only slightly for Agropyron. Bromus tectorum germination was unaffected by the exudate in any of the concentrations used.

III. Wildlife and Fisheries Management

A. Projects completed during the year:

Project WU-39. The Effects of Summer Utilization of Bitterbrush in Okanogan County, Washington.

Graduate student Charles F. Martinson completed this study during this current year. With K. E. Hungerford as advisor, Mr. Martinson conducted research on this study while he was employed as a biologist for the Washington Department of Game. That department and Mr. Martinson bore all financial cost of this project, except the advising and directing done by the college here. Martinson's thesis has been approved, and the project is now completed. While results of this project apply primarily to north central Washington, much of the information dealing with summer use on bitterbrush by livestock can be used in Idaho with its effects on a winter deer range. During the growing season it has very important implications on the total amount of available forage during the subsequent winter.

B. Continuing projects:

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

The sage grouse study entered and half completed the fourth and final phase during the past fiscal year. The fourth graduate student is now in the field. Brood census was run continuously from June 16 to July 26, 1958. A total of 262 broods were observed of which 34 or 13 percent were excluded because of the difficulty in identifying the individual broods. Of the 228 complete broods, containing 1,206 chicks, the number of individuals per brood varied from 4.0 to 6.8. A loss of 24.2 percent per brood was observed from June 16 to July 26.

Brood density as well as survival warranted a hunting season of 2 days with a 3 bird limit. Sage grouse in the study area are very accessible to hunters because of the numerous roads throughout the sagebrush. Vehicles (except jeeps) cannot be driven out through the sagebrush because of the extensive basalt lava outcroppings.

Red Road leg and neck banded sage grouse were observed on the short sage winter range in areas not previously worked because of our inability to get into the country by vehicle. A new U.S.D.I. four-wheel drive vehicle made possible determination of winter movements and the pattern of winter range occupancy to a much greater degree than heretofore. An attempt to trap grouse by spotlighting on winter range was not successful.

Three species of sagebrush make up the winter diet of sage grouse--*Artemisia tridentata*, big sage; *A. arbuscula*, and *A. arbuscula* var. *nova*. *A. arbuscula* was favored as evidenced from direct observation and tracking in the snow.

Trapping and banding on 12 strutting grounds revealed a ratio of one adult hen to 2.5 subadult hens. Adult hens appeared on the strutting grounds about one week ahead of the subadult hens. The peak of mating occurred

between April 10 and 20.

During the spring of 1959 the following sex and age classes of sage grouse were trapped on strutting grounds:

adult males	58	subadult males	49
adult females	22	subadult females	55

Of the Red Road strutting grounds censused continuously since 1952, the 1959 figures are by far the highest exceeding 1958 by 178 males.

The average life span of sage grouse is about 5 years. One female retrapped in the spring of 1959 was first trapped November 2, 1952, as a bird of the year. This female as of April 14, 1959, had lived approximately 6 years and 10 months. Sixty-two per cent of sage grouse banded in 1958 were observed in the spring of 1959.

Ten nests were observed in the spring of 1959 with an average of 7.6 eggs per nest. Of 39 eggs collected and artificially incubated, 38 were fertile.

Productivity data based upon ovarian analysis is only partially complete at this time, but consists of ovaries examined from hens killed during the hunting season, as well as from hens collected while incubating. The detailed analysis will appear at the close of the study a year hence.

Project WU-18. Productivity of Ruffed Grouse on Idaho Forests.

This project has been continued with activity in the analysis of microclimate data and comparison of records with previous years. Mr. Erickson is working on a phase of this project on the Flat Creek study area where he has been studying the location and movements of ruffed grouse broods including the dispersal of broods in the fall. During the next year plans are to band a number of trapped grouse broods and to trace their movements both visually and by hunter returns. Erickson's study should be completed in the spring of 1960.

Project WU-19. Ruffed Grouse Populations and Census Methods.

This project is on a maintenance basis with census comparison being made every two years. The standard strip census developed in earlier projects is being used in an early September pre-hunting season census. Along with this, checks are being made on the breeding populations through drumming counts in the spring and brood counts in the summer. During this last year the breeding population on the Flat Creek area was higher than for a number of years. However, brood survival was lower than average, resulting in about an average population at the beginning of the hunting season. Part of the work on brood counts was completed by Mr. David L. Erickson in his thesis research on the Flat Creek study area.

