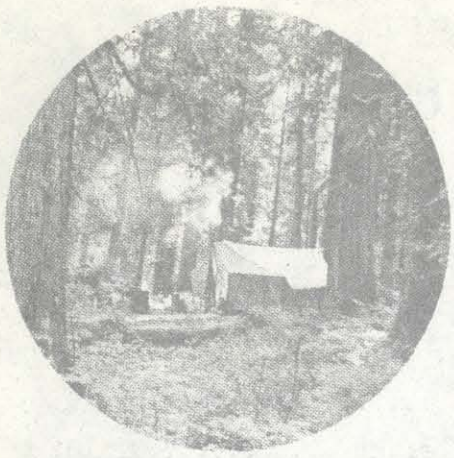
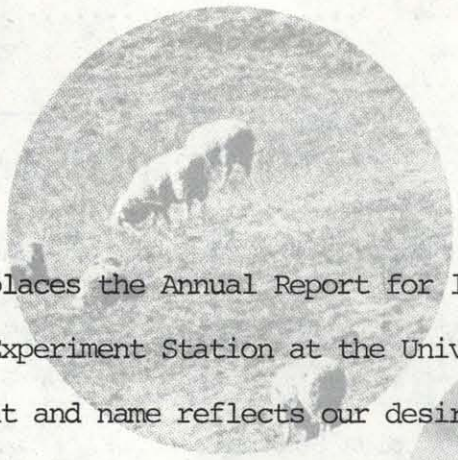
FOCUS

on Natural Renewable Resources

Volume 1 Number 1

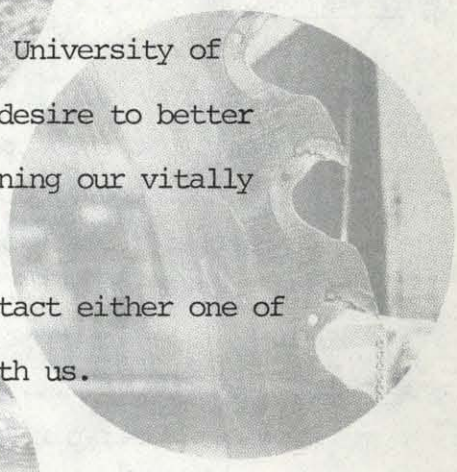
University of Idaho
Forest, Wildlife and Range Experiment Station
College of Forestry, Wildlife and Range Sciences
Moscow, Idaho





This issue of FOCUS replaces the Annual Report for 1974 of the Forest, Wildlife and Range Experiment Station at the University of Idaho. The change of format and name reflects our desire to better communicate and relate to issues of the times concerning our vitally important natural renewable resources.

We seek your comments. Please feel free to contact either one of us should you wish to share your ideas and advise with us.



J. H. Ehrenreich
Dean and Director

A. A. Moslemi
Associate Dean and Associate Director

Table of Contents

Introduction

A. A. Moslemi

This publication highlights some of the research projects underway by the Forest, Wildlife and Range Experiment Station during calendar year 1974. A complete listing of projects, publications, sources of funding and Station scientists appears in the back of this report.

The Forest, Wildlife and Range Experiment Station administers research in the College of Forestry, Wildlife and Range Sciences at the University of Idaho. In 1974, the FWR Experiment Station entered its 35th year of existence. It has proven to be a farsighted legislative act of the State of Idaho which, back in 1939, recognized the need for a structured approach to research dealing with the vast array of Idaho's natural renewable resources.

Forest Resources Vital to State

The forest resources of Idaho have a vital impact on the economic well-being of the state. For example, during 1974, employment in forest products industries accounted for 135,000 jobs. The wages earned amounted to about $115,000,000. Raw material for the industry consisted of some 1.7 billion board feet harvested from Idaho's forest lands.

The importance of these resources not only to Idaho but to the nation becomes clear when one considers that some 30 percent of all residences and some 40 percent of all commercial buildings which will exist in the United States in 1985 have not yet been constructed. With the energy crisis upon us, it is very likely that wood will play a prominent role in meeting the material demand for these residences and commercial buildings. This is due to the fact that wood requires less energy to process and possesses superior insulating properties, thereby minimizing energy requirements for heating and cooling of building interiors. Idaho's 21 million acres of forest land (particularly the 14 million commercial acres) will be called upon to effectively contribute to the material need for this building requirement.

Can Idaho's forest lands meet the challenge of greater productivity? Can the increased productivity be achieved without environmental degradation? These questions are being addressed in the FWR Experiment Station through the Intensive Timber Culture research program. This integrated program was initiated in 1973 with the cooperation of the United States Forest Service (Intermountain Forest and Range Experiment Station). A vitally important element in this program is the attention given to a variety of environmental factors as greater productivity is sought from Idaho's timber resources.

Fisheries and Wildlife Research Needed

The importance of timber resources to human welfare needs no great elaboration. It has been, however, only in the last decade or so that the public has begun to place an increasing importance on our wildlife and fisheries heritage. The State of Idaho's wildlife and fisheries resources are among the most renowned in the world. In Idaho, as indeed elsewhere, these resources have gradually faced greater pressures resulting from man's activities. The adoption of wise policies calls for an intensified research effort so that man can live in greater harmony with his co-inhabitants and be able to utilize these resources to his benefit. Some of the projects dealing with fisheries and

wildlife in the FWR Experiment Station during 1974 have been selected for brief elaboration in this report. It is vitally important that the impacts of management be determined on our fisheries and wildlife. The fisheries and wildlife staffs of the FWR Experiment Station have been called upon by various agencies to provide answers to some of these complex problems.

Focus on Rangelands

Energy and hunger have regularly been discussed in our newspapers and our other communication media in the last few years. These two interdependent issues present us with some of the greatest challenges man has faced on the finite earth. The need for accelerated food productivity with less demand on fossil energy resources is real indeed. This challenge has sharpened the focus on rangelands. Of the millions of acres of rangelands in the western United States, some 35 million acres are in Idaho. Important cattle and sheep industries depend on range resources for feed. The world food situation as well as Idaho's economy require a focused attention to proper utilization of rangelands. Intensified range management will require new knowledge generated by research if we are to avoid overuse and degradation. The FWR Experiment Station is now in the process of classifying Idaho's range resources so that base data are available for management purposes.

In all the manipulations with the natural environment, it is essential that environmental degradation be avoided. In earlier times, the need for economic development practically always overshadowed environmental planning aspects. The search for material well-being over the 200-year history of the United States has been intense. As a result, the environment has suffered. A challenge for research now is to attempt to repair that damage and begin to turn the corner in trying to return the land to its original ecosystem as nearly as possible.

North Idaho Mining Area Studied

The mining activities in the Silver Valley of North Idaho have had and continue to have significant economic importance to Idaho and to the nation. A variety of metals such as silver, zinc, lead and gold are being mined in this metal-rich valley. These activities, however, have not been without their environmental costs: sulfur dioxide emissions have sharply degraded the soil and mine tailings have adversely affected water quality. An area of several thousand acres has become denuded of vegetation in an area of magnificent beauty and large visibility. FWR Experiment Station scientists with the cooperation of the mining industry and the U.S. Forest Service SEAM program are now in the process of reversing the degradation in the once forested mountains surrounding the smelting plant and other facilities. The mine tailings accumulated on the valley floor are also being examined for revegetation. It will take a number of years before the revegetation and attendant problems of erosion, water quality and esthetic degradation are adequately solved. In this first issue of FOCUS, the reader will note a brief update on this project.

It is unquestionably true that research will play an increasing role in dealing with the complex socio-environmental and econo-environmental issues as we begin our tri-centennial in America. The FWR Experiment Station intends to play an effective role in contributing to the knowledge upon which we must depend.

Dr. Ali Moslemi joined the College of Forestry, Wildlife and Range Sciences in March of 1975 as Associate Dean in charge of graduate studies and research. A specialist in forest products, Moslemi comes to the University of Idaho from Southern Illinois University at Carbondale, where he was chairman of the Department of Forestry.

Forest Resources

Within the last decade, our nation's awareness of the importance of natural resources has emerged. The rising cost and demand for the products which come from natural resources, and impending shortages of energy-producing resources remind us of our material reliance on the environment. The effects of pollution on our water and air accenuate our physical dependence on the environment.

At the same time, lands made unproductive through overuse or misuse, and the decline of some wildlife species resulting from altered or disappearing habitats has taught us to recognize the impact our activities can have when they tip nature's balance.

