FOREST, WILDLIFE AND RANGE EXPERIMENT STATION

COLLEGE OF FORESTRY, WILDLIFE AND RANGE SCIENCES

UNIVERSITY OF IDAHO

Moscow, Idaho

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

For the Fiscal Year 1964-65

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

December, 1965

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INTRODUCTION

Experiment Station personnel were actively involved in 39 research projects during the year covered by this report. Nine of these investigations are listed for the first time and represent work recently initiated. An additional 10 projects are currently on inactive status.

No staff additions were actually made this year, but a scientist was selected to fill a newly created position in the field of watershed management. This appointment is to take effect early in the 1965-66 fiscal year.

Dean Wohletz was on sabbatical leave during the second semester. He visited forests and forestry schools in the southeastern United States and Puerto Rico, and spent one month inspecting German forestry installations as guest of the German Federal Republic. Professor Seale was in residence at the New York State College of Forestry the entire year completing requirements for his doctorate degree.

More effective use of the Forestry Building has resulted from relocation of the offices of many staff members. So far as possible, personnel working in the same general areas of investigation have been closely grouped around research laboratories devoted to their specialties. Repainting of the entire building was also accomplished during the year.

The constantly increasing complexity of research in forestry and allied fields demands advanced equipment for most fruitful results to be obtained. This year the facilities of the Experiment Station continued to be improved through expenditure of funds from various sources which are listed in the appendix. By use of these monies, for example, a completely automatic radioisotope counting system was acquired.

In order to facilitate dissemination of research results, the Experiment Station Research Note series has been superseded by two new publications. The new Station Notes series is chiefly designed to bring to those interested relatively short reports of work-in-progress. Two of these notes, commercially printed in an attractive format, were issued during the year. The second new series, to be called Station Papers, will be largely devoted to 'in depth' recapitulation of completed projects. The old Experiment Station Bulletin Series will be retained for the occasional more lengthy monograph.

Ernest Wohletz

Ernest Wohletz, Director

Howard Loewenstein

Howard Loewenstein, Acting Assoc. Director

WORK ACCOMPLISHMENTS

I. Forest Management and Wood Utilization

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

Approximately 80 specimens of injured and diseased trees were received from people throughout the state. No serious epiphytotics were found, except that a localized outbreak of a dieback of russian olive was studied. The cause is unknown at present. As a result of field observations, 8 new descriptions of decays were recorded.

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

Tests for ecotypic response in mycorrhizae were conducted using both fungi and lodgepole pine seed collected in two widely divergent habitats. The south seed source was located at Iron Creek on the Challis National Forest near the town of Stanley, Idaho. Seed and fungi were collected from a pine stand of lodgepole pine with an understory dominated by Vaccinium scoparium, V. caespitosum and Carex geyeri. This community is floristically similar to many thousands of acres of central Rocky Mountain disclimax lodgepole pine. The northern collections were made near Athol, Idaho on Rathdrum Prairie in a seral stand of lodgepole in a western redcedar/Pachistima myrsinites climax type. Thus the southern site was floristically central Rocky Mountain subalpine while the northern site represented a mid-slope Pacific coast flora.

Mycorrhizae were synthesized by the method described in the 16th Annual Report (Dec. 1964). Trees were grown in a growth chamber with a 14 hour photo period and an 80°-60°F. day-night temperature regime.

Two fungi were selected for this test: Suillus tomentosus and S. brevipes. Both are very common under lodgepole pine, both are constantly associated with hard pines (Sect. Diploxylon) throughout their range and both are abundant in northern and southern Idaho lodgepole stands. Development period varied from 21 to 30 weeks; a total of 201 seedlings were involved in the trials.

In the table below, percentage of mycorrhizal seedlings are shown for the two fungi-two seed source parings:

	North Fungi			South Fungi
North Seed	18	31	S. brevipes	6
	50	60	S. tomentosus	88
	44	42	both fungi	46
South Seed	52	57	S. brevipes	48
	44	15	S. tomentosus	75
	49	42	both fungi	57
TOTAL		42		51

These data give conflicting insights into the possibility of mycorrhizal ecotypes: S. Brevipes (South) formed mycorrhizae with only 6 per cent of the North Seedlings and 48 per cent of the South seedlings. On the other hand, S. brevipes (North) was mycorrhizal on 31 per cent of the North seedlings and 57 per cent of the South seedlings. S. tomentosus (North) was also much more mycorrhizal with North seed than with South (60%-15%) but S. tomentosus South was about equally compatible with North and South seedlings (88%-75%). Nonetheless, these are strong indications that further refinements in testing and analysis should be undertaken.

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

Findings indicate this disease is confined to seedlings and is caused by exposure and rough handling during lifting. After predisposition, soil-inhabitors, particularly Fusarium spp., invade and decay phloem tissues. Careful storage, sanitation in storage, handling and packing reduce damage.

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

Carbon and nitrogen requirements of the fungus were found less significant than micronutrients which permit utilization of most available sources. This work is being prepared for publication.

Field studies in northern Idaho indicate cull can be controlled by selecting specific ecotypes for planting, cultivation, and thinning. In addition, specific individuals can be selected to reduce pathological hazards. Sanitation appears to be useless. Cull can be estimated only on entire stands, because external indicators are unreliable on individuals but collectively indicate stand condition.

Partly or greatly decayed wood yielded 10 per cent to 20 per cent less pulp than sound material in laboratory studies, and strength values dropped markedly as decay began.

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

A new cooperative agreement for the Genetic Tree Improvement Program of the University and its cooperators were prepared in 1965. The cooperators in this program include: U. S. Forest Service, Region I, Northern Region and Region IV, Intermountain Region; Intermountain Forest and Range Experiment Station; U. S. Bureau of Land Management; Idaho State Department of Forestry; Southern Idaho Forestry Association and Northern Idaho Forestry Association.

Works related to the improvement of ponderosa pine are carried out according to the three-phase work plan prepared by the University. (Ref. FWR Annual Rep. p. 5A) Field testing of ponderosa pine progenies as conducted in project S. R. 77, and the basic research related to tree improvement projects the heritability and population studies, are reported in Project M. S. 3.

Phase I of the work plan is primarily for initial screening of genetically superior parent materials. The procedure includes (1) phenotypic selection of superior natural stands and trees in southern Idaho, (2) 1 - parent progenies of the initially selected trees are used in four plantations to be planted at the different elevations in Boise and Payette areas. They are established for

the combined purpose of progeny testing and seed production. (3) The natural stands, where from the best progenies, are produced as evidence by the 1 - parent progeny tests are managed as seed production areas for the immediate production of improved seeds and (4) the original plantations after successive selections, thinnings and roguings are reduced to approximately 40-50 trees per acre (or approximately five per cent of the original progenies). They are to be managed as seed orchards for mass seed production.

At the end of this growing season, approximately 48,000 seedlings of the selected progenies will be raised to 2-0 stage in the Lucky Peak Nurseries of the Forest Service, Boise. Four seed orchard sites have been selected by the seed orchard site committee. The two sites in the Boise area are in Idaho City and Holcomb, and two in the Payette area in Boulder Creek and Sagebrush Flats near McCall. Ground preparation will be made this fall. Full cooperation of all the cooperators is being experienced and the progress of this project is on schedule.

Project S. R. 77. Progeny Test of Ponderosa Pine.

The performance of 1-parent progenies from 284 trees selected in 1961 and 1962 and sowed in 1963 and 64 are observed in both the 1-0 and 2-0 stage. Preliminary result indicates the presence of consistent differences between progenies in the replicated seed bed plots.

Although the initial between-stand and between-parent-tree selections will not be made until five to ten years after out-planting, the obvious difference in seedling growth is valuable data for correlation studies between juvenile growth and mature characters. The process of improvement by selection could be considerably hastened in characters with high juvenile-mature correlations.

Seed size and seed weight are measured before sowing. In general seedling height growth is positively correlated to seed weight and seed size, however, there are considerable variation between progenies within the same seed weight and seed size class.

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

The purpose of this study is an attempt to develop fast growing trees through hybridization by using native Lodgepole Pine (Pinus contorta) as one parent.

The native lodgepole and hybrid plants are being grown from seed obtained from a lodgepole seed production area near Spirit Lake. Lodgepole flowers on different parents are being pollinated with Jack Pine pollen (Pinus banksiana) obtained from Minnesota. There are presently one year old and two year old plants growing at the

Forest Nursery which will be field planted starting in the spring of 1966. Three thousand hybrid and an equal number of open pollinated plants which became two years old in the spring of 1965 were field planted at the following three sites: thirty parent combinations at the Spirit Lake plots, 8 parent combinations at the Granite plots and 8 parent combinations at the Fish Creek plots.

Growth, form and survival data will be obtained from each field plot to evaluate the characteristics of the hybrid performance as compared to the native lodgepole. The three planting areas are different in climatic and soil characteristics which will give a good insight into hybrids in northern Idaho under varying environmental conditions.

Different parent combinations are being used in each pollination year to study compatability and seedling performance. It has been noted that there is generally a high percent of sterile hybrid seed and also a variation between individual mother trees in the percent of sterile seeds and average number of seeds produced per cone.

The following table indicates the amount of non-fertile seeds and average number of seeds per cone for different years from mother trees which have been replicated.

Tree No.	Treatment	Percent of Blank Seeds			Number of good seeds per cone		
		1962	1963	1964	1962	1963	1964
N.F-2	Control	10	5	20	52	38	31
N.F-2	Hybrid	75	95	66	13	2	16
N.F-3	Control	50		49	27		13
N.F-3	Hybrid	90		91	3		1
N.F-9	Control	30	15	33	54	28	20
N.F-9	Hybrid	65	40	88	10	13	1
N.F-27	Control	15		32	60		31
N.F-27	Hybrid	90		84	3		6

Project M. S. 3. The Heritability of Important Economic Characters and Population Structure of Ponderosa Pine.

For heritability studies controlled pollinations were made in June-July, 1964 on preselected mother trees of distinct genetic characters. Preserved pollen and fresh local materials were used. Of the 529 bags hand-pollinated 574 cones were harvested in early September, 1965.

The use of fiber glass bags prove to be most effective in reducing rodent damage and seed loss. Unfortunately, none of the preselected trees except one produced any female strobuli in the 1965 season. Even the most prolific wide crown trees produced only make strobuli. High nitrogenous fertilizers were applied to the selected trees to encourage flower production.

Field surveys were continued this year in the study of ponderosa pine population. Data was obtained on the habitat, stand composition, density and growth-form characters. Samples of wood core and preserved needles were collected for anatomical studies. Although 1965 was not a good seed year, seeds have been collected from nearly all of the selected stands with the exception of the isolated colonies in Wyoming and Nebraska where previous year's cone specimens will be used in this study.

The area covered in the second year's field survey include Oregon, Southern Washington, Montana, and isolated stands in adjacent Dakotas, Wyoming and Nebraska. A small colony of ponderosa pine west of the Cascade in coastal Washington was examined. Although last year's flower was abundant, developed cones and fertile seeds are scarce, a possible example of the serious effect of population size and isolation.

Project E. S. 36. The Drought Resistance of Ponderosa Pine Seedlings As Affected by Mineral Nutrition.

Survival percentages of ponderosa pine seedlings grown in Island Park, Idaho, during the summer of 1963 were analyzed statistically. Seedlings were grown under various combinations of three levels of nitrogen, phosphorus, and potassium nutrition. Both first-summer seedlings grown from seed sown in the field and 1-0 transplants were used in the experiment.