Project WU-23. Food Habits and Productivity of White-Tailed Deer.

With the assistance of John Thilenius and several wildlife students working

as summer field assistants, additional data has been collected on the summer food habits of deer in the Hatter Creek area. The same experimental design developed by Hungerford and Roberts has been used. This data is completing the longtime food habit study on the Hatter Creek area. This data is also being used in Thilenius's project (WU-38) on the impact of deer and cattle use on this forest range.

Several other phases of the research at Hatter Creek are being continued under this project number. Whenever possible, deer population estimates are being made in the Hatter Creek enclosure. Also whenever possible, deer from the Hatter Creek area are analyzed to help complete the productivity data. Another phase of the project, which is nearly completed, is the longtime clipping study which simulates different degrees of browsing on red-stemmed ceanothus at the Hatter Creek area. We now have seven years of data from the clipped sample shrubs.

Another phase of the Hatter Creek study is the relation of snow depth and density to the availability of various species of browse in the Hatter Creek enclosure. Suitable snow conditions during the past year prevented adding any data. Through cooperation with the Soil Conservation Service a snow sampling outfit is now available to continue this work when suitable snow conditions are present. Another protective exclosure was constructed this year to give complete protection from all grazing animals in a Douglas-fir stand near the north gate. This protects a series of serviceberry which have been tagged for a number of years and used in the snow density-availability study.

Project WU-24. The Influence of Magpie Predation on Nesting Pheasants and Waterfowl Populations in the Wilson Lake Area.

Field work on this project was completed during the summer of 1958 and Mr. Jones's thesis was completed in September. Jones accepted a doctoral fellowship at Oklahoma A & M College, leaving in late September after his orals had been completed. His Master's degree was awarded as of June, 1959.

As a result of this project, two manuscripts have already been submitted to journals. One describes a number of observations on the life history of the magpie in the Wilson Lake area of southern Idaho. This was submitted to Northwest Science and essentially comprises an award-winning paper which Mr. Jones read at the Spokane Northwest Science meeting. A second manucript is authored jointly by Hungerford, Jones and Clyle Novak, the first graduate student on this project. This manuscript describes the new technique of marking eggs with dye to trace nest predators; it is being submitted to the Journal of Wildlife Management.

Project WU-26. Salt as a Management Tool and Migration Studies on Elk in the Lower Selway Drainage of Idaho.

The winter of 1957-1958 was exceptionally mild. The average temperature was four and one-half degrees Fahrenheit above normal. Total snowfall during the 1957-1958 winter was only thirteen percent of the previous ten-year average. This abnormality no doubt had some effect on the behavior

patterns of elk in the course of this study.

The hunter-hour survey undertaken during the 1957 big game hunting season was considered as being a valuable method of obtaining herd movement data. It may be possible to use this method on a larger scale in the management of big game.

Hunter-hour data and field observations indicated that the autumn elk migration commenced prior to the appearance of deep snow. In this case, elk began their downward migration in late September, a full month before the first permanent winter snows fell on even the higher reaches of the study area. It is felt that snow is not the primary cause of fall elk migrations.

Two distinct types of migration were observed during the 1957-1958 winter. One was a long distance type while the other was a short vertical type.

A difference exists in the migration habits between the elk on the salted section and the unsalted portion of the study area. The elk on the salted segment of the study area exhibited a migration pattern described as being vertical. The elk population on the un-salted section combined the vertical, transverse, and parallel types of migration patterns. It is felt that the extensiveness of these migrations would have been increased had the winter been more severe.

Aerial and ground surveys placed the area of heaviest elk winter use in the Ballinger and Cascade Creeks vicinity. The elevation of heaviest concentration was between approximately three thousand and four thousand feet. The months of December, January and February were considered the periods of greatest concentration during the 1957-1958 winter. No doubt the elk would have been more concentrated for a longer period of time had the winter been an average one.

