NINTH ANNUAL REPORT

Forest Wildlife and Range Experiment Station
College of Forestry, University of Idaho
Moscow, Idaho
For The Fiscal Year 1956 → 1957

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INTRODUCTION

Thirty-four projects in the fields of forest, range and wildlife research were carried on. Five of these studies were completed by the end of this fiscal year, and three new projects were begun.

The Station staff during the year consisted of seventeen members. Only two of these were on a full-time research basis. The untimely death of Dr. Virgil Pratt, Associate Professor of Fishery Management, left a vacancy in this field which was not filled until August, 1957. New staff members added during this year include John P. Howe, Assistant Professor of Wood Utilization (replacing Dr. Ellis) and Dr. Edwin Clark, occupying a new position in Forest Entomology. Mr. George Frazier was appointed to a new position, as Research Assistant in Forest Economics. A position in Forest Physiology and Soils, left vacant by the resignation of Dr. Ferrell, remained open due to lack of qualified candidates at the salary available.

New positions authorized for the next fiscal year include a Forest Geneticist, an instructor in Wood Utilization and an additional Research Fellowship. The forest genetics position is made possible through the cooperation of the U. S. Forest Service Branch of Research and the Southern Idaho Forestry Association. This position will be full-time research.

Nine graduate Research Fellows aided in the Station research program throughout the year, while four others were on appointment for part of the year. The theses of six who graduated in June, 1957, are included in the List of Publications appended to this report.

Cooperation with other branches of the University and with other State, Federal and private agencies was maintained at a high level. A major feature was the conclusion of an arrangement whereby the U. S. Forest Service will locate a tree breeding orchard on the campus and supply a resident staff of forest genetics research personnel. Finances for Station research continued to come mainly from University funds, but substantial support was received also from the State Fish and Game Department, U. S. Bureau of Land Management, U. S. Forest Service, Sears-Roebuck Foundation, and through Regional Projects of the U. S. Department of Agriculture (in cooperation with the Idaho Agricultural Experiment Station).

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Respectfully submitted,

Ernest Wohletz
Ernest Wohletz, Director

E. W. Tisdale
E. W. Tisdale, Associate Director

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WORK ACCOMPLISHMENTS

I. Forest Management

A. Projects completed during the year:

Project E.S.5. Chemical Debarking of Trees.

In June, 1957, a final examination was made of all trees on plots treated most recently. This concluded the field work for this project which is being written up as a Station Research Note. The project demonstrated that monochloroacetic acid and its sodium salt were relatively effective as silvicides. A new bandage method of silvicide application gave improved short-term results.

The species treated showed differences in resistance to silvicides. These differences varied according to the length of the time interval after treatment. None of the chemicals used gave the desired peelability characteristics to the dead trees.

Project E.S.17. Photomicrography of Native Woods.

This project can be considered as completed. Photomicrographs of native woods will be added to the reference collection as time permits, but this is a teaching and service activity rather than research.

Project S.R.43. Forest Soil and Site Mapping.

This activity has been terminated as a Special Research Project due to lack of a forest soils man on the staff at the present time. Work may be resumed in the future depending on the availability of the necessary staff.

B. Continuing Projects:

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

Inspection of post tests at the Monson farm, Dienhard farm, Gaudle ranch, Rock Creek checking station, Asa Drake farm, Scheiss farm, Christiansen farm, and Horne farm was carried out in August of 1957. Potato cellars at Aberdeen, Thornton, Ashton, and Victor were also examined. A Station Research Note on the post treating tests is currently being prepared.

The potato cellar at Ashton was constructed half of untreated timbers and half of penta-treated timbers. This cellar showed well the results of treatment. Untreated timbers in the rear of the cellar are in an advanced stage of decay, several of them having failed completely, allowing the roof of the cellar to cave in. Fungus mycelium and fruiting bodies are abundant on the roof timbers and on the willow thatch over the timbers. All of the treated timbers are in good condition. Observations on other cellars also give evidence of the effectiveness of preservative treatment of potato cellar timbers.

The construction of potato cellars usually involves the use of a roof of willow or other brush or old boards laid over the roof timbers before a layer of soil is added to cover the cellar. Wood decaying fungi develop very rapidly in this roofing material and it subsequently acts as a source of infection for the roof timbers. The possibility of using some decay-proof material for roofing cellars should be considered. Another practice that favors the spread of decay fungi to structural timbers is leaving piles of old, rotting potatoes in the cellar after the shipping period. Wood decay fungi grow readily on these old potatoes and they should be removed as a sanitation measure to lessen spread of decay to timbers.

Further observations on the post tests and potato cellars will be made in 1957.

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

Annual inspection of the 10 plots on which the study is continuing was made in the period between July 29 and August 24, 1956. No plot maintenance was undertaken because of unavilability of field assistance.

Photographic records were continued for the cankers in these series that are still living. Two of the seven that were alive in 1955 died early in 1956 and were photographed for the last time on August 17. The remaining cankers were photographed on that date, and again on November 1. Rephotographing of plot sites, done originally in the early 1940's, was done on two plots in late August.

Transcription of canker development information from the old branch data sheets in use since 1941 was continued; the data for all branches, living and dead, being completed by the middle of May. The new branch data sheets now make available a consolidation of data originally carried in three separate records, and are much more efficient for interpretation of data.

Through the kindness of Mr. George H. Duvendack, Supervisor, the St. Joe National Forest authorized field assistance to complete plot inspections during 1956. One man was assigned to the project from the Clarkia blister rust headquarters for the period July 30 through August 17. Inspection of the northern plots was accomplished with one man hired from irregular help funds in the period August 20-24.

In 1953, the first consideration of survival of rust-infected trees that could be derived from the project's data was presented in F. W. R. Station Research Note #7. The work was of interim report character, because cankers on 65 of the 453 branches included in the study had not reached trunk or died enroute to the trunk by the end of 1952. Because the study of survival probability requires that the final status of every case in the population under study be known, it was necessary to predict the final status of these 65 cases. Prediction was simplified by the character of the canker records. These constitute a detailed record of each canker in all aspects of its development from its first appearance. Predictions were subjective and it was assumed that little error could result because of the long experience of the predictor im observation of canker development. The following is the record of accuracy of these predictions in the first four-year period.

At the end of the 1956 field season, 44 of the predicted cases had reached their final status. Of these, 8 failed to satisfy prediction; 5 that were predicted to die reached trunk; 3 predicted to reach trunk died enroute. Of the 21 cases still enroute toward trunk, whose predictions require re-examination, 4 must now be changed from the 1952 prediction. Of this group, 3 predicted to die may now reach trunk, and 1 predicted to reach trunk will probably die.

Table 1 presents the data employed in Research Note 7 (1953), and compares the data available at the end of the 1956 field season by classes of distance between the point of origin of canker and the trunk. In the data of each year all cases, including predictions, are shown in each class of distance from trunk. The number of predictions included in each class is shown separately. Grouping of the cases in various classes of distance, and determination of percentages that reached trunk and died in each class, provides the basis of survival probability.

Table 1 — Distance Canker Origin to Trunk. Cases classed as reached trunk or dead in one class out to 14 inches, in each inch from 14.1 to 24 inches, in 6-inch classes for the next 24 inches, and a single class thereafter, showing predictions of final status, wherever employed, in each category. Data to end of 1952 and to end of 1956 field seasons. A comparison illustrating the effect of errors in 1952 predictions of cases that have reached final status in the four-year period, 1952-1956.

		DISTANCE IN INCHES, CANKER ORIGIN TO TRUNK																	
STATUS 1/		0.1-14.0	15	16	17	18	19	20	21	22	23	24	TOTAL CASES	24.1-30.0	30.1-36.0	36.1-42.0	42.1-48.0	48.1-84.0	TOTAL CASES
		2/						ALL RECORDS TO AND INCLUDING 1952											
ALL CASES	R. TR.	103	2	4	5	4	4		1		2	1	126	3	2		1		132
	DEAD	49	4	6	10	6	4	16	11	11	8	11	136	52	44	43	26	20	321
PREDICTIONS	R. TR.	NONE	1	2	1	2	3		1		2	1	13	3	2		1		19
	DEAD	NONE						2			2		4	8	11	12	7	4	46
								ALL RECORDS TO AND INCLUDING 1956											
ALL CASES	R. TR.	103	2	4	5	4	4	1	1		4	1	129	5	3				137
	DEAD	49	4	6	10	6	4	15	11	11	6	11	133	50	43	43	27	20	316
PREDICTIONS	R. TR.	NONE									1	1	2	2	2				6
	DEAD	NONE											0	1	4	6	2	2	15

1/ - R. TR. = CASES CLASSED AS REACHED TRUNK.
DEAD = CASES CLASSED AS FAILED TO REACH TRUNK. THESE HAVE DIED ENROUTE TOWARD TRUNK, THE GREAT MAJORITY THROUGH DEATH OF THE BRANCH.

2/ - SEE TABLE 1, RESEARCH NOTE 7, 1953, FOR CASES IN EACH INCH FOR THE FIRST 14 INCHES OUT FROM TRUNK. NO PREDICTIONS WERE REQUIRED FOR THESE CLASSES, FOR ALL CASES WITHIN 14 INCHES OF TRUNK HAD EITHER REACHED TRUNK OF DIED BEFORE THE END OF 1952.

It should be noted that in 1952 all cases within 14 inches of trunk had either reached trunk or died (reached final status). Accordingly, they are grouped in a single class in this table. Their distribution in 1-inch classes may be seen in Table 1 of Research Note 7. The above table shows distribution of cases in 1-inch classes between 14.1 and 24 inches, and in 6-inch classes out to 48 inches. In 1952, a total of 19 cases were predicted to reach trunk, and 46 cases to die. In 1956, predictions were reduced to 6 and 15 respectively. These are the result of re-examination of 1952 predictions in the light of subsequent development of canker and branch for each case in the intervening 4 years. They are new predictions, of which 4 required change, as noted above.

In the 4-year period covered by this table, of the 19 cases originally predicted to reach trunk, 12 satisfied prediction, 3 died enroute, and 4 were alive and still enroute at the end of 1956. Within 24 inches of trunk, 13 cases were predicted to reach trunk. Of these 10 satisfied prediction, 1 died enroute, and 2 were still enroute at the end of 1956. These latter cases are virtually certain to reach trunk before the end of 1959. Thus, predictions to reach trunk within the presently-accepted "threatening canker" distance of 24 inches from trunk were wrong in only 1 of 13, or 7.7%.

Of the 46 cases predicted to die, 24 satisfied prediction, 5 reached trunk, and 17 were still enroute at the end of 1956. Within 24 inches of trunk, 4 cases were predicted to die. Only 1 died as predicted, the remaining 3 all reached trunk. Thus, predictions to die within the "threatening canker" distance was wrong in 3 of 4 cases.

Of all 17 cases within 24 inches of trunk whose final status was predicted in 1952, 4 were errors in prediction, or almost 24%. Of the total 44 cases that reached final status in the 4-year period, 8, or 18.2% were errors in prediction. The fact that the highest proportion of error lies in the cases nearest to trunk, within the presently-accepted "threatening canker" distance, and is almost entirely an under-estimate of ability to reach trunk is of the utmost importance.

It now appears that it may be necessary to extend the "threatening canker" distance beyond its presently-accepted 24 inches from trunk. There are two important reasons for this. First, a higher proportion of cankers than was originally demonstrable now appears capable of growing more than 24 inches to reach trunk. In Research Note 7 it was reported that only 3.8% of cases were in that category. In Table 1 it will be noted that, if predictions for 4 cases are correct, 8 cases in a total of 137, or 5.8% will now be in that category. Second, if these predictions are correct, the proportion of cases reaching trunk in each of the two 6-inch classes from 24 to 36 inches may be too high to ignore. The first of these classes, 24.1-30 inches, will show 10% reaching trunk, and the second, 30.1-36 inches, 6.5%. Thus, it may be essential to extend the "threatening canker" limit to at least 30 inches, and possibly beyond. Only the ultimate behavior of the 9 cases still enroute to trunk at distances between 24 and 36 inches will determine establishment of this limit.

Distance grown by cankers to reach trunk is a function of time. This is clearly illustrated by the following tabulation of the maximum distance grown by cankers reaching trunk in the years since 1951.

In the 2-year period covered by this table, [illegible] cankers [illegible] predicted to reach trunk, 12 satisfied prediction, [illegible] and still cankers at the end of 1953. Within 24 inches of trunk, 17 cankers were predicted to reach trunk; of these 10 satisfied prediction, 5 died entirely and 2 were still cankers at the end of 1953. These latter cases are virtually certain to reach trunk before the end of 1954. Thus, predictions to reach trunk within the presently "threatening canker" distance of 24 inches from trunk were wrong in only 2 of 17, or 12%.

Of the 16 cankers predicted to die, 14 satisfied prediction [illegible] and 13 were still [illegible] to the end of 1953. [illegible] 4 were predicted to die. Only 2 of [illegible] the remaining 2 reached trunk. Thus, predictions to die within the "threatening canker" distance was wrong in 2 of 4 cases.

Of all 21 cases within 24 inches of trunk about which a decision was predicted in 1952, 4 were wrong in prediction, an error of 19%. Of the total 17 cases that reached final results in [illegible], 15, [illegible] errors in prediction. The fact that the greater proportion of error lies in the cases needed to reach trunk within the presently "threatening canker" distance, and is entirely an under-estimate of ability to reach trunk is of the utmost importance.

It now appears that it may be necessary to extend the "threatening canker" distance beyond 24 inches from trunk. There are two important reasons for this. [illegible] the quantitative proportion of cankers that were originally [illegible] 24 inches of reach trunk. [illegible] Table 3 [illegible] in this category. In Table 4 [illegible] 37% [illegible] of all in that category. [illegible] the proportion of cankers reaching trunk from each of the 6-inch [illegible] 24-30 [illegible] 30-36 inch, 4.3%. [illegible] the "danger zone" limit [illegible] 36 inches [illegible]. The ultimate behavior [illegible] distance between 24 and 36 inches will determine the location of this limit.

[illegible] ability of cankers to reach trunk [illegible] is given by the following tabulation of the maximum distance grown by cankers reaching trunk in the years since 1951.

Table 2 - Cankers that have reached trunk, and are predicted to reach trunk, by years 1951 through 1964, with range of distances grown, and maximum distance grown for each year.