This heightened awareness of our need for natural resources and a growing understanding of the dynamics of our natural world has resulted in unprecedented efforts in land use planning and resource management in this country, and nearly revolutionized the natural resource sciences. In order to provide the biological and ecological information essential to effective resource management, researchers are developing new methods and approaches which give natural resource research revitalized and refocused direction and purpose.

Increasing attention in research is being directed toward deciphering the interrelationships between resources, so that the impacts of resource use can be predicted. Today, natural resource research is characterized by interdiscipplinary efforts and a holistic, "ecosystem" approach. Research is problem oriented and methods and results are management applicable. Finally, techniques such as modeling and remote sensing increase the applicability and scope of individual projects.

INTENSIVE TIMBER CULTURE PROGRAM INVOLVES COLLEGE AND FOREST SERVICE

An excellent example of this type of research in the forestry college at the University of Idaho is the Intensive Timber Culture program, a cooperative research effort between the Forest, Wildlife and Range Experiment Station and the U.S. Forest Service Intermountain Forest and Range Experiment Station. The objective of this program, which includes several interrelated projects, is to find ways of producing more timber while maintaining wildlife, recreation and watershed values. More than 20 researchers from the college Experiment Station and the Forest Service have pooled their expertise in silviculture, forest pathology and entomology, watershed and wildlife for the program.

Target Areas

Target areas for the research are western redcedar, western hemlock and grand fir habitat types in northern Idaho and adjacent states. Forests of these habitat types are the most productive of Rocky Mountain forests and have been the mainstay of the timber industry in North Idaho. In addition, they contain a wealth of wildlife, streams and rivers and abundant scenic and recreational opportunities. Management of these forests for all of their many resources is of vital importance to Idaho and the nation.

Each of the eight research projects in the Intensive Timber Culture program has been carefully planned by researchers from the U.S. Forest Service's Forestry Sciences Laboratory at Moscow, Idaho, together with researchers from the college's Experiment Station. The projects are designed to make use of ex-

isting Forest Service information on Northern Region forests as well as to generate new information which will be directly applicable within the framework of Forest Service management guidelines and methods. Much of the data from this research program will be used in a forest stand prognosis model (TREMOD) developed by Forest Service scientists at the Forestry Sciences Laboratory to predict how forest stands will change under different management regimens. The combined results of the program will also provide information to North Idaho's forest industries for management of their holdings in western redcedar, western hemlock and grand fir forests.

Project One: The resource and timber production potentials.

Dr. David L. Adams, FWR Exp. Sta.
Don Hanley, FWR Res. Assoc.
Glenn Deitschman, USFS Exp. Sta.

Basic information about western redcedar, western hemlock and grand fir habitat types, and the production potential of these types in the Northern Region is essential for setting research emphases and as a basis for judging gains in production resulting from silvicultural practices. The first job in this project was to compile data from various sources on the biologic, land and water resources for each national forest in the Northern Region, listing total acreages of each habitat, soil and landform type and grouping into meaningful classes the lake and reservoir acreages and the river and stream miles and discharge rates. The second job was to develop summaries of the present timber resources on Northern Region national forests from Forest Service inventories.

The major part of the study concerned timber production potentials. Estimates of tree biomass potentials for each habitat type were developed from existing tree and stand measurement data and from productivity information gathered from a search of the literature relevant to the tree species and site characteristics in North Idaho.

Project Two: The effects of silvicultural regeneration systems on success, timing, development and growth of regeneration.

Dr. David L. Adams, FWR Exp. Sta.
Margaret Harris, FWR Res. Assoc.
Bill Wykoff, USFS Exp. Sta.
Glenn Deitschman, USFS Exp. Sta.

A critical and presently lacking ingredient of the Forest Service's stand prognosis model (TREMOD) is the estimated period from the time a stand is cut until a newly regenerated stand reaches

Jonalea Tonn, University of Idaho graduate student, works with Mark Novak, right, USFS forestry aide to measure height increment of ponderosa pine in North Idaho.

meaningful basal area and volume. The purpose of this project is to obtain this necessary data to predict regeneration and development for a range of silvicultural regeneration systems and habitat types, and for various treatments of the regeneration.

The study methodology will be to select a grid of sample study areas representing the desired range of habitat types, stand structures, regeneration systems and time since cutting, and to measure the success, timing, development and growth of regeneration on these sample areas. Treatment of the regeneration and effectiveness of advance regeneration will be a part of the study.

Project Three: The effects of thinnings and partial cuttings on growth and yield of forest stands.

Dr. David L. Adams, FWR Exp. Sta.
Don Hanley, FWR Res. Assoc.
Bill Wykoff, USFS Exp. Sta.
Marvin Foiles, USFS Exp. Sta.
Ray Boyd, USFS Exp. Sta.
Glenn Deitschman, USFS Exp. Sta.

The TREMOD model is also dependent upon accurate data on growth rates resulting from stand treatments. During this study, treated and untreated stands in the various habitat types will be monitored to obtain the effects of silvicultural treatments over time. Thinnings will be the major practice to be studied. However, improvement cuttings, release cuttings and other partial cuttings will also be included.

As in the previous project, a grid of study areas covering the desired range of habitat types, cutting practices, stand structures and time since cutting will be selected. Response of reserved trees on the study areas will be measured.

During the 1974 field season, 44 regeneration and 23 thinning study units were established in western redcedar, western hemlock and grand fir habitat types throughout the Northern Region, and data was collected from plots within each study unit. Computer programs are currently being developed to analyze this information, from which stand model equations can be drawn.

Larva from the western pine-shoot borer, Eucosma sonomana, is at work mining the terminal shoot of lodgepole pine.

Project Four: The implications of silvicultural practices on insects and diseases and the effects of insects and diseases on timber yields.

Dr. Arthur D. Partridge, FWR Exp. Sta.
Dr. Karel J. Stoszek, FWR Exp. Sta.
Dr. Elmer R. Canfield, FWR Res. For.
Jim Moore, FWR Res. Assoc.
Harold Osborne, FWR Res. Assoc.

It is difficult to realize timber growth and yield potentials in forests of western redcedar, western hemlock and grand fir habitat types because of losses caused by insects and diseases. Forest managers must know the magnitude of insect infestations and disease, the relationships of cultural practices to insect and disease attacks and ways to control insects and diseases.

For this project, Drs. Partridge and Stoszek from the forestry college Experiment Station are developing "descriptors of severity" for individual insects and diseases which will be used in forest inventories to determine current stand conditions and trends. The researchers will also develop models which will relate growth and mortality of individual trees to these severity descriptors for specific insects and

diseases. In addition, stand conditions will be related to the levels and trends of insect and disease severity indicators, and as part of this objective, the effects of silvicultural treatments on stand conditions will be evaluated.

The study will focus on spruce budworm, larch caseborer, tussock moth, Douglas fir beetle, mountain pine beetle and Scolytus beetle (insects) and white pine blister rust, dwarf mistletoe, heart rots and root rots (diseases).

Project Five: The effect of silvicultural regeneration systems on wildlife species.

Dr. James M. Peek, FWR Exp. Sta.
Dr. Steven R. Peterson, FWR Exp. Sta.
Larry L. Irwin, FWR Res. Assoc.

Knowledge concerning the effects of silvicultural practices on both game and non-game species of wildlife contributes to an understanding of the interrelationships between resources, and is essential in order for the Forest Service to consider tradeoffs in resources under alternative management plans. One of the objectives of this project is to quantify the production over time of the food and cover needed by game and non-game species in areas where silvicultural practices are in use for timber production. These practices will include a range of silvicultural regeneration systems and thinning. The researchers will also model the effects of spatial dispersion of timber management practices on habitat suitability for game and non-game species.

Project Six: The effects of fertilization on growth of forest stands.

Dr. Howard Loewenstein, FWR Exp. Sta.
Franklin H. Pitkin, FWR Exp. Sta.
David Scanlin, FWR Res. For.

Professors Howard Loewenstein and Frank Pitkin and David Scanlin, research forester, have been studying the effects of fertilization on growth of trees and understory vegetation in thinned and unthinned stands of grand fir and Douglas fir for several years. Results from this research have provided information to the Forest Service TREMOD model. However, the fertilization study has been expanded for the Intensive Timber Culture program to encompass western redcedar and western hemlock habitat types.