Using the five-percent level of significance, it was found that the two higher levels of fertilization did not significantly alter survival when compared with the lowest level of fertilization. Also, the highest level of fertilization did not significantly alter seedling survival when compared with the intermediate level of fertilization. This was true for all three of the nutrients studied.

During the winter of 1964-65, ponderosa pine seedlings were grown in sand cultures in a growth chamber. The seedlings were given nutrient solutions containing one of four different nitrogen concentrations--approximately 25, 100, 200, and 300 parts per million nitrogen. The seedlings were subjected to drought when they were about two months old. Seedlings to which nitrogen had been supplied at a level of 200 ppm were significantly less resistant to damage from the drought treatment (five-percent level of significance) than seedlings grown at any of the other three

levels of nitrogen nutrition. Seedlings grown at 25 ppm nitrogen were the most resistant to drought damage.

Late in April, 1965, a growth chamber experiment was begun in which ponderosa pine seedlings were grown in sand cultures. The seedlings were divided into eight groups, and each group irrigated with one of eight nutrient solutions. These solutions were adjusted to provide all possible combinations of two levels of nitrogen, phosphorus and potassium. Other nutrient elements were kept constant.

Seedlings receiving each nutrient solution were grown both in one-pint paper cups and two-quart plastic pots of sand. Seedlings in the cups were subjected to drought treatment late in June. Those in pots will be analyzed for foliage nutrient content, root/shoot ratio, root titration value, height growth, and chlorophyll stability index. Relative turgidity of the needles will be determined both for seedlings subjected to drought and seedlings in the pots. Differences in results associated with the nutrient treatments will be subjected to statistical analysis.

In an attempt to study the effect of mineral nutrition on the field survival of ponderosa pine seedlings under potentially droughty conditions, 1600 seed spot sowings of ponderosa pine seed were sown near Spirit Lake, Idaho, in late April, 1965. Again, the experimental units were divided into eight treatments comprising all possible combinations of two levels each of nitrogen, phosphorus and potassium. Each treatment was represented by twenty seedspots in each of ten blocks.

The low level of the nutrients was the unfertilized natural soil content. Commercial fertilizers were placed around the seed spots at the time of sowing to provide the high level of the nutrients.

Seeds were protected from rodents by the placement of screen cones over the seedspots. However, rodents did cause appreciable damage to seedlings by digging alongside them after the screens were removed late in June.

The proportion of seedspots in which one or more seedlings became established was rather small--averaging about 28 per cent.

Survival of seedlings in each treatment will be observed and recorded weekly. In the fall, seedlings will be excavated for root growth and absorption capacity studies. Chlorophyll stability analyses will be run on the foliage, and shoot growth and nutrient content determined.

Project E. S. 39. Growth of Coniferous Seedlings As Affected by Treatment with Plant Growth Substances.

The effects of certain growth substances on survival and root growth of two-year old Douglas-fir seedlings were examined in the

greenhouse and on field plots located near Spirit Lake, Idaho and at Big Meadow Creek on the College Forest. Seedling roots were soaked in particular growth substance solutions for 2, 10 or 12 hours prior to planting. Greenhouse experiments were maintained for about three months, with measurements taken on field plots after one growing season. Results may be summarized as follows:

1. In the first greenhouse study a significant reduction in total root length and length of the three longest individual roots on each seedling occurred where treatment involved NAA at 100 ppm. There were significant but smaller reductions in average length of the three longest roots when IAA was applied at either 10 or 50 ppm. No significant differences were noted in average air dry weight of roots or absorption capacities as expressed in titration values.

2. In the second greenhouse study, no significant differences were found for total root system lengths, air dry weights or titration values. The data indicated important differences probably occurred but the small sample size employed in these experiments tended to make seemingly large differences non-significant.

3. In the third greenhouse experiment, there were large and significant reductions in the lengths of the three longest roots on each seedling treated with 100 ppm of either 2,4-D, 2,4,5-T or P-CPA. Differences in total root system were not as great, but significantly shorter root systems occurred in the same three treatments. No significant differences occurred in average air dry weights or titration values.

4. Valuable information on the rate of root growth as affected by growth substances may be obtained through refinements in techniques involving root observation boxes.

5. Field survival was not significantly affected by the growth substance treatments because unusually high soil moisture levels for all plants on both sites during the normally dry summer months provided excellent growing conditions.

6. Some stimulation or inhibition of root growth may have occurred in the field plots but difficulty in excavation of intact root systems made it impossible to confirm this possibility.

7. A significant reduction in top growth occurred at Spirit Lake in treatments involving kinetin or Superthrive, but the same trend was not observed at Meadow Creek. Factors not concerned with treatments, such as frost and animal damage, make it impossible to assign the observed differences solely to growth substance effects.

8. Particular treatment effects were not always of the same magnitude on the two experimental areas. Thus it is possible that if field use of growth substances becomes practical, formulations will have to be based on preliminary trials made in the environment of the specific site.

9. Variability of the experimental results emphasizes the need for more research concerning growth substance physiology within seedling roots. Such a study is planned for the coming year.

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

The fertilizer study plots established at Flat Creek on the College Forest in the spring of 1962 were re-examined in December, 1964. Leader growth was measured, and foliage taken for laboratory analysis. Some injury to terminal leaders of grand fir was noted, and was attributed to the succulent nature of the excellent current growth of the fertilized trees. Such a condition - long leaders of succulent nature - might make the fertilized stand more subject to damage from snowbreak, for example. This particular damage situation, however, was not noted on the fertilized plots in 1963, even though terminal leader growth was also great in that year.

Excluding those trees where damage occurred, 1964 growth of grand fir fertilized with 300 pounds per acre nitrogen as ammonium sulfate, 150 pounds per acre potassium as muriate of potash, and 66 pounds of phosphorus as treble super-phosphate averaged 267 per cent of the growth achieved in 1962, before fertilizer effects were evidenced. This percentage is considerably higher than that (211 per cent) for the comparison made after the 1963 growing season. Grand fir on control plots produced growth averaging only 107 per cent of the 1962 season. Fertilized Douglas-fir showed growth averaging 136 per cent of 1962 figures; on control plots the data indicated elongation was only 99 per cent of that noted in 1962.

Needle tissue analysis from selected trees showed that on control plots nitrogen contents of foliage produced in the current year were about the same as in needles sampled at the same time, but produced either one or two years previously. In contrast, current year needles from trees fertilized in 1962 show considerably more nitrogen (1.73 per cent) than needles sampled concurrently but produced in 1963 (1.28 per cent).

Project S. R. 70. Seedling Growth and Survival.

The wet cycle experienced in northern Idaho during the past several years continued through the summer of 1964. Thus, again the hoped for evaluation of techniques to improve survival in

the more frequent dry periods was not realized. Such evaluations are, of course, of prime importance in this study.

On the Athol plots, where chemical and mechanical methods of controlling competition with seedlings are being investigated, survival of 2-0 and 2-1 Douglas-fir trees planted in the spring of 1964 was uniformly high at the end of the first growing season regardless of treatment. Actual survival percentages ranged from 89 per cent for 2-0 seedlings on control plots (no treatment whatsoever) to 100 per cent on many of the treated areas. No definative conclusions as to the effectiveness of chemical treatments alone can be deduced from these data. No injuries due to the herbicide applications were noted on any seedlings.

Soil moisture (eight-inch depth) was recorded weekly for all treatments. This information indicated that the wilting point was reached by mid-August on control plots, where weed vegetation was heavy. The moisture level at this eight-inch depth had also been quite low on these particular plots for some weeks previous to the time the wilting point was actually reached. Data from the dry years of 1960 and 1961 show that once the wilting point was neared at that time mortality of seedlings became heavy. Such mortality did not occur among the 1964 planted seedlings, probably because frequent moderate rain fell. This moisture did not penetrate to the eight-inch depth, hence did not bring this soil above the wilting point. However, shallow roots on the seedlings undoubtedly had access to this precipitation and thus maintained a viable condition. In 1960 and 1961 such light rain as fell, once the soil became depleted in moisture, was not sufficient to prevent severe mortality on weedy plots.

Re-examination of the 1964 experiments at Athol was made after the winter of 1964-65. Far greater mortality took place during the winter than during the first growing season. A considerable amount of frost heaving was noted, especially on clean cultivated plots. Mole and ground squirrel damage occurred also and was especially concentrated in specific parts of the area.

Project S. R. 94. Cultural Practices for Improving Quality of Christmas Trees in Idaho.

This project was initiated to determine for north Idaho conditions the most practical or economical cultural techniques required to produce a high percentage of quality Christmas trees.

Data collected to date has not been statistically analyzed; however, some preliminary results can be reported.

Cultural treatments made to Scotch pine very early or late in the growing season have been unsatisfactory. Tip and lateral pruning during the latter part of June resulted in crows nests or the

instigation of an excessive number of adventitious buds, while treatments during the latter part of August resulted in the absence of an adequate number of buds. Results during the years 1964 and 1965 have revealed that July appears to be the best period for cultural work.

Data from the Strychnine and Big Creek grand fir plots reveal a high variation of tip angle after pruning by both the normal and reverse tip pruning methods. The degree of angle varied from 0^{o} to 45^{o} for both methods. It is suggested at this time that if growth rate can be reduced satisfactorily by basal pruning, tip pruning should be eliminated. This is not only because of the uncertainty of results but because of the higher cost of plant improvement due to increased labor necessary. Fan trimming has produced some exceptionally high quality plants; however, the improvement made over side shearing with machetes or knives has not been adequate to offset the increased labor necessary for fan trimming. Thinning stands of trees to a proper spacing and following this with basal pruning and side shearing if desirable seems to be the most practical procedure to follow in managing wild stands for Christmas tree production.

Plans for the coming year are to develop plots of both Scotch and white pine every two weeks beginning May 15th in an attempt to determine more closely a favorable culture period.

Project M. S. 2. Elongation and Activity of Roots of Coniferous Seedlings as Determined by Radioactive Tracers.

The initial phase of these investigations involved a comparison of root development of 2-0 Douglas-fir seedlings and 2-1 Douglas-fir transplants. The experiment was conducted at the nursery with carefully graded stock. Fourteen treatments (each replicated four times) were utilized. The isotope (P_{32}) was placed in the soil in a circular pattern around individual plants by means of a specially designed probe. Lateral distances of 1 to 18 inches were associated with placement depths of 3 to 24 inches. The short half-life of P_{32} made necessary two series of soil injections, one made in early May, the other in late July. Samples of needle tissue were analyzed weekly for radioactivity with a positive test indicating that a root had reached the zone of isotope placement involved in the particular treatment. The actual amount of radio-activity detected was also recorded in an attempt to ascertain the area where root absorption was most pronounced. This zone, of course, would not necessarily coincide with the zone of maximum root extension.

Complete details of the procedures outlined above and other details may be found in the Sixteenth Annual Report of the FWR Expt. Sta. (Dec., 1963).

Activity was first detected in 2-1 seedlings on June 4 from P^{32} injected at eight-inch soil depths one inch from the stem. On

June 11, 2-1 seedlings showed activity from the three inch depth placement. No 2-0 seedlings became radioactive until June 25.

The dates on which radioactivity was first detected in foliage samples from the various treatments are shown in the following table.

