FOREST, WILDLIFE AND RANGE EXPERIMENT STATION

COLLEGE OF FORESTRY

UNIVERSITY OF IDAHO

Moscow, Idaho

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

For the Fiscal Year 1962-1963

Ernest Wohletz, Director E. W. Tisdale, Associate Director

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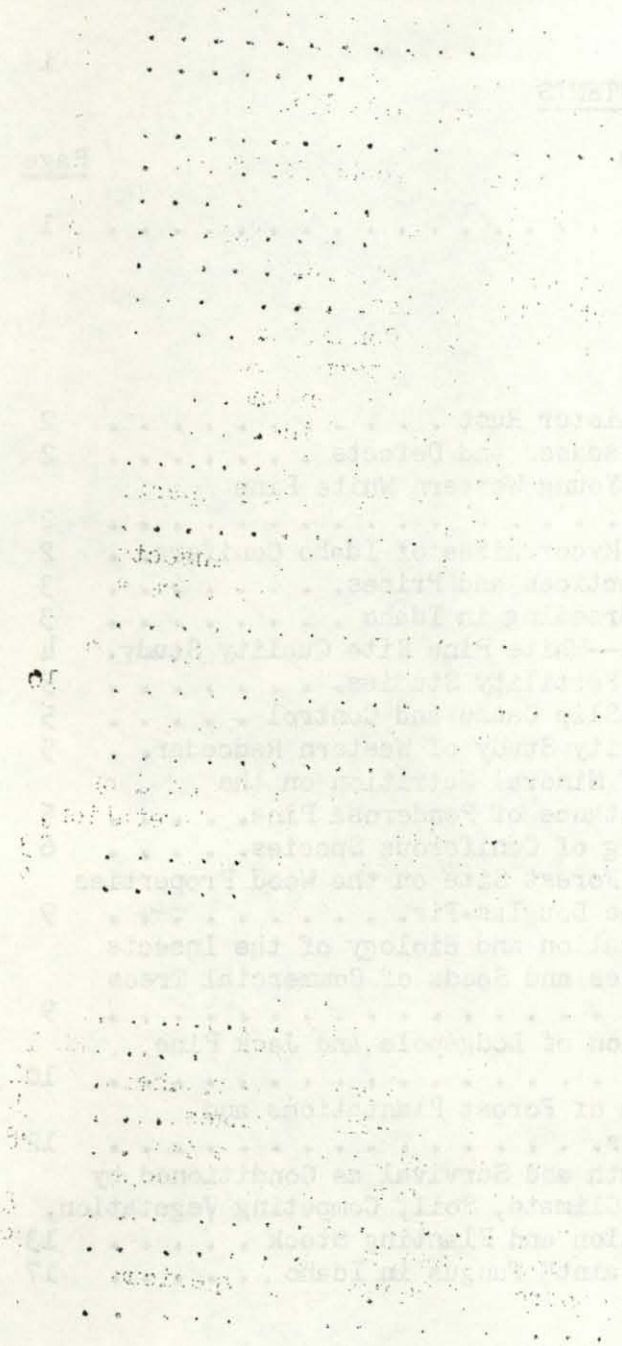

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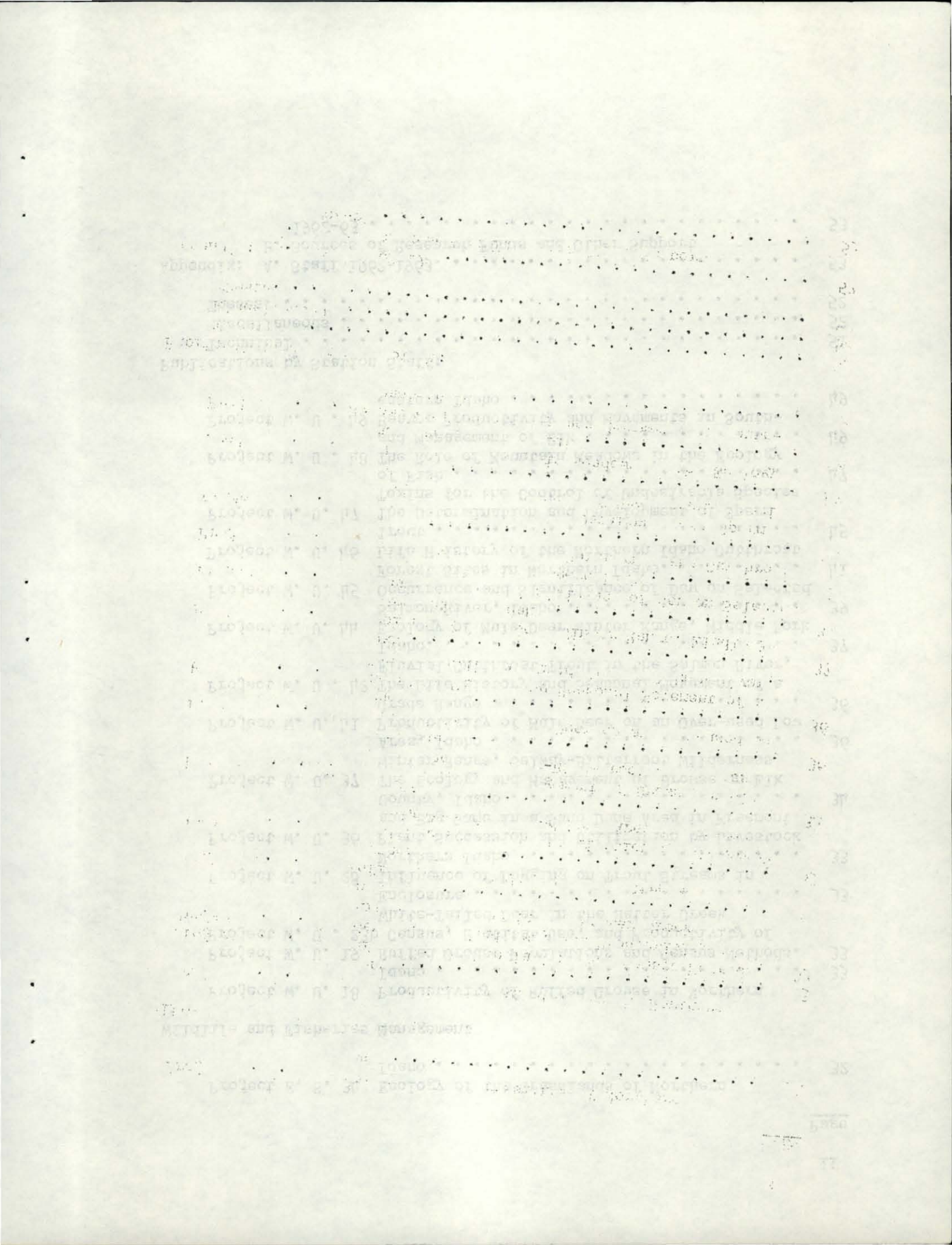


INTRODUCTION

The research program continued to develop well, with 41 projects active during the year. Four of these were new investigations, while 6 projects were completed.

The Station Staff was increased to 19 during the year by the temporary appointment of Mr. James Howland to fill the vacancy in Forest Recreation. A permanent replacement for this position has since been obtained.

Fourteen Research Fellows were on appointment during the year. Eight completed their work and received degrees in June, 1963.

Support for research in the form of funds, facilities and other assistance was received from many sources. A list of contributors is presented in Appendix B of this report. No new major source of support developed during the year, but federal legislation recently passed may provide funds in 1963-64 for projects under the McIntire-Stinnis Cooperative Forestry Research Bill, and for support of a Fisheries Research Unit comparable to the present Cooperative Wildlife Research Unit.

Eleven technical publications, eight theses and 3 miscellaneous items were published during the year.

Ernest Wohletz

Ernest Wohletz, Director

E. W. Tisdale

E. W. Tisdale, Associate Director

I. Forest Management and Utilization

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

Records are being compared as they are found and sorted, but work has proceeded slowly because of the complex mass of data and lack of adequately trained help. No new findings are reported.

Project E.S. 6. Idaho Tree Diseases and Defects.

Seven new records of diseases and defect were noted. These include Fomes laricis on cedar, Daldinia concentrica on Ailanthus altissima, Polyporus montanus on western white pine, Poria obliqua on alder and birch, Valsa abietis on subalpine fir, and a specimen of Polyporus elisii. A manuscript, describing these, is being prepared.

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

This project is on a maintenance basis until field plot data are more complete. No plot examinations were made during the 1962 season.

Project E.S. 20a. The Study of Mycorrhizae of Idaho Conifers.

Species emphasis was changed from western white pine to lodgepole pine. The three principal reasons for this change are:

1. Trials with lodgepole pine, made this year, indicated that good germination, growth and mycorrhizal syntheses were possible with this species.
2. There are two distinct morphological types of lodgepole pine in Idaho. These occur on distinctly dissimilar habitats and are geographically widely separated, thus the exploration of ecotypic and genotypic variation both with mycorrhizal fungi and the trees is enhanced.
3. Extensive collections of higher fungi have been made by University of Idaho and University of Michigan mycologists in the proposed study areas. Access to this information will be a great aid since many new or unrecorded species of fungi occur in Idaho. Furthermore, some of these are Boletes of an interesting species complex involving Suillus americanus/sibericus/kaniksuensis--the former an undescribed species.

Trials were made with lodgepole pine from two seed sources: Heaven's Gate on the Nez Perce and Stanley Lake on the Challis National Forests. Three species of lodgepole-associated Boletes formed typical corralloid ectotrophic mycorrhizae: Suillus sibericus, S. brevipes and S. granulatus.

Continuation of work on western white pine revealed limited mycorrhizal formation on 2½ year seedlings in a vermiculite medium. These seedlings were about three inches high, badly malformed but of healthy color. Inoculation was by the agar block method after seedling establishment. The fungus involved was Suillus subluteus, our most consistent performer with white pine. Some mycorrhizal development took place, presumably early, but it was confined to the upper ½ inch along the main root axis. There was no development below this point, although there was a total of several feet of roots coiled around the bottom of the flask. This seems to indicate one of two things: either a favorable moisture/air balance was achieved only at this level or the fungi could not grow satisfactorily in this medium. Previous tests show that the latter is not the case, thus the problem of aeration appears to again be the culprit. This confirms to some degree suspicions expressed several years ago when a change was made from vermiculite to sponge-rock. A new material, acrylic plastic beads, is an excellent rooting observation medium for young Douglas-fir seedlings[1]; this will be tried, if possible, next year.

1. Bloomberg, W. J. 1963. A translucent rooting medium for the observation of Douglas-fir seedling roots. Plant Disease Reporter 47:455-58.

Project E.S. 23. Marketing Practices and Prices.

This project terminated at the close of this fiscal year. A manuscript entitled "The Northern Idaho Sawmilling Industry" has been prepared for publication in 1963.

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

The forest genetics and tree improvement program of the University of Idaho is conducted in cooperation with private wood-using industries and federal and state forestry agencies, viz.: Southern Idaho Forestry Association, Idaho State Forestry Department, U.S. Bureau of Land Management, and U. S. Forest Service.

Controlled pollinations and selfings were made this year between individual trees of characteristic tree forms. Progenies of selected trees raised in 1961 were ready for field testing (2-0). They were outplanted in two experimental plantations: (1) an 8-replicate plantation at the University Forest (Meadow Creek, Plantation #63-2), and (2) a similar but larger 8-replicate plantation at Heyburn Park (Plantation #63-3). The #63-3 plantation was made through the cooperation of the Idaho State Forestry Department. (SR #77)

To broaden the basis of selection for tree improvement purposes, 57 additional stands of phenotypically desirable trees were located. Seeds from the 10 best trees from each stand were collected by cooperators. The cones were kiln dried by Mr. George Crookham and seeds were extracted and measured at the University and raised at the Lucky Peak Nursery of the U.S. Forest Service.

The University received from Dr. J. W. Wright of Michigan State University, a set of ponderosa pine seedlings raised from Callahan's seed collection, and also a complete set of Schoenike's collection of jack pine seeds (University of Minnesota, 90 sources). The understanding of geographic variation and population structure of a tree species is fundamental to forest genetics and tree improvement studies. The Michigan seedlings (45 sources) together with a number of other accumulated sources formed the 157 seed source ponderosa pine provenance study (Hoyburn Park, Experimental Plantation #63-1). The jack pine seeds were raised by Dr. Duffield of Nisquallis Forest Nursery. They are valuable materials for ecotypic study and interspecific crosses.

Forest genetics research at the University includes two problems studied by Ph. D. candidates in residence: (1) A study on the variation of juvenile foliage characters of jack pine (Pinus banksiana), by Donald Copes, a National Defense Fellow, and (2) Genetic variation of tracheid characters of Western red cedar (Thuja plicata) by James Crooks. The red cedar study is supported by a U. S. Forest Service grant.

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

This project received little attention during the year, largely because a lack of adequate greenhouse facilities precluded more than preliminary work on studies concerning nutrient requirements of the species and short term nutrient uptake by seedlings planted on soils from sites supporting stands of various site indexes. With the completion of the new forestry greenhouse, work should be accelerated during the coming fiscal year.

In October, 1962, foliage was sampled from white pine growing on an area of high site index (Lacey Creek) and one nearby which had a lower potential (Charlie Creek). The trees sampled were as much as 135 feet in height, and the foliage was collected by shooting down branches from the upper crown. Analysis revealed very little difference in nutrient content of needles from the two sites. Nitrogen percentage was 1.32 at Lacey Creek, phosphorus, 0.16 and potassium, 0.66. At Charlie Creek the percentages were 1.27, 0.14, and 0.66. It appears that some factor other than content of these three major elements was responsible for growth differences on these sites.

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

This project was inactive during the fiscal year 1962-63.

Project E.S. 33. Robinia Root Slip Cause and Control.

Fusarium sp., plus rough handling, predispose seedlings to this root decay. Crushed or bruised roots deteriorate in less than one month of storage. Washing prior to storage, maintenance of a high pH, and/or phytoactin dips relieve some losses. A manuscript describing recent findings is being prepared.

Project E. S. 35. A Growth-Quality Study of Western Redcedar.

During the fiscal year 1962-63 the cooperative U.S. Forest Service, University of Idaho, Western Red Cedar Study progressed as follows:

1. A subject for the thesis research was chosen and a work plan, entitled, "Natural Variation in Tangential Tracheid Diameter in Inland Western Red cedar (Thuja plicata, D. Donn.)" was prepared.

2. In the field 15 experimental plots were established and 10 invrement cores (11 mm in diam.) were obtained per plot.

3. The age of each tree was determined in the laboratory.

4. Presently, each core is being measured in the laboratory for number of cells in a tangential row 0.5 mm long and for ring width. Forty-five ages common to all cores are being measured. The laboratory work was approximately one-third completed by the end of the fiscal year.

5. Plans were made to have the data processed by the Statistical Services Center, University of Idaho. An analysis of covoriance will be used.

Project E. S. 36. The Effect of Mineral Nutrition on the Drought Resistance of Ponderosa Pine.