Study sites for this expanded study were selected during 1974 from those chosen for the regeneration and thinnings projects. The major nutrient to be studied is nitrogen, which will be applied in the form of urea. On certain sites, phosphorus, sulfur and boron responses will also be monitored. The researchers will have preliminary information on growth as affected by fertilization after two growing seasons, and more definitive data on growth, as well as the influence of fertilization on wood quality, will be obtained after four growing seasons.

Mule deer browse along East Fork of the Salmon River.

Project Seven: Stand treatment and water quality models.

Dr. George H. Belt, FWR Exp. Sta.
Dr. Al Stage, USFS Exp. Sta.
Harold Haupt, USFS Exp. Sta.

This study will monitor the effects of spatial dispersion of forest stand treatments on water quality models, and address the problem of linking silvicultural treatments and logging activities such as road building with water quality models. The study will also provide the

Forest Service with methodology for assessing soil stability and hydrologic regime as influenced by harvest practices in redcedar - hemlock - grand fir forests.

Project Eight: Program analysis and integration of research.

Timing and integration of the eight projects in the Intensive Timber Culture program is of the utmost importance. A five-year plan of research and a program analysis is being prepared by C. A. Wellner, retired from the Forest Service Intermountain Forest and Range Experiment Station, to serve as a guide for this cooperative, coordinated research effort.

Drs. John Howe, left, and Chi Wu Wang examine poplar seedlings ready for planting in research plots at the Idaho National Engineering Laboratory near Arco.

THERMAL WATER USES IN FORESTRY

Dr. John P. Howe
Dr. Chi-Wu Wang
Charles Harrison, graduate student
Robert Shoemaker, graduate student
William Gibson, FWR major

Television cameras were trained on the first truckload of tree seedlings that arrived last summer at the sagebrush covered plain of the Idaho National Engineering Laboratory (INEL) near Arco, Idaho. Grow a forest in the desert? That's the idea of Drs. John Howe and Chi Wu Wang from the University of Idaho, and this was the beginning of a cooperative research project between the forestry college Experiment Station, the newly-formed Energy and Research Development Adminstration (ERDA) and the Idaho Nuclear Energy Commission.

The Environmental Protection Agency estimates that 200 billion gallons of cooling water will pass daily through nuclear power plants in the United States by 1980, coming out at temperatures between 90 and 125 F. If unused, this is a daily heat wastage of approximately $50\text{-}108 \times 10^{12}$ BTUs. In energy-conscious America, an all-out effort must be made to utilize this energy. And since the heat energy carried in cooling water will be added to some part of the environment as a thermal pollutant, it's doubly important that beneficial uses be found for it.

In Idaho, where large quantities of warm water are expected from nuclear facilities, geothermal sources and industrial plants, and where forest industries are already well established, thermal water could have great economic value if put to work in forest genetics research and wood production.

First Phase Underway

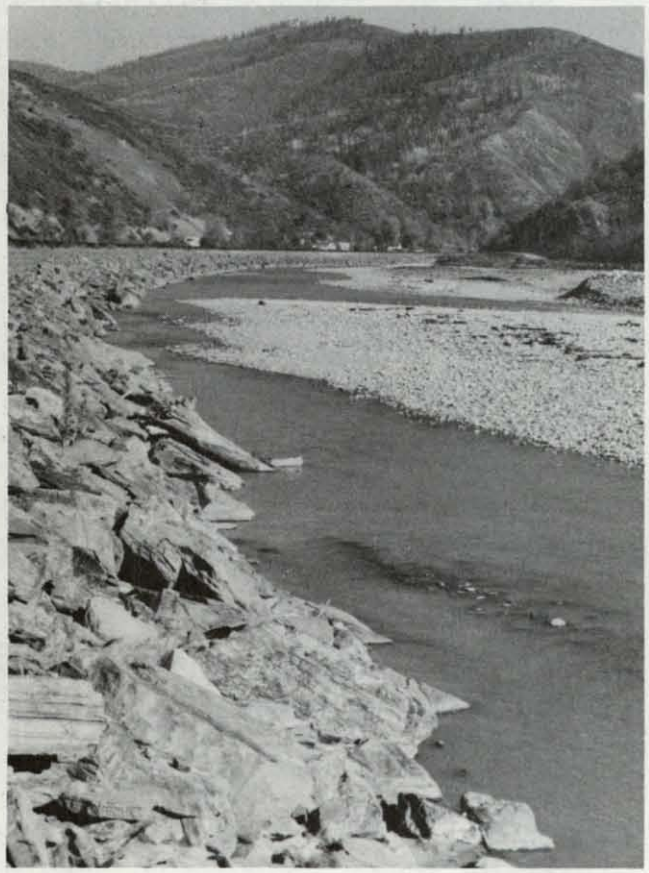
Howe and Wang plan to study the effects of thermal water irrigation and soil heating on tree growth in two phases. The first phase, the "cold water project," was initiated in 1974. Phase II, the "hot water project," will begin following exploratory investigations and selection of test materials and sites.

For the initial research, Howe and Wang have test planted six major groups of conifer and hardwood trees on two

acres of INEL land. The test materials - 1,200 trees of 39 species, varieties and geographic races - are being irrigated with non-thermal water and tested for differences in growth response, genetic and site interaction and optimum levels of water and chemical treatments.

The researchers have also planted test trees in seven satellite areas around the periphery of the Snake River plain at Aberdeen, Arco, Idaho Falls, Kimberly, Lidy Hot Springs (Dubois), Rexburg and Shoshone, Idaho. Elevations of the seven satellite test sites range from 3,960 feet to 5,452 feet, and growing seasons vary from 109 to 130 days.

In addition, Howe and Wang are propagating and preparing 5,800 conifers and poplar hybrids for the hot water phase of research. During Phase II, Howe and Wang will continue selective breeding of forest trees for improved growth rate and wood quality under thermal water conditions. Wang has already done considerable work in Idaho on the genetic improvement of ponderosa pine. The use of warm water to induce vegetative propogation, early flowering and seed production could be a useful tool in the development of superior strains of trees.



REVEGETATION RESEARCH IN THE COEUR D'ALENE MINING DISTRICT

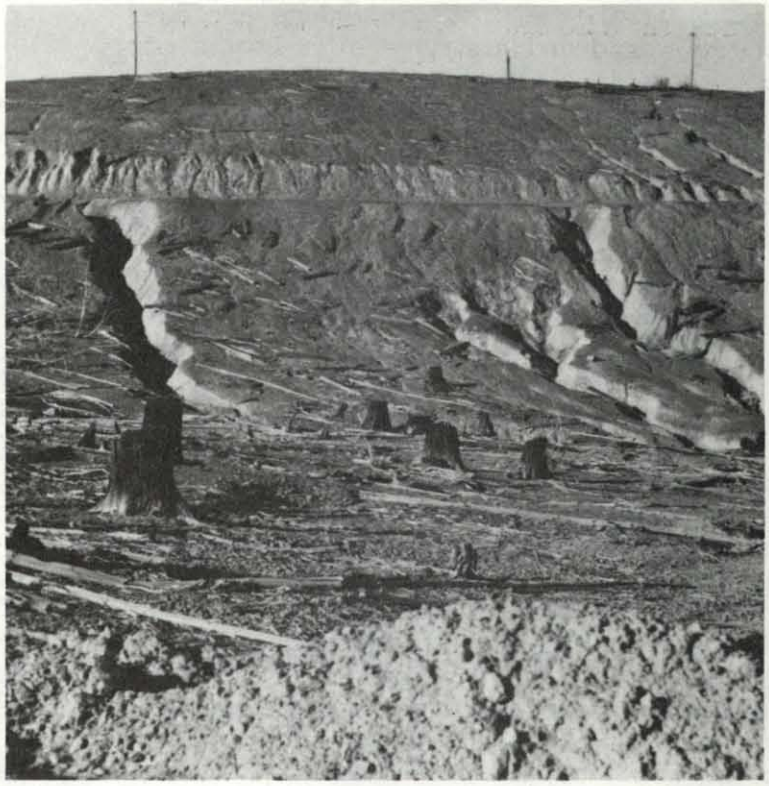
Franklin H. Pitkin
Dr. Howard Loewenstein
Dr. John E. Mitchell
Roger Gordon, Res. Assoc.
Edward Pommerening, Res. Assoc.

The Coeur d'Alene Mining District in northern Idaho has been the scene of intensive mining activity since gold was discovered there in the early 1880's. As the mining industry developed in the district, the emphasis shifted from gold to silver, lead and zinc. The area is now one of the world's leading producers of these metals.

