FOREST, WILDLIFE AND RANGE EXPERIMENT STATION COLLEGE OF FORESTRY, WILDLIFE AND RANGE SCIENCES UNIVERSITY OF IDAHO

Moscow, Idaho

SEVENTEENTH ANNUAL REPORT

For the Fiscal Year 1964-65

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

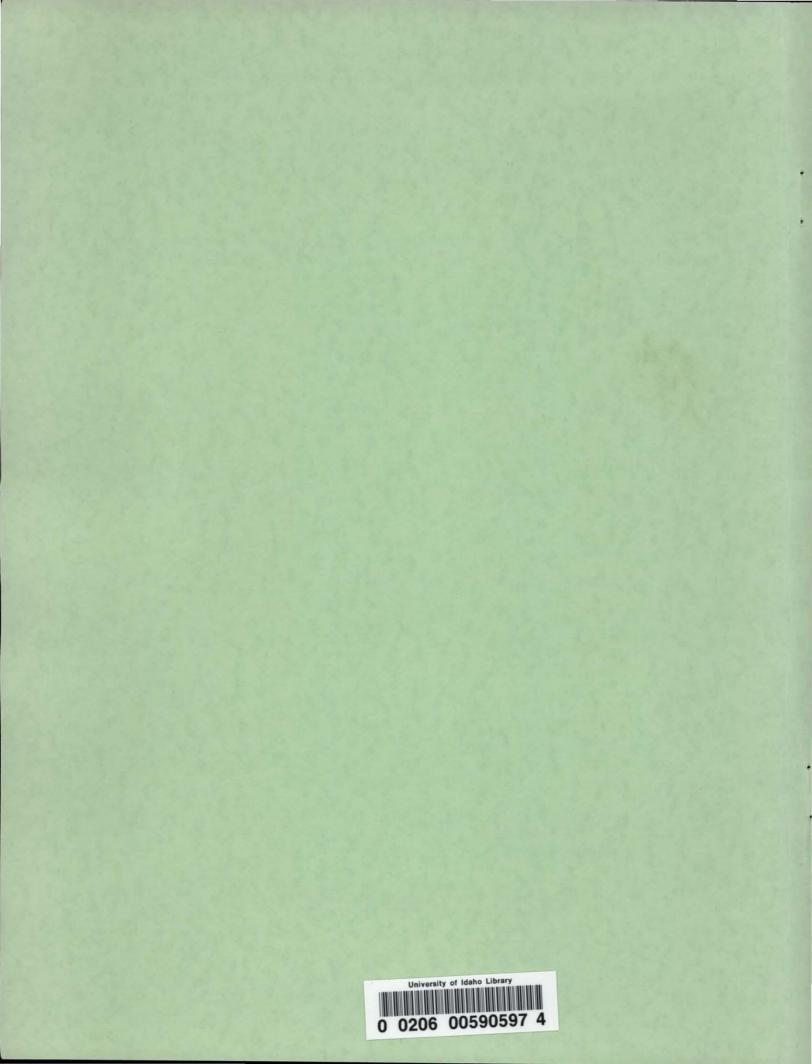
December, 1965

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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 <u>Research Note</u> series has been superseded by two new publications. The new <u>Station Notes</u> 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 <u>Station</u> <u>Papers</u>, 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, Director

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Howard Loewenstein, Acting Assoc. Director

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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 <u>Carex geyeri</u>. 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/<u>Pachistima myrsinités</u> 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 $80^{\circ}-60^{\circ}F$. day-night temperature regime.

Two fungi were selected for this test: <u>Suillus tomentosus</u> and <u>S. brevipes</u>. Both are very common under lodgepole pine, both are constantly associated with hard pines (Sect. <u>Diploxylon</u>) 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.

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Approximately 80 spectment of infured and discussion transform received from pacels throughout the state. To serious sciphytotics were found, except that a localized outbroak of a diseart of runsion office was studied. The cause is unknown at present. As a result of field observations, i new descriptions of decays were recorded.

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

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

These data give conflicting insights into the possibility of mycorrhizal ecotypes: <u>S. Brevipes</u> (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. <u>S. tomentosus</u> (North) was also much more mycorrhizal with North seed than with South (60%-15%) but <u>S.</u> <u>tomentosus</u> 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.

		Indial devot		
	5. brackpes		31	daxel
3/1			50	
	Land died.			
		57		
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In this reals below, percentage of typortized scentified and the for the funkt-two seed source parings:

Share data rive conflictions for all as a free the persisting of any combinal ecosyptes: % <u>Structures</u> (South) formal approxibities with ray, i ser cash of the Horeb Scotlings and 46 are can of the South availings. On the other hand, S. browiece (North) mas any symptric on 31 err control the deriv meditors on 51 per cont of the South senditing. % <u>Resentance</u> (Arth) was also much not contrast with worth losi cons with loath (Bold-153) mag. <u>Southers South was about equally corpatible with North and</u> indications that further references to be and the south and course on lings (ed. (S.)). Nonether has, these are strong to losify as undertained in the south one, these are strong about the south further references to be and souther should be undertained. 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 <u>Fusarium</u> 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

Protoct L. S. 33. Robinia Root-Silp Caune and Control.

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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 (<u>Pinus banksiana</u>) obtained from Minnesota. There are presently one year old and two year old plants growing at the the combined purpose of progeny testing and acad production. (3) The natural stands, where from the best proposites, are produced as evidence by the 1-* parent progeny tests are managed as sociproduction arong for the incodinte production of improved sceds and (4) the original plantecions after successive selections, chinnings and regulars 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 or chards for mass area production.

At the end at this growing season, approximately \$3,000 seadings of the selected pregenies will be raised to 2.0 stage in the lacky beak Nurseries of the Forest Service, Rokes. 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 sites in the Boise area in Boulder Greek and Streburge Flute sear two is the Payeric area in Boulder Greek and Streburge Flute sear MCC11. Ground preparation will be made this fail. Full cooperation of all the cooperators is being organizated and the prepress of this project is on schedule.

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

The performance of 1-parent propendes from 235 trees suiceted in 1961 and 1962 and seven in 1963 and 64 are observed in both the 1-0 and 2-0 stage. Preifminary result indicates the propende of consistent differences between propendes in the replicated seed bed plots.

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

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Project S. S. 53. Mais Production of Lodgepole-lick Pine Hybrids.

The purpose of this study is an attempt to develop fast growing trees through, hybridization by uping native lodgepole Fint (Pinos conterts) as one parent.

The native lodgepole and hybrid plants are holds grown from 400d obtained from a lodgepole sand production area near spirit lake, lodgepole flowers on different parents are bala; politanted with Jack five polien (Figus ban; signa) obtained from Minuscota, There are prosently one year old and the year old plants prowing 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.

Tree No.	Treatment	Percent of reatment 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	

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.

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. Normat Mornery which will be Need plane 4 starbing in the spring of 1956. Three thousand by Tid and an equal number of open pollinered plants which becarbing yours old in the spring of 1955 were field planted of the following three store: thirty parent combinations at the Spirit Lake plots, 5 period continents at at the Greatre plots and 6 percet continuations at the Fish Great plots.

provit, form and survival data will be obtained from and their plot to evaluate the characteristics of the hybrid performance at compared to the marky lodgepole. The three planting areas are different to elimetic and soil characteristics which will alve a wood insight into hybrids to corthern I take under whying environcontel conditions.

Different parent combinations are being used in each pollowhich year to study compatability and sociling pariormane. It has been noted that there is posselly a high percent of socile hybrid wed and also a waristion between todividual mather trees in the percent of aterile steds and average number of socie produced tor ever.

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realizating table indicates the encount of non-families access and average member of seeds per cone for difference years from mother trees which have been replicated.

Project N. S. J. The Haritability of Important Seconds Characters and Permission Opportuge of Portagon Play.

