FOREST, WILDLIFE AND RANGE EXPERIMENT STATION

COLLEGE OF FORESTRY

UNIVERSITY OF IDAHO

Moscow, Idaho

T W E L F T H A N N U A L R E P O R T

For the Fiscal Year 1959-1960

Ernest Wohletz, Director

E. W. Tisdale, Associate Director

November 1960

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INTRODUCTION

Out of 43 projects listed, 40 were active. Seven of these investigations were completed and 3 begun during the report year.

The Station staff for the bulk of the year consisted of 20 members, of whom only three were on full-time research. Three staff vacancies were filled by the appointment of Dr. Arthur Partridge in Forest Pathology, Mr. E. L. Williams in Forest Economics and Mr. A. D. Hofstrand in Wood Utilization.

Vacancies were created by the resignation of Dr. L. Inman (Forest Genetics), the death of Mr. A. Slipp (Forest Pathology) and the resignation of Dr. Edwin Clark (Forest Entomology). Professor Slipp had been a member of the Station staff since 1945 and had remained active in spite of ill-health extending over a period of several years. The tragic death of Dr. Clark, following his resignation, removed a most promising scientist and teacher. None of these three positions was filled by the end of the report year, but arrangements were made to obtain the services of Dr. C. W. Wang for the position in Forest Genetics.

L. A. Sharp, Associate Professor of Range Management, was on leave during the academic year 1959-1960 studying for the doctorate degree at Oregon State College. During Mr. Sharp's absence, his teaching duties were carried out by Mr. Frederick Hall on temporary appointment as Assistant Professor, Acting. Mr. Hall had helped with the teaching load in Range Management the previous year during the absence of Dr. Tisdale.

Twelve graduate fellows were on appointment during the year, and five of these completed their theses in June, 1960.

Financial and other forms of research support continued to be provided by the same organizations who had helped in previous years. In addition, a special grant was received from Potlatch Forests, Inc. to enlarge the research effort on the effects of site on wood quality in Douglas-fir.

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 or discontinued during the year:

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

This project was completed and the results reported in a bulletin by Mr. George Frazier. A few of the major points brought out by this study are as follows:

The problem of "size" of woodland is not as critical in northern Idaho as it is in other sections of the west and of the nation. However, the size is still small enough to constitute part of the "small woodland problem" in the region.

In general, small woodland holdings are located relatively close to a market. There is a relatively large number of firms in the area which can furnish a market for products from small woodlands.

The owner's present use of the woodland resource is for purposes other than forest production, but the trend in the future is toward greater utilization of the woodland. This may indicate that small woodland owners are changing their thinking about their woodlands.

Lack of knowledge of market sources and woodland values did not seem to be as important a deterrent in selling forest products as the small physical size of the woodland. Other values, for the most part non-monetary, were important reasons for withholding forest products from the market, especially in the case of the non-farm owner.

The results of this study would indicate the primary price-making forces are outside the influence of the characteristics, attitudes and marketing practices of the small non-industrial woodland owner. Without doubt these have an influence upon prices received for woodland products. However, this study was unable to demonstrate that such was the case for prices received by 764 small non-industrial woodland owners in the eight northern counties in Idaho composed of Boundary, Bonner, Kootenai, Shoshone, Benewah, Latah, Clearwater and Idaho.

B. Continuing projects:

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

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

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

Work on this project was brought to a halt by the death of Professor Albert Slipp. Efforts are being made to have much of the information from this long-term project analyzed and put in shape for publication. As a first step in this direction, the canker data were

THE ACCOMPLISHMENTS

I. Forest Management and Utilization

A. Projects completed or discontinued during the year.

Project G.S. 21. Study of Idaho Small Area Forests.

This project was completed and the results reported in a bulletin by [illegible] Factors. [illegible] study are as follows:

Separation of [illegible] ownership is not as critical in northern Idaho as it is in other sections of the West and [illegible]. However, the area is still small enough to contribute [illegible] of the small woodland problem in the region.

In general, small woodland holdings are located relatively close to markets. There is a relatively large number of firms in the area which can furnish a market for products from small woodlands.

The owner's present use of the woodland resource is for purposes other than forest production, but the trend in the future is toward greater utilization of the woodland. This may indicate that woodland owners are changing their thinking about their woodlands.

Lack of knowledge of market sources and woodland values did not seem to be an important deterrent in selling forest products and the small physical size of the woodland. Other reasons, for example [illegible] taxes were important reasons for withholding forest products from the market, especially in the case of the non-farm owners.

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B. Continuing projects.

Project [illegible] Woodland [illegible] Service [illegible].

In addition [illegible] work was done during the year [illegible] material [illegible] for [illegible] in future years.

Project G.S. 24. White Pine Blister Rust.

Work on this project was brought to a [illegible] by the death of [illegible] Albert [illegible]. Efforts are being made to [illegible] from [illegible] project [illegible]. As a first step [illegible] the [illegible]

carded, with all data for one canker brought together on one card.

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

This project was inactive during the past year.

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

Although disease incidence seemed about normal during 1959, inquiries regarding tree disease conditions were very few. The bulk of the inquiries involved winter damage of Norway, blue and Engelmann spruces. Needle diseases of several types were in from western white pine, Engelmann spruce, western larch, lodgepole pine, Douglas-fir, grand fir and ponderosa pine.

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

Salable trees were selected and sold from the following plots: Twin Falls, Parma, Grangeville and Sandpoint. Data on species preference and prices were obtained. A publication is being planned as soon as additional information is obtained in December, 1960.

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

Active field work was suspended on this project and plans are being made to close out this phase of pole blight research. Several types of sample plots will be re-examined periodically to complete data collection. Seven progress plots, two spread plots, all strangulation plots, all armillaria inoculation plots and all living pole blight grafts will be checked at intervals ranging from one to five years. All other field plots will be suspended. All mycorrhizal work on pole blight has been transferred to Project S.R. 11-C, and will be summarized there.

Project E.S. 23 (WM-42). Effect of Market Structure and Marketing Practices of Initial Processors on Market Stability and Prices for Timber from Small Woodlands.

The objectives of this study are as follows:

1. To identify and describe the initial processors of timber obtained from small forest ownerships, to determine their timber purchasing practices, appraise the significance of the small woodlands in their overall supply, and to establish the degree of competition among such buyers.

2. To describe the market structure and marketing practices of these processors.

3. To determine the effect of structure and practices upon the stability of prices they receive and the volume of their output.

4. To investigate the relationship of these findings to the timber purchasing practices of the processors and the consequent stability of markets and prices available to small woodland owners.

carried, with all data [illegible] together [illegible].

Project I.S. 3. [illegible].

This project was inactive during the past year.

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

Although disease incidence seemed about normal during 1959, inquiries regarding tree disease conditions were numerous. The bulk of the inquiries involved winter damage of conifers, and [illegible] cankers. Needle diseases of several types were in evidence on white pine, Engelmann spruce, western larch, lodgepole pine, Douglas-fir, grand fir and ponderosa pine.

Project I.S. 8. Christmas Tree Test Plantings.

Suitable trees were selected and sold from the [illegible] plot [illegible] Farm, Grangeville and [illegible]. [illegible] species preference and prices were [illegible]. A [illegible] will be prepared as soon as additional information is obtained [illegible].

Project I.S. 10. Fertility of Young Western White Pine Trees (I.S. FI-6-1)

A [illegible] field study was [illegible] in this project and plans were made to [illegible] the phase of pole blight research. Several types of [illegible] will be co-ordinated [illegible] to complete data collection. [illegible] progress [illegible] all [illegible] alive [illegible] will be checked at intervals [illegible]. All other field plots will be [illegible] pole blight [illegible] and will be [illegible].

Project I.S. 11. [illegible] Effect of Market Structure and Existing Practices of Initial Processors on Market Stability and Prices for Timber from Small Woodlands

The objectives of this study are as follows:

1. To identify and describe the initial processors of timber obtained from small forest ownerships, to determine their timber purchasing strategies, capacity and significance of the [illegible] in their overall supply, and to establish the degree of competition among such buyers.

2. To identify the market structure for existing practices of these processors.

3. To determine the effect of structure and practices upon the stability of various [illegible] and the volume of their output.

4. To evaluate the relationship of these findings to the timber purchasing practices of the processors and the consequent availability of markets and prices available to small woodland owners.

A questionnaire designed to determine the general characteristics of the sawmills has been designed, tested, and used on thirty sawmills. In the coming summer this initial questionnaire will be completed on all mills north of the Salmon River. Following the initial survey, the mills will be grouped and representative mills selected from which information will be gathered on cost of logs and lumber prices received.

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

The program on improvement of ponderosa pine was halted temporarily by the resignation of Dr. Inman in October, 1959. As no replacement was obtained during the remainder of the report year, little progress was made in this project. Work will be resumed in the fall of 1960 with the appointment of Dr. C. Wang to fill this position.

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

This study has resulted in a publication "Identification of Coniferous Seedlings in the Northern Rocky Mountains" by D.S. Olson (Station Research Note #15, 1959). The need for this descriptive key is indicated by the strong demand for copies of the publication.

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

There is little or no information presently available concerning fertility relations of white pine which has passed the nursery seedling stage. In this study an attempt is being made to correlate the level of certain soil nutrients with tree growth on a variety of white pine sites. Such correlations, if found, would greatly aid in judging the potential productivity of burned or cut-over land. Planting programs could then be concentrated on the soils showing the greatest promise.

After several delays, analysis of soil samples from profiles of 26 white pine sites was completed during the spring of 1960. These data will now be examined for possible correlations with tree growth. It is also planned to go back to the sites and collect foliage from leading trees and samples of the ground cover vegetation. These will be subjected to analyses similar to those performed on the soil, with the resulting data tested for possible correlations with soil nutrient levels and tree growth.

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

Greenhouse work in connection with this project has continued throughout the year. This has involved both pot and root observation box trials. During the coming spring it is planned to fertilize nursery plots. Panes of glass will be inserted vertically in the ground on these plots, and seeds of various species will be germinated immediately behind them. This technique will permit observation of the fertilizer effect on root development continually through the growing season.

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

Due to the resignation and subsequent death of Dr. Clark, little progress was made on this project this year. Efforts will be made to edit and publish a manuscript left by Dr. Clark and dealing with the damage caused by the spruce weevil in Idaho.

