



UNIVERSITY OF IDAHO

MOSCOW, IDAHO

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

## TWENTY - FIRST ANNUAL REPORT

January 1 - December 31, 1969

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1969

Ernest Wohletz, *Director*

E. W. Tisdale, *Assoc. Director*

June, 1970

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Moscow, Idaho

T W E N T Y - F I R S T A N N U A L R E P O R T

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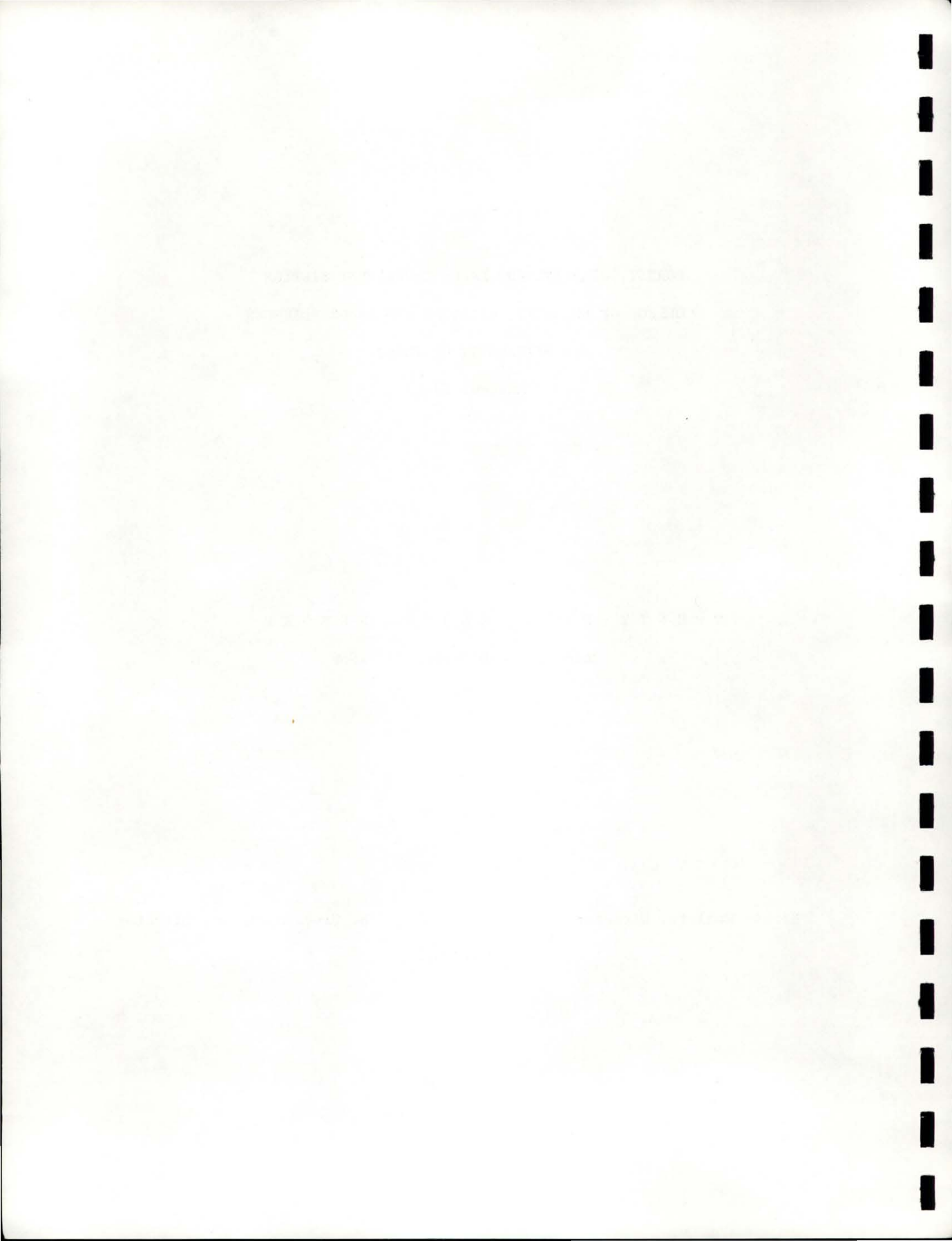
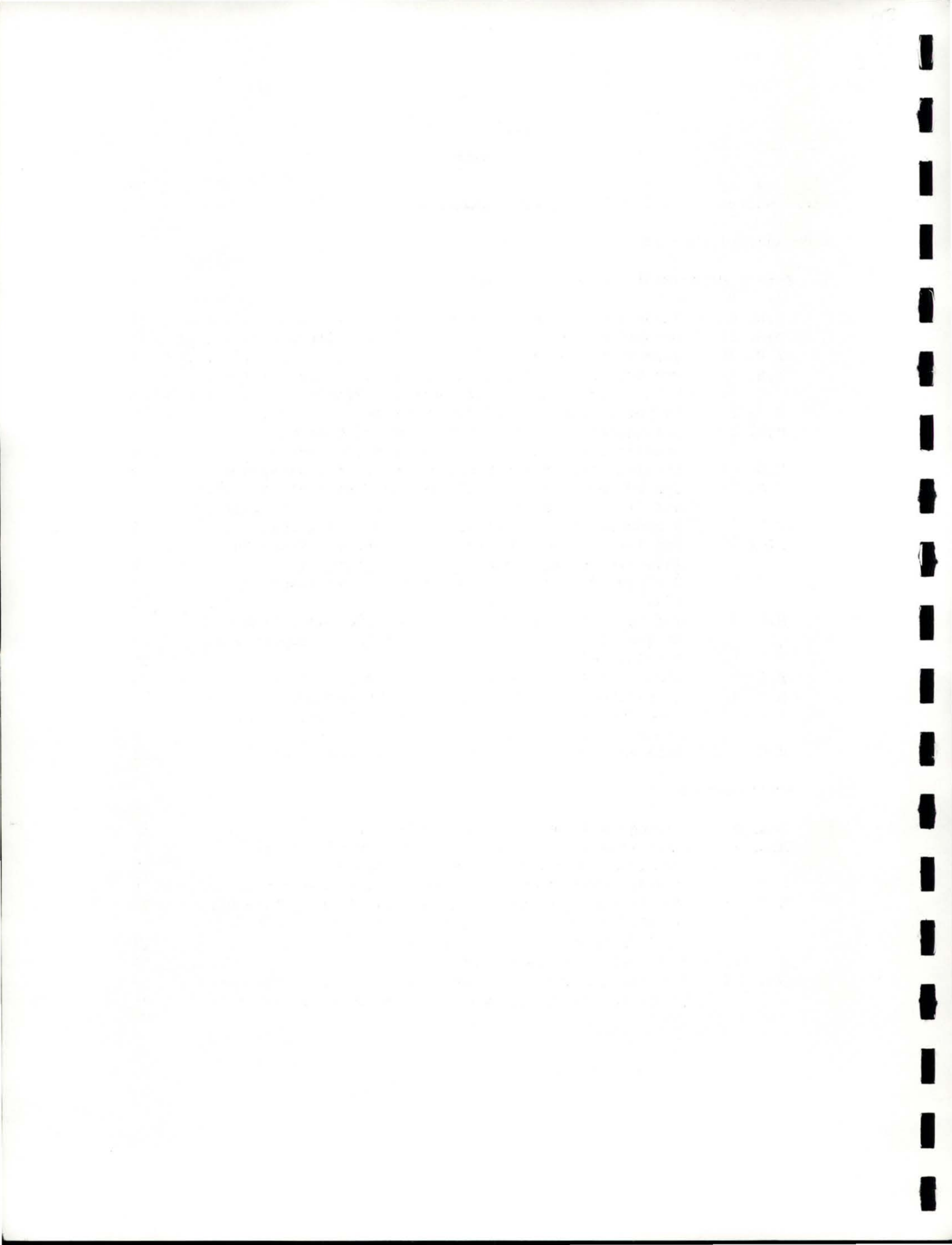


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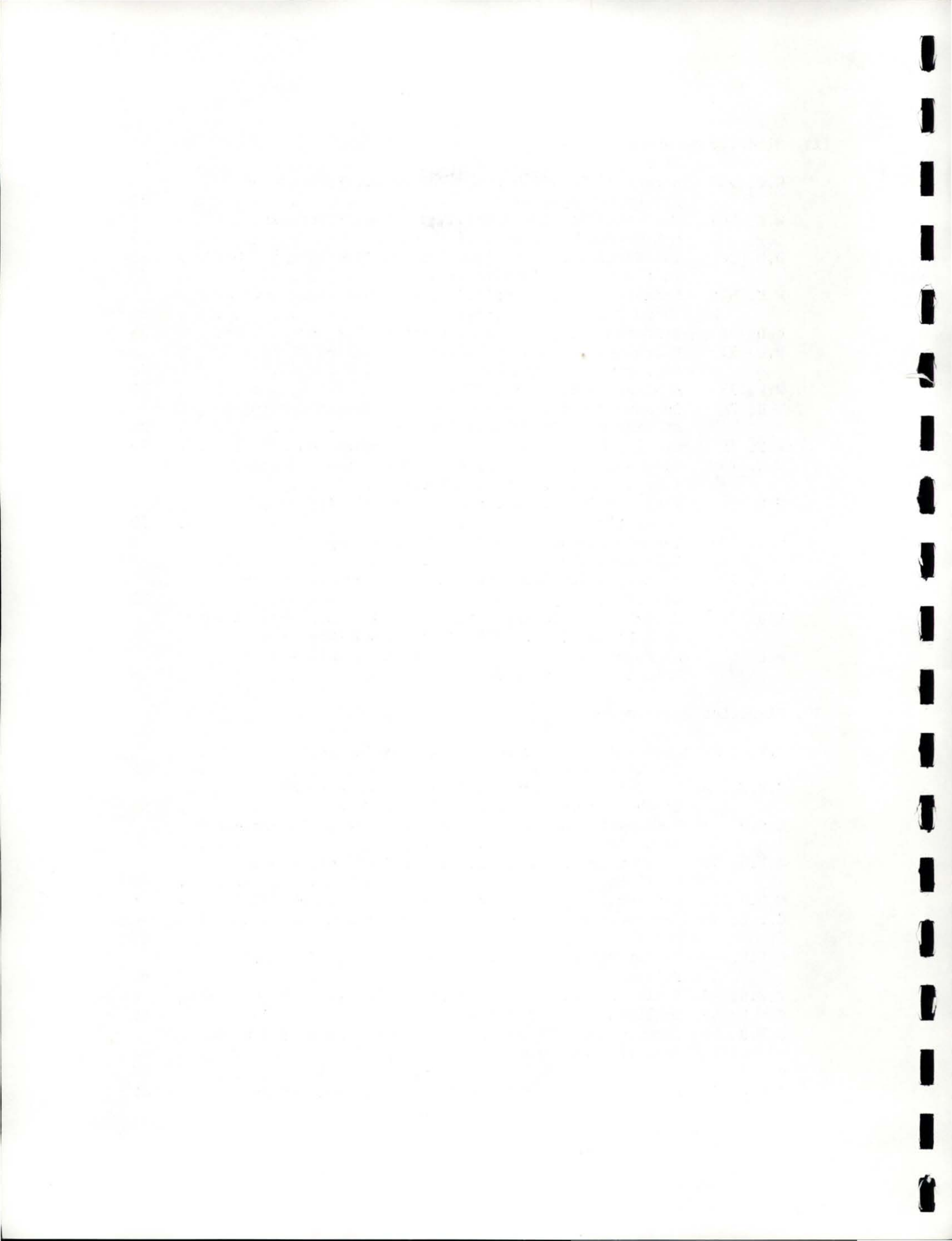
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## INTRODUCTION

The bid for the new Forestry Building was awarded to Skyline Construction Company of Salt Lake, Utah and construction is planned to begin in January, 1970.

Two staff members were added during the year. These were Michael Falter as Assistant Professor in Fisheries Management and Kenneth Sowles, Assistant Professor in Wood Utilization. Loring Jones was appointed as Instructor in Forest Management (Recreation) to replace Douglas Morrison who resigned. In addition, Roy Adams was appointed as Acting Instructor in Wood Utilization, temporarily replacing A. D. Hofstrand who was on sabbatical leave working towards his doctorate at Oregon State University. Promotions included A. D. Partridge from Associate Professor to Professor, and G. H. Belt and R. R. Knight from Assistant to Associate Professor.

The University of Idaho Wilderness Research Center became a reality with the purchase of the 65 acre Taylor Ranch in the Idaho Primitive Area. Active recruitment for the position of director of the Center was begun with Dr. Maurice Hornocker as the representative of our College on the selection committee.

New project grants included one under the Desert Biome on the International Biological program for research on growth and development in native range grasses. Support by the Food and Agriculture Organization of the United Nations (FAO) was obtained for a study of the effect on the fishery resource of impounding the Kafue River in Zambia, Africa. The report on forage resources of the public lands was completed and accepted by the Public Land Law Review Commission.

Graduate student numbers rose to 63 in the fall of 1969, exceeding the previous high of 53 in 1968. Forty five of these students held assistantships or fellowships. Masters degrees and doctorates awarded in the 1969 commencement totalled 8 and 10 respectively.

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PROGRESS FOR 1969

I. Forest Management and Wood Utilization

E.S. 6. Idaho Tree Diseases and Defects

Project Leader - A. D. Partridge

The objectives are to survey, describe, publicize and recommend controls for new or unusual diseases or defects of Idaho's trees and their products.

A survey of Dutch elm disease revealed spread only into the Boise Valley. Mortality in areas without control averaged 11% of the population. Where controlled the disease killed 0.4% of the population.

We have not induced dieback of siberian pea using field isolates from Arco in the laboratory, but sanitation and tool sterilization seem to have limited field spread.

Nectria canker of elm commonly caused the common wilt symptoms we found in northern Idaho. Eighty-seven percent of symptomatic trees yielded Nectria spp.

Borers and bark beetles associated with a purple canker of ash in southern Idaho seem linked with a Phytophthora-like fungus in the vessels.

M.S. 11. Decays of Inland-Northwestern Timber Trees

Project Leader - A. D. Partridge

Grad. Students - D. Miller

E. R. Canfield

Technicians - Mrs. Margo Gill

Mrs. Barbara Stellmon

The objectives are to delimit and describe the frequency and extent of decays, to find means for predicting and estimating decays, to outline growth requirements of the causal organisms and to find ways to reduce loss from decays.

We visited and recorded data from 165 plots during the past two summers. Trends in our data imply:

1. Armillaria mellea occurs in 67% of all trees with root rot.
2. Bark beetle infestations often occur concurrent with or subsequent to root rot, and 42% of symptomatic trees had both.
3. Echinodontium tinctorium and Fomes pini are the two fungi most frequently isolated from decadent trees.