YEAR	CASES	RANGE OF DISTANCES GROWN	MAXIMUM DISTANCE GROWN
1951	106	1.0-17.7	17.7
1952	113	11.1-18.6	18.6
1953	119	15.9-22.6	22.6
1954	127	15.2-25.4	25.4
1955	129	29.8-32.1	32.1
1956	130	27.4	32.1
		Predictions	
1957	None		
1958	1	22.9	32.1
1959	3	23.9, 29.7, 30.6	32.1
1961	1	30.0	32.1
1964	1	35.1	35.1

As was pointed out in Research Note 7 (p. 2), conclusions respecting maximum distance beyond which cankers are not capable of reaching trunk must await the full record of performance of all cankers included in the study, which is amply demonstrated in this tabulation. Although they cannot be included in derivation of survival probabilities, observations on the natural cankers of this study on branches of larger diameter, greater length, and located higher in their trees, must be employed in reaching such a conclusion.

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

The remainder of over 300 sections of white pine wood and bark were sectioned, stained, and mounted. No further analysis of data was undertaken during 1956.

Several more samples were taken to make geographical and site sampling more nearly complete. Data analysis will be made during next year as time permits.

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

Tree disease problems referred to the station during the past year include the following:

1. Winter drying of spruce
2. *Cytospora* canker of Mountain ash
3. *Tubercularia* canker of elm
4. Twig blight of western juniper
5. Leaf spot of silver maple
6. Leaf spot of aspen
7. Fasciation of weeping birch
8. Dieback of birch
9. Slime flux of poplar and maple
10. Dieback of russian olive
11. *Peridermium* needle rust of spruce
12. Cedar - apple rust

Winter injury to ornamental spruce trees appears to have been unusually widespread and severe in Idaho during the past winter.

One week was spent by Gilbertson observing tree disease problems in form woodlots and windbreaks in southern Idaho in company with the state extension forester. The growing of trees in the non-forested portions of southern Idaho results in a number of troublesome pathological problems that should be investigated for development of control methods. Among the problems most commonly encountered are dieback of Russian olive and cutleaf weeping birch, and winter drought injury to ornamental conifers.

Investigation of an olive-green decay and stain of the heartwood of living conifers, especially Douglas-fir, was continued during the past year. This defect has now been observed in Douglas-fir, ponderosa pine, Englemann spruce, and western red cedar. The causal organism has been isolated, but is not yet identified. Douglas-fir on the College Forest has been found to be heavily infected with this fungus. Inoculation tests are in progress to determine the rate of development of the decay in the living tree.

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

Survival and growth observations were made twice during the year on each of the different experimental plantings.

The plantings at Caldwell and Tetonia were replanted in an effort to obtain reliable data in those areas.

The Norway spruce at Parma has made remarkable growth and it may be advisable to market that species this fall.

Stump culture tests will be started with each species as soon as cutting is possible.

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

I. Intensification and spread of the disease in stands

Six permanent plots were examined in late summer of 1956. Four of these, established in 1949, are 0.2 acre "progress" plots at Fourth of July Canyon and Hudlow Creek on the Coeur d' Alene National Forest, and Nickleplate Mtn. and Kerr Ranch on the Kaniksu National Forest. The other two, established in 1950, are "spread" plots located at Charlie Creek and Big Sand Creek on the St. Joe National Forest. These consist of transects radiating from a center of pole blight development. A total of 633 white pines in the dominant, codominant, and intermediate crown classes were present on these plots at the time of establishment.

Trees on these plots are given a numerical rating each year according to the following system: 0 = healthy; I = early pole blight; II = intermediate pole blight; III = late pole blight; and IV = dead with a past history of pole blight and death not attributable to other causes.

The following table shows an annual pole blight severity index for the six plots checked in 1956.

Table 1

Plot	Pole blight severity index							
	1949	1950	1951	1952	1953	1954	1955	1956
Charlie Creek	--	0.13	0.20	0.23	0.40	0.55	0.69	1.05
Big Sand Creek	--	0.33	0.61	0.59	0.88	1.15	1.61	1.93
Hudlow Creek	0.31	0.45	0.52	0.55	0.63	0.72	0.75	0.77
Nickleplate Mtn.	0.63	0.86	0.96	0.76	1.04	1.15	1.29	1.40
Kerr Ranch	0.35	0.67	0.67	0.57	0.83	0.89	1.04	1.08
4th of July Canyon	0.24	0.63	0.75	0.71	0.83	0.96	1.16	1.36
Overall P. B. Index	0.32	0.37	0.49	0.47	0.64	0.80	1.01	1.26

Of interest also is the number of new pole blight trees appearing on these plots each year. The following table shows that the steady increase in the polt blight severity index is not due solely to the steady decline of pole blight trees present on the plot at the time of establishment, but is due in part to the appearance of pole blight symptons in trees originally classed as healthy.

Project [illegible]. Susceptibility of Eastern White Pine Trees (Pole Blight)

1. [illegible] and spread of the disease in stands

Six permanent plots were examined in late summer of 1956. Four of these, established in 1949 [illegible] Canyon and Dudley Creek on the [illegible] National Forest, and [illegible] on the Kaniksu National Forest. The other two, established in 1950, [illegible] pole blight development. A total of [illegible] pines in the [illegible] present on these plots at the time of pole blight [illegible].

Trees on these plots are given a numerical rating each year according to the following system: [illegible], I = early pole blight, II = intermediate pole blight, III = late pole blight, [illegible] history of pole blight [illegible].

The following table shows the annual pole blight severity index for the six plots through 1956.

Table 1

Plot	Pole blight severity index							
	[illegible]	[illegible]	[illegible]	1952	1953	1954	1955	1956
Canyon Creek [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Creek [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Of [illegible] the [illegible] of new pole blight are [illegible] [illegible] following table [illegible] the [illegible] in the pole blight severity index [illegible] of pole blight [illegible] present on the plot [illegible] but [illegible] of pole blight [illegible] slightly [illegible].

Table 2

Plot	New Pole Blight Trees								
	1949	1950	1951	1952	1953	1954	1955	1956	Sum
Charlie Creek	--	23*	13	8	20	5	17	28	114
Big Sand Creek	--	26*	13	0	8	10	15	9	81
Hudlow Creek	12*	0	0	0	3	1	0	2	18
Nickleplate Mtn.	14*	2	0	0	0	1	1	1	19
Kerr Ranch	9*	0	0	0	4	0	2	1	16
4th of July Canyon	22*	1	0	0	6	1	6	1	37
Total New PB Trees	57	52	26	8	41	18	41	42	285

* Pole Blight trees present on plot at time of establishment

An analysis of pole blight severity index by crown classes on the six plots indicates that Dominant trees have developed pole blight to a greater extent than have the Co-dominant and intermediate crown classes.

Table 3

Pole Blight Severity Index on 6 Plots by Crown Classes

	Severity Index							
Crown Class	1949	1950	1951	1952	1953	1954	1955	1956
Dominant	0.61	0.50	0.66	0.57	0.81	0.93	1.26	1.54
Co-dominant	0.40	0.40	0.52	0.50	0.67	0.86	1.03	1.29
Intermediate	0.08	0.16	0.25	0.30	0.39	0.54	0.63	0.80

An examination of the pattern of development of pole blight on the Charlie Creek spread plot shows no definite pattern of radial development from the original Pole Blight center. Pole blight trees tend to appear each year on the transects in widely scattered groups of 2-4. There is a very definite development of pole blight uphill from the original center and very little development of pole blight downhill from this center.

II. Possible Causes of Pole Blight

A. Virus-- Grafting of pole blight scion material onto healthy trees to determine if pole blight was transmissable in this manner was first attempted in 1948 and 1949 by the Division of Forest Pathology of the Bureau of Plant Industry and the University of Idaho respectively. The patch grafting technique was used in these early studies and few unions resulted. None of the trees on which patch grafts were made have been reported as developing pole blight symptons.

In 1954, the Inland Empire Research Center and the University of Idaho

Table 2

Site	[illegible]
Shoshone Creek	[illegible]
Big Sand Creek	[illegible]
Hollow Creek	[illegible]
Mink [illegible]	[illegible]
Kent [illegible]	[illegible]
[illegible] of Sully Canyon	[illegible]
[illegible] 10 Trees	[illegible]

* Pole blight trees present on sites [illegible]

An analysis of pole blight severity [illegible] crown classes [illegible] [illegible] greater extent than [illegible] crown classes.

Table 3

Pole Blight Severity [illegible] Crown Classes

Crown Class	[illegible]
Dominant	[illegible]
Co-dominant	[illegible]
Intermediate	[illegible]

In [illegible] of pole blight [illegible] [illegible]

II. Possible Causes of Pole Blight

[illegible]

In 1954, the Inland Empire Research Center and the University of Idaho [illegible] made a number of approach grafts of branch material from pole blight trees on healthy white pines in the greenhouse and in the field. This type of grafting was continued in 1955 and 1956 by the University of Idaho. The results are shown in the following tables. Results for 1955 are not shown as survival of grafted scions that year was virtually nil due to lateness of the grafting period and unfavorable weather conditions.

Table 4

Grafting 1954

Scion Material	No. of grafts	Alive 8/54	Alive 8/55	Percent Survival 1954	1955
P. B.I	49	39	3	80%	6%
P. B.II	36	31	2	86%	6%
Total P.B.	85	70	5	82%	6%
Healthy	21	21	11	100%	52%
Total grafts	106	91	16	86%	15%

Grafting in 1954 was done at Potlatch Creek and Porcupine Creek on the St. Joe Forest, and Sands Creek on the Coeur d' Alene Forest.

Table 5

Grafting 1956

Scion Material	No. of grafts	Alive 8/56	% Survival
P. B. I	75	37	50%
P. B. II	140	38	27%
P. B. III	24	2	8%
Total P. B.	239	77	32%
Healthy	12	8	67%
Total grafts	251	85	34%

Grafting in 1956 was done at Lacey Creek on the St. Joe Forest, and Sands Creek and Marten Creek on the Coeur d' Alene Forest.

No evidence of transmission of pole blight has been observed on any of the trees to date. All of the trees will be examined again in the summer of 1957.

The small white pines on which grafting was done by Dr. Leaphart of the Inland Empire Research Center in 1954 have been transplanted to the U. of Idaho Nursery. Eighty-three of these plants are still alive and 9 of these still have living scions from pole blight trees. Many of the scions from pole blight trees appear to have formed a good union, and the scion wood appears to be alive although the terminal portion of the scion has died and been broken off. There is no evidence that an infective agent has been transmitted by grafting, and the living scions from pole blight trees appear to be developing normally.

No further grafting is planned for the coming field season.

B.--Nematodes-- In 1955, soil samples from pole blight stands at Nickleplate Mountain, Fernan Saddle and Fourth of July Canyon were sent to Dr. Thorne for analysis for Nematodes. He reported 9 genera of nematodes in the samples with specimens of Trichodorus spp., one of the "stubby root" nematodes, present in samples from all three areas. Thorne sent specimens of the Trichodorus to Dr. Allen of the University of California, who requested more soil samples. These were sent to him in 1956. From the specimens found in these samples, he described a new species, Trichodorus elegans. Dr. Allen also reported the samples from Fourth of July Canyon contained an undescribed species of Meloidodera, a genus recently described for a root-parasitic nematode associated with a decline of slash pine seedlings in the South.

In September, 1956, soil and white pine seedlings were collected from the Charlie Creek pole blight plot and placed in a flat in the forestry greenhouse. In March, 1957, the soil in the flats was analyzed for nematodes and Trichodorus elegans was found to be present.

The following table shows the genera of Nematodes found in white pine stands in 1956-57.

The small white pines on which grafting was done by Dr. Leaphart at the Inland Empire Research Center in 1954 have been transplanted to the U. of Idaho Nursery. Eighteen of these plants are still alive and 9 of these still have living scions from pole blight trees. Many of the scions from pole blight trees appear to have formed a good union, and the scion wood appears to be alive, although the terminal portion of the scion has died and been broken off. There is no evidence that an infectious agent has been transmitted by grafting, and the living scions from pole blight trees appear to be developing normally.

No further grafting is planned for the coming field season.

B. Nematodes -- In 1955, soil samples from pole blight stands at [illegible] [illegible] Saddle and Fourth of July Canyon were sent to Dr. Thorne for analysis for Nematodes. He reported 9 genera of nematodes in the samples with specimens of *Trichodorus* spp., one of the "stubby" root nematodes, present in samples from all three areas. The remaining specimens of the *Trichodorus* to Dr. Allen of the University of California, who requested more soil samples. These were sent to him in 1956. From the specimens found in these samples, he described a new species, *Trichodorus [illegible]*. Dr. Allen also reported the samples from Fourth of July Canyon contained an undescribed species of *[illegible]*, a genus recently described for a root-parasitic nematode associated with a decline of [illegible] in the South.

In September, 1956, soil and white pine small trees were collected from the [illegible] Creek pole blight plot and placed in a flat in the forestry greenhouse. In March, 1957, the soil in the flats was analyzed for nematodes and *Trichodorus [illegible]* was found to be present.

The following table shows the [illegible] of [illegible] and [illegible] in 1956-57.

Table 6

Genera of Nematodes Found Associated With
The Rootlets of W.W.P. in Northern Idaho

Genera of Nematodes Found	Plant Parasitic	Pole Blight Charlie Cr.	Pole Blight 4th July	Pole Blight Nickleplate	Pole Blight Fernan Sad.	Healthy Marten Cr.
Trichodorus	yes	x	x	x	x	
Meloidodera	yes		x			
Rotylenchus	yes				x	
Xiphinema	yes					
Criconema	yes			x	x	
Tylenchorhynchus	?				x	
Tylenchus	?	x				
Triplonchiun	?		x	x	x	
Tylencholaimus	?	x			x	
Criconemoides	yes			x	x	
Axonchium	?			x		
Dorylaimus	?	x		x	x	x
Dorylaimellus	?	x				
Aphilenchoides	?	x				
Mononchus	no	x		x	x	x
Plectus	no	x				x
Prismatolaimus	no	x				
Cephalobus	no	x				
Acrobeloides	no	x				x

Unidentified nematodes have also been isolated from all samples.

The nematode population on 10 pole blight areas and 10 healthy areas will be sampled during the summer of 1957. The latter will include five stands within the range of pole blight and five stands outside the range of the disease. The diseased and healthy areas to be sampled will represent a wide range in the distribution of white pine and pole blight in Northern Idaho. From this study we hope to determine the nematodes present in the white pine type in Northern Idaho and to determine if the nematode population differs in generic or specific composition and numbers in pole blight and non-pole blight areas.

C. <u>Mycorrhizae</u> <u>of</u> <u>Western</u> <u>White</u> <u>Pine</u> - The field collecting and cultural work in connection with mycorrhizal studies is described under special research project 11-B. Sectioning and preparation of permanent slides of mycorrhizal white pine roots was continued throughout 1956 whenever possible, and a good representative collection of slides of all types of white pine mycorrhizae is being built up. These will be necessary if an understanding of the nutritional significance of the various mycorrhizal types is to be developed.