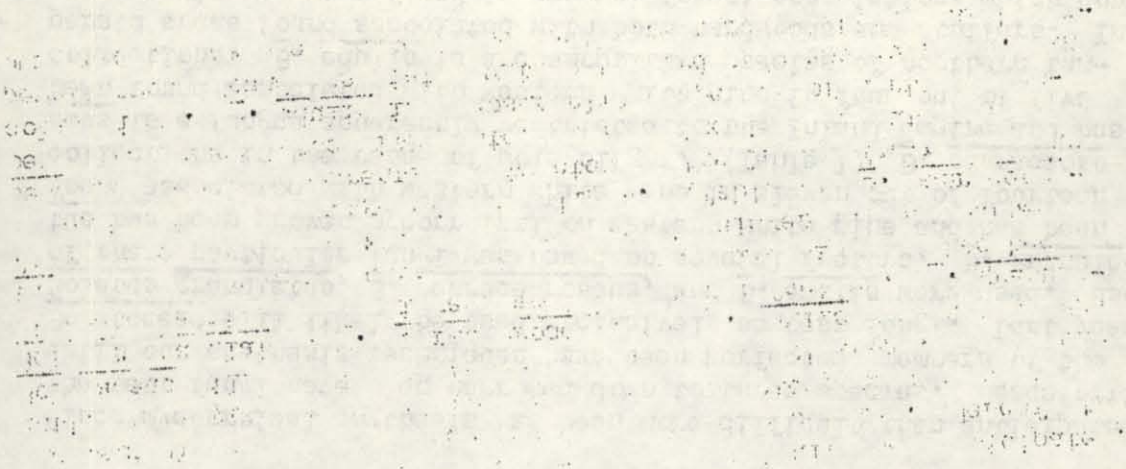
Project S.R. 11-C. Forest Tree Physiology.

Administrative commitments precluded doing any field work on this project during the 1959 field season; therefore, this report will be entirely based on laboratory work.

Experiments in the snythesis of mycorrhizal fungi were continued. To date no positive instances of artificial mycorrhizal formation have been established. Several possible endatrophic mycorrhizal roots mentioned in last year's report were subsequently microsectioned and examined; none were mycorrhizal. Variables introduced into 1959 synthesis trials include pH, rooting medium, and time. Nine-month trials were the longest tried thus far and proved ineffective in causing mycorrhizal formation. Hydrogen ion concentrations of pH 5.0 and 5.5 were also tested and had no more effect than pH 6.0 and 6.5 formerly tried. Sporge rock did not retain moisture long enough to sustain seedling growth over the nine-month period, but a 50:50 mixture of sporge rock and screened Terralite vermiculite seemed to provide ample moisture and good seedling growth and vigor.

Contamination of seedlings has been a constant problem in the past. Surface sterilants powerful enough to kill positively all seed surface spores were also detrimental to seedling viability--probably the lower surface tensions and/or longer sterilization time permitted entry of the sterilizing solution through the micropyle and allowed damage to the embryo. On the other hand, sterilization that gave good viability of seeds was not adequate. It appeared that most of the contamination came from the seed; probably spores hidden under bits of resin or the seed coat were missed by low surface tension sterilants. Last year the seed coats were aseptically lifted from the expanding cotyledons just before they fell. Contamination was reduced over 70%.

Since mycorrhizal snythesis has been more difficult than anticipated, the test fungi have been narrowed down to three species. Henceforth until our snythesis techniques have been perfected, members of the Boletaceae will likely be used exclusively as test fungi. Last year Boletus granulatus, B. ochraceoroseus, and B. edulis were used. Use of these particular fungi was based on several factors. B. granulatus has been proven mycorrhizal on eastern white pine and has been found associated with western white pine in eleven out of fourteen collections in the range of pole blight. (Table 1) B. ochraceoroseus is a fungus apparently restricted to the Inland Empire and has been found associated with western white pine in four out of five collections. B. edulis is a cosmopolitan species of northern temperate areas found associated with both hardwoods and conifers. In our area it has been found in several forest associations which con-



Fungus	Western white pine	Western hemlock	Western red cedar	Grand fir	R.M. Douglas-fir	Lodgepole pine	Ponderosa pine	Western larch	Engelmann spruce	Subalpine fir	Pacific yew	Salix spp.	R.M. maple	Alnus spp.	Betula spp.	Quaking aspen	Black cottonwood	Number of Collections
Boletus cavipes	8	3	6	5	5	2	1	9	1	-	-	-	1	2	-	2	-	10
B. tomentosus	16	5	8	7	7	4	2	9	5	2	-	1	1	1	-	1	1	20
B. elegans	8	3	5	6	3	2	-	8	1	1	-	-	-	1	-	-	-	9
B. vevsipelle	3	-	2	-	-	2	3	2	2	-	-	1	-	-	-	4	-	4
B. ochraceoroseus	5	3	4	-	2	4	1	4	1	1	-	-	-	-	-	-	-	6
B. subluteus	5	2	2	3	-	1	-	1	3	1	-	-	-	-	-	-	-	5
B. granulatus	11	6	5	10	2	4	2	3	2	-	1	-	-	-	-	-	-	14
B. americanus	6	-	3	5	1	1	1	2	2	1	-	-	-	1	-	-	-	6
B. subaurens	3	2	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	4
Lactarium deliciosus	3	1	2	2	2	2	-	2	2	1	-	-	-	-	-	-	-	5

Table 1. Ten probable and proven mycorrhizal fungi common in the white pine forest and collected within ths range of pole blight and their association with forest tree species of this area.

tain western white pine. These fungi were also selected for their availability and vigor in culture. None of the trials with these fungi employing the variables discussed were successful. In total 85 seedlings were involved in various mycorrhizal inoculation trials.

Mycorrhizal snythesis problems were discussed in meetings last year in Berkeley, California (University of California) and at Pullman, Washington (Washington State University). Several new approaches seem to have promise and will be tried in the near future. Experiments involving the carbohydrate (sugar) balance and certain B vitamins will be initiated next year.

No field collections were made in 1959 despite an excellent fruiting season reported for Boletes. In connection with the selection of test fungi, tree/fungus associations were tabulated for some fungi from our extensive collection. As seen in Table 1, several Boletes show high constancy of association with western white pine. Boletus americanus in six collections has been found to be constantly associated with white pine. All other fungi listed had high constancy but did occasionally appear without white pine. The mycorrhizal relationships of several of these fungi have never been reported and several are almost certainly mycorrhizal or western white pine. B. ochraceoroseus is such fungus; in addition B. tomemtosus, B. subluteus, and B. subaureus would be particularly interesting to synthesize and experiments with these fungi await perfection of techniques. Several species of Boletes previously unreported for Idaho are now in our collection as well as at least two species which may be undescribed. An additional five species of Boletes not listed in Table 1 have been collected in white pine associations. Further collection will help to clarify the tree species/Bolete relationships as well as noting the relationship between certain Boletes and forest ecological associations.

Cultural descriptions of Boletes are not frequent in mycological literature and most of our species have not been described. A paper entitled "Cultural Characteristics of Boletes from the Northern Rocky Mountains: I. Boletus subluteus Peck" is in rough draft and should be completed next year. This species was selected to be first in our series of cultural descriptions since it is common in our area, is very constantly associated with white pine in our collections (although this is not true of collections by other workers) and three cultures were available which showed little gross variability.

In connection with earlier physiological work on western white pine under Project S.R. 11-B one paper was published: "Movement and Distribution of Radio-phosphorus in Crowns of Healthy and Pole Blighted Western White Pines (Pinus monticola D. Don.)" by W. K. Ferrell, F. D. Johnson and C. E. Michelson, Plant Physiology 35(4):413-417, July, 1960.

Project S.R. 24. Slash Disposal Studies.

Active work on this project by this Station is being terminated at the close of the current fiscal year. The various facets of the logging slash problems originally proposed for study by the 17-man

[illegible] which have also been selected for their [illegible] in culture. None of the isolates from these [illegible] were successful. [illegible] [illegible] involved [illegible].

[illegible] (University of [illegible]) [illegible] (Washington State University), several [illegible] [illegible] [illegible] [illegible] balance and [illegible] [illegible].

[illegible] collections were made [illegible] isolated [illegible] with the [illegible] [illegible] fungi, [illegible] were found [illegible] isolated [illegible] [illegible] collections, [illegible] several [illegible] [illegible] of association with [illegible] [illegible] collections [illegible] found to be [illegible] [illegible] white pine. All other fungi listed [illegible] [illegible] without white pine. [illegible] [illegible] of these fungi have never been reported [illegible] almost certainly mycorrhizal [illegible] [illegible] is such that [illegible] would be particularly [illegible] [illegible] that these fungi [illegible] [illegible] of isolates previously [illegible] [illegible] collection [illegible] [illegible] [illegible] species of [illegible] not listed [illegible] [illegible] [illegible] collections [illegible] [illegible] these species [illegible] [illegible] [illegible] certain isolates and [illegible] [illegible].

Cultural descriptions of [illegible] are not [illegible] [illegible] [illegible] [illegible] have not been [illegible].

In [illegible] July, 1964.

Project F.S. 24. [illegible] Seedlings.

[illegible] work [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

advisory committee, have been explored and tested as far as it seems advisable to go at this time. Results from these studies have been reported in six publications and several articles from this Station, and three publications from the U.S. Forest Service.

This August, the Forest Service will conduct the final burning tests in the series of inflammability studies to determine the rate of spread and radiant heat generated in 5-year old slash. A manuscript reporting the results of these tests is in process of publication by the Forest Service.

It is desirable to make at least one more weighing of samples from the Deception Creek rate-of-decay plots. Such sampling is planned for next fall or the following spring. Based on oven dry weight, average decomposition rates in these plots after two years, are as follows:

Western white pine	36%
Douglas-fir	46%
Engelmann spruce	53%
Grand fir	51%
Western hemlock	24%
Western larch	52%

Much of the weight loss shown for the short needle species is due to needle cast. After being shed, short needles sift through the branchwood to the ground where they no longer contribute to fire danger. Hence they are not included in subsequent weighing of the samples. On the other hand, the longer pine needles continue to be dangerous as a flash fuel and so are weighed until they disintegrate. Consequently, much of the 36 percent weight loss in western white pine represents loss through decay in the sapwood. The relatively low weight reduction shown for western hemlock was due to loss of considerable foliage before the initial weighing of the samples.

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

Professor Hofstrand joined our staff in September and has helped with the work on this project since that time.

During the winter, samples from four National Forests were analyzed in the laboratory. Soil samples were tested for mechanical analysis, fineness, pH, bulk density and wilting point or field capacity.

Increment cores were measured to determine percent springwood and summerwood. This was done on a device especially built for this purpose. It is hoped that the results can be used as a basis for developing a more rapid test using a beta ray method of analysis. Selected cores from each sample plot were macerated and the resulting fibers were prepared for fiber analysis next winter.