4. Isolation success depends on the time of year, temperature, method of handling, and position of isolation. Artifact isolations commonly mask actual causes which we confirm by wood-block inoculations.
5. Traditional nutrient requirements of Cu, Fe, Mg, Zn, etc. do not hold for wood-rotting fungi in our area, and many efficiently use carbon and nitrogen from unusual and sparse sources.

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

Project Leader - C. W. Wang

Grad. Student - L. Y. Hsin  
Technician - Barbara Stellmon

Four 13-acre progeny test plantations for the improvement of ponderosa pine in southern Idaho were established in the vicinity of (1) Boise (Holcomb); (2) Idaho City; (3) New Meadows (Boulder Creek) and McCall (Jack Creek). Each plantation includes 284 open pollinated progenies in ten replications. They represent parent trees selected from six southern counties, viz.: Adams, Boise, Elmore, Gem, Idaho, and Valley.

The 5-year progeny performance observed and analyzed include individual tree measurements of height growth, diameter, initial survival, vigor, branching, damage sustained and agent. The first year and second year seedling growth was found to be positively correlated with seed weight but the height growth was not so correlated at the 5-year stage. The best progenies in 5-year height growth and vigor were isolated and will be used for control pollination and further field trials. Mother trees of the best progenies are managed for quantity seed production.

A ponderosa pine tree improvement project for northern Idaho and the Inland Empire region was initiated in 1968. The basic approach is essentially a program of half-sib family selection from the indigenous population of the Inland Empire region including Idaho north of the Salmon River. Natural stands of parent trees to be included in the program were selected and reported to the Stand Selection Committee for evaluation.

Plantation sites were selected for progeny tests under the different site conditions.

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

Project Leader - C. W. Wang

Grad. Students - Mozi Rahman  
C.C. Lin  
L.Y. Hsin

The objectives are to investigate the heritability of tree characters of economic importance and population structure in ponderosa pine.

Nanometric technique is used to measure the respiration rate of seed and seedling of ponderosa pine. Materials for this study include 1206 seed samples representing 16 western states and Canada. The purpose is to determine their innate differences in metabolism as related to the observed differences in growth rate phenology.

The most consistent result was obtained from the germinated seed with newly emerged tip of radicals measured at 30-minute intervals. In general the coastal ponderosa pine has the lowest respiration rate among the four areas tested at 86°F. Among inland ponderosa pines, the Central Rockies sources are lower in respiration rate than Idaho-Montana or Arizona sources. Other parts of seedlings tested included root tip, elongating stem, and 30-day seedling terminal. Seedling terminals show distinct differences in respiration rate, but the root tip and stem did not give meaningful results at this short observation interval.

Needles and terminal buds of ten geographic sources of ponderosa pine planted in four plantations in Oregon and Washington were analyzed for their chemical composition. The elements analyzed include N, P, K, Ca, Mg, Fe, Mn, Zn, Cu, Mo, and Na. Within each plantation the ten geographic sources differ significantly in their foliar composition. In the four plantations there are seed source x site interactions in all elements except phosphorus and sodium.

#### E.S. 58. Karyotype Analysis of the Genus *Abies*

Project Leader - C. W. Wang

Grad. Student - Lian-Yi Hsin

The objectives of this study are: (1) to observe specific and ecotypic differences in gross morphology of chromosomes and (2) to interpret the chromosomal basis of speciation and evolution of this world-wide genera.

Materials used include 15 species of true firs indigenous to North America, Asia, and Europe: (1) N. America (*Abies amabilis*, *A. balsamea*, *A. concolor*, *A. fraseri*, *A. grandis*, *A. lasiocarpa*, *A. magnifica*, and *A. procera*); (2) Asia (*Abies homolepis*, *A. kawakamii*, *A. mariesii*, and *A. veitchii*); (3) Europe (*Abies alba*, *A. cephaonica* and *A. nordmanniana*).

Preliminary results showed that  $2n = 24$  in all the fir species. However, there are considerable differences between species in the length, size and minor chromosomal features.

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

Project Leaders - H. Loewenstein and F. H. Pitkin Grad. Student - M. Coffman

The objectives are to determine the effect of ecological and physiological variations on root development of coniferous seedlings, particularly as revealed by radiotracer technique. Information obtained is then related to growth and survival of such seedlings.

A greenhouse study was conducted during the spring of 1969 to determine the effects of foliar applications of MH (maleic hydrazide) on root growth stimulation produced by soaking roots in IAA (indoleacetic acid)-IBA (indolebutyric acid) solutions. Auxin treatments containing (1) 0.5 ppm IAA, 0.05 ppm IBA, 50 ppm MH, and (2) 2.0 ppm IAA, 0.1 ppm IBA, and 0 ppm MH exhibited about  $1\frac{1}{2}$  times more root growth, shoot elongation, and bud breakage than the other treatments tested. These results indicated that MH may interfere with acropetal translocation of IAA and IBA. The phosphorus-32 isotope technique of detecting root growth did not reveal the true pattern of root growth, largely because root growth patterns, resulting from pot influences, were such that the roots rarely penetrated the region of isotope placement.

A growth chamber study conducted following the greenhouse study showed that the auxin treatment containing 0.5 ppm IAA, 0.05 IBA, and 50 ppm MH exhibited nearly twice as much root growth, shoot elongation, and bud breakage during the first 2-3 weeks than did the control treatment, although differences greatly diminished by the seventh week. Respiration and photosynthesis rates were about 6 times as great for the auxin treatment than for the control treatment for the first two weeks. Differences were negligible after two weeks. A mineral analysis of new foliage and roots revealed 20% less phosphorus and potassium in auxin treated roots than in control roots while no differences were detected between treated and untreated foliage. An analysis for calcium and magnesium showed that treated foliage had 40% more Ca and 25% more Mg than the untreated foliage, while no differences were detected between roots of treated and control seedlings.

E.S. 47. Seedling Growth and Survival in Coniferous Species

Project Leader - H. Loewenstein

Grad. Students - J. Malcolm  
D. Scanlin

The broad objective is to determine ways to improve survival and early growth of planted seedlings by investigation of the interrelationships of these factors with the environment and with the planting stock utilized.

Among remeasurements made were those involving plots established in the spring of 1967. This study involved a comparison of growth and survival of seedlings from four provenances of ponderosa pine. Also considered



was the effect of fertilizer and site preparation on planting success and seedling growth. After three growing seasons, the best survival was achieved with the Idaho City provenance planted in cleared strips without further site treatment (about 90%). About 3% of the mortality occurred in the first growing season, the other 7% coming later. Best height growth was found for the local Blanchard source on plots where the seedlings were planted in a shallow trench within the cleared strip. After three growing seasons the average height of these seedlings was about 37cm. Seedlings from the California provenance were the shortest, averaging about 26cm, for example, in trenched plots. Fertilizer, whether broadcast or placed in the planting hole, was harmful, with particularly unfavorable effects being noted in the latter treatment. The influence of these two treatments on survival persisted through the second and third growing seasons, higher mortality occurring on these plots than on those not originally receiving fertilizer. Apparently many of the trees that died on fertilized plots during the second and third growing seasons were severely weakened during the initial growing season and never recovered.

After the first growing season, the California stock seemed to be the fastest grower on this site. By the end of the third season, however, it had dropped to fourth (last) place. The importance of evaluating plantation establishment over a period of years rather than just one is clearly shown by these results.

In a second phase of this project, the effects of nitrogen level on some of the factors of growth of grand fir (*Abies grandis* (Dougl.) Lindl) are being investigated. Data obtained from nursery plots and field plantings will be supplemented by those obtained in growth chamber studies.

Two nursery beds, one of newly germinated seedlings and the other of 1:0 stock, were divided into random plots of three treatments - no additional nitrogen, 100 kilograms per hectare, and 200 kilograms per hectare. Fifteen seedlings were randomly selected from each plot and tagged for future measurements. Measurements of height, diameter and color have been made on these seedlings. Future measurements will include root and shoot mass, number of roots longer than one centimeter, height and diameter growth, shoot:root ratio, moisture percentages of shoots and roots, and chemical composition of shoots and roots.

One hundred plants from each treatment will be transplanted into the field and measurements of photosynthesis, respiration, moisture stress, and survival will be made at various times during the first growing season.

One hundred and twenty-eight seedlings were transplanted, four to a pot, and treated with one of four levels of nitrogen in a standard nutrient solution. The treatments were as follows: no nitrogen, 125 ppm nitrogen, 250 ppm nitrogen, and 375 ppm nitrogen. Treatment applications were made every other day in 100 ml doses and alternated with 100 ml applications of distilled water. One of the pots from each treatment was analyzed after two weeks. Measurements included the following: height growth, color determination, photosynthetic rate, respiratory rate, photosynthesis:

respiration ratio, dry weight of roots, dry weight of shoot, number of roots less than 1 cm, number of roots greater than 1 cm, length of tap root, average length of the 3 longest roots, shoot moisture percentage, root moisture percentage, shoot:root ratio, chemical analysis of shoots and roots. The remaining pots were analyzed in a similar manner at two week intervals for sixteen weeks.

This experiment was designed to provide a measure of variation in the above parameters and to indicate which will be most useful in assessing the effects of nitrogen on grand fir seedlings.

Data obtained to date indicate the following trends:

Height Growth. Height growth is influenced greatly by the nitrogen level of the rooting medium. The control plants (i.e., no nitrogen) had significantly less height growth than the treated plants. The highest nitrogen level showed the least growth among the treated groups, while the 125 ppm and 250 ppm treatments showed no consistent differences. Height growth is apparently a linear function of time, at least for the first few months.

Color. The control plants showed considerably lighter foliage than the treated plants. Differences among the treated plants were detectable for whole plants, but when individual needles were compared by Munsell Color Charts, the differences were less apparent.

Dry Weight of Roots. No significant differences were found among any of the treatments, but a trend was apparent after the twelfth week. Root mass increased with nitrogen level for the first three levels, but the highest level was considerably less than the control. Dry weight of the roots is primarily a linear function of time, but a quadratic term improves the accuracy of estimate.

Dry Weight of Shoots. Significant differences were found between the control plants and the treated ones, with weight of the controls considerably less than that of the treated seedlings. Shoot dry weight is also primarily a linear function of time, though a quadratic term improved the estimate.

Number of Roots Less Than One Centimeter. The number of short roots apparently is not a function of nitrogen level, as no significant differences were found among the treatments and the relative magnitudes of the means varied from week to week. Again, the number of short roots is a linear function of time.

Number of Roots Greater Than One Centimeter. The differences among the means of the various treatments were not significant until the sixteenth week, but the trend was apparent after the twelfth week. It is likely that the number of longer roots decreases as the nitrogen level increases. A larger sample size may indicate a more certain relationship. A linear function of time is indicated, with a quadratic term providing a slightly better estimate.

Length of Tap Root. No relationship is apparent between nitrogen level and length of taproot. Taproot length is strictly a linear function of time, increasing slowly with increasing time.

Average Length of the Three Longest Roots. No relationship is apparent, though a linear function of this variable with time is highly significant.

Root Moisture Percentage. Significant differences were noted among the means of the various treatments, but the relative magnitudes of the means vary from week to week, making these differences meaningless. It is impossible to tell the relationship of root moisture with time from this data.

Shoot Moisture Percentage. As with the roots, the shoot moisture percentages vary in relative magnitude from week to week. There is, however, an apparent narrowing of the range of means with increasing time. Shoot moisture percentage is a quadratic or cubic function of time.

Shoot:Root Ratio. The control plants have significantly smaller ratios than the nitrogen treated plants. The ratios among the treated plants show no consistent relationship. The ratio is apparently a cubic function of time.

E.S. 51. Use of Commercial Fertilizers on Forest Plantations and Natural Stands.

Project Leader - H. Loewenstein and F. H. Pitkin

The objective is to determine the effects of fertilization on growth and quality of major Idaho tree species.

Major work during the past year involved growth measurements of trees involved in an experiment installed in the spring of 1968. Certain trees in a thinned stand of 20 to 30 year-old Douglas fir were treated with urea at a rate equivalent to 200 lb acre nitrogen, others received a rate equivalent to 400 lb acre nitrogen, others served as controls. Control trees had an average diameter increase of 0.42 inches during the two year period after fertilization, those fertilized at the 200 lb acre nitrogen rate produced an increase of 0.48 inches, and the 400 lb/acre nitrogen rate of treatment resulted in a 0.57 inch increase. Substantial height increases also resulted from fertilization, most notably in the second year after fertilization. Control trees grew an average of 10.5 inches during 1969, 200 lb acre fertilizer nitrogen produced 14.8 inches of height increment, while the 400 lb acre rate stimulated a 14.2 inch gain. Why the 400 lb. acre rate of nitrogen application did not result in a greater height gain than the 200 lb acre rate is not presently known.

In this experiment, the stand was thinned so that no tree was closer than two meters from another. A determination was made as to whether having either 0, 1, 2, 3, or 4 competitors in the zone located 2 to 4 meters from a control or treated specimen affected growth. In this regard, no consistent trend could be found. Evidently competition at this distance was not a critical factor.

M.S. 13. Bionomics and Control of Cone and Seed Insects

Project Leader - J. A. Schenk

Grad. Student - John Dale

The objectives are to ascertain life histories and intra-and inter-specific relationships of cone and seed insects; to correlate fluctuations of insect populations to environmental factors; and to develop methods of control which cause least disruption of the ecosystem.

A general failure of the 1969 cone crop on ponderosa pine throughout Idaho, eastern Washington, and western Montana severely restricted research on the cone and seed insects of this tree species. Only two small stands of cone bearing trees were found in Idaho, and a cone beetle, Conophthorus ponderosae Hopk., destroyed 99% of the cones in one of these.

Insect Identification: The presence of both Laspeyresia miscitata and L. piperana (Kearf.) on ponderosa pine was definitely established. Spring emergence of adults from 1968 cones collected at several sites in Idaho, eastern Washington, and western Montana should provide reasonable estimates of the distribution of these two species within the sampled area.

Control: Mauget units again proved unsatisfactory for implantation of Meta-Systox-R in ponderosa pine even though the systemic was mixed with equal parts of (1) dimethyl sulfoxide (DSMO), and (2) cellosolve. The drillhole method gave satisfactory uptake of the 50% technical material without the addition of solvents. No cones were available for bio assay or residue analysis in 1969. Mauget injector units will again be tried for implantation of Meta-Systox-R into the root crown and large roots. A surface treatment will also be used on the larger roots.

Vegetational analysis: Plant associations and unions were defined for each of the collection sites. Comparisons with insect population levels may indicate the best locations for future seed orchards and seed-production areas.

STAR 34. The Influence of Condition of Grand Fir Slash on Intensity of Attack by Scolytus ventralis.

Project Leader - J. A. Schenk

This exploratory study was initiated in July 1969 with the following objectives:

1. to evaluate the influence of time of felling-bucking and complete pruning on the intensity of beetle attack in grand fir thinning or logging slash; and
2. to evaluate brood development, mortality factors, and attack behavior under the treatment conditions.