D. Armillaria mellea inoculation studies - Inoculation of the roots of healthy western white pine with Armillaria mellea was carried out in 1955. Three methods of inoculation, reported in last year's annual report, were used. Fifty roots were removed for examination in June, 1957. Eighteen of these had been severed between the inoculum and the tree. No infection of healthy roots was found. Although the inoculum was still viable in many cases in 1957, well developed callus tissue had virtually sealed off the wounds made in the bark at the time the inoculations were made.

Several of the severed roots appeared to be alive and healthy distal to the point of severing. The fact that these roots remained alive for 21 months after their direct connection to the tree was severed indicates the presence of natural root grafts. These observations, in addition to others made during the course of root studies of western white pine, indicate that root grafting is not uncommon in that species.

The results of this experiment support the viewpoint that Armillaria mellea is not a virulent wound parasite on healthy roots. More information on the method of infection by Armillaria mellea under natural conditions is necessary to properly evaluate the significance of the observations reported here.

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

Mr. George Frazier was appointed on February 1, 1957, to undertake work on this project. In addition, he is working on the woodland marketing project (ES-23) and integrating the work on these two related studies.

A summary of work done in 1956 on this project was completed showing the areas of tree farms in northern Idaho counties.

Several meetings were held with representatives of industry, the State, and the Western Pine Association. These meetings have pointed the way to extensive cooperation by industrial foresters and others. This should make possible the gathering of all the field data during the 1957 field season.

Questionnaires have been sent to forest land owners in Latah County and a sample from the returns will provide the basis for field sampling work. The interview forms and the statistical requirements for sampling and analyzing the field data have been worked out.

From six to eight foresters will contribute to the gathering of the field data which will be used to construct economic models illustrating the present situation, and the possibilities in the future, both for the individual and the community and region.

D. *Armillaria mellea* inoculation trials. Inoculation of the roots of healthy western white pine with *Armillaria mellea* was carried out in 1956. The fifty methods of inoculation reported in last year's annual report, in which fifty roots were removed for examination in January 1957. Eight [illegible] had been severed between the inoculum and the tree. No infection of healthy roots was found. Although the inoculum was still viable in many cases in 1957, callus developed [illegible] tissue had effectively sealed off the wounds made in the bark at the time the inoculations were made.

Several of the severed roots appeared to be alive and healthy and able to throw a point of [illegible]. The fact that the severed roots remained alive for 21 months after their direct connection with the tree was severed indicates the presence of the natural root grafts. These observations, in addition to others made during the course of root studies of western white pine, indicate that root grafting is not uncommon in that species.

The results of this experiment support the viewpoint that *Armillaria mellea* is not a virulent wound parasite on healthy roots. More information on the method of infection by *Armillaria mellea* under natural conditions is necessary to properly evaluate the significance of the observations reported here.

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

Mr. George Frazier was appointed on January 1, 1957, to undertake work on this project. In addition, he is working on the woodland marketing project (BS-23) and is integrating the work on these two related studies.

A summary of work done in 1956 on the project was completed covering the area of tree farms in northern Idaho counties.

Several meetings were held with representatives of industry, the State, and the Western Pine Association. These meetings have resulted in a major step toward cooperation by industrial foresters and others. This should make possible the gathering of all the field data during the 1957 field season.

Questionnaires have been sent to forest land owners in Latah County and the sample from the returns will provide the basis for field sampling. The interview forms and the statistical requirements for sampling and analyzing the field data have been worked out.

From six to eight foresters will contribute to the gathering of the field data which will be used to construct economic models illustrating the present situation, and the possibilities in the future, both for the individual and the community and region.

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

This project is being carried on in cooperation with the Agricultural Economics Department.

Work was started in the summer of 1956. Because of the difficulty of securing staff, Mr. Sverre I. Scheldrup, College of Business, was engaged by the Agricultural Economics Department to initiate the field work. He spent three months in the field collecting names and addresses of non-industrial owners for Latah, Nez Perce, Clearwater, Idaho and Lewis Counties.

A full time staff member was hired February 1, 1957. Half time is being devoted to this project and half time to Project E.S.21, "Study of Idaho Small Tree Farms."

The first activity following this appointment was to define the population with which the study would be concerned and to review the literature. It was decided that only those non-industrial owners owning from 1 to 5000 acres of timber or woodland would be considered. The work plan was divided into two phases: (1) a study of the seller side of the market and (2) a study of the buyer side of the market. It was decided that becaise of the size of the population which would be considered in the seller portion of the market, that the first efforts would be devoted to the study of the methods of selling timber, ownership patterns and what was being sold.

Because of the area of the State and the location of the primary timberland areas, the project is concentrated in the ten northern counties in Idaho. Later, the study may be extended to the other counties in the State which have timberland within their boundaries.

The farm population in the State received $867,428 for wood products sold in 1954. Of this amount, $801,179 or 92.4% was reported as being received by farmers in the ten northern counties. This group of farmers has a total of 1,552,053 acres of woodland in the State of which 1,047,636 acres or 67.5% was reported by the farmers in the ten northern Counties.

An attempt was made in the first stages of the study to determine the area of timberland within each of the ten counties. It was soon discovered that accurate figures were not available for the class of owners with which the project was concerned. The agencies which have made area studies, defined their limits differently enough that their statistics have limited application to this study. Further, it was found that few of these estimates of land areas could be tied to each other in a manner which would indicate what the land area is by ownership class, type of timber or wood land, etc. This is especially true in the case of ownerships classes, e.g., private, Federal, municipal.

Much time and thought was devoted to the development of a questionnaire. The work of the other cooperators in the regional project was reviewed. The five questionnaires were put together in one bulky rough copy and from this, four alternative types of questionnaires were developed. It was decided to test the efficiency of a mail questionnaire in Latah County. The mail questionnaire was further refined and it was limited to two pages with considerable difficulty.

Several County Court Houses were visited in an attempt to design a field form which would facilitate the collection of the names and addresses for mailing purposes. It was found that the State Tax Commission had assisted the counties in the re-evaluation of their real property. In this re-evaluation, they have reclassified all of the timberland with the result, that it was felt we would be able to use Assessor's land classification, e.g. "Timber, Woodland, Reforestation Land" and not have to consult the aerial photos in an attempt to classify these lands. In Latah County, it was found that the names and addresses were on Addressograph plates which greatly facilitated the making of the mailing lists. These were used in preparing 3 x 5 file cards showing name, address, location, land description. The assessors' records were then consulted to determine for each ownership the total acres in the ownership and the acres in woodland, reforestation land, and timberland. All of the industrial holdings were eliminated as the cards were made. These cards were in turn given to the IBM statistical center at the University. IBM cards were punched for each ownership and summary cards prepared for those owners having more than one ownership in the county. From these cards, a listing of names and addresses were prepared to be used as a mailing list. Individual identifying numbers were assigned to each individual to allow the respondant to eliminate giving his name and address if he so desired.

A printed cover letter and questionnaire was first considered, but results have been so gratifying from Latah County that we have discarded this idea and will use mimeographed letters and questionnaires. It was suggested that the letter be as personalized as possible, by adding to the letter a hand written post script. To test this suggestion, 500 of the names in Latah County were sent the letter with the P. S. and the balance of 502 names were not sent the P. S. The results are below:

Letter w/P. S.			
In-State Owners	500	156	31.2
Letter wo/P. S.			
In-State Owners	374	76	20.6
Out-State Owners	128	34	26.6
	502	110	21.9
Totals	1002	266	26.5

This would perhaps indicate that the P. S. was quite important in the rate of response. The P. S. is being continued on an experimental basis. Clearwater County questionnaires will be sent on a 50-50 basis and Idaho County will be sent on a 100% P. S. basis.

Of the 266 responses received to date from Latah County, 45.8% have reported as sellers and 54.2% have reported as non-sellers. Some of the seller responses are not usable because answers concerning the quantity and price are lacking. The balance of their information given will be valuable in constructing a picture of the market. No analysis of the respondants has been made at the present time, other than above.

On a basis of Latah, Clearwater, and Idaho Counties, it is estimated that about 8500 owners will receive questionnaires. If the response holds up, there will be about 2500 questionnaires for analysis purposes of which about 1000 will be sellers and 1500 non-sellers.

Plans for the coming year include the development of a buyer questionnaire. A mail questionnaire will be used in this phase of the study. The questionnaire will be considerably more detailed than the one which was developed for the seller.

Project No. S.R. 11-B. Forest Tree Physiology.

During the past year, emphasis has been shifted from a study of the mineral nutrition of trees in the field to the mineral uptake in relation to mycorrhizae of western white pine.

To complete the data on Armillaria mellea infected trees, four healthy and four diseased trees were injected with radiophosphorus and radiocalcium. These trees were located in a suspected pole blight area on the Clearwater National Forest. Absorption by these trees was erratic and no conclusive data supporting Armillaria deposition patterns was gained. This work terminated this phase of the field work on the physiology of white pine. A paper appeared in SCIENCE describing the mobility of calcium in pole blighted and healthy trees. Several other papers are in the process of preparation.

Work on the establishment of the relative efficiencies of various white pine mycorrhizae occupied the major portion of the effort during the past year. Since methods for the introduction of radiophosphorus and a satisfactory auto-radiographic technique were developed during 1955, no further introduction of radioisotopes will be made until satisfactory cultured mycorrhizae has been grown.

This would perhaps indicate that the P.-S. was quite important in the rate of response. The P.-S. is being continued on an experimental basis. Clearwater County questionnaires will be sent on a 50-50 basis and Idaho County will be sent on a 100% P. S. basis.

Of the 206 responses received to date from Idaho County, 43.8% have reported as sellers and 56.2% have reported as non-sellers. Some of the smaller responses are not usable because answers concerning the quantity and price are lacking. The balance of their information would be valuable in constructing a picture of the market. No analysis of the respondents has been made at the present time, other than above.

On a basis of Latah, Clearwater, and Idaho Counties, it is estimated that about 6500 people will receive questionnaires. If the response holds up, there will be about 2500 questionnaires for analysis purposes of which about 1000 will be sellers and 1500 non-sellers.

Plans for the coming year include the development of a buyer questionnaire. A mail questionnaire will be used in this phase of the study. The questionnaire will be considerably more detailed than the one which was developed for the sellers.

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Work on the establishment of the relative efficiencies of various white pine mycorrhizae occupied the major portion of the effort during the past year. Various methods for the introduction of radiophosphorus and radiostrontium autoradiographic techniques were developed during 1953. Further introduction of radioisotopes will be held until satisfactory cultures of mycorrhizae have been grown.

The initial phases of the mycorrhizal research will be closely correlated with similar work being conducted on the Project E.S. 20 (Pole Blight). This correlated research will consist of the collection, identification and culture of sporophores of suspected mycorrhizal fungi and the culture and subsequent identification of fungi isolated from natural mycorrhizae in the field. These cultures will then be used to inoculate aseptic white pine seedlings; mycorrhizal formation is accepted proof of mycorrhizal relationship. Once sufficient quantities of mycorrhizae are formed on seedlings, other studies can be undertaken. The cooperative phases of the mycorrphizal work for both projects during the past year will be summarized here.

Three hundred forty seven collections of possible mycorrhizal fungi were made during the 1956 field season. Data on these collections includes ecological, geographical and tree association information; this provides for application of this data to future mycorrhizal work in addition to the white pine study. After isolations were made, the fungi were identified by members of the Forest Pathology staff and placed in the herbarium. Most identifications were confirmed by Dr. A. H. Smith of the University of Michigan.

Sixty of these fungi were successfully cultured and are being maintained in a stock culture collection for future inoculation material and for trade to other institutions for needed fungus culture. Most of the fungi in the Boletaceae suspected of forming mycorrhizae with western white pine have been cultured. Further collections and cultures will be made as opportunities arise during the rest of the time these projects are active. During 1957, collection emphasis will center on members of the Agaricaceae.

The growing of aseptic white pine seedlings has proven to be a slow process, but successful techniques have been developed during the past year. Apparently the greatest difficulty is in pretreatment of the seed to overcome the seed coat and embryo dormancy of white pine seed. Present sterilization techniques are giving good results. This involves a short bath in a .01 percent solotion of bichloride of mercury followed by a long rinse in sterile distilled water. A Slaukis root-tip sterilizer greatly facilitates sterilization of the seeds.

Growth of seedlings on a "Ferralite" medium enriched with Rayner's Nutrient solution is not uniform. This is believed partially due to environment conditions, but genetic factors are also suspected as a cause of some poor seedling vigor. Several methods of seedling inoculation have been tried and a promising technique has recently been found. No cultured mycorrhizae have been formed in the first group of eighteen inoculations. Thirty-six inoculations are now growing and will be ready for examination shortly. A new medium, "Sponge Rok" is being tested as a means of promoting formation of mycorrhizae after inoculation. Seedlings are grown in the greenhouse during the winter, but are kept under florescent lights in a cool basement from May through September.

Project S.R. 24. Slash Disposal Studies.

Participation by the University in this cooperative project continued on a part time basis. Plans for future work have been disrupted by the transfer of George Fahnestock of the Forest Service to another region. He had given full time to this project the past 5 years. This vacancy is to be filled by the Forest Service at the first opportunity, but until then, and while the trainee is becoming familiar with the work, this Station is primarily concerned with keeping the project active and protecting studies now underway.

1. Inflammability studies. Burning tests of rate of fire spread in current, one and two-year old slash have been completed and reported in several publications. There remain 50 plots to be burned in 1959 for determining rate of spread in 5-year old slash. A vast amount of data on radiant heat have been obtained from the burning tests made thus far. These have been analysed and the results are to be presented in a publication now under preparation by the Forest Service. Heat generated by burning slash in various arrangements, volume and species composition is an important factor in drying and raising the temperature of fuels in advance of the fire. It is also an important factor in determining width of fire breaks and degree of partial disposal to be effective in breaking fuel continuity.

2. Evaluation of fire hazards in logging slash. Appraisal of fire hazard by fuel types has been largely dependent upon the experience of experts in fire behavior. Through analysis of past fires and recent studies in slash inflammability and rate of decay, numerical and relative ratings can be assigned to some of the more important factors affecting fire behavior in slash. This will provide guides for appraising the fire hazard under most of the conditions commonly found on cut-over areas.

The fire hazard rating of logging slash under various combinations of conditions, is indicated in Table 1. At the same time, the factors largely responsible for "high" and "extreme" danger ratings are easily detected in this table and indicate adjustments that will reduce the fire danger to "moderate" or less. For example: volume exerts the greatest influence on slash inflammability and volume may be controlled by lighter cuts or reduced by disposal practices. Where uniform fuel arrangement is the critical factor, partial disposal is the logical treatment to break fuel continuity. From rate of decay studies and burning tests, we know that second year slash of predominantly short needled species in medium volume, is no more dangerous than current slash in light volume, because of needle cast. Hence, if such "high" hazard areas can be safeguarded for one year by intensive protection, slash disposal is unnecessary.