A full-time man was hired for summer field sampling. Sampling was completed on the Kaniksu, Coeur d'Alene, and St. Joe National Forests as well as on the University of Idaho Forest.

Project S.R. 55. Survey of Insects Affecting Cones and Seeds of Western White Pine.

Work under this project began with samples of western white pine cones taken throughout northern Idaho to determine what species attack the cones and seeds and their level of relative importance. After opening cones to observe what pest species infested the cone and the type of damage, the remaining cones were used in rearing out the adults and parasites for positive identification.

The two most commonly encountered pest species of western white pine were a cone moth Dioryctria abietella D. & S. and a cone beetle Conophthorus monticolae Hopk. Additional damage by unidentified species of a moth Eucosma sp. and cone midges were found. The 1959 cone crop in western white pine was good and accordingly the infestation should have been low due to an abundance of food. The heaviest infestation of cones by Conophthorus monticolae was 44 percent and by Dioryctria abietella as high as 55 percent in some areas. Comparisons with data from future cone crops will be made to determine whether the size of the cone crop has a significant effect on the degree of infestation.

Seed orchards and cone production areas that require a heavy investment are being developed, thus the need for control of cone- and seed-destroying insects assumes increasing urgency. The ultimate objective of this project is the development of methods of prevention and control of cone- and seed-destroying insects. However, a knowledge concerning what insect species caused damage of economic importance and their biologies are necessary before clues to methods of suppression can be found.

The biologies of Conophthorus monticolae and Dioryctria abietella are being studied to gain information concerning the seasonal behavior of the insect and includes such data as time of emergence, place of oviposition, number of broods per season, brood size, and overwintering habits. The biologies of these two economically important pests plus biologies of other important pests of western white pine cones will serve as a basis for studies in prevention and control. The information gained from this project will be submitted as a thesis for the M.S. degree in June, 1961.

The work on Douglas-fir and ponderosa pine cone and seed insects has been inactive since the recent death of Dr. Edwin C. Clark. However, a manuscript on Barbara colfaxiana (Kearff) as a pest of Douglas-fir cones in northern Idaho is planned as a Research Note.

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

The objective of this project is to determine the feasibility of producing lodgepole-jack pine hybrids for pulpwood plantations. On June 17, 1960, lodgepole flowers which had been bagged previously were pollinated with jack pine pollen obtained from Minnesota. The resulting hybrid cones will be mature and ready for collection September of 1961.

During the spring of 1959 eighteen lodgepole pine parents were selected a few miles south of Spirit Lake and the pine flowers fertilized with jack pine pollen. The mature hybrid cones from this project have been collected and seed extraction will be made soon. The resulting hybrid seed and control seed of both lodgepole and jack pine will be planted in nursery beds next spring. The production of hybrid cones was not as great as expected because of a robbery which occurred. Each of the parent trees was protected from such a hazard with a metal band around the trunk. However, a few of the local cone hoarders (squirrels) found a way into the seed production area, apparently from the air.

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

It is hoped that through fertilization of plantations and natural stands already past the seedling stage both growth and quality of timber can be markedly improved on many sites.

This project was initiated during the spring of 1959, with 42 plots utilizing various fertilizers being installed in ponderosa pine plantations and lodgepole pine thickets located near Spirit Lake and on the College of Forestry Experimental Forest. Details concerning these plots were presented in the Annual Report for Fiscal Year 1959-1960.

During the fall of 1960, the trees involved in this first phase of the experiment will be measured for height and diameter increment and 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. All trees on these plots have been numbered, and in addition, five trees per plot have been equipped with band type dendrometers.

At the time of this writing before the 1960 growing season only occular examination has been made of the above plots. It is apparent from these observations that the needles of trees growing on plots fertilized with nitrogen are a deeper green than trees growing on other plots. Also, the ground vegetation on nitrogen treated areas is very lush in comparison with that on non-nitrogen treated areas.

In May, 1960, several more fertilizer test plots were established. A series of plots are located on the St. Joe National Forest in the vicinity of Ramskull Creek. One experimental area is in a mixed plantation of white pine and ponderosa pine. The ponderosa pine was planted in 1939, and growth since then has been quite poor. Because of this, white pine was planted under the older ponderosa in 1949. These trees, also, have failed to show vigorous growth. Treatments, which were applied to duplicate plots, include: 1. 150 pounds per acre nitrogen as ammonium sulfate; 2. 150 pounds per acre nitrogen as ammonium sulfate, 150 pounds per acre potassium as commercial muriate of potash, and 150 pounds per acre P_2O_5 as treble superphosphate; and 3. control,

no fertilizer added.

A stand of natural white pine, about 30 years old, was also fertilized in the Ramskull Creek area. Treatment consisted of 300 pounds per acre nitrogen as ammonium sulphate.

In the vicinity of Athol, Idaho, fertilizer was applied to two lodgepole pine thickets during the spring of 1960. Strips 6 feet wide and 100 feet long were treated with 300 pounds per acre nitrogen as ammonium sulfate, 150 pounds per acre potassium as commercial muriate of potash, and 150 pounds per acre P_2O_5 as treble superphosphate. Six strips were fertilized in each thicket, with intervals of 35 feet between strips. It is hoped that the fertilizer will stimulate growth of the treated trees, thus promoting the expression of dominance and hastening the death of untreated trees between the strips. In this way the stagnation occurring in the thickets may be broken.

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

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

Tests made at Orofino and Athol this year were a duplication of plots set out in 1959. In each test plot there were a total of 200 seedlings which were planted along with a Mora tree feed pellet. An additional 200 plants were set out as controls. The pellets were inserted directly under each seedling tested. A randomized planting design was used with 25 plants in each block replicated 4 times in both cultivated and non-cultivated ground.

Survival, approximate surface soil temperature and soil moisture content at 8 inches below the soil surface was taken weekly during the summer.

Data, although not complete at this time, indicates survival is regulated to a great extent through the environmental influence of soil moisture. One hundred and five degree air temperature and over 150 degree surface soil temperature had no detrimental effects. The Athol test plot which is on one of our poorer planting sites has yielded a 90 percent survival with clean cultivation as compared to below 40 percent on non-cultivated rows. Moisture content at the 8, 12, 18 and 24 inch levels was considerably greater with clean cultivation. No apparent increase in survival resulted from the effects of the fertilizer pellets.

There is no growth difference between the fertilized plants and the controls at this time. However, it is possible an increase will be significant during the second growing season. Foliage samples will be collected for analysis. Foliar nutrient levels can then be compared to give an added indication of the value of the pellets.

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

Survival and growth of planted seedlings on many sites in Idaho is exceedingly poor. Complete failures or establishments of less than 10 or 15 percent of the plants is not uncommon. With increased emphasis on planting in recent years, it is imperative that more be learned as to the causes of repeated losses and of techniques to improve survival. Information gained during the life of this project will be of benefit to those planting on difficult sites not only in Idaho, but throughout the western United States. The objectives of the study may thus be summarized as follows:

1. To determine the effects of different methods of land preparation and treatment on soil moisture and temperature relations of critical planting sites representative of large areas needing reforestation or aforestation.

2. To determine the survival and early growth of planted trees as affected by the different treatments mentioned above.

3. To determine the effects of age of planting stock and seed source variation on survival and early growth of trees planted on these critical sites.

During the spring of 1960, study areas were developed on two sites in northern Idaho. One of these is at Athol, the other near Cavandish. Both sites are in need of reforestation, and both are representative of large areas consistently producing poor survival. Top priority was given these sites after consultation with informed opinion in both public agencies and private companies. In subsequent years of this project, it is planned to develop study areas on other sites typical of extensive problem lands.

Plots were installed on both sites according to the plan outlined below:

I. Land summer fallowed in previous year.

   A. No cultivation immediately prior to planting or during growing season.

      1. Irrigated during growing season.
      2. Bark mulch around each seedling.
      3. Fertilizer pellets in planting holes.
      4. Ground scalped prior to planting.
      5. Control.

   B. Cultivation before planting and during growing season.

      1. Irrigated during growing season.
      2. Bark mulch around each seedling.
      3. Fertilizer pellets in planting holes.
      4. Ground scalped prior to planting.
      5. Control.

II. Land undisturbed until treatment--no summer fallow in previous year. Treatments as listed under A and B above.

All stock was 3-0 double root pruned Douglas-fir, graded for uniformity at the nursery. Individual treatments were replicated four times.

Observations:

A. Soil Moisture. Resistance blocks for soil moisture determination were installed at a depth of eight inches on each replicate. In addition, one series of blocks were placed at various depths throughout the soil profile at both Athol and Orofino. These blocks will be metered once weekly during the growing season.

B. Soil Surface Temperature. Tempil pellets, which have the property of melting at certain specified temperatures, were placed on the mineral soil surface of each replicate. These pellets indicate whether the temperature of the replicate has reached 113°F, 125°F, 138°F, or 150°F or 163°F. Examinations will be made weekly and melted pellets replaced.

C. Precipitation. Rain gauges were placed at the two sites and will be read weekly.

D. Air Temperature. Maximum and minimum thermometers were placed at each site and will be read weekly.

E. Plant Survival. Counts will be made weekly during growing season.

F. Plant Growth. Growth measurements will be made on plots at end of growing season.

G. Plant Quality. Vigor will be estimated from ocular examination several times during growing season. Color will be noted by means of Munsel color charts. At end of growing season randomly selected plants from each replicate will be lifted and roots examined, root-shoot ratio determined, dry weights calculated, and the plants analyzed for various nutrients.

H. Competition. Estimates will be made, based on degree of ground cover and soil moisture readings.

I. Photographs. A complete photographic record of plants from the various plots will be obtained.

II. Range Management

A. Projects completed or discontinued during the year:

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

This study has been discontinued since there appears to be no likelihood of time for further joint studies of the Douglas-fir zone in British Columbia. Certain aspects of the problem will be investigated in the future if circumstances permit.

B. Continuing projects:

Project E.S. 7 (SR-27D). Evaluation of Salt-Desert Ranges.
Project E.S. 15. The Ecology and Control of Halogeton.

Records from the area where halogeton and salt-desert shrub evaluation studies are being conducted show a continuation of the results reported in the last Annual Report.

Intact stands of perennial vegetation continue to maintain effective halogeton control. Depleted stands of salt-desert shrub vegetation remain principally as stands of halogeton.

Some improvement in the vigor of the individual winterfat plants in the vicinity of cluster F-I was noted. This area was fenced in the fall of 1958 against livestock and rabbits. This area, it is hoped, will provide information on rate of recovery of a winterfat stand after severe grazing for a number of years by livestock and rabbits.