For boritability studios concreited politations were and in dust-duly, 1960 on pressingted mother in es of distinct generic cheracters. Preserved polien and fresh local meterials were mad. 01 the 519 bage band-politinated 571 conce were introdued in early Soptember, 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 firstsummer 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 the use of fiber glass has a prove to be most affictive is toducine reduce demage and soul loss. Informately, some of the pressionted areas encapt one produced any female strobuil in the 1965 square. From the most prolifie wide aroun trees produced only make strobuil. Eigh a treescass fortilizers take applied to the selected trees to encourage flower production.

Field curveys were continued this year in the study of ponisional prime population. Seen was obbatcod on the hobital, trand composition, density and grouth-form characters. Samples of bord comand preserved medies were collected for eratemical studies. Althout 1965 was art a good need your, moda have been collected from nearly all of the activited formanda with the emergien of the inclated colonies in Frankov and tobrash where provide year's come meeting all be used in this study.

The area sowersd in the second year's Hald survey include Gregon, Southern Weinington, Forumes, and isolited struke in adjacart Pateras, Sympton and Robrasha. A small solary of pendernan rine east of the Concard Robrasha, A small solary of pendernan rine last var's flower the Acatari Mathickan was exactned. Although last var's flower the Acatari Mathickan are found at fartile about the source, a particle example of the actions sized of objuiction fice and locartica.

Folget B. S. M. The Brought Resistance of Fond real Fine Scoulings

Survival persentages of condernast pine socilings gram in letant Part, linko, durine the summer of 1003 were scalized controlesly. Socilizes were grown your, burlous continentions of three levels of alreagen, phospharic, bull potnesion nurvicien. Soch firstcurper and from even from soci cove in the first and 1-0 transplants were used in the superiorates.

thing the five-percent level of nimiticarea, it was found that the can higher levels of fertilization did not algoritheanely alter angeingt when empored with the lower level of fertilization. The, the highest level of fertilization did not significantly alter woodlike survival when expand with the intermediate level of fertilization. This was true for all three of the utificate with de-

baring the winter of 19.4%5, penderess pine scalings were grown in and quicates in a growth chamber. The sections vere given antriest solutions contriving one of hour different airrogen concentrations - appratuately 25, 100, 200, and 30 parks per million airrogen. The secdimus ware subjected to drought then they were about two works old. Goodfings to which airrored had been supplied at a level of 200 pps were afgairfeantly leve resistant to damage from the drought trainment (floo-persons level of contributions that acadimus grown at any of the other three of contributions that acadimus grown at any of the other three of contributions that acadimus 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 onepint 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 lovels of altheorem autrition. Seedlings grown at 15 ppm extremely ware the most readstant to drought damage.

Late in April, 1965, a provid chamber orgenizant we begut in which perdenose pine stediings were grown in and cultures. The seculing were divided into elebt groups, and each group infigured with one of sight untrient solutions. These solutions were adjusted to provide all pessible combinations of two levels of aftropen, phosphorus and potassium. Other married demosts were kept constant.

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2rojabt 3. 5. 39. Growth of Goalfgroup Socillage As Alfacted by Ironsmean with Flant Growth Substances.

line offorts of cartain growth substances on survivol and toot erouth of two-year old Bourdas-fir acedlings 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 nonsignificant.

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. erendouse and on field plote located near initial late, idend and at hig Mendow Greek on the Collage Forest. Soudling react were worked in particular mouth substance solutions for 2, 10 or 10 hours prior to planting. Greenhouse experiments were maintained for about three mouths, with measurments taken on the d plots after one growing seamer. Recally may be symmitted in follower

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 A significant reduction in the grouth commend at operit land in treatments involving binaris or supertirive, but the same trend was not observed at leader freeh, Pactors not crucerned with treatments, such as freeh and unlast decays, rate it invostible to grafes the observed differences colely to grouth mubacance 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 3. Particular treatment effects were not always of the same anguitude on the two experimental areas. Thus it is possible that if field use of growth substances because practical. formulations will have to be based on preliminary trials and in the evironment of the specific site.

 Pariability of the experimental results capherizes the aded for none research concerning growth substance physiology withta stedling room. Such a study is planned for the cosing year.

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The test syste experienced in northers [daho during the past several years continued through the number of 1951. Thus, ceair the hered for evolution of techniques to inprove 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 the news frequent dry periods was not realized. Such evaluations are, of course. of prime froorcance in this study.

the the sthol plots, where chemical and machanical methods of controlling compatition with seedings-are boing investigated, survival of 2-0 and 2-1.0 contas-fir trees alanted in the variag of 1966 was uniformly high at the eed of the first econics season regardless of treatment. Actual survival perseasages ranged from 39 per cent for 2-0 seedilings on control plots (no treatment whatseever) to 100 per cent on many of the treated areas. No definative controles as to the effectiveness of chemical treatmence alone can be deduced from these data. No injuries due to the bookstic medications were noted on any seedilings.

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Cultural treatments made to Scotch plac very early or tate in the growing spaces have been unsatisfactory. The and intersi prucing during the latter part of June resulted in crows seats 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° to 45° 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 (P32) 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 halflife of P32 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 radioactivity 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 P³² injected at eight-inch soil depths one inch from the stem. On

Instigation of an excessive number of advectivious budg, while treatments during the letter part of August resulted in the nerance of an adepeate number of buds. Results during the years 1965 and 1965 area revealed thet July appears to be the best period for cultural work.

Data from the Strycholog and Sig Greek grand fir plate reveal a high varianted of the angle after pruning by both the normal and reverse the pruning methods. The degree of angle varied from 9° to 45° for both methods. It is suggested at this time clust if growth rate can be reduced solisiactorily by bear pruning, it 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 accessing through the uncertainty of results but because of the higher actions of the uncertainty of results but because of the higher triming has produced some exceptionally high quality plants bouver, the improvement used over aide shearing with medicies or knives has not been adequate to office the increased labor actions and following this with beast proper actions and following the word the rest predicted the triming and following the set predicted predicted to desire the one the set predicted predicted the stands of trees to be the next predicted procedure to follow if desire the set of the set predicted procedure to follow if desire the set of the rest predicted procedure to follow if desire the set of the rest predicted procedure to follow

Plans for the coming year are to develop plata of both Scotenand white pine every two weeks beginning May 15th in an attempt to determine more closely a frvorable culture partot.

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The Unitial biage of these incentinations involved a converses of root development of 2-0 bouglas-fir medifices and 2-1 longias-fir errosplants. The experiment was conducted at the arrory with entities) were utilized. The frotope (Pg2) was placed in the self. In a circuit pattern around individual places by means of a specially designed prove. Lateral distances of 1 to 18 indust were in a circuit pattern around individual places by means of a specially designed prove. Lateral distances of 1 to 18 indust were in a circuit pattern around individual places by means of a nucceited the platement depths of 3 to 20 induse. The chart halfbale of Pg2 rade necessary two methes of soil injections, our role into a rate with platement date fair. Semples of needle fiere are numblyzed weakly for redistrictly with a positive ther involved in the particular treatment. The actual ratioinvolved in the particular treatment. The actual rate activity detected was also redefied to an attempt to anterphic the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair activity detected was also redefied to an attempt to anterfair the activity detected was also redefied to an attempt to anterfair.

Couplets details of the precedurar outlined above and other details any be lound in the Einstein Annual Report of the ME Expt. St. (Doc., 1963).

Addivity was first detected in 2-1 condition on June 6 from P." in Joneted at sight-inco and depths are first the sten. On

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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		Seed	Seedling age		
Depth	Distance from stem	2-1	2-0		
Depen	LIOM SLEM	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. "Anne 11, 2-1 acodifice saaved activity from the three this depth

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The datas on which radioactivity was first detected in founda carples firs the virious creatments are shown in the following cable.

it appears that duiting the early summer, control of 2-1 recolleds elongated at a nore rapid rate then the 2-0 model, and sere actively growing at a later date in the fall then were the rects of the youtper treat. For a time in eld-summar elongation of roots of both claimer of stark proceeded at the same rate.