3. Rate of Decay. Ocular estimates have been the principal means of appraising fuel reduction by natural processes in 5, 10, and 15 year periods. Now that inflammability has been correlated with dry weight of slash, it appears possible to obtain an accurate measure of hazard reduction in decaying slash from weighed samples. In other words, the difference between the dry weight of fresh slash and the dry weight at later periods, will establish the rate of decay in the various permanent sample plots. This correlation has already been obtained for needle cast. Disintegration of branchwood is the next phase. This year it is planned to stake out and weigh sufficient 3' x 3' plots within large bodies of slash to provide adequate samples for weighing periodically in the next 10 years without using the same sample twice.

4. Portable Wood Chippers. Cost studies were made in the operation of a tractor-mounted chipper for slash disposal by the Forest Service. Results were not considered satisfactory due to lack of proper training of the crew operating the chipper. This Station has been asked to aid in further studies this year.

The fire hazard rating of logging slash under various combinations of conditions, is indicated in Table 1. At the same time, the factors largely responsible for "high" and "extreme" danger ratings are easily detected in this table and indicate adjustments that will reduce the fire danger to "moderate" or less. For example: volume exerts the greatest influence on slash inflammability and volume may be controlled by lighter cuts or reduced by disposal practices. Where uniform fuel arrangement is the critical factor, partial disposal is the logical adjustment to break fuel continuity. From rate of decay studies and burning tests, we know that second year slash of predominantly short needled species in medium volume, is no more dangerous than current slash in light volume, because of needle drop. Hence, if such "high" hazard areas can be safeguarded for one year by intensive protection, slash disposal is unnecessary.

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4. Portable Slash Chippers. Cost studies were made in the operation of a tractor-mounted chipper for slash disposal by the Forest Service. Results were inconclusive and unsatisfactory, due to lack of proper training of crew in operating the chipper. This Station has been asked to aid in further studies this year.

FIRE HAZARD RATING OF LOGGING SLASH IN THE WESTERN WHITE PINE TYPE
(Based on Rate of Spread)

White pine and mixed, with less than 25% cedar slash	Current Slash						Second Year Slash - predominantly short needle species					
	60 - 90% Shade		30 - 59% Shade		clear cutting		60- 90% Shade		30 - 59% Shade		clear cutting	
	Aspect		Aspect		Aspect		Aspect		Aspect		Aspect	
	N	S	N	S	N	S	N	S	N	S	N	S
Light Slash Volume (5-10 tons per A)*												
Patchy fuel arrangement	L	M	M	M	M	H	L	L	L	M	M	M
Upper half of slope	L	M	M	M	M	H	L	L	L	M	M	M
Lower half of slope	L	M	M	H	H	H	L	L	L	M	M	M
Uniform fuel arrangement	L	M	M	H	H	E	L	L	L	M	M	M
Upper half of slope	L	M	M	H	H	E	L	L	L	M	M	M
Lower half of slope	M	M	H	H	H	E	L	L	L	M	M	M
Medium Slash Volume (10-25 tons per A)*												
Patchy fuel arrangement	M	H	H	E	E	E	L	M	M	H	H	H
Upper half of slope	M	H	H	E	E	E	L	M	M	H	H	H
Lower half of slope	H	H	H	E	E	E	M	M	M	H	H	E
Uniform fuel arrangement	H	H	H	E	E	E	M	M	M	H	H	E
Upper half of slope	H	H	H	E	E	E	M	M	M	H	H	E
Lower half of slope	H	E	E	E	E	E	M	H	H	H	E	E
Large Slash Volume (over 25 tons per A)*												
Patchy fuel arrangement			E	E	E	E			E	E	E	E
Uniform fuel arrangement			E	E	F	F			E	E	E	E

White pine and mixed, with more than 25% cedar slash						
Light Slash Volume						
Patchy fuel arrangement	M	H	H	H	H	E
Uniform fuel arrangement	M	H	H	E	E	E
Medium Slash Volume						
Patchy fuel arrangement	H	E	E	E	E	E
Uniform fuel arrangement	E	E	E	E	E	E
Large Slash Volume						
Patchy fuel arrangement			E	E	E	E
Uniform fuel arrangement			E	E	F	F

Predominantly pine and cedar

Same rating as for current slash

←

*Oven dry weight.

L - Light

M - Medium

H - High

E - Extreme

F - Flush

II. Range Management Research

A. Projects completed during the year -- None

B. Continuing projects:

Project E.S.-7. Evaluation of Salt-Desert Shrub Ranges.

The data for this project are reported this year in conjunction with those for Project E.S.-15, Ecology and Control of Halogeton.

Project E.S.-8. Study of Medusa-Head Range on Idaho Ranges.

Ecological studies were emphasized this past year. Root studies of medusa-head and cheatgrass indicated that the replacement of cheatgrass by medusa-head has not been due to soil moisture. In addition to the comparable rate of root development, cheatgrass matures several weeks earlier than medusa-head. Studies are being continued to determine the factor or factors responsible for this replacement.

Tests of medusa-head seeds recovered after two years' burial in soil under field conditions show that the seed of this species is able to retain its visability for at least two years. Because of this, the elimination or control of medusa-head is more difficult than that of cheatgrass. Treatment, such as burning or other means of destroying the current year's seed crop, results in temporary reduction only. Sufficient seed remains in the soil to permit dominance by this species after one or two years unless replaced by a more competitive species.

Observations during the early stages of development of "choke-out" spots reveal that soil moisture and/or inability for seed to germinate because of excessive litter are not factors responsible for this phenomenon. Numerous seedlings were present in late winter but as spring growing conditions approached, the seedlings died while ample soil moisture was present. At present, numerous weedy annual forbs occupy the space resulting from medusa-head die-out. It has been observed that medusa-head again dominate these spots in a year or two.

Chemical analysis of medusa-head and cheatgrass show that the chemical composition of the two species are very much alike. Total protein content for similar growth stages is comparable. Lignin content is slightly higher for cheatgrass during the growing season but much alike for fall collected samples. The lignin analysis did not reveal any information as to why decomposition and oxidation of medusa-head litter is slower than that of cheatgrass litter.

Intermediate wheatgrass was the best of five species tested in the Crane Creek reseeding trial. Although somewhat patchy, a fair to good stand of this species was established with the burn-broadcast-dixie harrow treatment. Crested wheat and pubescent wheat did not do as well as intermediate wheatgrass. However, it was felt that had a more uniform seed placement been obtained, a good uniform stand of the three species would have resulted. Until a better seed covering method (uniform depth of seed placement) can be found, reseeding cannot be recommended in such stony areas.

Results of some of the seed germination studies were published during a full-scale review and problem analysis of the medusa-head problem was prepared early in 1957. This will serve as a basis for intensified work planned for the next two years or more. Starting July 1, 1957, a Special Research Project (27-D), which includes funds for a Research Fellowship, will aid in the medusa-head study.

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

Emphasis continued to be placed on Objective No. 1, the recognition, analysis and description of habitat-types in the sagebrush-grass region of Idaho. This involved sampling sites located previously and selecting new ones for study in 1957. The general program of moving eastward was continued, so that the bulk of the sites sampled in 1956 were in the Twin Fall-Burley-Shoshone area. For 1957, the area of concentration will be as far East as Dubois and Idaho Falls.

Fourteen new sites were sampled in the summer of 1956, and additional work was done on the 16 sites established in 1955 to bring them into line with the missed procedures. This consisted mainly of obtaining foliage intercept data for all shrub species on each site. About 20 sites were located for study in 1957.

Six sagebrush-grass associations were recognized tentatively on the basis of the studies made in 1955 and 1956. Certain of the data for the vegetation of these associations are summarized in Tables 1 and 2.

TABLE 1

Average percent basal area of perennial grass species in 6 associations of sagebrush-grass range in Idaho.

Species in Group	Plant Community Artemisia tridentata-Festuca	Artemisia tridentata Agropyron spicatum	Artemisia arbuscula-Festuca	Artemisia tripartita-Festuca	Artemisia tridentata-Agropyron Poa.	Artemisia tridentata Agropyron Stipa thurk
Agropyron spicatum	3.2	8.1	1.3	1.0	4.2	2.6
Festuca idahoensus	4.8	-	3.0	5.4	-	-
Stipa thurberiana	-	-	-	-	-	3.5
Sitanion hystrix	0.1	-	0.3	-	0.7	1.3
Miscellaneous species	0.2	-	0.1	0.4	-	-
Sub-Total	8.3	8.1	4.7	6.8	4.9	7.4
Poa secunda	2.2	0.9	2.3	1.2	7.0	2.5
Miscellaneous species	-	-	-	0.6	-	-
Sub-Total	2.2	0.9	2.3	1.8	7.0	2.5
Total Grasses	10.5	9.0	7.0	8.6	11.9	9.9

TABLE 2

Frequency of occurrence of perennial forbs in 6 associations of sagebrush-grass range in Idaho.

Number of species with frequencies over 5%	Plant Community Artemisia tridentata-Festuca	Artemisia tridentata-Agropyron spicatum	Artemisia arbuscula Festuca	Artemisia tr partita-Festuca	Artemisia tridentata-Agropyron-Poa.	Artemisia tridentata-Agropyron-Stipa thurk
Tall perennial forbs	9	8	6	3	1	1
Low perennial forbs	5	3	4	3	2	6
All species	14	11	10	6	3	7

The vegetation of these 6 communities differs in many respects, only a few of which are indicated in the tables shown above.

The soils of these habitat-types are being studied by the soils staff of the Department of Agronomy. The data show marked differences among the 6 major groups, and are correlated in most cases with the vegetational characteristics. Differences in great soil group, in organic matter content, depth of the horizon total, profile depth, degree of permeability of the "B" horizon and presence and depth of a calcium carbonate layer are some of the principal profile features in which significant differences have been formed.

Sufficient field reconnaissance has not been done to determine the extent of these 6 range types in Idaho, but it appears that each is of considerable importance. Several other types may be recognized when more sampling has been done.

In September, 1956, one week was spent on a joint inspection trip with the Oregon and Washington workers in this same regional project (W-25). This trip covered a portion of the study area in each of the 3 states, and proved extremely valuable for correlating and clarifying the work of the 3 groups.

In May, 1957, additional field work was done in locating new areas for study sites and in reviewing the plot study methods currently in use. No major changes in methodology were made, but minor revisions were made in the procedures for counts on single stem species, and for recording perennial grasses and forbs on depleted sites.

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

A paper entitled "The Douglas-fir Zone of Southern Interior British Columbia" was completed and will appear in the July issue of ECOLOGICAL MONOGRAPHS. This paper presents much of the basic ecological data gathered to date. Other studies dealing with the effects of grazing on the vegetation will be reported in the near future. Occasional field studies are being continued as time permits, in cooperation with the staff of the Range Experimental Station at Kamloops, B. C.

Project E.S.-13. Studies of Ecotypes in Important Range Grasses.

This project was begun in July, 1956, in cooperation with Mr. Robert Olson of the Soil Conservation Service Plant Materials Center at Pullman, Washington. Mr. Olson is enrolled as a graduate student in Range Management at Idaho.

The vegetation of these 6 communities differs in some respects, only a few of which are indicated in the [illegible] shown here.

The soils of these habitat-types are being studied by the [illegible] of the Department of Agronomy. The data show marked differences among the 6 major groups, and are correlated in most cases with the vegetational characteristics. Differences in great soil group, in organic matter content, depth of the [illegible] horizon, [illegible] degree of [illegible] of the [illegible] horizon, and presence and depth of a definite carbonate layer are some of the [illegible] profile features in which significant differences have been found.

Sufficient field reconnaissance has not been done to determine the extent of these 6 range types in Idaho, but it appears that each is of considerable importance. Several other types may be recognized when more work has been done.

In September, 1954, one week was spent on a joint inspection trip with the [illegible] Washington workers in this same regional project ([illegible]). This [illegible] a portion of the study area in [illegible] Washington, [illegible] extremely valuable for correlating [illegible] of the 3 groups.

In May 1954, additional field work was [illegible] in locating new areas for study [illegible] and for resurveying the plot areas established [illegible]. [illegible] changes in methodology were made, [illegible] for [illegible] on a single site basis, and for [illegible] grasses and forbs on permanent plots.

Project S.S.-11. [illegible] of Interior British Columbia.

A manuscript titled "The [illegible] of Interior British Columbia" [illegible] completed and will [illegible] in the [illegible]. [illegible]

Project S.S.-13. Studies of Ecotypes in Intermountain Range Grasses.

This project was started in 1949, [illegible] cooperation with the [illegible] Soil Conservation Service [illegible] Pullman, Washington, [illegible]

The object of this project is to obtain a better understanding of the ecology and requirements of major range grass species of the area, particularly as affected by the presence of different ecotypes (physiological strains). A knowledge of ecotypic variation in major range species is needed especially for determination of the indicator value of such species, also for a better understanding of their requirements and response to various management practices. Knowledge of this kind is urgently needed to facilitate other research, as in Project E.S.-9, where the indicator value of the principal species is a matter of significance.

The first phase of this project will concentrate on Idaho fescue (Festuca idahoensis, a dominant species in both the sagebrush-grass and Palouse bunch grass range regions.

During the summer and fall of 1956, seed and in a few cases whole plants of Idaho fescue were collected at selected sites in Idaho, Oregon and Washington. The clones from several collections were separated and the clonal fractions planted at the S.C.S. nursery after being started in the greenhouse. Other collections were started from sand. Altogether seven accessions, representing a variety of habitat conditions, were established in the field during the spring of 1957. The progeny of each clone, or each single sand collection constitutes a separate row in this uniform nursery trial. A complete record of the growth and development of the plantings will be made. Field collections will be continued also, in order to sample the F. idahoensis population as widely as possible. In addition, preliminary studies of other important range grasses will be started as time permits.

Project E.S.-15. The Ecology and Control of the Halogeton.

The emphasis on this project during the past two years has been on the competitive relationships of halogeton with native and reseeded species. The loop transect method, augmented by information obtained from exclosures, competition plots and permanent photographic records, has been the main research tool employed in this study. The transect clusters embrace all of the shrub types found in Raft River Valley and bridge rather striking diversities in condition class.

Fortunately, most of the 41 clusters were established in 1951, before the major invasion of halogeton occurred, making it possible to document the invasion pattern of this plant. Many of the clusters have been examined annually, thereby providing six years of comparative data.