Work on the ponderosa pine seedling drought resistance project included a greenhouse experiment and the establishment of field study plots.

In the greenhouse ponderosa pine seedlings were transplanted to weighed pots of white silica sand. The pots of seedlings were then

divided into four treatments which were subirrigated with a nutrient solution in metal pans holding eight pots each, and four treatments in which the nutrient solution was applied to the upper surface of the sand. The latter treatments contained two pots each.

Treatments in the pans included a control which was supplied with 100 ppm nitrogen and 78 ppm potassium, a high nitrogen treatment with 350 ppm nitrogen, a high potassium treatment with 313 ppm potassium and a triple control treatment in which the entire nutrient solution was three times as concentrated as the control.

Treatments which were irrigated from the surface included a high nitrogen with 460 ppm nitrogen, low nitrogen with 35 ppm nitrogen, high potassium with 450 ppm potassium, and low potassium with 20 ppm potassium.

Chlorophyll stability analysis indicated that there may be some difference in the drought resistance of the seedlings grown on different levels of nutrients, but the results have not been analyzed statistically as yet.

Field plots were established on a clearcut lodgepole pine site near Island Park, Idaho. Fifteen treatments were replicated four times. Two of the replicates consisted of 40 seed spot plantings of ponderosa pine seed and two contained 20 transplanted ponderosa pine seedlings.

The treatments included combinations of three levels of nitrogen, phosphorus, and potassium fertilization. Sertilizer was applied to the soil surface in the spring.

A severe frost during the last part of June caused high mortality in the seedlings which were just emerging from the planted seed. Two-year survival on these plots will be measured, and foliage will be analyzed for chlorophyll stability and nutrient content. Seedling dry weight and root growth will also be measured.

Project E.S. 37. Direct Seeding of Coniferous Species:

Renewed interest in direct seeding as an aid to reforestation, coupled with many past failures of this method both in the northern Rockies and elsewhere, prompted this investigation. Results of earlier work tend to be extremely erratic, and thus the sporadic successes which were achieved in the region do not allow conclusions regarding effective techniques to be drawn with any confidence. The vagaries of climate, uncertain quality of seed, changing numbers of rodents and birds, and complexity of soil and topographic factors on wildlands are but some of the factors contributing to the difficulty of interpreting direct seeding experiments. The present study is being conducted with close observation and measurement of many of

divided into four treatments which were subirrigated with a nutrient solution in metal pans holding eight pots each, and four treatments in which the nutrient solution was applied to the upper surface of the sand. The latter treatments contained two pots each.

Treatments in the pans included a control which was supplied with 200 ppm nitrogen and 75 ppm potassium, a high nitrogen treatment with 800 ppm nitrogen, a high potassium treatment with 300 ppm potassium and a triple control treatment in which the entire nutrient solution was three times as concentrated as the controls.

Treatments which were irrigated from the surface included a high nitrogen with 800 ppm nitrogen, a low nitrogen with 50 ppm nitrogen, a high potassium with 150 ppm potassium, and low potassium with 25 ppm potassium.

Chlorophyll stability analysis indicated that there may be some differences in the drought resistance of the seedlings grown on different levels of nutrients, but the results have not been analyzed statistically as yet.

Field plots were established on a clearcut lodgepole pine site near Island Park, Idaho. Sixteen treatments were replicated four times. One of the replications consisted of 40 seed spots planted of ponderosa pine seed and the remainder 70 transplanted ponderosa pine seedlings.

The treatments included combinations of three levels of nitrogen, phosphorus, and potassium fertilization. Fertilizer was applied to the soil surface in the autumn.

A severe frost [illegible] caused high mortality in the seedlings which were just emerging from the planted seed. Fall-year survival on these plots will be determined, and foliage will be analyzed for chlorophyll stability and nutrient contents. Seedling dry weight and root growth will also be measured.

Project ISL-27. Direct Seeding of [illegible] Species

[illegible] in direct [illegible] of [illegible] in the northern Rocky Mountains [illegible]

the factors involved. It is hoped, therefore, that the reasons for failures and successes can be clearly determined and techniques promising better survival than heretofore can be devised.

One of the direct seeding experiments initiated in the fall of 1961 is described below. The plots were located on the west slope of an area subjected to a controlled burn in the fall of 1960 by the Inland Empire Paper Company. Just prior to seeding in the fall of 1961, one section was reburned and cultivated; another was burned but uncultivated. Eight hundred seeds each (8 replicates, 100 seeds per replicate) of ponderosa pine, Douglas-fir, grand fir, and cedar were drilled in rows on each section. During the spring of 1962 duplicates of these fall plots were seeded. Gypsum blocks were placed at soil depths of 3 and 8 inches to record soil moisture, stakes streaked with temperature-indicating chemicals were installed to record the range of temperatures reached just above the ground surface of each of the four main sections, and a rain gauge, hygrothermograph, and evaporometer were placed on the site.

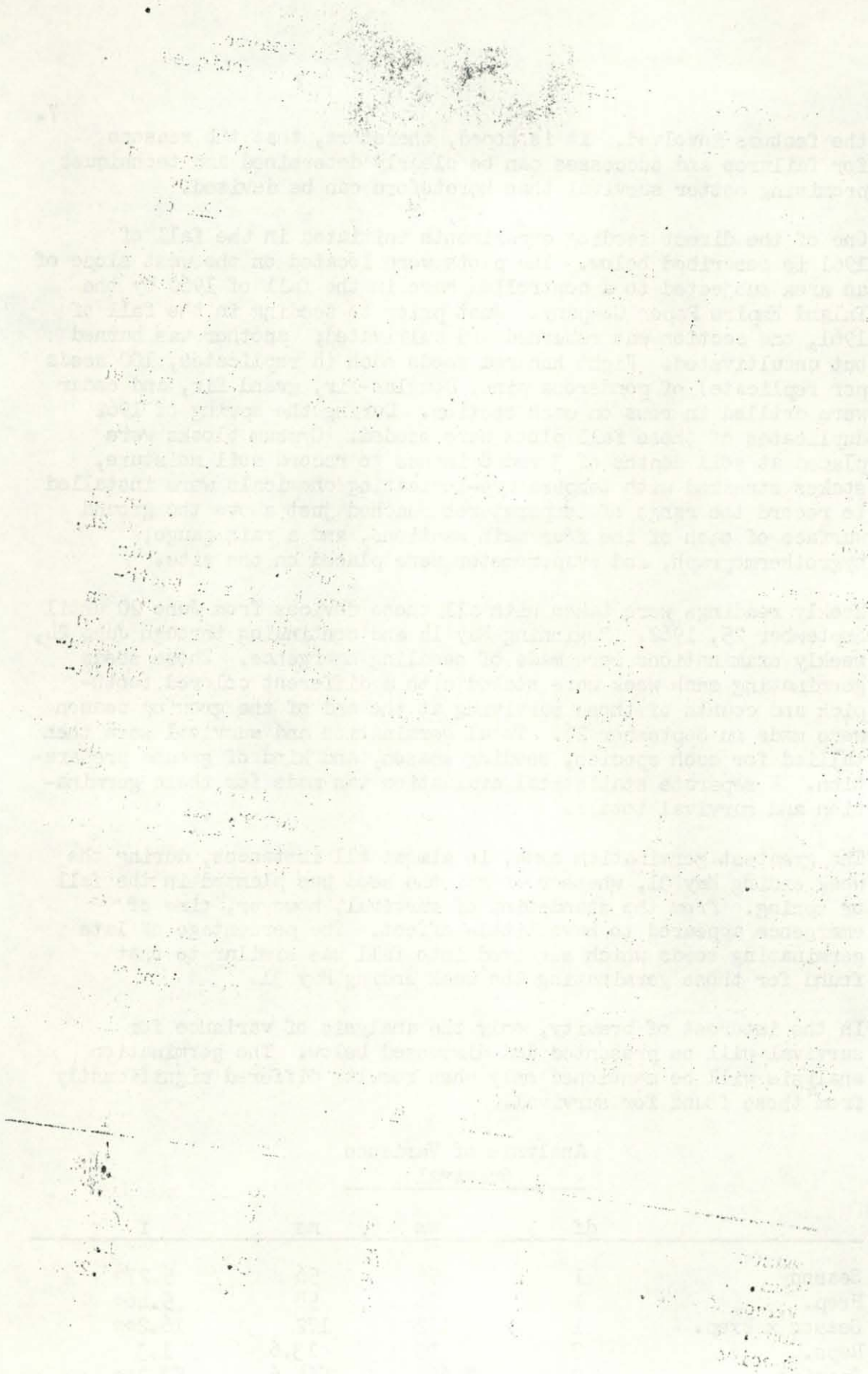
Weekly readings were taken with all these devices from June 20 until September 25, 1962. Beginning May 14 and continuing through June 24, weekly examinations were made of seedling emergence. Those seeds germinating each week were staked with a different colored toothpick and counts of those surviving at the end of the growing season were made on September 26. Total germination and survival were then tallied for each species, seeding season, and kind of ground preparation. A separate statistical evaluation was made for these germination and survival totals.

The greatest germination came, in almost all instances, during the week ending May 31, whether or not the seed was planted in the fall or spring. From the standpoint of survival, however, time of emergence appeared to have little effect. The percentage of late germinating seeds which survived into fall was similar to that found for those germinating the week ending May 31.

In the interest of brevity, only the analysis of variance for survival will be presented and discussed below. The germination analysis will be mentioned only when results differed significantly from those found for survival.

Analysis of Variance
Survival

	df	ss	ms	f
Season	1	56	56	5.27*
Prep.	1	58	58	5.46*
Season x Prep.	1	172	172	16.2**
Reps.	7	95	13.6	1.3
Species	3	1,694	564.6	53.2**



Sp. x Season	3	201	67	6.3**
Sp. x Prep.	3	147	49	4.6**
Sp. x Season x Prep.	3	312	104	9.8**
Pooled Error	105	1,115	10.6	
Total	127	3,850		

Duncan's New Multiple Range Test was employed to detect just where the significant differences revealed by the analysis of variance lay. Some of the pertinent information gleaned from the analysis of variance and multiple range test are:

1. Fall seeding produced significantly higher survival than spring seeding.

2. In total, burning plus cultivation produced significantly better survival than burning alone. No significant differences in germination occurred between the two methods of preparation.

3. Considering the interaction between season of seeding and method of ground preparation, burning alone, followed by fall seeding produced the best results.

4. The sum total of ponderosa pine survival was significantly better than the other species studied. In turn, Douglas-fir was significantly better than grand fir, and grand fir significantly better than cedar.

5. Considering the interaction between species and season, ponderosa pine planted in the spring produced significantly higher survival. From the standpoint of germination, however, Douglas-fir planted in the fall was significantly better than all others.

6. Considering the interaction between species and method of ground preparation, ponderosa pine seeded on burned and cultivated land produced significantly higher survival.

7. Considering the interaction between species, season, and method of ground preparation, ponderosa pine, planted in the spring on burned and cultivated land, produced significantly higher than all other treatments.

It must be remembered that these results, while revealing much of interest, do not tell the final story. In other situations and in other seasons, other patterns of survival may be found. To this end such direct seeding experiments are being carried forward in a variety of locations from year to year.

To be kept in mind, also, is the fact that good survival after the first growing season does not always indicate success. Frost

heaving and rodent damage the following winter, for example, can severly decimate the area. Changes of this nature have been noted in the experiment described above and when evaluated any significant changes will be reported.

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

This year work on this project has been especially concerned with developing and using special laboratory equipment for studying additional wood properties. Equipment was set up for measuring the lengths of wood fibers. Specially-built pycnometers were obtained for measuring the specific gravity of segments of increment cores.

Attention is being given to the effect of irrigation on wood properties. This is being done in cooperation with Washington State University. Some of our test specimens are being used by Washington State University in their study of the use of radiation to evaluate wood properties.

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

Investigations of the "Biology of Eucosma rescissoriana Hein. in Western White Pine of Idaho (Lepidoptera: Olethreutidae)" were completed and submitted as a Master's thesis by M. M. Ollieu. The following is a summary of the data presented in this thesis:

Eucosma rescissoriana was present in all 20 collection sites established throughout the range of Pinus monticola in Idaho. Populations varied from endemic to epidemic levels between the same and different locations, but exhibited a generally high endemic level over the entire study area. In 1961, approximately 15 percent of the cones examined were infested in varying degrees by E. rescissoriana. The intensity of attack the following year was nearly twofold, with an average of about 21 percent of the cones attacked over the two year period. Higher rates of infestation appeared in the more open-growing stands of the same age class, while lower rates were found on valley floor sites than on those located at higher elevations.

The adults appear in late May and early June and the eggs are laid in masses of $\pm$ 16 between cone scales. After eclosion, the larvae bore between the cone scales until the seed area is reached. Feeding continues on both seed and scales unless lack of food (crowding) forces the larvae to penetrate the cone axis. Larvae are present in the cones from mid-June to early August, and require 2 to 4 weeks to complete development. Under laboratory conditions,

development is completed in 2 to 3 weeks. Pupation occurred in duff and litter in the bottom of cages in the laboratory, but the pupal site was not established in the field.

A new phase of study entitled "Distribution, General Biology and Seed Losses in Relation to Stand Density of Pinus Monticola" was initiated on a pilot basis during 1962-63 with a three-phase objective:

1. The quantitative determination of the cone and seed insect species present in the area, with at least partial life histories.

2. The determination of total seed losses and the seasonal (time) progression of those losses.

3. The determination of the progressive rates of parasitism.

In conjunction with the primary objective, the relationship, if any, of stand density to insect-caused seed losses also will be determined. After procedural modification based upon a statistical analysis of the data, a project outline and budget for 1963-64 was submitted to the Forest Insect Research Division, Intermountain Forest and Range Experiment Station, U.S. Forest Service, for consideration as contract research.

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

Lodgepole pine flowers which were pollinated with jack pine pollen June 2, 1961, were collected as mature cones September, 1962.

Table 1. lists the apparent viability determination. Note the high percent of sterile hybrid seed and also the variation between individual mother trees in the number of sterile seeds produced. Hybrid seed will be produced in a succeeding year from most of the parent trees to recheck pollination techniques and compatability to jack pine pollen.

The hybrid seed was nursery planted May 1963 along with an equal number of open pollinated lodgepole pine seed from each parent. The hybrid and open pollinated seed was planted in replicated nursery plots. Jack pine seed was also nursery planted for growth and form comparison.

On May 31, 1963, 400 pollination bags were installed over approximately 800 lodgepole pine flowers in the Spirit Lake seed production area. The flowers were pollinated June 12. The resulting hybrid seed will provide a replicate to compare with the seed analysis shown in Table 1.

development is completed in 2 to 3 weeks. Pupation occurred in duff and litter in the outdoor [illegible] and in the laboratory, but the [illegible] was not established in the field.

A new phase of study entitled, "Distribution, General Biology and Seed Losses in Relation to Stand Density of *Pinus monticola*", was initiated on a pilot basis during 1962 with 3 preliminary objectives:

1. The quantitative determination of the cone and seed insect species present in the area, with at least partial life histories.