A stand of grand fir, comprising greater than 2/3 of the total basal area, was selected along Big Creek, Latah County, on land owned by Potlatch Forests, Inc. Two trees were felled at each of 3 felling dates (early June, mid-July, and August) in each of 3 replicates within the stand. At each felling date and replicate, 1 tree was topped at its 2 inch (o.b.) diameter, pruned its entire length, and bucked into a maximum of 5, 10-foot logs plus residual length. The second tree at each date and replicate was left entire and unpruned but marked at its component 10-foot logs. Total heights, d.g.l., and growth rings/last inch were recorded for each tree. Samples of bark and sapwood were taken 2 weeks after each felling from each 10-foot log, and from 6 standing trees. These standing trees also were sampled at the time of each felling. Chemical analyses were conducted by Potlatch Forests, Inc., to determine qualitative and quantitative changes over time in total starch, amylose, amylopectin and reducing and non-reducing sugars.

In late fall, a 1-foot subsample was removed from each of 3 height equivalents (5, 15 and 25 foot) along each of the 18 felled trees (9 bucked-pruned, 9 untreated). One-square foot of bark-wood surface ( $1/2 \text{ ft}^2$  top,  $1/2 \text{ ft}^2$  lower surface) of each subsample bolt was examined in the laboratory and the following attack and brood characteristics recorded: number of successful and unsuccessful attacks, cause of attack failure, total length of egg galleries, average gallery length, total number of eggs laid, egg mortality, total number of larvae (= egg hatch), larval mortality by causal agent, total number of pupae, pupal mortality, number of callow and emerged adults, and the numbers of parasites, predators, and associated insects (by species, where possible). All values were converted to numbers per  $\text{ft}^2$  of bark surface, where appropriate, to facilitate comparisons between height equivalents and treatments.

M.S. 14. Ecology of Disjunct Populations of Red Alder in Idaho.

Project Leader - F. D. Johnson

The objectives are to determine the distribution and describe the present and potential forest communities of disjunct populations of red alder (Alnus rubra Bong.) in Idaho. Also to make comparisons between these disjunct communities and previously described forest associations.

The principal phase of work this year involved a population of Cornus nuttallii associated with one of the Alnus rubra disjunct populations. Knowledge of the ecology of Cornus will aid in assessment of habitat factors peculiar to this site; further, there seems to be little

synecological and no autecological work on this species. An aerial survey was used to spot potential study sites and determine the distribution of Cornus in rugged terrain which has had virtually no human disturbance. Cornus was found to occur in all stages of fire succession on climax Thuja plicata habitats. Successful seedlings appear only under nearly complete canopy cover of conifers or Betula papyrifera. It sprouts vigorously after fire, is apparently deeprooted and occasionally reproduces by layering. Under Thuja stands, Cornus dominates the tall shrub layer in a vascular union previously undescribed for Idaho... A second area of concentration involved more intensive reconnaissance of Alnus rubra in the northern Rockies. Two new major populations were found in a combined aerial-ground survey. The recording of 12 additional vascular plants which are also disjuncts as well as reasonably exclusive to Alnus habitats supports the hypothesis that disjunct communities may also be involved here... An 80-mile stretch of the North Fork of the Clearwater River has the most extensive population of Alnus in the State, and will be the center for a community study of this species, since about two thirds of the 20 Alnus sites will be inundated when Dworshak Dam backs water in 1972... Three climatic/phenological stations were established to supplement one weather bureau and one private station which are operating in disjunct habitats.

M.S. 7. Influence of Some Physical Properties of Inland Douglas-fir on Unit Fiber Stress Under Compression Perpendicular to the Grain.

Project Leader - A. D. Hofstrand

The objectives are to investigate compression perpendicular to the grain as influenced by growth ring orientation, moisture content and specific gravity when the stress is applied at various angles to the direction of the growth rings.

A total of 425 compression tests were made on specimens from a single Douglas-fir. One hundred-seventy-five specimens were tested for each of three moisture contents - green (above 100%), 12% and 6%. Within each moisture content group, twenty-five specimens were tested for each of seven growth ring angle classifications - 0, 15, 30, 45, 60, 75, and 90° to the direction of applied stress. Data collected included; rings per inch, summerwood per cent, and specific gravity at time of test and over-dry weight. Tests were made in accordance with ASTM Standards D 143-48 modified to allow for growth ring orientation.

Statistical analysis of the data confirmed the following conclusions:

1. Regardless of moisture content of the test specimens, the Modulus of Elasticity decreased as the growth ring angle varied from 0° to 45° and then increased as this angle varied from 45° and 90°. The following regression equations can be used to predict MOE from actual growth ring angle.

Moisture Content per cent	Regression Equation	Regression Coefficient R <sup>2</sup>
Green	$Y=47,325 - .00091001 x + .001043 X^2$	0.46
12	$Y=84,457 - .00001714 x + .002071 X^2$	0.49
6	$Y=93,796 - .00002302 x + .002813 X^2$	0.69

2. Average modulus of elasticity values for green specimens were practically the same when tested at 0° and 90°F. Specimens at 12% and 6%, however, had average MOE values 9% and 26% greater when tested at 0° than those tested at 90°, respectively. This agrees with present published data with respect to compression strength of specimens tested at 0° and at 90°F.

3. Regardless of moisture content, no relationships could be found between specific gravity, rings per inch and summerwood percent and MOE, maximum compressive stress and fiber stress at proportional limit.

4. Within a given growth ring angle class, the average MOE for green test specimens was approximately 50% of those tested at 6%. The ratio of MOE at 12% to MOE at 6% varied according to the growth ring angle. Specimens tested, at 0, 15 and 90° exhibited greater average MOE value at 6% while those at 30 and 45° exhibited a lower average MOE at 6%. There appears to be no difference between average MOE values at 60 and 75°.

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

Project Leader - H. Alden

The objectives are to refine and update activity participation rates for both resident and non-resident users to refine prediction methodology for future demand; to update supply data of both the public and private sector; and to provide a more definitive need and responsive action program for future allocation of resources to outdoor recreation use in Idaho.

Virtually all data have been collected and analyzed for this study. Results are currently being prepared for publication of Idaho's updated State Outdoor Recreation Plan.

#### E.S. 57. Recreation User Preferences and Recreation Development Priorities on Potlatch Forests, Inc. Lands.

Project Leader - H. R. Alden

The objectives of this study are to assess recreation user preferences for recreation opportunities and related facilities; to estimate the future level of demand for recreation; to determine user attitudes towards Potlatch Forests, Inc. reference providing outdoor recreation opportunities; to evaluate existing recreation facilities provided by Potlatch Forests, Inc. and develop plans and cost analysis for site rehabilitation; and to evaluate several Potlatch Forests, Inc. land areas for potential recreation developments.

One season's field work collecting user preference data and information on user attitudes towards Potlatch Forests, Inc. has been completed. The data are currently being analyzed. Site evaluations of existing areas have been completed, rehabilitation plans have been developed including costs to rehabilitate.

Additional work will include user preference data collection during 1970. A landscape resource inventory procedure will be developed and applied to Potlatch Forests, Inc. land to evaluate recreation land use and management potentials.

M.S. 10a. Influence of Elk and Cattle on Reforestation.

Project Leaders - F. H. Pitkin                      Grad. Student - Fred Faulkner  
                                    R. R. Knight

The objectives of this project are to investigate animal behavior in relation to the cultural practices of reforestation and to determine the significance of trampling damage and levels of animals use that may impair seedling survival.

Field work began in late April and terminated in early September. Morning and evening observations on elk were conducted from the start of field work until July 10. Cattle were present in the study area from early June to mid-August, after which they dispersed to higher areas.

Of 500 2-0 stock ponderosa pine seedlings marked and counted every two weeks during the field season, only 208 (41.6%) survived. The primary source of mortality was attributed to drought and poor planting. Pocket gopher damage and poor seedlings (which are closely related to the drought conditions on the area) were factors of less importance.

Data from 375 randomly located seed spots (Ponderosa Pine) showed that small mammal damage inhibited seed germination and establishment. Elk observations showed 4, possibly 5, "preferred sites" consistently used by elk. These sites will be intensively studied during the next field season. The effects of trampling were found to be statistically nonsignificant.



## II. Range Management

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

Project Leader - M. Hironaka

Grad. Student - C. Green

The objective is the replacement control of medusahead with desirable perennial forage species of infested areas that are too rocky or steep to be seeded by conventional means.

Sitanion hystrix, a native perennial bunchgrass establishes naturally in medusahead infested ranges as secondary succession advances. The process is slow, however. The mechanism of this successional process is under study to gain information as to how replacement of medusahead by Sitanion and other perennials may be hastened.

In the fall of 1969, experimental plots were broadcast seeded with Sitanion at 20 seed/sq. ft. in natural medusahead stands in 2 areas. The plots were broadcast fertilized with the following rates: N33, N66, N100, P20, P80, K30, K60, N66, P40, N66 P80, N100 P80, and No Po Ko (control).

Establishment success and seedling development of Sitanion will be investigated. The nutrient cycle of the added nutrients will be followed over a 2-year period.

To determine whether addition of nitrogen at microsite of the seed is beneficial for the establishment of pubescent wheatgrass, coated or capsuled seeds were spot seeded in four medusahead stands. Each spot contained 5 coated seeds or in the case of capsulated seeds, each capsule contained 4 seeds with 0.5 or 1.0 g of 38% urea formaldehyde. Medusahead competition was not disturbed. Establishment and seedling development will be studied over a 2-year period.

## M.S. 1. Site Relationships and Productivity of Foothill Woodland-Shrub Grazing Lands In Idaho.

Project Leader - E. W. Tisdale

Grad. Students - R. W. Roberts

J. W. Burkhardt

R. S. Scheldt

The objectives are to ascertain habitat factors associated with distribution of vegetation in foothill zones, and to characterize major vegetation-soil complexes.

## (a) Juniper Vegetation

Study of vegetation dominated by western juniper (Juniperus occidentalis) in Idaho has revealed significant facts concerning the ecological status

of this species. Old stands of juniper are confined to rocky soils of ridges and escarpments. Younger stands of juniper, all under 100 years, are found on adjacent areas of deeper and much less rocky soils. These latter stands are increasing in size, and juniper is increasing its dominance within them. The young stands represent invasion by juniper into stands of sagebrush-grass vegetation.

Causal factors proposed for this "juniper invasion" include climatic change, overgrazing and fire. Investigation revealed that only fire shows a direct relationship. We found ample evidence in the form of fire scars and charcoal to indicate that fire was a major factor of the environment in the region for many years prior to white settlement. Presumably the cover of sagebrush-grass vegetation on deep, well-developed soils burned completely and frequently enough to keep juniper from becoming established. Only on bare, rocky ridges, where fuel was adequate only for patchy ground fires, could juniper establish mature stands. The establishment of white settlement marked the end of uncontrolled fire, and since that time juniper has spread steadily into adjacent sagebrush-grass ranges. This invasion has proceeded about as rapidly on lightly grazed as on overgrazed ranges, and abundance of shrub or herbaceous vegetation was found not to inhibit establishment of juniper.

For land management, it is clear that controlled grazing will not prevent juniper invasion into large areas of sagebrush-grass range, and that forage yields will be greatly reduced by this invasion. Direct control of juniper is needed to preserve grazing values on such areas, and fire is one possible method. The climax juniper type, however, presents a different situation, with open tree stands and low potential for forage production. Such stands have high watershed and esthetic value, and should be left essentially undisturbed.

#### (b) Mountain Shrub Vegetation

The area currently under study is heavily used deer winter range in the South Fork of the Boise and Payette Rivers.

Major shrub species include Prunus emarginata, P. virginiana, Amelanchier alnifolia, Philadelphus lewisii, Ceanothus velutinus, and Symphoricarpos spp. Understory vegetation includes Agropyron spicatum, Bromus tectorum, and numerous forbs.

Fire, grazing, insects, disease, and drought affect the stands. Disturbances have been so frequent that almost none of the stands being studied may be termed pristine.

In many of the stands, Bromus tectorum has replaced most of the perennial grasses, probably because of overgrazing by livestock.

Fire may be beneficial to the perpetuation of some mountain shrub species, especially Prunus spp. which sprout from the roots.

Reconnaissance data gathered during the first field season are being analyzed to separate groups of stands. Further sampling of stands within each group will be followed by an attempt to correlate stand occurrence with environmental factors such as soil moisture, aspect, soil temperature, elevation, and with disturbances such as fires, grazing, and insect attacks.

E.S.9. Ecology and Production of Sagebrush-grass Ranges.  
(W-89)

Project Leaders - E. W. Tisdale  
M. A. Fosberg  
M. Hironaka

Grad. Students - A. Qureshi  
A. Winward

The objectives of this project are to provide means for recognizing range habitats of similar potential in the sagebrush region and to be able to predict the vegetational sequence of improvement if a particular range is properly managed.

The inverse analysis approach to classification of sagebrush-grass vegetation has produced encouraging results. As a test of Q technique, data from an existing classification was reanalyzed. A similar classification was produced. The species groups generated by Q technique were internally highly correlated. When this analysis was performed on data from seral vegetation of 2 habitat-types, the species groups represented stages of succession. Work is progressing on establishing the relationships of seral stages objectively within and between habitat types.

This study included identification of subspecies and forms of Artemisia tridentata Nutt. (big sagebrush) in Idaho, and evaluation of the importance of these intraspecific separations based on environmental and behavioral differences associated with each taxon. Thin-layer chromatography was used to assist in making identifications in this group. Repeatable patterns of methanol-soluble compounds coincided with morphological characteristics and substantiated the presence of five taxonomic units of Artemisia tridentata. Cytological and phenological studies also were conducted for each taxon. Artemisia tridentata subspecies wyomingensis, A. tridentata subspecies tridentata, A. tridentata subspecies vaseyana and A. tridentata subspecies vaseyana form spiciformis were found in distinct habitats throughout the sagebrush-grass region of Idaho. An additional taxon, not previously described, was found in the west-central portion of the state. It is tentatively referred to in this study as subspecies vaseyana "form xericensis".

Ecological studies were limited to Clark and Lemhi Counties. Presence and frequency data for Artemisia and associated species assisted in recognition of eight habitat-types of big sagebrush in these two counties. Soil moisture and temperature measurements indicate that these habitat-types (from most xeric to most mesic) are arranged as follows: (1) A. subspecies wyomingensis/Stipa comata, (2) A. subspecies wyomingensis/Sitanion hystrix, (3) A. subspecies wyomingensis/Agropyron spicatum, (4) A. subspecies tridentata/Stipa comata, (5) A. subspecies vaseyana/Stipa

comata, (6) A. subspecies vaseyana/Agropyron spicatum, (7) A. subspecies vaseyana/Festuca idahoensis and (8) A. subspecies vaseyana form spiciformis/Bromus marginatus/Festuca idahoensis.