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The first phase of this project will concentrate on Idaho fescue, *Festuca idahoensis*, a dominant species in both the sagebrush-grass and Palouse bunchgrass range regions.

During the summer and fall of 1956, seed and in a few cases whole plants of Idaho fescue were collected at selected sites in Idaho, Oregon and Washington. The clones from several collections were separated and the clonal divisions planted at the S.C.S. nursery after being started in the greenhouse. Other collections were started from seed. Altogether seven accessions, representing a variety of habitat conditions, were established in the field during the spring of 1957. The progeny of each clone, or each single-plant collection constitutes a separate row in this uniform nursery trial. Cumulative records of the growth and development of the plants will be made. Field collections will be continued, in order to sample the *F. idahoensis* population as widely as possible. In addition, preliminary studies of other important range grasses will be started as time permits.

Project R.S.-15. The Ecology and Control of the Halogeton.

The emphasis on this project during the past two years has been on the competitive relationships of Halogeton with native and reseeded species. The line transect method, supplemented by information obtained from enclosures, competition plots and permanent photographic records, has been the main research tool employed in this study. The transect clusters include all of the shrub types found in the Snake River Valley and include other existing diversity in condition classes.

Fortunately, most of the 14 clusters were established in 1953, before the major invasion of Halogeton occurred, making it possible to document the invasion pattern of this plant. Many of the clusters have been examined annually, thereby providing six years of comparative data.

Consideration of the results from all of the clusters reveals some important tendencies. No annual species found in the Raft River Valley has in any but the most temporal sense precluded halogeton invasion or has provided even significant competition. Halogeton has taken over without exception all areas which at the start of this study supported an annual community. Only in years of extremely favorable conditions, such as in 1956, have the other annuals been present in any measurable amount in halogeton-dominated communities. Russian-thistle, a close relative of halogeton, is most competive of the other annuals.

With the exception of one site in a near climax sagebrush-grass area, the native grasses, principally squirreltail (Sitanion hystrix) and Sandberg bluegrass (Poa secunda) have markedly declined in all of the shrub types sampled. Reasons for this decline are not clear. It may be that short-lived grasses such as squirreltail go through cycles of abundance and that it is now in a low end of a cycle. Or it may be that because of grazing, these grasses in the good condition types have retreated to the shelter of the shrubs and simply disappeared elsewhere. Cactus (Opuntia polyacantha) has been perhaps the most stable of any of the species sampled. It occupies roughly the same area as it did at the initiation of this study.

Some indications of the level at which perennial shrubs lost control of the site, permitting halogeton invasion, have become clear. Whether these indications have meaning outside of the immediate areas from which they were derived is by no means yet clear.

Retrogression in one winterfat (Eurotia lanata) community has been most striking. Not only has it permitted halogeton invasion, but big sagebrush (Artemisia tridentata) invasion as well. Halogeton invasion occurred when the basal index was approximately six percent, a foliage cover of under 20 percent, and when plants per square foot were less than four. Invasion on big sagebrush, greatly accelerated in recent years, has been in progress since the beginning of the study. A good condition winterfat stand had in 1956 a basal index of approximately six, a foliage cover of above 30, and nearly five plants per square foot.

Halogeton invaded two deteriorating saltsage (Atriplex nuttallii) stands when the basal cover approached six, the foliage index dropped below 40, and when there were about six plants per square foot. Good condition stands a short distance away have basal indices of above seven, foliage indices of above 55, and four to ten plants per square foot.

Desert molly (Kochia americana) in one area has permitted halogeton invasion at a basal level of seven, a foliage level of 40 and when there were ten plants per square foot.

Shadscale (Atriplex confertifolia) stands having a basal index of over one, a foliage cover of above 30 and approximately six-tenths of a plant per square foot almost totally excluded halogeton.

A basal cover of one percent or more, a foliage index of approximately 30 and from three to five-tenths of a plant per square foot have effectively denied entrance to halogeton in the sagebrush stands.

Good condition greasewood (Sarcobatus vermiculatus) stands sampled in this study had foliage indexes of above 30 and had been successful in excluding halogeton.

It was found that reseeded areas having saline-alkaline soils are likely to fail. Such programs should be applied largely to sagebrush lands. Reseeding sagebrush lands will help to solve the halogeton problem by providing new sources of forage so that halogeton will no longer be a menance to livestock. Such new sources of forage may also relax the grazing pressure elsewhere so that these areas may regain a measure of their vigor and thus be in a better position to provide competition to halogeton.

Project E.S.22 (R-296) Beef Cattle Nutrition on Seeded and Native Forage in Idaho

The results of the 1956 spring and fall grazing trials on the Point Springs pastures are summarized below.

Spring Grazing Trial.

Sampling to determine production and stocking rate was accomplished between April 19th and April 24th. At this time, new leaf growth ranged from three to eight inches and averaged approximately five inches. Growing conditions during the spring of 1956 were extremely favorable for the crested wheatgrass. Although precipitation during April was less than normal, temperatures averaged higher than normal and by the end of the month new growth was well along. Growth during the month of May was exceptional and often exceeded the amount being consumed by the animals grazing the pastures. Both precipitation and temperatures were above normal during this period. June temperatures were higher than normal but precipitation was considerably less than normal. Growth of crested wheatgrass, however, was largely completed by the first of June.

Animals for the spring grazing trial arrived over a two day period. The initial weighing began on May 5th and was completed on May 6th. A portion of the animals were trucked to the area on May 4th and 5th and the remainder were trailed to the pastures in the late afternoon of May 5th and weighed on the morning of May 6th. A total of 157 animals were contributed by the livestock cooperators during this period. In addition, nine University steers, used for fecal collections, grazed the pastures from May 8th to June 8th.

Production and Utilization

Initial production to establish stocking rates was determined approximately ten days before the pastures were opened for grazing. Due to above average growing conditions during this spring period, the desired level of use in the pastures was not achieved.

The initial production (Table 1) determined between April 22nd and April 24th was corrected on the basis of growth measurements takem in the adjacent ungrazed pastures. Average plant weight determined from clippings increased 308 percent between April 24th and June 21st. An increase in height of 294 percent was found on 18 individually measured plants between April 20th and June 17th. With these measurements as a basis, initial production was increased 300 percent as an estimate of the total production obtained during the grazing period.

The number of grazed plants were counted when the final clippings were made in the pastures as a source of additional information on utilization. The number of plants grazed in the six photoplots located in each pasture was also obtained at the close of the grazing period and these are presented in Table 1.

Livestock Gains

The distribution of the 157 animals contributed by the livestock cooperators was as follows:

Light Use Pasture	44
Moderate Use Pasture	50
Heavy Use Pasture	63
Total	157

Sixty-five of the animals were weighed and placed in the pastures on May 5th. The remaining animals were weighed and distributed in the pastures on May 6th. All animals were held off feed and water overnight prior to weighing. Distribution to the various pastures was done proportionately by ownership. Nine University owned steers, three in each pasture, grazed the area from May 8th to June 8th. The weights of these animals are not included in the summary of gains presented in Table 2.

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

Pasture	Block	Initial Production Per Acre (Pounds)	Initial Production Per Acre Plus Growth* (Pounds)	Forage Per Acre Remaining At End of Grazing Season (Pounds)	Utilization (Percent)	Plants Grazed in	
						Clipped Samples (Percent)	Photo Plots (Percent)
E Light	A	144	432	218	50	82	
	B	346	1038	605	42	63	
	C	485	1455	921	37	38	
	Aver.	325	975	581	40	61	63
W Moderate	A	153	459	178	61	82	
	B	297	897	441	51	85	
	C	294	882	532	40	63	
	Aver.	248	746	384	49	76	78
SE Heavy	A	222	666	346	48	87	
	B	255	765	354	54	71	
	C	313	939	496	47	76	
	Aver.	263	790	398	50	78	68

*Estimated increase of 300 percent over initial production during grazing period.

Table 2. Summary of cattle gains during the spring grazing trials of 1956.

Grazing Intensity	Avg. Initial Weight (pounds)	Avg. Final Weight (pounds)	Avg. Total Gain (pounds)	Avg. Daily Gain (pounds)
Light	387	518	131	2.91
Moderate	402	519	117	2.60
Heavy	409	530	121	2.69

Fall Grazing Trial

Sampling to determine forage production and stocking rate for the fall grazing trials was conducted during the period of September 3rd through September 6th. Animals began arriving by truck on October 7th and a group of animals was trailed to the area on October 8th. The 95 animals trucked to the area were held off feed and water overnight and weighed during the morning of October 8th. The 140 animals arriving on October 8th were held in the corrals overnight and weighed during the morning of October 9th.

Forage Production and Utilization

Forage production and utilization figures for the fall grazed pastures are presented in Table 4. Even though the number of animals and their average size was greater than during the previous year, the desired level of forage utilization based on weight of forage remaining was not obtained in the various pastures. Utilization as shown by the percentage of plants grazed was somewhat higher but did not show any consistent pattern.

Livestock Gains

A summary of livestock gains is presented in Table 3. It is evident that crested wheatgrass at this season provides little more than a maintenance ration.

Table 3. Summary of cattle gains for the fall grazing period, October 8 to November 18.

Grazing Intensity	Avg. Initial Weight (pounds)	Avg. Final Weight (pounds)	Avg. Total Gain (pounds)	Avg. Daily Gain (pounds)
Light	630	642	12	.289
Moderate	628	637	9	.218
Heavy	620	637	17	.408

Table 4. Forage production and utilization by blocks within pastures as determined from clippings and count of plants grazed for the fall grazing period.

Pasture	Block	Initial Production Per Acre (Pounds)	Forage per Acre Remaining At End of Grazing Season (Pounds)	Utilization (Percent)	Plants Grazed in Clipped Samples (Percent)	Plants Grazed in Photo Plots (Percent)
NE Light	A	599	452	24	65.5	
	B	1003	484	52	73.0	
	C	958	659	31	61.0	
	Aver.	853	532	38	66.5	76.3
SW Heavy	A	266	263	01	72.75	
	B	628	289	54	69.75	
	C	804	284	65	82.0	
	Aver.	566	279	51	74.8	87.2
NW Moderate	A	730	246	66	43.5	
	B	644	271	58	68.0	
	C	760	444	42	72.25	
	Aver.	711	320	55	61.25	76.3

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

Beginning in July, 1956, the research fellowship was discontinued and the project reduced to a maintenance level. The major objectives of the project as originally developed in 1951 have been largely accomplished, and additional work of a major nature would require a new emphasis.

All permanent study plots will be maintained, and will be re-sampled at intervals of 3-5 years to determine further changes which may occur in the plant cover.

The major activity during the past year consisted of work on a manuscript covering the work on this project. This work is now well along, and should be completed by the end of 1957.

Field work has consisted mainly of checking the status of Hypericum on two sites in the lower Clearwater area; one of these, near Webb, was one of the five sites on which Chrysolina beetles were released in 1948, and is one of two study sites on which biological control measures date back this far. The other site, on Coyote Grade, was established in 1951. On both sites, the once-heavy stands of Hypericum have been reduced almost to extinction. However, some regeneration of this species, presumably from seed, occurred in 1956, especially on the Webb site. Counts of seedlings and plants of Hypericum were begun on both sites in the fall of 1956 and will be continued during the 1957 field season.

Project S.R.-38 Evaluation of Range Reseeding.

A thesis submitted by Dwight W. Kimsey summarized the first four years of information gathered on this project.

A comparison of study sites to indicate the influence of grazing upon range condition in reseeded stands was made on the Warm Creek seeding from 1953 through 1956. Study site B on the Warm Creek seeding was lightly used during 1953 and 1954. The construction of a windmill approximately one-quarter of a mile away, resulted in heavy use of this site during 1955 and 1956. The injurious effect of heavy grazing can be seen by comparing the response of this site with site A which was moderately used during this period. Overgrazing on site B caused a highly significant decline in the number of crested wheatgrass plants per square foot. Vigor and percentage of the ground covered by crested wheatgrass was reduced and many plants died as a result of overgrazing (Table 1).

Table 1. Average Measurements of crested wheatgrass on study sites at the Warm Creek seeding showing the effects of overgrazing.

Plot	Year	Degree of Utilization	Plants[1]/per square foot	Cover per cent	Height inches	Dead plants/ square foot
A	1953	Moderate	1.54	0.97	13.86	----
A	1954	Moderate	1.54	1.78	5.39	----
A	1955	Moderate	1.52	1.52	9.29	0.17
A	1956	Moderate	1.67	2.10	7.32	0.04
B	1953	Light	2.61	1.42	9.88	----
B	1954	Light	2.13	1.57	7.19	----
B	1955	Heavy	1.08	1.30	7.86	1.10
B	1956	Heavy	1.04	1.58	7.76	0.13

1/ Seedlings are not included.

An understanding of the effect of various environmental factors upon vegetal response should enable the range manager to estimate future forage production and range condition. The most important environmental factor influencing the response of the seedings studied in southern Idaho was rainfall; April-May rainfall is closely related to the amount of crested wheatgrass forage produced and the height of the plants. Late May and June rainfall appeared to be essential for the production of crested wheatgrass seed. Areas which received little late May and June rainfall produced seed which was only 30 percent viable while similar areas which received ample late May and June rainfall produced crested wheatgrass seed which was 90 percent viable.

Drought conditions on one reseeding during 1954 caused a reduction in the number of plants per square foot, basal area, and percentage of ground covered by crested wheatgrass. The larger plants were most susceptible to drought injury on this particular seeding. The effect of rainfall upon species other than crested wheatgrass merits further study. Climatic conditions which favor one species appear to be detrimental to other species of annual vegetation on the reseeded areas.

Relationships between soil types and vegetal response were studied. Soils formerly supporting big sagebrush produced excellent stands of crested wheatgrass, but areas formerly occupied by saltsage and other salt-tolerant species produced very poor stands of crested wheatgrass. Attempts to revegetate saline areas in southern Idaho have often resulted in great increases of undesirable plants such as halogeton at the expense of desirable perennial shrubs. Thus it appears that saline areas supporting stands of saltsage, greasewood, or shadscale should not be reseeded with crested wheatgrass.

Incomplete eradication of sagebrush prior to reseeding will greatly reduce the amount of crested wheatgrass produced. Removal of the sagebrush by spraying or burning is advisable on those areas which support numerous crested wheatgrass and sagebrush plants.

Crested wheatgrass appears to be resistant to fire during August, while sagebrush can be eradicated by burning during this period. Spraying with 2, 4-D during 1956 greatly reduced the amount of sagebrush present on the Warm Creek seeding, but further study is needed to evaluate the response of the vegetation to spraying on this area.