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The sampling problem described above will be the subject of infinistudy, develor, even taking into account depic variability, area treads to relative activity uses quice promotent.

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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, 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. <u>Eucosma rescissoriana</u> 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 <u>Dioryctria abietella</u> (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.

Desired E. S. 38. Intraregional Connectifica in Anaber and Plywood Marketing in the Vestern United States.

In this study the total consurption and production of lumber and plywood to the Pastern United States by species is to be deterthered by regions within each state. Icaho was divided into approximate another regions.

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

coloct S. S. S4. Influence of Porest Site on the Mood Properties of Inland Douglas-Pir.

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This study has also been concerned with the effect of irrivation on wood properties. Noed samples from irrigated and control trees have been analyzed for prowth rare, specific gravity, fiber learth, percent lebewood, bucker of cells produced and year, and cell widths. The resulting data have been proceesed through the main cell widths. The resulting data have been proceesed through the statistic of fifercat beights to the tree and the offset of irrigation on wood at differcat beights to the tree and at the four certical volues. A report on this study is fifty percent emplote. This study is being cade in recommended with lessington State University and the Washington Water France Co.

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 Clatriburien and seed logate in relation to stand density. (Initiated 1963; completed in 1964).

Conversions and a solicated from four dousities (518, 100, 45 stame per acre, and mixed metarol stands) and discreted longitulinally through the axis to obtain the version insect damaged said on the face. A scale by scale exactorized provided the actual percent of othered and, <u>income</u> resolutorized befor, accounted for 51.1 and 95.6 mercent of the sead leases in 1963 and 1964, respectively, or 12.2 and 0.5 per cont, thereatively, when theresued as a propertion of total scad, leases den to <u>Horgetria shietells</u> (0.86.), completerat resulted of the actual of the understand of the 19.5, respectively.

If Separted as 8 x 8 fast (630 stoms per sere) is the loth Apausi 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. <u>Apanteles starki</u> Mason, <u>Chelonus n. sp., and Pimploperus n. sp. were the most</u> 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. were relatively unimportant. Highly rightforms differences in aced loares were found between densities of 536, 169, and 46 anno por stre. Loases in the mixed natural stands were not significantly different from these in the rest dense plot.

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

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 The parasite complex associated with <u>Eucomp rescienting</u> Hein, in corriers lishe (Lopidoptern: Olethroutine) (Initiated 1963; continued 1966).

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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. Plans for the 1565 scenau fuelude wholly collections from the extering plus the addition of two further plots. More effort will be directed to the life histories of the three most important paraulic energies. This third part of data is expected to eid considerably th spectraining treads in spundance and progressive rates of parasitian, plus provide vote biological and phonological observations.

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purine che redreation penson of 1965 a graduete spudent will collect visitor une information to svainate the counting instrument and develor visit and sao prediction curven. 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 toget 2. S. 51. Maho Comprehensive Outdoor Recreation Plan.

The College of Foregary, Wildlife and Earge Sciences has played a key role is initiating research towards a state outdoor representen plan. The plan to include a discription of State resources agoncy recreation responsibilities, supply, damand, need and actica promeuar initiated into the fall of 1966 but war not fully itaneous by the State and Bureau of Outdoor Recreation ward with 1, 1965.

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Objectives: "Ene present rock is designed to:

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5. Ancertain the present rate of lease deposition in the eres.

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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. nitrates, ritrites, 'aminute, bydromium ico concentration, and quantity of marifediate matte... Colorimetric procedures will be used for analysing amount, altrete, and untrice. Albuminoid witrores concent will be recordanced by mirrobjeldabl procedures. both 7-ray diffraction and the electron midroscope will be used to identify resocate.

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Mirear programing techniques mock to optimize, inst la centaise or minimure, sere linear objective inaction which is itself side west to contrain constraints that are expressed as linear inequalities. Thet is, for example, to manimize a firms profile subject to an array of rescriptions of the use of land. Tabor or expiral.

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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. In this study two linear programming models that will optimize allowable timber yields from a typical foreac unit in north idano's white pine timber type will be developed. Appressed in a very simple ponner, the first wodel will maximize physical volume vields swither to erea controls, volume controls, or a combination of bach. The second will maximize the foreats present but worsh from a series of future timber harvests, once sgair under conditions of area or volume control, or a combination of the two.

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Project D. S. 2. White Pine Bilisber Rust. Project D. S. 20. Mertality of Young Western White Hims (Fole Bilght). Project E. S. 17. Soil Natrient - White Fine Site (mality Study, Project E. S. 28. Minsery Soil Farallity Studies. Project L. S. 37. Direct Secting of Conference 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:

0 0.3 0 0	Foliage Hits 0 0.3 0	Basal Hits 0.7 0 0.7	Foliage Hits 0.7 0.7
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	0	0.7	1.0
0	0	0.7	0.7
0.3	3.	0	0
0.3	3.	0	0
0.3	0.7	0	0
		0	0
		0	0.7
0	0	0	0.7
0.3	4.3	0	6.0
	0.3 0.3 0	0.3 1.0 0.3 0.7 0 0	0.3 1.0 0 0.3 0.7 0 0 0 0

Growth Development of Salt Desert Shrub Species

Investigations of the yearly growth development of six salt-desert species, saltsage (<u>Atriplex nuttallii</u>), winterfat (<u>Eurotia lanata</u>), kochia (<u>Kochia americana</u>), shadscale (<u>Atriplex confertifolia</u>), Indian ricegrass (<u>Oryzopsis hymenoides</u>), and squirreltail (<u>Sitanion hystrix</u>) 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

I. Sanke Mapagement

eroject E. S. T. Breluetion of Salt-Desere Banges. Project L. S. 15. The Realogy and Cratrol of Malogecon.

Successional changes is depicted sult-desart shrub communities were atudied. Trynstigations concerning the life history of salzsige (Atriples nuccellit) and other species wars continued in 1959.

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Growth Novel stant of Sale Densit Shrub Sactos

invertigations of the yearly provid development of all sale-doarst mometer salesage (Astiples mpter1141), where at (Eurotia Innate), locate (Sochle americana), shadgeale (Astiples confercifelle), Indian cheegeas (Orwappels Symeosices), and saulareitall (Strankes Symetic) were continued. The plants of cash species were narized when the only and setal tage in 1952, and growth notes were started. The following table gives the average markawar beight attained wearly since 1956.

The greatest offect as growth repears to be cliente, and the work expressed allights response occurred in 1961, the fourth and last perr of a cycle of driet than normal years. This variation is climate for the various versa screars 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					Indian	
Measurement	Saltsage	Winterfat	Kochia	Shadscale	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. on the three helt-chrobe (universe, vinceriet, and Kachia). Shedscale being a true shrub sepagra to be affected forst by alfants.

the eliteric effect on the presses is apparent only or the instanrecepteds. The redeon for little of no effect on the squarelinil is not known for some, but it is believed that at least part of the reason for the steady increase in statute of the squirrelinit is due to the are of the marked plants.

					Saltsage	
		6.8				
		0.0		Art		
			4.5	7.8		
ELE		0.0				
	9.51		3.6			
3.8		1.7		19.2		
			7.2			
		08.48	5.35	8,29		

Response of Saleyage to C'ipping Treatments

The saltsage clipting study which whi initiated in Hay, 1962 was constanted in 1966. However, arms oligifing dates were missed: theredore, the 1964 results are note of an imitantion of the offects of previous clipping study antalls a comparison of two altoping. Secondally the clipping study antalls a comparison of two altoping heights, the alights itequencies, and five dotes of initial altoping heights. The initial clipping at the lie?, 1963 and 1956 scarce were made hay i, and is and antiference with in the first dipping war made were the constant at two-weet intervals for elect weeks offer the initial constant at two-weet intervals for elect weeks other the initial strong (early sugnat). The centrel plots were dipped only of the scarpiction of growth. The following table comparise only of the complete of growth. The following table compares the sportege at an initial offer the loce offer plots were dipped only of the scarpiction of growth. The following table compares the average

There is a significant interaction between altoping belaht and date of initial clipping. Ar the date of initial clipping programme, the effect of diverting beight becomes have appeared, and in the later clippings there is no difference. Flows clipped in late June and Joly had considerably higher yields then the others, including the entrol plots which were clipped only at the the growing entered. Also these bisher yields have been maintained for all three years. This suggests that are clipped any stigulate production.