Texture, organic matter and percent calcium carbonate equivalent measurements were made on the soils of each habitat-type. Coarse soil texture was strongly related to the Stipa comata habitat-types of all three Artemisia subspecies. Organic matter varied from 3.60 pounds per square foot of solum in the wyomingensis habitat-types to 7.09 pounds in the spiciformis habitat-type. Percent calcium carbonate equivalent was consistently higher in the upper ten inches of soil of wyomingensis habitat-types, but was high only in the deeper horizons in the other habitat-types. High percentages of soil carbonates occurring below 20 inches in depth appeared to have little influence on the vegetational composition.

M.S. 12. The Effect of Climatic Factors and Grazing Intensity on the Growth, Carbohydrate Levels, and Forage Production of Crested Wheatgrass.

Project Leader - L. A. Sharp

Grad. Student - J. Reese

The objective is to determine the effect of climatic factors and grazing intensity on the growth and forage production of crested wheatgrass and to determine the effect of grazing intensity on carbohydrate levels of crested wheatgrass using etiolated growth as an index.

In 1969 infiltration rate, surface bulk density and average sodium percentage were determined from the soil of eleven exclosures and six adjacent grazed areas at the Point Springs Experimental Grazing Area in southern Idaho. No general relation of infiltration rate to grazing treatment was found and it appears that grazing by cattle did not significantly change the water infiltration rate of the soil. Grazing tended to increase surface bulk density, but the increase did not reach the significant level. Since ~~neither~~ surface bulk density nor infiltration rate showed a significant relation to grazing treatment it appears that grazing did not compact the soil at Point Springs ~~greatly~~ and therefore did not materially affect plant growth. Soil salinity (indicated by sodium percentage) was found to exert a pronounced effect on plant growth, and was considerably more important in influencing growth than was soil compaction.

E.S. 26. Evaluation of Range Seeding.

Project Leader - L. A. Sharp

Ample winter precipitation was made ineffective for forage production on the Point Springs experimental area because of cold temperatures and drying winds in April. Soil moisture was essentially exhausted by early May when temperatures became suitable for plant growth. Only 0.7 inches of precipitation fell in May and this did not contribute substantially to forage production. Forage production ranged from about 170 to 360

pounds per acre in the various pastures. Livestock response in the spring, as measured by daily gain, was less than in 1968 and averaged 1.54 pounds per day for the 56 day period. Daily gain in the fall averaged 0.76 pounds per day and slightly exceeded the long term average.

Plant reserve studies in 1969 showed that heavy spring grazing reduced organic reserves of crested wheatgrass and that fall grazing did not (under normal fall growing conditions). In a year with unusually large amounts of forage growth in the fall (1968), early fall grazing did reduce plant reserves. We also found that plant reserve levels returned to the level of ungrazed plants after only one year of rest if grazing did not occur during the reproductive period in the spring. Plants grazed during the reproductive period required more than one year of rest from grazing to reach former reserve levels.

Grazing treatment affected other growth processes of crested wheatgrass plants through its effect on reserve levels. High reserve levels favored a rapid initial rate of tillering which in turn favored a large number of tillers at the end of the growing season. This occurred because plants with rapid initial tillering rate could most efficiently use the short period of favorable soil moisture and temperature in early spring for tiller production.

Tiller numbers increased rapidly through the early part of the spring season, reached a peak just prior to the initiation of the reproductive stage and then declined. Reproductive tillers appear to compete more successfully for light moisture and nutrients than tillers which remain vegetative and thus tend to inhibit the formation of new tillers.

Forage production also appeared related to previous grazing treatment. This relationship results from the effect of grazing treatment on reserve levels. Plants with high reserves produced more tillers initially and thus had a high initial rate of forage growth. The high initial rate of forage growth tended to result in high forage production at the end of the growing season because it allowed the plants to most efficiently use the spring period for growth. Grazing had a more pronounced effect in 1969, (a year of below-normal May-June precipitation) than in 1968 (a year of average May-June precipitation).

STAR 33. A Grazing Management Program for Native Sagebrush-grass and Mountain-brush Rangeland in Southeastern Idaho.

Project Leader - L. A. Sharp

Grad. Student - W. Butler

The Idaho Citizen's Grazing Association of Caribou County through the Idaho Agricultural Extension Service and the Idaho Department of Lands requested assistance of the University in developing a program of management for the range resource that they use. Because of the variety of land ownership and land uses, and the mixture of cattle and sheep on this rangeland area, a number of aspects of land use can be studied.

The objectives of the research program initiated in the early summer of 1969 were:

To develop a livestock management program on native sagebrush-grass and mountain-brush rangeland in southeastern Idaho that will:

- a. Increase livestock output
- b. Improve and/or stabilize the resource by increasing and improving the quantity and quality of the vegetative cover.
- c. Enhance other uses of the land including recreation, hunting and fishing.

The field season of 1969 was devoted to obtaining basic information about the resource under investigation and the problems associated with the efficient use of this resource.

Data were obtained on (1) land ownership and land use within Caribou County and the area used by the Idaho Citizen's Grazing Association, (2) physical features of the area including climate, soils and vegetation, (3) livestock production practices and (4) other resource uses and values.

Approximately 39 percent of the land area in Caribou County is in Federal ownership and 10 percent is owned by the state of Idaho. All but 319 acres of the state owned land is leased for grazing. Considering that the majority of the Federal public land is used for grazing by domestic livestock and 57 percent of the privately owned land is used for grazing livestock, over three fourths of the County land area of 1,140,482 acres is grazed by domestic livestock.

The Idaho Citizen's Grazing Association lease and own 93,375 acres of rangeland in Caribou County. Approximately 88 percent of this land is leased from the state of Idaho, three percent from the Fort Hall Indian Agency and one percent from the Bureau of Land Management. Eight percent of the land is being purchased by the association on state contracts, Table 1.

Table 1. Land ownership status of the Idaho Citizens Grazing Association area.

Ownership Status	Acres	Percent of Total
State Leased Land	81,875	87.7
Indian Leased Land	2,940	3.1
BLM Leased Land	960	1.0
State Contract Purchases	7,600	8.1
Total	93,375	99.9

Additional intermingled privately owned land is grazed by members of the Association in conjunction with the association controlled land.

In 1969, the paid shares in the ICGA allowed for 6,862 cattle and 54,789 sheep to graze for a total of 66,260.9 AUM's. Actual use amounted to 6,066 cattle and 27,083 sheep or about 44,339 AUM's.

Information on the vegetational characteristics of the study area was gathered by the research team during the summer of 1969. Plant collections, species lists, phenological development, forage production, and samples for chemical determination of the nutrient content were types of information obtained in 1969. The Soil Conservation Service at Pocatello has made available site descriptions of the study area.

Livestock production practices were ascertained through interviews with members of the Idaho Citizens Grazing Association and questionnaires sent to the membership. The size of cattle operations are given in Table 2 and wintering areas of operators using Idaho Grazing Association lands are given in Table 3.

Table 2. Size of cattle operations on the Idaho Citizens Grazing Association.

Number of Mature Animals	Number of Operators	Percent of Operators
0	2	6
1-49	6	18
50-99	6	18
100-199	14	41
200-399	5	15
400+	1	3
Total	34	101 <sup>a</sup> / <sub>1</sub>

Source: 1969 Livestock Data Questionnaire

<sup>a</sup>/ Total exceeds 100% due to rounded values.

Table 3. Wintering areas of cattle using Idaho Citizens Grazing Association lands.

Wintering Area	Number of Operators	Cattle Shares	Percent of Cattle Shares
Caribou County	27	2,397	56
Idaho - except Caribou County	11	1,850	43
Utah - Nevada	1	40	1
Total	39	4,287	100

Source: Livestock operator interviews.

Of the cattle operators interviewed, the majority reside in Caribou County and fifty-six percent of the cattle permitted to graze on ICGA range are wintered in Caribou County (Table 3).

Most cattle ranchers start feeding hay about December 1 and feed until the animals move to ICGA range in mid-May. Some ranchers, however, have spring grazing permits on BLM land at lower elevations and graze these areas before coming to the ICGA range.

Calving begins in early March and the bulk of the cows have calved by mid-May. Bulls are turned on the range about June 1 and stay with the cows until late September.

After roundup in late September, the Chesterfield land and livestock ranchers use privately owned fields to graze their animals for two to three weeks. Some operators move their animals to leased land or to Indian leased lands. Following this, most of the cattle move to ranch headquarters to graze crop aftermath and begin the winter feeding period.

Pregnancy testing of cows in the fall is a common practice. Culling practices vary among operators. Some cull only those animals that are not bred and others cull all animals that will not calve until after July 1 of the following year. Additional cows may be culled on the basis of age, past production, and/or conformation. The number of animals culled yearly from a herd varies from about ten to twenty percent.

About half of the cattlemen regularly feed protein supplement in block form during the winter. About forty percent of the ranchers interviewed do not feed a protein supplement other than hay during the winter period.

Sheep operations that use the ICGA lands are typical ewe-lamb operations except for one yearling operator. Five of the seven ewe-lamb operations lamb on the range beginning in May. Two operators lamb in February and March under shed conditions.

The average size ewe-lamb sheep operation consists of about 3402 head of ewes, with a range from less than 2,000 head to over 6,000.

The sheep operators move their animals to the ICGA range land about May 1. The range-lambing operations begin lambing at this time. In early July the sheep move from ICGA range land to the Cache and Caribou National Forests. About one-half the operators track their sheep to the National Forest areas and the others are trailed. Lambs are weaned and sold in mid-September as the sheep are moved from National Forest land back to the ICGA range where they remain until about November 1. Most of the sheep are then trailed across Fort Hall Indian Reservation lands on their way to land administered by the BLM. All the sheep are wintered outside of Caribou County. Privately owned and leased land generally provide feed and forage for the sheep beginning in late December. Shed lambing operations move to the lambing sheds in late January or early February. In late



March or early April the sheep move from the wintering areas to the public lands of the BLM, across the Indian Reservation lands in late April and arrive on the ICGA range about the first of May.

Recreational values in the forms of hunting, fishing, camping and esthetics are also important. Mule deer and elk, are the principal big game species. Sage grouse, sharptail grouse, ducks and geese comprise the harvestable upland bird and waterfowl populations. The area is also extremely important for nesting of the greater sandhill crane, a rare subspecies.

Fishing and the attendant camping is mainly important on the Blackfoot River Reservoir, the Blackfoot River, the Little Blackfoot River and Corral Creek.

There appears to be little or no conflict at this time between the livestock and recreational use of the lands leased and owned by the ICGA.

Phosphate deposits and phosphate mining activities have an impact on the grazing use of parts of the area used by the ICGA.

## III. WILDLIFE MANAGEMENT

## W.U. 56. Effect of Prescribed Burning on Nutritive Value of Key Browse Species.

Project Leader - K.E. Hungerford

Grad. Student - D.A. Asherin

The objectives are (1) to ascertain the effects of prescribed burning on the nutritive value of key browse species; (2) to define the burning temperatures of prescribed burns in relation to subsequent reproduction of plant species and survival of existing browse species; and (3) to compare big game use of burned and unburned areas in relation to nutrient changes.

Relative use of burned and unburned areas was compared at the Hatter Creek deer enclosure. Pellet group counts were made on belt transects located both perpendicular and parallel to the contour of the slope. Results are listed in Table 1.

Table 1. A comparison of relative use of burned and unburned sites by white-tailed deer at the Hatter Creek enclosure, October, 1969.

Type of Area Sampled	No. Transects Counted	Area Counted (acres)	No. Deer Pellet Groups Tallied	Pellet Groups per Acre
Fall burn (1968)	42	3815	167	438
Unburned No. 1 (adjacent to 1968 Fall burn)	10	2	20	100
Spring Burn (1969)	42	3815	132	346
Unburned No. 2 (No burned area adjacent)	10	2	13	65

Sixty browse samples were collected on the Avery and Hatter Creek study areas and have been oven-dried, ground, and sent off for chemical analysis.

Three new study sites were located near the confluence of Boulder Creek and the Lochsa River on the Lochsa Ranger District of the Clearwater National Forest. These include areas which were prescribe-burned in the springs of 1967, 1968 and 1969. In addition, one new study site, a 1967 spring burn, was located in the Hammond Creek drainage of the St. Joe National Forest.

Frequency and density data were taken on these four new stands as well as on two previously located stands in the Avery study area. Each stand was sampled at 25 randomly located points in both the burned area and in an unburned area nearby. These data are in the process of being analyzed.

W.U. 58a. The Maintenance and Function of Territoriality in a Mountain Lion Population.

Project Leader - M. G. Hornocker                      Grad. Student - J. C. Seidensticker  
Assistant    W. Wiles

We have now reached the point where more refined techniques must be employed to obtain information of a specific nature. This phase of the work will involve the use of radiotelemetry which will enable us to gather data otherwise unobtainable. The objectives are (1) to instrument with radio transmitters selected individuals in an established population of mountain lions; (2) to simultaneously monitor the daily, weekly, and seasonal movements and activities of instrumented lions; (3) to assess information on activity and movement in relation to territoriality and determine its significance in mountain lion population dynamics; and (4) to obtain specific information on food habits and to interpret the importance of these data in the dynamics of both the lion and its prey populations.

The radio-tracking system was thoroughly tested and evaluated. Further developmental work is underway on components that did not meet requirements.

W.U. 60. The Ecology and Herbivore Use of Five Mountain Meadows in the Idaho Primitive Area.

Project Leader - P. D. Dalke                              Grad. Student - L. D. Wing

The objectives are to describe the general characteristics, vegetation and herbivore use of mountain meadows representative of those found on the Big Creek Ranger District in the Idaho Primitive Area.

Resident herds of elk (Cervus canadensis nelsoni), pack and saddle animals, and Columbia ground squirrels (Citellus columbianus) were the principal herbivores. Vegetation was typed as "wet", "moist", "dry", and "very dry" according to prevailing soil moisture. Soil moisture percentages ranged from 3 to 15 in the dry type, 10 to 60 in the moist type, and 35 to 300 in the wet type. Wet type soils remained saturated throughout the summer; moist type soils were saturated during early summer, but dried on the surface by mid-July. Dry type soils were well-drained, and low in moisture content most of the summer. The percentage of area occupied by the wet, moist, dry, and very dry types was 49.6, 38.2, 10.1, and 3.1 respectively. The percentage of ground covered by vegetation, excluding mosses, was 36.0, 48.7, 58.8, and 68.7 for the

very dry, dry, moist, and wet cover types respectively. The very dry type was dominated by forbs, the dry and moist types by nearly equal proportions of grasses and forbs, and the wet type by sedges. Pounds of air-dried forage production per acre averaged 354, 2,167, 2,076, and 3,237 for the very dry, dry, moist, and wet cover types respectively. Average pounds of forage removed per acre varied between meadows from: 46 to 248 for ground squirrels, 62 to 680 for elk, and 117 to 353 for horses. Ground squirrels removed nearly equal amounts of forage from the dry, moist, and wet cover types. Approximately 70 percent of all forage used by elk came from the moist cover type, 26 percent from the dry, and 4 percent from the wet. Horses obtained 40 percent of their forage from each of the wet and moist cover types, and 20 percent from the dry. The percentage of forage removed varied from 17.8 to 55.6 on the dry type, 12.5 to 33.1 on the moist type, and 2.9 to 22.6 on the wet type. Elk use of meadows was highest during June, dropped during the summer, and was rare by late August. Elk activity was maximum from 5 to 11 p.m. and minimum from 11 a.m. to 5 p.m. Forbs were the most frequently used plants by elk with sedges second, grasses third, and shrubs last. Heaviest use of sedges occurred early in the summer during their blooming period. Heaviest use of both grasses and forbs occurred between July 7th and 31st. Forb utilization was greatest near the full bloom period, but use of grasses occurred well in advance of blooming.