The browse on the winter range received only light to moderate use in the course of the 1957-1958 winter. The appearance of the more preferred shrub species indicates that this was not the case in previous years. Dead and stunted shrubs are common and afford evidence of heavy use in years gone by.

The transverse migration exhibited by the elk on the eastern portion of the study area occurred in conjunction with the spring thaw. It is felt that this may have been the case in other years also; that is, as the deep snows melt and make accessible vast resources of preferred browse, elk cross the Selway River in quest of it.

Hourly use of Ballinger natural lick was determined on 5 different days from June 16 to September 9, 1958. The numbers of elk using the lick varied from 125 on June 16 to 5 on September 9. Calves first appeared on the lick proper on June 26, but did not actually use the lick until August 20. Behavior of bulls, cows and calves was described in detail at each visit. Briefly, elk occupancy of a lick could be described as one of belligerency. Fighting among the cows was frequent. Old bulls were almost never molested and were not observed fighting. Young bulls with antlers of 2 or 3 points were usually involved in fighting the older cows and were rarely defeated. Yearlings were constantly being driven from the lick and from their mid-day beds by older bulls.

During the fall of 1958 artificial salt licks were established on the formerly unsalted portion of the study area as well as on the continuously salted portion to measure upward movement during the spring of 1959.

Thirteen flights over the study area were made from February to and including May. Erratic altitudinal movements of elk over the entire study area noted in February and March were associated with the storms of late winter and early spring. The degree of movements at this time is directly associated with the amount and dispersion of older age classes of timber in the two sections of the study area. There was more movement of elk in the area of sparse timber. During wet snow and cold rain, elk seek out the timbered areas to a greater degree than during mid-winter snowstorms.

After April first, altitudinal movements of elk were comparable over the entire study area. There was a distinct downward movement during April with the advent of green herbaceous vegetation and then a steady movement to higher elevations as vegetation emerged. During May and early June the artificial salt licks received heavy use. However, many elk continued to move above the licks as vegetation developed. A later daily movement back to the licks, particularly the natural licks, was noted in the summer of 1958.

Project WU-28. A Study of the Influence of Logging on Trout Streams in Northern Idaho.

This project can be partitioned into three natural divisions for study, namely: pre-logging, logging, and post-logging phases of investigation. The research stream in the Clearwater River area is now in the second or logging phase of the project while the research stream in the St. Joe River is still in the first or pre-logging phase of the study. Until sufficient new data is gathered to insure the originality of the research, no Master's candidates can be assigned to the problem. The Unit is continuing the research, however, on a half-scale basis. Two series of samples were obtained from each of the two study areas in August and September, 1958. These have already been partly analyzed and the findings will be placed in a final report on the project.

Project WU-33. Post-Larvel Development and Diet of the Coarsescale Sucker, Castastomus macrocheilus, Girard.

In young suckers a series of morphological, physiological and behavioral changes occur after the absorption of the yolk sac. Such larval phenomena have been studied extensively in other species of fish. Balinsky (1948) defined in detail 46 stages in the development of minnows from the unfertilized egg to the acquisition of scales and the completion of the lateral line canal. Le Cren (1951) found that two straight logarithmic regression lines were needed to suitably describe the length-weight relationships of the yellow perch, Perca flavescens (Mitchill), one for larval fish 6 to 30 mm. in fork length and one for larger fish. Stewart (1926) described various developmental characteristics of the post-larval white sucker, Catastomus commersoni (Lacepede) and related changes in the position of the mouth from a terminal to an inferior position with changes in feeding behavior. In addition to describing and contrasting the development and diet in post-larval and early juvenile stages of the coarsescale sucker,

Catastomus macrocheilus, Girard, this paper integrates some of the concepts developed by Balinsky, Le Cren and Stewart within a single fish species.

The following statements summarize the salient features of this investigation:

1. Larval metamorphosis is complete except for the coiling of the intestine in post-larvae, about 20 mm. in fork length.

2. The length-weight relationships of post-larval and juvenile suckers are described by two straight logarithmic regression lines. The intersection of these lines coincides with the end of major changes in physiognomy and thus, could be useful as a criterion for signifying the end of post-larval development.