The number of plants which establish themselves on a given area determines to a large degree whether the number of plants per square foot will decrease, increase or remain constant. If too many plants are present, intraspecific competition will eliminate the weaker plants without affecting the total forage production significantly. When enough young plants are present to utilize the available soil moisture or other factors which may limit the site's potentiality, a substantial decrease in numbers will occur. Plants grow larger with age and fewer plants are then needed to utilize the site potential. If, too, few plants are present to utilize the site potential, the number of plants will tend to increase during good seed years. An apparent reduction in the number of plants per square foot occurs when plants grow together and form clumps as a result of their increasing diameters. Severe overuse will decrease the number of crested wheatgrass plants and allow the increase of undesirable plants such as halogeton on reseeded ranges in southern Idaho.

III. Wildlife and Fisheries Management

A. Projects Completed During the Year:

Project WU-25. Productivity of Antelope in Owyhee County.

This project was completed in the fall of 1956 and a master's thesis presented by Robert V. Folker. The principal results are given in the following summary:

The rut occurred during the first three weeks of September and reached its peak about the middle of the month. Pre-rut behavior was noted about the middle of August and activities reminiscent of the rut were noted in the spring. Harem sizes fluctuated to a considerable extent; the average was about ten animals including fawns. Younger bucks were seen with harems of one to three does.

The antelope hunts in 1951, 1952, and 1953 came during the early part of September, coinciding with the rut. This may or may not have had a detrimental effect on productivity, but rather than risk serious herd decimation, an earlier or later hunt should be scheduled if possible or perhaps a special study of this situation may be undertaken at a future date.

The gestation of Owyhee antelope appears to be about 240 days or possibly as much as 250 days. A total of 48 fawns, including 32 twins and 16 single fawns, was observed on Area I between May 18, 1956 and June 12. Seventeen of these fawns were seen early enough for the observer to be reasonably certain that there were six pairs of twins and five singles, resulting in an average of 1.54 fawns per doe. This figure compares favorably with those in other areas. It appears that weather conditions exert some influence on the selection of kidding grounds and the concentration of does on these grounds. It was noted that one of a set of twins is often weaker. There may be a possibility of differential sex mortality.

Fawns may be distinguished from adults without too much difficulty until the latter part of August. From then on every means possible must be used to make distinction. Height is not very useful after August and cannot be relied upon to give consistent results. The size of the rump patch, the shape of the head, muzzle length and the length of the body are useful criteria.

Six fawns were tagged with aluminum tags. It was found that a horse was very helpful in making the kidding observations and in seeking out and tagging the fawns. Tagged fawns were observed three times after the tagging operation had been completed.

III. Wildlife and Fisheries Management

A. Projects Completed During the Year:

Project W-2R. Productivity of Antelope in Crook County.

This project was completed in the fall of 1956 and a master's thesis [illegible] The condensed results [illegible] following summary:

The rut occurred during the first three weeks of September and reached its [illegible]

The antelope [illegible] 1951, 1952, and 1953 were during the early part of [illegible]

The population of Crook County antelope appears to be about 150 [illegible]

There may be differences [illegible]

Six [illegible]

The estimated death rate of 6.4 percent, based on the 371 animals using the area, was not considered excessive and therefore, no single factor causing antelope mortality could be considered significant. Three pregnant does, each carrying twins, were included in the winter mortality, and resulted in a potential loss of six more antelope. It is suspected that a more severe winter such as occurred in 1951-1952, would increase the mortality considerably. All of the dead antelope examined were free of parasites and disease insofar as it could be determined. The bone-marrow test was made on all the antelope examined but as no criterion exists for the application of this technique to antelope, no valid conclusions may be drawn.

Golden eagles and coyotes, while present in both study areas, were not observed to prey on antelope. Coyotes were not encountered on the kidding grounds but moved into Area I toward the middle of the summer. Bobcats were present in both study areas. Three bobcat kills were found on the winter range, and this predator probably accounts for some kid mortality in the spring.

Mule deer, cattle and sheep are found on the Owyhee antelope ranges. Competition on the study areas is probably greatest with cattle, although it was not considered excessive. Sheep may possibly prevent full use of suitable antelope habitat in parts of Owyhee County, but they were not considered important competitors on the study areas.

Antelope were observed feeding on dwarf and big sagebrush, serviceberry, elderberry, bitterbrush and mule's ears. Other forbs and some grasses were also eaten but the species utilized and the extent of utilization was not determined. Antelope used all the habitat cover types in the study area, the preference and degree of use depending somewhat on the time of year. During the winter, antelope were seen feeding on shadscale, sagebrush, four-winged saltbush, Russian thistle, prickly pear and grasses.

A qualitative analysis of seven stomach samples revealed that sage and shadscale made up the bulk of the diet through the winter. Toward spring, grass was included in the diet in increasing amounts. Drying antelope stomach samples was found to be a poor procedure as it was impossible to relax these samples later without destroying the identity of much of the material.

Antelope migration seems to be largely regulated by the weather, and the amount of dispersal by range conditions. Probably Owyhee County has both summer and winter range for a larger herd of antelope, but since very little is known about the carrying capacity of a particular habitat for antelope, there is no way of telling for certain if more of these animals could be accommodated and if so, how many. It is not thought that range capacity is a factor limiting herd size at present.

Productivity as shown by aerial counts and ground observations over a three-year period has been high and compares very well with results in neighboring states. The average doe: kid ratio was 100:100. All buck: doe ratios obtained indicate a buck population more than adequate for normal breeding requirements.

Productivity and mortality figures point to an expected increase that does not appear in winter aerial counts. Possible reasons for this are suggested, such as poor technique of finding evidence of mortality on the summer range or variability in fawn production and survival over the entire range. It is also possible that part of the herd increase is masked by drift of antelope into other wintering areas.

Project WU-29. A Fishery Survey of Priest Lake.

In 1955, a survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries was initiated. The main purpose of the study was to determine the factor or factors causing the decline in the cutthroat numbers in the lake. The project was completed in May, 1957.

Priest and Upper Priest Lakes, situated in the Selkirk mountain range, have a coniferous forest covered watershed of approximately 600 square miles. Priest Lake has a surface area of about 24,000 acres and Upper Priest Lake a surface area of about 1,900 acres. The maximum recorded depth in Priest Lake was 355 feet and 98 feet in the upper lake.

Dissolved oxygen was found to be abundant at all depths. The total alkalinity or total hardness in Priest Lake was approximately 23 ppm.

The dominant forms of zooplankton collected were Diaptomus sp., Cyclop sp., and Bosmina sp. present in measurable number throughout the summer and fall and Daphnia sp. which did not become numerous until late July. Daphnia sp. constituted a major portion of the diet of the kokanee, even though it constituted only a small percentage of the total number of zooplankton present in the lake.

The estimated catch of fish from Priest and Upper Priest Lakes amounted to 93,300 in 1955 and 111,400 in 1956. Approximately 68,800 hours were fished in 1955 and 103,900 in 1956. Of the hours fished in 1956, 81 percent were expended to catch kokanee, 10 percent cutthroat, and 9 percent Dolly Varden and mackinaw. Of the total catch in 1956, kokanee constituted 93 percent (103,800), cutthroat 5 percent,(5,500) and Dolly Varden and mackinaw 2 percent (2,100).

Resident fisherman expended 23 percent of the effort compared with 77 percent exerted by non-residents. Approximately 34 percent of the hours fished were expended by fishermen staying in private cabins and the remaining 66 percent by anglers staying at resorts or public camp grounds.

The average rate of catch for the 1956 season for kokanee in Priest Lake was 2.46 fish per boat per hour. In the upper lake the rate was 0.86 fish per boat per hour. The average rate of catch for cutthroat in the upper lake was 1.02 compared with 0.70 in Priest Lake.

The average size cutthroat caught from Priest and Upper Priest Lakes in 1956 were 11.1 and 11.2 inches total length respectively.

Juvenile cutthroat spawned from fish migrating from the lakes were found to spend an extended period of time in the streams before migrating to the lakes. Of the fish collected from Priest Lake in 1956, 38 percent spent two years in the streams before migrating, 57 percent three years and 5 percent four years. For the upper lake, 6 percent migrated after their first years, 35 percent after their second, and 58 percent after their third.

The spawning season of cutthroat trout in Priest and Upper Priest lakes begins in April and generally ends by July 1. Upper Priest Lake fish appear to have a slightly later season than the Priest Lake fish. Cutthroat in the Priest Lakes mature predominatly during their fifth year of life. Some males may mature during their third year of life, while some fish may not mature until their sixth year. Only a very small number of fish ever spawn a second time.

In streams where brook trout have become abundant, the competition for food and space between brook trout and cutthroat is very intense. There is some competition present in the lakes, however, it appears to be much less than in the streams.

An average of nearly 500,000 cutthroat per year, mostly fry, have been planted in the Priest Lake drainage for at least the last 10 years. The return to the creel of these plants was less than 1 percent if only the planted fish appeared in the creel, as the annual catch in 1955 and 1956 was approximately 5,000 cutthroat.

The Dolly Varden, a stream spawner, also remains in the stream for extended periods of time before entering the lakes. Once the fish enter the lakes, growth is very good with some fish attaining weights up to 25 pounds. Most of this species appear to spawn for the first time during their fifth or sixth year of life. Kokanee are the major item in its diet in Priest Lake.

The catch and spawning escapements of kokanee from Priest Lake during 1955 and 1956 were composed mainly of fish in their fifth year of life. The population in Upper Priest Lake varied, however, fish in the fifth and sixth years of life were present.

The kokanee in Upper Priest Lake mature at the same age as the Priest Lake fish, however, they average about 3 inches longer in length. Growth of kokanee during the first and second years of life is nearly equal in the two lakes, but fish in the upper lake continue to grow at a fast rate during their third year of life while fish in Priest Lake grow at a slower rate.

B. Continuing Projects:

Project WU-15. A Study of Sage Grouse Populations in Eastern Idaho to Evaluate Booming Ground Activity and Census Methods.

Of the sage grouse banded with the plastic neck bands in the spring of 1956, a return of 23 percent were observed on the Red Road booming grounds in the spring of 1957. Of the banded birds returning, approximately 41 percent were observed on the same booming ground where they were banded a year ago. The 59 percent of the returning banded birds were noted 0.4 to 2.1 miles from the points of original capture.

Preliminary figures on non-breeding females in a sage grouse population were obtained as a result of a 1 1/2 day sage grouse hunt in September, 1956, in Fremont County.

The 1957 breeding ground banding was improved by the addition of a radio controlled firing device for the cannon net traps. Traps can be fired by remote control and, therefore, are not limited to locations close to roads.

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

During the year, much of the data collected on this project was set up for analysis with punched card methods. Analysis of a large number of ruffed grouse brood ranges in all parts of Idaho was adopted for the Unisort marginal notch, 5" x 8" card. This data is in the process of being analyzed to determine why some ruffed grouse brood ranges produce broods of grouse each year, while others have broods only certain years, usually those of high population leads.

Another phase of this project is the micro-climate study which is being analyzed by use of IBM punched cards. Data is being processed to show differences in micro-climate by cover-type, in relation to use by grouse broods.

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

This is a long-time study to determine the population trends on the 2200 acre Flat Creek study area. Activity is confined to the annual pre-hunting season census in September and some comparative drumming counts on this same area. Grouse populations in 1956 were still at a low level.

Project WU-20. Productivity of Mule Deer on the Cassia Division of the Sawtooth National Forest, Idaho.

The fifth and last year of productivity data were collected at the time of the fall hunting season in 1956. The ovarian analyses were made by Burt McConnell in January, 1957. A smaller number of ovaries were collected in 1956 because of the investigator's inability to travel to the study area at the time of the annual hunt. The final report of this project, the major share of which is a master's thesis by McConnell, will be prepared this next fiscal year.

A summary of the fertility rates of four age classes of deer during the five year period 1952-1956 is given in Table 1.

Table 1

Fertility rates, Cassia Deer Herd 1952-1956 incl.

Age	No. of does	No. of does bred	Per Cent bred
Yearling	59	39	66.1
2-year old	44	43	97.7
Prime (3-8 yrs.)	124	121	97.6
Old (Over 8 yrs.)	42	40	97.5
	269	243	89.7

The fertility rates of all age classes of mule deer compares closely with records from Utah where considerable work has been done by Robinette. The number of corpora lutea found in each age class of does is summarized in Table 2.

Project TP-49. Ruffed Grouse Population and Census Methods.

This is a long-time study to determine the population trends of [illegible] [illegible] Creek study area [illegible] activity is continued by the [illegible] preceding [illegible] census in September. [illegible] counts on this same area. [illegible] 1956 [illegible] at a low level.

Project WP-20. Productivity of [illegible] Between the Coastal Plains of the [illegible] National Forest, [illegible]

The [illegible] and last year of [illegible] [illegible] during the [illegible] [illegible] the [illegible] [illegible] in January [illegible] smaller range of [illegible] [illegible] in 1955 because of the [illegible] [illegible] [illegible] area at the time of the annual hunt. The [illegible] [illegible] [illegible] major [illegible] [illegible] [illegible] be prepared this next fiscal year.

A summary of the fertility [illegible] [illegible] classes of does during the five year period 1952-1956 is given in Table 1.

Table 1

Fertility Factor, [illegible] Deer May 1952-1956 incl.

	No. of	No. of	Per 100
	does	[illegible]	does
Yearling	[illegible]	[illegible]	[illegible]
2-year old	14	[illegible]	[illegible]
Prime (3-6 yrs.)	[illegible]	[illegible]	[illegible]
Old (Over 6 yrs.)	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]

The [illegible] [illegible] of [illegible] [illegible] [illegible] [illegible] with records from [illegible] [illegible] the work has been tabulated. The number of corpora lutea found in each [illegible] of does is summarized in Table 2.

Table 2

Analysis of Ovaries of 269 Does, Cassia Division, 1952-1956 incl.

Age	No. of deer	Total No. of ovarian scars	Av. No. ovarian scars per doe
Yearling	59	53	0.90
2-year old	44	70	1.59
Prime (3-8 yrs.)	124	231	1.86
Old (Over 8 yrs.)	42	78	1.86
	269	432	1.61

Eventually the actual fertilization success should be determined for the Cassia herd. Only by comparing the number of foetuses with the pigmented corpora lutea scars can the fertilization success be determined. For comparative purposes the Utah figures will give reasonably close calculations. For each live foetus (half way through the gestation period) in 482 does there were 1.12 ovarian scars. Applying these ratios to the Cassis deer herd the 269 does in Table 2 were carrying an average of 1.44 foetuses. Prenatal mortality amounted to 3.3 percent, leaving 1.39 fawns per doe.

The Cassia hunts precede the rut in mule deer, therefore, data on fertilization success would be available only by examining dead does in late fall and winter or collect animals systematically throughout the winter.