The mining district is approximately 25 miles long and ten miles wide, encompassing the valley of the South Fork of the Coeur d'Alene River. Native vegetation in the area was primarily coniferous forest, with willow, alder, cottonwood and dogwood common along stream channels. But much of the native vegetation was destroyed by a series of major fires, the last of which occurred in 1945.

Emissions from a lead smelter built in 1918 and an electrolytic zinc plant built in 1928 have prevented natural regeneration of the native vegetation, and the Kellogg-Smelterville area is surrounded by several thousand acres of barren hillsides. Thousands of additional acres support only scattered, stunted brush. The valley floor has been disturbed by highway, railroad and tailings pond construction and many areas are covered by deposits of mine tailings. Spring runoff causes flooding along sections of the South Fork where the stream channel is poorly defined.

Sites denuded by fire and sulfur dioxide fumes from the zinc plant rise above highway along the Coeur d'Alene River.



Erosion cuts deeply through barren hillsides above Kellogg, near the Bunker Hill plant.

Research Begins

In 1972, both forestry and range scientists from the forestry college at the University of Idaho began revegetation research in the Coeur d'Alene Mining District with funds from the University of Idaho, Greater Shoshone County Inc. and the U.S. Bureau of Mines. Initial work, directed by Dr. Richard White, professor of range resources, concentrated on pinpointing the factors limiting revegetation in the district, and finding plant species that were suited to the existing conditions.

Ongoing research is supported through grants from the Department of Agriculture's Surface Environment and Mining (SEAM) program, Greater Shoshone County Inc., the University of Idaho and The Bunker Hill Company. Current research director Frank Pitkin and research associates Roger Gordon and Ed Pommerening are involved in large-scale tree and native shrub planting operations, and research with bare-rooted and container-grown trees and native shrub seedlings. Several sizes and types of container-grown seedlings are being compared with bare-rooted seedlings for ease of planting, survival and growth on research plots throughout the district.

Dr. Howard Loewenstein and graduate student Dan Carter are working on chemical analyses of soils from the mining district, looking for ways to rehabilitate soil from both tailings areas and the surrounding slopes. Finally, Dr. John Mitchell and graduate student John Hansen are establishing grass research plots on tailings materials to compare hydroseeding with several combinations of seed, mulch and fertilizer.

Sources of Problems

According to the researchers, most of the revegetation problems in the Coeur d'Alene Mining District are related to sulfur dioxide emissions, contaminated soils near the lead smelter and zinc plant, and deposits of mine tailings. Although SO_2 emissions are being reduced to comply with state and federal regulations, sulfur dioxide remains a significant factor limiting plant survival and growth in the vicinity of the zinc plant.

The denuded hillsides near the smelter and zinc plant are steep, and erosion is severe. In addition, the soils are very acidic, have high concentrations of heavy metals and low levels of plant nutrients and organic matter.

Several types of mine tailings are

found within the district. Some are extremely acid and all have high levels of heavy metals. Mine tailings also have limited soil moisture retention capability due to their coarse texture, and are very low in nutrients and organic matter.

Some Successes

From tests on screening plots on representative sites throughout the mining district, the researchers have found that Austrian pine is very successful on brush-covered hillsides, and Scotch and lodgepole pines have also grown well in these areas. Hardwoods have been less successful on the hillsides, although black locust has done well in some areas.

Container-grown alder, mountain maple and willow have shown promise on certain tailings materials. More than 30 lines of hybrid poplar were planted throughout the district, and several lines appear to be well adapted to the area.

Experimental plots on terraces have been very successful in areas where hillside plantings have done poorly. Grass studies have provided the information needed to prescribe planting programs for all the tailings pond dikes in the district. Greenhouse experiments with soils taken from near the zinc plant have shown that the toxic effects of high concentrations of heavy metals and low pH can be overcome by applications of lime.

Large-Scale Planting Begun

A variety of large-scale plantings are planned for 1975-76 at locations where previous research has shown a good potential for success. A demonstration/research area will be planted along the South Fork of the Coeur d'Alene River to show the potential for revegetating disturbed stream channels. Several miles of rip-rapped stream channel will be planted with willow and poplar cuttings and 100 acres of brush covered hillsides will be planted with conifer seedlings.

The Bunker Hill Company will plant 40 acres near Kellogg using bare-rooted pine seedlings obtained from the University of Idaho Forest Nursery, and Douglas fir and white pine seedlings donated by the Forest Service through the SEAM program will be planted on 40 acres above the Sunshine Mine. The Bunker Hill Company will also hydroseed with grass 15 acres of dryland areas and five acres of lawns in Kellogg and Smelterville.

Greater Shoshone County has established a nursery for rooting 50,000 native willow, golden willow and hybrid poplar cuttings which were made this winter. The rooted cuttings will be planted throughout the district in 1976. The Bunker Hill Company is initiating a terracing program to reduce erosion on barren hillsides and provide a suitable micro-climate for revegetation.

Range Resources

IDAHO BATHOLITH RESEARCH YIELDS INFORMATION ON RANGELANDS

Dr. Lee A. Sharp
Dr. Minoru Hironaka
Dave Griggs, graduate student
Jim Cornwell, graduate student
Ron Lambeth, graduate student

The Idaho Batholith is the largest granitic intrusion in the United States, underlying an area of about 16,000 square miles of central Idaho and western Montana. It is characterized by rough mountainous topography dissected by streams and rivers in deep canyons.

The area provides extremely valuable resources including water, fisheries, wildlife, timber, forage, minerals and recreation opportunities. But because of the unstable granitic soils combined with precipitous terrain, utilization of these resources has caused problems and generated serious concern about some land use activities.

A thorough understanding of the various habitat types and their interrelationships is essential to accurately appraise the area's capabilities and limitations for management, and to enable decisions to be made in a truly ecological framework. In June of 1974, a project was begun to define and quantify the major plant communities and habitat types of the central Idaho Batholith and to develop a scheme for classifying vegetation and its probable successional trends within habitat types. From this information, the researchers can assess the capabilities of habitat types for summer grazing of domestic livestock, principally sheep, and other uses such as timber, watershed, wildlife and recreation.

The researchers chose three study areas near Riggins, Idaho in the Nezperce and Payette National Forests for vegetative sampling. Each area is a mountainous or subalpine grazing allotment administered by the U.S. Forest Service. Area I is for the most part transitional, including soils derived from both Columbia River basalt and granitic parent materials, and is representative of the western periphery of the Batholith. Area II, recently classified a wilderness candidate, is roadless. At present, the primary land use is sheep grazing, with a limited amount of timber harvest. Area III is most representative of the Batholith formation. The soils are characteristically shallow, loose sandy loams derived from granitic parent material.

Thirty-one sample sites have been selected according to eight site factors on two of the study areas. Vegetative cover types are being identified on the ground and delineated on aerial photographs provided by the U. S. Forest Service. Grazing use, erosion and any history of fire or other disturbances are also noted on the aerial maps.

Hironaka and Sharp are also studying the present land uses in the Batholith area, particularly their impact on soils, vegetation and water resources and their importance to the state and local economies. During this past field season, the researchers interviewed livestock operators and observed livestock handling methods in the study areas.

The information from this research should help land managers to coordinate land uses with ecological capabilities and limitations. For example, special grazing systems might be used as a tool for improving vegetative cover on the unstable granitic soil types of the Batholith area.

Wood Utilization

IDAHO FOREST INDUSTRIES STUDIED

Dr. E. Bruce Godfrey
Dr. Ervin G. Schuster
William Koss, graduate student

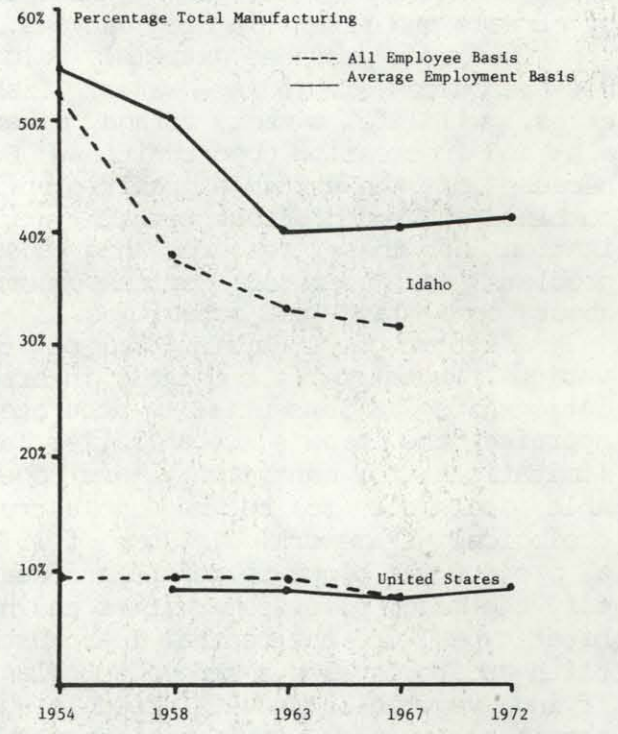
The spring of 1974 brought a new research effort into the College of Forestry, Wildlife and Range Sciences - one that emphasizes the business and people side of forest utilization. The research, sponsored by the U.S. Forest Service's Intermountain Forest and Range Experiment Station, the forest industries of Idaho and the forestry college's Experiment Station, describes the forest industries of Idaho and measures their importance to the economy of the state.