3. The diet of young suckers in Payette River consisted essentially of diatomes, protozoans, rotifers, cladocerans, and midges. The frequency of occurrence of diatomes, protozoans and rotifers was higher and that of cladocerans was lower in juvenile than in post-larval fish.

4. In general, the average number of diatomes and protozoans ingested per gram weight of fish was greater for juvenile than for post-larval suckers whereas the average number of rotifers and cladocerans eaten was less for juvenile than for post-larval suckers.

5. A change in behavior from surface to bottom feeding is associated with a shift in the ventral jaw of the mouth, whereas a behavioral change from discriminate to non-discriminate feeding is associated with the development of the coiled intestine.

Project WU-34. Bear Lake Fisheries Investigation--A Preliminary Bioassay of Bear Lake Waters, Bear Lake, Idaho.

A bioassay of Bear Lake waters was conducted at the request of the Idaho Fish and Game Department in order to determine what chemical factors, if any, are inhibiting or limiting phytoplankton growth and if possible to determine some practical method of altering chemical composition of the lake in order that phytoplankton growth may be increased. According to past reports, the standing crop of plankton has been relatively low. The trout fishery is meager although the supply of other species of fish is fairly great. In an effort to detect whether or not the heavy metal ions present were acting as inhibitors and to find some means of increasing plankton production and possibly trout yield, various chemicals were added to both natural water from Bear Lake and to artificially made water simulating that from Bear Lake. To each test solution an alga, Chlorella vulgaris, Emerson, was added as a culture organism, the growth of which was measured by cell counts. The experiment was so designed that an analysis of variance could be used for statistical interpretation of the results.

An inspection of algae counts revealed that the standard deviations of the replicates were proportional to their arithmetic means. Since a fundamental requirement of the analysis of variance is that the variance be independent of the means, a logarithmic transformation was made as a convenient method of fulfilling this requirement. For all experiments, an analysis of variance yielded F-values which were highly significant.

To determine which of the solutions tested were significantly different at the five percent level, a new multiple range test was utilized which is called the "shortest significant range" (SSR). The results of this test are given in detail in an unpublished report.

Under the experimental conditions imposed, the addition of heavy metal ions to artificial and natural Bear Lake waters had no deleterious effect on cell production. This suggests the possibility that any inhibiting effects, if any, are relatively minor and that more critical experimentation would be necessary to discover to what degree the heavy metal ions effect plankton production.

A reduction in the quantity of magnesium in artificial Bear Lake water was tested and was found to increase algal growth. The size of the increase due to lack of magnesium, however, was not as great as that due to added nutrients. A positive correlation between alga production and concentrations of a chelating agent occurred. This could result from the agent reducing the concentration of magnesium as well as the heavy metal ions. Since chelating agents may increase production, further experimentation with agents of this type might prove fruitful. The presence of nutrients in these chelated solutions, however, is noted and if use of a chelating agent is to be made, the addition of nutrients may also be necessary.

On the basis of these exploratory experiments, the availability of nutrients appears to be the main factor limiting phytoplankton growth rather than possible inhibitory effects due to the chemical composition of Bear Lake waters. Further experimentation is necessary to determine what specific nutrients are limiting and what minimal amounts of these compounds are needed to appreciably increase phytoplankton production. Ultimately, the results of laboratory experiments should be tested in the field, possibly using small artifically restricted areas of the lake itself.

That this bioassay of Bear Lake water is purely exploratory should be emphasized. Not only is the scope of this experimental work limited but different results might be expected from different species or strains of algae, especially if those native to Bear Lake were used as cultural organisms. Consequently, these results may be regarded only as indicators of the direction that more extensive research might take and application of these findings to Bear Lake should be done with caution.

Project WU-36. Plant Succession and Utilization by Livestock and Big Game in a Sand Dune Region in Fremont County, Idaho.

An extensive area northwest of St. Anthony, Idaho, contains both active and stabilized sand dunes. The latter supports stands of chokecherry and bitterbuush and is an important wintering area for elk, moose, and deer. Moose and elk migrate 15 to 35 miles from the higher, timbered summer ranges to the northeast adjacent to and including western Yellowstone National Park, across the sagebrush-grass plain to the sand dune area.