Isotope placement		Seedling age	
Depth	Distance from stem	2-1	2-0
3"	1"	July 2	June 11
	6"	July 30	July 30
8"	1"	June 25	June 4
	6"	July 30	July 30
	12"	Aug. 27	Sept. 3
16"	1"	July 30	July 30
	6"	Aug. 6	Aug. 6
	12"	Aug. 27	-
24"	6"	Oct. 1	-

It appears that during the early summer, roots of 2-1 seedlings elongated at a more rapid rate than the 2-0 stock, and were actively growing at a later date in the fall than were the roots of the younger trees. For a time in mid-summer elongation of roots of both classes of stock proceeded at the same rate.

Attempts to determine relative activity of specific parts of the root systems met with some difficulties because of variation occurred in activity shown by different needles on the same plant. Thus a needle selected from a plant may produce a low reading for radioactivity when analyzed, leading one to conclude that roots were not very active in the zone of soil where isotope had been placed. Another needle from the same seedling however, might give a fairly high reading, and if this needle were the one taken for analysis a different conclusion would be reached.

The sampling problem described above will be the subject of further study. However, even taking into account sample variability, some trends in relative activity were quite pronounced.

A greenhouse experiment conducted during the winter provided an opportunity for technique evaluation. Two factors were particularly emphasized, 1) interval between the time a root entered the zone of isotope placement and radioactivity was detectable in the foliage, and 2) accuracy of single needle analyses in reflecting relative activity of roots in a specific zone of isotope placement. Data from this experiment have not yet been analyzed.

Project E. S. 38. Intraregional Competition in Lumber and Plywood Marketing in the Western United States.

In this study the total consumption and production of lumber and plywood in the Western United States by species is to be determined by regions within each state. Idaho was divided into northern and southern regions.

All the data necessary has been collected from Idaho mills and submitted to the regional coordinator. The data is to be compiled on a regional basis and released as a regional publication.

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

Data resulting from the laboratory analysis of Douglas-fir increment cores are being tabulated prior to making a statistical analysis of them. This will show the relationship of growth rate, specific gravity and percent latewood as affected by environment.

This study has also been concerned with the effect of irrigation on wood properties. Wood samples from irrigated and control trees have been analyzed for growth rate, specific gravity, fiber length, percent latewood, number of cells produced each year, and cell widths. The resulting data have been processed through the University computer to determine the effect of irrigation on wood at different heights in the tree and at the four cardinal points. A report on this study is fifty percent complete. This study is being made in cooperation with Washington State University and the Washington Water Power Co.

Project S. R. 55. Identification, Biology and Ecology of the Cone and Seed Insects of Idaho (Initiated 1957).

I. Cone and seed insects of western white pine in Idaho, Phase 3. Distribution and seed losses in relation to stand density. (Initiated 1963; completed in 1964).

Cones were collected from four densities (538[1/], 109, 48 stems per acre, and mixed natural stands) and dissected longitudinally through the axis to obtain the percent insect damaged seed on the face. A scale by scale examination provided the actual percent of damaged seed. Eucosma rescissoriana Hein. accounted for 81.1 and 95.6 percent of the seed losses in 1963 and 1964, respectively, or 12.2 and 0.5 per cent, respectively, when expressed as a proportion of total seed. Losses due to Dioryctria abietella (D.&S.), Conophthorus monticolae Hopk., and an unidentified cecidomyiid

1/ Reported as 8 x 8 feet (680 stems per acre) in the 16th Annual Report.

were relatively unimportant. Highly significant differences in seed losses were found between densities of 538, 109, and 48 stems per acre. Losses in the mixed natural stands were not significantly different from those in the most dense plot.

Thus, the thinning of older, closed stands, whether for stand regeneration or for seed production areas, concentrates the ubiquitous insect population on the very trees selected to produce the seed required. Direct control measures then may be necessary to obtain sufficient seed to satisfy demand.

To minimize insect-caused seed losses under such circumstances and in the absence of direct control, the most desirable density appears to be 435 to 680 stems per acre (10 x 10 to 8 x 8 feet) and certainly not less than about 300 stems per acre (12 x 12 feet).

I. Cone and seed insects of western white pine in Idaho, Phase 4. The parasite complex associated with Eucosma rescissoriana Hein. in northern Idaho (Lepidoptera: Olethreutidae) (Initiated 1963; continued 1964).

Objectives:

1. To ascertain the progressive rates of parasitism of E. rescissoriana;'

2. to obtain the relative abundance of each parasite species and its relation to stand density; and

3. to study the biologies and life histories of the more important parasite species.

Progress:

Cones were collected bi-weekly from June 24 to September 1, 1964 from two plots near Cathedral Peak in Shoshone County, and weekly from a plot ten miles northwest of Hope, Bonner County, Idaho. The relative abundance and progressive rates of attack for each species or species group were ascertained. Apanteles starki Mason, Chelonus n. sp., and Pimploperus n. sp. were the most abundant parasitic species and accounted for 55 and 95 percent of the total parasitism at plot 3 north of Hope, and plots 1 plus 2 near Cathedral Peak, respectively. Biological and life history studies were directed towards these three species.

Laboratory investigations into the life history and behavior of the parasites were only partially successful. The main deterring factors appeared to be high temperatures and extremely low relative humidity, which caused excessive mortality of the host larvae and absence of synchronization between host and parasite. Information pertaining to host specificity was gained through these studies however. Partial life histories were obtained through cone-bagging studies under field conditions.

Plans for the 1965 season include weekly collections from the existing plus the addition of two further plots. More effort will be directed to the life histories of the three most important parasite species. This third year of data is expected to aid considerably in ascertaining trends in abundance and progressive rates of parasitism, plus provide more biological and phenological observations.

Project M. S. 5. Effects of methyl demeton on Douglas-fir and its cone and seed insects and rodent indicator species.

Objectives:

1. To develop methodology for trunk implantation of methyl demeton, and for the evaluation of its effectiveness in controlling the cone and seed insects attacking Inland Douglas-fir;

2. To ascertain the effects of the insecticide on test species of rodents fed treated seed; and

3. To ascertain the phytotoxicity and the influence of the insecticide on seed production, viability, and seedling development.

Progress:

A report of this project was inadvertently included in the Station's sixteenth annual report covering the fiscal year 1963-64.

Project M. S. 4. Methods for Estimating Recreational Visits and Use on Unattended Recreation Sites.

The development of methods for estimating recreational visits and use on unattended forest recreation sites was initiated during the 1964 recreation season. Both instrumentation and sample form questionnaires were developed.

The basic instrument developed was a simple battery operated circuit with counter and "inlet" for a variety of micro-switch types. The values of this instrument have included low initial and maintenance cost, efficient and ease of use on a variety of recreation sites.

The interview questionnaire, evolved from well tested O.R.R.R.C. techniques, proved quite successful. Information gained from the initial use of this questionnaire is published in Station Paper No. 1, "Characteristics and Preferences of Recreationists in Selected Northern Idaho State Parks."

During the recreation season of 1965 a graduate student will collect visitor use information to evaluate the counting instrument and develop visit and use prediction curves.

Project E. S. 41. Idaho Comprehensive Outdoor Recreation Plan.

The College of Forestry, Wildlife and Range Sciences has played a key role in initiating research towards a state outdoor recreation plan. The plan to include a description of State resources agency recreation responsibilities, supply, demand, need and action program, was initiated late in the fall of 1964 but was not fully financed by the State and Bureau of Outdoor Recreation until June 1, 1965.

The deadline for various research-work elements of the plan indicate this project will be completed and published by the end of 1965.

The plan will be a major contribution to the logical development of Idaho's recreational potential in that it will qualify the State for five to six million dollars for planning, acquisition and development of State recreational areas and facilities.

Project E. S. 42. Sources of Nitrogen in Precipitation and Sedimentation Near Moscow, Idaho.

Objectives: The proposed work is designed to:

1. Identify nitrogen carrying compounds and their sources found in precipitates and sediments near Moscow, Idaho,

2. Ascertain the amount and composition of nitrogenous compounds in precipitates and sediments deposited throughout the year,

3. Ascertain the importance of absorption on nitrogen accumulation in snow,

4. Ascertain the effectiveness of precipitation in removing atmospheric contaminants, and

5. Ascertain the present rate of loess deposition in the area.

Three field stations will be positioned to collect precipitation and aerosols weekly from different areas and elevations throughout a two-year period. Precipitation will be analyzed for nitrate, nitrite, ammonia, and hydronium ion concentrations. Particulate matter brought down by precipitation will be identified quantitatively and analyzed for organic matter and albuminoid nitrogen. Aerosols will be collected with a vacuum apparatus during various weather conditions and analyzed for nitrates, nitrites, ammonia, hydronium ion, albuminoid nitrogen, and organic matter. A quantitative identification will be made. The concentrations of nitrogen compounds will be correlated with weather patterns, precipitation form, aerosol identification, and hydronium ion concentration. Absorption of nitrogen by snow will be tested by sampling periodically after various snowfalls and analyzing for

nitrates, nitrites, ammonia, hydronium ion concentration, and quantity of particulate matter. Colorimetric procedures will be used for analyzing ammonia, nitrate, and nitrite. Albuminoid nitrogen content will be ascertained by microkjeldahl procedures. Both X-ray diffraction and the electron microscope will be used to identify aerosols.

The work to date has been involved with constructing field stations and developing procedures. The expected small sample size necessitates a modification of presently known procedures. Data collection is slated to begin July 1, 1965.

Project E. S. 40. Comparative Phenology of Recently Disturbed Areas in the Cedar/hemlock and Grand Fir Habitat Types.

This project was initiated late in this fiscal year (May, 1965). A comparison is being made of plant periodicity between selected species on two recently burned slopes on the Coeur d'Alene National Forest. The study sites are located on a south slope and are on an east slope in the same four-year-old burn. Standard weather bureau instruments and stations are to be maintained on each site in addition to other temperature and soil moisture recording devices. The use of a sucrose solution is also being tested in the determination of "effective" temperatures. Complete phenological records will be taken from first snow removal until permanent snow. Shrubs, forbs, tree seedlings and some grasses will be included in the study. Comparisons will be made between this and other burned areas and between these weather data and standard valley weather station data to aid in extrapolation of information.

Project E. S. 43. Linear Programming - A Decision Tool for Optimizing Allowable Annual Timber Yields.

Operations research is a recently developed discipline available to those who wish to organize resources into meaningful operating entities for the express purpose of achieving specified goals. Its areas of interest are the minima-maxima relationships of an operating system, or producing unit. Operations research normally involves the use of a systematic quantitative analysis, and of the many mathematical tools available, linear programming is one of the most useful.

Linear programming techniques seek to optimize, that is maximize or minimize, some linear objective function which is itself subject to certain constraints that are expressed as linear inequalities. That is, for example, to maximize a firms profits subject to an array of restrictions on the use of land, labor or capital.

In this study two linear programming models that will optimize allowable timber yields from a typical forest unit in north Idaho's white pine timber type will be developed. Expressed in a very simple manner, the first model will maximize physical volume yields subject to area controls, volume controls, or a combination of both. The second will maximize the forests present net worth from a series of future timber harvests, once again under conditions of area or volume control, or a combination of the two.

This project was initiated during the past year and to date the first model has been developed and will be tested on the University of Idaho's IBM 1620 computer. The second model is still in its conceptual stage, but should be completed and tested by early 1967.