W.U. 62a. Behavior of White-tailed Deer Within Three Northern Idaho Plant Associations.

Project Leader - K. E. Hungerford      Grad. Student - V. W. Howard, Jr.

The objectives are (1) to determine uses of three plant associations by white-tailed deer with (a) changes in local climatic factors and (b) hours of daylight and darkness; (2) to evaluate neon blinkers, bells and radio transmitters as aids for ascertaining the activities of white-tailed deer; and (3) to determine the responses of white-tailed deer to "predators".

Eleven individual deer, which were captured and marked with numbered ear-tags and collars, were observed to determine deer behavior. The collars used in the study were neon blinker collars with no. 8 copper sheep bells, Swiss bells, and transistorized radio transmitters.

The deer in the 20-acre enclosures had a rhythmic pattern of feeding and bedding throughout the nights. This usually consisted of a feeding period starting before and extending past sunset, three bedding periods separated by two feeding periods during the night hours, and a fourth feeding period which began before sunrise and extended into the early daylight hours. Changes in the weather influenced this pattern. On some nights, the deer bedded only twice while on others they bedded four times. Individual deer had different feeding and bedding periods. High winds (20 mph or more) and rainstorms were the two weather factors most disruptive to the deer's nocturnal behavior.

Radio-tracked deer showed a definite selection for particular cover types within the enclosure. This was significantly different between summers. The deer also spent much more time bedded in 1967 than in 1968, particularly during the latter one-half of the summer. Average minimum home range in 1967 was 40.2 acres while in 1968 it was 64.9 acres.

White-tailed deer apparently seek cool areas during the summer months. During the summer of 1967, the deer concentrated along the valleys which had noticeably lower average temperatures than did the surrounding ridges. Need for water was not the cause of this concentration since water was available at distances less than one-half mile from any place within the enclosure. The animals did not concentrate in the valleys in the summer of 1968 when the ridge-tops were either cooler or only slightly warmer than the valleys.

Two kinds of bells provided most of the observational data. Neon blinkers were helpful only if the animals were in openings. The blinker collars made it possible to determine more details about deer behavior on dark nights. Radio-tracking within the 20-acre behavior pens was not practical since the observer had to continually change locations to triangulate the deer's locations. This movement often alarmed deer when the observer was at ranges of 35 yards or less.

Radio-tracking was useful in determining the nocturnal behavior of deer within the main Hatter Creek Enclosure. Six deer that were radio-tracked had rhythmic nocturnal feeding and bedding periods similar to those of the animals in the two 20-acre behavior pens.

The deer in the East Pen did not show an escape response to either man or man with dog(s) as long as these did not directly approach the animals. The deer were aware of the presence of the disturbance and would stand or be at attention if they had previously been bedded. (The deer possibly were familiar with dogs since hounds frequently chased bobcats and black bear in the vicinity.) They had a definite escape response to the introduction of the three cougars into the 1.5-acre pen which adjoined their pen. The deer pen adjusted to the presence of the cougars during the 62 days the latter remained in the 1.5-acre pen.

Three of the four deer that were equipped with transmitter, shifted their home ranges in 1968 after the cougars were released into the 1.5-acre pen. One of the animals, a two-year old buck, also shifted his home range a second time as a result of continued disturbance from man. The deer did not return to their previous home ranges, during the study period, after the disturbances were discontinued.

## W.U. 71. Effects of Logging on Patterns of Elk Use.

Project Leader - R. R. Knight

Grad. Student - J. L. Davis

The objectives are (1) to ascertain the effect a controlled logging operation has on the elk calving habitat and on the pattern of elk use in the South Fork of Moyer Creek; and (2) to obtain information about the number of elk using the area for calving and the specific habits of the elk while in the study area.

I conducted a two year study in eastern Idaho to assess the effects of controlled logging on the patterns of elk use and to obtain additional information on elk ecology. Data collected during (March-July, 1968) and after (March-July, 1969) logging were compared by Chi-square tests. The number of elk observed, in the same number of trips, and the number of pellet groups counted during the two years showed no significant difference in total elk use of the control and treated areas combined. Both types of counts showed that the two control areas received significantly less use after logging, one of the treated areas received the same amount of use and one received more use. Sampling intensity for the pellet group counts were significant at the 95% confidence level for an error risk of .10 of the mean. Calving occurred in the same area during both years.

Forage utilization, measured by clipping and weighing vegetation on 1/1000 acre plots, showed less than 10% forage removal on the heaviest used areas on spring and summer range. Soil disturbance by elk trampling was not attributed to spring range deterioration. Examination of 57 feeding sites showed that elk utilized a large number of plant species during the spring and summer depending primarily on availability and phenology.

## W.U. 72. Status of Introduced California Bighorn Sheep in Owyhee County, Idaho.

Project Leader - M. G. Hornocker

Grad. Student - J. Drewek, Jr.

The objectives are (1) to determine population size, structure, and productivity of the Owyhee sheep herd; (2) to describe the habitat; and (3) to determine those factors acting both favorably and unfavorably upon bighorn numbers.

Scabies disease was a primary cause in the extirpation of the original Owyhee bighorn herd. The ranges of two subspecies of bighorn sheep, Ovis canadensis canadensis and O. c. californiana, met and possibly overlapped in the area of Owyhee County.

Thirty-eight bighorns of the subspecies californiana were reintroduced into the East Fork of the Owyhee River from 1963 through 1966. A minimum of 80 bighorns of all classes were present in the area as of November, 1969. The actual population lags the theoretical maximum population by two or three years, due primarily to poor reproductive success or survival of lambs in the first years after the releases. In the years of the study there were good lamb crops with excellent survival through the first year of life. The herd's structure in 1969 were as follows:

Ewe : Lamb : Yearling : Ram

100 : 77 : 77 : 54

Lungworm infested the entire heat, but no other serious parasites were identified. Predation was an insignificant factor. Competition on the range came chiefly from domestic cattle and mule deer. Winter ranges were judged to be in good condition. Three cases of bighorn mortality were discovered, but cause of death in all cases was unknown.

The bighorns had dispersed a maximum distance of less than 15 miles in any direction from the release site. About 80% of the population wintered along the north rim of the Owyhee canyon west of Battle Creek, with a few small groups utilizing lower Battle Creek and a small portion of the Deep Creek drainage. The animals became well distributed over their total range through the summer.

Most behavior of the Owyhee bighorns was typical of the species reported elsewhere. Rams occurred on the ewe range in all seasons; they showed interest in the ewes, but were ignored except during the rut. The Owyhee bighorn sheep herd was well established, and appeared to be an expanding one.

#### W.U. 73. Ecology of the Golden Eagle

Project Leader - M. G. Hornocker

Grad. Student - J. Beecham

Assistant V. Ogden

The objectives are (1) to determine population size, structure and density; (2) to determine productivity, nesting success, and mortality factors; (3) to determine food habits; and (4) to attempt to isolate factors acting to regulate eagle population numbers.

The nesting ecology of the golden eagle (Aquila chrysaetos) was studied in southwestern Idaho during 1968 and 1969. Twenty-five breeding pairs of eagles were located in 1968 and 36 in 1969. Nesting success for the 1969 breeding season was 61 percent. During this season 22 pairs of eagles laid an average of 2.1 eggs per eyrie. The average hatch per eyrie per nesting attempt in 1969 was 1.3 eaglets. The average number of eaglets fledged per successful nest was 1.5 and 1.4 in 1968 and 1969,

respectively. In 1969 0.9 eaglets fledged per eyrie per nesting attempt. Human interference accounted for 5 of 9 mortalities.

Four hundred eighty-three prey items collected during 1968 and 1969 were identified. Black-tail jackrabbits and desert cottontails dominated the prey taken. I banded 70 eaglets during the study; 45 of these were fitted with individually color-coded neck markers. One bank return was received from northern California. The incubation period for one pair of eagles was 43 days. Adult eagles brooded their young until the eaglets were approximately  $2\frac{1}{2}$  weeks old. One hundred seventeen observations of 5 eaglets from 3 eyries were made during the 1968 field season. Two eaglets remained in the vicinity of their nest for approximately 3 months after fledging.

W.U. 74. Redstem Ceanothus Response to Cutting and Burning at Different Phenological Stages

Project Leader - R. R. Knight

Grad. Student - W. O. Hickey

The objectives are (1) to determine the phenological stage at which cutting the crown of redstem plants will produce the greatest quantity of vigorous sprouts; (2) to ascertain what changes take place in annual production when the crowns of redstem plants are killed at different phenological stages; and (3) to compare the sprouting and annual production of redstem plants treated by cutting and burning at the same growth stage.

Weighing and measuring of redstem twigs collected last fall were completed. The twigs were stratified into length classes. Sample size for computing an average twig weight for each length class was determined by using the formula  $N = S^2T^2/d^2$  (Shafer 1963). Twig weights in each length class were analyzed by using a desk computer programmed to solve the above formula.

Samples collected for each length class were adequate, except for the 78 to 117 cm class. An additional 13 twigs were collected for this class.

The 50 redstem plants marked for the late-format treatment were treated March 25 by cutting them off at the root crown with a large pruning shears.

During the summer, the bud-active cutting, fire treatments and full-bloom cutting treatment were applied. A portable propane torch was used to burn 50 plants. The stems of each plant were burned at ground level until charred, but no attempt was made to burn them in two.



An average twig weight of 1.571 grams, was computed from the twig weight data. Annual production was then computed for each plant by multiplying the number of annual twigs per plant times the average weight. The largest plant produced 1041.57 grams of annual growth last year.

Twenty twigs were measured periodically to determine when annual growth was completed. By the third week in August the terminal buds appeared to be dormant and growth had stopped. However, current sprouts were still growing. The after-stem-elongation treatment was applied by cutting 50 plants off at the root crown.

During October I collected the post-treatment data from plants treated at the following phenologic stages: late-dormant, bud-active, and full-bloom.

Most plants sprouted. The data collected from the plants that sprouted include average crown diameter, maximum and average sprout height, number of sprouts per plant, and number of twigs per sprout.

During the application of each cutting treatment I made annual ring counts of the larger live stems. Oldest stem ages for the 250 plants sampled varied from 3 to 18 years average 9.3 years.

After computing an average twig weight (1.57 g) from a random sample, I computed the pre-treatment annual production for all plants. Average annual production per plant (summer 1968) ranged from 172 to 316 g. (air dry) with an over-all average of 214 g.

Twigs 7 to 35.5 cm long made up 70 percent of those collected. This same group of twigs contributed only 30 percent of the average twig weight. Twigs grouped into the 36 to 63.5 cm class contributed 25 percent of the sample and 47 percent of the average twig weight. Twigs 64 to 117.5 cm long made up 4 percent of the sample and 23 percent of the average weight.

A highly significant (.01 level) difference was found between the total production for subplots. A significant (.05 level) difference existed between total production for locations and production of plants on a subplot.

#### W.U. 75. Density Regulation in a Bobcat Population.

Project Leader - M. G. Hornocker      Grad. Student - T. N. Bailey

The objectives are (1) to calculate seasonal and annual variations in bobcat densities; (2) to discover the influences of food, habitat, interspecific competition, and social behavior in regulating bobcat densities; and (3) to learn how these influences operate by measuring natality, mortality, and dispersion in a bobcat population.

Trapping was confined to the northern section of the Craters site during June. A total of 453 trap nights yielded only one bobcat which escaped before the traps were checked.

Two bobcats were captured on the Craters site: an adult male on July 4, and an adult female on July 22. Since both bobcats were captured unharmed in unpadded traps and another escaped for the second time from a padded trap, the padding will be removed from all traps.

Three bobcats were captured on the NRTS site: an adult male on July 3, a female kitten on July 30, and an adult male on August 4. The first male was accidentally killed. Attempts to capture the kitten's mother and littermates were unsuccessful.

Bobcats were given intramuscular injections of Sernylan (phencyclidine hydrochloride) at a concentration of 100 mg. of drug per c.c. of solution. Dosages were calculated from estimates of the bobcats' weights. The first bobcat was killed with a drug overdose because I was unfamiliar with the uncoordinated, lunging movements that bobcats make while under the influence of the drug.

The first effect of the drug on bobcats was increased salivation followed by lying down. All bobcats panted rapidly even if placed in the shade. Vigorous lunging movements occurred 20 to 30 minutes after injection. The duration between these periods of activity varied from 10 to 45 minutes until the bobcat regained its footing. Bobcats often walked in circles and bumped into objects until they became better coordinated. They often sought shady areas to rest in during the final stages of recovery.

The importance of rabbits in the diet was evident by the number of rabbit remains found at an active bobcat den on the NRTS site; no remains of any other prey items were found. The rabbit populations on both areas were sampled by driving along trail roads and counting the number of rabbits observed in the road. Counts were made between sunset and complete darkness. Rabbits were rare in the northern Craters sections and abundant on the NRTS site along the Big Lost River.

Small rodent populations were sampled in each cover type where I trapped bobcats. Snap traps were set about 10 feet apart in transect lines. These preliminary findings indicate that small rodents are more abundant on the NRTS site than on the Craters.

Twelve bobcats were tagged on the NRTS study area from October to December. No bobcats were captured on the Craters of the Moon study area, but an adult male tagged there on July 4 was captured by a fur trapper on December 23 near Martin, about 2.5 miles from the initial capture location.

Tracking bobcats in the snow on the NRTS area indicates that where prey is abundant, bobcats seldom move great distances from areas of shelter such as caves, old craters and other rocky areas. The role of bobcat feces and urine in territorial marking remains obscure as both covered and uncovered bobcat scats have been found, but urine spraying on rocks and bushes has been noted. Evidence from tracking also indicates that some bobcat family groups still remain together in mid-winter.

Bobcat sign on the Craters study area was rare. Bobcat prey was scarce on the Craters compared to the NRTS area at this time of the year; therefore, bobcats may leave the Craters area.