Each forest products firm that could be identified was contacted by Dr. Bruce Godfrey, the project leader, Dr. Ervin Schuster, a resource economist, or graduate student William Koss to obtain information such as the location and volume of timber used, use of residuals, the cost of producing products and where the products are sold.

The amount of timber cut in 1967 and 1972 and the amount expected to be cut in 1982 on lands administered by the U.S. Forest Service and the forest industries of Idaho was also obtained. Employment and wages paid by the forest products industry was provided by the Idaho Department of Employment.

Three publications have resulted from this project to date and several more are in the final stages of production. One of the publications that is now available is a directory of the forest products industry in Idaho listing each firm by location, the products produced, and the species used by each firm.

Two other publications emphasize employment and wages generated by the forest products industry in Idaho. The publications illustrate the importance of forest industries to the state's economy, especially in regions such as northcentral Idaho. These and future publications should be of use to any person who is concerned with the role and use of forest lands in Idaho.



Source: Idaho Department of Employment
U.S. Department of Commerce

Figure 2. Forest products industry employment as percentage of manufacturing, 1954-1972

RESEARCHERS DEVELOP NEW RAILROAD CROSSTIES

Dr. John P. Howe
Robert Shoemaker, graduate student

You don't feel safe standing beside some railroad tracks when the train goes by. The tracks shake and the train rattles because some of the crossties are rotted or broken.

In 1961, railroad crosstie replacements had dropped to 12 million ties from a high of 47 million per year during World War II. Inadequate crosstie replacement continues today and will become more acute as the 35-year life cycle of the World War II ties draws to a close. To make matters worse, domestic supplies of tie-length hardwood logs will be insufficient to adequately supply the full size solid crossties that the railroads need to keep the trains running properly.

Dr. John Howe and graduate student Robert Shoemaker are working on a promising solution to the problem using two halfties pinned together with steel dowels. These half ties can be cut from small trees that contain 8 1/2-foot long logs 8.5 to 9 inches in diameter. The research of Howe and Shoemaker has shown that the holding power of the dowels can be significantly improved by laminating the ties when they are green.

Fortunately the softwood forests of the West and the hardwood forests of the South and East are well supplied with these small trees from which half ties can be cut. Indeed, the removal of these smaller trees could be a boon to the forest manager who would like to restock his forest with more desirable species.

Working with the U.S. Forest Service Southern Forest Experiment Station, the railroads and major tie producers, Dr. Howe has documented the satisfactory service of dowel-laminated crossties. And currently, a manufacturing system is being devised to produce dowel-laminated ties competitive in price and function with 7 by 9-inch ties. In this system the half ties will be cut on a revolutionary new Koch shaping lathe. The flake by-products of this lathe can be pressed into a "super-strong" structural board.

Dr. John Howe examines dowel-laminated oak crossties on the main line of the Illinois Central Railroad at Reevesville, Ill., during a 1974 summer field survey. The ties were placed in a 1961 field test.

RESEARCHER TESTS PROPERTIES OF STRUCTURAL PARTICLEBOARD

Arland D. Hofstrand

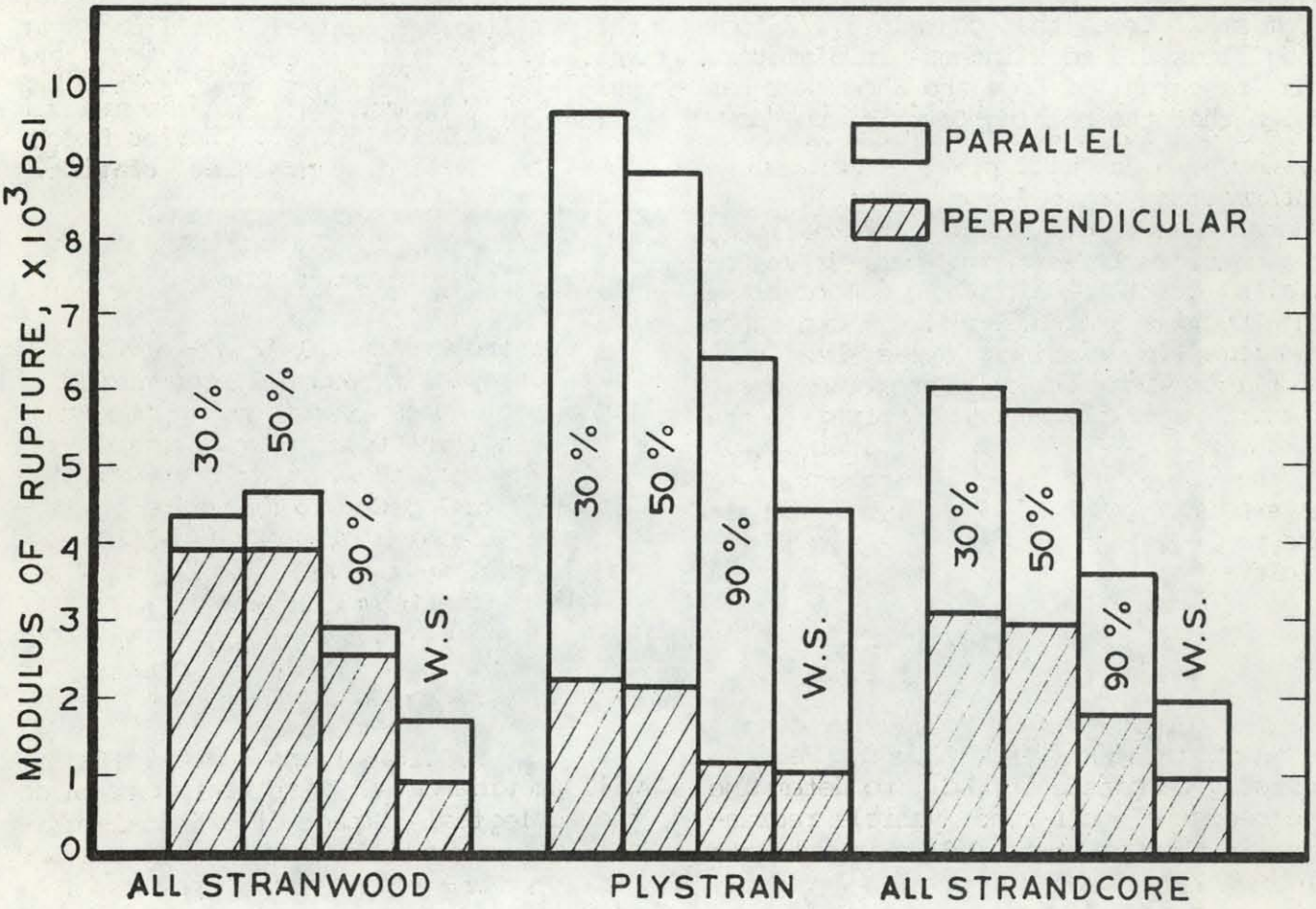
Until recent years, some 98 percent of the particleboard manufactured was used for indoor, non-structural purposes. Particleboard just didn't have the high strength, stability and durability prerequisite for building materials which have to support a structure and its interior furnishings against the elements over prolonged periods.

Pressured by the shrinking supply of timber and soaring demands for lumber, manufacturers and wood scientists looked for a way to produce particleboard for structural applications. They found that by orienting or aligning strand-type particles or flakes, artificially reproducing the directional "grain" of natural lumber, structural particleboard could be manufactured. Now the physical and engineering properties of structural particleboard, and how these properties are influenced by exposure to stresses such as levels of moisture is of concern to manufacturers, architects and structural engineers.