Projects Inactive During the Year

Project E. S. 2. White Pine Blister Rust.
Project E. S. 20. Mortality of Young Western White Pine (Pole Blight).
Project E. S. 27. Soil Nutrient - White Pine Site Quality Study.
Project E. S. 28. Nursery Soil Fertility Studies.
Project E. S. 37. Direct Seeding of Coniferous Species.

II. Range Management

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

Successional changes in depleted salt-desert shrub communities were studied. Investigations concerning the life history of saltsage (Atriplex nuttallii) and other species were continued in 1964.

Successional Changes in Salt-Desert Shrub Communities

Fifteen years of protection from grazing and favorable climatic conditions during the last two years have produced substantial increases in the amount of grass in some of the salt-desert shrub communities during 1964. This is particularly true in shadscale types. The following data from one shadscale study area illustrates the change that is taking place:

	Sitanion hystrix		Poa secunda	
Year	Basal Hits	Foliage Hits	Basal Hits	Foliage Hits
1951	0	0	0.7	0.7
1952	0.3	0.3	0	--
1953	--	--	--	--
1954	0	0	0.7	0.7
1955	0	0	0.7	1.0
1956	0	0	0.7	0.7
1957	0.3	3.	0	0
1958	0.3	3.	0	0
1959	0.3	0.7	0	0
1960	0.3	1.0	0	0
1961	0.3	0.7	0	0.7
1962	0	0	0	0.7
1963	--	--	--	--
1964	0.3	4.3	0	6.0

Growth Development of Salt Desert Shrub Species

Investigations of the yearly growth development of six salt-desert species, saltsage (Atriplex nuttallii), winterfat (Eurotia lanata), kochia (Kochia americana), shadscale (Atriplex confertifolia), Indian ricegrass (Oryzopsis hymenoides), and squirreltail (Sitanion hystrix) were continued. Five plants of each species were marked with nails and metal tags in 1958, and growth notes were started. The following table gives the average maximum height attained yearly since 1958.

The greatest effect on growth appears to be climate, and the most apparent climatic response occurred in 1961, the fourth and last year of a cycle of drier than normal years. This variation in climate for the various years appears to have the greatest effect

on the three half-shrubs (saltsage, winterfat, and Kochia). Shadscale being a true shrub appears to be affected least by climate.

The climatic effect on the grasses is apparent only on the Indian ricegrass. The reason for little or no effect on the squirreltail is not known for sure, but it is believed that at least part of the reason for the steady increase in stature of the squirreltail is due to the age of the marked plants.

Date of Measurement	Saltsage	Winterfat	Kochia	Shadscale	Indian ricegrass	Squirreltail
9/9/58	10.0	7.2	4.2	5.4	12.6	3.6
9/7/59	10.4	6.4	5.2	6.0	18.2	4.0
8/17/60	9.1	7.8	4.5	5.9	16.6	4.2
9/9/61	5.7	6.8	2.2	6.0	14.5	5.3
9/15/62	11.0	6.5	7.4	5.9	17.9	5.6
9/6/63	Missed	10.7	6.8	5.7	22.9	8.2
8/28/64	11.2	12.6	7.2	5.7	19.8	8.7
Average for All Years	9.57	8.29	5.36	5.80	17.50	5.66

Response of Saltsage to Clipping Treatments

The saltsage clipping study which was initiated in May, 1962 was continued in 1964. However, some clipping dates were missed; therefore, the 1964 results are more of an indication of the effects of previous clipping than of the present years clipping. Essentially the clipping study entails a comparison of two clipping heights, five clipping frequencies, and five dates of initial clipping. The initial clippings of the 1962, 1963 and 1964 seasons were made May 1, May 14, and June 4, respectively. The first clipping was made when the male infloresence were in the black bud stage. Clipping was continued at two-week intervals for eight weeks after the initial clipping, and a final clipping was made at the end of the growing season (early August). The control plots were clipped only at the completion of growth. The following table compares the average treatment yields for 1962, 1963 and 1964.

There is a significant interaction between clipping height and date of initial clipping. As the date of initial clipping progresses, the effect of clipping height becomes less apparent, and in the later clippings there is no difference. Plots clipped in late June and July had considerably higher yields than the others, including the control plots which were clipped only at the end of the growing season. Also these higher yields have been maintained for all three years. This suggests that some clipping may stimulate production.

Number of weeks after first clipping that sequence was initiated	Times Clipped	Total Seasonal Yields (Lbs./Acre) 1962 Clipped Height 3/4"	1962 Clipped Height 1½"	1963 Clipped Height 3/4"	1963 Clipped Height 1½"	1964 Clipped Height 3/4"	1964 Clipped Height 1½"	3-Year Ave. Clipped Height 3/4"	3-Year Ave. Clipped Height 1½"
0	1	984	696	459	648	473	725	639	689
	2	966	642	614	684	690	737	757	705
	3	810	571	549	642	421	1076	593	673
	4	958	552	484	624	343	674	595	617
	5	898	657	456	682	264	597	540	646
2	1	1096	916	736	882	437	827	756	872
	2	1125	799	968	686	742	719	945	729
	3	1299	878	540	874	472	---	771	---
	4	1686	810	548	764	624	992	953	856
4	1	1098	1024	934	780	507	640	788	815
	2	1082	852	434	838	435	882	650	856
	3	1416	924	864	899	1176	905	1152	909
6	1	1338	1038	1428	1098	1127	---	1297	---
	2	1734	961	1548	1082	1684	1192	1655	1078
8	1	1431	1388	1840	1359	1742	1272	1671	1339
Control		922	830	600	610	520	670	681	704

Project E. S. 8. Ecology and Control of Medusahead.

The explanation of medusahead's ability to take over a cheatgrass community is not clear. The classical explanation that one annual community replaces another in succession because of more efficient and rapid utilization of soil moisture is not adequate in situations where medusahead and cheatgrass are involved. Although the two species germinate at about the same time in the fall, medusahead is the later maturing of the two. To shed light on the process of succession, a study was initiated in 1961. An area was cleared of vegetation and kept fallow during the spring and summer, and experimental plots were seeded with known numbers of seed of the two species prior to the advent of fall rains. The numbers of seeds/sq. ft. introduced were: Treatment 1) 150 cheatgrass; Treatment 2) 75 cheatgrass and 75 medusahead; and Treatment 3) 150 medusahead. No precaution was taken to prevent "outside" seeds from entering the plots after the first season. The reproductive success (ratio of seeds present in the fall versus the number of plants established before moisture stress was evident in the spring) was determined annually. Summarized results are presented in Table 1.

Table 1. Reproductive Success (Ratio of Number of Seed Versus Established Individuals) of Medusahead and Cheatgrass.

Seeds/Sq.Ft. Introduced	Per Cent Reproductive Success			
Treatment I.	1961-1962	1962-1963	1963-1964	1964-1965
0 Medusahead	--	41	87	60
150 Cheatgrass	17	58	51	46
Treatment II				
75 Medusahead	12	60	92	56
75 Cheatgrass	13	52	58	21
Treatment III				
150 Medusahead	16	70	87	65
0 Cheatgrass	--	52	43	38

The reproductive success of medusahead was consistently higher than cheatgrass. The factor(s) contributing to the higher winter mortality of cheatgrass was not determined. The resulting differential in reproductive success of the two species can, at least in part, explain how medusahead is able to enter a cheatgrass community and become the dominant species. The early spring sampling prior to moisture stress rules out moisture competition as the primary reason for the change from a cheatgrass to medusahead dominated community. Greater the difference in reproductive success, the more rapid is the change.

The use made of medusahead range by cattle has been of speculative nature. For a more objective evaluation as to how much medusahead and associated species are actually grazed, utilization transects were established in a cattle allotment and sampled in April and June. Nested plots with the following dimensions were used: 2" x 2", 6" x 6", 12" x 12", and 12" x 24". Eight transects were located, and the frequency of grazed and ungrazed plots were tallied by species in 50 nested plots along each transect. The transects were located away from bottoms where animals tend to concentrate. The distance between the two farthest transects was about four miles. There was much variability in grazing pressures where the transects were located. One area was not grazed, although it was within the allotment. Summarized results are presented in Table 2.

The data indicate that in relation to the distribution of species, cattle tend to prefer some species over others. By early June, the animals had selected out a high percentage of the Tragopogon dubius and Agoseris sp. in the area. Poa secunda was another species sought out by cattle, as indicated by 63 per cent of the plots containing this species being grazed. Cheatgrass was found in a large number of plots, but was of low density and stature. Cheatgrass was often hidden by the presence of a much higher density of medusahead and cattle did not seek out individual plants. Use on both cheatgrass and medusahead was light.

Under conditions where animals are forced to use medusahead range in small confined areas, the use of medusahead is considerably

higher than on "open" range. Degree of use of medusahead in one area was 87 per cent. Generally, wherever cow chips were present, the immediate surrounding area for several inches were avoided. Much bare ground was exposed, litter was conspicuously lacking, and more palatable species were missing.

The use of nested plots to determine relative utilization has not been previously tested for reliability. The correlation coefficient between sum frequencies of annual grasses (medusahead and cheatgrass) obtained in April and June was r = .88. The April values were somewhat lower than those of June, particularly along two transects. In early spring, the presence of small annuals are easily overlooked and careful scrutiny of the plots is necessary. The two transects that yielded widely different values between April and June were sampled in the late afternoon. This suggests that poor light might have been a factor in failure to observe the presence of small inconspicuous plants.

Perennials were more easily detected because of their larger size and contrasting color in comparison to annual grasses. Correlation coefficient for sum frequencies of perennials between April and June was 4 = .97.

Table 2. Percentage of Plots Grazed Containing Medusahead and Associated Species. Based on Sum Frequency Obtained From Nested Plots.

Species	Total Sum Freq.	Grazed Sum Freq.	% Grazed
Medusahead	2324	120	5.16
Cheatgrass	1888	156	8.26
Poa secunda	540	344	63.70
Sitanion hystrix	220	90	40.90
Agropyron spicatum	170	80	47.05
Tragopogon dubius	1014	864	85.21
Agoseris sp.	142	108	76.05

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

The enormous amount of soil and vegetational data obtained from more than 100 sagebrush-grass stands makes analysis of data by desk calculator extremely tedious and incomplete. To take advantage of the benefits of automatic data processing, the vegetational data have been codified and transferred onto more than 5,000 punch cards. The problem of addition of numeric code for species has been resolved. Cooperating with Oregon State University, a master deck containing alpha and numeric codes, scientific name, common name, synonym, and life form of more than 3,500 plant species in the Pacific Northwest was generated. This master deck has been edited and corrected several times. Provisions are made to permit addition of species.

Numeric coding of species on data cards can now be accomplished automatically by collating the master deck with field data cards.

An important part of the ecosystem is the soil. To correlate soil properties with vegetational characteristics by machine processing the soil information needs to be put on cards also. With the experience gained while working on the card layout for the vegetational aspect of the study, the development of the card layout for soil was not as difficult as anticipated. Again working with Oregon State University, a card layout was developed with provisions to include all information normally obtained while describing a soil profile in accordance with the Soil Survey Manual. Transfer of soil information onto punch cards will be a major effort this year.