Jackrabbits and cottontails continued to be the most frequently found bobcat prey items on the NRTS. A bobcat den located in October had the remains of 22 jackrabbits, 5 cottontails, 4 kangaroo rats and 3 chipmunks in the vicinity of the den. Five instances of bobcats feeding on sage grouse have been recorded in an area where a large concentration of grouse is wintering.

W.U. 76. Adaptability of Japanese Northern Green Pheasants Introduced Into Northern Idaho.

Project Leader - E. G. Bizeau

Grad. Student - R. A. Adair

The objectives are (1) to determine nesting habits and brood care; (2) to obtain dispersal information; (3) to ascertain food habits; and (4) to evaluate survival through winter.

Food habits, reproduction, dispersal, and survival of 1,002 Japanese green pheasants introduced in the Minaloosa Valley, Beneway County, Idaho were studied from April 1969 to March 1970.

Spring foods consisted of green plant parts, waste grain, and early maturing seeds. In summer, animal matter amounted to 15.9% by volume of all food consumed. Grasshoppers were the most important animal food. Important plant items included hawthorn fruits, spring beauty seeds, wheat, oats, barley and snowberry fruits. Fall and winter foods were waste grain, weed seeds, and grain and hay at livestock feed lots.

Minimum size was established for the territories of 16 cocks. Mean minimum territory size was 7.1 acres.

Average clutch size of the 20 nests found was 6.5. Nesting preference was for hayfields. Average brood size was 5.7 for 12 broods observed. Broods remained together for 8 to 10 weeks.

Most birds remained within a mile of the release site. The maximum movement recorded was 9.5 air miles.

Survival was poor. Of 1,002 birds released from April to November 1969, an estimated 50 birds remained in the study area by March 8, 1970. Predation by goshawks, great horned owls, domestic cats and coyotes was high.

Ten hens were radio-tracked and home ranges ascertained for 3 hens.

W.U. 77. Physiological Values and Disease in Bighorn Sheep Populations.

Project Leader - K. E. Hungerford      Grad. Student - A. W. Franzmann

The objectives are (1) to establish the general health status of the bighorn sheep; (2) to determine the presence of specific diseases in bighorn sheep; (3) to establish normal physiological values in bighorn sheep; and (4) to evaluate clinical and laboratory procedures in their application to bighorn sheep disease studies.

The following bighorn sheep populations were sampled during 1969: 5 Rocky Mountain bighorns at Wasa, B. C. on feeding trials. This group was sampled 3 times this quarter. 24 California bighorns at Okanogan game farm, Penticton, B. C.; 12 Rocky Mountain bighorns at Banff, Alberta.

Blood samples from these have been analyzed and recorded. A computer program for handling the data and correlating individual values with herd conditions is being prepared.

M.S. 10b. The Effects of the Northern Pocket Gopher on Reforestation:  
Activity and Movement.

Project Leaders - K. E. Hungerford      Grad. Student - L. E. Kuck  
F. H. Pitkin

The objectives are (1) to ascertain type and extent of pocket gopher damage to ponderosa pine and Douglas-fir seedlings; (2) to evaluate pocket gophers as an influence related to other seedling mortality factors; (3) to correlate pocket gopher movements with the time of year tree seedling damage occurs; and (4) to correlate pocket gopher activity with surface indicators, as a technique for approximating gopher populations.

The study area was located on a ten-year old forest burn near Headquarters, Idaho.

Pocket gophers were the primary source of mortality for seeded ponderosa pine. Drought and frost heaving accounted for nearly three-quarters of the Douglas-fir mortality. The only form of pocket gopher damage to seeded plants was by incidental burying of seedlings by gopher earth casts during winter.

The influence of pocket gophers on planted seedlings was second only to planting losses. Ten percent of the plantings were lost to pocket gophers during the first year after planting. Planted seedlings became an important food source for gophers when preferred forbs were scarce in late summer and winter.

Individual pocket gophers were tagged with the radionuclide tantalum-182 and tracked with a scintillation counter to determine activity and movement. Daily activity was strongly diurnal with some activity occurring throughout the day. A short-term rhythm pattern was exhibited by gophers with rest periods longer than activity periods.

Summer activity for twenty marked gophers was directly related to available soil moisture after the first week in July. Prior to this date there was no correlation between activity and soil moisture. The activity of pocket gophers decreased during the summer to a point to suggest that some individuals estivated.

Seasonal movement showed that distance traveled remained constant during the summer. There was no correlation between seasonal movement and activity. Generally adult females and juveniles were more active and moved farther than adult males.

Estimates of home ranges of pocket gophers varied considerably between individuals and with techniques used. All home ranges expressed in area showed that adult males traversed a larger area than adult females and juveniles. The home ranges appeared to be linear in shape.

Centers of activity and standard diameters of activity were determined for the marked gophers. Adult males used less area than adult females and juveniles. There was no difference between adult females and juveniles. Pocket gophers spend 50 percent of their time in less than four percent of their home range.

W.U. 78. Ecology of the Greater Sandhill Crane in Southeastern Idaho.

Project Leader - E. G. Bizeau

Grad. Student - R. C. Drewien

The objectives are (1) to describe the daily and seasonal movement, behaviour, distribution and density of the crane population breeding in Southeastern Idaho; (2) to examine crane reproduction and preferred

breeding habitat requirements; (3) to delimit factors influencing crane population dynamics, including distribution and habitat requirements of both breeding and non-breeding segments of the population; and (4) to evaluate crane depredation on small grain crops in the vicinity of Grays Lake, Idaho.

Field work was initiated in mid-June with the study centered in the vicinity of Grays Lake National Wildlife Refuge in southeastern Idaho.

Production: Aerial surveys in mid-July showed 365 pairs of which 93 (25.5%) were accompanied by broods. Since field work was initiated after most nesting had terminated, the status of pairs without broods was not determined. Many of these pairs may consist of immature non-breeders that have established pair bonds.

Four active nests were visited during June. Two of these were located in baltic rush, Juncus balticus, one in a mixed stand of cattail-bulrush, Typha latifolia-Scirpus acutus, and one in a mixed stand of sedge, Carex sp. and willow, Salix sp. Three nests hatched successfully.

Of 93 broods observed during the mid-July survey, 84 had both parents in attendance and were considered complete broods. The 84 broods averaged 1.50 young. Size of non-flying broods at Grays Lake averaged 1.59 young. Size of flying broods averaged 1.45 young.

These data suggest that relatively little chick mortality occurred from the time observations were initiated in mid-June to flight stage. Seven broods containing 2 chicks each were color-marked when 35-50 days old. All 7 broods reached flight stage without any loss.

The aerial survey in mid-July showed 45 broods. However, 26 non-flying broods were color-marked at Grays Lake and observations showed that they comprised about 40 percent of the non-flying broods. Based upon this I estimated that a minimum of 65 non-flying broods were present in the Grays Lake area during the latter part of July and early August.

Fifty-seven cranes were captured and individually marked with colored 2" to 3" square nylon tags attached above the tibio-tarsal joint. Ten adults, 10 juveniles, and 37 local chicks were captured. Fifty-three cranes were captured at Grays Lake while the remaining 4 were caught 10 to 17 miles southeast along tributaries of the Blackfoot River. Twenty-six cranes were captured by night-lighting while 31 chicks were captured on foot during July and August.

In recent years an increasing number of crane depredations on small grain have occurred in major staging areas in eastern Idaho. In order to evaluate crane use of small grain fields in the Grays Lake area, 17 fields were selected along the east and south shores and censused weekly from mid-June through early September.

Counts showed that cranes started frequenting grain fields in early August with a steady increase in use occurring throughout August and early September. Increased use of grain fields in August coincided with the time that most broods started flying and cranes became more gregarious. Flying broods and their parents, and non-breeders, left summering areas lacking adjacent grain fields and concentrated in the south and east portions of Grays Lake near grain fields.

Grain fields most susceptible to depredations were usually within two miles of Grays Lake and often had an adjacent water source. Creeks, irrigation ditches, and stock watering areas all served as crane loafing sites during the day between trips to adjacent grain. Fields immediately adjacent to these favored water areas suffered damage from trampling by cranes.

Crane, and to a lesser extent Canada geese, depredations at Grays Lake, Blackfoot Reservoir, Bear River Valley, Bear Lake area, and Teton Basin are perennial problems and to date have not received adequate attention. Some ranchers have taken it upon themselves to minimize depredations by harassing both cranes and geese with gunfire. The harassment effects on cranes from gunfire are minimal; they often returned shortly after being disturbed. Although many individuals are apparently only attempting to scare birds, some are being shot.

W.U. 79. Effect of Field Applications of Selected Insecticides on a Population of Wild Ring-necked Pheasants.

Project Leader - E. G. Bizeau

Grad. Student - J. P. Messick

The objectives are (1) to evaluate the effects of agricultural pesticide use on ring-necked pheasant behavior, survival, and reproduction; and (2) to monitor pesticide residues in pheasants, their eggs, in associated soils, and pheasant foods.

During the period July through August, 1969, samples of pheasant eggs and pheasant adipose, liver and brain tissues were collected for pesticide residue analysis. Soil samples and samples of principal pheasant foods were also collected. A portion of these samples was taken from the primary study area, Gold Island, in Canyon County, Idaho. No pesticides have been used there for a number of years. Sampling was also done on two other no-pesticide-use areas, Deer Flat National Wildlife Refuge, and the Jordan Dairy Farm near Caldwell, Idaho. Sampling was carried out on four farms selected as heavy pesticide-use areas.

All pesticide residue analyses were conducted by the laboratory staff of the Canyon County Community Pesticide Study. A total of 87 pheasant eggs representing 33 nests were submitted for residue analysis. Only one or two eggs were taken from each active nest. A larger number of eggs were collected from nests that had been abandoned or destroyed.

Twenty-seven pheasants ranging in age from a few hours to adult were collected and specified tissues removed for analysis.

Eighteen soil samples and 5 pheasant food samples were collected. Some testing of Markusen radio tracking equipment was performed and a tentative pesticide spray program was formulated for use on Gold Island in 1970.

The Denver Wildlife Research Laboratory measured the thickness of 31 eggshells. This shell thickness data will be useful in evaluating the effects of pesticides on calcium metabolism.

W.U. 80. Maximum Sustained Yield of Enclosed White-tailed Deer in Northern Idaho.

Project Leader - R. R. Knight

Grad. Student - G. C. Will

The objectives are (1) to ascertain the maximum sustained yield of white-tailed deer in a representative coniferous forest of northern Idaho; and (2) to elicit a positive population response through intensive management.

Much of the field work was directed toward censusing the white-tailed deer population. Several inventory techniques, including the drive, the Hahn deer-cruise, and the Lincoln Index were used.

On October 18, I conducted a drive census in which 35 deer were counted. The census was only moderately successful. Because of the dense vegetation and several large gaps in the drive line, many deer escaped detection. One doe was accidentally killed during the drive when she hit the enclosure fence.

Eight linear transects were marked through the enclosure to census the deer population using Hahn's deer-cruise census technique. I tested the usefulness of this technique in November after a walking trail was cleared through the dense brush along the center line of one transect. I walked the transect several times during the late evening, but counted no deer. Other attempts to census the population by this technique will be made during the winter and spring months.

The Lincoln Index will provide a relatively good estimate of the total population when 50 to 75 percent of the individuals are marked. Three bucks and two does were captured in Clover traps, marked with aluminum ear tags and neck bands and returned to the population. I removed one canine from each deer for age classification using Gilbert's method of preparing the tooth and counting the annuli in the cementum layer.



Harvest: An attempt was made to harvest 35 percent of the fall population. Organized and controlled hunts were conducted on 11 different days. Hunters were asked to hunt as they normally would outside the enclosure. A total of 112 sportsmen hunted 615 1/4 hours and averaged 5 1/2 hours per hunting trip. For the entire hunting season, hunters saw 66 deer (12 fork-antlered bucks, 33 does, 1 fawn, and 20 unclassified), fired 46 shots, and killed 3 bucks and 2 does. The average hunting time required to kill one deer was 123 hours. There was no known crippling loss. I collected lower jaws from all harvested deer for age classification and all female reproductive tracts for determination of past and present reproductive success.

## IV. Fisheries Management

## C.F.U. 3. Evaluation of Methods for Increasing Native Cutthroat Stocks in Northern Idaho.

Project Leaders - T. C. Bjornn	Grad. Students - G. Rankel
C. MacPhee	G. Reid
	K. Ball

The objectives are to devise management techniques for increasing the catchable stocks of Yellowstone cutthroat trout in northern Idaho.

Recent declines in harvest of cutthroat trout (Salmo clarki) on the St. Joe River were found to be due to reductions in population caused by increased access and harvest. Investigations of the life history of squawfish (Ptychocheilus oregonensis) did not show any significant impact on creel-size trout populations. Seines, explosives and angling were used to collect 679 specimens of squawfish. The scales of 106 of these were studied for data on age and growth. Female squawfish were found to live longer than the male, and attains a larger size, but both sexes mature at age class V. Juvenile squawfish were found to school and rear in slow-water areas, mainly sloughs.

Studies of angler catch in northern Idaho showed a preponderance (92%) of juvenile steelhead (Salmo gairdneri) with cutthroat trout making up most of the remainder. Anglers spent 4.8-10.5 hours catching each cutthroat, and 60% of them preferred to catch a few large fish rather than many smaller ones. Eighty-five percent of anglers were residents and 75 percent were male.

## C.F.U. 3a. The Impact of Northern Squawfish on Planted Rainbow Trout and Wild Cutthroat Trout.

Project Leader - C. MacPhee	Grad. Student - G. Reid
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The objectives are: (1) to determine the impact of eradication of northern squawfish with regard to the following: (a) survival of fingerling and creel-size rainbow trout, (b) distribution of rainbow fingerling; (2) to determine the impact of relatively small numbers of adult squawfish which migrate seasonally upstream on wild populations of resident creel-size cutthroat trout; and (3) to determine the rate of re-infestation of squawfish in river areas in which the fish has been selectively poisoned.

The lower stretch of the fast water of the St. Joe River (Marble Creek to St. Joe City) was selected to determine the impact of large squawfish on the survival and distribution of trout. Because this part of the river contained few wild fingerling trout, 157,000 rainbow fingerlings were planted each year of the study. In addition, the Idaho Fish and Game Department stocked about 7,000 creel-size rainbow each year as part of their stocking program.

The discovery of squoxin (1,1'-methylenedi-2-naphthol) provided a tool for eradicating squawfish without harm to other species of fish or fish food organisms. Skin-divers counted fish at selected observation stations in the 22-mile treatment area for all three summers and in an upriver 25-mile stretch between Gold Creek and Avery for the summer of 1969.

Over four times as many fingerling rainbow occurred during the treatment summer as compared with the average of the control summers.