2. The determination of total seed losses and the seasonal (time) progression of these losses.

3. The determination of the progressive rates of parasitism.

In conjunction with the primary objectives, the relationships, if any, of stand density to insect-caused seed losses also will be determined. After procedural modification based upon a statistical analysis of the data, a project outline and proposal for 1963 was submitted to the Forest Insect Research Director, Intermountain Forest and Range Experiment Station, U.S. Forest Service, for consideration as an continuing research.

Project 6.K. 4.1. Seed Production of Jeffrey and Jack Pine Hybrids.

Lodgepole pine flowers which were pollinated with jack pine pollen June 7, 1961, were collected as mature cones September, 1962.

Table 1 lists the apparent viability determination. Note the high percent of sterile hybrid seed but also the variation between individual mother trees in the number of sterile seeds produced. Hybrid seed will be produced in a succeeding year when more of the parent trees to evaluate pollination techniques and possible [illegible] jack pine pollen.

The hybrid seed was nursery planted May 1963 along with an equal number of open pollinated lodgepole pine seed from each parent. The hybrid and open pollinated seed was planted in replicated nursery plots. Jack pine seed was also nursery planted for growth and form comparison.

On May 15, 1962, 400 pollination bags were installed over approximately 800 lodgepole pine flowers in the [illegible] Lake seed production area. The flowers were pollinated June 12. The resulting hybrid seed will provide a replicate to compare with the seed analysis shown in Table 1.

Table 1. Lodgepole-jack pine hybrid study. Lodgepole Pine plot No. 1, flowers bagged May 26, 1961; pollination June 2, 1961; and bags removed June 18, 1961.

Tree Number	Treatment	Percent of blank seeds	Weight of 100 seeds	Number good seeds per cone
U.C.N.F. 32	Open	5	.2633	33.66
U.C.N.F. 32	Hybrid	90	.2622	1.50
U.C.F. 29	Open	40	.5587	39.00
U.C.F. 29	Hybrid	60	.5430	14.07
U.C.F. 39	Hybrid	95	.4776	.52
U.C.F. 39	Open	-	-	-
U.C.F. 40	Open	20	.3350	41.87
U.C.F. 40	Hybrid	90	.3273	2.53
N.F. 12	Open	25	.2804	32.39
N.F. 12	Hybrid	80	.3022	3.71
N.F. 13	Open	20	.3169	65.39
N.F. 13	Hybrid	85	.3195	8.31
N.F. 19	Open	15	.3441	48.73
N.F. 19	Hybrid	90	.3892	3.51
N.F. 20	Open	40	.3784	37.40
N.F. 20	Hybrid	65	.4003	13.18
N.F. 22	Open	20	.3298	43.60
N.F. 22	Hybrid	70	.3069	1.08
N.F. 23	Open	20	.3415	55.57
N.F. 23	Hybrid	90	.3095	2.52
N.F. 2	Open	10	.3757	52.00
N.F. 2	Hybrid	75	.3892	13.15
N.F. 3	Open	50	.3762	27.70
N.F. 3	Hybrid	90	.3888	3.14
N.F. 7	Open	25	.4035	56.17
N.F. 7	Hybrid	95	.3751	.875
N.F. 9	Open	30	.3414	54.39
N.F. 9	Hybrid	65	.4193	10.42
F. 11	Open	15	.3793	58.40
F. 11	Hybrid	80	.4122	7.16
F. 21	Open	20	.4421	54.44
F. 21	Hybrid	75	.4583	9.95
F. 25	Open	30	.5124	55.98
F. 25	Hybrid	90	.6309	1.56
U.C.N.F. 30	Open	55	.4929	15.65
U.C.N.F. 30	Hybrid	65	.5213	9.89
U.C.N.F. 31	Open	20	.4595	29.17
U.C.N.F. 31	Hybrid	95	.4400	.83
N.F. 24	Open	15	.3666	67.75
N.F. 24	Hybrid	90	.3122	4.25
N.F. 26	Open	5	.3955	46.45
N.F. 26	Hybrid	50	.4173	16.45
N.F. 27	Open	15	.3903	60.95
N.F. 27	Hybrid	90	.3770	3.48

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

As noted in the Annual Report for 1961-62, new fertilization research plots were established on two areas on the College Forest during the spring of 1962. A 25-year old white pine plantation in the Meadow Creek unit served as one site. Plots 1/10 acre in size were treated with 30 pounds of nitrogen as ammonium sulfate, 150 pounds of potassium as muriate of potash, and 6.6 pounds of phosphorus as treble super phosphate. Young naturally propagated grand fir and Douglas-fir growing on the Flat Creek unit of the forest were similarly treated.

During October of 1962, at the end of the first growing season after fertilization, foliage from three trees on each plot was collected and subjected to nutrient analysis. Results are presented below:

	% N	% P	% K
Meadow Creek			
White pine--fertilized	1.75	0.167	0.819
control	1.35	0.180	0.71
Flat Creek			
Grand fir--fertilized	2.86	0.280	1.157
control	1.00	0.190	1.207
Douglas-fir--fertilized	2.20	0.180	0.910
control	1.03	0.183	1.127

It is apparent from the data that substantial gains in foliar nitrogen occurred after fertilization. The percent of phosphorus and potassium in the tissue did not show consistent increases with fertilization, and in fact some decreases were noted. Because needle size and density were greater in fertilized trees, the total quantity of these elements was probably higher as a result of fertilization regardless of any percentage declines. These results are in agreement with those previously reported for white pine and grand fir fertilization experiments at Ramskull Creek.

Growth measurements were not made on these plots in 1962. In contrast to changes in nutrient content, changes in growth patterns usually do not occur until the second growing season after treatment. Accordingly, growth factors will not be examined until the fall of 1963.

As noted in previous Annual Reports, attempts to increase nutrient uptake and growth of ponderosa pine in northern Idaho have not shown encouraging results as yet. Investigations with this valuable species are continuing, however, and a small-scale experiment was initiated on the Lone Mountain ponderosa pine plantation in the spring of 1963. The

Project S-6. Fertilization of Forest Plantations and Natural Stands.

20-year-old trees were fertilized with ammonium sulfate in one instance; with ammonium nitrate in another. Both 150 and 300 pound per acre rates of nitrogen were employed.

The use of fertilizers at time of planting in order to increase survival and early growth of seedlings is also under investigation. (This project was formerly listed as S.R. 66, Effects of Tree Seedling Fertilization.) In the fall of 1962, foliage was collected for analysis from Douglas-fir seedlings planted near Athol in 1960 and 1961. Some of these seedlings received no special treatment at planting time, whereas others were planted in holes containing a Mora Treefeed pellet. These 9-gram pellets contained 28 percent N and 5 percent P_2O_5. Analysis revealed little change in nutrient status as a result of treatment. Observations of survival and general vigor of seedlings revealed no beneficial effects of fertilization to date. Similarly, seedlings treated with Golden Vigaro (same nitrogen rate as the Treefeed pellets) in the spring of 1962 have shown little if any response. Survival and early growth of Douglas-fir nursery stock under northern Idaho conditions is apparently so strongly influenced by other factors (e.g. competition) that fertilization plays a secondary role. Whether this would be true in all years and whether poorer stock might benefit are unanswered questions at present.

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

By the end of this, the third year of seedling survival studies, experiments are being conducted on five sites. Of major interest was the introduction of treatments employing the herbicide Simazine. Information accumulated from studies the previous two fiscal years revealed that satisfactory survival rates were achieved only when the quantity of herbaceous vegetation was drastically reduced. This reduction preserved soil moisture, making it available to the seedlings during critical drought period. (For further details see Annual Reports for 1960-61, 1961-62, and Forest, Wildlife and Range Experiment Station Research Note No. 18.)

Cultivation several times during the growing season was the most effective method used to eliminate the competing vegetation in these earlier experiments. The first experiment reported herein was designed to show whether a single application of a pre-emergence herbicide soon after tree planting (with little or no cultivation during the growing season) would be as satisfactory.

At the Athol experimental site (abandoned farmland), the following treatments were utilized, replicated four times each (25 Douglas-fir seedlings planted per replicate) on (1) land summer fallowed during 1961 and (2) land not summer fallowed.

A. 2-0 stock

1. Cultivation during growing season only up to tree row.
2. Simazine 80W (4#/acre rate) and cultivation up to tree row.
3. Simazine 80W (4#/acre rate).
4. No cultivation, no Simazine.
5. Clean cultivation.

B. 2-1 stock.

Same treatments as above.

Trees were machine planted on April 19, 1962, and Simazine was applied by means of back-pack sprayers on May 3.

The treatments outlined above, with the exception of A. 1 and A.4, were also employed on summer fallowed land at the Orofino experimental site. Here the trees were planted April 25 and plots sprayed May 1.

Survival counts were made weekly on both sites, and at the same time soil moisture and climatic information was collected. Final inspections of the plots were made in mid-November, after which statistical analyses of the data were conducted.

Athol Survival Plots--1962
Analysis of Variance

Source of Variation	df	ss	ms	F
Main Plots:				
Fallow x non-fallow	1	1,386	1,386	38.0**
2-1 x 2-0	1	374	374	10.2**
Age x fallow, non-fallow	1	17	17	0.5
Main plot error (A)	12	438	36.5	
Sub Plots:				
Treatments	4	9,096	2,274	120.3**
Treatment x fallow, non-fallow	4	4,718	1,179	62.3**
Treatment x age	4	218	57.5	2.8**
Treatment x fallow x age	4	64	16	0.8
Sub plot error (B)	48	910	18.9	
Total	79	17,219		

** Significant at 1 percent level.
* Significant at 5 percent level.
Correlation between survival at end of growing season and average soil moisture (8" depth for period 7/10-8/23). r=0.967.

Survival Percent--Athol--1962 Plots

NO	SF	2-0	Cult. to tree	98	SF	2-0	Cult. to tree	95
			Sim. & cult. to tree	99			Sim.& cult.to tree	99
			Sim. no cult.	90			Sim. no cult.	98
			No cult. no sim.	46			No cult., no sim.	88
			Clean cult.	98			Clean cult.	97
		2-1	Cult. to tree	100		2-1	Cult. to tree	99
			Sim. & cult. to tree	100			Sim.& cult.to tree	100
			Sim., no cult.	97			Sim., no cult.	100
			No cult., no sim.	60			No cult., no sim.	95
			Clean cult.	100			Clean cult.	100

Before further consideration of the Athol data, it should be emphasized that, in contrast to 1961, the summer of 1962 produced a precipitation pattern favorable for seedling survival. From the middle of June to the end of August, 1961, a total of 0.13 inches of precipitation was measured at the Athol site. The comparative figure for 1962 was 1.28 inches. A similar situation prevailed at Orofino. Nearly an inch of rain fell at Athol during the first week of August, 1962. This undoubtedly saved many trees on uncultivated plots, trees which would have succumbed had the year been as dry as 1961. It is also difficult to assess comparisons between Simazine and cultivation treatments. We cannot conclude that Simazine alone will consistently assure survival as high as treatments employing cultivation even though the 1962 tests produced no significant differences between the two. Some weeds remain on uncultivated plots treated with Simazine, as of course they also do on plots cultivated only to the tree row. In a dry year, when very limited moisture would have to be shared with the weeds, significant differences among these treatments might occur. We are attempting to devise techniques to produce satisfactory survival in the frequent droughty years. The occasional wetter summers present no problems. Thus these results, while encouraging, need to be reaffirmed by similar results found in a drier season.

The statistical analysis of the 1962 data from Athol indicates the following:

1. Summer fallow in 1961 vs. no summer fallow in 1961: Highly significant difference in favor of summer fallow. This result is mainly due to substantially higher survival on summer fallowed plots receiving no cultivation or Simazine compared to similar plots which were not summer fallowed. For treatments receiving Simazine or cultivation, summer fallowing made slight or no difference.

2. 2-1 vs. 2-0 stock: Highly significant difference statistically (favor of 2-1), but in actuality the percentages varied little. It should be noted that 2-0 stock has performed as well, or almost as well, as 2-1 stock in all experiments to date, whether in abandoned farmland or in forest-type plantings, and whether the

summer was wet or dry. A very considerable saving in planting stock cost would result if the younger stock became standard for planting in the region.

3. Treatment: Highly significant difference between plots receiving no Simazine or cultivation and all others. As stated above, a dry year might bring out more treatment differences.

4. Treatment vs. fallow, no fallow interaction: Highly significant differences. No fallow, no Simazine or cultivations plots poorer than fallowed, no Simazine or cultivation plots. These in turn were poorer than all other plots.

5. Treatment vs. age interaction: Survival of 2-0 stock on no Simazine, no cultivation plots poorer (highly significant) than 2-1 stock growing on similar plots. This in turn poorer than all other treatments.

Results at Orofino were similar to those at Athol.

In the spring of 1963, plots duplicating those of 1962 were developed at both Athol and Orofino.

Experiments were conducted for the second year at Spirit Lake, in cooperation with the Inland Empire Paper Co. This cut-over area, relatively level in general, is characterized on the plot site by undulating topography of low relief. Strips several feet wide have been bulldozed in a north-south direction and the Douglas-fir seedlings machine-planted in these. Plots of 25 trees each were randomly distributed in the rows, each treatment being replicated 4 times. Treatments were as follows:

A. 2-0 stock

1. Control--no treatment.
2. Evaporation retardant applied to foliage at planting time.
3. Fertilizer (3.2 gm. nitrogen plus other elements) placed in hole at time of planting.
4. Evaporation retardant plus fertilizer.

B. 2-1 stock

Same treatments as above.

Examination of the data obtained from this site indicates that neither the evaporation retardent nor fertilizer enhanced survival on this site in 1962. In fact, percentage survival figures for the control are well above the other treatments. Another factor, however, mitigates against drawing a firm conclusion on this point. Because of the rolling terrain, five topographic sites may be recognized on the area--north slope, ridge, south slope, level and bottom. As mentioned above, the plots were randomly placed in the continuous

rows of machine planted seedlings. A tally of topographic location of trees from each treatment reveals that distribution was unequal. Treatments showing the poorest survival usually had a relatively large percentage of trees growing on the more unfavorable aspects. A simple evaluation of the treatment data will not suffice on this site, and further analysis of the interaction between treatment and slope is necessary.

Experimental plots were again developed on the Spirit Lake site in the spring of 1963. The influence of slope on survival will be studied more intensively, and to this end instruments to detect differences in evaporation were placed on all aspects.

Additional information concerning the factors affecting survival is being obtained from plots established during the year at Mica Flats (in cooperation with the State of Idaho Forestry Department) and on the College Forest.

This study is supported in part by funds granted to Regional Research Project W-71, Forest Tree Seedling Establishment. The Technical Committee for this project, consisting of representatives from several western universities and government agencies, held its annual meeting at Moscow in September, 1962. A field trip to the Athol and Spirit Lake sites was a feature of this meeting.