The initial work on this project concerns correlating soils with plant succession, initiating measurements to determine the trend in vegetation and utilization of browse and movement of big game within the study area.

A 37-acre exclosure typical of the stabilized sand dune ridges with adjacent residual soil was built by the Bureau of Land Management at our request. The five strand barbed wire fence excludes only livestock. The wires are lowered in the fall and replaced after big game animals have left the area. A high fenced exclosure of 10 acres built by the State Fish and Game Department completely excludes all species except rodents and rabbits and small plots are being established for the exclusion of these animals.

First winter's observations on utilization indicate that bitterbrush and chokecherry received the greatest use. Small amounts of rabbitbrush and sagebrush were used. Elk paw down through the snow to obtain dried grasses. Giant wild rye was often eaten off to the snow line and below.

The results of the pH sampling as an age indicator of sand dune areas are not completely analyzed. Preliminary results indicate that vegetation and fire evidently affect sand pH considerably and often mask the effect of time on the leaching of bases. Areas burned within the last 18 years had a considerably higher surface pH than unburned sites of similar age. Surface pH in unburned depressions first dropped below 6.0 at about 1300 years. At the same time a slightly alkaline layer (pH 7.4) formed at the 10 foot level.

Dune movements calculated from 1941 and 1951 aerial photographs varied from 2 to 16 feet per year, averaging 9 feet per year.

Six vegetational stages of succession on sand dunes are present on the study area. On areas of old sand (over 3000 years) sagebrush appears to occupy only shallow sand and islands of native soil and rock outcrops, with bitterbrush forming dense stands on deeper sands. Perennial grasses form solid stands on moderately shallow old sand.

Project WU-38. Browsing Competition Between Cattle and Whitetailed Deer on a Northern Idaho Forest Range.

Much of the lower elevation forest land of northern Idaho affords summer range for cattle and yearlong range for whitetailed deer. The greater portion of these forest lands have a shrub understory. Good stands of forage grasses are therefore rather scarce, and except in localized areas, cattle are forced to use shrubs for a considerable part of their diet. Whitetailed deer subsist almost entirely on browse throughout the year. As a result of this dual use, many of the more palatable shrubs show signs of overuse and the forage resource is being depleted.

Sampling to determine the shrub understory composition was determined both inside the Hatter Creek enclosure where the vegetation is browsed only by deer and adjacent areas outside the enclosure which are used by both deer and cattle. The coverage by shrubs was determined by line intercept and canopy cover methods. Variance and standard error were determined on the basis of 25 sampling sites.

Twelve shrub species were measured, but variance was computed on only species because of low frequency. However, calculations for the number of samples needed to have the population mean within plus or minus one standard error (corrected) at the 95 percent level of significance ranged

between 24 and 27.

In addition to the sampling of the understory, 50 1/5 acre circular plots were used to sample the overstory, 25 plots being outside the enclosure and 25 plots inside. Two dominant species are present--Pseudotsuga menziesii and Pinus ponderosa with Pinus contorta and Abies grandis as co-dominants.

Composition and density of both shrubs and the tree overstory having been determined, summer utilization is being measured in 1959.