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

Robert E. Jones, research fellow, began work on this second phase of the project during the year. From March on through the nesting season, active field work was under way on this study. More than 500 magpies were marked on the winter roosts by Mr. Jones and Mr. Charles Blake, fish and game department biologist cooperating. Pheasant crowing counts, magpie nest census, and the dummy nest study are being continued as in the first part of the project. Four new dyes for egg staining were tested and found usable. Some of these newer dyes are being used in emergent vegetion in the study of magpie predation on waterfowl nests.

This second part of the project is planned to include two spring nesting seasons on the project area.

Table [illegible]

Analysis of [illegible] of 249 Deer, Gaspe Division, 1954-1956 incl.

[illegible]	No. of deer	Total No. [illegible]	Av. No. [illegible]
Yearlings ([illegible] yrs.)	57	53	[illegible]
2-year-olds	44	70	1.59
Prime ([illegible] yrs.)	121	231	[illegible]
Old (over [illegible] yrs.)	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.52

Generally the [illegible] could be [illegible] for [illegible] [illegible] with the [illegible] [illegible] figures [illegible] compared. For comparative purposes the [illegible] figure [illegible] [illegible] [illegible] [illegible] in [illegible] were [illegible] [illegible] deer in Table [illegible] [illegible] mortality amounted to [illegible] percent, [illegible] [illegible] [illegible]

The [illegible] [illegible] [illegible] [illegible] would be [illegible] only by [illegible] [illegible] [illegible] throughout the [illegible]

Project [illegible]. The Influence of [illegible] Production [illegible] and Waterfowl Populations in the [illegible] Lake Areas.

[illegible] [illegible] during the year. [illegible] [illegible] [illegible] of the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] were [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of [illegible] production [illegible] [illegible].

This second part of the project is planned to include two [illegible] [illegible] records on the [illegible] area.

Project WU-26. Salt in the Management of Elk in the Lower Selway River Area, Idaho.

The first phase was completed by Robert D. Beeman and a thesis presented. A summary of the findings to date follows:

There were at least forty-two active artificial salt licks in the study area. This is a high number considering the size of the area. Several active licks are probably present in the summer ranging area of almost every elk. Most of the licks are on brushy or high meadow ridges. Their elevations average 5,240 feet.

The present salt drops generally are being made after the peak of elk migration from the winter range has occurred.

Most salt drops are located by big game within one or two days and are used heavily. A few drops are made slightly above or below the area of greatest late spring elk activity. These drops may not be discovered by the game for several weeks and receive comparatively minor use. The area of greatest late spring elk activity on Coolwater Ridge in 1956 was between about 4,500 and 5,500 feet.

Salt blocks dropped in dense brush, seeps, canyon bottoms, or other out-of-sight locations may not be found by big game. This indicates that deer and elk may not be able to smell salt from very far, if at all. It also shows that it is possible to lose salt through misplacement. At least two, or eleven percent, of the nineteen 1956 study area salt drops were misplaced.

Losses from salt blocks smashing when dropped are insignificant. Probably not more than three to four percent of all salt blocks smash badly when air-dropped. Most of the pieces of smashed salt blocks are probably located by big game.

Evidently very little salt can be lost by weathering. Salt was washed from standard fifty-pound salt blocks at the rate of about 1.2 pounds per inch of precipitation during the period from September 3, 1955 to June 8, 1956. Sodium analyses of soil samples from artificial licks indicated that big game eat almost all of the soil into which salt has leached from the blocks. There was also indication that big game may remain interested in lick craters after all artificially supplied salt had been removed. This suggests that elk were attracted, by the presence of a crater, to a point where they were not getting any more sodium than their tongues could ionize in normal soil.

The length of time that salt remains in block form and the effective life of artificial licks, is quite variable. The effective life depends on the proximity of, and activity in, nearby licks and the amount of elk activity in the area. Salt may remain in block form from three weeks to several months after placement. Salt drop locations continue to be licked by elk long after all visible signs of salt are gone. If salt is not placed in or near old craters, they continue to receive heavy use for two years and slight to moderate use for one or more years after that.

Project 86-ch. Salt in the [illegible] of [illegible] in the [illegible] Salmon River Area, Idaho.

[illegible]

The field [illegible] completed by Robert [illegible]. [illegible] Sheets [illegible]. A summary of the findings to date follows:

[illegible]

There were at least [illegible] with artificial salt [illegible] in the study area [illegible] number [illegible] of the [illegible] [illegible] probably [illegible] in the [illegible] range [illegible] [illegible] average [illegible] feet.

The [illegible] salt [illegible] generally [illegible] made after the [illegible] of elk migration from the winter range had occurred.

[illegible] salt [illegible] located [illegible] within [illegible] two days [illegible] [illegible] late spring [illegible] between about 4,000 and 5,500 feet.

Salt blocks dropped in [illegible] [illegible] [illegible] [illegible] [illegible] percent [illegible] 1956 [illegible] salt [illegible] [illegible].

Loss of [illegible] blocks [illegible] more than 2 [illegible] to four percent [illegible] salt [illegible] [illegible] of the [illegible] [illegible] located [illegible].

[illegible] salt [illegible] [illegible] [illegible] salt [illegible] [illegible] [illegible] 1956 [illegible] [illegible].

[illegible] [illegible] effective life [illegible] [illegible] salt [illegible] [illegible] [illegible] for two years [illegible].

The amount of salt dropped per placement probably could be reduced without reducing the attractiveness of the resulting licks to elk.

The age of artificial salt licks varies greatly. Some licks receive new salt almost every year. Most licks get salt only one or two years and are constantly being replaced by newly created licks.

Erosion and forage overuse do not seem to be seriously increased by the presence of artificial salt licks in most cases. Considerations of the seasonal changes in browse utilization that salting may have caused, or may be causing, are severly complicated, because various parts of the area have been salted by the Fish and Game Department for thirty-five years.

Natural licks do concentrate elk. These locations may be important in the social behavior of elk to a degree not equalled by artificial licks.

The element that is sought by big game in the lower Ballinger Creek natural lick may be sodium. If this is true, then the minimal levels of sodium concentration that are needed to attract elk are very low and evidently are different for natural and artificial licks.

The attractive agent in the upper Ballinger Creek natural lick was not fully apparent from the present sampling and analyses. The only differences of note evident between the upper lick samples and the unlicked control samples were the lick's higher concentration of HCO_3 and a much more basic pH.

Data from the trail use studies and from direct observation of the elk were taken from similar elevation ranges and appear to be comparable both within themselves and between each other. The pellet count data, as now collected, are comparable only within themselves.

No definite conclusions can be drawn from the contrasting information of the pellet group counts and direct observation records as to the validity of the hypothesis: "There is no difference in the migration rate of elk in the salted and unsalted areas." The present quantitative methods of studying migration may not be gathering sufficient information to produce meaningful results. Further research, involving increased sampling and analysis of techniques, is needed to determine whether pellet group counts or direct observation produce the more reliable information. It should be determined what factors, other than salting, might be responsible for all or part of migration differences. It is possible that significant differences in migration rate exist between different ridges as a result of some of the many natural variables of the environment.

The amount of salt applied per placement schedule could be reduced without reducing the attractiveness of the resulting licks to [illegible].

The use of artificial salt licks varies greatly. Some licks are used [illegible] almost every year. Most licks are only used for a few years and are gradually being replaced by newly created licks.

Breeding and [illegible] [illegible] do not [illegible] [illegible] the presence of artificial salt licks [illegible] [illegible] seasonal changes [illegible] [illegible] [illegible] may be [illegible] [illegible] [illegible] have been [illegible] by the Fish and Game Department for [illegible] years.

Natural licks [illegible] [illegible]. These [illegible] may be important in the [illegible] of salt [illegible] [illegible] artificial licks.

The [illegible] [illegible] [illegible] [illegible] [illegible] natural licks [illegible] [illegible] are needed to [illegible] [illegible] [illegible] for natural and artificial licks.

The attraction of [illegible] to the [illegible] [illegible] [illegible]. The only difference [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

Each year the [illegible] [illegible] [illegible] [illegible] compared both [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of the environment.

Observations of the spring activity and behavior of the elk cows and yearlings seem to indicate that artificial licks were not influencing migration, but rather were being used just as normal activities included them. Any bull elk which may range yearlong at high elevations were not included in these observations. Such bulls, however, would be of little importance to the objectives of this study. Snowline had little direct effect on spring elk movements. Vegetation readiness and migration did not seem to be clearly correlated. The most important factor evidently was getting to the calving grounds in time for parturition. The cows, some yearlings, and calves grouped for awhile, then a general dispersion for the summer was noted. A drop in lick activity began about the same time as the dispersion. Salting did not prevent the elk from dispersing for the summer. Comparatively few elk remained on the low winter ranges of the lower Selway area during the summers of 1955 and 1956. The browsing pressure of these few elk is probably not of management significance.

Salt blocks placed above or below the range of greatest elk activity were comparatively little used. Such salt, even when fully visible, evidently was not attractive enough to cause many elk to enlarge their ranging areas to include it.

Salt is most desired by big game in the spring, during the period of lush vegetation. Desire declined through the summer to a low during hunting season, peaked slightly in mid-winter, and dropped again just before the spring rise.

Elk and cattle are the main species using artificial licks in the study area. Salt use by other animals is of a minor nature.

The intake of salt by elk evidently does not automatically create a desire for water.

Social ranking is evident at salt licks. Elk have priority over deer. Class ranking in elk at licks follows this order: lead cow, subordinate cows, yearlings. The social position of cattle, bull elk, and elk calves was not determined.

Further intense research is needed to determine the validity of these preliminary conclusions and to further the understanding of the effects of salt on elk migration.

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

Oien completed part of the pre-logging phase of this study with the results presented in a thesis entitled: "A Pre-logging Inventory of Four Trout Streams in Northern Idaho." The following paragraphs are condensed from the summary.

It has long been a popular concept that logging has harmful effects on trout streams. It is difficult to reach a conclusive generalization from any of the studies made to date because of the complexity of the variables involved. Conditions in the watershed and effects of disturbance of forest cover vary greatly from region to region.

This study constitutes the first, or pre-logging, phase of a long-term project. It is designed to measure the influence of currently accepted logging practices and associated activities on selected streams in the Clearwater River and St. Joe River watersheds. The streams have been chosen in pairs, one in a drainage to be logged after two or more years of observation and measurement and the other to be left undisturbed as a control. The pairs chosen are Gold and Simmons Creeks, which drain into the St. Joe River; and Crystal and Silver Creeks, tributaries to Orogrande Creek, which empties into the North Fork of the Clearwater River. Gold and Crystal Creeks are in the watersheds to be logged within the next five years; the other members of the pairs are to serve as controls for five or more years before they too are logged.

Selected phyisco-chemical and biological features of the streams and watersheds have been measured periodically before logging. The same measurements will be made in essentially the same manner both during and after logging. During logging, detailed records of the operations will be kept. A comparison of these measurements will provide the means of determining the nature and magnitude of any changes that may occur in the streams as a result of logging the watersheds. Wherever possible, the specific cause or causes of any changes will be determined. It is hoped that it will be possible to make recommendations which will be helpful in minimizing harmful effects and maximizing beneficial effects which logging may have on the streams.

Several factors influenced the selection of the study sites. The streams are all of "trout-stream" quality and are relatively free from outside disturbances. In both areas, the control stream drains the adjacent watershed and possesses ecological features similar to those in the stream draining the watershed to be logged. Virgin forests consisting largely of white pine stands cover both areas. The Gold-Simmons Creek study area is in the St. Joe National Forest; logging contracts for these watersheds will be administered by the U. S. Forest Service. The Crystal-Silver Creek

Project F-20. A study of the influence of logging on Trout Streams in Northern Idaho.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

study area is partially on State Land and partially on land belonging to Potlatch Forests, Inc. The different ownership and administration of logging contracts for the two study areas provide a possible source of variation in logging practices; such variation is desirable in a study of this nature since it may enable a comparison to be made of the effects produced by one method with those produced by an alternate method. The Clearwater study streams are much smaller and drain less extensive and more gently sloping watersheds than do those on the St. Joe.

The Clearwater streams have alternate sections of steep gradients with fast water followed by gentle gradients where the water flows smoothly through wet meadows. In contrast to this, the St. Joe streams have uniformly high gradients with fast water throughout their length. All streams are somewhat lacking in pool development but riffles are plentiful. No obstructions to fish movement were observed in any of the streams. The bottom types in Gold and Simmons Creeks are largely coarse rubble and, to a lesser extent, coarse gravel. No rooted stream-bed vegetation occurs in these streams. Gravel is the predominant bottom type in Silver and Crystal Creeks although rubble and sand occur to some extent in the latter stream. Rooted stream-bed vegetation covers considerable areas in both Silver and Crystal Creeks.

Periodic measurements made during the summers of 1955 and 1956 indicate that the St. Joe streams have consistently greater volumes of flow and higher water temperatures than do the Clearwater streams. Normal turbidity was very low on all streams and siltation was negligible.

In 1955, the standing crop of invertebrate benthic macrofauna was comparable in all streams except Simmons Creek, which inhibited a significantly larger standing crop of bottom organisms.

The t-test was used to detect significant differences in the mean volumes of the standing crop of bottom organisms. The tests showed that significant differences exist between bottom types, between vegetated and non-vegetated stream bottoms, and between periods of collection. In 1955, Simmons Creek had a significantly larger mean volume of bottom organisms than Gold Creek. In 1956, the mean volume of bottom organisms had been significantly reduced in both streams. In Crystal and Silver Creeks the 1956 samples showed no significant change from 1955. Five orders of insects (Plecoptera, Ephemeroptera, Trichoptera, Coleoptera, and Diptera) constituted the bulk of the bottom organisms both as to number and volume in all streams.

Analysis of stomach contents revealed that aquatic organisms generally constitute a higher percentage of trout food than do terrestial organisms, even during the summer months. Plecoptera, Ephemeroptera, Trichoptera, and Diptera were the four principal orders of aquatic insects consumed by the trout. Forage ratios of Trichoptera and Diptera were especially high in several of the streams.

study area [illegible] Potlatch [illegible] logging [illegible] variation [illegible]

The [illegible] composite [illegible]

[illegible] 1948 and 1949 [illegible]

In 1950 [illegible]

[illegible]

In 1952 [illegible]

Cutthroat trout are native to all the study streams. Silver Creek also has a sizable population of eastern brook trout. Dolly Varden trout are known to be present in the upper part of Simmons Creek. Sculpins are present in all of the streams. Trout in the St. Joe streams have a faster growth rate and appear to grow to a larger size than do those of the Clearwater streams. Condition factors appear to become lower as the trout increase in length. Variation between condition factors of trout collected from different streams was not great. Variation between years appeared to be normal for all streams.