Project S.R. 80. The "Indian-Paint Fungus" in Idaho.

More than 25 carbon sources in combination with organic and inorganic nitrogen sources have been utilized in physiological studies of this organism. Very limited growth was obtained with any carbon source or carbon/nitrogen combination. This was traced to biotin or a related vitamin deficiency. Other physiological tests indicate specific requirements of the fungus but are too inconclusive to report at this time.

Pulp and strength losses have been checked in wood affected by this fungus at all stages of deterioration. Presently, it appears that such wood may not be utilized economically even though the decay is early incipient.

Field measurements and statistical analyses indicate:

a. An inverse relationship between unpruned branches and the presence of decay.
b. No correlation between decay and crown position, height or diameter.
c. A direct relationship between slow growth and decay, with the last 10-years' growth being a better indicator than total average growth.

At present 5000 trees in 200 townships have been examined. Analysis of the results will continue through the year.

II. Range Management

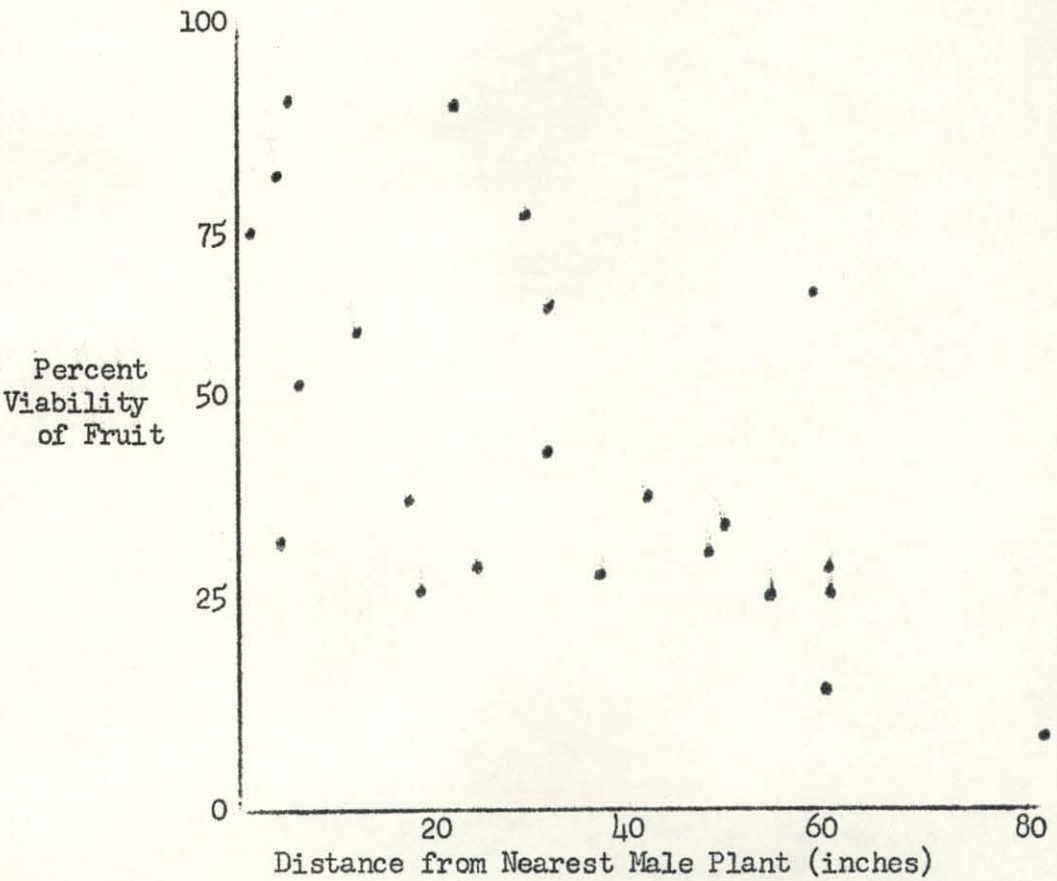
Project E. S. 7. Evaluation of Salt-Desert Ranges.
Project E. S. 15. The Ecology and Control of Halogeton.

Life history investigations of saltsage (Atriplex nuttallii) were continued in 1962-63. Emphasis was on the (1) factors affecting viability and germination, (2) taxonomy, (3) genecology, and (4) clipping studies.

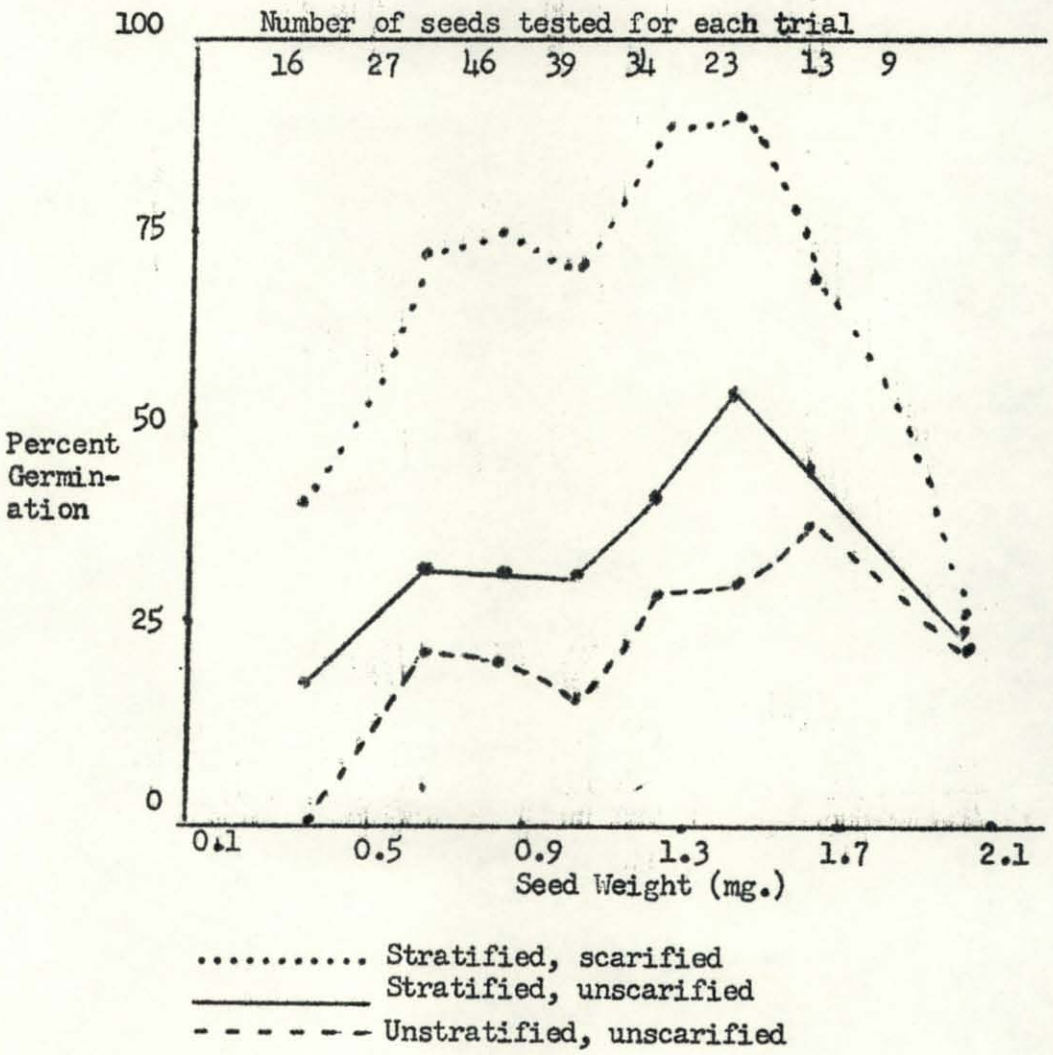
Viability and Germination

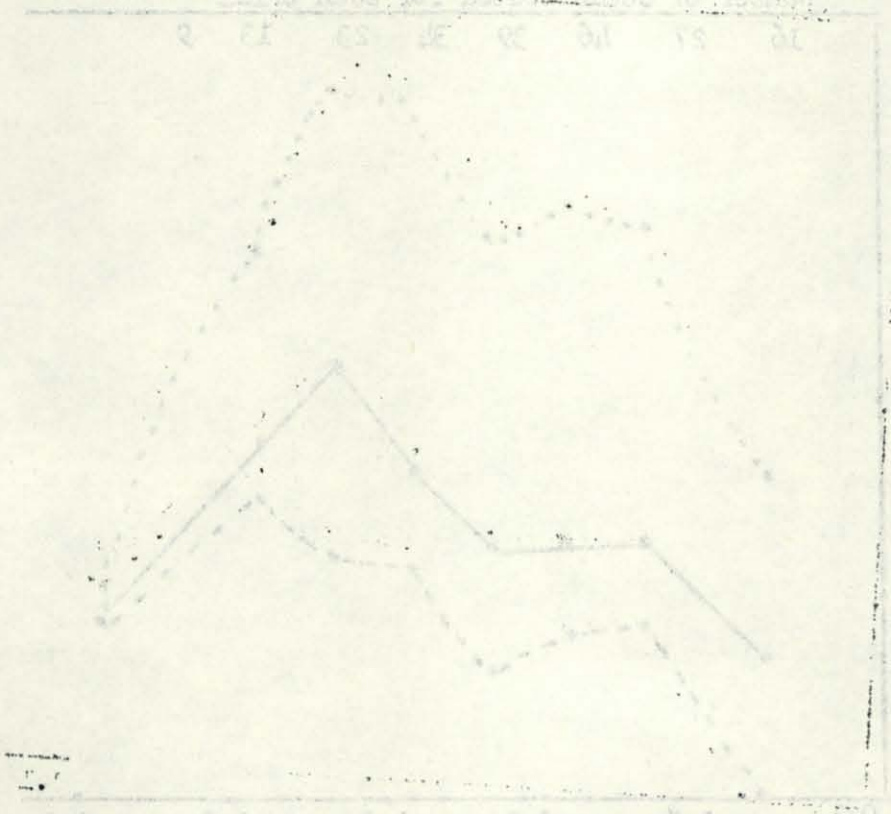
Saltsage generally produces considerable fruit under favorable conditions. Commonly, however, more than 60 percent of the fruit is empty. Earlier studies indicated that pollination failure was the principal factor limiting saltsage fruit viability, with insect damage generally occurring in less than 10 percent of the fruit.

Investigations were initiated during the summer of 1961 and were intensified in 1962 in which the relationship between stand density and fruit viability were studied. A strong correlation was found between the viability of fruit collected from individual female plants and the distance to the nearest pollen source. The following graph illustrates this relationship. Each point represents the percent viability of 100 utricles from a single female saltsage plant and the distance from that plant to the nearest male.



Germination characteristics of saltsage vary considerably between fruit lots. Some lots germinate readily after 3-4 months stratification, whereas others require 9 months or more to achieve a comparable rate. Excised seed of different weights were germinated in an effort to determine if differences in seed maturity caused variation in germination characteristics. The results are presented below.





The broken line represents the percent seed germinated after 11 days at room temperature without prior stratification. The continuous line represents the percent germination after 11 days with prior stratification (30 days at 34-40° F.) The greatest germination occurred in seeds weighing 1.1 to 1.7 mg., with the smaller green seeds and the very large, mature seeds germinating significantly less. After nearly all germination had ceased, the testae of the viable, ungerminated seeds were cracked, stimulating germination among the small-and medium-sized seeds (dotted line). These results indicate that the seed coats of the immature seeds are relatively impermeable and gain permeability with maturity. With maturity the seeds acquire an internal physiological dormancy. The 1.1-1.7 mg. seeds may be in a transition between the two types of dormancy. The degree of maturity of a fruit or seed lot, therefore, is apparently an important factor influencing the germination characteristics of the lot.

Taxonomy

One-hundred and thirty sheets of saltsage specimens, borrowed from various herbaria in the west, were examined in an effort to determine the taxonomic status of saltsage in southern Idaho. Measurements of leaf blades and petioles were made, in addition to notes concerning habit and habitat, leaf, fruit, and root characteristics.

Saltsage ranges from southern Saskatchewan to eastern Colorado, northern New Mexico and Arizona to northeastern California, eastern Oregon and Washington and southern Alberta. Over this relatively wide range it has developed into a number of variations. Five of its six subspecies have numerous intermediate forms so that many populations cannot be definitely placed. The Raft River Valley in southern Idaho, which is located near the center of the species range, has particularly mixed populations of saltsage.

Genecology

A species occurring in a wide geographic range such as saltsage and growing in a variety of habitats could be expected to contain a large number of ecotyes. Knowledge of such ecotypic variation would be valuable in selecting appropriate strains for reseeding purposes. With this in mind, 57 saltsage fruit lots collected in 1961 and 1962 were seeded September, 1962, at 9 sites in the Raft River Valley. These sites included 2 shadscale, 2 upland greasewood, 1 bottomland greasewood, 2 depleted saltsage, 1 good-condition saltsage, and 1 sagebrush-depleted saltsage habitat. Saltsage subspecies included in the trial were A. nuttallii, A. gardneri, A. tridentata, A. cuneata, and A. falcata. Subspecies A. buxifolia, a rare and dubious taxon from eastern Wyoming, was not seeded.

The broken line represents the percent [illegible] after 11 days at [illegible] temperature [illegible] germination. The [illegible] line represents the percent germination after 11 days [illegible] stratification ([illegible] °C). The greatest germination occurred in seeds [illegible] mg [illegible] smaller green seeds and the very large, heavy seeds germinated significantly [illegible]. After [illegible] stratification and [illegible] of the [illegible], ungerminated seeds were crushed, [illegible] germination among the small and [illegible] seeds [illegible]. These results indicate that the [illegible] of the [illegible] seeds are relatively [illegible] and [illegible]. With [illegible], the seeds [illegible] germination [illegible]. The 1.1-1.7 mg [illegible] between [illegible] of dormancy. The degree of [illegible], therefore, is apparently an important factor influencing the [illegible] characteristics of the [illegible].

Taxonomy

[illegible]-hundred and thirty sheets of [illegible] specimens, borrowed from various herbaria in the west, were examined [illegible] the taxonomic status of [illegible] in the [illegible]. [illegible] leaf blades, and petioles were noted, in addition to [illegible] both [illegible], leaf, [illegible] characteristics.

[illegible] ranges from southern [illegible] northern [illegible] and [illegible] in [illegible], Oregon and Washington, and [illegible]. Over this relatively wide range it has developed [illegible] number of variations. Five of [illegible] subspecies have [illegible] intermediate forms [illegible] populations [illegible] Salt River Valley [illegible] the [illegible] of the species range, [illegible].

Germination

A species [illegible] and [illegible] in a variety of [illegible] large number of [illegible] variations [illegible] 1962, [illegible] [illegible] [illegible] [illegible] [illegible]

Weather conditions during the spring of 1963 were favorable for saltsage germination and, except for a two-week period in May, were also conducive to high rates of seedling survival. It appears that satisfactory stands of most of the planted material will be obtained.