Number of						Yields		statement of the local division of the local		
weeks after		state of the local division of the local division of the	62	and in case of the local division in the loc	63	and the second se	64	3-Year	and the second s	
first clipping		Clipp			Clipped		Clipped		Clipped	
that sequence	Times	Height		Height		Hei	Height		Height	
vas initiated	Clipped	3/4"	13"	3/4"	11/2"	3/4"	13"	3/4"	13	
	1	984	696	459	648	473	725	639	689	
	23	966	642	614	684	690	737	757	705	
0	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	
	1	1096	916	736	882	437	827	756	872	
2	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	
	1	1098	1024	934	780	507	640	788	815	
4	2	1082	852	434	838	435	882	650	856	
	3	1416	924	864	899	1176	905	1152	909	
	1	1338	1038	1428	1098	1127		1297		
6	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.

			P#	52 1010 ⁻		eple14	s/a Baul)		
rotta ellor								3-200	
leat elipping		ngk10 IgkoH		g110 toP					
		2/4.2							
						12421		593	
			916						578
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in foot E. S. C. Moolney and Control of Meduaabood.

The explanation of meduacherd's attitive to take over a divergrass accountly is not clear. The classical explanation that one cannot commuley replaces absume in succession because of were efficient and replet utilization of noll multivate is not advance in structions where meduanced and descriptions are involved. Although the two success permittee at much the mass the in the fail, mecoscherd is autocasion, a study was inteined in 1961. An area was cleared of repletion and kept is low during the exting and much effects of magnetization to the although the horizon the data of autocasion, a study was inteined in 1961. An area was cleared of experiment plate were studied with horizon much and mumbers of medspectrament plate were studied with horizon much and mumbers of and of the first termined on a studie and from a first of the process of the althout of fall raise. The muchers of another are its inter the althout of fall raise. The muchers of another is the process and N muchaed in the fall raise of another of the interference of the althout of the fall raise of the process of the althout of the transmitter and the first school of the althout of the process and N muchaen and and a state of the process of the althout of the transmitter of the alter the first school, the reproductive muchaed for plote alter the first school, the reproductive muchaed for of the tor colliture streads and event four det spring) and determined before colliture streads and event four the spring) was determined accurative. Supervised results are presented in Table 1.

	cess	ductive Succe	Per Cent Repro		Seeds/Sq.Ft. Introduced
4-1965 60	1	1963-1964 87	1962-1963 41	1961-1962	Treatment I. O Medusahead
46	-	51	58	17	150 Cheatgrass
					Treatment II
56		92	60	12	75 Medusahead
21		58	52	13	75 Cheatgrass
					Treatment III
65		87	70	16	150 Medusahead
38		43	52		0 Cheatgrass
		43			0 Cheatgrass

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

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: $2" \times 2"$, $6" \times$ 6", $12" \times 12"$, and $12" \times 24"$. 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 <u>Tragopogon</u> <u>dubius</u> and <u>Agoseris</u> sp. in the area. <u>Poa</u> <u>secunda</u> 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 Table 1. Reproductive Success (Ratio el Mumber of Meed Versus fatablished Individuals) of Feduadend And Chemigrand

			Souls/Bo.Ft. Tutroduced
1963-1964 87 51	· 1962-1963 61 58	1961-1962	
			Treatman II 25 Medunahad 75 Cheerran
		16	Tretenant III 150 Prinanhad 0 Chestgrass

The reproductive success of medunchead was constructed bicker than chartgrass. The factor(s) contributing to the bicker winter upreating of chartgrass was not determined. The resulting differential in has meansahed is able to only a charter computity and becare the dominants aposies. The early spring sampling prior to mitting stress reles out melature competities as the prior to mitting charter reles out melature competities as the prior to mitting the dominance for melature competities as the prior to mitting charter reles out melature competities as the prior to mitting. Stress relevant the destribution is the prior to mitting the difference in reproductive success, the area rapid is the chart.

The use and of multiacheed range by coltie has been of speculative macure. For a some objective evaluation as to how much acdusated and associated species are actually presed, utilization transects were tatabilized in a caltile allotment and anapled in April and Junc Merted plots with the following dimensions were used: $2^n \times 2^n$, $6^n \times$ 6^n , $12^n \times 12^n$, and $12^n \pm 24^n$. Multi transects were located, and the frequence of grazed and unpressed plots were totated by species in above the two farthest transects were located and the plots with the transacts were and by species in the maneous of grazed and unpressed plots were totated by species in above the two fartheat transacts was about four plots. The transects above the two fartheat transacts was about four plots. The plots of the transacts were about four plots were above the two fartheat transacts was about four plots. The maneous is a located and unpressed to concenture, the transects were located. One area was not grazed, although it was within the located. Gue area was not grazed, although it was within the substance. Summethed results are promented in Table 2.

The data indicate that in relation to the distribution of species, cattle tend to profes some species over others. By early how, the satisfie had relacted out a high percentages of the <u>Trepperson</u> inplies and <u>Aconeria</u> op. In the arce, <u>Pas seconds</u> was motiler operies nough: out by cattle, as fullenced by 63 per cent of the place containing this species bolt, started. Conspress was found in a large author of plote, but now of lev density and reather. Conservates was often bidden by the presence of a much higher density of methode and earlie did not seek ant fully due of earlier.

Inder conditions where spinels are forced to use reducated rings

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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.

11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Total	, Grazed	
Species	Sum Freq.	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

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

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 editéd and corrected several times. Provisions are made to permit addition of species. higher than an "open" range. Degree of use of reducabled in and area who 17 per cent, Constally, wherever car chips were prosent, the immediate surrounding area for several inches were evolved. Noch here ground was exposed, litter one conspicuously lacking, and nore palatable species were minutage.

The use of meted plots to determine relative utilization has not been previously tested for reliability. The correlation coefficient between sum frequencies of summal grantes (meducabed and chestgrass) obtained in April and June was r = .85. The April values note mean hat lover than there of June, particularly along the transactuin early spring, the presence of small annuals are costly everlapted and carteful scrutlay of the plats is nacessary. The two transactuthat yielded widely different values between April and June uste sempled in the late afternoon. This magests that peer light mine incomplete a factor in failure to observe the presence of scall incompletence of sail and plate the presence of scall incompletence of sail and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the plate the presence of scall incompletence of scall and the scale of scall and the plate the presence of scall incompletence of scall and the scale of scall and the plate the presence of scall and the scale of scall and the scale of scale of the scale of scale of scale of scale of the scale of scale of scale of the scale of scale of scale of the scale of scale of scale of scale of scale of the scale of scale of scale of the scale of the scale of scale of

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Agronyton epitentim		
Trunopagon dubius		85.21
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Tabla 2. Fercentage of Plets Grazed Containing Meducaliana and Associated Species. Sased on Sum Fronuency Obtained From Moded Plets.

trolect t. S. J. (8-287) Recolory of Schebruch-grass Rangen

the environment amount of soil and vegetational data obtained from more than 100 argobrach-orean stands makes analysis of data by deal colouistor extremely todinus and increpiets. To take advantures of the beaufits of intractic data processing, the vegetational data have been codified and transferred onto more than 5,000 punch cards. The problem of addition of memoric code for species use been resolved coorernaing with Oregon State University, a mester deck cantalaing alpha and amount codes, solvatifie usar, counts mane, symmom, and life form of more than 5,500 plant opecies in the Posifie Horehvert vama generated. This matter deck has been edited and corrected towards these. Travisions are made to perify and corrected

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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.