Arland Hofstrand, in cooperation with Potlatch Corporation, investigated the influence of prolonged exposure to moisture on the strength and linear expansion properties of oriented particleboards manufactured by Potlatch Corporation.

Analysis of data indicated that linear expansion was influenced by the orientation of the stands in relation to the long axis of the panel regardless of the level of moisture conditioning. Linear expansion in the direction perpendicular to the panel's long axis was greater than that parallel to the long axis of the panel. As moisture content increased, linear expansion increased.

Both strength and modulus of elasticity were influenced by the level of moisture absorption. Specimens in water-soaked condition exhibited the greatest decrease in strength of modulus of elasticity.



Influence of conditioning conditions on modulus of rupture.

Wildland Recreation

OFF-ROAD VEHICLE USE

STUDIED FOR STATEWIDE PLAN

Dr. John E. Mitchell
Dr. John H. Schomaker
Dr. Charles Hatch
Dennis Probst, graduate student

Wildland recreation is a relatively new academic option within the College of Forestry, Wildlife and Range Sciences, and research on "people management" and the impacts of recreational use in wildland areas is intensifying.

One of the more pressing needs in this area in recent years has been for research which will provide management information on off-road vehicle use. These increasingly popular recreational vehicles, including four-wheel drive vehicles, trail machines and motorcycles, dune buggies and snowmobiles, can cause problems in wildland areas when they conflict with other recreation uses, disturb wildlife or damage fragile environments. Several states, particularly in the West, are currently looking at ways to regulate off-road vehicle use, and provide for adequate off-road vehicle areas.

Governor's Committee Formed

In May of 1972, Idaho Governor Cecil D. Andrus appointed an Off-Road Vehicle Advisory Committee (ORVAC) to determine the needs of off-road vehicle recreation in the Gem State and to investigate the problems created by off-road vehicle use. A team of researchers from the University of Idaho is providing ORVAC with information which will be used as a basis for developing a comprehensive off-road vehicle plan for Idaho.

A study on the legal status of off-road vehicles was completed during 1973 by John Power from the University of Idaho College of Law. Ongoing research includes studies on the ecological impacts of off-road vehicle use, the attitudes and opinions of managers of off-road vehicle areas, and the current and future use patterns and preferences of off-road vehicle users. Members of the research team are Dr. John Mitchell, principal investigator and professor of range management; Dr. John H. Schomaker, assistant professor of wildland recreation; Dennis Propst, wildland recreation graduate student; and Dr. Charles Hatch, forestry college consulting statistitian.

Field Work Underway

For the ecological impact study, 45 "trouble spots" and a larger number of heavy use areas throughout the state have been identified. This summer, the research team is working on vegetative and soil analyses to determine the impact of intensive off-road vehicle use on a representative sample of these sites. The team will also analyze information collected from a questionnaire sent to a sample of off-road vehicle users and managers in the state.

The results of the current studies will provide ORVAC with information on the ecological impact of off-road-vehicle use, the relationship between use patterns and the availability of off-road vehicle areas, and the attitudes of public managers as well as off-road vehicle users.

Fisheries Resources

DWORSHAK RESERVOIR PROJECT CONTINUES

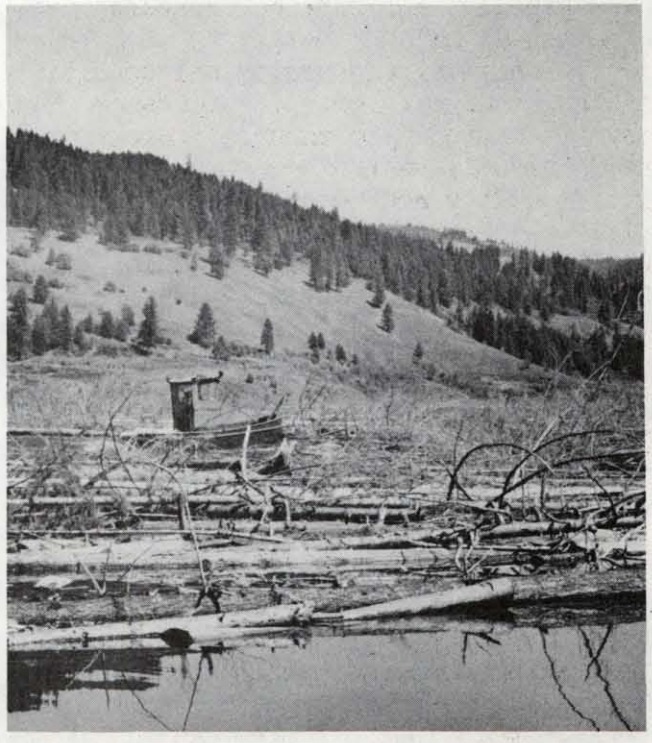
Dr. C. Michael Falter
Jack Skille, graduate student
Rick Stowell, graduate student

Limnological studies in fisheries resources during 1974 under the direction of Dr. C. Michael Falter concentrated on Dworshak Reservoir and Lake Pend Oreille in North Idaho.

The Dworshak research is a multiphase program funded by the U.S. Army Corps of Engineers to explain the internal workings of Dworshak Reservoir, a four-year-old, 650-foot-deep, cold-water impoundment. After three-and-a-half years of study, Falter and his research team are developing an explanation of the early years of the reservoir's life. Particular aspects studied were: (1) nutrient abundance in relation to sources, (2) factors controlling algae production, (3) vertical migration of zooplankton, (4) zooplankton response to shifts in algae composition, and (5) the role of log leachates in algae blooms.

Feast or Famine

The researchers are trying to relate the "feast or famine" recent history of algae and zooplankton development in the reservoir to resulting fish growth. In 1972 and 1973, the reservoir supported heavy fishing pressure with large numbers of full-bodied fish removed, but in 1974 fish growth slowed considerably. The quality of fish flesh also declined with the food supply. The researchers found that high silt inputs from shoreline slumping as well as turbid inflows from spring runoff set spring algae blooms back 7-8 weeks. This disturbance caused out-of-phase algal and zooplankton cycles throughout the summer and fall.



Sea-Cat booms up debris for layer removal of timber and slash which covered a large portion of Dworshak Reservoir in 1972.

Once the study team has deciphered some of the major causes and effect relationships of natural food production in Dworshak, management agencies can better assess the management alternatives available to them. The researchers now believe, for example, that a major cause of a 1972 mid-summer bloom of blue-green algae was the high volume of slash timber permitted to float on the reservoir for up to two years. Experimental work has shown that large amounts of algae nutrients were leached from this timber. Experimental testing of log leachates on algae growth has demonstrated specific stimulatory effects on algae populations and the rest of the fish

food chain. This information will remove much uncertainty in future management decisions on reservoir clearing and log rafting practices.

Falter and his assistants are also exploring the relationship between algae composition and zooplankton populations in Dworshak Reservoir. As the reservoir has matured in 1973 and 1974, zooplankton control of algal populations has been seen.

Management Results

Finally, the Dworshak research program has detailed the week by week physical, chemical and biological condition in the reservoir so that Dworshak Dam may be operated to enhance in-reservoir needs as well as the downstream fishery, water quality and recreation. For example, the researchers recommended that the heat content of the epilimnion (surface layer) could be maximized for swimming in the reservoir by mid- or deep withdrawals through the summer. At the same time, cooler water releases have improved trout fishing downstream from the reservoir.

LIMNOLOGY OF LAKE PEND OREILLE

Dr. C. Michael Falter
Bruce Rieman, graduate student

Research on Pend Oreille Lake is describing seasonal trends in the limnological characteristics of the lake, and determining the relative abundance and location of zooplankton aggregations correlated with kokanee distributions.

Falter and graduate student Bruce Rieman are comparing their results with previous knowledge of the lake to find out whether changes in the lake's water quality or productivity relate to a 10-year decline in the kokanee harvest. It is now apparent that the basic productivity of the lake is about 15 percent higher than 20 years ago. Declining food supply, therefore probably is not the reason for the decreased kokanee catch.

Among Idaho's lakes, Pend Oreille is unique for its extreme depth of 1,200 feet. According to Falter, zooplankton production in the lake seems to be intimately related to upwellings of nutrient-rich water from lower depths.