SUMMARY OF F. W. R. EXPERIMENT STATION PROJECTS 1958-1959

No.	Title	Started	Present Status	Personnel
	I. FOREST MANAGEMENT			
E.S. 1	Wood Preservation Tests	1946	Cont. Inact.	Howe, Burlison
E.S. 2	White Pine Blister Rust	1940	Cont. Act.	Slipp
E.S. 3	White Pine Stem Anatomy	1953	Cont. Act.	Johnson
E.S. 6	Idaho Tree Diseases	1950	Cont. Act.	Gilbertson, Slipp
E.S. 20	Mortality of Young White Pine	1948	Cont. Act.	Johnson
E.S. 21	Idaho Small Tree Farms	1956	Cont. Act.	Deters, Seale, Frazier
E.S. 23 (WM-31)	Marketing Practices & Prices	1956	Cont. Act.	Seale, Frazier
E.S. 24	Forest Tree Breeding in Idaho	1957	Cont. Act.	Inman
E.S. 25	Idaho Wood-Rotting Fungi	1957	Discontinued	Gilbertson
E.S. 26	Identification of Conifer Seedlings	1958	New	Olson
E.S. 27	Nutrients in White Pine Site Quality	1958	New	Loewenstein
E.S. 28	Nursery Soil Fertility	1958	New	Loewenstein
E.S. 29	Engelmann Spruce Weevil	1958	New	Clark
S.R. 11-B	Forest Tree Physiology	1951	Cont. Act.	Johnson
S.R. 24	Slash Disposal	1949	Cont. Act.	Olson, Gilbertson
S.R. 54	Wood Quality & Log Standards	1957	Cont. Act.	Howe
S.R. 55	Cone and Seed Insects	1957	Cont. Act.	Clark
S.R. 63	Lodgepole-Jackpine Hybrids	1958	New	Pitkin
S.R. 65	Fertilizing of Forest Stands	1958	New	Loewenstein, Pitkin
S.R. 66	Seedling Fertilization	1958	New	Pitkin, Loewenstein
	II. RANGE MANAGEMENT			
E.S. 7 (SR-27D)	Evaluation of Salt-Desert Ranges	1951	Cont. Act.	Sharp, Windle
E.S. 8	Ecology & Control of Medusa-Head	1950	Cont. Act.	Hironaka, Tisdale
E.S. 9 (R-287)	Ecology of Sagebrush Ranges	1949	Cont. Act.	Hironaka, Tisdale
E.S. 10	Ecology of Douglas-Fir Zone in Interior B.C.	1946	Cont. Act.	Tisdale
E.S. 13	Ecotypic Variation in Range Plants	1956	Cont. Act.	Tisdale
E.S. 14	Harvester Ants on Idaho Ranges	1956	Cont. Act.	Sharp
E.S. 15	Halogeton on Idaho Ranges	1950	Cont. Act.	Sharp, Windle
E.S. 22 (R-296)	Range Forage Nutrition	1955	Cont. Act.	Sharp, Helle
S.R. 27c	Study of Goatweed (Hypericum)	1951	Cont. Act.	Tisdale
S.R. 38	Evaluation of Range Reseeding	1952	Cont. Act.	Sharp, Davis

No.	Title	Started	Present Status	Personnel
	III. WILDLIFE AND FISHERIES MANAGEMENT			
W.U. 11	Study of Blue Grouse	1952	Inactive	Dalke
W.U. 15	Study of Sage Grouse	1952	Cont. Act.	Dalke, Schlatterer
W.U. 18	Productivity of Ruffed Grouse	1952	Cont. Act.	Hungerford
W.U. 19	Ruffed Grouse Population Study	1951	Cont. Act.	Hungerford
W.U. 23	Food Habits & Productivity of White-Tailed Deer	1952	Cont. Act.	Hungerford
W.U. 24	Magpie Predation on Pheasants	1955	Completed	Hungerford, Jones
W.U. 26	Salt in Elk Management, Selway Area	1955	Cont. Act.	Dalke, Williams
W.U. 28	Influence of Logging on Trout Streams in Northern Idaho	1955	Cont. Act.	MacPhee
W.U. 33	Post-Larval Development & Diet of Largescale Sucker, Catastomus macrocheilus, Girard	1957	Cont. Act.	MacPhee
W.U. 34	Bear Lake Fisheries Investigation--Bioassay of Artificial & Natural Bear Lake Waters	1957	Cont. Act.	MacPhee
W.U. 36	Plant Succession & Utilization by Livestock & Big Game, Fremont County	1958	New	Dalke, Chadwick
W.U. 38	Browsing Competition Between Cattle & Whitetailed Deer on a Northern Idaho Forest Range	1958	New	Hungerford, Thilenius
W.U. 39	Effects of Summer Utilization of Bitterbrush in Okanogan Co., Washington	1958	Completed	Hungerford, Martinson

PUBLICATIONS

I. Technical Publications

Heiberg, S. O., L. Leyton and H. Loewenstein. 1959. Influence of potassium fertilizer level on red pine planted at various spacings on a potassium deficient site. Forest Science 5:142-153.