Species	#/Acre	% Variability (Sx/x)
Total Yield	472 <u>+</u> 72	15.0
Agropyron spicatum	332 <u>+</u> 28	8.4
Sitanion hystrix	11 <u>+</u> 2	18.0
Poa secunda	52 ± 54	103.0
Bromus tectorum	82 <u>+</u> 42	51.2

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

Numeric coding of species or data cards can now be accorptized automationally by colleting the master dock with field data corose.

An important part of the teoryster is the sell. To corretate and properties with vegetational characteristics by machine processing the soil information needs to be put or cards site. With the experience gained while working on the card invent for the vegetational aspect of the study, the development of the card injuration and was not as difficult as anticipated. Again working with cregos State University, a card involve was developed with provision to factude all information normally obtained while describing a soil profile is secondence with the boll Survey Namel. Transfer of and information onto wash the boll Survey Namel. Transfer of and information on and the boll Survey Namel. Transfer of and information onto wash cards will be a major offert this year.

Yields were obtained for the seventh consecutive year in two exclosures located in two associush-years associations. During the seven-year period (1939-1965) great variability in growing conditions occurred and was reflected by the verying yields of the nere sensitive species. <u>Arropyron micetum</u> should th least variability (Tables 1 and 2). <u>Tes actuals</u>, a shallow-rooted perennial grane, behaved much like the summal grane, <u>Bromas performs</u>. Both showed high variability in yield during the period of the experiment. A production of <u>Bromas tester</u>, the correlation between For and Digh variability in yield during the correlation between For and Digh variability in yield during the correlation between For and Digh variability in yield during the correlation between For and Digh variability in the testering. The correlation between For and Digh variability in the during the seven years which is a soluted Dight the forder Walley available of the intervent of the seven production of Broms testering. The correlation between For and Dight the forder worked to correlation between for and Dight the forder worked to seven years were r = .05 (significant of T.CO) in the forder Valley exclosure.

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	472 ± 72			
	332 ± 28			
16.0		Strandon hystrix		
		Pos secunda		
51.2				

Table 1. Variability of Vields Buring Seven Consecutive Teans 11 the Jordan Valiey Evelosure. Annual Precipitation About 12 Inches.

Species	#/Acre	% Variability (Sī/ī)
Total Yield	1813 <u>+</u> 153	.8.4
Agropyron spicatum	894 <u>+</u> 66	7.4
Perennial forbs	677 <u>+</u> 88	13.0
Poa secunda	118 <u>+</u> 47	39.8
Miscellaneous	101 <u>+</u> 43	42.5

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

*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 <u>Sitanion</u> <u>hystrix</u>, <u>Agropyron spicatum</u> and <u>Stipa</u> 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:

2 Varianitey (28/2)	AActe .	Species
å.ß.	1013 + 153	Total Yanid
		Auropyron spiearum
13.0		
	118 ± 47	Post uncurda
\$2.5	101 ± 43	

Table 2. Variability of Vields Duries 6"Years in the Hidvals Exclosure, Annual Precipitables Nout 17 Inches.

Almin collected in 1951 was emitted because of a wildfire burn in late summer of 1950 that greatly atteated the yielde the following year.

A comparative study of establishment and survival of Sitenion hystory, Acropyran apicatus and Stips churberlans under Datural and extiticial conditions was initiated in the opting of 1955.

Objectives of this study are at follows:

 To ampare Arropyrod spicature, Sitanico System and Stips churcheriana in their colevance to both soil temperature and coil coletare stread.

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 To determine the influence of segentuch and other established, vesetation on a cite in limiting mediate establishment.

 To investigate possible taxis influences of screbrush litter in reducing percential event seediing contrapted and survival.

The study aroan were located in the sprine of 1953 in the Artennet cridentals-fitter thurberiens and Artenians rillenta-Apropyres apleares baldent-types in the vicinity of Ivia Falls, Timbo. By the and of the fited year some seed had been collected and cost been on the field study plots.

In the field study broadcast seeding and planting of the three species will be compared under five degrees al compatizion with mainty vertextion. The five degrees of compatizion 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	То	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. 1. Cleared bare, 3. Cleared of same runh overstory, 1. Cleared of outerstory vertetton. . Thinned samebruch, 5. No treatment.

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

Project E. S. 26. Evaluation of Rango Sandlogs

Expressed vigor of created wheatprass resulting from the favorable conditions in 1963 combined with the favorable conditions continuing in 1964 produced greater yields than in provious years.

andry Trinia

Presipitation, sithough not pulte as abundant as in 1953, use in excess of our inches for the April-Nay period and perior signs (7.90) inches for the April-May-June period, see table 1. Values for comparable periods in 1963 ware 7.79 and 9.30 inches resucctively.

Precipitation		
	In	
1.62		
	18-1-81	10-1-1
	7-1-64	-1-66
	D-1-86	
0.21	10-9-64	-1-54
E.S	10=30-64	
	12-6-54	

Teble 1. Freedplustion at the Point Springs Experimental Area 17 1964.

Air dry forane production and utilization along with livested:

Fornes production was above the 1963 production and much above some of the enviler years. The graning period (May 4 to July 20) year extended from the planted \$5 days to 76 days is order to emproach a wore desirable utilization lovel in the partures.

Avorage animal much reflected the longer graving period and ranged between 165 and 167 pounds. Average daily rein fluctuated struct two pounds a day and ranged from 1.9 to 2.2 pounds. Gate per scre world between 50.6 and 05.2 pounds.

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Pasture		on & nsity	Initial Production Pounds/Acre	Initial Prod Plus Growth Pounds/Acre	. Utili- zation Percent	Avg. Initia Animal Weight	l 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	<u>63</u> 88	705	-19	-0.4	$\frac{-6.4}{65.1}$	$\frac{1.98}{0.64}$
20	Spring	Light	232	790	48	497	145	1.9	50.5	1.17
	Fail	Light		319	47 79 59	714	-2	0.1	$\frac{0.5}{51.0}$	2.42
30	Spring	Moderate	208	819	59	538	163	2.2	64.2	0.79
	Fall	Moderate		320	70 88	696	-3	-0.1	$\frac{-1.0}{63.2}$	$\frac{1.98}{0.71}$
40	Spring	Light	228	1180	32	500	169	2.2	50.2	1.34
	Fall	Heavy		584	<u>86</u> 93	649	0	0	$\frac{0.2}{50.3}$	$\frac{0.81}{0.50}$
50	Spring	Moderate	308	1158	53	471	152	2.0	82.3	0.82
	Fall	Light		431	<u>48</u> 80	695	10	0.2	$\frac{3.7}{86.0}$	$\frac{1.72}{0.55}$
60	Spring	Light	199	888	50	500	167	2.2	59.59	1.15
	Fall	Moderate		386	<u>59</u> 82	677	12	0.3	5.46	$\frac{1.44}{0.64}$

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

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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

Full Trinlo

Precipientico, folicating the Cavarable spring and early somer period was sincet totally lacking until seer the end of the fail granted period, table 1. A total of 0.25 inches fail in the combined period of July, August and September. The 1.25 inches that occurred bereives Ostober 9 and Detober 30 fail on the 29 and 30 of that month. As a result of the dry fail conditions, as fail regrouth developed on the created bestgrange.

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Torage production was comparable to the 1963 levels but invested, response the left that just. While there was a not gain of only ht in the solid of 1963, estable lost weight in five of the also partures in the fail of 1966. Here to very little gain was used by the samely graving in the other four partures. Cain per acre was lets in 1964 then in 1963 although livestock sumbers werslightly proceed in 1964.

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Seedings to this study are located in three physic maphically distinancess the foothill type with partic dominants boing jumper and conclusing the porthern excension of the basic and range province with antive dominants of account and salt-desort thrubs; end and Sanke River Flates which were originally dominated with account and puncharmes. The second and third types are included in the following report.