STEELHEAD AND SALMON TRACKED IN CLEARWATER AND SNAKE RIVERS

Dr. Ted C. Bjornn
Rudy Ringe, Res. Assoc.
Fred Stabler, graduate student

Dworshak Dam, located at the mouth of the North Fork of the Clearwater River was completed in 1969 and blocked the migration of steelhead trout to spawning grounds in the North Fork. Dworshak National Fish Hatchery, the largest steelhead hatchery in the world, was built by the U.S. Corps of Engineers to mitigate for the loss of this steelhead spawning area.

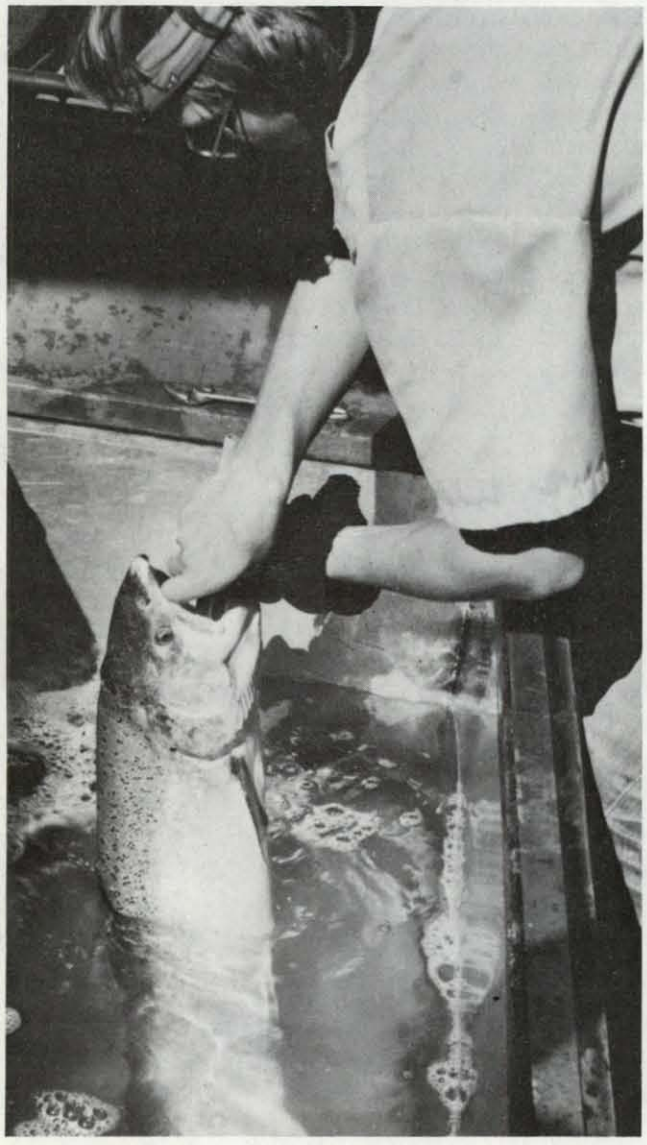
During 1974, Dr. T.C. Bjornn, leader of the Idaho Cooperative Fisheries Unit in the College of Forestry, Wildlife and Range Sciences, and research associate Rudy Ringe began research on the movements of steelhead trout and chinook salmon under the influence of planned schedules of water releases from Dworshak Dam. They hope to evaluate the effect of changed flows and the newly-filled Lower Granite impoundment on the migration of steelhead and chinook into the Clearwater River. They will also study the effect of Dworshak Dam water releases and Lower Granite Reservoir on the important Clearwater River steelhead fishery.

Lake Pend Oreille near Garfield Bay.

Fishery May Change

Spring runoff from the North Fork Clearwater River drainage is stored behind Dworshak Dam during summer for recreation uses. But before the occasional winter floods and the next spring runoff, the reservoir must be evacuated to allow storage at excess flows. Evacuation of water from Dworshak Reservoir during the fall and winter months coincides with the peak months of the steelhead fishing season on the Clearwater River downstream from Dworshak Dam. Changes in flow that result from the operation of Dworshak Dam for hydroelectric generation and flood control may alter the behavior of the fish and change this important fishery.

In addition, with the completion in the winter of 1974-1975 of Lower Granite Dam, the confluence of the Snake and Clearwater Rivers and a section of the Snake River where steelhead traditionally overwinter have been flooded. Steelhead may be forced to overwinter elsewhere and may have difficulty entering the Clearwater River because of the impoundment.



Phil Hiebert, biological aide, inserts radio tag into the stomach of a chinook salmon at Little Goose Dam.

Chinook salmon also enter the Clearwater River, primarily during May, June and July. Cooler water discharged from Dworshak Dam during these months, and the impoundment of Lower Granite pool may affect the entrance of salmon into the Clearwater River and their movement upstream past the mouth of the North Fork.

Research Methods

The researchers are marking steelhead and chinook with sonic or radio tags and releasing the fish in the Snake and Clearwater Rivers in order to track their movements. They will monitor the steelhead sport fishery through "creel census" (interviewing anglers on the rivers) and test fishing. Their results will be compared with migration and fishing data from previous years.

Specifically, Bjornn and Ringe will be looking at the effects of larger than normal flows proposed during September in the Clearwater on the movement of steelhead in the confluence area of the Snake and Clearwater, and the effects after September of peaking flows (rapid fluctuation of flows associated with hydroelectric generation) on steelhead movements. At the same time, the researchers will record the effects of changed flows on the sport fishery for steelhead and try to determine at which flows angling success begins to decline rapidly.

The research team will also assess the effects of Lower Granite impoundment on overwintering and the rate of "straying" (disorientation from usual migration path) of adult steelhead, as well as the effects of the impoundment on both steelhead and chinook salmon fishing in that area.

The results of this study should provide the Corps of Engineers with information which will help them in planning schedules of water releases which will optimize the sport fishery for steelhead and chinook and minimize interferance with the upstream migration of these fish.

IDAHO HUNTER SURVEY COMPLETE

Dr. Ted C. Bjornn

In 1974, Dr. T. C. Bjornn completed work on a questionnaire survey of Idaho hunters for the Idaho Fish and Game Department which provides detailed information on the characteristics of people who hunt in Idaho, their hunting activities and preferences, their opinions on important issues related to hunting and wildlife management and their economic expenditures while hunting.

1971 Hunters

Bjornn also conducted a questionnaire survey of Idaho anglers for the state Fish and Game Department in 1968.

The hunter questionnaire was mailed to some 10,000 hunters, 91 percent resident and nine percent non-resident, who purchased hunting licenses in 1971. Bjornn summarized the responses to the questionnaire with the aid of a computer.

Idaho hunting license records for 1971 show that some 85 percent of the states' male population between the ages of 20 and 49 are hunters, and among men from 30 to 39 years old, 92 percent bought hunting licenses in 1971. Such statistics prompted Bjornn to point out in his survey results that "a large group of males in Idaho with opinions and preferences which differ from those reported in the survey does not exist."

Survey Publications

The survey, available now in published form, should be a valuable aid to the Idaho Fish and Game Department in decision-making on hunting regulations and management policies.

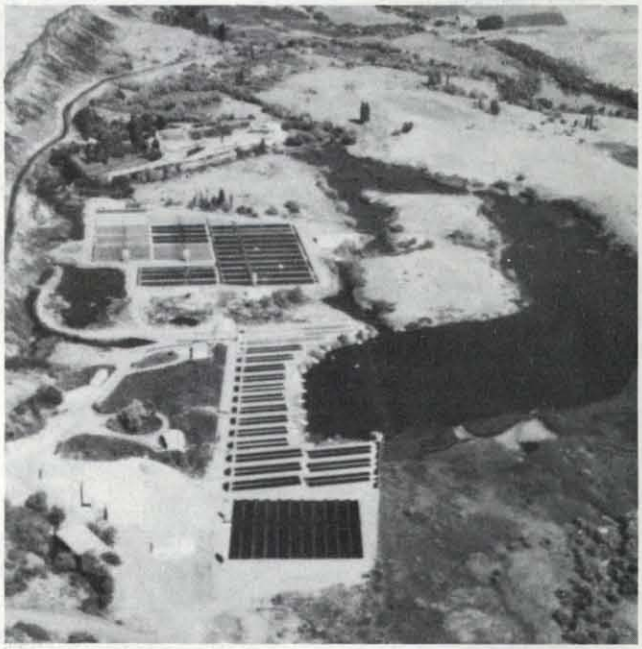
Also available in published form are the results of two surveys Bjornn conducted in conjunction with the Idaho hunter survey, for the purposes of comparison. One compares the responses from the hunter questionnaire with the responses of Idaho Fish and Game Department personnel who completed the same questionnaire. The second reports on the responses of a sample of Idaho hunters whose questionnaires included supplemental, background information about hunting regulations and wildlife management policies which was not provided in the original survey questionnaire.