The counts of creel-size rainbow trout about doubled in 1968 and about quadrupled in 1969 as compared with 1967, suggesting considerable winter carry-over of fingerling trout.

Squawfish were observed in the upper 25-mile study area between July 30 and September 2, 1969, however, none were seen as early as July 18 or as late as September 27. No correlation existed between the relatively small numbers of large squawfish and the abundance of creel-size cutthroat and rainbow trout.

After poisoning the St. Joe River, the skin divers observed only a few squawfish in the upper portion of the treatment area which, presumably, had migrated downstream from the unpoisoned area above. However, the river was re-infested the following summer after the June squawfish spawning run. Similarly except for one sample out of 35 samples taken intermittently throughout the summer at five different stations, no large squawfish were found in the St. Maries River, a tributary of the St. Joe River, after a June treatment in 1969. Apparently, squawfish do not move upriver during the summer months after their spawning run is finished.

#### C.F.U. 3b. Feeding Responses and Food Assimilation in Northern Squawfish.

Project Leader - C. MacPhee

Grad. Student - M. Falter

Experimentally determined digestive rates of squawfish from the St. Joe River system in northern Idaho were used to assess daily rations for squawfish from the system. Digestive rates varied with temperature. Digestive rates at average summer stream temperatures were 3 to 4 times the rates at winter stream temperatures. Digestive rates were inversely proportional to squawfish size for all food items tested (cutthroat trout, redbside shiners, and stonefly nymphs). There were no apparent differences in digestibility of cutthroat and shiners. Stonefly food items were digested more slowly than were cutthroat and shiners but this may have been due to an exchange of stonefly tissue for a digestive fluid complex; the complex then remaining within the still intact exoskeleton. Water velocity had no effects upon digestive rates since there were no significant differences between digestive rates in vats and digestive rates in an artificial stream channel. Prior feeding or starvation was found to have no significant effects on digestive rates. These digestive rate data were applied to field-collected stomachs to interpret

ingestion times, hence feeding rates of squawfish in the St. Joe and St. Maries Rivers.

Examination of 449 stomachs showed marked size-related differences in food preference: (1) small squawfish (<19 cm T.L.) fed primarily on insects, ologochaetes, and plant material; (2) medium squawfish (21 to 36 cm T.L.) had a similar diet but with a high proportion of fish in summer months; (3) large squawfish (>36 cm T.L.) fed primarily on fish and crayfish. No trout were found in any of the stomachs, probably because of habitat segregation between trout and squawfish and the large ratio of squawfish to trout in the system. Daily rations increased from small, through medium, to large fish. Small and medium squawfish may be food-limited in fall, winter, and spring months. Daily rations ranged from a yearly high of 1.45% in June to a low of 0.1 - 0.2% in the fall and spring months and presumably in the winter months also. Daily rations of fish collected from fastwater areas were higher than those from slackwater in the summer, but similar throughout the rest of the year. Total yearly rations were 178.4%, 211.1%, and 274.8% for small, medium, and large squawfish, respectively. Further research is recommended on squawfish stock size, growth rates, and utilization by other species in these rivers in order to quantify the role of squawfish in the system.

#### C.F.U. 3c. Interaction of Brook Trout and Cutthroat Trout in Small Streams.

Project Leader - D. W. Chapman

Grad. Student - J. Griffith

Since their introduction into Idaho about 75 years ago, brook trout have been expanding their range and displacing or replacing native cutthroat. To study this interaction, field studies were made on the two species living separately and together to assess the extent of overlap in habitat selection and diet, and laboratory studies were made to assess behavioral differences.

Results indicate that members of the two species communicate with similar behavioral signals. In all study streams brook trout emerged before cutthroat and maintained a 20 mm size advantage over cutthroat of the same age groups throughout their lives. Underyearling members of the two species were spatially segregated by different habitat selection, particularly water depth, and chances for interaction were minimized.

Older brook and cutthroat trout occupied focal points in significantly different water velocities, with cutthroat in higher velocities, but considerable interspecific overlap occurred with respect to other habitat characteristics. However, brook trout initiated significantly fewer aggressive encounters under experimental conditions than did equal sized cutthroat and do not seem capable of displacing cutthroat behaviorally.

Diet studies are in progress.

## C.F.U. 4a. Serological Separation of Races of Chinook Salmon.

Project Leader - D. W. Chapman

Grad. Student - Carl Armour

The objective is identification of races of chinook salmon in mixed stocks. The project was conducted as a pilot study to assess the feasibility of distinguishing races by characteristics of their serum.

A study was conducted to assess feasibility of identifying races of spring chinook salmon (Oncorhynchus tshawytscha) by qualitative properties of serum proteins. In 1967 blood was obtained from adults of three races of salmon in Idaho. The fish were indigenous to the Lemhi River, the upper Salmon River, and the headwaters of the Middle Fork of the Salmon River. Sera were compared by immunodiffusion and immunoelectrophoresis. No qualitative inter-racial differences of proteins were detected. Females had an antigen not found in males.

In 1968 sera of adult salmon of Rapid River, Idaho and the Willamette River of Oregon were studied. Samples of individual fish could be identified as to racial origin by comparison of immunoelectrophoretic patterns of an albumin. Polymorphism tests indicated the inter-racial albumin difference was quantitative. Total protein concentrations of sera of the two groups of adults were not significantly different at the 5% level. Sera of juvenile salmon of the two races were also compared by immunoelectrophoresis, but albumins of the two groups were indistinguishable. However, sera of Willamette River juveniles typically had an antigen in the globulin zone not common to sera of Rapid River juveniles. The difference in the albumin of Willamette River adults was attributed to unknown causes, and the globulin difference of juveniles was attributed to their immunological response to pathogens. Jacks of Rapid River and Lemhi River races were sampled again in 1968, and sera samples of individual fish were compared. The immunoprecipitate unique to pooled antigens from Rapid River jack samples collected in 1967 was present in similar frequencies in sera from fish of both groups. Apparent lack of the antigen in serum of a fish was caused by the protein being present in low titer.

It was concluded that immunoelectrophoresis and immunodiffusion will not readily reveal qualitative differences of races of salmon.

## C.F.U. 4b. Interaction of Juvenile Chinook Salmon and Steelhead Trout.

Project Leader - D. W. Chapman

Grad. Student - F. H. Everest

The objectives are (1) define the ecological demands for physical habitat of juvenile chinook salmon and steelhead trout, and (2) assess the extent of interaction for physical habitat between these species.

Investigations of the spatial requirements of juvenile spring and summer chinook salmon and steelhead trout were made to define their preferences and interactions for physical habitat. All data were collected by divers from two Idaho streams. A survey of 2840 m<sup>2</sup> of habitat in 1966 indicated that during summer coexisting populations of these species are segregated. Age 0 steelhead were most abundant over rubble substrate at velocities and depths of less than 0.15 m/sec and 0.15 m, respectively; densities of age 0 chinook were maximal over silt substrate at velocities of less than 0.15 m/sec and depths of 0.15-0.3 m; age I steelhead were most abundant over large rubble substrate at bottom velocities and surface velocities of 0.15-0.3 m/sec and 0.75-0.9 m/sec, respectively, and depths of 0.6-0.75 m. In 1967, habitat occupied by allopatric populations of each species was sampled to see if segregation was the result of interspecific interaction. The results did not demonstrate an interactive segregative mechanism, and indicated that the presence of one species had little impact on distribution of the other. Juvenile chinook and steelhead of the same size were found to have similar ecological demands. But, steelhead spawn in spring and chinook spawn in early fall, creating intra- and interspecific size groups of pre-smolts and minimizing the potential for interaction. Individuals of both species hibernate in rocky areas of the stream bottom (particle size >40 cm) in winter.

C.F.U. 4c. Behavior of Idaho Fishes. C. Factors Affecting Downstream Movement of Chinook Salmon.

Project Leader - D. W. Chapman

Grad. Student - W. H. Miller

The objectives are to determine if (1) upstream density, (2) temperature, (3) food, and (4) race of fish are factors in chinook salmon fry emigration.

Emigration of chinook salmon fry was studied in artificial stream channels. In spring and early summer of 1966, 1967 and 1968, chinook fry were introduced into various channels and their response to different environmental factors by the number and percent of volitional downstream movers, upstream movers (where upstream movement was monitored) and "residents" were evaluated. Time lapse from beginning to end of each test varied from one to seven days for the different tests. Factors tested included (1) density of fry population, (2) physical and visual isolation, (3) food, (4) bottom type, (5) moonlight strength, (6) temperature, (7) water source, and (8) race of fish.

C.F.U. 4d. Distribution and Behavior of Idaho Fishes: D. Yield of Seaward Migrant Chinook Salmon and Steelhead.

Project Leader - T. C. Bjornn

Steelhead trout fry released into Big Springs Creek rear for two years before migrating to the ocean. Survival from fry to smolt ranged from 1.6

to 2.2 percent. A good positive correlation exists between fry released and yield of migrants. Evaluation of the effects of introduction of chinook salmon into the creek on the yield of steelhead trout smolts will be facilitated by the correlation.

The yield of both sub-yearling and yearling steelhead trout continued to be proportionate to the number of fry released. The number of 1965 year class smolts leaving the upper Lemhi River was 2,850 down from 4,800 of the 1964 year class.

The 1968 run of chinook salmon was the largest number (1,943) counted at the Lemhi weir since counting began in 1964. Fish which had spent three winters in the ocean comprised 60 percent of the run. Jacks (1 year in the ocean) comprised the usual small percentage of the run (2 percent).

A correlation between spawners and fry and smolt abundance exists which indicates an escapement on the Lemhi River of more than 1000 redds may be needed to maximize yield of smolts. Additional years of data with large escapements are needed to verify or reject the theory that larger escapements will lead to more smolts.

C.F.U. 4e. Distribution and Behavior of Idaho Fishes: E. Smallmouth Bass Ecology.

Project Leader - D. W. Chapman

Grad. Students - J. F. Keating  
G. L. Munther

The objectives are (1) to assess distributional behavior of smallmouth bass; (2) to assess growth rates, life history, and food habits of smallmouth bass; (3) to predict possible impacts of water impounding upon ecology of smallmouth bass.

Movements and distribution of smallmouth bass, Micropterus dolomieu, was studied in the middle Snake River. Seventy-six per cent of tagged bass recovered after being free at least seven days were recovered in the same pool in which they were tagged. Of those that had moved, 71 per cent had moved less than 1200 m. Movement that occurred inter-seasonally was, in part, due to changes in habitat preference at different seasons. In spring smallmouth occupied warm shallow pools as well as the main river channel and in summer they occupied pools, eddies and slow runs having a broken rock substrate. During late fall and winter smallmouth occupied still pools at least 3 m deep and under laboratory conditions went beneath the substrate when temperatures were below 6.7°-7.8°C. During summer smallmouth moved throughout an entire pool, associating with the edge of the current during early morning. During midday some moved into quiet surface waters, and in late afternoon were similarly located, but those that were not associated with the edge of the current were in deeper water than at midday. At night they laid on or beneath a broken rock substrate in quiet water.

Smallmouth bass from the study sections of the Snake, Clearwater, and Salmon Rivers grew slowly (approximately 85 mm the first year and 60 mm in the next two years) compared with other smallmouth bass populations reported in the literature.

Bass from the warmer, more fertile upper Snake River section grew slightly faster than those in the lower Snake River, the Clearwater River and the Salmon River in their first three years of life, but bass from the latter sections grew faster in older age classes and all populations reached approximately 300 mm total length by the end of their sixth year. Bass over six years old grew at reduced rates of 12 to 20 millimeters a year through age class nine. Crowded and indistinct annuli prevented me from accurately determining age from scales with more than 8 or 9 annuli; however, I estimated from 10 to 15 annuli on the few scales available from "lunker" bass 381 to 521 mm long.

Growth increments of bass did not vary with normal, minor fluctuations in the annual sums of degree days over 10 C in three growth-temperature comparisons made and I concluded that other environmental factors, such as inter- or intra-specific competition, overrode any benefits that occur in these river sections in warmer years.

Annual thermal sums of the Clearwater River approached minimum sums of waters listed by Coble, 1967. A reduction of only 2 C in daily water temperature of the Clearwater River by dam regulation during four summer months would reduce the annual thermal sum from 1,000 to below 800 degree days and could adversely affect bass growth and survival.

Smallmouth bass in the Snake River feed predominately on crayfish while those in the Clearwater River and Salmon River rely heavily on fish and to a lesser degree on insects. The variation in food habits is due to food availability as crayfish are abundant in the Snake River and scarce in the Clearwater and Salmon Rivers.

Further study is needed to explain why smallmouth bass in the 50 percent warmer, more fertile, "better" appearing bass habitat of the Snake River do not grow faster than bass in the "poor" habitat of the Clearwater River.

C.F.U. 4f. Distribution and Behavior of Idaho Fishes: F. Interaction of Hatchery-planted Catchable Trout and Juvenile Anadromous Fish.

Project Leader - T. C. Bjornn

Grad. Student - H. Pollard

A study was undertaken during the summer of 1968 to assess the effects of angling and planted trout on wild juvenile steelhead trout in the upper tributaries of the Clearwater River. A large proportion of the juvenile steelhead in a stream can be removed by angling. The presence of hatchery-reared, catchable-size rainbow trout did not affect the



angling harvest of juvenile steelhead trout. Angling removal caused declines in the fish populations of catch-remove study sections. The number of fish observed in unfished sections did not decline. Catch declined proportionately with population. Recolonization of fished-out areas occurred. Steelhead smolt production might be increased by curtailing the fishery. Angling was selective for larger juvenile steelhead in the test sections, but had no detectable effect on the average size of fish in subsequent samples because fished-out areas were recolonized by fish which were the same size as fish which were removed. When a large number of fish are removed throughout the stream, the average size of fish in the catch may become smaller. Recapture of marked fish was low due to adverse effects of the marking procedure and/or migration of fish from the study sections. The interactions between hatchery rainbow trout and juvenile steelhead trout were reduced by differences in size and habitat preferences. The density and distribution of wild juvenile steelhead trout was changed somewhat by the hatchery trout released into study sections. Too few marked fish were recovered to assess growth and movement under the various different conditions of the study.

C.F.U. 4g. Distribution and Behavior of Idaho Fishes: G. Production of Fish in Two Streams in Idaho.

Project Leader - T. C. Bjornn

Grad. Student - W. H. Goodnight

Fish production (tissue elaboration) was estimated in Big Springs Creek and the Lemhi River, tributaries of the Salmon River in Idaho. Annual production in Big Springs Creek reached  $11.8 \text{ g/m}^2/\text{yr}$ . Eighty-eight percent of this production came from rainbow-steelhead (Salmo gairdneri). I estimated annual production in the Lemhi River as  $13.6 \text{ g/m}^2/\text{yr}$ ., of which whitefish contributed 52% (Prosopium williamsoni). In Big Springs Creek the contribution of species to production closely paralleled contribution to total standing crop. However, the species that dominated total biomass (whitefish) did not efficiently produce fish flesh, probably because older age groups predominated in this species. Forty-five percent of the tissue produced in Big Springs Creek by age 0 and age 1 rainbow-steelhead was realized as smolt yield (production/yield = 2.2).