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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. under heavy grazing. On the highly hillse wolfs, common to ready aross of the huft filver Velley, created wheatgrass did and sortive continuous harwy spring use. Son-enflorm grazing was in part highly saline colfs. Einsey (1957) suggested taste of the grass on miles colfs might be a factor in the animals' preference. It could also very colf be a factor in the animals' preference. It haity' spots are usually finer in centure that the second on the factor because plants on the adjecent sec-relies of large for the the second of the second adjecent sec-relies of the second second bart on the

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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

reoleat B. S. I. Site Salationships and Froductivity of Footnill Vootland Sarub Grasing Lands in Idaho.

After a reconnensance of the neuments abrub ranges of contracts Labo, it and decided to inconsively study the (uniper communicient first. The puriper zone in Idaho consists primerity of Utah Juniper (<u>Juniperus Ostocoperma</u>) and western juniper (<u>Juniperus ostocoperma</u>) and seater juniper (<u>Juniperus ostocoperma</u>) and seater juniper (<u>Juniperus ostocoperma</u>) and seater southern about the active of the sout extends north and south from about the conthern edge of the souter plains to the southern state border. This range is is to be found to the externa part of southern labo and the vectors juriper secure only (is western Idaho. The break between the two soutes is rear the Toda Palle-Formercop area,

Throughout their ranges, both species seen to occupy predeminately cost outerees as very reaky, personable sells. The eldert individuals occur on the reak outerops with analier and pounder individuals the slopes down from the outerops. Both species drougt the rate between the satebrock-grass and the ponderess plan-boughes-fit forest. Howweet, the lower limit of Uteb justice extends forther into the driet part of the segubrush-grass when then does the wateru justice

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During the course of recommissioner, mindy after very selected and methods for measurement of the veretation developed. Sites were selected within two veretective conditions of junipers old exceptioned stands and foundary 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. Inve

Investigations of Harvester Ants on Southern Idaho Rangelands. of studying frators costrolling juniper distribution and account." On each or there sizes, the following attributes of vegetation will be compared: cross districtory recent diameter, height and ego of there is density and cross incorrect of annues; neared frequency of all herbackees plants. In addition to meanwring vegetation, soil dera will be taken from each size. This will consider of a complete modific description and analysis.

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Fraject 2.5. M. Investigations of Marvester Ants on Southern Idamo

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. Twentyfive 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 shrubso	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

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Mean	19"	16"
Range	11-26"	12-24"
Mean	8"	8"
Range	6-13"	6-13"
Mean	40"	35"
Range	29-52"	21-54"
Mean	3"	3"
Range	0-18"	0-20"
	4	13
	4	15
	2	9
	2	0:
	2	5
	Range Mean Range Mean Range Mean	Range 11-26" Mean 8" Range 6-13" Mean 40" Range 29-52" Mean 3' Range 0-18" 4 4 2 2 2

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:

- 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.

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Observations of scentulo parts in the Ste Canyon Grant diverses during early spring shread to extend on ressonal weverent. Mids were observed in the one general area as during the provise finit 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 reachoof white-tailed deer. In these stands, spring burning appears to have a great deal of promise in raising the production of available deer browse. A permit van obtitued from the Idaho Fish and dama Depitizant to collect five Adult souncaln quail during March, April and Day. During June, July and August 10 immature birds per month ware connitted. The purposes of collecting the birds wore: to study food habits, to study sex differences and to develop a series of study skins for the Idaho Cooperative Wildlife Ruscarch Unit collection.

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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
- 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 along. 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.

Project MD-58. A Study of the Scology of the Mountain Lica.

Relatively little is hrown of the life-history and the sectorical relationships of the harth American mountain lion (Kelis convelor). Inconsive studies of the lion have not been undertaken introly because of the difficulty in working in the extremely rough terrain it inhabits, its secretive hobits, and the beards involved in banding such a formidable animal. As unregulated bunting by abeeknes and aport hunters stratily increases, the med for detailed biological and ecological information on this splendid animal has used in the Valued Status, and in some meas has because a charge in the Valued Status, and in some meas has because a chrostened openies.

A long-term investigation doutgoed to document the life-history and acology of the mountain lion was fulciated in the wister of 1964-65 in the Elche Frinktive Area. The scale sime of the research area

- . To eather date on the dynamics of a lies population and
- Is no available the role of the line as a predator and its circul on populations of prov spoints.

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The housy is being undertained in the Idaho Primitive Area. The Primitive Area is Located in contral Idaho and is extendly moreh; a vast system of mountain ranges extend beyond its other boundaries. Access in winter is limited to strengt and travel on the Study Area itself is by foot only. Communication to "publide" recommittee is by abortway radio.

Investigations will be conjucted in four walor drainingss within the Frimitive Area. Baradre the principal investigator was employ in an academic program at the University of British Columbia the past sector, intensive work was limited to the Big Greek drainage along. An area roughly 15 by 3 miles, or 54 square miles, was marked intensively.

An experienced iton hunter and long-class resident of the Printerod area, Mr. Wilbur Wiles, was hired to assist in the project. Trained dogs owned by Mr. Wiles were used to expense all itons.

A base cabin was leaved on our of the three private struttpell the Big Greek drainage. Fice reat camps were set up of atratecto points and were stocked with provisions. This allows' for operations in the ontire 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.
- 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.
- 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

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- 1. A cotel of 10 floos was captured, individually marked, and reinfordd. Flicas were composed of seven adult males, two adult females, and a juvenile remain.
- . Five itoms were recaptured furing the course of the second. One adult ferals was recaptured two (filerent times, making a zoral of six recaptures. Greacest distance traveled by any lieu from the original capture site was three miles:
 - All Hone were given intramerular injections of "sernylan", a brand of phenoyoliding shuelactured by Parle, Davis and Commany. This drog, a fast-isting tranguilizer, calced the antrals sufficiently for detailed inspection and measurempt and for earling.
 - . Potebte and a series of cresurerents were obtained from all lions concurved. These preliminary data suggest that the size and weight of meture forming is quite constant, there there of protons makes varies constitutely.
- 1. A minimum tatal population of 22 was arrived at for the signature threek intension by empirizing information galand three through capturing and marking with the obtained from trick date. The individuals were marked but, because of facily groupings, gave information entries different lies. To addition, and the individuals were and determined by addition, be and the second of the second states of the second states of the second states and the individuals were and the second states of the second states of the second states of the second states and the second stat
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- Countra ware made of all big-game aportan signed antiac the court of the search. In a possible, see and set directification ware arrived at in an actance to sher relative numbers evillable ware arrived at in an actance to sher relative numbers evillable to the itom population. Those curulative rotain were sis (Cirven especiants) - 500, of which 160 ware classified to als set sext vale for (Coccilent projects) - 1,019, of with 11, were classified; bighers about (Origin minimum) - 1,019, of with of which 98 were almosticid.
 - This made by Itons vore located furing the course of other

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.
- To conceptualize and test optimum population sizes and structures.
- To develop analyses for data now collected on big game populations.

acceldered to have been made by lique. A "probably" category was applied to some kills that the investigator believes were unde by lique, but for which conclusive evidence was not obtained. Tes definice elb kills and sight definite deer wills were located. In addition, three elk and six deer were sasigned the "probably kill" category. We kills of bighers abeen ware found.

- 5. Age of animals tilled by itons was arrived at by comparing wear of the check-teeth to that of known-age speckmens. All ten old definitely billed by itons were aged; six of the eight definite deer kills were used using this rechainer.
- (0. Physical condition of the animals killed was extermined by Laspection of the curveds (when possible) and by examination of bross-mercow from the femure. Four of mine alk definitely killed by lions were judged to be in an advanced stars of columnicition, the order five appeared to be healthy mainate. Only one of 11 definite and probably door kills (for which determineitons were made) was suffering from value titlen, as determineiton the bone-marrow from.