Yields were obtained for the seventh consecutive year in two exclosures located in two sagebrush-grass associations. During the seven-year period (1959-1965) great variability in growing conditions occurred and was reflected by the varying yields of the more sensitive species. Agropyron spicatum showed the least variability (Tables 1 and 2). Poa secunda, a shallow-rooted perennial grass, behaved much like the annual grass, Bromus tectorum. Both showed high variability in yield during the period of the experiment. A high yielding Poa year tended to correspond with years of high production of Bromus tectorum. The correlation between Poa and Bromus production during the seven years was r = .86 (significant at P.05) in the Jordan Valley exclosure.

Table 1. Variability of Yields During Seven Consecutive Years in the Jordan Valley Exclosure. Annual Precipitation About 12 Inches.

Species	#/Acre	% Variability ($S\bar{x}/\bar{x}$)
Total Yield	472 ± 72	15.0
Agropyron spicatum	332 ± 28	8.4
Sitanion hystrix	11 ± 2	18.0
Poa secunda	52 ± 54	103.0
Bromus tectorum	82 ± 42	51.2

Table 2. Variability of Yields During 6*Years in the Midvale Exclosure. Annual Precipitation About 17 Inches.

Species	#/Acre	% Variability ($S\bar{x}/\bar{x}$)
Total Yield	1813 ± 153	8.4
Agropyron spicatum	894 ± 66	7.4
Perennial forbs	677 ± 88	13.0
Poa secunda	118 ± 47	39.8
Miscellaneous	101 ± 43	42.5

*Data collected in 1961 was omitted because of a wildfire burn in late summer of 1960 that greatly affected the yields the following year.

A comparative study of establishment and survival of Sitanion hystrix, Agropyron spicatum and Stipa thurberiana under natural and artificial conditions was initiated in the spring of 1965.

Objectives of this study are as follows:

1. To compare Agropyron spicatum, Sitanion hystrix and Stipa thurberiana in their tolerance to both soil temperature and soil moisture stress.

2. To determine the abilities of the three species to compete with one another under different environmental conditions.

3. To determine how individuals of a species from divergent ecological areas differ in their physiologic responses.

4. To determine the influence of sagebrush and other established vegetation on a site in limiting seedling establishment.

5. To investigate possible toxic influences of sagebrush litter in reducing perennial grass seedling emergence and survival.

Two study areas were located in the spring of 1965 in the Artemisia tridentata-Stipa thurberiana and Artemisia tridentata-Agropyron spicatum habitat-types in the vicinity of Twin Falls, Idaho. By the end of the fiscal year some seed had been collected and work begun on the field study plots.

In the field study broadcast seeding and planting of the three species will be compared under five degrees of competition with native vegetation. The five degrees of competition are as follows:

Table 2. Variability of Yields During 6 Years in the Midvale Exclosure. Annual Precipitation About 17 Inches.

Species	#/Acre	% Variability (SE/$\bar{x}$)
Total Yield	1813 ± 153	8.4
Agropyron spicatum	890 ± 66	7.4
Perennial forbs	617 ± 82	13.0
Poa secunda	118 ± 47	39.8
Miscellaneous	101 ± 43	42.5

*Data collected in 1951 was omitted because of a wildfire burn in late summer of 1950 that greatly affected the yields the following year.

A comparative study of establishment and survival of *Stipa lyberta*, *Agropyron spicatum* and *Stipa thurberiana* under natural and artificial conditions was initiated in the spring of 1955.

Objectives of this study are as follows:

1. To compare *Agropyron spicatum*, *Stipa lyberta* and *Stipa thurberiana* in their tolerance to both soil temperature and soil moisture stress.

2. To determine the abilities of the three species to compete with one another under different environmental conditions.

3. To determine how individuals of a species from divergent ecological areas differ in their physiologic responses.

4. To determine the influence of sagebrush and other established vegetation on a site in limiting seedling establishment.

5. To investigate possible toxic influences of sagebrush litter in reducing perennial grass seedling emergence and survival.

The study areas were located in the spring of 1955 in the *Artemisia tridentata*-*Stipa thurberiana* and *Artemisia tridentata*-*Agropyron spicatum* habitat-types in the vicinity of Twin Falls, Idaho. By the end of the first year some seed had been collected and work begun on the field study plots.

In the field study broadcast seeding and planting of the three species will be compared under five degrees of competition with native vegetation. The five degrees of competition are as follows:

1. Cleared bare, 2. Cleared of sagebrush overstory, 3. Cleared of understory vegetation, 4. Thinned sagebrush, 5. No treatment.

Greenhouse studies to determine the relative drought resistance of each of the three species will be begun this fall.

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

Improved vigor of crested wheatgrass resulting from the favorable conditions in 1963 combined with the favorable conditions continuing in 1964 produced greater yields than in previous years.

Spring Trials

Precipitation, although not quite as abundant as in 1963, was in excess of our inches for the April-May period and nearly eight (7.90) inches for the April-May-June period, see table 1. Values for comparable periods in 1963 were 7.79 and 9.30 inches respectively.

Table 1. Precipitation at the Point Springs Experimental Area in 1964.

Date		Precipitation
From	To	Inches
12-6-63	4-10-64	3.39
4-10-64	5-1-64	1.42
5-1-64	6-1-64	2.91
6-1-64	7-1-64	3.57
7-1-64	8-1-64	0.02
8-1-64	9-1-64	0.02
9-1-64	10-9-64	0.21
10-9-64	10-30-64	1.25
10-30-64	12-4-64	1.32
TOTAL	12/6/63 to 12/4/64	14.11

Air dry forage production and utilization along with livestock weights and gains are given in table 2.

Forage production was above the 1963 production and much above some of the earlier years. The grazing period (May 4 to July 20) was extended from the planned 45 days to 76 days in order to approach a more desirable utilization level in the pastures.

Average animal gain reflected the longer grazing period and ranged between 145 and 167 pounds. Average daily gain fluctuated around two pounds a day and ranged from 1.9 to 2.2 pounds. Gain per acre varied between 59.6 and 85.3 pounds.

Table 2. Average Air Dry Forage Production and Utilization, Livestock Weights, Gains and Stocking Rate by Pasture and Season for the 1964 Grazing Trials.

Pasture	Season & Intensity		Initial Production Pounds/Acre	Initial Prod. Plus Growth Pounds/Acre	Utilization Percent	Avg. Initial Animal Weight	Avg. Total Gain Per Animal	Avg. Daily Gain Per Animal	Animal Gain Per Acre	Acres Per Animal Month
02	Spring	Light	409	1017	51	512	165	2.2	69.5	0.94
05	Spring	Moderate	426	1028	62	465	149	2.0	85.3	0.72
03	Spring	Heavy	258	692	80	511	152	2.0	74.2	0.83
01	Fall	Light	1041	1041	58	667	-8	-0.2	-6.9	0.77
06	Fall	Moderate	1290	1290	62	651	-11	-0.2	-10.4	0.70
04	Fall	Heavy	860	860	79	643	-7	-0.2	-7.9	0.61
10	Spring	Moderate	187	860	62	505	164	2.2	71.5	0.93
	Fall	Heavy	---	287	63	705	-19	-0.4	-6.4	1.98
					88				65.1	0.64
20	Spring	Light	232	790	48	497	145	1.9	50.5	1.17
	Fall	Light	---	319	47	714	-2	0.1	0.5	2.42
					79				51.0	0.79
30	Spring	Moderate	208	819	59	538	163	2.2	64.2	1.12
	Fall	Moderate	---	320	70	696	-3	-0.1	-1.0	1.98
					88				63.2	0.71
40	Spring	Light	228	1180	32	500	169	2.2	50.2	1.34
	Fall	Heavy	---	584	86	649	0	0	0.2	0.81
					93				50.3	0.50
50	Spring	Moderate	308	1158	53	471	152	2.0	82.3	0.82
	Fall	Light	---	431	48	695	10	0.2	3.7	1.72
					80				86.0	0.55
60	Spring	Light	199	888	50	500	167	2.2	59.59	1.15
	Fall	Moderate	---	386	59	677	12	0.3	5.46	1.44
					82				65.0	0.64

Fall Trials

Precipitation, following the favorable spring and early summer period was almost totally lacking until near the end of the fall grazing period, table 1. A total of 0.25 inches fell in the combined period of July, August and September. The 1.25 inches that occurred between October 9 and October 30 fell on the 29 and 30 of that month. As a result of the dry fall conditions, no fall regrowth developed on the crested wheatgrass.

Forage production, utilization, and livestock weights and gains are given in table 2 for 45 day grazing trial (September 14 to October 30).

Forage production was comparable to the 1963 levels but livestock response was less than in that year. While there was a net gain of weight in the fall of 1963, animals lost weight in five of the nine pastures in the fall of 1964. None to very little gain was made by the animals grazing in the other four pastures. Gain per acre was less in 1964 than in 1963 although livestock numbers were slightly greater in 1964.

Project S. R. 95. A Ten-Year Evaluation of Range Reseeding in Idaho.

This project was started July 1, 1963 and terminated June 30, 1965. Fluctuations of crested wheatgrass plant density and distribution on some of the seedings were illustrated in last year's report. The complete report of study results appears in Jay D. McKendrick's thesis.

Seedings in this study are located in three physiographically distinct areas; the foothill type with native dominants being juniper and sagebrush; the northern extension of the basin and range province with native dominants of sagebrush and salt-desert shrubs; and the Snake River Plains which were originally dominated with sagebrush and bunchgrass. The second and third types are included in the following report.

During the 1964 field season two major phases of the project were completed; (1) reading of condition-tred sites, and (2) collection of soil samples from each seeding.

Findings of the study indicated significant positive responses in density, distribution, and basal area of crested wheatgrass only occurred during years with above normal spring precipitation after the seedings had become established. Changes during other years with normal or subnormal precipitation amounts were gradual or not detectable. Exceptions to this were noted on seedings which had been heavily grazed during the spring for several consecutive years. However, even these areas, which did not respond to the additional spring moisture, were able to maintain stands of low vigor grass

under heavy grazing. On the highly saline soils, common to many areas of the Raft River Valley, crested wheatgrass did not survive continuous heavy spring use. Non-uniform grazing was in part responsible for the reduction of crested wheatgrass stands on these highly saline soils. Kimsey (1957) suggested taste of the grass on saline soils might be a factor in the animals' preference. It could also very well be a mechanical factor because plants on the "salty" spots are usually finer in texture than those growing on adjacent non-saline soils.

Two other possibilities are offered to explain why crested wheatgrass does not persist on highly saline soils: (1) physiological drought, and (2) ionic toxicities. The first reason seems most likely at the present because crested wheatgrass plants are able to invade these saline areas during years with above-average precipitation (even during grazing) and then die out during droughts; crested wheatgrass is also able to persist on highly saline soils in the upper end of Raft River Valley (Almo, Idaho), where additional available moisture compensates for the osmotic effect of the soil solution salts. The annual precipitation in this portion of the valley is about 1.16 inches greater than that at Malta, Idaho; and soils near Almo are coarse textured and quite permeable to water.

The possibility of an imbalance among certain ions in the soil solution of the highly saline soils should not be overlooked. Shifts in relative concentrations that could occur among ions during the growing season and over several years might also be an important factor controlling crested wheatgrass survival.

Whitmar wheatgrass at Richfield and Bliss, Idaho persisted during the ten-year period, but did not produce replacement seedlings as well as did crested wheatgrass in these same areas. Whitmar wheatgrass is also more susceptible to mismanagement than is crested wheatgrass under the growing conditions of the middle Snake River Plains. In mixed stands, containing both species, crested wheatgrass is preferred over Whitmar wheatgrass in the early spring by grazing animals.