Studies on the ecology of Indian ricegrass (Oryzopsis hymenoides), squirreltail (Sitanion hystrix), desert molly (Kochia americana) and shadscale (Atriplex confertifolia) were initiated in 1958 and continued in 1959. Individual mature plants of each species were marked for observations on growth and development. Seedlings of shadscale, saltsage (Atriplex nuttallii) and winterfat were also marked to obtain information on rate of growth and mortality. Germination characteristics of each species are being investigated in the laboratory and under field conditions. Root studies and transplant studies are also under way on a number of the native perennial species of the salt-desert shrub type of vegetation. Results will be presented in subsequent reports.

Project E.S. 8. Ecology and Control of Medusa Head.

The return of perennial vegetation in a dense stand of medusa head is encouraging. In the Crane Creek exclosure, constructed in 1952 by the Bureau of Land Management, the perennial vegetation was so sparse that the locations of the perennial plants, excepting Poa secunda, were charted within 100 x 100' grids. In 1955 the exclosure was sampled with 16-line and 4 x 50' belt transects from which basal cover and density of the perennial species were determined. The vegetation was again sampled in 1960. A summary of the data is presented in Table 1.

Table 1. Average Number of Plants per 200 sq. ft.

Species	1955	1960	Diff.	Sign.at 5%
Poa secunda	60.6	56.8	- 3.8	No
Sitanion hystrix	9.5	18.5	+ 9.0	Yes
Other perennials (mostly Agoseris grandiflora)	4.6	55.8	+51.2	Yes

Average Line Interception in Percent on 50-Foot Lines

Species	1955	1960	Diff.	Sign.at 5% Point
Poa secunda	8.8	4.2	- 4.6	Yes
Sitanion hystrix	0.3	1.7	+ 1.4	Yes

The basal area of Poa secunda was reduced during the past five years although the number of plants remained essentially the same. The Poa plants apparently reached their maximum development and deterioration of the plant is taking place. The "old" plants have started to break up with development of dead centers.

The density of the other perennials continue to increase. This is notably true of Sitanion hystrix and Agoseris grandiflora. The increase in number of Agoseris has been phenomenal on one slope with an east aspect. On the average it increased from 9 to 192 plants per 200 square feet.

Several studies of growth development, competition, seed germination characteristics and soil moisture relations of medusa head and associated species were begun but have not progressed far enough to yield results.

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

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

Yield studies were continued on the 2 sites started in 1958. The plan is to obtain long-term yield data from representative sites in each of the major sub-divisions of the sagebrush grass region in Idaho.

Reconnaissance of the Salmon-Lemhi area in east-central Idaho in October, 1959 resulted in the location of a number of areas for future study. Five of these sites were sampled in June, 1960 and a number remain to be done next year.

Emphasis on soil analyses during the year has enabled a large backlog of material to be completed. There is now available a full set of profile descriptions and physical analyses for 65 study sites, plus complete chemical analyses of 27 sites.

Detailed plans were made for studies of the effect of cover manipulation of shrubs on the production and composition of associated vegetation. A site was selected for sagebrush thinning studies, and the plots laid out and both the herbaceous and shrub vegetation sampled prior to cutting. The treatments planned will produce stands of sagebrush ranging from clear cut plots to untreated checks, with 2 or 3 intermediate densities.

Analysis of the vegetational data for all sites was begun according to the ordination approach developed at the University of Wisconsin. This method permits the use of all species in the analysis and aims at positioning sites according to their degree of similarity. Sufficient progress has not yet been made on the analysis to report results.

The use of distance measurement between plants was begun in order to determine the value of this technique for studying sagebrush-grass vegetation. It seems that this method for determining plant density and distribution may be particularly suitable for depleted areas where the numbers of perennial grasses and forbs are often very low. Use of this method to sample the vegetation of 2 exclosures in the Burley-Twin Falls area appeared satisfactory in terms of the actual measurements obtained and time required. Analysis of the data will be made to evaluate the results in quantatative terms.

A joint approach and methods have been developed and used by the Idaho and Oregon workers in their respective contributing projects to Regional Project W-25 under which the ecology of sagebrush ranges has been studied. A manuscript describing this joint approach and methodology has been completed in cooperation with Dr. C. E. Poulton of Oregon State College.

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

Studies of intraspecific variation in Idaho fescue (Festuca idahoensis) and closely associated fescues included notes on nursery material and a small amount of cytological work. Notes were taken throughout the year on growth development and characteristics of the material in the fescue nursery at Moscow. Less detailed observations were recorded for the Stanford, California nursery material by Dr. Nobs of the Carnegie Institution of Washington.

At Moscow, the general pattern was one of active leaf growth during the moist fall of 1959, followed by a high percentage of winter survival. The most severe winter loss (7 percent) was suffered by U. of I. No. 19, a collection from high mountain grassland (7300 feet) at Bull Creek in western Montana. Growth development in 1960 was accelerated by above normal temperatures in early April, with most plants reaching the sheath stage by the middle of that month. Flowering for most collections occurred in early June. Culm production was greater than normally observed in the field, giving most of the plants a "stemmy" appearance. Seed production was heavy in most lots. Vivipary was found in the panicles in 2 plants of F. idahoensis, U. of I. No. 13, from a shallow soil site near Roger's

[illegible] plants were [illegible] of [illegible] the number of [illegible] leaves of rosette plants [illegible] on the [illegible] [illegible] of the [illegible] [illegible] was selected [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] of [illegible] [illegible] of [illegible] [illegible] From close cut plots to uncrowded [illegible], with 2 or 3 intermediate densities.

[illegible] that of the vegetation [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] to [illegible] [illegible] [illegible] at the University of [illegible]. This [illegible] [illegible] the [illegible] of [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of [illegible] [illegible] progress has not yet been made on the analysis to report re-sults.

The [illegible] of [illegible] measurements of [illegible] plants was begun [illegible] to [illegible] the value of this technique for [illegible] [illegible] [illegible] [illegible] vegetation. [illegible] [illegible] that this method [illegible] [illegible] plant density [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of the data will be [illegible] to evaluate the results in quantitative terms.

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of the [illegible] and [illegible] has been [illegible] in cooperation with Dr. C. E. Poulton of Oregon State College.

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

[illegible] of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] (*[illegible]*) [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] were taken [illegible] the same [illegible] [illegible] of the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of the [illegible] [illegible] [illegible] of [illegible].

[illegible] [illegible]

Pass, Montana.

At Stanford there was a much higher rate of vivipary and of mortality than at Moscow. Vivipary was particularly developed in all of the collections from Montana and one from McCall, a cool high elevation station in Idaho. Collections from Oregon showed only a slight degree of vivipary and the single one from California (Susanville) showed none.

Marked variation was evident both among and within the F. idahoensis nursery populations. The characters involved included leaf coarseness, width and color; number, coarseness and erectness of culms; survival percentage; and amount of vivipary. Characters such as the predominance of "blue-green" over "olive green" foliage color and presence of "dwarf" plants in most of the Montana collections showed as clearly as in the previous year. On the other hand, some of the features of the relatively small, fine-leaved collections from dry sagebrush-grass communities (Dubois, Squaw Butte, etc.) were obscurred by the ranker growth and more abundant culm production in the nursery plants.

Cytological work included embedding root tip material collected at Stanford during the spring of 1959. Sections were made of some of this material, but not enough work was done to provide accurate chromosome counts. Preliminary counts indicated that a 2 N number of 28 as reported by California workers probably is common, but it is too soon to assume that this number prevails for all the F. idahoensis material.

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

The study of the harvester ant continued with the collection of data from the three study areas established in 1956. The data for this year bear out the findings reported in the last Annual Report.

The results of the first three years of this study, published in the Journal of Range Management, indicate that: (1) Harvester ants are an important factor on the 2 range types studied (shadscale and Nuttall saltsage). (2) Within the saltsage type, the number and total area of bare areas produced by harvester ants was greater on depleted areas than on those in good range condition. (3) The actual area occupied by these "ant clearings" averaged 3.5 percent on the good condition saltsage range and 5 to 8 percent on poor condition areas within this type.

Project E.S. 22. Beef Cattle Nutrition on Seeded and Native Forage in Idaho.

Project E.S. 26. (Formerly S.R. 38). Evaluation of Range Reseeding.

Due to the close relationship of these two projects and the fact that the same area is used in both studies, the results of studies on these projects are reported together. Project E.S. 22, which formed part of Regional Project W-34, was terminated at the end of the report year due to closing out of the Idaho contributing pro-

Pine, Montana.

All [illegible] of the [illegible] elevation [illegible] from California [illegible] (Janesville) showed none.

Seed variation was noted [illegible] nursery [illegible] [illegible] percentages [illegible] of Bouteloua [illegible] in [illegible] grown [illegible] competition [illegible] the nursery plants.

Cytological work [illegible] during the [illegible] [illegible] nursery plants. [illegible] of 29 as reported by California [illegible] [illegible]

Project MS. 21, Investigations [illegible] on Southern Idaho [illegible].

The study of the [illegible] [illegible] reported in the last Annual Report.

The results of the [illegible] three years of this study [illegible] Journal of Range Management [illegible] [illegible] of [illegible] [illegible] [illegible] percent [illegible] percent [illegible] areas [illegible] than [illegible].

Project MS. 22, [illegible] on [illegible] and Native [illegible] Idaho.

Project [illegible] Evaluation of Range Reseedings.

[illegible]

ject to W-34.

Unfavorable growing conditions during the spring trials of 1959 retarded growth and resulted in over-utilization of all three pastures. Gain per acre was nearly the same for all three pastures during this year.

During the late summer of 1959, all six pastures on the study area were sampled using the same procedure as used during the first year of the study to determine density and frequency of crested wheatgrass. Table 1 compares density of crested wheatgrass in the 1959 sample to the values obtained in 1955.

Table 1. Number of crested wheatgrass plants per square-foot in 1955 and 1959.

	1955	1959	Diff.	% Increase
Spring				
Light Use	1.31	2.33	1.02	77.9
Moderate Use	0.96	2.86	1.90	197.9
Heavy Use	1.01	2.61	1.60	158.4
Fall				
Light Use	1.36	2.67	1.31	96.3
Moderate Use	1.28	3.13	1.85	144.5
Heavy Use	0.97	3.10	2.13	219.6

Preliminary analysis shows the increase of crested wheatgrass plants to be highly significant on all pastures over the first five years. A marked increase in crested wheatgrass plants per square-foot has occurred in all six pastures.

Crested wheatgrass has filled in the open spaces throughout the pastures to give a greater than 90 percent frequency (Table 2.). It is difficult at this point to determine any influence of grazing intensity. A higher frequency in the fall pastures may result from greater seedling survival and establishment.