Project W-53. Reproduction of the Casala Deer Mard in Lanna,

In 1953-54 a productivity study was made at the Galars adde deal herd when the population was to peak numbers. In 1995 a bundle, second of 9 days and 5,400 permits leaved had been reduced to 5 days and 2,600 permits in 1960. With the analier hard a second productivity study has been undertained. A sample of 27 dees in the fail of 1954 showed a production of 1.59 fauns per doe and 16 deed collected from February through April 1965 showed 1.39 fauns per dee;

Juve production by sheep and critile allotment enoyed at Lands per 100 door on sheep allotments and 113 faves per 100 door on cattle allotments.

Project SR-101. Computer Analyzan and Simulations of Dig Game reputation

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- Is fo investigate the pathemarics of big gate population dynamics by the use of electronic computers.
- To conceptualize and test optimum population sizes and atructures.
-). To develop analyses for data now collected on aig game populations.

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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 lifetable 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 capturerecapture 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.

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The procedures to be used are intropy incontracted and advantated (mistin, population revisio call be collected, evaluated, and substituted (or initial). The prooral areas of incorest and empiration will be initially intropied rates of incorest and empiration will be the solution of investors, effect of empirication, differenof the subpling of live population, warington in set and age structures, influence of armitical selection in set and age and influence of armitical stress factors as populations.

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Decembered and Dignification of Irw on Selected Forest	Project MI-63.

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.

Source	Number received	Number
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 4,727	<u>499</u> 2,570

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

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

IV. Pisborics Management

Project PU-1, The Decermination and Development of Chamicaly for the Grainet Public Spectra of Pish.

For Viscal year 1955, the cath program was directed invarian the detection of piscicides lither to sense 10, but non-lether to extend finner.

tor the infilml screening propriat, only journalie fishers were used. Squarefish (2 to 3 inches in longth) were spinod from Satin Creek and the St. Marias River and aboved in a fish holding facility at Those Creek until oney were meshed for pisziside rests. As in recoding years, salaonid fishes were transported by pince IV-m the cost. Small Chinock salarn and coho anizon were obtained fact the Casile Creek ant cost itsh Herebery at Datacods, Dregon and were hold and tod in a fish Herebery at Datacods, Dregon and the casile Creek ant or a fish facility at Marian, St. Marian, the tasks of the tot in 10 mine the mere the same as were hold and tod in a fish facility at Marian, Dregon and these streat in the fish facility of Mission Point, St. Marian, those given in the Fish facility of Fiscal Fort, 1963, and Carperly those given in the Fish Report for Fiscal Fort, 1963, and Carperly those given in the Fish 1966).

The number of chemicals obtained from various sources and fasted an potential plactenies are listed to Table 1. The external chemicals from Hammard hay listed by Applegate at al. (1957) ware sent from the Gal aston inheretory where they had here used for other tests research. Of this group, 1./50 chemicals remain to be screened most of which not being return at the concentrations reported. About 400 chemicals from other sources at 11 read to be tested.

Table 1. The source and mucher of obsticals obtained and boated as

The adjutation of the charicals was constant were the year and .

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. Heather conditions in the fail of 1964 permitted juvenile soundfail to be collected later than unual. As a result, fish assays were contacted through verly December. In addition, this floes pref's data was reviewed and antirzed. A unumry of the status of our plactable program and decails of prefering screening cate which detected chemicals that may prove selectively lethal to equivisible failed in this report.

For the years 1963 and 1956, the number of pizzithde tasts is given to Table 2. For completeness the numbers of larvacide costs conducted is the year 1963 are then included.

> Table 2. Summary of bioassays conducted in 1963 and 1969 for selective fish costus.

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On proliminary serengine, differences in slapsed time to doath (vere noted for a faw of the chemicals tested at 10 p.m. When narried differences occur, the obsainals have to be tested at other concentrations. The toxins listed in Table 1 were thus tested but further assays are still necessary. The sed result, boover, was that two minimum concentrations were roughly determined, one, teshal so squarish and, the other, lathal to veremide.

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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	centra	um lethal con- ations, ppm gh fishes	Salmonids	Standard selectivity index
762нн	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. Eable 3. The standard selectivity indices of two potential pinetoids of which are differentially lethal to equavitab and selection. For comparison, the selectivity index of the sed largery largeride. 3-triffournathyl-b-altrophenol (TPM) is given.

Srandari Giectivizy nder		Minison lethal com- contrabions, ppd Souch fisher	
		(defiverpa) CO.0	762нн
0.25	8 (rainbou)	2.0 (sea lamrey)	
. ð. 0	IC (cohe, & steelhend)	(dailwaupa) 0.0	

Standard at lectivity indices were conculated for the theoretic listed in Tables 3 and 3. The word "standard" indicates that there indices were colouisted from data for fish exposed to the chemical for 24 hours and does not take into account any setayed metalities which might have eccurred had the fill been observed for a longer parted of there after recoval from the polyet. An absolute selectivit index which includes detayed normality chould eventually be calculated for all chemicals and pooles which have a standard index of source 0.5 or less. For precised purposes chemicals which have an index value greater then 0.5 would likely prove incident in selective hours which filling rough file.

The standard acleativity indicas in Table 3 are arranged in other of warmiteds. An index of 0.5 for Chemical A was calculated from data given in Table 3 of the Quarterly Report (July, August, September, 1953) and an index of 0.25 was calculated from Table 1 of a technical vaport (Asplayate at al. 1961) for the langueside, 3-trifteorrothyl-4-attrophenel.

Table 3 shown that the most relective torin identified has a atradard selectivity index of less them 0.015. This chemical (code its: (6288) whith are given in this chemical, the details of which are given in table 4. In this example, the minimum concentration tethal to equawine thus the determined age less than 0.021 per and the maximum concentration non-lechal to chimosh and cohe select was greater than 2.0 pps. Unfortunately, the stock of this chemical on hand was impate subsumpled and firster that for evaluating delayed most subsumpled and no firster that for evaluating delayed most subsumpled and no

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Concen- tration,	Maximum temperature	Time of death, hour		
ppm	degrees F.	Squawfish	Chinook	Coho
0.031*	51	17월, 17월, 21월	DND**	DND
0.062	51	12	DND	DND
0.125*	48	5월, 13월, 21월	E*** 13 ¹ / ₂	DND
0.125	53	13	DND	DND
0.125	52	15	DND	DND
0.25	51	14	DND	DND
0.5	53	8월	DND	DND
0.5	52	12	DND	DND
1.0	52	11	DND	DND
2.0	52	1312	E 23눌	DND
5.0	51	13½	17눌	DND
0.0	51	1312	5월	DND
0.0	51	131	DND	DND

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.

*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 itssequilibrium 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.

The affect of various concentrations of a selective	Table 6.
plackelde (chanical code number (62HB) on the tine of	
death of squarefab and salaonida. Toess were conducted	
for a trobty-four hour period in four liters of worse	
.bojon wakarata masing	

	Time of depth, hour	MAXILINE FORDER'S LORE,	Concen-	
Conc			dagrees P.	
				*100.0
		12		\$20.0
	PET WAR	55, 134, 211		0.125%
	Dist.			0.125
				0,125
				68.0
			53	
		11		0.5
				0.0
				0.0

First conducted in the liters of water containing three that of another synchos.

whom a Fish did not die in the Sechor tent pariot.

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With respect to other priniting chemicals, most have been subjected to only see or two preliminary screening teste and more asteyn are moded to detremine the orade selectivity indices. Further tests are also required to establish the tethel concentrations of scale testime which may be selective but which gove incondistent produces. Some of these inconsistencies may have been due to the enavoidable use of different stocks of chemicals which might have bed will be different rowing impurities.

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 postlarval 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 lar- val death, hr.	Maximum con- centration, ppm nonlethal to fish	Crude Selecti- vity 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.

LARVACIDES

Of the 638 chemicals bracked as larvacider, atamand entectivity initians were calculated for can of the matt effective larvacted. Which were non-lethal to first at the concentrations indicated. Table 5 whow that these indices ranged from 0.23 to 6.2. Chemical A man included in the equivitud was ensured from 0.23 to 6.2. Chemical isonel acets of the equivitud was ensured with the juvenile stage of squartish and salaonide to extra 15th an index. The invest of squartish and salaonide to extra 15th an index. The invest stars conducted separately item the electede content and differences that conducted separately item the electede content of the stars conducted separately item the electede content of the test solation. Salar from content the second proved for the sale of assays.