Quantity of available potassium was found inversely related to depth in the soil profile. This was true in both the Raft River Valley and the Snake River Plains soils. Calcium, magnesium, potassium, and chloride ions were noted to be most abundant in the moderately saline soils; and calcium, sodium, magnesium, and chloride were dominants of the highly saline soil. Soils of the Snake River Plains were low in soluble salts; and the dominating available cations were calcium and magnesium. The pH of Raft River Valley soils ranged from 7.2 to 9.2 at the surface. Corresponding values on the Snake River Plains soils were 6.3 to 7.0.

Project M. S. 1. Site Relationships and Productivity of Foothill Woodland Shrub Grazing Lands in Idaho.

After a reconnaissance of the mountain shrub ranges of southern Idaho, it was decided to intensively study the juniper communities first. The juniper zone in Idaho consists primarily of Utah Juniper (Juniperus osteosperma) and western juniper (Juniperus occidentalis). The juniper zone extends east and west entirely across the state and extends north and south from about the northern edge of the Snake River plains to the southern state border. This range is not continuous and the two species do not overlap. Utah juniper is to be found in the eastern part of southern Idaho and the western juniper occurs only in western Idaho. The break between the two species is near the Twin Falls-Rogerson area.

Throughout their ranges, both species seem to occupy predominately rock outcrops or very rocky, permeable soils. The oldest individuals occur on the rock outcrops with smaller and younger individuals on the slopes down from the outcrops. Both species occupy the zone between the sagebrush-grass and the ponderosa pine-Douglas-fir forest. However, the lower limit of Utah juniper extends further into the drier part of the sagebrush-grass zones than does the western juniper.

In many places throughout the juniper zone, there is invasion of young trees into adjacent sagebrush-grass communities. To study this condition, aging transects were established and tree ages taken by means of an increment bore. Analysis of data from these transects indicates several interesting features of the juniper invasion.

1. The invasion is long-term, having started nearly one hundred years ago and continuing up to the present with the majority of the trees having invaded about thirty to forty years ago.

2. The parent juniper stands contain trees several hundred years old.

3. Tree density decreased steadily from the old stands out to the advancing fronts, ranging from approximately 1 tree/300 sq. ft. down to zero trees.

4. Tree ring sequences going back about 300 years consistently show only two drought periods of sufficient severity to be recorded as a series of reduced growth rings. These periods are 3-6 years ago and 30-40 years ago.

During the course of reconnaissance, study sites were selected and methods for measurement of the vegetation developed. Sites were selected within two vegetative conditions of juniper: old established stands and invading stands. This is for the purpose

of studying factors controlling juniper distribution and movement. On each of these sites, the following attributes of vegetation will be measured: crown diameter, stem diameter, height and age of trees; density and crown intercept of shrubs; nested frequency of all herbaceous plants. In addition to measuring vegetation, soil data will be taken from each site. This will consist of a complete profile description and analysis.

Project Inactive During the Year

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

III. Wildlife Management

Project WU-48. The Ecology and Use of Mountain Meadows by Elk.

Numbers of elk on the key meadows were counted for a 45-day period (June 16-July 31). Numbers of elk observed on the same meadows during the same period in 1964 were approximately three times greater.

Daily rides were made until July 31, both morning and evening, but the last elk on the meadows were observed on July 19. No analysis of range conditions was made during 1965.

Project WU-52. Nesting and Brood Habitat of Sage Grouse.

Fifty-seven nests were located on 34 forty acre plots. Thirteen nests were from 1965 nesting and 44 previous to 1965. Twenty-five young birds were collected, 3 each week up to 8 weeks of age, for a food habitat study. Five random vegetation samples were taken from each forty acre plot.

Presence of broods during the early part of the summer was associated with acres of lush vegetation and as summer advanced areas of green herbaceous vegetation were almost always inhabited by grouse broods. Food therefore appears to determine to a large extent movements of broods. No noticeable concentrations of broods occurred near watering troughs, yet the greener areas along creeks and irrigation ditches were common feeding spots. Leaves, buds and flowers of forbs made up a major portion of the diet of young sage grouse.

Table 1. Characteristics of Sage Grouse Nests Found on the U. S. Sheep Experiment Station, June 1965.

	1965 nests	Pre-1965 nests
Number of nests located under or beside:		
Artemisia tridentata	3	1
Artemisia tripartita	6	24
Purshia tridentata	1	2
Tetradymia canescens	0	0
Combination of above species	4	15
Live shrubs	11	35
Dead shrubs	0	3
Partially live	3	4
One shrub	1	5
Clumps of two shrubs	4	15
" " three shrubs	8	14
" " four shrubs	1	4
" " five shrubs	0	5

Total shrub height over nest	Mean	19"	16"
	Range	11-26"	12-24"
Ground to branches of shrub	Mean	8"	8"
	Range	6-13"	6-13"
Shrub or clump diameter	Mean	40"	35"
	Range	29-52"	21-54"
Distance to surrounding shrubs	Mean	3'	3'
	Range	0-18"	0-20"
Number located at elevation			
5350'-5450'		4	13
5450'-5550'		4	15
5550'-5650'		2	9
5650'-5750'		2	0
5750'-5850'		2	5

Project WU-53. The Development of a Dental Cement Annuli Technique for Aging White-Tailed Deer.

Progress this year has been in perfecting the techniques in grinding teeth to the desired thickness without cracking or chipping. Sections were ground to 80 microns. Growth rings were observed in both transverse and longitudinal sections.

Project WU-54. The Habitats Used by Mountain Quail in Idaho.

The objectives of the study are:

1. To study the daily and seasonal movements of mountain quail in relation to habitats used.

2. To describe the habitats used by mountain quail.

3. To evaluate plumage differences which will facilitate sex and age separation.

June 15 through September 17, 1964 was spent in the Big Canyon Creek drainage of the Snake River, Idaho County, studying the mountain quail population. Thirty three birds were trapped and marked to facilitate study of daily and seasonal movements.

A general reconnaissance of the Potlatch River drainage in the Kendrick-Juliaetta, Idaho, area in February, 1965, revealed the presence of a larger population of mountain quail than occurred in the Big Canyon Creek drainage. The principle study area was changed to this area.

Observations of mountain quail in the Big Canyon Creek drainage during early spring showed no extensive seasonal movement. Birds were observed in the same general area as during the previous field season.

A permit was obtained from the Idaho Fish and Game Department to collect five adult mountain quail during March, April and May. During June, July and August 10 immature birds per month were permitted. The purposes of collecting the birds were: to study food habits, to study sex differences and to develop a series of study skins for the Idaho Cooperative Wildlife Research Unit collection.

The vegetation of 41 sites, 22 in the Juliaetta area and 19 in the Big Canyon Creek Drainage, was sampled. At each site two 50-foot line transects were established at right angles to each other; the point at which a quail had been observed determined the midpoint of each line. One-tenth square meter frequency plots were checked for species occurrence at four foot intervals along each line. The information collected will be analyzed after the field season.

Project WU-56. Experimental Burning in Deer Range.

This project aims at investigating the use of fire as a tool in managing winter deer ranges. Burning both in spring and fall have been effective in killing the crowns of shrubs to cause resprouting.

During the spring of 1965 effective burning was done in March and in April, at the Hatter Creek Deer Experimental Area. These burns caused no damage to the site burning only the last years accumulation of dead vegetation. The moist humus layer is not even warmed but sufficient heat is generated just above the ground to kill the stems of shrubs. Snowberry, serviceberry, willow and red stemmed-ceanothus are killed and show immediate resprouting and good growth following the burn.

Burns in April moved quickly with moderate winds. Temperature studies using thermocouples buried under the bark, four inches above ground, but showed that maximum temperatures were reached within five minutes after temperature increase was first noted. Both red stemmed-ceanothus and willow were killed back to the roots with temperatures in the range of 150° to 180°F. These shrubs readily sprouted during the growing season following the burns.

Spring burning on the Hatter Creek deer ranges has been possible because of the build-up of fuel resulting from grazing protection. No cattle have grazed this part of the deer enclosure for a number of years. In contrast, the area grazed by cattle outside the deer enclosure did not have enough fuel to sustain a spring burn.

Experimental burning has been carried on only in open shrub stands where shrubs were largely out of reach of white-tailed deer. In these stands, spring burning appears to have a great deal of promise in raising the production of available deer browse.

Project WU-58. A Study of the Ecology of the Mountain Lion.

Relatively little is known of the life-history and the ecological relationships of the North American mountain lion (Felis concolor). Intensive studies of the lion have not been undertaken largely because of the difficulty in working in the extremely rough terrain it inhabits, its secretive habits, and the hazards involved in handling such a formidable animal. As unregulated hunting by stockmen and sport hunters steadily increases, the need for detailed biological and ecological information on this splendid animal has become more urgent. It has been exterminated in much of its former range in the United States, and in some areas has become a threatened species.

A long-term investigation designed to document the life-history and ecology of the mountain lion was initiated in the winter of 1964-65 in the Idaho Primitive Area. The basic aims of the research are:

1. To gather data on the dynamics of a lion population and

2. To evaluate the role of the lion as a predator and its effect on populations of prey species.

Procedure:

The study is being undertaken in the Idaho Primitive Area. The Primitive Area is located in central Idaho and is extremely mountainous throughout. The main Salmon River bounds it on the north; a vast system of mountain ranges extend beyond its other boundaries. Access in winter is limited to aircraft and travel on the Study Area itself is by foot only. Communication to "outside" communities is by shortwave radio.

Investigations will be conducted in four major drainages within the Primitive Area. Because the principal investigator was engaged in an academic program at the University of British Columbia the past season, intensive work was limited to the Big Creek drainage alone. An area roughly 18 by 3 miles, or 54 square miles, was worked intensively.

An experienced lion hunter and long-time resident of the Primitive area, Mr. Wilbur Wiles, was hired to assist in the project. Trained dogs owned by Mr. Wiles were used to capture all lions.

A base cabin was leased on one of the three private airstrips in the Big Creek drainage. Five tent camps were set up at strategic points and were stocked with provisions. This allowed for operations in the entire drainage.

Results:

1. A total of 10 lions was captured, individually marked, and released. These were composed of seven adult males, two adult females, and a juvenile female.

2. Five lions were recaptured during the course of the season. One adult female was recaptured two different times, making a total of six recaptures. Greatest distance traveled by any lion from the original capture site was three miles.

3. All lions were given intramuscular injections of "sernylan", a brand of phencyclidine manufactured by Parke, Davis and Company. This drug, a fast-acting tranquilizer, calmed the animals sufficiently for detailed inspection and measurement and for marking.

4. Weights and a series of measurements were obtained from all lions captured. These preliminary data suggest that the size and weight of mature females is quite constant, while that of mature males varies considerably.

5. A minimum total population of 22 was arrived at for the Big Creek drainage by combining information gained through capturing and marking with that obtained from track data. Ten individuals were marked but, because of family groupings, gave information on 14 different lions. In addition, eight other individuals were tracked and determined to be animals other than those marked or those associated with marked animals. Family groupings, distances between areas, differences or similarities between times when tracks were made, and individuality of certain track impressions were factors considered in making the determinations.

6. Age and sex structure of the population was projected using the same technique employed in the census. This speculated structure is composed of 8 adult males, 7 adult females, and 6 juveniles, with one adult unclassified.