Clipping Study

This study was initiated May 1, 1962, in an enclosed saltsage (A. falcata) stand near Malta, Idaho. It entails comparison of two clipping heights, five clipping frequency levels, and five dates of initial clipping. The first clipping of the 1962 season was done May 1, when the inflorescences of the male saltsages were in the black bud stage. From then on clippings were made at two-week intervals until July 1. A final clipping was made at the end of the growing season (August 1) on all plots.

The following table compares the accumulative yields of all plots for the 1962 season:

Date of Clipping		Total Seasonal Yield (lbs/acre)				Times Clipped
		Block 1		Block 2		
		Clipping Height		Clipping Height		
First	Last	3/4"	1½"	3/4"	1½"	
	July 1	930	401	866	913	5
	June 16	862	347	1055	756	4
May 1	June 1	501	476	1118	666	3
	May 16	989	531	944	754	2
	May 1	950	514	1018	877	1
	July 1	1970	815	1402	805	4
	June 16	1366	836	1232	921	3
May 16	June 1	1241	675	1009	923	2
	May 16	1121	886	1070	946	1
	July 1	1272	871	1559	977	3
June 1	June 16	917	658	1246	1045	2
	June 1	1043	860	1152	1189	1
June 16	July 1	1767	870	1701	1052	2
	June 16	1344	985	1331	1090	1
July 1	July 1	1571	1411	1291	1364	1

Data for several seasons will be required before conclusions can be drawn concerning the effects of foliage removal on saltsage. Initially, clipping during the early flowering stages (May 1) appears to cause a

stress on the saltsage, resulting in significantly lower yields than when clipped May 16 and later. With the exception of the May 1 clipping series, greater cumulative yields appear to accompany the higher frequencies of clipping at the 0.75 inch clipped height.

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

The artifically established populations of medusahead, cheatgrass and a 50-50 mixture of the two species were resampled in the spring of 1963. The low plant density, averaging about 20 per square foot in 1962, resulted in vigorous individuals that produced abundant seed for the 1963 crop. Litter conditions were less satisfactory.

The number of seeds produced per square foot in 1962 and the survival percentage of plants to the early inflorescence stage of cheatgrass development in 1963 are presented in Table 1. The initial invasion of medusahead from adjacent plots into the cheatgrass plots appears to have started. One of the interesting trends is the consistent higher average survival percentage of medusahead in all populations, regardless of the initial number of seed. Seed production per unit area will be determined after seed cast.

Table 1. Summary of population potential and percent survival of cheatgrass and medusa in 1963.

	Av. no. seed per sq. ft. 1963 crop*	Av. no. plants per sq. ft. surviving at early flowering of cheatgrass	Percent plant survival of total seed supply
Population I.			
Cheatgrass	2661	1759	66
Medusahead	163	116	71
Total	2824	1875	66 (Av.)
Population II.			
Cheatgrass	82	49	60
Medusahead	1910	1261	66
Total	1992	1310	66 (Av.)
Population III.			
Cheatgrass	1644	838	51
Medusahead	1080	680	63
Total	2724	1518	55 (Av.)

* Includes blow-in from adjacent plots.

Medusahead seed buried in the soil for two years still show a fairly high percentage of germinable seeds. Seeds placed in the upper 3 inches of soil had an average germination of approximately 5 percent after two years of burial as contrasted with 10 percent after one year. Seeds recovered from the 6-inch depth failed to germinate the second year.

Sitanion hystrix is a native bunchgrass that is able to establish itself naturally in cheatgrass and medusahead ranges when a seed source and adequate protection are provided. To study its competitive ability, lots of 5 Sitanion seeds were seeded with 5 and 10 medusahead or cheatgrass seeds in small containers. The bottom of the 2.5-inch diameter tin containers was removed and a total of 120 containers were "planted" even with the ground surface prior to being seeded. The area where the experiment was conducted receives about 11 inches of precipitation annually. The experiment was duplicated with Siberian wheatgrass in place of Sitanion for comparison purposes. With medusahead competition 41 percent of the Sitanion seeded containers had one or more established individuals at the beginning of the second growing season as compared to only 12.5 percent for Siberian wheatgrass. With cheatgrass competition the percentages of containers with at least one established perennial were 33 and 38 for Sitanion and Siberian wheatgrass respectively. The results of the cheatgrass competition are inconclusive because of the poor establishment of cheatgrass in the containers. The experiment will be repeated.

The need for a method that is both accurate and rapid to sample sparse populations of remnant perennials in medusahead dominated communities led to the development of a Frequency-Intercept method. This method incorporates the principles of the line intercept and the list count methods. The time required to obtain an adequate sample of plant density and basal cover is considerably less than when these attributes are sampled separately by existing methods. The method was tested on a randomly distributed artificial population with known parameters. The results of the test were gratifying and substantiated the validity of the theory upon which the method is based.

A study designed to provide information about the environmental complexes to which medusahead is adapted was initiated in the spring of 1963. Study sites were chosen so that areas infested with medusahead and adjacent, non-infested sites could be studied simultaneously. Field measurements included relief, aspect, percent slope, elevation, precipitation, associated vegetation, and soil characteristics. A soil profile description was made at each plot. Laboratory analyses will be made of physical and chemical characteristics of each horizon in each soil profile. Multiple correlation analysis will be used to determine the relative influence of the various site factors studied.

Field germination, rate of survival, causes of mortality, and incidence of disease on medusahead and associated annuals were followed on Coyote Grade in Nez Perce County from the date of initial fall germination in 1962 to seed maturity in 1963. Results indicate that the seedlings produced were almost entirely from fall germination. Laboratory germination of periodically collected seeds in the field indicated that those remaining ungerminated beyond November had an induced dormancy that strongly inhibited spring germination.

Medusahead, cheatgrass, squirreltail grass, and crested wheatgrass plants were grown in the same pot to study their relative resistance to soil moisture depletion. Evapotranspiration losses were determined by weight and evaporation losses were evaluated from similar pots without plants. The wilting coefficient of the soils used were approximately 12 percent. When the moisture fell below 12 percent, transpiration losses almost ceased. Weight loss after that point was about the same as for the evaporation check pot. All of the species became limp and wilted at moisture levels below this point. When soil moisture dropped to 6 percent, all species appeared dead. Subsequent restoration of a high moisture level for 10 days caused approximately half of the squirreltail and crested wheatgrass plants to revive, but none of the annuals responded.

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

Fourteen new sites were sampled, bringing to 97 the total studied to date. Most of these represent major types of sagebrush-grass vegetation relatively free from disturbance by heavy grazing or other factors. The 1962 sampling was designed primarily to fill in gaps in existing data on sagebrush types in the drier portions of the region. Included were 3 kipukas, areas protected from livestock grazing by relatively recent lava flows. One of these areas, located near Carey, Idaho, is of particular importance due to its isolation and size (180 acres). Intensive sampling was done on this area to determine the modifications produced in vegetation and soils by local differences in relief and parent material.

A start was made at the second phase of this project, dealing with the nature and causes of change in the sagebrush-grass communities of the state. Modifications of the basic sampling methods for vegetation were made to fit the objectives of this phase of the study, and these were given preliminary field tests. Soil sampling procedures are also under test. The overall objective is to modify the basic methods to the minimum extent necessary to cope with such special features of disturbed sites as sparseness of herbaceous

perennials, abundance of annuals and soil surface disturbance. The data obtained will be kept as comparable as possible to those taken on undisturbed sites.

A special study of the relation of environmental factors to the distribution and abundance of major species in the sagebrush-grass region of Idaho was continued by Min Hironaka. This work has been submitted as a doctoral thesis at the University of Wisconsin. Discriminant analysis was used to determine the relative effect of the environmental factors controlling distribution and dominance of two species of sagebrush, Artemisia tridentata and A. arbuscula, and one grass, Festuca idahoensis.

Annual yield studies were continued on two representative areas of sagebrush-grass vegetation. Data obtained from the drier of the two sites during the past four years indicate the productivity from a typical site in the Artemisia tridentata/Agropyron spicatum/Poa secunda type occurring on soils in the Sierozem group in an area with average annual precipitation of 9 inches.

Table 1. Air dry yields in pounds per acre from the Jordan Valley study area, 1959-1962.

Species	1959	1960	1961	1962	Average
Agropyron spicatum	193	388	360	416	339
Sitanion hystrix	12	7	13	9	10
Poa secunda	5	46	32	81	41
Bromus tectorum	22	83	38	38	45
Total	232	524	443	554	435

The variations in total annual production show the influence of an especially dry year (1959), also marked fluctuation in yields of the annual Bromus tectorum, and even greater variability for Poa secunda, an early-developing, dwarf perennial.

The second clipping site is located in the Artemisia tridentata/Agropyron/Festuca type in the Chernozem soils group with an annual precipitation of about 15 inches. Results have been affected by the effects of wildfire which swept the area in 1960. Average herbage production for 1959, 1960 and 1962 was 1,997 pounds per acre, with forbs contributing about 900 pounds of this amount.

All treatments of the sagebrush thinning study begun in 1960 were resampled to determine basal area, plant density and frequency. The distance measure method previously used for this purpose was dropped because of the excessive time required to reach a reasonable level of accuracy. The new sampling method involves a set of 32 permanent plots, each 1 x 0.5 meters in size, randomly located along 4 transects in each treatment. This type of sampling appears to provide the intensity needed to measure change in the vegetation and is fairly rapid.

The results obtained to date are summarized in Tables 2 and 3. The data indicate considerable variability in the vegetation of the 4 treatment plots, as well as the difficulty of sampling sparse populations such as those of Stipa thurberiana and Agropyron reparium. The trend toward increased herbaceous growth in the thinned plots is evident, however, and appears to be roughly in proportion to the amount of sagebrush removed. This is particularly true in the case of Sitanion, which is the major grass on the area at present. The increase of the early-developing Poa secunda was about the same in all treatments and appears to be a response to more favorable climatic conditions rather than to sagebrush removal.

Table 2. Percent basal area of understory in sagebrush-thinned plots, 1961-1962.

Year	Species	Amount of sagebrush crown cover remaining 0%	2-3%	7-8%	15%
1961 *	Sitanion Hystrix	1.52	.70	.75	.49
	Poa secunda	1.16	1.53	1.07	1.17
	Stipa spp.	.46	.39	.21	.45
	Agropyron riparium	.01	.01	.01	-
	Total	3.15	2.63	2.04	2.11
1962	Sitanion hystrix	2.66	1.09	1.70	.50
	Poa secunda	4.07	3.65	2.93	3.24
	Stipa spp.	.18	1.01	.92	1.11
	Agropyron riparium	.08	.28	.38	.04
	Total	6.99	6.03	5.93	4.89

* Sampled by distance measure.

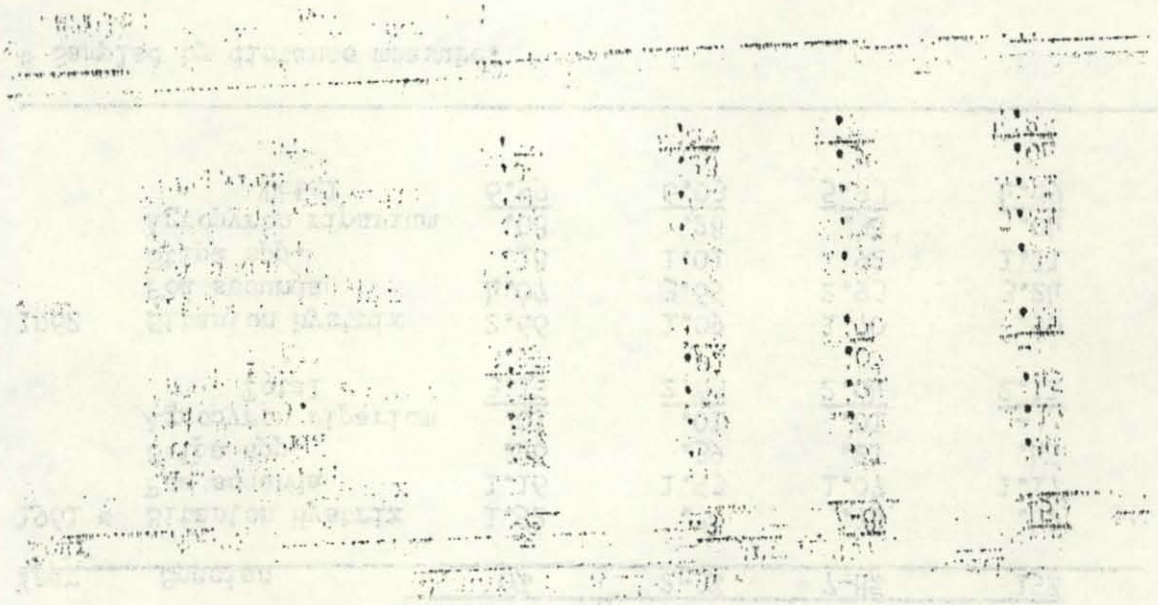


Table 3. Average number of individuals per plot (1 x .5 meters) in 1962.

Species	Amount of Sagebrush cover remaining 0%	2-3%	7-8%	15%
Sitanion hystrix	7.69	2.81	3.04	1.63
Poa secunda	26.97	38.50	27.88	31.72
Stipa spp.	.48	1.10	.78	1.32
Agropyron riparium	6.89	21.69	26.41	1.35

A four-day trip was made to study sagebrush range types in northern Nevada. Dr. Robertson and members of his staff provided an excellent review of this area for the group which included representatives from Oregon, Washington and Idaho. The areas visited showed close relationships with sagebrush vegetation in much of the tri-state area, and particularly to types in southern Idaho. Apparent differences included the relative status of Agropyron spicatum and Stipa thurberiana in the drier areas and that of Elymus cinereus (giant wildrye) in more mesic situations. The latter species appears to have been a major constituent of sagebrush-grass vegetation in many areas in Nevada. A feature of the areas seen in Nevada was the scarcity of sites with relatively undisturbed vegetation.

E. W. Tisdale spent two days with members of the Kamloops Range Experiment Station staff on a review of sagebrush vegetation in south central British Columbia. The areas visited included types dominated by Artemisia tridentata typica, the low-land form of big sagebrush; A. tridentata vaseyana, a high elevation form and A. tripartita (three-tip sagebrush). These appear to be the only members of the woody section of the genus Artemisia in British Columbia. The areas occupied by all except A. tridentata typica are relatively small. Each of the three forms of sagebrush listed is a dominant in permanent communities, and possess special interest due to their location at the northern extreme of the sagebrush-grass region. Mr. Leonard Marchand, a member of the Kamloops Experiment Station Staff, is investigating the autecology of these three forms of sagebrush, with emphasis on seed production, germination and seedling development. This study will be used as a Master's thesis at the University of Idaho.

A manuscript entitled "Secondary Succession in Annual Vegetation in Southern Idaho" by Hironaka and Tisdale has been submitted to Ecology.