Table 1. The crube selectivity failess calculated from proluminary screening date of 10 personal lervicides which was fifterentially beckel to pondiarval squaritab and juvenile test first (usecobe saines, checkinger tainen, a stretheal, squarent bb).

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Denther work will be done on these producing leaviering and the controlled conductors. Over 4,000 chantes on hand still reads to is tested as achective intractions. In runy chestes ore size discriminating, many addictoral intraction should be found and intral resorts. 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. polegate et al. (1961) reported 3-trifulormethyl-4-mitrophenol as wing selectively toxic to see impress and non-lethel to most ther equatic organisms. They also firt mine other closely related dirophenols which were class selectively lethel to impress. This experts that intracta and related derivatives which have imple edical substitutions should be examined for those chemicals which have a moderate to a high letter of selectivity. The products of substitution of these chemical faulity and a high priority

MANISCHITT BERPARATES

A report is being prepired which seminized the data for the offered experiments conducted during the part three verse. The report will be number to Special Scientific Terret existenties 25. 207 entitled, "Toxicity of 4.345 checkeds to invest lamprays and fisher," (Aplenate of al. [961). Here of the report will be 'n toble form giving "Interaction on the the 'n here at which theresified, obtacol, onle, information on the the 'n here's equilibrius and/or dist. The checked of sciences train lost the's equilibrius and/or dist. The checked of sciences will be included in concentrations, temperatures, volumes, and vector courses used in each cost will be included. The unplet of chemicals testrate will be closeliked according to the system used by chemicals testrates and will be listed signaberically in the tests will a summer assigned will be listed signaberically in the tests will a summer assigned.

The report will include information on over 1,000 different chemicals and about 2,000 different trates, but does not line the results of chemicals that are known only by code municas. Not included is information on thendedia they exhibited great testedty to aquavitab that to over or poir species of case samooids:

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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

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The holding (anilities in the figh array intoffatory on computed word improved. Four 250 gallow statnices recei tarks ware installed on one the of the inborecory, inculated sith two tarks of signofams, and covered with one-ball ince thick plywood. Refrigeration colls wares secured to the outside of each task underneth the insulation. Two, three-lourths h.p. reitzigeration compressors, one for each two tasks, whe installed to cool the tanks. The compressors (with weight to the estable of the building for nors efficient cooling. A thermostat was provided for each task of that where is paratores is an interpret was provided for each task of that where is paratores is the information between room temperature and about 32 decrees f. The information provided for each task of that where is paratores in all experiments, for acclinating the experimental vater used in all experiments, for acclinating experiments.

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for conducting prelimitary tests, four fish assay usbit vere constructed and of which has a capatty for simultaneously testing 20 separate chemicals. These tables are confeed with a pinatte pipe rectrediction system and with an appropriate number of carators. C 1 from air is supplied by a special air confronted of designed for this purpose.

Project Wi-2. A Supplemental Doily Varden Speudiag Acce.

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Study requits indicated that intragraval oxygen and permeability were not glosely correlated; in fact a glight inverse relationship chitted with higher oxygen levels at the ways end of the area and higher permeabilities in the seather postion. The sparning 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 troutsculpin biotope."

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

when considered vary poor when compared to past years and the results of redd alte selection associated with intropraval oxygen and permeability were inconclusive, hour of the lick, hourver, did sprea in the area of higher intratrovel oxygen. The tagging of a portion of the fish present revealed that may fish in the area did not spraw there: Because of this, no contaction of the spawning pepulation could be made. Tagging and subasquent recovery cohervations did, however, preduce an estimate of about 350 Dolly varies present in the area over the period of the aptiming secontine planting of 3000 ergs in 100 ergs lots in the gravel indicated chat aurorival was area poor in the cantern two-thirds of the action and fine start in the stary poor in the cantern two-thirds of the seconcate aurorival was area poor in the cantern two-thirds of the seconand fine start in the gravel have been the the anomit of site chat aurorival was area poor in the cantern two-thirds of the seconcate aurorival to the stary poor in the cantern two-thirds of the secontent aurorival to the spawel sugrests that the anomit of site cate yes consisted to 1951.

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PUBLICATIONS

I. Technical Publications

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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.

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- Marchand, Leonard S. An ecological study of sagebrush in interior British Columbia.
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Ph.D. June, 1965

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

Frechtes, A. D. and F. C. Johnson. 1954. Saw records of forest tand in Idaho. M.V. Sci. 36(4):137-137.

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 - Hose, J. F. 1965. The Instering beatness rolld about. Spokrammer-Nevlew Programs Edition. Spoking, Mathimater.
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- Phone. 1965 Roche, Ban F., Jr. Scologic studies of yellow star-thistle (Contauros

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

I. Regular Staff Members

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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

APRIME A. F.G.S. LATERINE STATION STATE

Require Staff Manbers

K. H. Hinder, Associate Minester entered (Nergel Parket, M.)
K. Midea, Associate Director and Trofesnor (Range Barketert)
D. J. Chaptan, Leader, Frofessor (Broest Parket Parketer Doit and Professor (Ficherics Hangemat)
P. J. Dalle, Larder, Cooperstive Wildlife Research Dait and trafessor (Wildlife Nangemat)
M. E. Perers, Froinsor (Wildlife Mangemat)
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J. Beferrad, Assistant Professor (Range Janagemat)
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K. D. Johoson, Assistant Professor (Foreit Mangemat)
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J. Bartridge, Associate Professor (Foreit Mangemat)
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J. J. Saale, Associate Professor (Foreit Mangemat)
J. B. Schenk, Assistant Professor (Foreit Mangemat)
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S. L. Williams Analotene Foront Screensla

Kessarch Fellows

Burne Andrews--Munice Management
Marne Brukinedt--Hanze Management
Reiph Colbarg--Ferent Feenomics
A. Bavis--Kildlife Management
Jares Corss-Stivicaliture
Motman Hauce--Fisheries
Johne B. Marput--Mood Brilliation
A. Elobarow-Mildlife Management
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A. Kilobarow-Mildlife Management
A. Kilobarow-Mildlife Management
M. K. Maguer-Jorest Soils
M. R. Maguer-Forest Soils
Jay F. McKendrich--Rauge Management
Jerstek Marcuspie--Fisheries

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT

- University of Idaho, Forest, Wildlife and Range Experiment Station, projects in Forest Management, Range Management, Wildlife Management and Wood Utilization.
- 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.
- Idaho State Fish and Game Department. Regular support for the Wildlife and Fisheries Research Units.
- Inland Paper Company. Labor, equipment and field accommodations for work on tree hybridization, seedling survival and forest fertilization.
- Potlatch Forests, Inc. Potlatch Research Fellowship and a special grant for work on forest site influences on wood properties of inland Douglas-fir.
- Southern Idaho Forestry Association. Financial support for forest genetics research.
- United States Bureau of Commercial Fisheries. Funds for research on determination and development of sperm toxins for control of undesirable species of fish.
- 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.
- 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.

WERENESS . SOURCES OF REFLACE FUNDS AND OTHIS SUPPORT

- . University of Links, forest, Midline and Range Superinces Storiet, projects in Forest Einstement, Some Management, Wildit's Namagew ment and Wood Utilization.
 - University of Idabo Special Sessarch Funds for Projects I-U.
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 - United States Europe of Land Management. Funds for casesred on subelevert virub ranges, inclities and assistance for robut Springs grazing project, reducated rosearch and forest genetics studies.
 - 11. Balted Shakes Eurean of Sport Fisheries and Hildific. Funds for
 - United States Department of Agriculture. Jouds from and Scintification Stends Act; and Segional Research Projects Mi-02, M-25 and M-71, through comportion of Agricultural Experiment "tation, University" of Idate.
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