7. Counts were made of all big-game species sighted during the course of the season. When possible, age and sex classifications were made (age: adult, yearling, juvenile). Cumulative totals were arrived at in an attempt to show relative numbers available to the lion population. These cumulative totals were: elk (Cervus canadensis) - 599, of which 160 were classified to age and sex; mule deer (Odocoileus hemionus) - 1,019, of which 181 were classified; bighorn sheep (Ovis canadensis) - 460 of which 98 were classified.

8. Kills made by lions were located during the course of other field activities. If sign was not conclusive the kill was not

considered to have been made by lions. A "probable" category was applied to some kills that the investigator believes were made by lions, but for which conclusive evidence was not obtained. Ten definite elk kills and eight definite deer kills were located. In addition, three elk and six deer were assigned the "probably kill" category. No kills of bighorn sheep were found.

9. Age of animals killed by lions was arrived at by comparing wear of the cheek-teeth to that of known-age specimens. All ten elk definitely killed by lions were aged; six of the eight definite deer kills were aged using this technique.

10. Physical condition of the animals killed was determined by inspection of the carcass (when possible) and by examination of bone-marrow from the femur. Four of nine elk definitely killed by lions were judged to be in an advanced stage of malnutrition, the other five appeared to be healthy animals. Only one of 11 definite and probably deer kills (for which determinations were made) was suffering from malnutrition, as determined by the bone-marrow test.

Project WU-59. Reproduction of the Cassia Deer Herd In Idaho.

In 1953-54 a productivity study was made of the Cassia mule deer herd when the population was in peak numbers. In 1955 a hunting season of 9 days and 5,800 permits issued had been reduced to 5 days and 2,000 permits in 1964. With the smaller herd a second productivity study has been undertaken. A sample of 27 does in the fall of 1964 showed a production of 1.59 fawns per doe and 18 does collected from February through April 1965 showed 1.89 fawns per doe.

Fawn production by sheep and cattle allotment showed 93 fawns per 100 does on sheep allotments and 113 fawns per 100 does on cattle allotments.

Project SR-101. Computer Analyses and Simulations of Big Game Population Dynamics.

The objectives of this project are:

1. To investigate the mathematics of big game population dynamics by the use of electronic computers.

2. To conceptualize and test optimum population sizes and structures.

3. To develop analyses for data now collected on big game populations.

Procedures:

The procedures to be used are largely intellectual and academic. Existing population models will be collected, evaluated, and submitted for trial. The general areas of interest and examination will be initially: intrinsic rates of increase, biotic potentials, differential social and breeding patterns, effect of exploitation, efficiency of the sampling of live populations, variations in sex and age structures, influence of artificial selection factors on populations, and influence of hypothetical stress factors on populations.

The above studies will make use of the calculus, algebra and biometry. Later work will involve newer concepts in the field of operations research and systems engineering with major emphasis on linear programming, and simulation techniques utilizing techniques of the Monte-Carlo and game-theory methods.

Programming will be in FORTRAN. The investigator will write some programs, prepare descriptions of others for consultants to program. The investigator will proof and "debug" all programs. Data used will be supplied by the Idaho Department of Fish and Game, published research and hypothetical data.

Progress:

Four major computer programs have been completed toward development of an elaborate analysis system for big game populations. The life-table and plotting programs have application in other University research and service. Tables have been prepared for (1) relating sex ratio and young per female to rate of increase, (2) hunter days of effort and proportion of population killed to vulnerability, total harvest, and initial population, and (3) sigmoid growth curves. Progress has been made on a FORTRAN conversion of a capture-recapture population estimation program.

In manuscript are "Working Models of Game Population Stability," "Computer Studies of the Intrinsic Rate of Natural Population Increase," and Electronic Data Processing of Capture-Recapture and Other Ecological Data."

Projects Inactive During the Year

Project WU-14. Availability of Deer Browse Under Varying Snow Conditions.
Project WU-37. The Ecology and Management of Browse on Elk Winter Range, Selway-Bitterroot Wilderness Area, Idaho.
Project WU-45. Occurrence and Significance of Dew on Selected Forest Sites in Northern Idaho.
Project WU-55. Browse Fertilizing Tests at Hatter Creek.

IV. Fisheries Management

Project FU-1. The Determination and Development of Chemicals for the Control of Undesirable Species of Fish.

For Fiscal year 1965, the main program was directed towards the detection of piscicides lethal to squawfish, but non-lethal to salmonid fishes.

For the initial screening program, only juvenile fishes were used. Squawfish (2 to 5 inches in length) were seined from Santa Creek and the St. Maries River and stored in a fish holding facility at Thorn Creek until they were needed for piscicide tests. As in preceding years, salmonid fishes were transported by plane from the coast. Small Chinook salmon and coho salmon were obtained from the Eagle Creek National Fish Hatchery at Estacada, Oregon and were held and fed in a fish facility at Mission Point, St. Maries, Idaho. The procedures used for piscicide tests were the same as those given in the Final Report for Fiscal Year, 1963, and Quarterly Report (April, May, June, 1964).

The number of chemicals obtained from various sources and tested as potential piscicides are listed in Table 1. The original chemicals from Hammond Bay listed by Applegate et al. (1957) were sent from the Galveston Laboratory where they had been used for other toxin research. Of this group, 1,750 chemicals remain to be screened most of which not being lethal at the concentrations reported. About 400 chemicals from other sources still need to be tested.

Table 1. The source and number of chemicals obtained and tested as piscicides.

Source	Number received	Number tested
Chemicals from Hammond Bay listed in SSR Fish No. 207	3,357	1,607
Chemicals from Hammond Bay not listed in SSR Fish No. 207	425	400
Chemicals from the USFS laboratory, at Galveston, Texas	446	64
Chemicals from other sources	499	499
	4,727	2,570

The acquisition of new chemicals was continued during the year and new sources of supply were developed.

Weather conditions in the fall of 1964 permitted juvenile squawfish to be collected later than usual. As a result, fish assays were conducted through early December. In addition, this fiscal year's data was reviewed and analyzed. A summary of the status of our piscicide program and details of preliminary screening tests which detected chemicals that may prove selectively lethal to squawfish follow in this report.

For the years 1963 and 1964, the number of piscicide tests is given in Table 2. For completeness the numbers of larvacide tests conducted in the year 1963 are also included.

Table 2. Summary of bioassays conducted in 1963 and 1964 for selective fish toxins.

Number of different chemicals tested as larvacides	488
Number of larvacide assays conducted	757
Number of different chemicals tested as piscicides	2,570
Number of piscicide assays conducted	3,267

STANDARD SELECTIVITY INDEX

On preliminary screening, differences in elapsed time to death were noted for a few of the chemicals tested at 10 p.m. When marked differences occur, the chemicals have to be tested at other concentrations. The toxins listed in Table 3 were thus tested but further assays are still necessary. The end result, however, was that two minimum concentrations were roughly determined, one, lethal to squawfish and, the other, lethal to salmonids.

To evaluate the degree of selectivity exhibited by certain chemicals a selectivity index was devised which quantitizes the selective effectiveness of the toxin. The selective index is calculated by dividing the minimum concentration lethal to the pest fish by the minimum concentration lethal to the desired species. Selectivity indices could theoretically vary between zero and infinity but where selection is in favor of the preferred species, these indices would vary between zero and one. Values of one or greater are not selectively lethal to the pest fish. The smaller the value of the index, the greater the selectivity of the chemical. It should be noted that the minimum lethal concentration for a given species approximates the maximum non-lethal concentration and could be used inter-changeably in the calculation of the selectivity index.

Table 3. The standard selectivity indices of two potential piscicides which are differentially lethal to squawfish and salmonids. For comparison, the selectivity index of the sea lamprey larvacide, 3-triflourmethyl-4-nitrophenol (TFM) is given.

Chemical code number	Minimum lethal concentrations, ppm Rough fishes	Salmonids	Standard selectivity index
762HH	0.03 (squawfish)	2(coho & chinook)	0.015
TFM (lamprecide)	2.0 (sea lamprey)	8(rainbow)	0.25
A	6.0 (squawfish)	10(coho & steelhead)	0.6

Standard selectivity indices were calculated for the chemicals listed in Tables 3 and 5. The word "standard" indicates that these indices were calculated from data for fish exposed to the chemical for 24 hours and does not take into account any delayed mortalities which might have occurred had the fish been observed for a longer period of time after removal from the poison. An absolute selectivity index which includes delayed mortality should eventually be calculated for all chemicals and species which have a standard index of about 0.5 or less. For practical purposes chemicals which have an index value greater than 0.5 would likely prove ineffective in selectively killing rough fish.

The standard selectivity indices in Table 3 are arranged in order of magnitude. An index of 0.5 for Chemical A was calculated from data given in Table 3 of the Quarterly Report (July, August, September, 1963) and an index of 0.25 was calculated from Table 1 of a technical report (Applegate et al. 1961) for the lamprecide, 3-trifluormethyl-4-nitrophenol.

Table 3 shows that the most selective toxin identified has a standard selectivity index of less than 0.015. This chemical (code No. 762HH) was tested at nine different concentrations, the details of which are given in Table 4. In this example, the minimum concentration lethal to squawfish thus far determined was less than 0.031 ppm and the maximum concentration non-lethal to chinook and coho salmon was greater than 2.0 ppm. Unfortunately, the stock of this chemical on hand was almost exhausted and no further tests for evaluating delayed mortality were conducted.

Table 4. The effect of various concentrations of a selective piscicide (chemical code number 762HH) on the time of death of squawfish and salmonids. Tests were conducted for a twenty-four hour period in four liters of water unless otherwise noted.

Concentration, ppm	Maximum temperature, degrees F.	Time of death, hour		
		Squawfish	Chinook	Coho
0.031*	51	17½, 17½, 21½	DND**	DND
0.062	51	12	DND	DND
0.125*	48	5½, 13½, 21½	E*** 13½	DND
0.125	53	13	DND	DND
0.125	52	15	DND	DND
0.25	51	14	DND	DND
0.5	53	8½	DND	DND
0.5	52	12	DND	DND
1.0	52	11	DND	DND
2.0	52	13½	E 23½	DND
5.0	51	13½	17½	DND
10.0	51	13½	5½	DND
10.0	51	13½	DND	DND

*Test conducted in ten liters of water containing three fish of each species.

**DND - Fish did not die in the 24-hour test period.

***E - One fish lost its equilibrium at the time indicated but did not die.

With respect to other promising chemicals, most have been subjected to only one or two preliminary screening tests and more assays are needed to determine the crude selectivity indices. Further tests are also required to establish the lethal concentrations of some toxins which may be selective but which gave inconsistent results. Some of these inconsistencies may have been due to the unavoidable use of different stocks of chemicals which might have had slightly different toxic impurities.

Table 6. The effect of various concentrations of a selective piscicide (Antimycin) code number 1627SH) on the time of death of spunwfish and salamanders. Tests were conducted for a twenty-four hour period in four liters of water unless otherwise noted.

Concentration, ppm	Temperature, degrees F.	Time of death, hour		
		Spunwfish	Chinook	Coho
0.031*	51	17½, 17½, 21½	DND**	DND
0.062	51	12	DND	DND
0.125*	49	5½, 13½, 21½	5**, 13½	DND
0.125	52	13	DND	DND
0.125	52	15	DND	DND
0.25	51	14	DND	DND
0.5	52	8½	DND	DND
0.5	52	12	DND	DND
1.0	52	11	DND	DND
2.0	52	12½	8 2½	DND
5.0	51	13½	12½	DND
10.0	51	13½	5½	DND
10.0	51	13½	DND	DND

*Test conducted in ten liters of water containing three fish of each species.