Table 2. Frequency of occurrence of crested wheatgrass plants per square-foot in 1955 and 1959.

	1955	1959	Diff.	% Increase
Spring				
Light Use	63.6	91.5	27.9	43.8
Moderate Use	57.4	95.0	37.6	65.6
Heavy Use	58.3	92.8	34.5	59.1
Fall				
Light Use	67.9	95.1	27.2	40.0
Moderate Use	66.8	98.6	31.8	47.6
Heavy Use	56.8	98.3	41.5	73.0

[illegible]

[illegible] plants [illegible] 19[illegible] [illegible] growing [illegible] 1959 [illegible] growth not [illegible] were nearly the same for all three pastures during the year.

[illegible]

[illegible] in the 1959 sample [illegible] in 1957.

Table 1. Number of 1954-seeded [illegible] plants per square-foot in 1957 and 1959.

	1957	1959	[illegible]	% Increase
Spring				
Light Use	[illegible]	[illegible]	[illegible]	[illegible]
Moderate Use	[illegible]	[illegible]	[illegible]	[illegible]
Heavy Use	[illegible]	[illegible]	[illegible]	[illegible]
Fall				
Light Use	[illegible]	[illegible]	[illegible]	[illegible]
Moderate Use	1.20	[illegible]	[illegible]	[illegible]
Heavy Use	0.67	3.10	2.15	[illegible]

[illegible] preliminary [illegible] increase [illegible] over [illegible] plants per square-foot [illegible] occurred in all six pastures.

[illegible] seeded [illegible] killed in the [illegible] greater than 50 percent [illegible] different [illegible] greater seedling survival [illegible]

Table 2. Frequency of occurrence of [illegible] plants per square-foot in 1957 and 1959.

	1957	1959	[illegible]	% Increase
Spring				
Light Use	[illegible]	[illegible]	[illegible]	[illegible]
Moderate Use	[illegible]	[illegible]	[illegible]	[illegible]
Heavy Use	[illegible]	[illegible]	[illegible]	[illegible]
Fall				
Light Use	[illegible]	[illegible]	[illegible]	[illegible]
Moderate Use	[illegible]	[illegible]	[illegible]	[illegible]
Heavy Use	[illegible]	[illegible]	[illegible]	[illegible]

Differences in animal production by intensity of use have not shown up at the end of the first five years of this study. Yearly variations in cattle gains may be attributed directly to the amount and development of the crested wheatgrass forage. A statistical analysis of animal production by intensity and season of use has not been done at this early stage of the experiment; however, average daily gains tend to indicate a significant difference between seasons of use.

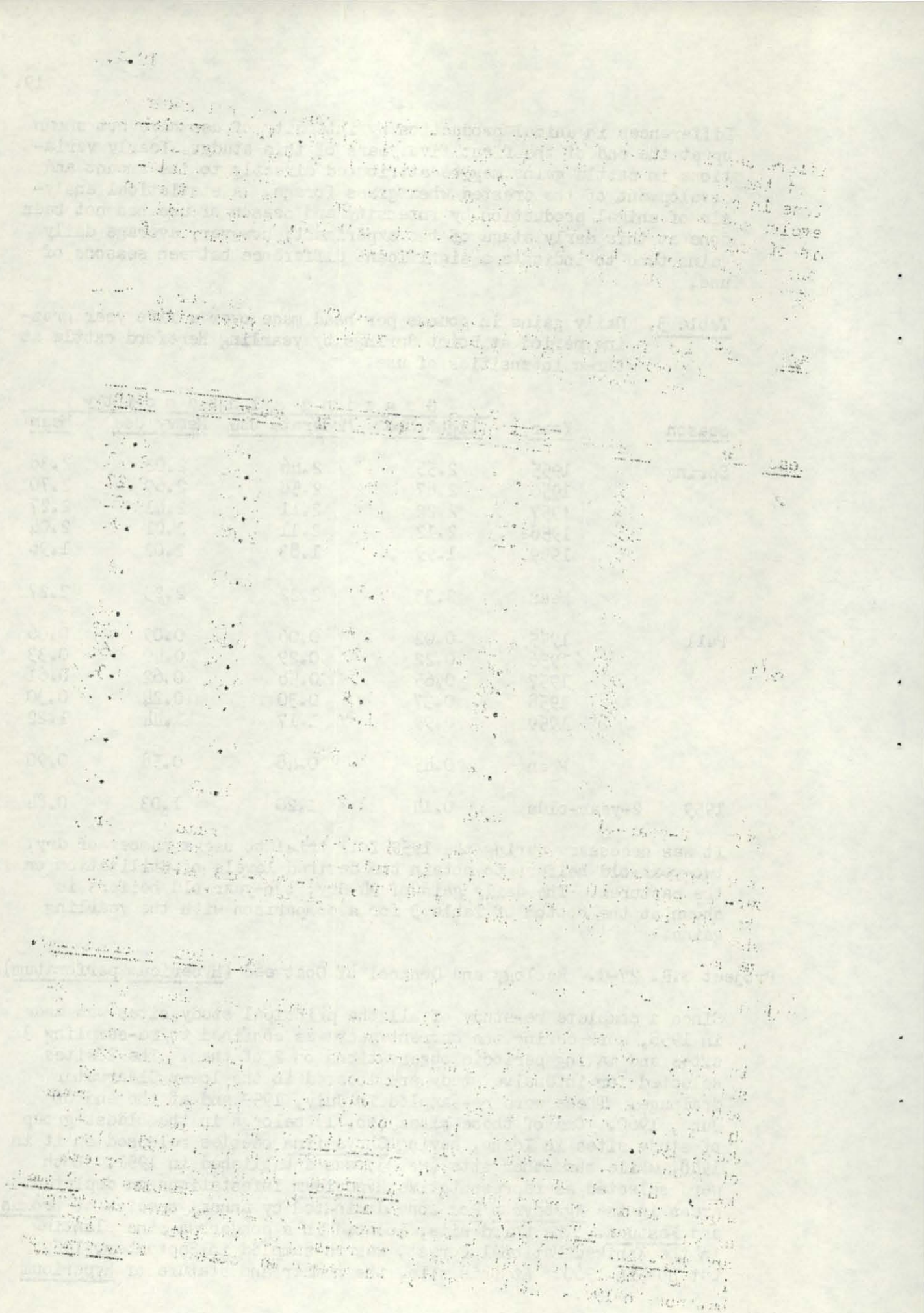
Table 3. Daily gains in pounds per head made over a five year grazing period at Point Springs by yearling Hereford cattle at three intensities of use.

Season	Year	Grazing Intensity			
		Light Use	Moderate Use	Heavy Use	Mean
Spring	1955	2.55	2.46	2.02	2.38
	1956	2.87	2.58	2.69	2.70
	1957	2.22	2.11	2.41	2.27
	1958	2.12	2.11	2.01	2.04
	1959	1.99	1.83	2.02	1.96
	Mean	2.33	2.22	2.23	2.27
Fall	1955	0.02	0.06	0.09	0.06
	1956	0.22	0.29	0.49	0.33
	1957	0.65	0.58	0.62	0.61
	1958	0.37	0.30	0.24	0.30
	1959	0.99	1.17	1.44	1.22
	Mean	0.45	0.48	0.58	0.90
1959	2-year-olds	0.14	1.20	1.03	0.84

It was necessary during the 1959 fall trial to use a number of dry, two-year-old heifers to obtain the desired levels of utilization on the pastures. The daily gain of 94 dry, two-year-old heifers is shown at the bottom of Table 3 for a comparison with the yearling gains.

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

Since a complete re-study of all the principal study sites was made in 1958, work during the current year was confined to re-sampling 3 sites and making periodic observations on 2 of them. The 2 sites selected for intensive study are located in the lower Clearwater drainage. These were re-sampled in July, 1959 and at the end of June, 1960. One of these sites (No. 1) belongs in the oldest group of study sites in Idaho, having Chrysolina beetles released on it in 1948, while the other site (No. 3) was established in 1951. Both were selected as representative Hypericum infestations on depleted areas in the Agropyron/Poa zone dominated by annual species of Bromus and Festuca. The third site, located in a ponderosa pine planting in the Kaniksu National Forest, was re-sampled in September, 1959 but not in 1960. At this site, the number and stature of Hypericum



plants showed a sharp drop due to increased beetle activity.

At both sites 1 and 3 there was a definite increase in beetle activity and a marked decrease in number and stature of Hypericum plants from 1959 to 1960. At the oldest site, for example, the average number of live Hypericum plants per square meter declined from 15.2 to 2.5. In 1959 the plants were relatively vigorous, with little beetle damage evident and many were producing seed. At the same period in 1960 the few live plants remaining had the leaves and upper shoots heavily eaten by Chrysolina beetles, and no seed was being produced. A similar situation was found at the other intensively studied site.

These results indicate that attainment of a dynamic equilibrium between populations of Hypericum and the Chrysolina beetles may be near, but further work is needed to determine the limits within which fluctuations in the populations of each may occur.

[illegible] showed a sharp drop due to increased beetle activity.

[illegible] both sites 2 and 3 there was a definite decrease in [illegible] [illegible] and a marked decrease in number [illegible] of [illegible] from 1958 to 1961. At the wettest site, for example, [illegible] were [illegible] of the Hypericum plants [illegible] from 15% to 2%. In 1959 the plants were relatively vigorous, [illegible] little beetle damage occurred and many were grazed [illegible] each period. In 1960 the relatively [illegible] leaves and upper shoots heavily eaten by Chrysolina [illegible] seed was being produced. A similar situation was found at the other intensively studied site.

These results [illegible] of a dynamic equilibrium [illegible] indicate that [illegible] the [illegible] population [illegible] and the Chrysolina [illegible] but further work is needed to determine the [illegible] fluctuations in the populations of each [illegible].

III. Wildlife and Fisheries Management

A. Projects completed or discontinued during the year:

Project W.U. 33. Postlarval Development and Diet of the Largescale Sucker, Castastomus macrocheilus, Girard.

Field work on this project was completed during the 1958-1959 fiscal year and the results summarized in the report for that year (11th Annual Report). No further experimental work was done during the current year, but a paper covering the results of the project was prepared and published.

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

Field and laboratory work on this project was completed during the previous year and a summary of the results published in the Annual Report for 1958-1959. The Idaho Fish and Game Department, at whose request this research was performed, has a complete report of this project on file.

B. Continuing projects:

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

The field work of this project begun in 1952 except for brood counts during July, 1960, is complete. The final thesis will be ready in the late summer of 1960. The project was planned to provide for a succession of four M.S. graduate students, each taking a phase of the research as well as continuing a common core of effort such as trapping, banding, and certain aspects of productivity. A certain amount of continuity to the several phases has been provided by the Unit Leader. A final report on the entire project will be written following the completion of the fourth thesis.