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

Notes on native Festuca collections were confined to observations on materials in the nursery on the University campus. Data were obtained on survival rates, vigor, dates of curing and occurrence of vivipary.

Survival data showed continued declines for the more poorly adapted collections and little change for the remainder. A feature in 1962 was the common occurrence of vivipary. Vivipary, which has not been reported for F. idahoensis under natural field conditions, occurred in many lots in the nursery at Stanford, California, and to a much smaller extent at Moscow during the study period 1959-1961.

In 1962 both the percentage of viviparous plants and the number of lots affected was more than twice that recorded in previous years at Moscow. Fifteen out of 19 lots were affected, with percentages of viviparous spikelets varying from 1 to 16. Data from the two nurseries do not support the hypothesis that photoperiod is a major factor, but its prevalence in late maturing spikelets in an unusually cool, moist summer at Moscow suggests that temperatures may be involved.

The main activity during the current year has been the analysis of data and preparation of a manuscript covering the entire study. It is expected that this paper will be published in the coming year.

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

The number of ant clearings in the good condition saltsage remained the same as in 1961, declined slightly in the depleted shadscale and increased in the depleted saltsage. The area cleared increased in the good condition saltsage and decreased almost one-third in the depleted saltsage. The nature of the surrounding vegetation appears to be the best explanation for the difference in direction of area change in the two saltsage stands. Annual vegetation in the depleted stands germinated in abundance due to favorable May precipitation and consequently filled in the edges of the clearings more rapidly than the ants could remove it. The perennial vegetation surrounding the clearings in the good condition saltsage responds more slowly as regards reproduction and establishment of new plants so the clearings were enlarged rather than diminished in size.

Project E. G. 13. Ecotypic Variation in Purshia Species.

Notes on native [illegible]. [illegible] were confined to observations on materials in the nursery on the University [illegible]. Data were [illegible] on survival [illegible], dates of [illegible] and occurrence of [illegible].

Survival data showed continued declines for the more poorly adapted collections and little change for the remainder. A feature in 1963 was the common occurrence of [illegible]. [illegible] had not been reported for P. tridentata under natural [illegible] conditions, occurred in very low [illegible] the nursery at [illegible] California, and to a much smaller [illegible] at Moscow during the study period 1959-1962.

In 1963 both the percentage of [illegible] plants and the number of lots affected [illegible] more than twice that recorded in previous years at Moscow. Fifteen out of 17 lots were affected, with percentages of [illegible] varying from 1 to 12. [illegible] nurseries, do not support the hypothesis that [illegible] is a major factor, but its prevalence in [illegible] spring [illegible] unusually cool, moist summer at Moscow suggests that temperatures may be involved.

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The average per acre values obtained at the three locations are given below:

	1960			1961			1962		
		Area Cleared Per Acre			Area Cleared Per Acre			Area Cleared Per Acre	
	No.	Sq.Ft.	Percent	No.	Sq.Ft.	Percent	No.	Sq.Ft.	%
Good Condition Saltsage	9.3	1465.3	3.36	9.0	1468.6	3.37	9.0	1626.0	
Depleted Saltsage	47.3	3830.3	8.79	47.3	3394.4	7.79	49.0	2387.2	
Shadscale	14.3	--	--	14.3	--	--	13.5	--	--

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

Crested wheatgrass on the pasture area responded to favorable growing conditions during 1962. The first two weeks of the spring grazing period were without rain and it appeared that the season would be as dry as the previous year. Light scattered showers occurred on May 12 and May 14 and a soaking rain on May 18. Periodic rains fell through the rest of the month and continued in the early part of June. The total precipitation for May was 2.07 inches and for June 0.48 inches.

Percipitation during the fall of 1962 was insufficient in amount and distribution to produce any quantity of green growth.

Spring Trials

Forage production and utilization for each spring use pasture is shown in Table 1. Approximately twice as much forage was produced this year as compared to 1961. In contrast to 1961, use levels were generally below those desired. Additional animals were added at the second weight date but these were insufficient to keep up with the additional growth that developed during the latter part of May and early June.

Animal gains are shown in Table 2. Animals averaged over two pounds a day in all pastures during the spring period. Exceptionally good gains were also obtained for the fall period. Abundant feed plus the fact that a number of animals in poor condition were used is thought to be responsible for these gains.

Table 1. Air dry forage production and utilization for the spring grazing trials of 1962.

Pasture	Intensity of use	Initial Production lbs/acre	Initial Production Plus Growth lbs/acre	Utilization Percent
02	Light	148	631	34
05	moderate	201	515	48
03	heavy	119	452	73
10	moderate	180	439	28
20	light	191	628	40
30	moderate	154	518	44
40	light	128	424	41
50	moderate	164	452	43
60	light	170	452	26

Table 2. Average animal weights and gains by pasture and season during the spring and fall of 1962.

Past No.	Season	Intensity	Initial Weight (lbs)	Total Gain/ Animal (lbs)	Daily Gain/ Animal (lbs)	Gain/ Acre (lbs)	Acres/ Animal Month
02	Spring	Light	503	109.7	2.44	29.0	2.5
05	Spring	Moderate	446	111.0	2.46	32.6	2.3
03	Spring	Heavy	449	104.2	2.31	44.1	1.6
01	Fall	Light	614	42.6	1.52	15.6	2.3
06	Fall	Moderate	601	44.5	1.59	20.5	1.6
04	Fall	Heavy	591	44.3	1.58	20.3	1.5
10	Spring	Moderate	554	94.0	2.08	16.4	3.9
	Fall	Heavy	596	39.5	1.41	16.8	3.6
						33.2	1.4
20	Spring	Light	421	110.8	2.46	34.0	2.3
	Fall	Light	599	45.8	1.64	11.9	2.9
						45.9	1.3
30	Spring	Moderate	476	112.0	2.48	30.9	2.4
	Fall	Moderate	589	43.2	1.54	10.2	3.1
						41.1	1.4
40	Spring	Light	508	118.0	2.62	23.6	3.5
	Fall	Heavy	554	37.3	1.33	10.2	3.3
						33.8	1.7

Past No.	Season	Intensity	Initial Weight (lbs)	Total Gain/ Animal (lbs)	Daily Gain/ Animal (lbs)	Gain/ Acre (lbs)	Acres/ Animal Month
50	Spring	Moderate	455	123.1	2.74	26.3	3.2
	Fall	Light	613	50.2	1.80	8.6	4.2
						34.9	1.8
60	Spring	Light	449	110.1	2.44	16.0	4.2
	Fall	Moderate	587	42.9	1.53	12.0	3.3
						28.0	1.8

Fall Trials

Table 3 shows production and utilization for the fall use pastures. A request for 230 animals to be used during the grazing study was not met; consequently the pastures were understocked during this trial. To partially offset the lower number of animals (171), they were grazed for 52 days instead of the normal 45 days. Cold weather forced the termination of the trial at this time.

Table 3. Air dry forage production and utilization for the fall grazing trials of 1962.

Pasture	Intensity of use	Initial Production (pounds)	Utilization	
			Fall (percent)	Combined Spring & Fall (percent)
01	Light	466	34	--
06	Moderate	405	52	--
04	Heavy	344	74	--
10	Heavy	315	53	66
20	Light	252	33	73
30	Moderate	212	44	77
40	Heavy	221	58	78
50	Light	194	48	78
60	Moderate	225	45	72

Project E. S. 32. Ecology and Control of Goatweed (Hypericum perforatum).

Plans were made to re-sample a number of the more important study sites and to include the results in a comprehensive report covering 12 years of study. This sampling was accomplished and 1 or 2 publications will be prepared in the coming year.

The general trend at most study sites in 1963 was for a continued decline in Hypericum numbers from the moderate resurgence observed in 1959 and 1960. Populations of chrysolina beetles were observed on most sites where appreciable amounts of Hypericum occurred.

Project E. S. 34. Ecology of the Grasslands of Northern Idaho.

This project was on a maintenance level during the year, with no student help available to work on it. Limited reconnaissance of the Salmon and Snake River Valleys in the Riggins-Grangeville region was continued, with emphasis on the distribution and ecology of Aristida longiseta (three-awn). This unpalatable perennial is prevalent on many of the lower ranges of the region, and appears to have increased on heavily grazed areas. Efforts by ranchers to control this plant by burning appear to be of dubious benefit, especially on slopes where erosion potential is high. A study of the ecology and control of Aristida is being considered as a possible segment of this project.

III. Wildlife and Fisheries Management

Project W. U. 18. Productivity of Ruffed Grouse in Northern Idaho.

No field work was done on the project during the year except the continuation of grouse banding. Banding and attaching colored plastic neck bands was done both on the brood ranges in the fall, and on the drumming logs in the spring.

Project W. U. 19. Ruffed grouse populations and census methods.

Project inactive. Manuscript being prepared for final report.

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

Harley G. Shaw completed his Master's thesis under this project in September, 1962. The summary of his findings were reported in the annual report a year ago. The Idaho Fish and Game Department has multilithed the thesis under the title, "Seasonal Habitat use by Whitetail deer in the Hatter Creek Enclosure." This was listed as a Research Completion Report under Federal Aid in Wildlife Restoration, Project W131-R-1, dated 1962.

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

This study began in 1955 to determine the effect of specialized logging practices on stream environments and associated resident trout populations. The research consists of three phases, namely, a prelogging, logging and a postlogging phase. The project is now in the postlogging phase of analysis in one study area and in the logging or postlogging phase in a second study area.

Physical, chemical and biological samples were taken during the summer from each of the study areas. These samples were analyzed at the University laboratory and the findings were tabulated.

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

The winter of 1961-1962 was more severe than average and caused high concentrations of game animals on relatively small areas of range. During a more normal winter, the area would probably receive about the same amount of overall use, but would be better distributed over the range.

Big game and livestock use of the range as a whole was not excessive, but some areas of game concentration were over-used. A certain amount of overuse may be unavoidable, if proper overall use of the range is to be accomplished.

The bulk of big game use occurred on the stabilized sand between the Big Grassy Road on the north and the southernmost dune sands on the south. Within this area, a strip about one mile wide received the heaviest big game use. This strip extended from the westernmost Juniper Buttes on the north, through Nipple Buttes, and south and east along the southwest and south-facing slopes of the southernmost buttes.

Although a few game animals spent considerable time in the North, Northwest, and East Dune Areas, they were used primarily as migratory routes to and from the South Central Dune Area. Parts of these areas support good stands of browse forage and would undoubtedly receive more use during a more open winter.

Moose use was well distributed over the entire range, but mule deer and elk tended to concentrate near the buttes. Livestock use was quite evenly distributed over the portions of the range that they used.

Competition in this study is defined as occurring when two or more species of animals seek to obtain a supply of forage that is not adequate for both, where 50 per cent of current annual growth is considered to be the supply of forage. Competition according to this definition did occur between domestic sheep and big game, for chokecherry and bitterbrush, on the portions of the range where big game concentrated heavily during the Winter. Over-use of these areas by game would probably have occurred regardless of whether or not they were used by sheep. The sheep merely contributed to a problem that already existed.

Fall sheep use of browse species, prior to snow depths sufficient to render grasses and forbs at least partially unavailable, presented no real threat to the browse forage resource and contributed very little towards livestock-big game competition.

Browse consumption by sheep increased markedly after snow depths reached six inches or more. When sheep use the areas of heaviest game concentrations, after six or more inches of snow are present, competition with big game is probable.

Cattle used the range during the fall of 1961 before snow depths exceeded six inches, ate very little or no shrub growth, and did not compete with big game for browse forage. If cattle are left on the range after snow depths exceed six inches, browse consumption will undoubtedly increase, as will the likelihood of competition with big game.

Domestic sheep undoubtedly remove the largest amount of forage annually of any species, and very likely contribute to, or accelerate, the shrub climax on much of the range. Elk remove the next largest amount of forage, but use only slightly more than half as much as sheep. Deer and moose used approximately the same amount of total forage and together removed about the same amount as elk. Cattle remove half as much forage as either deer or moose.

Antelope bitterbrush is by far the most important single browse species on the winter range and is the mainstay in the diets of elk, moose, and mule deer. Western chokecherry and big sagebrush are both used extensively, but are of secondary importance. Chokecherry is used more intensively by moose and elk than by mule deer. Sagebrush is used considerably by deer and elk, but very little or none at all by moose. Rubber rabbitbrush is rated the third most important browse species, and is used considerably by elk, lightly by mule deer, and very lightly or not at all by moose.

The greatest detrimental effect on browse production has been the burning of shrub stands, and the second greatest, the concentration of game on the remaining stands of shrubs. Winter use of browse by livestock is considered to be the third greatest factor contributing to browse depletion. Because of their preference for grasses, elk are probably less affected by the burning of shrubs than are the browse-loving mule deer and moose.

The Juniper Buttes range could support more sheep and cattle if the big game was removed, and the shrub stands burned, and the area managed for livestock only. It could also support more big game if the livestock were removed, and no burning was allowed. However, the maximum benefit is probably derived by allowing both livestock and big game to use the range.

Project No. W. U. 37. The Ecology and Management of Browse on Elk Winter Range, Selway-Bitterroot Wilderness Area, Idaho.

No work was done on this project during the past year, but a number of chemical analyses of browse plants are planned for the coming year.

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

Since the thesis of the above title has been completed the summary of the project is given as the final report. Collection of deer for added productivity study is being continued.

A study on the productivity of mule deer on the Middle Fork of the Salmon River was conducted from September 1, 1961, through June 7, 1962. The study area included the winter range from the river to approximately 6,500 feet on three drainages - Warm Springs, Brush, and Sheep Creeks.

The population trend of the area appears relatively stable. Estimates are obtained through yearly trend counts conducted by personnel from local sportsmens' clubs, the Salmon and Challis National Forests and from the Department of Fish and Game. The 1962 trend count showed 568 deer on the study area from which a total population estimate of 800 deer was made.

Sex ratio and doe-fawn counts were conducted in late fall and early spring. The spring sex ratio showed 45.7 bucks per 100 does and the doe-fawn counts indicated 46.2 fawns per 100 does. Age classes for the study area herd taken from hunter kills, collected deer and the trapped deer showed 22 per cent yearlings, 10.2 per cent $2\frac{1}{2}$ year olds, 43.2 per cent prime deer ($3\frac{1}{2}$ through $7\frac{1}{2}$ year olds) and 24.6 per cent old deer (8 years and over). For the productivity calculations, the prime group was expanded to include the $2\frac{1}{2}$ year olds.

Reproductive data was obtained by ovarian analysis of ovaries taken from hunter kills and thirty-five does collected from December through April. In 1960, 100 per cent of the forty-two does examined, including yearlings, were pregnant. In 1961, sixty per cent of the yearlings, 94.1 per cent of the prime and 100 per cent of the old deer had experienced pregnancy.

The fertilization rate or number of ova shed that are fertilized as ascertained from the collected deer was 100 per cent. This was believed to be too high and a 95 per cent figure was used in

Project No. [illegible] The [illegible] of [illegible] Numbers [illegible] in the [illegible] Area, Idaho.