**DND - Fish did not die in the 24-hour test period.

***2 - One fish lost its equilibrium at the time indicated but did not die.

LARVACIDES

Of the 488 chemicals tested as larvacides, standard selectivity indices were calculated for ten of the most effective larvacides which were non-lethal to fish at the concentrations indicated. Table 5 shows that these indices ranged from 0.25 to 0.8. Chemical A was included in the table for comparative purposes. The post-larval stage of the squawfish was compared with the juvenile stage of squawfish and salmonids to establish an index. The larval tests were conducted separately from the piscicide tests and differences existed in temperature and possibly in the oxygen content of the test solutions. Water from Rochat Creek, however, was used for both sets of assays.

Table 5. The crude selectivity indices calculated from preliminary screening data of 10 potential larvacides which were differentially lethal to postlarval squawfish and juvenile test fish (co=coho salmon, ch=chinook salmon, st=steelhead, sq=squawfish).

Chemical code number	Minimum concentration, ppm lethal to larvae	Time of larval death, hr.	Maximum concentration, ppm nonlethal to fish	Crude Selectivity index	Species
A	1.5	14	6	0.25	co,st
981BM	5	17	15	0.33	co,st,sq
458FH	5	4	10	0.5	co,ch,sq
486IH	5	6	10	0.5	co,ch,st,sq
977FM	5	18	10	0.5	co,ch,sq
448DH	5	21	10	0.5	co,st,sq
464BH	5	22	10	0.5	co,st
470CH	5	23	10	0.5	co,ch,sq
477EH	8	2	15	0.53	co,ch,st
977CM	8	3	10	0.8	co,ch,sq

Further work will be done on these promising larvicides under controlled conditions. Over 4,000 chemicals on hand still remain to be tested as selective larvacides. As many chemicals are size discriminating, many additional larvacides should be found and larval research should be continued.

Applegate et al. (1961) reported 3-trifulormethyl-4-nitrophenol as being selectively toxic to sea lampreys and non-lethal to most other aquatic organisms. They also list nine other closely related nitrophenols which were also selectively lethal to lampreys. This suggests that isomeres and related derivatives which have simple radical substitutions should be examined for those chemicals which show a moderate to a high degree of selectivity. The procurement and subsequent testing of these chemical families has a high priority in this program.

MANUSCRIPT PREPARATION

A report is being prepared which summarizes the data for the piscicide experiments conducted during the past three years. The report will be similar to Special Scientific Report--Fisheries No. 207 entitled, "Toxicity of 4,346 chemicals to larval lampreys and fishes," (Applegate, et al. 1961). Most of the report will be in table form giving information on the time in hours at which squawfish, chinook, coho, or steelhead trout lost their equilibrium and/or died. The chemical concentrations, temperatures, volumes, and water sources used in each test will be included. The number of chemicals tested will be classified according to the system used by chemical abstracts and will be listed alphabetically in the table with a number assigned identifying the chemical and the company from which it was received.

The report will include information on over 1,600 different chemicals and about 2,000 different tests, but does not list the results of chemicals that are known only by code numbers. Not included is information on chemicals that exhibited great toxicity to squawfish than to one or more species of test salmonids.

Isomeres and derivatives of chemicals that have indicated the greatest degree of selectivity are being ordered as funds permit. These will allow a more equitable evaluation of specific chemical radicals and radical positions within the compounds and enable a decision to be made on the most practical toxins for squawfish eradication.

A table has now been completed in its final form which gives the results of 2,552 separate fish assays which tested the selective potential of 1,888 chemicals. A rough draft of the text for the publication has also been completed and it is anticipated that the manuscript will be ready for publication early in the fiscal year of 1966.

Three of the larger females were injected intraperitoneally with whole pituitary glands extracted from adult squawfish. The injections were fatal to one fish; a few eggs were obtained from the other two, but they were pale colored, misshapen and obviously degenerate.

FISH ASSAY FACILITIES

Fish holding facilities in the fish assay laboratory on campus were improved. Four 270 gallon stainless steel tanks were installed on one side of the laboratory, insulated with two inches of styrofoam, and covered with one-half inch thick plywood. Refrigeration coils were secured to the outside of each tank underneath the insulation. Two, three-fourths h.p. refrigeration compressors, one for each two tanks, were installed to cool the tanks. The compressors were vented to the outside of the building for more efficient cooling. A thermostat was provided for each tank so that water temperatures can be maintained between room temperature and about 32 degrees F. The tanks are being used for cooling the experimental water used in all experiments, for acclimating salmon and squawfish prior to use and for conducting some delineating experiments.

A 4,567 gallon glass-lined water storage tank was buried in the parking lot adjacent to the campus laboratory. The tank is filled through an inlet on the surface of the parking lot and connects directly to the inside of the assay laboratory through a short tunnel made in the building foundation. The tunnel which houses water and drain pipes permits access to a manhole for cleaning purposes. To insure that the water delivered into the laboratory will be non-toxic, all the fittings are lined with fiberglass unless they are made of stainless steel or polyvinyl chloride.

For conducting preliminary tests, four fish assay tables were constructed each of which has a capacity for simultaneously testing 20 separate chemicals. These tables are equipped with a plastic pipe recirculation system and with an appropriate number of aerators. Oil free air is supplied by a special air compressor designed for this purpose.

Project FU-2. A Supplemental Dolly Varden Spawning Area.

This project included the study of relationships of intragravel dissolved oxygen and permeability levels to redd site selection by Dolly Varden char in an artificially created spawning area on the lower Clark Fork River in northern Idaho. The project was also concerned with the evaluation of the incubational quality of the gravel in the area, general observations of Dolly Varden spawning behavior, and measurement of certain physical characteristics of the area. A probe for sampling intragravel oxygen was developed for the study. Field work was initiated in July 1964, and completed in January 1965. A master's thesis was completed by John T. Heimer in June 1965.

Study results indicated that intragravel oxygen and permeability were not closely correlated; in fact a slight inverse relationship existed with higher oxygen levels at the west end of the area and higher permeabilities in the eastern portion. The spawning population

was considered very poor when compared to past years and the results of redd site selection associated with intragravel oxygen and permeability were inconclusive. Most of the fish, however, did spawn in the area of higher intragravel oxygen. The tagging of a portion of the fish present revealed that many fish in the area did not spawn there. Because of this, no estimation of the spawning population could be made. Tagging and subsequent recovery observations did, however, produce an estimate of about 350 Dolly Varden present in the area over the period of the spawning season. The planting of 3000 eggs in 100 egg lots in the gravel indicated that survival was very poor in the eastern two-thirds of the area. Sampling of the spawning gravel suggests that the amount of silt and fine sand in the gravel has increased significantly since the area was completed in 1961.

Project FU-3. Evaluation of Methods for Increasing Native Cutthroat Stocks in Northern Idaho.

The objective of this project is to develop economically feasible methods of increasing the size of the adfluvial cutthroat fishery in North Idaho. The study involves an evaluation of two methods of rearing juveniles (impoundment versus stream) and two races of cutthroat (native adfluvial versus stock from Henry Lake). For this purpose, tentative plans are to construct two drainable impoundments, five to ten acres in size by a suitable tributary stream. The yields of fish feeding on a natural diet in the ponds are then to be compared with those of juveniles in streams in which resident trout and scrap fish have been removed. An evaluation of the survival of the two races will also be made by comparing the numbers of adults returning to spawn with the number of juveniles released.

Some exploratory work was done on the early life history of the cutthroat trout in 1964-65. A paper concerning this phase of the study is ready for submission for publication and is entitled, "The length composition and distribution of fishes in a trout-sculpin biotope."

No graduate students will be assigned to this project until 1966.

PUBLICATIONS

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Dalke, Paul D., Robert D. Berman, Frederic J. Kindel, Robert J. Robel, and Thomas J. Williams. 1965. Use of salt by elk in Idaho. Jour. of Wildlife Mgmt. 29(2):319-332.

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III. Graduate Theses

M.S. June, 1965

Heimer, John T. A supplemental Dolly Varden spawning area.

Kowalsky, Stephen I. Ecology of mountain meadows and use by elk.

Leege, Thomas A. Beaver productivity and movements in southeastern Idaho.

Marchand, Leonard S. An ecological study of sagebrush in interior British Columbia.

McEwen, Harold R. Effects of some plant growth substances on root growth and survival of Douglas-fir seedlings.

Ph.D. June, 1965

Roche, Ben F., Jr. Ecologic studies of yellow star-thistle (Centaurea Solstitialis L.).

APPENDIX A. F.W.R. EXPERIMENT STATION STAFF

I. Regular Staff Members

Ernest Wohletz, Director and Professor (Forest Management)
E. W. Tisdale, Associate Director and Professor (Range Management)
H. R. Alden, Assistant Professor (Forest Management)
D. W. Chapman, Leader, Cooperative Fisheries Research Unit and Professor (Fisheries Management)
P. D. Dalke, Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Management)
M. E. Deters, Professor (Forest Management)
R. H. Giles, Instructor (Wildlife Management)
M. Hironaka, Assistant Professor (Range Management)
A. D. Hofstrand, Assistant Professor (Wood Utilization
J. P. Howe, Associate Professor (Wood Utilization)
K. E. Hungerford, Professor (Wildlife Management)
F. D. Johnson, Assistant Professor (Forest Management)
H. Loewenstein, Associate Professor (Forest Management--Soils)
C. MacPhee, Associate Professor (Fisheries Management)
A. D. Partridge, Assistant Professor (Forest Management--Pathology)
F. H. Pitkin, Assistant Professor and Nurseryman
R. Ruelle, Acting Research Associate (Fisheries Management)
R. H. Seale, Associate Professor (Forest Management)
J. E. Schenk, Assistant Professor (Forest Entomology)
L. A. Sharp, Associate Professor (Range Management)
R. N. Thompson, Assistant Leader, Cooperative Fisheries Research Unit and Assistant Professor (Fisheries Management)
C. W. Wang, Associate Professor (Forest Genetics)
E. L. Williams, Assistant Forest Economist

II. Research Fellows

Duane Andrews--Range Management
Wayne Brukhardt--Range Management
Ralph Colberg--Forest Economics
J. A. Davis--Wildlife Management
James Gosz--Silviculture
Richard A. Goyer--Forest Entomology
Norman Howse--Fisheries
James B. Kasper--Wood Utilization
D. A. Klebenow--Wildlife Management
Richard Lantz--Wildlife Management
Lee McConnell--Forest Soils
H. R. McEwen--Forest Soils
Jay D. McKendrick--Range Management
Patrick Marcuson--Fisheries
John Ormiston--Wildlife Management
Edward Schlatterer--Range Management

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT

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

2. University of Idaho Special Research Funds for Projects 27-D, 54, 55, 63, 65, 70, 77, 80, 94, 95 and 101.

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

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

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

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 Cooperative Wildlife and Fisheries Research Units.

12. United States Department of Agriculture. Funds from the McIntire-Stennis Act; and 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, for research on cone and seed insects, 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. Wildlife Management Institute. Funds for wildlife research.

15. The Theodore Roosevelt Memorial Fund of the American Museum of Natural History, the Boone and Crokett Club, and the New York Zoological Society have contributed financial assistance for Project W. U. 58.

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