The 1959 production of sage grouse in the two-county area was down about 19 percent over 1958. Sage grouse are quite vulnerable to unfavorable weather during the hatching period. The peak of the 1959 hatch was between May 24-30. During this period there were cold rains, snow and high winds, all of which contributed to early brood mortality and to delaying the arrival of the chicks into the Camas Meadows and Shotgun Valley by one week. All broods were aged into one week periods by comparing them to known aged captive grouse chicks being raised in Idaho Falls by Dr. J. G. McCue.

In both 1958 and 1959 no ovary contained more than 30 ovulated follicles. In 1959, 2.7 percent had not ovulated, as compared to 1.5 percent in 1958. The average number of ovulated follicles per adult female in 1958 was 20, and for yearlings 10.6; in 1959 the average was 14.6 for adults and 8.6 in yearlings. The small difference in average number of ovulated follicles in yearling females between 1958 and 1959 would indicate that they are stimu-

lated to a lesser level than the adult females and in any one year no matter what the conditions, make only a single nesting attempt.

The most sage grouse observed on any one day on the winter range in the vicinity of Sage Junction (highways U.S. 91 and Idaho 28) was about 1,000 birds. The rough nature of the terrain made it impossible to estimate the total numbers of sage grouse in the area on any one day. Because of late winter snowstorms sage grouse were two to three weeks later in their initial appearance on the Red Road strutting grounds in 1960. Earliest flocks are predominately males, both adult and yearlings. With the predominance of adult males over the subadult males the duration of occupancy of the strutting grounds was at a minimum.

The reduction in surviving yearlings into the spring of 1960 resulted in a change in strutting ground performance heretofore unrecorded. The proportion of adults to yearlings was about 80 to 20 on the strutting grounds. This resulted in abandonment of the strutting grounds two to three weeks earlier than has been previously experienced.

Marked sage grouse showed an interstrutting ground movement as much as 3.3 miles with females more likely to move to other strutting grounds than males.

A count of the males on strutting grounds 10 times during the peak of breeding activity gave little more accuracy on population trends than the standard three time run used by the Idaho Fish and Game Department. The technique of using the high count of males for three times serves as an adequate population trend tool providing all of the grounds within one strutting ground complex are used. Single or isolated strutting grounds are so variable from day to day as to be unreliable in providing population trend data.

Brood count figures upon which to base hunting season recommendations are reliable until about the third week in July. After this time the individual brood structure breaks down and large multiple broods make their appearance with two and often three hens attached.

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

This project has been active during the past year in the work of David Erickson, graduate student not on fellowship. Dr. Hungerford is project leader.

Erickson's thesis project (W.U. 18c) is a study of the movement and dispersal of ruffed grouse on the University Experimental Forest. The trapping of grouse broods and mirror trapping of male grouse has been the main technique used. Birds have been banded and tracked with plastic neckties to facilitate the observation of movements.

Work on the hunter bag check and study of wings and tails from this population was continued.

[illegible] regain a level [illegible] Eagles are in and [illegible] rather than [illegible], make [illegible] always [illegible].

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The data collected confirms much of the earlier work done on Project W.U. 1 and on former phases of W.U. 18. The cover use pattern was somewhat different because of an abnormally wet August and September followed by an unusually mild winter. Marked birds confirmed the general directions of movement which had been worked out earlier.

Hunter returns of marked birds did not contribute as much information as hoped. Twenty-six percent of the marked birds were returned in the hunter bag. This again points to the under harvest of the grouse population in this area of abundant cover.

This phase of the project will be completed with a M.S. thesis, which is in preparation as the year ends.

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

This project was inactive during the year. It has been kept at a maintenance level in recent years with a grouse census of the Flat Creek study area conducted every other year. No census was made in 1959.

Maintenance of the project was attempted to correlate long-time population records with other projects such as W.U. 18 above.

Project W.U. 23. Food Habits and Productivity of White-Tailed Deer.
Project W.U. 38. The Effect of Browsing by Cattle and White-Tailed Deer on a Northern Idaho Forest Range.

The data for these two projects are reported together.

Much of the low elevation forest lands of northern Idaho are grazed during the summer by cattle and through the year by white-tailed deer. These forests have an understory dominated by shrubs. Good forage grasses are scarce. Because of the scarcity of grasses the cattle must utilize browse for the major part of their food supply, leading to a potential conflict with white-tailed deer, which subsist almost entirely on browse.

This study was conducted to determine the browse species receiving dual use by cattle and white-tailed deer; the extent of this use; and its effect on the vigor of the plants. The study was conducted in the Hatter Creek Deer Enclosure, an 800-acre wildlife research area, administered by the Idaho Cooperative Wildlife Research Unit and on University of Idaho Forest lands adjacent to this enclosure. The area outside the enclosure is grazed by cattle from May 15 to October 15, and by white-tailed deer throughout the year.

The composition, summer use, and vigor of the vegetation on the study area was sampled at 50 randomly located sites, 25 outside the enclosure and 25 inside. Vegetational composition was sampled by the line interception method and by canopy coverage estimations. Utilization was sampled by counting all the browsed current annual stems present on a 48 square foot plot and estimating the percentage utilization of each species. Two hundred of these plots were

[illegible]

The data collected [illegible] of the [illegible] were [illegible] and on [illegible] of [illegible]. The [illegible] was [illegible] because of [illegible] and [illegible] of movement which had been [illegible].

[illegible] of [illegible] data [illegible] such as [illegible] grouse populations in this area of [illegible].

This phase of the [illegible] will be [illegible] in production [illegible] the year [illegible].

Project [illegible]: Ruffed Grouse Populations and [illegible].

The project was inactive during the year. [illegible] Creek study area [illegible].

Since none of the project was allocated to [illegible] population response [illegible] other projects [illegible].

Project [illegible]

Project [illegible] on a [illegible] management area.

The data for these two projects are reported [illegible].

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The composition, [illegible], and [illegible] of the vegetation on [illegible] study [illegible] plant [illegible] sampling [illegible] and [illegible] of each [illegible].

used. The vigor of the browse species was determined by measuring the length of a sample of current annual stems.

Browse species utilized by cattle in order of importance were: Symphoricarpos rivularis, Spiraea betulifolia, Physocarpus malvaceus, Rosa spp., Amelanchier alnifolia, Holodiscus discolor, Ceanothus sanguineus and Lonicera utahensis. For white-tailed deer the important summer browse species were: Symphoricarpos rivularis, Ceanothus sanguineus, Rosa spp., Spiraea betulifolia, Physocarpus malvaceus, Vaccinium membranaceum, Amelanchier alnifolia, Philadelphus lewisii, and Holodiscus discolor.

There was significantly heavier use ($p < .05$) in the area used by deer and cattle on Symphoricarpos, Amelanchier, Physocarpus and Holodiscus. This increased use was attributed to the cattle. Ceanothus appeared to be more heavily used in the area grazed only by white-tailed deer, but the difference was not significant at the 95 percent level. Two browse species, Physocarpus and Holodiscus, were apparently much more palatable to cattle than to white-tailed deer. No significant difference ($p < .05$) was found between the mean stem lengths of the browse species in the two areas; indicating that for this one year there was no decline in the vigor of these species from dual use by cattle and deer. It was concluded that although the cattle were using many of the browse species also used by white-tailed deer, this use had not decreased the food supply of the deer to the point where they were unable to survive a normal winter.

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

The field work of the last segment of this study was completed in the spring of 1960.

Movements of elk during the early spring followed closely the pattern in other years. The advent of spring vegetation has a greater effect on elk movements than does the presence of artificial salt during this time of the year. Even during the late spring elk were more abundant on the areas supporting mostly grasses and sedges.

The western third of the study area, on top of Coolwater Ridge, is used by cattle during the summer. Elk occupy the entire top of the Coolwater Ridge and Round Top Mountain until cattle are trucked in for the summer. A definite dispersion of elk takes place as cattle spread out along the top of the Coolwater Ridge, and throughout the summer most of the elk remain at elevations less than 5,000 feet. In other portions of the study area not used by cattle, elk occupy many of the highest mountain meadows.

Elk concentrations on artificial salt grounds reached a peak during the third week in June. Salt grounds within the areas supporting greater amounts of herbaceous succulence were used more heavily than in the areas predominately shrubs.

The use of two of the largest natural licks is illustrated in Table 1. The numbers of elk utilizing these licks are conservative fig-

ures, but are of sufficient magnitude to be indicative of the use being given to some 22 natural licks in the lower Selway-Lochsa area.

Table 1. Numbers of elk observed at Stuart Hot Springs and Ballinger Natural Licks, spring and summer, 1959.

Date	Stuart Hot Springs	Ballinger
	Number of Elk	
April 3	3	0
April 14	13	0
April 20	27	0
April 29	68	0
May 11	126	6
May 23	141	77
May 30	157	77
June 3	150	76
June 16	87	60
June 28	65	26
July 13	52	59
July 25	13	43
August 19	13	13

The pattern of use on 16 natural licks from June 3 to August 28, 1959, is illustrated in Table 2.

Table 2. Total numbers of elk observed at natural licks in the Selway and Lochsa River drainages, June-August, 1959.

Date	Number of Elk
June 3	707
June 28	630
July 13	410
July 25	233
August 5	56
August 19	80
August 28	23

The water in sixteen natural licks was analyzed by the U.S. Salinity Laboratory, Riverside, California. Sodium, calcium, magnesium, potassium, boron, chlorine and fluorine were determined. Sodium varied from 18 to 91 p.p.m. while all other elements were in very much smaller concentrations. The only element which appeared in abnormal amounts in four of the licks was fluorine (6.08 to 6.46 p.p.m.). Although fluorine is a cumulative poison in animals, it is questionable that there is a deleterious effect upon the health of the elk because of the relatively short period of use of these natural licks. Most licks receiving intense use by elk have sodium concentrations from ten to ninety-six times as much as calcium, magnesium, potassium, chlorine or fluorine.

Elk ingest considerable quantities of soil at the artificial licks where craters two to four feet deep are made. Evidence of actual use of the soil at any of the natural licks is meager, however.

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

During the summer of 1959, the limnology of the four streams selected for this project was investigated four separate times. In addition, samples of fish were taken for age and growth studies. The stations selected for sampling and the techniques used are similar to those which were utilized in previous years. The laboratory analysis and tabulation of data collected has now been completed and filed for future inclusion in a final report pending the completion of logging operations.