Fishing pressure is greatest on Simmons Creek and somewhat less on Gold Creek. Fishing pressure is negligible on Crystal and Silver Creeks, presumably because of the small size of the fish and the large size of the mosquito population.

Project WU-30. Clearwater Fisheries Investigation.

Under contract with the Idaho Fish and Game Department, the Cooperative Wildlife Research Unit has undertaken a study to determine methods of distinguishing races of rainbow trout of steelhead origin from other races of rainbow trout so that the value of the immature steelhead in the sport fishery may be determined.

The following studies are being conducted:

(a) Explore the use of spectroscopic or spectrographic methods in distinguishing steelhead rainbow from other rainbow trout.
(b) Explore the use of antigens and/or other bacteriological methods for separating or distinguishing between steelhead or their eggs and progeny and other rainbow trout and their eggs or progeny.
(c) Make studies of age-growth of young rainbow trout suspected of being progeny of steelhead and determining what correlation, if any, exists between these and adult steelhead making use of age-growth data of the adults through back calculations.
(d) Compare the age and sexual maturity of steelhead progeny with other races of rainbow known not to be steelhead progeny.

cutthroat trout are [illegible] without [illegible]. Since [illegible] has been [illegible] of hatchery [illegible] rainbow trout, [illegible] brook trout [illegible] known to be present in the upper portion of [illegible] Silver Creek. Sculpins are present in all of the area [illegible] rainbow trout [illegible] to grow to a larger size than do those of [illegible] other [illegible] sucker appear [illegible] trout [illegible] in length. Variation [illegible] between [illegible] collected from different [illegible] and [illegible]. Variation [illegible] appeared to be normal for all streams.

[illegible] is greatest on Silver Creek [illegible] fishing pressure [illegible] of the [illegible] populations.

Project II — [illegible] Investigation.

Under contract with the Idaho Fish and Game Department, the Cooperative Wildlife Research Unit has undertaken a study to determine methods of distinguishing races of rainbow trout [illegible] from other races of rainbow trout [illegible] the value of the [illegible] may be determined.

The following studies are being conducted:

(a) Explore the use of spectroscopic or [illegible] methods in distinguishing [illegible] rainbow from other rainbow trout.
(b) Explore the use of [illegible] and/or other [illegible] methods for [illegible] distinguishing between [illegible] and other rainbow trout [illegible].
(c) [illegible] studies of [illegible] young rainbow [illegible].
(d) [illegible] the [illegible] of [illegible].

I. SUMMARY OF F. W. R. STATION PROJECTS 1956-1957

No.	Title	Started	Present Status	Personnel
	I. FOREST MANAGEMENT			
E.S.1	Wood Preservation Service Tests	1946	Cont. Act.	Howe, Burlison
E.S.2	Study of White Pine Blister Rust	1940	" "	Slipp
E.S.3	White Pine Stem Anatomy	1953	" "	Johnson
E.S.4	High Frequency Current Seed Treatments	1952	" Inact.	Pitkin
E.S.5	Chemical Debarking of Trees	1952	Completed	Howe, Gilbertson
E.S.6	Idaho Tree Diseases	1950	Cont. Act.	Gilbertson, Slipp
E.S.17	Photomicrography of Native Woods	1952	Completed	Howe
E.S.19	Christmas Tree Test Plantings	1953	Cont. Act.	Pitkin, Burlison
E.S.20	Mortality of Young White Pine	1948	" "	Gilbertson, Johnson
E.S.21	Study of Idaho Small Tree Farms	1956	" "	Deters, Seale, Frazier
E.S.23(WM-31)	Marketing Practices and Price Analysis of Idaho Timber	1956	New	Seale, Frazier
S.R.11b	Forest Tree Physiology	1951	Cont. Act.	Johnson
S.R.24	Slash Disposal Studies	1949	" "	D. Olson, Gilbertson
S.R.43	Forest Site and Soil Mapping Research	1954	Completed	Ferrell
	II. RANGE MANAGEMENT			
E.S.7	Evaluation of Salt-desert Shrub Ranges	1951	Cont. Act.	Sharp
E.S.8	Study of Medusa-head Rye	1950	" "	Hironaka, Tisdale
E.S.9(R-287)	Ecology of Sagebrush Ranges	1949	" "	Hironaka, Tisdale
E.S.10	Ecology of Douglas-Fir Zone in B. C.	1946	" "	Tisdale
E.S.13	Ecotypes of Idaho Fescue	1956	New	Tisdale, R. Olson
E.S.15(BLM #1)	Study of Halogeton	1950	Cont. Act.	Sharp, Johnson
E.S.22(R-296)	Nutritional Study of Idaho Range Forages	1955	" "	Sharp, Bullock
S.R.27c	Study of Goatweed	1951	" "	Tisdale
S.R.38	Evaluation of Range Reseeding	1952	" "	Sharp, Kimsey

C. WILDLIFE MANAGEMENT

W.U.11	Study of Blue Grouse	1952	Cont. Act.	Dalke
W.U.15	Study of Sage Grouse	1952	" "	Dalke, Stanton
W.U.18	Productivity of Ruffed Grouse	1952	" "	Hungerford
W.U.19	Ruffed Grouse Population Study	1951	" "	Hungerford
W.U.20	Productivity of Mule Deer	1952	" "	Dalke
W.U.23	Food Habits and Productivity of White-tailed Deer	1952	" "	Hungerford
W.U.24	Magpie Predation on Pheasants	1955	" "	Hungerford, Jones
W.U.25	Productivity of Antelope in Owyhee County	1955	Completed	Dalke, Folker
W.U.26	Salt in Elk Management, Selway Area	1955	Cont. Act.	Dalke, Beeman, Kindle
W.U.28	Influence of Logging on Trout Streams	1955	" "	Pratt, Oien, Bachmann
W.U.29	Fishing Survey of Priest Lake	1955	Completed	Pratt, Bjornn
W.U.30	Clearwater Fisheries Investigation	1956	New	Pratt, Bjornn, Spiker, Weeks

PUBLICATIONS AND MANUSCRIPTS

I. Technical Publications

Clark, E. C. 1956. Survival and transmission of a virus causing polyhedrosis in Malacosoma fragile. Ecology 37(4):729-732.

Clark, E. C. and C. E. Reiner. 1956. The possible use of polyhedrosis in the control of the Great Basin tent caterpillar. Jour. Econ. Entomol. 49:652-659.

Clark, E. C. and C. E. Reiner. 1956. The availability of certain proprietary adjuvants for use with the polyhedrosis viruses of insects. Jour. Econ. Entomol. 49:703-704.

Gilbertson, Robert L. 1956. The genus Poria in the central Rocky Mountains and Pacific Northwest. Lloydia 19(2):65-86.

Hungerford, Kenneth E. 1957. A portable instrument shelter for ecological studies. Ecology 38(1):150-152.

Sharp, L. A., M. Hironaka and E. W. Tisdale. 1957. Viability of medusahead (Elymus caput-medusae L.) seed collected in Idaho. Jour. Range Management 10(3):123-127.

Steel, Paul E., Paul D. Dalke and Elwood G. Bizeau. 1956. Annotated list of the avifauna in and around Gray's Lake, Idaho. The Murrelet, January-April.

Steel, Paul E., Paul D. Dalke and Elwood G. Bizeau. 1956. Duck production at Gray's Lake, Idaho, 1949-1951. Jour. Wildlife Management 20(3):279-286.

Steel, Paul E., Paul D. Dalke and Elwood G. Bizeau. 1957. Canada goose production at Gray's Lake, Idaho, 1949-1951. Jour. Wildlife Management 21(1):38-42.

Tisdale, E. W. 1956. Range management education. II. College training in range management. Jour. Range Management 9(5):218-220.

Tisdale, E. W. and A. McLean. 1957. The Douglas fir zone of southern British Columbia. Ecological Monographs 27(3):247-266.

II. Graduate Theses (M.S. June 1957)

Beeman, Robert David. 1957. Salt in the management of elk and other wildlife in the lower Selway River area. M.S. Thesis.

Bjornn, Theodore C. 1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries, Idaho. M.S. Thesis.

PUBLICATIONS AND MANUSCRIPTS

I. Technical publications

Clark, E. C. 1958. Survival and transmission of a virus causing polyhedrosis in *Malacosoma fragile*. Ecology 39(2):279-282.

Clark, E. C. and C. G. Thompson. 1954. The possible use of polyhedrosis virus in the control of the Great Basin tent caterpillar. Jour. Econ. Entomol. 47:[illegible]

Clark, E. C. and [illegible] Reiner. 1956. The availability of certain proprietary adjuvants for use with the polyhedrosis viruses of insects. Jour. Econ. Entomol. 49:703-704.

Gilbertson, Robert L. 1956. The genus *Irpex* in the central Rocky Mountains and Pacific Northwest. Lloydia 19(2):[illegible]

Hungerford, Kenneth E. 1957. A portable instrument shelter for ecological studies. Ecology 38(1):150-152.

Sharp, L. A., K. Hironaka and E. W. Tisdale. 1957. Viability of medusahead (*Elymus caput-medusae* L.) seed collected in Idaho. Jour. Range Management 10(3):123-126.

Steel, Paul E., Paul D. Dalke and Elwood G. Bizeau. 1956. Annotated list of the avifauna in and around Gray's Lake, Idaho. The Murrelet, January-April.

Steel, Paul E., Paul D. Dalke and Elwood G. Bizeau. 1956. Duck production at Gray's Lake, Idaho, 1949-1951. Jour. Wildlife Management 20(3):279-285.

Steel, Paul E., Paul D. Dalke and Elwood G. Bizeau. 1957. Canada goose production at Gray's Lake, Idaho, 1949-1951. Jour. Wildlife Management 21(1):38-41.

Tisdale, E. W. 1956. Range management education. II. College training in range management. Jour. Range Management 9(5):218-220.

Tisdale, E. W. and A. McLean. 1957. The Douglas fir zone of southern British Columbia. Ecological Monographs 27(3):247-266.

II. Graduate Theses (M.S. and Ph.D. 1957)

Beeman, Robert David. 1957. Studies on the management of elk and other wildlife in the lower Selway River area. M.S. Thesis.

Bjornn, Theodore C. 1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries, Idaho. M.S. Thesis.

Folker, Robert V. 1957. A preliminary study of an antelope herd in Owyhee County, Idaho. M.S. Thesis.

Johnson, Kendall L. 1957. An investigation of the competitive relationship of halogeton in native shrub and reseeded communities in southern Idaho. M.S. Thesis.

Kimsey, Dwight W. 1957. Vegetal response on selected crested wheatgrass reseedings in southern Idaho. M.S. Thesis.

Oien, Waine E. 1957. A pre-logging inventory of four trout streams in northern Idaho. M.S. Thesis.

Pratt, Raymond L. 1959. A preliminary study of an antelope herd in Custer County, Idaho. M.S. Thesis.

[illegible], [illegible] L. 1959. An investigation of the competitive relationship of cattle and antelope on native [illegible] in [illegible] Idaho. M.S. Thesis.

[illegible], [illegible]. 1957. Vegetal response on selected grazed areas [illegible] southern Idaho. M.S. Thesis.

Olson, [illegible]. 1957. A pre-logging inventory of four trout streams in northern Idaho. M.S. Thesis.

APPENDIX A. STAFF 1956-57

I. Regular Staff Members

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

*Deceased, January 22, 1957. Mr. Theodore Bjornn took over as Acting Instructor for the second semester of the 1956-57 academic year.

II. Research Fellows

Roger Bachman--Fishery Management
*Robert Beeman--Wildlife Management
Theodore Bjornn--Fishery Management (Acting Instructor second semester)
**Arnold Bullock--Range Management
John Crawford--Wildlife Management
*Robert Folker--Wildlife Management
Kendall Johnson--Range Management
Robert Jones--Wildlife Management
Dwight Kimsey--Range Management
Fred Kindel--Wildlife Management
William Nickle--Forest Pathology
*Waine Oien--Fishery Management
Robert Robel--Wildlife Management

*Appointments terminated by February 1, 1957
**Appointment begun February 1, 1957

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT 1956-57

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

2. University of Idaho, Special Research Fund. Projects SR. 11, 24, 27C, and 38.

3. Idaho State Fish and Game Department. Regular support for the Wildlife Research Unit, plus additional funds for Clearwater Fishery Study and other projects.

4. Potlatch Forest, Inc. Potlatch Research Fellowship.*

5. Sears-Roebuck Foundation. Funds for project ES-21 (Small Tree Farms).

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

7. United States Fish and Wildlife Service. Regular funds for Wildlife Research Unit.

8. United States Forest Service. Office space (Boise), field living accomodation, and numerous other facilities.

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

* Fellowship not filled in 1956-57, due to University staff changes.

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

APPENDIX C. MAJOR ADDITIONS TO FACILITIES AND EQUIPMENT

I. Tree Genetics Center.

Arrangements were completed during the year for establishment on the campus of a forest tree genetics center by the U.S. Forest Service. The primary objective of this center will be the development and propagation of strains of white pine (Pinus monticola) which are resistant to blister rust. This genetics center will include a 40-acre tract for use as a tree orchard, and a 2-acre area on the present Forestry Nursery for a small breeding nursery and building site. Buildings to be constructed include an office and laboratory, storage shed and garage. This center will be staffed by two or more permanent U.S. Forest Service staff members.

II. Point Springs Experimental Range.

With the help of Bureau of Land Management personnel, the corrals and scales were remodelled for greater efficiency in handling separate lots of experimental animals. Electricity was made available on the site for the first time by the extension of a rural power line. An electrical pump was installed to replace the windmill which had proven inadequate for maintaining a water supply for the experimental livestock.

III. Facilities for Trout Stream Study.

Potlatch Forests, Inc. and the U.S. Forest Service cooperated in providing sites for this study of the influence of logging on trout streams in northern Idaho. Employees of Potlatch Forests also helped in the construction of weirs to measure stream flow.

IV. Forest Genetics Research in South Idaho.

Office space and the use of a vehicle for this new project were provided by the U.S. Forest Service, and funds for travel by the Southern Idaho Forestry Association. These organizations, together with the State Forester, are all cooperating in providing study sites for this project.

V. Soil Bank Program.

Funds made available under this program and through Region 1 of the U.S. Forest Service have provided for an additional 20-acre forest nursery on the new addition to the University Farm. A well, sprinkler irrigation system, storage and drying shed, tractor and pick-up were also obtained through this program. While not designed for research purposes, these facilities enhance the opportunities for research in developing suitable tree species and strains for use in the Soil Bank or other tree planting programs.