No work was done on this project during the past year, but a number of chemical analyses of browse plants are planned for the coming year.

Project No. [illegible]

Since [illegible] of the [illegible] has [illegible] the [illegible] of [illegible]

A study on the [illegible] in the Middle Fork of the Salmon River [illegible] through [illegible] 1964. [illegible]

[illegible] population [illegible] of the [illegible] relatively [illegible] are obtained [illegible] collected by [illegible] from local [illegible] the Salmon and Challis National Forests and from the [illegible] The [illegible] [illegible] study [illegible] were [illegible] by [illegible] per cent [illegible] years old, [illegible]

The [illegible] have been collected from [illegible] through April. In 1964, [illegible] were [illegible]

The [illegible] as determined from the [illegible] believed to be [illegible]

calculations. Prenatal loss was 1.92 per cent or one of the fifty-two fetuses collected. Using these figures, 159 fawns were produced for every 100 does of breeding age in 1961. In 1962, the figure was 147 fawns per 100 does.

Early fawn mortality, as obtained from doe-fawn counts, was 47.6 per cent. The over-winter loss was 18.5 per cent. Some malnutrition was observed in fawns. Diseases and parasites did not appear to cause any significant losses. The pre-winter and post-winter summer adult losses were assumed to be one per cent for each period. The primary cause of the high early fawn loss was not ascertained, but it is believed to be due to poor doe condition during parturition.

The hunting kill on the study area was 102 deer or 12.7 per cent of the deer on the study area. Fifty-eight and eight-tenths per cent of the kill was bucks, 31.4 per cent was does and 9.8 per cent was fawns. Crippling loss was assumed to be fifteen per cent of the legal kill.

Observations of the sixteen tagged deer indicated the deer did not travel between drainages on the study area, nor did they cross the river. Four observations of these deer on their summer ranges show movements of forty to fifty miles.

Potential productivity of the deer on the study area for the 1961 breeding season was 85.1 per cent. This figure is high because of the 45.7 bucks per 100 does sex ratio, the low percentage of unproductive yearlings and the relatively high production of 1.59 fawns per doe.

Net productivity after the heavy natural losses are deducted, was 18.9 per cent. For 1961, an increase of 4.3 per cent occurred in the study area herd.

Winter range condition appeared to be the most important factor in influencing productivity. Most of the heavy early fawn mortality and over-winter losses can be indirectly attributed to poor winter range condition.

Project W. U. 42. The Life History and Seasonal Movement of a Fluvial Cutthroat Trout in the Salmon River, Idaho.

This project is described in a thesis entitled, "The Life History and Seasonal Movements of Cutthroat Trout in the Salmon River, Idaho." The following was taken from the summary of the above thesis.

A tagging experiment was begun in July, 1959, to determine seasonal movements of the cutthroat trout population. Jaw tags were attached to 2,247 cutthroat trout of which 173 or 7.7 per cent have been recovered. Ninety-five or 55.9 per cent of the cutthroat trout recovered were recaptured downstream, 32 or 18.8 per cent were recaptured upstream, and 43 or 25.3 per cent were recovered in the same location as tagged. The mean number of miles between release and recovery sites for the tagged fish which were recovered 1 or more miles from release sites was approximately 18 miles with a range of 1 to 80 miles. Cutthroat trout moving downstream has an average movement of 19.9 miles with a range of 1 to 80 miles. Tagged cutthroat trout moving upstream to spawn had an average movement of 21.6 miles with a range of 6 to 45 miles while the remaining upstream migrants had an average movement of 10.8 miles with a range of 1 to 57 miles. Seventy-five per cent of the cutthroat trout recovered upstream or downstream from the release sites were captured more than 5 miles from the release sites. There was no correlation between size and distance traveled in fish moving downstream. Among the upstream migrants there appeared to be a trend for the larger fish to move farther. Downstream cutthroat trout movement took place in the fall and upstream movement in the spring. Many fish were recovered in the Salmon River in the winter. Scale readings indicated that seven year classes existed in the Middle Fork cutthroat trout population.

Many cutthroat trout in the Middle Fork do not form an annulus at the end of the first year of life, the exact percentage varying with the age class. Percentage of normal scales (forming an annulus at end of first year of life) in each age class as determined from 472 scale samples was: Age Class II - 73.7 per cent, Age Class III - 74.6 percent, Age Class IV - 55.2 percent, and Age Class V - 66.7 percent. These variations are probably related to annual environmental differences related to growth. Middle Fork cutthroat trout matured at approximately 295 millimeters fork length or in their sixth year of life. Approximately 23.5 percent of the cutthroat trout caught on project float trips were fish that had spawned the spring of the year that they were caught or were capable of spawning the following spring. Calculated mortality rates of Middle Fork cutthroat trout were as follows: total annual mortality, 67.9 percent; fish exploitation, 17.4 percent; and natural mortality, 50.5 percent. Mortality incurred in tagging of cutthroat trout was determined to be less than 5 percent.

In 1960, commercial float trips down the Middle Fork contained 238 anglers who applied a total of 5,320 angler hours of fishing pressure. Commercial float trips released approximately 85 percent of the cutthroat trout caught as compared to 26.5 percent released by anglers flying into airfields.

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

Summary of the project is given in the conclusions and summary of the above thesis:

The following tentative conclusions concerning the study area can be made from the results of this investigation.

1. The soil is generally very unstable.
2. The ground surface does not have adequate vegetational cover to protect the soil from disturbance.
3. The bitterbrush stands are over-mature and there is inadequate reproduction to maintain the browse.
4. There is a very limited amount of available soil water in the upper twelve inches of the soil during the months of July and August.
5. The area is in poor condition.
6. The trend of the range is toward an increase in grasses and a decrease in shrubs.
7. The large concentrations of mule deer that winter on the study area definitely contribute to the instability of the soil, the low ground-surface vegetational cover value, and the poor condition rating. They contribute to the lack of browse reproduction, and therefore, to the trend of the range.
8. During a more severe winter, a major portion of the bitterbrush plants available for deer use would be utilized above the recommended 60 percent maximum utilization factor. If a very severe winter occurred, there would be large numbers of deer lost from starvation.

A preliminary ecological study was conducted on a small portion of the Middle Fork of the Salmon River mule deer winter range from June 1961 to June 1962. This study was instituted to aid in the management of this important winter range. A resume of the methods and results follows:

The bitterbrush type was separated from other vegetational types by the preparation of a type-map. All of this study was conducted within this bitterbrush type.

Weather data were recorded at two weather stations. The maximum temperature recorded was 106°F. and the minimum was -19°F. The precipitation from August 1961, through July 1962, totaled 11.9 inches at the lower weather station and 15.0 inches at the higher weather station.

Soil temperature data were collected at surface, 2-inch, and 4-inch depths. The maximum soil surface temperature recorded was 164°F.

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Soil temperature data were collected at surface, 2-inch, and 6-inch depths. The maximum soil surface temperature recorded was 1[illegible]° F.

There was very little available water in the soil at 4- and 12-inch depths during the months of July and August, as ascertained by the weight method of determining the percentage of soil moisture in the soil. The percentage of soil moisture in the soil during these two months was similar to the percentage of soil moisture in the soil at the wilting point (15 atm.).

An attempt was made to ascertain the stability of the soil by the use of soil transects and can sites, and by observation. The soil is generally very unstable on these relatively steep slopes with three forces causing the general downslope movement--surface run-off, animal movement, and gravity.

Information was gathered on the cover of the range by the line interception method. A ground-surface vegetational cover value of 21.7 percent was ascertained with over one-half of the cover consisting of litter.

The same method showed bitterbrush, big sagebrush, gray rabbitbrush, and slenderbush eriogonum, which provided 9.0, 5.4, 4.3, and 4.3 percent of the live ground surface vegetational cover respectively, to be the predominant shrubs. Bluebunch wheatgrass (12.7 percent) was the predominant grass, and balsamroot (36.8 percent) and buckwheat (3.7 percent) were the most important forbs. Balsamroot was measured at the leaf-spread level rather than at the ground-surface.

Density measurements were made to the nearest perennial plant, perennial grass, shrub, and bitterbrush with the point-centered quarter method. The same plants predominated as in the composition study, with one exception. Phlox sp. was the forb that occurred the most frequently. Relative density of the shrubs as determined by measurements to the nearest shrub was 27.7 percent for bitterbrush, 23.3 percent for gray rabbitbrush, 19.3 percent for big sagebrush and 14.8 percent for slenderbush eriogonum. Relative density of the perennial grasses as determined by measurements to the nearest perennial grass was 62.5 percent for Agropyron spp., 20.6 percent for needle-and-thread, and 12.6 percent for Sandberg bluegrass. Relative density of the perennial forbs as determined by measurements to the nearest perennial plant was 8.4 percent for Phlox sp., 5.1 percent for balsamroot, and 3.5 percent for buckwheat.

The mean of the distances to the nearest perennial plant was 2.0 $\pm$ 0.1 feet; to the nearest perennial grass was 4.2 $\pm$ 0.5 feet; to the nearest shrub was 9.9 $\pm$ 0.6 feet; and to the nearest bitterbrush was 25.2 $\pm$ 1.6 feet. The mean number of the plants per acre were ascertained from these measurements. There are approximately 10,890 perennial plants per acre on the study area; approximately 2,469 perennial grass plants per acre; and approximately 444 shrubs per acre, of which 69 are bitterbrush plants.

Utilization of bitterbrush was ascertained by linear twig measurements of the current annual growth "before and after use". Utilization of the bitterbrush on the study area during the 1961-62 winter was 55.5 percent of the annual growth.

The mean age of the aged bitterbrush plants for Warm Springs Creek was 53 ± 7 growth rings; for Sheep Creek, 53 ± 6 growth rings; and for lower Brush Creek, 40 ± 5 growth rings.

On the basis of the data collected, the limited available soil water in the soil during July and August appears to be a major reason for the lack of bitterbrush reproduction.

The condition of the range was classified as poor. The basis for this rating was primarily the instability of the soils, the low ground cover value, and the lack of the young age class for bitterbrush.

The trend of the range appears to be toward an increase in grasses and a decrease in shrubs, based on data gathered from repeating plant occurrence counts originally made in 1931 and 1950.

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

During July, August, and September 1962, microclimatic measurements, including dew measurements, were made at 18 "permanent" sites as well as at 56 temporary stations. Station instrumentation varied according to the purpose of each station in the research scheme. Fully instrumented stations contained a hygrothermograph, recording anemometer, and a dew gauge. A maximum-minimum thermometer and dew gauge were used at temporary stations in dew-temperature-relative humidity studies. Precipitation was measured at three sites.

Dew Gauge Development

During the summer of 1962, we continued to test several types of dew measurement devices. A four inch square plate of matted Acetate (Keuffel and Esser Herculene Drafting Film .002 inch thickness) mounted on a frame of brass welding rod, again was our basic instrument. This gauge is designed for weight determination of dew. The gauge was positioned so that the matted acetate plate was at a height of six inches and parallel to the ground surface. The plates were exposed overnight, and weighed the following morning before evaporation of accumulated dew began.

Collector gauges designed for volumetric measurement, described in the 1962 report were tested again. It was found difficult to accurately measure all dew formed on the collection surface. The effect of the angle of suspension and the funneled portion of the gauge present problems in evaluation of the measurement. Treatment of the collector surface with a detergent solution (Scott, 1962) produced erratic results.

To gather information about the rate of accumulation and the duration of dew, we modified the recording dew gauge used by Lloyd (1961) in his experiments in northern Idaho. As he used it, the instruments consisted of an expanded polystyrene block mounted on a balance, a drum driven by a 7-day clock, and a pen geared from the balance to the drum. As dew accumulated, weight changes of the block were recorded on a chart mounted on the drum.

Because of possible errors due to the moisture absorption and heat exchange properties of the polystyrene block, we replaced it with a 12 by 24 inch sheet of matted acetate, but the acetate plate was too light to produce the desired sensitivity. Further experiments with this dew gauge are planned.

Experiments with electronic dew recording were continued, using a varying resistance correlated with amount of dew. Pressure sensitive paints have been wired in circuits to give records on strip-chart recorders. We can get records of amount of dew by this method, but have not yet overcome the problem of lack of sensitivity. Stacking paint spots and other means of adding sensitivity have not yet solved this problem. Work on this type of dew gauge will continue.

One entirely new idea is now being tested as a possible dew gauge. This is a capillary tube arrangement for converting dew precipitated on a surface to a volumentric tube where comparative readings can be made. A number of preliminary experiments have been made during the winter in the laboratory, and field testing is planned for the 1963 season.

Amounts and Pattern of Distribution of Dew.

As in 1961, dew measurements were restricted to a series of clustered sites. The weighing procedure dictated this system of location. For the most part, the same sites described in the 1961 report were used during the summer of 1962. Dew measurement profiles were established in three major ravines of the study area.

The summer of 1962 has been characterized as cool and often unsettled. Above normal precipitation and wind would have allowed for few accurate dew measurements during June. A summary of dew occurrence during July, August and September is presented in

Table 1. Measurable dew accumulation did not occur on only 9 out of 59 attempted measurement days. Overcast skies were the main prohibiting cause. Below normal temperatures contributed to favorable microclimatic conditions for dew accumulation whenever evening skies were clear. In fact, dew often formed in early evening and was frozen by morning. These conditions were not the case in 1961 when high temperatures were common. Table 2 summarizes dew measurement made at the "permanent" stations with the .002 inch thick acetate plates. For ease of comparison, the weight of dew in grams has been converted to the equivalent in millimeters. It was determined that measurements were not sufficiently accurate beyond one-tenth of a gram or one-hundredth of a millimeter.

Table 1.
Summary of 1962 Dew Occurrence

	July	Aug.	Sept.	Totals
Number of days measurements attempted-	20	20	19	59
Number of days dew measured-	17	17	16	50
Number of days without measurable dew-	3	3	3	9
Number of days measurements not attempted but occurrence of dew probable-	10	4	6	20
Number of days rain prevented dew accumulation or measurement-	1	6	5	12

Table 2.
Summary of Dew Measurements on "Permanent" Stations
Summer of 1962

Site	No. Nights Exposed	No. Nights Dew Recorded	Range of Dew Measurements in Millimeters	Mean in Mn.
Clearcut Station A	45	35	.01 -.20	.094
Clearcut Station B	19	13	.01 -.11	.065
Clearcut Station C	19	13	.01 -.10	.063
Clearcut Station D	55	6	.01 -.06	.035
Clearcut Station E	46	36	.01 -.20	.092
Clearcut Station F	19	13	.01 -.14	.085
Clearcut Station G	19	13	.01 -.12	.062
Clearcut Station H	56	11	.01 -.10	.045
Clearcut Station I	55	42	.01 -.27	.122

Site	No. Nights Exposed	No. Nights Dew Recorded	Range of Dew Measurements in Millimeters	Mean in Mm.
Clearcut Station J	19	14	.03 - .16	.106
Clearcut Station K	19	14	.01 - .14	.086
Control Station L	56	0	---------	0
Clearcut Station M	19	11	.01 - .14	.087
Clearcut Station N	19	11	.01 - .16	.079
S.W. Corner Block #3	9	6	.03 - .14	.090
N.W. Corner Block #3	9	7	.04 - .18	.107
Meadow	59	49	.01 - .21	.125
Railroad Grade	50	44	.06 - .28	.204

Daily measurements ranged from .01 to .28 mm. Mean measurement values varied from 0.000 mm. under the dense canopy of conifers at Station L to .204 mm. at the railroad grade station. Under loss dense canopies, dew did occur at stations D (.035 mm.) and H (.045 mm.). The railroad grade and meadow stations had the highest mean dew deposition. Improved weighing facilities allowed for more accurate measurements at the ravine stations than were possible in 1961. As in 1961, Station I had the highest mean value of any station in the clearcut blocks.