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

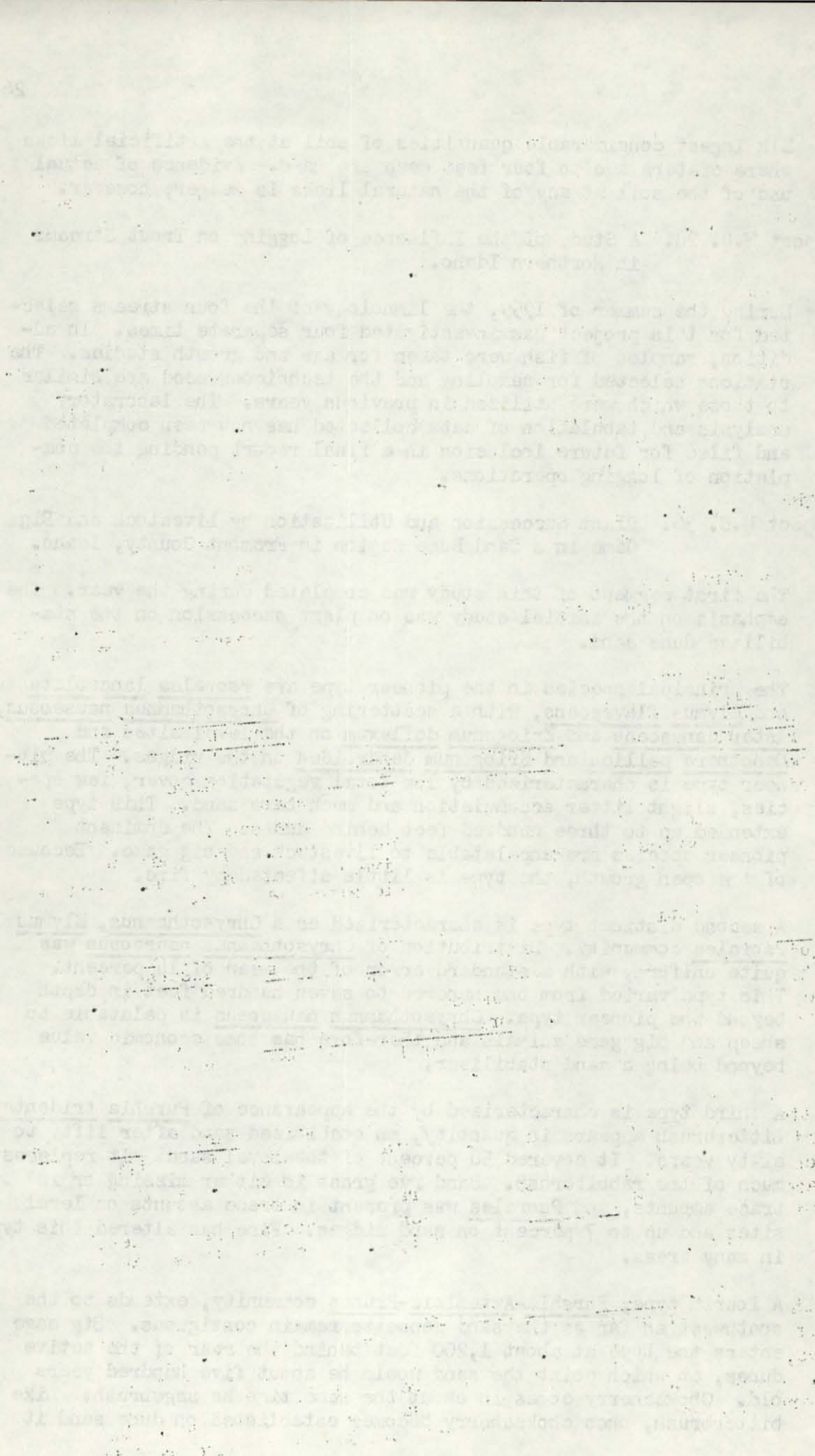
The first segment of this study was completed during the year. The emphasis on the initial study was on plant succession on the stabilized dune sand.

The principal species in the pioneer type are Psoralea lanceolata and Elymus flavescens, with a scattering of Chrysothamnus nauseosus, Aster canescens and Eriogonum deflexum on the level sites and Oenothera pallida and Eriogonum dendroides on the ridges. The pioneer type is characterized by low total vegetation cover, few species, slight litter accumulation and much bare sand. This type extended up to three hundred feet behind dunes. The dominant pioneer species are unpalatable to livestock and big game. Because of the open growth, the type is little affected by fire.

A second distinct type is characterized as a Chrysothamnus, Elymus Psoralea community. Distribution of Chrysothamnus nauseosus was quite uniform, with a standard error of the mean of 14 percent. This type varied from one hundred to seven hundred feet in depth beyond the pioneer type. Chrysothamnus nauseosus is palatable to sheep and big game animals and therefore has some economic value beyond being a sand stabilizer.

A third type is characterized by the appearance of Purshia tridentata. Bitterbrush appears in quantity, on stabilized sand after fifty to sixty years. It covered 58 percent of the level sand. It replaces much of the rabbitbrush. Sand rye grass is either missing or in trace amounts, and Psoralea was present in trace amounts on level sites and up to 7 percent on sand ridges. Fire has altered this type in many areas.

A fourth type, Purshia-Artemisia-Prunus community, extends to the southwest as far as the sand deposits remain contiguous. Big sage enters the type at about 1,200 feet behind the rear of the active dunes, at which point the sand would be about five hundred years old. Chokecherry comes in about the same time as sagebrush. Like bitterbrush, once chokecherry becomes established on dune sand it



remains indefinitely unless disturbed. By seven hundred years very little sagebrush remains on deep sand, and the vegetation is dominantly bitterbrush and chokecherry. Since sagebrush is lacking, almost without exception, on sand over a thousand years old, its disappearance on old sand seems to be a part of the natural succession rather than having been caused by disturbance. The grasses and forbs, particularly balsam root, are valuable sheep forage.

The Purshia-Prunus type is extensive and valuable for both sheep and big game. Bitterbrush coverage varied from 43 to 67 percent and plants on the older sand are much spread out by layering. Grass occupies the space between bitterbrush plants.

Two types, the Purshia-Bunchgrass community and the Old Field Bunchgrass community, consist largely of needlegrass (Stipa comata), Idaho fescue (Festuca idahoensis) and bluebunch wheatgrass (Agropyron spicatum). By far the most dominant species was needlegrass.

Total unavailable, and available moisture below a depth of one foot was compared in sand and native soil during the dry part of the summer. Results showed there was no available water present in any of the native soil samples, even though moisture was higher than in sand. Total moisture was low in sand, but the level of unavailability was even lower, and some water was available to plants in every one of the samples tested. This probably explains the greater vegetational growth, and the presence of chokecherry and dense bitterbrush, on stabilized sand as compared to adjacent native soil.

Project W.U. 40. Characteristics and Structure of Early and Late Spawning Runs of Chum Salmon, Oncorhynchus keta (Walbaum), in Streams of Prince William Sound, Alaska.

The commercial fishery in Prince William Sound is primarily dependent upon pink salmon, Oncorhynchus gorbuschua (Walbaum), and to a lesser degree, chum salmon, Oncorhynchus keta. During the course of pink salmon studies in this area both the Bureau of Commercial Fisheries and the Fisheries Research Institute of the University of Washington have observed and recorded the distribution and timing of some chum salmon spawning runs, but this information is far from complete. A limited program of sampling the commercial catch for size and age composition was accomplished by the Bureau of Commercial Fisheries in 1958. Three age classes were established by this study and intra-seasonal variations in the occurrence of these age classes were found to exist.

In order that a commercial fishery for chum salmon may be regulated properly, more of the life history of this species in Prince William must be known.

During 1959 the commercial fishery for pink salmon and chum salmon in Prince William Sound was closed. This closure provided an opportunity to accomplish a sampling study with the entire run of chum salmon on the spawning grounds.

Each stream was visited at approximately ten-day intervals. At

each visit observations were made regarding the relative magnitude of the run, proportionate use of the intertidal area, stage of spawning, and sex ratios on riffles. Length and scale samples were collected from dead fish only.

Early and late streams at the head of Sheep Bay (FWS Nos. 11 and 12) were selected for intensive study which included the acquirement of data on fecundity, order of occupancy and duration of life in fresh water by means of tagging in the estuaries, temperatures, stream level fluctuation, pH, and stream bed classification.

The conclusions attained from this study have been extracted from a Master's thesis and are presented herewith:

1. Bimodality in the occurrence of spawners took place in four early run streams. The second run corresponded with the time of entry in late run streams.

2. Bimodality in the occurrence of spawners took place in three clear streams at the head of Port Fidalgo. The other streams at the head of Port Fidalgo contained glacial silt and high water until the first part of September when their volume of flow were much reduced and their waters cleared. Chum salmon did not enter these streams in appreciable numbers until this change of volume and turbidity took place.

3. Sex ratios determined throughout the season by riffle counts indicated a preponderance of males. Sex ratios within age classes were also unequal. Males were predominate in Age Class III while an excess of females over males occurred in Age Classes IV and V.

4. The percentage age class composition on comparable occasions varied between streams.

5. Intraseasonal variation in age classes was found to occur. Generally, older fish were more abundant in the early runs while younger fish became increasingly numerous in the later runs.

6. The length frequency distribution for males exhibited positive skewness while that for females was negatively skewed, i.e. the mode of the males occurred at a shorter length than that of the females.

7. Mean length for males and females within age classes varied between streams.

8. Intraseasonal variation in mean length for males and females within age classes was found to occur.

9. An analysis of variance of circuli counts between the focus and the first annulus resulted in mean squares for streams and age classes that were highly significant.

10. An analysis of variance of the distance between the focus and

the first annulus resulted in the mean square for age classes being highly significant.

11. Tagging studies indicated that the length of life of adult male chum salmon after their entry into a spawning stream (Sheep Bay 12) is approximately two weeks.

12. The fecundity samples were subject to a known bias in time of sampling.

This study was made possible by the United States Fish and Wildlife Service, Bureau of Commercial Fisheries, in conjunction with the Gulf of Alaska Salmon Investigations and was undertaken as part of a broader research program--Chum Salmon Studies in Prince William Sound. This program was under the immediate supervision of Mr. F. V. Thorsteinson, Supervisory Fishery Research Biologist.

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

Up until the recent increase in air traffic, the Middle Fork of the Salmon River has been comparatively inaccessible to the sportsman and the trout population has been virtually untouched. Each year there has been an increase in the number of commercial boat trips down the river and a corresponding increase in fishing pressure. The investigator was hired by the Idaho Department of Fish and Game to study the trout population in the Middle Fork of the Salmon River while it was still in a natural and virtually undepleted state. The information from this study should be of great help in managing the Middle Fork trout fishery in the future, as well as providing fundamental information on the life history, especially migration, of cutthroat trout.