C.F.U. 5. Influence of Logging on Ecology of Trout Streams.

Project Leader - C. MacPhee

Grad. Student - J. Edgington

The objectives were to test the hypothesis that "no change occurs in the ecology of two northern Idaho trout streams from logging."

The effects of logging were monitored from 1955 through 1966, in two study locations each with test and control streams. Eight percent of one test basin was logged and no effect was shown to have occurred in stream bottom invertebrates or water quality characteristics.

Ninety-seven percent of another basin was gradually logged in small settings. An impact on the stream ecology was noted in early years of observation from siltation due mainly to road construction. Abundance of four orders of stream insects declined during the middle years (1958-1962) and then recovered gradually by 1966. A decline in insect abundance due to siltation was noted only for the order Plecoptera.

Timing and method of timber harvest are credited for the moderate effect of logging on stream ecology in both test watersheds.

C.F.U. 6. Economic and Angular Preference Survey of Sport Fisheries in (STAR 15) Idaho.

Project Leader - T. C. Bjornm

Grad. Student - D. Gordon

A questionnaire survey was conducted in 1968 to assess: (1) gross annual expenditures associated with Idaho sport fisheries, (2) net value of high quality Idaho sport fishery resources and (3) distribution of fishing effort in Idaho. We mailed 9317 questionnaires to resident and non-resident anglers, over a 12 month period, and received 45.1% of them in usable form.

The results indicated that resident Idaho anglers spent \$8,488,000 on durable equipment items used for fishing in 1968. Resident and non-resident anglers spent an additional \$11,086,000 within State boundaries on transfer costs associated with fishing trips in 1968. Gross expenditures of Idaho anglers, including license fees of \$1,429,000 was approximately \$21,000,000.

An estimated 2,939,000 angling days were spent in Idaho in 1968. Fishing pressure was relatively evenly distributed (ranging from 14% to 23% total days fished) among Fishery Management Areas, but 60% of the total transfer costs were expended in two areas with high quality fisheries.

Resident anglers accounted for 60% of the total license sales, 42% of the transfer cost expenditures, and 77% of the total days fished. Non-resident anglers bought 50% of the licenses, accounted for only 23% of the days fished, but spent 58% of the transfer costs. Resident anglers fished an average of 12 days, and spent an estimated \$2.04 per day. Non-residents averaged 5 days fishing in Idaho and spent \$9.67 per day.

A net annual economic value of \$4,650,000 was calculated for eight Idaho sport fisheries which attracted many anglers. Consumer surplus for the eight fisheries, or the net annual benefit realized by anglers under present non-market conditions, was estimated to be \$9,435,000. Using the calculated net economic value and the standard national water project interest rate of 4 3/4%, we estimated the capitalized value of the eight

fisheries to be about \$100,000,000. Since the eight fisheries accounted for only 1,320,000 of 2,939,000 angling days in Idaho, estimated net economic, consumer surplus, and capitalized values must be considered minimal.

We also conducted a questionnaire survey to ascertain the preferences, opinions, and behavior of anglers utilizing Idaho sport fishery resources in 1967. We mailed out 10,014 questionnaires to resident and non-resident anglers, and received 57.4 percent of them in usable form.

A majority of anglers, particularly non-residents, preferred to catch a moderate number of medium sized fish rather than many small ones or a few large ones. A significant majority (80%) of the respondents expressed satisfaction with present Idaho bag limits. Approximately two thirds of all respondents fished in streams for trout, and over one half fished in lakes for salmonids. Participation in the other fishery segments ranged from 10 to 20 percent of the anglers sampled.

A majority of anglers preferred to see pre-smolt steelhead protected in rearing areas rather than accept losses due to angling. When offered a choice between a restricted catch of "native" trout and supplemental stocking of hatchery fish, about half the respondents chose each alternative indicating a substantial interest in native stocks. The majority of anglers thought fishing-for-fun (catch-and-release), a worthwhile idea and indicated they would try it.

Many indicated they would pay more to maintain or improve specific sport fisheries in Idaho. Many respondents, who did not participate in a fishery, indicated they would pay to help support that particular resource. The majority of respondents expressed satisfaction with present Idaho non-resident license fees. More respondents would like to see greater emphasis placed on hatchery fish production, closely followed by research and evaluation, then rough fish control. Anglers assigned relatively low priorities to public access and reservoir construction for fishing.

Most respondents were satisfied with the quality of hatchery fish, but wanted the size increased more than any other aspect listed. If restrictions are necessary to limit the harvest of fish, a significant majority prefer to see bag limits reduced rather than shorter seasons or restricted methods. Three quarters of the respondents used bait, slightly more than half used lures, and less than half used flies while fishing in Idaho.

The angler of the future will likely accept the concept of paying more for his fisheries recreation, assign high priorities to hatchery fish production, rough fish control, and research and evaluation, and approve of fishing-for-fun programs.

## C.F.U. 7. A Lethal Index for Classifying Chemicals Which Affect Water Quality.

Project Leader - C. MacPhee

Grad. Student - D. E. Norman

The objectives were (1) to arrange common toxic chemicals which have known physiological effects on fish into broad physiological categories by calculating lethal indices, (2) to use these indices as standards or references to classify chemicals by physiological effect for which the lethal causes are not yet known, and (3) to investigate the effect of water temperature as a variable on the value of the lethal index.

Seventeen toxic chemicals were bioassayed to investigate the possibility of measurable physiological responses to death in northern squawfish. Lethal indices, dependent upon concentration and temperature for each chemical, in terms of time between loss of equilibrium and death, were established.

The physiological process of suffocation caused by the action of heavy metals and organic compounds of lactic acid, formaldehyde, and p-nitrophenol was identifiable and unaffected by concentration or temperature. The anesthetic effect of p-chlorophenol was discrete and also unaffected by concentration or temperature. The physiological actions of nitrites, other phenols, chlorinated hydrocarbons, and organophosphorus compounds were not discretely identifiable and the data indicate multiple physiological effects for these chemicals depending on concentration.

## C.F.U. 8. Ecology of Fish in the Kafue River, Zambia.

Project Leader - D. W. Chapman

Grad. Students - R. Dudley  
W. H. Miller  
R. Scully

The University of Idaho, through the Cooperative Fishery Unit, College of Forestry, is conducting a study of fish populations in Zambia. The work is designed to predict and minimize effects of a hydropower dam on the commercially-important fishes of the Kafue River. Three graduate students in fisheries are spending 18 months on the Kafue River. They will return to the University of Idaho in September 1970. The research in Zambia is financed by the Food and Agricultural Organization of the United Nations.

C.F.U. 9. Steelhead Migration in Relation to Water Quality in the Snake River, Idaho-Washington.

Project Leader - C. M. Falter

Grad. Students - Milton Daily  
Karl Johnson  
Technician - Rudy R. Ringe

This study was begun in January, 1969 and is sponsored by the Federal Water Pollution Control Administration. The work is part of an expanding program to assess environmental impact of water development projects in the Northwest.

The free-flowing Snake River downstream from Lewiston, Idaho is scheduled for impoundment in 1975 by a pool backed up behind Lower Granite Dam. Water quality is expected to change in the new reservoir due to impoundment alone. Pollution inputs from various sources in the Lewiston-Clarkston area are also expected to adversely affect water quality to an unknown extent. Inputs to the river are from an 800 ton/day Kraft pulp mill, meat packing plants, food processors, feed lots, and primarily treated domestic sewage. Effects of these conditions upon upstream migration of adult steelhead trout will be studied.

Correlations of water quality prior to impoundment with steelhead migration rates, movement patterns and behavior were made throughout 1969.

The quality of water entering the study area is high, with significant deterioration at Lewiston-Clarkston. The water below these cities shows a significant decline in oxygen and increases in total dissolved solids, tannins and lignins, ammonia, sulfates, biological oxygen demand, and turbidity.

Twenty four adult steelhead were fitted with ultrasonic transmitters in 1969 and their individual travel paths through the study area plotted. The fish showed some degree of avoidance of waste-carrying water below the confluence of the Snake and Clearwater Rivers.

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APPENDIX A. F.W.R. EXPERIMENT STATION STAFFI. Regular Staff Members

Ernest Wohletz, Director and Professor (Forest Management)  
E. W. Tisdale, Associate Director and Professor (Range Management)  
R. D. Adams, Acting Instructor (Wood Utilization)  
H. R. Alden, Associate Professor (Forest Recreation)  
G. H. Belt, Associate Professor (Watershed Management)  
E. G. Bizeau, Assistant Leader Cooperative Wildlife Research Unit and  
Assistant Professor (Wildlife Management)  
T. C. Bjornn, Assistant Leader, Cooperative Fisheries Unit and Associate  
Professor (Fisheries Management)  
D. W. Chapman, Leader, Cooperative Fisheries Unit and Professor  
(Fisheries Management)  
M. E. Deters, Professor (Forest Management)  
C. M. Falter, Assistant Professor (Fisheries Management)  
M. Hironaka, Associate Professor (Range Management)  
\*A. D. Hofstrand, Assistant Professor (Wood Utilization)  
M. G. Hornocker, Leader, Cooperative Wildlife Research Unit and Associate  
Professor (Wildlife Management)  
J. P. Howe, Professor (Wood Utilization)  
K. E. Hungerford, Professor (Wildlife Management)  
F. D. Johnson, Associate Professor (Forest Management)  
L. M. Jones, Instructor (Forest Recreation)  
R. R. Knight, Associate Professor (Wildlife Management)  
H. Loewenstein, Professor (Forest Soils)  
C. MacPhee, Professor (Fisheries Management)  
D. Morrison, Instructor (Forest Recreation) Resigned July, 1969  
A. D. Partridge, Professor (Forest Pathology)  
F. H. Pitkin, Associate Professor (Forest Management) and Nurseryman  
J. A. Schenk, Associate Professor (Forest Entomology)  
R. H. Seale, Professor and Associate Dean (Forest Management)  
L. A. Sharp, Professor (Range Management)  
K. Sowles, Assistant Professor (Wood Utilization)  
A. R. Tiedemann, Acting Assistant Professor (Range Management)  
C. W. Wang, Professor (Forest Genetics)

\* on sabbatical leave starting September, 1969.

II. Graduate Assistants

Robert Adair - Wildlife  
Carl Armour - Fisheries  
Kent Ball - Fisheries  
John Beecham - Wildlife Management  
Scott Brown - Wood Utilization  
Wayne Burkhardt - Range Management  
Wally Butler - Range Management  
Michael Coffman - Ecology and Silviculture  
Kin Daily - Fisheries  
John Dale - Forest Entomology  
James Davis - Wildlife Management  
Rod Drewein - Wildlife Management  
John Drewek - Wildlife Management  
Fred Everest - Fisheries  
Fred Faulkner - Wildlife Management  
Bill Goodnight - Fisheries  
Doug Gordon - Fisheries  
Curtis Green - Range Management  
Dan Green - Forest Management  
John Herbst - Watershed Management  
Bill Hickey - Wildlife Management  
Volney Howard - Wildlife Management  
L. Y. Hsin - Forest Genetics  
Steve Judd - Wildlife Management  
Mike Kochert - Wildlife Management  
Lon Kuck - Wildlife Management  
John Messick - Wildlife Management  
James Miller - Range Management  
Bill Miller - Fisheries  
Herb Pollard - Fisheries  
Gary Rankel - Fisheries  
George Reid - Fisheries  
Bob Roberts - Range Management  
David Scanlin - Forest Soils  
Steve Scheldt - Range Management  
John Seidensticker - Wildlife Management  
Roy Snyder - Wildlife Management  
Bob Steele - Forest Ecology  
David VanLear - Forest Soils  
Gary Will - Wildlife Management  
Larry Wing - Wildlife Management

III. Other Fellowships (N.D.E.A., A.I.D., etc.)

Duane Asherin - Wildlife Management  
Dean Aulerich - Forest Management  
Ted Bailey - Wildlife Management  
Mike Beach - Forest Management  
George Briggs - Range Management  
Elmer Canfield - Forest Pathology  
Chung-hsien Chen - Wood Utilization  
Richard Dudley - Fisheries  
C. Michael Falter - Fisheries  
John Francis - Soils  
Albert Franzmann - Wildlife Management  
Jack Griffith - Fisheries  
Robert Hursey - Wood Utilization  
Chia-Tsang Liu - Forest Genetics  
M. Anwar Qureshi - Range Management  
Jerry Reese - Range Management  
Brent Ritchie - Wildlife Management  
Laren Roper - Forest Ecology  
Richard Scully - Fisheries  
Alma Winward - Range Management

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT

1. University of Idaho, Forest, Wildlife and Range Experiment Station.
2. University of Idaho short term applied research funds (Star).
3. University of Idaho Water Resources Institute. Support for fisheries and watershed projects.
4. Boise-Cascade Company. Assistance in forest genetics research.
5. Idaho Dept. of Public Lands. Support and facilities for forest genetics research, and forest planting studies.
6. Idaho State Fish and Game Department. Regular support for the Cooperative Wildlife and Fisheries Units.
7. Inland Empire Paper Company. Labor, equipment and field accommodations for work on tree hybridization, seedling survival and forest fertilization.
8. Potlatch Forests, Inc. Potlatch Research Fellowship, and field sites for work on tree hybridization, seedling survival and forest fertilization.
9. Northern Idaho and Southern Idaho Forestry Associations. Financial support for forest genetics research.
10. United States Bureau of Commercial Fisheries. Funds for research on determination and development of sperm toxins for control of undesirable species of fish.
11. United States Bureau of Land Management. Facilities and assistance for Point Springs grazing project, medusahead research, and forest genetics studies.
12. United States Bureau of Sport Fisheries and Wildlife. Funds for the Cooperative Fisheries and Wildlife Units.
13. United States Department of Agriculture. Funds for projects from the McIntire-Stennis Act; and Hatch Act Regional Research Projects W-89 and W-71, through cooperation of Agricultural Experiment Station, University of Idaho.
14. United States Forest Service. Field living accommodations and assistance in collection of research material for several projects, including field transportation for a study of big sagebrush.
15. Wildlife Management Institute. Funds for wildlife research.

APPENDIX B. SOURCES OF RESEARCH FUNDS AND OTHER SUPPORT - Continued

16. The Food and Agricultural Organization of the United Nations, funds for a fisheries research project in Zambia, Africa.
17. Federal Water Pollution Control Administration. Support for a study on pollution effects on adult steelhead migration.
18. National Science Foundation. Funds for a project under the Desert Biome of the International Biological Program.
19. Idaho Citizens Grazing Association. Funds and other support for a grazing study in S.E. Idaho.

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