Microclimatic Factors

Recording instruments loaned to us by the Weather Bureau have accumulated a large volume of microclimatic data. Instruments charts have been transcribed onto permanent record sheets. The data have not yet been machine analyzed. We hope to define relationships existing between temperature, relative humidity, air drainage, and dew accumulation.

Nocturnal temperature inversions occur during most of the summer months in the ravines of the study area. On a majority of our observation days, dew accumulation has appeared to be related to microclimatic conditions characteristic of these inversions. Profile stations were established in each of the major ravines to detect the influence of these cold air pools on dew formation. Because of the density of vegetation, uniformly open hillsides were difficult to find. Diversity in the pattern and growth form of vegetation has often masked the effects of the inversion. Further interpretation and new profiles are planned. These measurements have emphasized the ever-changing pattern of dew proneness in a forested area.

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

The title of the project report was changed from "The Life History of the Cutthroat in Northern Idaho" to "Studies of Two Races of Cutthroat in Northern Idaho." The latter title is more descriptive of the study.

The important findings of the study are summarized as follows:

1. A life history study of the cutthroat trout in the St. Joe River of northern Idaho was begun in July 1961, and terminated in September 1962.

2. Two races of cutthroat trout, Salmo clarki lewisi (Girard), inhabit the St. Joe River drainage. One race is adfluvial and moves from a stream to a lake environment; the other race is resident and spends its entire life in a stream environment. Scales from adfluvial cutthroat show 1 to 3 years of stream growth characterized by fine, narrowly-spaced circuli, and 1 to 3 years of lake growth characterized by broad, widely-spaced circuli. Resident cutthroat scales show only the fine, narrowly-spaced circuli.

The two races are significantly different at the 0.01 level on size at first annulus and number of included circuli within the first annulus. A meristic comparison among the largest cutthroat of the lower four tributaries and Gold Creek (one of the two upper tributaries) shows that (1) scales in a diagonal row above the lateral line are significantly different at the 0.05 level between Gold Creek fish and those from the lower tributaries and (2) pyloric caeca counts are significantly different at the 0.05 level between Gold Creek cutthroat and those from Benewah and Thorn Creeks.

Adfluvial cutthroat were captured in Benewah and Thorn Creeks during the study period, and anglers report catching adfluvial cutthroat in Trout and Mica Creeks during early June. Thus, it appears that at least some if not most of the juvenile cutthroat in the lower tributaries downstream from adfluvial spawning areas are premigrant forms that have not completed their stream residency.

Angler catch records show that the adfluvial cutthroat do not range above the Turner Flat Campground area. This is some 28 river miles below the upper tributaries. An abrupt elevation change in the river (851 feet) takes place between the upstream limit of the adfluvial cutthroat spawning range and the upper tributaries, and thus may help to separate geographically the two cutthroat races.

3. Adfluvial cutthroat begin their spawning migration in early April. This migration extends about 75 miles up the St. Joe River. In the lower tributaries spawning takes place in early May, and most of the fry have emerged by late June. In the upper tributaries spawning is apparently later as some unscaled fry were collected as late as September 12.

4. Annuli are formed during the spring, as indicated by the presence of a distinct annulus immediately prior to the first lake-formed circuli. Thus, lakeward movement of juvenile adfluvial cutthroat apparently takes place during the spring, and may coincide with the upstream migration of mature adfluvial cutthroat.

5. Of the 90 adfluviat cutthroat scales examined during this study, 28 per cent showed one year, 66 per cent showed two years, and 6 per cent showed three years of stream growth. Of these same scales, 14 per cent showed one year, 57 per cent showed two years, and 29 per cent showed three years of lake growth.

6. Adfluvial cutthroat show accelerated growth upon entrance to the lake complex. This is most apparent in fish that leave the stream environment after their second year of life. The year prior to spawning the growth rate decreases.

7. First-year cutthroat begin to form scales at a fork length slightly greater than 40 millimeters. Scales first develop in the area of the caudal peduncle, both above and below the lateral line.

8. Mature female adfluvial cutthroat contained from 204 to 1384 eggs. A trend was apparent between length of fish and number of eggs.

9. Adfluvial cutthroat provide an early season fishery in the St. Joe River. Reports from anglers reveal that the majority of the adfluvial cutthroat have returned to the lake complex by mid-June. The last adfluvial cutthroat captured in the river was on July 22.

10. The importance of the cutthroat trout fishery in the St. Joe River is attested by the fact that the cutthroat has survived and maintained itself in the presence of increased angling pressure, the introduction of other game fish, and increased numbers of non-game fish. The future of the cutthroat fishery will depend upon the protection of the spawning runs and the environment of the tributary streams where spawning takes place and where young cutthroat spend their first crucial years of life.

Project W. U. 47. The Determination and Development of Sperm Toxins for the Control of Undesirable Species of Fish.

This project is directed toward the development of a selective toxin which would not be lethal to salmonids, but which would suppress selected coarse fishes and presumably improve the production efficiency of our fishing waters. The northern squawfish, Ptychocheilus oregonensis, was singled out as a test species for this research because a number of investigators have shown that it is both a serious competitor and predator of young salmon and trout. It occurs in large numbers and preys upon both hatchery planted fish as well as natural stocks of salmonids.

The objectives of the project were as follows:

1. To determine the minimum effective concentrations, lethal to fish sperm, of various toxins which are sublethal to young salmonids at the concentrations tested.

2. To test the effectiveness of sperm toxin in suppressing a natural squawfish population.

3. To explore and develop any toxins, which during the course of this investigation are noted accidentally to have detrimental effects on the eggs or larvae of the course fish utilized.

Although not in the original plan, the determination of piscicides became a fourth objective of this program.

Laboratory facilities were constructed at Rochat Creek during the spring and summer of 1962. This enabled the investigators to conduct bioassays in a natural supply of cool water. The creek is located in close propinquity to the confluence of the St. Joe and St. Maries Rivers, both of which support large populations of squawfish. Screened tanks, provided with running water, were arranged outside the laboratory for sorting and holding live squawfish. Also, along the Rochat Creek side of the laboratory a large pond was evacuated which was open to the creek on one side. A wire fish pen (16' x 8' x 2½') was constructed and placed in the pond. The wire pen was subdivided into three compartments which facilitate the sorting and handling of fish.

Potential toxins to be used in the spermacide bioassays were prepared at the Fishery Laboratory of the University of Idaho. At the St. Joe River field laboratory, each chemical was diluted with water and placed in a squat, cardboard tub so that the resulting solution contained 5 ppm of chemical. Plastic petri dishes were placed in the tubs and small quantities of squawfish eggs were stripped directly into the petri dish which was submerged in the toxin. A few drops of milt were squirted into the

solution directly over the eggs and the solution stirred. A series of tubs complete with petri dishes but containing different toxins was available so that a female could be totally stripped of her eggs in one operation. Three control tubs which contained pure water instead of toxins were used for the first, middle and last batches of eggs.

In 1962, the developing eggs were preserved in vials for later microscopic examination and mortality counts. In 1963 the percentage of mortality was roughly estimated by inspection on the first and sixth days after fertilization.

Construction of the laboratory delayed the start of chemical screening in 1962; because of this, the spawning run of squawfish was almost completed and only a few laboratory tests could be made.

As the spermacide approach to the general problem of rough fish control is somewhat unique, unpredictable problems arose in the development of techniques, design of apparatus and the incubation of squawfish eggs. In 1962 only twenty-two batches of eggs and in 1963, thirty-five batches of eggs were available for spermacide studies.

Criteria for distinguishing between degenerated eggs and fertile eggs have been established, but the problem of obtaining quantities of viable squawfish eggs has not been solved. If ripe, a dozen large females would produce over 1000 batches of eggs from testing toxins.

A total of 415 piscicide toxins were tested at concentrations of 10 ppm. Of these 143 proved to be biologically active. Forty-three of these 143 toxins have been tested at concentrations of 1 ppm, thus far. At this lower dilution, 12 of the 43 toxins have proved lethal to squawfish in a 24 hour period.

In order to ascertain what compounds or groups of compounds had been identified as biologically active so that bioassay tests could be conducted with those chemicals which appeared to have the greatest likihood of success, a review of appropriate literature was made. 520 articles from Biological Abstracts, 74 from Chemical Abstracts, 3 sections of Excerpts Medica and 10 articles from Indexus Medicus were reviewed.

To date, the research has been essentially exploratory in nature. Much time has been spent organizing equipment and devising workable procedures. The piscicide research was begun as a side issue with the idea of making maximum use of time and materials.

Project W. U . 48. The Role of Mountain Meadows in The Ecology and Management of Elk.

JUSTIFICATION:

Mountain meadows appear to be important spring and summer range for elk. Detailed information is lacking on the importance of mountain meadows in total elk ecology.

Many of the meadows near Elk City are also used by cattle. The degree of competition between elk and cattle must be learned in order to calculate proper stocking rates. The Idaho Fish and Game Department has encouraged the Wildlife Research Unit to start this research because of continued complaints of elk reducing grazing capacity for cattle.

The field work for this project began June 10, 1963, by graduate student Kowalsky. A statement of the objectives follows:

1. To determine reduction in total forage production caused by premature spring grazing by elk.
2. To determine the degree of competition that exists between elk and cattle on the mountain meadows.
3. To determine whether elk are inducing a trend in the condition of the meadows.
4. To determine the relationship between elk use and size and shape of meadows.
5. To determine the relative use of parts of a meadow at different distances from the edge.
6. To determine population trend of elk on meadows during spring and summer.
7. To determine importance of mountain meadows as elk calving grounds.

Project W. U. 49. Beaver Productivity and Movements in Southeastern Idaho.

JUSTIFICATION:

Productivity of a population is an important factor in determining management plans for beaver. A large population exists in the study area and further information is needed to more efficiently manage the beaver resource. The bulk of the beaver population remains within the national forest boundaries but adjacent irrigated farms constantly report damage to irrigation ditches, roads and culverts. The extent to which beaver move into these farming areas is unknown and hence a part of this study.

Field work began on June 12, 1963, northeast of Montpelier, Idaho.

OBJECTIVES:

1. To determine the productivity of a beaver population in Bear Lake County, Idaho.
2. To determine movements of this population in relation to migration to adjacent irrigated agricultural lands.
3. To evaluate damage to irrigation structures.
4. To determine relationship of aspen harvest and regeneration to stability of beaver population.

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I. Technical Publications

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II. Miscellaneous Publications

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III. Graduate Theses (M.S. June, 1963)

Averett, Robert C. "Studies of Two Races of Cutthroat Trout in Northern Idaho."

McIlvain, Billy G. "Effects of Grazing Intensities on Cattle Gains and Crested Wheatgrass Ranges in Southern Idaho."

Mallet, Jerry L. "The Life History and Seasonal Movements of Cutthroat Trout in the Salmon River, Idaho."

Ollieu, Max M. "The Biology of Eucosma rescissoriana Heinrich in Western White Pine of Idaho (Lepidoptera:Olethrentidae)."

Presby, Richard C. "Ecology of the Mule Deer Winter Range on the Middle Fork of the Salmon River, Idaho."

Shaw, H arley G. "Seasonal Habitat Use by White-tailed Deer in the Hatter Creek Enclosure."

Wing, Larry D. "Big Game and Livestock Browse Utilization and Feeding Habits on a Sandy Range in Southeastern Idaho."

Wood, Robert E. "A Productivity Study of Mule Deer on the Middle Fork of the Salmon River, Idaho."

2. University of Idaho Special Research Funds for Projects 27-D, 54, 55, 63, 65, 70, 77 and 80.

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

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

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

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

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

8. Southern Idaho Forestry Association. Financial support for forest genetics research.

9. United States Bureau of Commercial Fisheries. Funds for research on determination and development of sperm toxins for control of undesirable species of fish.

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

11. United States Bureau of Sport Fisheries and Wildlife. Funds for the Wildlife Research Unit.

12. United States Department of Agriculture. Funds from Regional Research Projects WM-42, W-25 and W-71, through cooperation of Agricultural Experiment Station, University of Idaho.

13. United States Forest Service. Funds for a growth-quality study of western red cedar, office space at the Boise office of the Intermountain Forest and Range Experiment Station, field living accommodations and assistance in collection of research material for several projects.

14. United States Weather Bureau. Funds for research on distribution and significance of dew on selected forest sites.

15. Wildlife Management Institute. Funds for wildlife research.

APPENDIX A. F.W.R. EXPERIMENT STATION STAFF 1962-1963

I. Regular Staff Members

Ernest Wohletz, Director and Professor (Forest Management)
E. W. Tisdale, Associate Director and Professor (Range Management)
P. D. Dalke, Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Management)
M. E. Deters, Professor (Forest Management)
Minoru H ironaka, Assistant Range Ecologist
A. D. H ofstrand, Assistant Professor (Wood Utilization)
J. P. Howe, Associate Professor (Wood Utilization)
J. R. Howland, Acting Instructor (Forest Management)
K. E. H ungerford, Professor (Wildlife Management)
F. D. Johnson, Assistant Professor (Forest Management)
H oward Loewenstein, Associate Professor (Forest Management--Soils)
Craig MacPhee, Associate Professor (Fisheries Management)
A. D. Partridge, Assistant Professor (Forest Management--Pathology)
F. H. Pitkin, Assistant Professor and Nurseryman
R. H. Seale, Associate Professor (Forest Management)
J. E. Schenk, Assistant Professor (Forest Entomology)
L. A. Sharp, Associate Professor (Range Management)
Chi-Wu Wang, Associate Professor (Forest Genetics)
E. L. Williams, Assistant Forest Economist

II. Research Fellows

R. C. Averett--Fisheries Management
J. R. Crooks--Forest Genetics
B. E. Dahl--Range Management
J. D. Daniels--Forest Genetics
S. I. Kowalsky--Wildlife Management
T. A. Leege--Wildlife Management
B. G. McIlvain--Range Management
W. S. McNamara--Wood Utilization
J. R. N elson--Range Management
M. M. Ollieu--Forest Entomology
R. C. Presby--Wildlife Management
H. G. Shaw--Wildlife Management
S. W. Stroup--Forest Management
L. D. Wing--Wildlife Management
R. E. Wood--Wildlife Management

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT 1962-1963

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