Heiberg, S. O. and H. Loewenstein. 1959. Depletion and rehabilitation of a sandy outwash plain in northern New York. Proceedings, North American Forest Soils Conference.

Hungerford, K. E. 1957. Evaluating ruffed grouse foods for habitat improvement. Trans. North American Wildlife Conference 22:380-395.

Inman, L. L. 1959. The divergent points of view of forest geneticists and agronomic and horticultural crop breeders. Jour. Forestry 57:375-377.

McClure, N. R. 1958. Grass seedings on lodgepole pine burns in the northwest. Jour. Range Management 11:183-186.

Mohler, L. L. and P. D. Dalke. 1959. Elk and elk hunting in Idaho. Trans. North American Wildlife Conference 23:491-501.

Tisdale, E. W., M. Hironaka and W. L. Pringle. 1959. Observations on the autecology of Hypericum perforatum. Ecol. 40:54-62.

II. Graduate Theses (M.S. June, 1959)

Brown, E. R. 1958. The use of sodium TCA and dalapon to control competition of perennial grasses with bitterbrush seedlings.

Frazier, G. D. 1959. Small woodland ownerships in northern Idaho.

Hill, R. B. 1959. A study of leader elongation in western white pine.

Jones, R. E. 1959. The effect of magpie predation on pheasant and waterfowl populations in southern Idaho.

Robel, R. J. 1959. Salt as a management tool and migration studies of elk in the lower Selway River drainage of Idaho.

Skovlin, J. M. 1959. A study of the relative utilization of important forage plants on summer cattle range in the Blue Mountains.

Stanton, D. C. 1959. A study of breeding and reproduction in a sage grouse population in southeastern Idaho.

APPENDIX A. STAFF 1958-1959

I. Regular Staff Members

Ernest Wohletz, Director and Professor (Forest Management)
E. W. Tisdale, Associate Director and Professor (Range Management)
E. C. Clark, Assistant Professor (Forest Entomology)
P. D. Dalke, Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Management)
M. E. Deters, Professor (Forest Management)
G. D. Frazier, Assistant Forest Economist, Jr.
R. L. Gilbertson, Assistant Professor (Forest Pathology)
Minoru Hironaka, Assistant Range Ecologist, Jr.
J. P. Howe, Assistant Professor (Wood Utilization)
K. E. Hungerford, Associate Professor (Wildlife Management)
L. L. Inman, Assistant Professor (Forest Genetics)
F. D. Johnson, Acting Instructor (Forest Management)
Howard Loewenstein, Assistant Professor (Forest Management)
Craig MacPhee, Assistant Professor (Fishery Management)
D. W. Olson, Research Silviculturist
F. H. Pitkin, Nurseryman
R. H. Seale, Associate Professor (Forest Management)
L. A. Sharp, Associate Professor (Range Management)
A. W. Slipp, Assistant Professor (Forest Pathology)

II. Research Fellows

Howard Chadwick -- Wildlife Management
John Davis -- Range Management
Joseph Helle -- Range Management
Edward Schlatterer -- Wildlife Management
Nicholas Tipple -- Wood Utilization
John Thilenius -- Wildlife Management
Thomas Williams -- Wildlife Management
Leaford Windle -- Range Management

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT 1958-1959

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

2. University of Idaho, Special Research Fund. Projects S.R. 11, 24, 27c, 27d, 38, 54, 55, 63, 65 and 66.

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

4. Idaho State Department of Forestry. Partial support for Forest Genetics Project.

5. Potlatch Forests, Inc. Potlatch Research Fellowship.

6. Sears-Roebuck Foundation. Funds for Project E.S. 21 (Small Tree Farms.)

7. United States Bureau of Land Management. Funds for Project E.S. 15 (Halogeton), plus facilities and manpower on Point Springs Grazing Study.

8. Southern Idaho Forestry Association. Partial support for Forest Genetics Project.

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

10. United States Forest Service. Office space (Boise Research Center), field living accommodations, and numerous other facilities.

11. United States Department of Agriculture. Funds from Regional Research Projects WM-31, W-25, W-34. *

12. Wildlife Management Institute. Funds for wildlife research.

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