The principal objectives of the study are as follows:

1. To determine the mortality factors acting upon the trout populations and the relative importance of each.

2. To determine the present distribution, migration pattern, and spawning areas of the cutthroat trout population.

3. To determine the age and rate of growth of the trout harvested from the river.

4. To obtain some measure of the harvest and fishing pressure.

The investigator pursued an extensive tagging program during the summer months of 1959 in which 669 cutthroat trout were tagged and released as well as 205 rainbow and 231 dolly varden trout. Lengths and weights were taken on most fish tagged and numerous scale samples were procured for later analysis.

A voluntary creel census, which was established on the Middle Fork of the Salmon River, was undertaken in cooperation with resorts and commercial boat operators. The investigator will continue field work in the project area in February, 1960.

Thanks are due the Idaho Department of Fish and Game for their cooperation in permitting the material collected on this study to be utilized in a Master's thesis.

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

Although many limnological and fishery surveys have been made, very little work has been done on backwater areas transitional between lakes and rivers. Studies of such backwater areas could produce information concerning successional sequence of fish species and food organisms from a lake to a river environment.

The lower St. Joe River provides an excellent area for this type of limnological study. Since the construction of Post Falls Dam, the water level in Lake Coeur d'Alene was raised, producing a backwater area in the lower St. Joe River.

Physical, chemical and biological measurements were taken in early spring, 1960, and are continuing throughout the year. Changes in relative abundance of fish species are being determined by gill netting. For sampling purposes, nine stations have been selected along the backwater. These stations begin at the outlet of Coeur d'Alene Lake and terminate about thirty miles upstream where the fast water of the St. Joe River enters the backwater.

The results of this study should be valuable for establishing fish management programs on this and similar areas. The objectives of this project are as follows:

1. To determine physical and chemical characteristics of the backwater.

2. To ascertain the general productivity of the backwater with special reference to fish-food organisms.

3. To determine the successional sequence and relative abundance of fish species and food organisms from a lake to a river environment.

SUMMARY OF F. W. R. EXPERIMENT STATION PROJECTS 1959-1960

No.	Title	Started	Present Status	Personnel
	I. FOREST MANAGEMENT			
E.S. 1	Wood Preservation Service Tests	1946	Cont. Inactive	Howe, Burlison
E.S. 2	White Pine Blister Rust	1940	Cont. Active	Slipp
E.S. 3	White Pine Stem Anatomy	1953	Cont. Inactive	Johnson
E.S. 6	Idaho Tree Diseases	1950	Cont. Active	Partridge, Johnson
E.S. 19	Christmas Tree Test Plantings	1953	Cont. Active	Pitkin
E.S. 20	Mortality of Young White Pine	1948	Cont. Active	Johnson
E.S. 21	Study of Idaho Small Tree Farms	1956	Completed	Deters, Seale, Williams
E.S. 23 (WM 42)	Market Structure & Marketing Practices	1956	Cont. Active	Seale, Williams
E.S. 24	Forest Tree Breeding in Idaho	1957	Cont. Active	Inman
E.S. 26	Identification of Coniferous Seedlings	1958	Completed	Olson
E.S. 27	Nutrients in White Pine Site Quality	1958	Cont. Active	Loewenstein
E.S. 28	Nursery Soil Fertility	1958	Cont. Active	Loewenstein, Pitkin
E.S. 29	Engelmann Spruce Weevil	1958	Cont. Active	Clark, Williamson
S.R. 11-C	Forest Tree Physiology	1951	Cont. Active	Johnson
S.R. 24	Slash Disposal	1949	Cont. Active	Olson
S.R. 54	Forest Site Influences on Wood Properties of Inland Douglas-Fir	1957	Cont. Active	Howe
S.R. 55	Cone and Seed Insects	1957	Cont. Active	Clark, Williamson
S.R. 63	Lodgepole-Jackpine Hybrids	1958	Cont. Active	Pitkin
S.R. 65	Fertilizing of Forest Stands	1958	Cont. Active	Loewenstein, Pitkin
S.R. 66	Seedling Fertilization	1958	Cont. Active	Pitkin, Loewenstein
S.R. 70	Seedling Growth & Survival	1960	New	Loewenstein, Pitkin
	II. RANGE MANAGEMENT			
E.S. 7	Evaluation of Salt-Desert Ranges	1951	Cont. Active	Sharp, Windle
E.S. 8 (S.R. 27-D)	Ecology & Control of Medusa Head	1950	Cont. Active	Hironaka, Tisdale, Heller
E.S. 9 (R-287)	Ecology of Sagebrush Ranges	1949	Cont. Active	Hironaka, Tisdale
E.S. 10	Ecology of Douglas-Fir Zone in Interior British Columbia	1946	Discontinued	Tisdale
E.S. 13	Ecotypic Variation in Range Plants	1956	Cont. Active	Tisdale
E.S. 14	Harvester Ants on Idaho Ranges	1956	Cont. Active	Sharp
E.S. 15	Halogeton on Idaho Ranges	1950	Cont. Active	Sharp, Windle
E.S. 22 (R-296)	Range Forage Nutrition	1955	Cont. Active	Sharp, Helle
E.S. 26	(Formerly SR-38) Evaluation of Range Reseeding	1952	Cont. Active	Sharp
E.S. 27-C	Study of Goatweed (Hypericum)	1951	Cont. Active	Tisdale

No.	Title	Started	Present Status	Personnel
	III. WILDLIFE AND FISHERIES MANAGEMENT			
W.U. 15	Study of Sage Grouse	1952	Cont. Active	Dalke, Schlatterer
W.U. 18	Productivity of Ruffed Grouse	1952	Cont. Active	Hungerford
W.U. 19	Ruffed Grouse Population Study	1951	Cont. Inactive	Hungerford
W.U. 23	Food Habits & Productivity of White-Tailed Deer	1952	Cont. Active	Hungerford
W.U. 26	Salt in Elk Management, Selway Area	1955	Cont. Active	Dalke, Williams
W.U. 28	Influence of Logging on Trout Streams in Northern Idaho	1955	Cont. Active	MacPhee
W.U. 33	Postlarval Development & Diet of Largescale Sucker	1957	Completed	MacPhee
W.U. 34	Bear Lake Fisheries Investigation	1957	Completed	MacPhee
W.U. 36	Plant Succession & Utilization by Livestock and Big Game, Fremont County	1958	Completed	Dalke, Chadwick Hungerford,
W.U. 38	Browsing Competition Between Cattle & White-Tailed Deer	1958	Completed	Thilenius
W.U. 40	Characteristics & Structure of Chum Salmon Spawning Runs	1959	Completed	Helle
W.U. 42	Life History of Salmon River Cutthroat Trout	1959	New	MacPhee, Mallet
W.U. 43	Limnological Survey of Backwater of Lower St. Joe River	1960	New	MacPhee, Davis

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I. Technical Publications

Frazier, G. D. Small non-industrial forest owners in northern Idaho. Idaho Agric. Exp. Sta. Bull. No. 317. March 1960. 31 pp.

Jones, R. E. Activities of the magpie during the breeding period in southern Idaho. Northwest Science 34(1):18-25. Feb. 1960.

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McLean, A. and E. W. Tisdale. Chemical compositions of native forage plants in British Columbia in relation to grazing practices. Canada Jour. Plant Science 40:405-423. April, 1960.

Olson, D. S. Identification of coniferous seedlings in the northern Rocky Mountains. FWR Sta. Research Note #15, Aug. 1959. 4 pp.

Olson, D. S. and Dale Arnold. Skidding entire cedar trees to a landing for pole making as a means of reducing the fire hazard. FWR Sta. Research Note #16, August 1959. 7 pp.

Robel, R. J. Determining elk movements through periodic aerial counts. Jour. Wildlife Mgt. 24(1):103-105. January, 1960.

Sharp, L. A. and W. F. Barr. Preliminary investigations of harvester ants on southern Idaho rangelands. Jour. Range Mgt. 13(3): 131-135. May, 1960.

II. Graduate Theses (M.S. June, 1960)

Chadwick, H. W. Plant succession and big game winter movements and feeding habits in a sand dune area in Fremont County, Idaho.

Crawford, J. E. The movements, productivity and management of sage grouse in Clark and Fremont Counties, Idaho.

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

Helle, Joseph. Results of a five-year grazing study on a crested wheatgrass seeding in southern Idaho.

Martinsen, C. F. The effects of summer utilization of bitterbrush in north-central Washington.

Thilenius, J. F. Forage utilization by cattle and white-tailed deer on a northern Idaho forest range.

Tipple, N. E. Contributions of log sorting and production program-

ming to lumber marketing.

Windle, L. C. An investigation of the ecology of six perennial native species of the salt-desert shrub type in southern Idaho.

III. Miscellaneous Publications

Robel, R. J. Selway elk migrations. Idaho Wildlife Review 12(2): 3-4. 1959.

Tisdale, E. W. Book Review of "Grass Productivity" by Andre Voisin. Northwest Science 34(1):39-40. February 1960.

Wohletz, Ernest. Understanding of problems of forest conservation. (Panel Chairman and speaker). Proceedings 50th Western Forestry Conference, Spokane, Wash. September 1959. pp. 36-57.

APPENDIX A. F. W. R. EXPERIMENT STATION STAFF 1959-1960

I. Regular Staff Members

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

II. Research Fellows

H. W. Chadwick--Wildlife Management
S. P. Davis--Fishery Management
E. E. Farmer--Forest Management
Joseph Helle--Range Management
T. H. Heller--Range Management
J. L. Mallet--Fishery Management
Edward Schlatterer--Wildlife Management
J. F. Thilenius--Wildlife Management
N. E. Tipple--Wood Utilization
Thomas Williams--Wildlife Management
D. L. Williamson--Forest Entomology
L. C. Windle--Range Management

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT 1959-1960

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 Funds. Projects S.R. 11-C, 24, 27-C, 27-D, 54, 55, 63, 65 and 70.

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 and a special grant for Project S.R. 54 (Forest Site Influences on Wood Properties of Inland Douglas-Fir).

6. United States Bureau of Land Management. Funds for Project E.S. 15 (Halogeton), plus facilities and manpower for Point Springs Grazing Study, and E.S. 8 (Ecology and Control of Medusa Head.).

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

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

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

10. United States Department of Agriculture. Funds from Regional Research Projects WM-42, W-25 and W-34.*

11. Wildlife Management Institute. Funds for wildlife research.

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