IDAHO FOOD FISH INDUSTRY DESCRIBED

Dr. George W. Klontz

Dr. George W. Klontz, professor of fisheries management, has published a report, Aquaculture in Idaho and Nationwide, which is the first in-depth description of the food fish industry in Idaho. The purpose of the report is to describe the aquaculture industries of Idaho and their relationships to those in the nation as a whole from the aspects of 1) quantity and quality of water used, 2) production and marketing, 3) economic significance, 4) current factors affecting the industries and 5) future prospects. The data presented were collected during individual interviews, when possible, with each commercial fish farm manager in the state.

Centered in the Thousand Springs area near Buhl, Idaho, the commercial food fish industry in the state of Idaho produced an estimated 19.22 million pounds of rainbow trout and channel catfish in 1973, representing nearly 90 percent of the total U. S. production of processed rainbow trout. The gross value of fish produced in Idaho in 1973 has been estimated at $25 million.



Three fish hatcheries located near Buhl are Clear Springs Trout Company, foreground, Clear Lakes Trout Company, middle, and in the trees at rear, Thousand Springs Trout Company's Snake River Trout Farm.

CHINOOK SALMON KIDNEY DISEASE CONTROLLED AT RAPID RIVER

Kevin Amos, graduate student
Dr. George W. Klontz

Every year large numbers of adult chinook salmon migrate up the Columbia River system into Idaho to spawn. These salmon are an important resource for the state and the Northwest, and provide an exciting challenge for anglers.

A large number of these fish make their way up the Little Salmon River into Rapid River, and then to the Rapid River Hatchery where they originated. Rapid River Hatchery is owned by the Idaho Power Company and operated by the Idaho Fish and Game Department in mitigation for dams on the Snake River.

The salmon that move up Rapid River are held in large ponds at the Rapid River Hatchery until they are ready to spawn. The personnel at the hatchery spawn the adults and raise the resulting offspring until they are ready to migrate back to the Pacific Ocean.

Kidney Disease Problem

While the adult salmon are being held at the hatchery prior to spawning, they are plagued with a systemic bacterial infection named Bacterial Kidney Disease (KD). The incidence of this fatal disease has increased annually since the hatchery began in 1968, with annual mortality in adult spawners reaching higher than 35 percent.

Injections Successful

In 1974, the Fish and Game Department funded a two-year study to be conducted by Dr. George W. Klontz, professor of fisheries management, and fisheries graduate student Kevin Amos to investigate the cause of KD and to find a cure or control for it. Experiments carried out during the summer of 1974 indicated that injection of selected antibiotics into adult salmon in the hatchery is highly successful in controlling the disease. The injections had no ill effect on the adults or the resulting fry and therefore greatly increased the productivity of the spawning run. Plans are being made to inject adults again this summer, but on a much larger scale since the injections proved to be effective and safe.

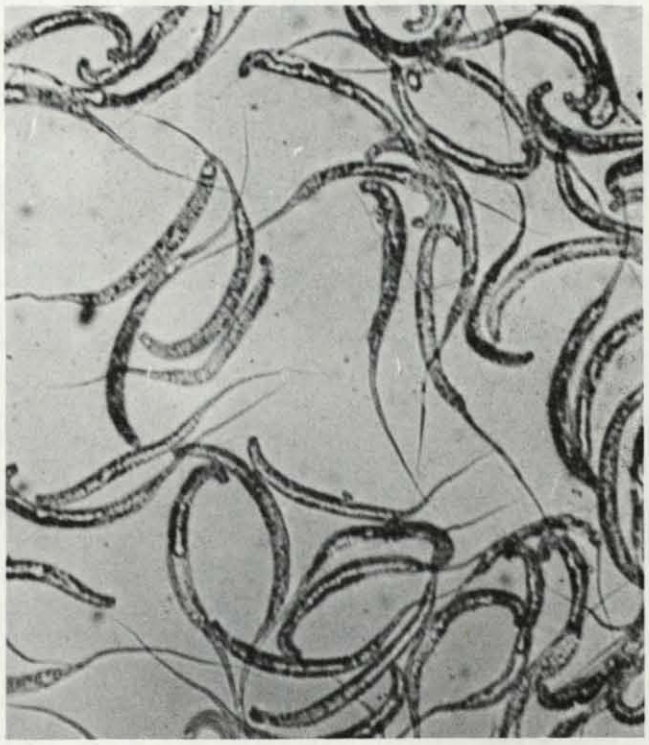
FISH PARASITE STUDIED AT PALISADES RESERVOIR

Athappily Jim Chacko, graduate student
Dr. George W. Klontz

Also under the supervision of Dr. Klontz, graduate student Athappilly (Jim) Chacko completed research on a nematode parasite infecting the body cavity of fishes in the upper Snake River drainage. The parasite, Philonema agubernaculum, causes binding of the visceral organs of fishes and in acute cases, a reduction in the reproductive potential of the fish. Palisades Reservoir in southeastern Idaho has a particularly high percentage of Philonema infection.

In 1973, the college Experiment Station entered into a contract with the Bureau of Reclamation to investigate the problem of Philonema in trout of the Palisades Reservoir and related drainages of the Snake River, and to recommend control measures.

Chacko brought hatchery-reared rainbow trout from Palisades Reservoir for a series of experimental infection studies in the laboratory to elucidate the life cycle of the parasite. The



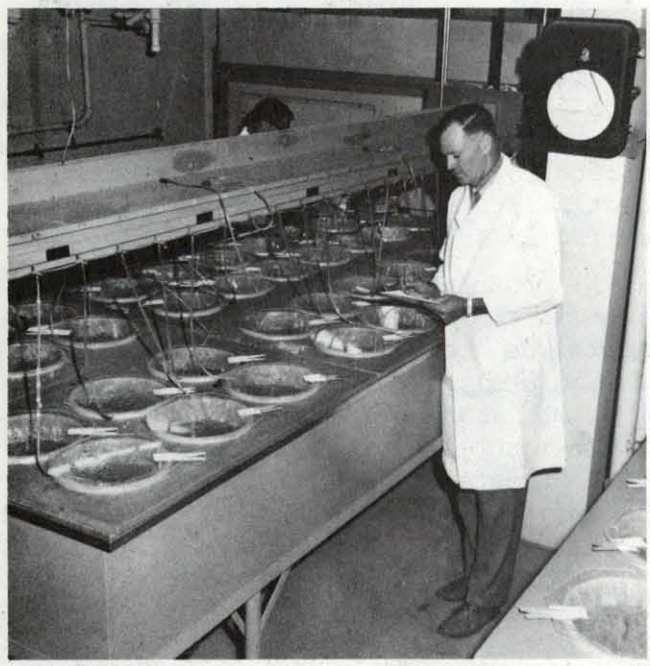
Larval form of Philonema agubernaculum.

zooplankton Cyclops becuspidatus was used as intermediate host. Cyclops exposed to Philonema larvae were transferred into a gelatin capsule and inserted into the esophagus of anesthetized juvenile rainbow trout. Adult Philonema worms were seen in the body cavities of the experimental hosts by the 205th day. Juvenile rainbow trout which were fed Cyclops from Palisades Reservoir also developed infection. Cutthroat trout fry exposed directly to the larvae of Philonema did not become infected.

Chacko's recommended control measures included a discontinuance of stocking of fish in the reservoir, stocking larger fish, or changing the species of fish stocked.

Palisades is Nidus

Fish were also collected from different locations in the Snake River and the Teton River and examined for Philonema to determine the incidence of infection. Chacko reported that Palisades Reservoir is currently the nidus of Philonema in the Snake River drainage of Idaho. He noted that infection with Philonema in the Teton River was very low, but that impoundment may lead to higher incidence of Philonema infection.



Dr. Craig MacPhee monitors a series of bioassays in progress determining the effects of temperature and chemical concentrations on fish.

SELECTIVE CONTROL OF STICKLEBACKS AND SUCKERS

Dr. Craig MacPhee
Dr. Fong-Chian Cheng, Res. Assoc.

The use of chemicals for the selective control of undesirable fish provides a useful tool for fisheries managers. By suppressing competing undesirable fishes, desirable fish populations obtain more food and grow larger.

A study begun in 1974 by Dr. Craig MacPhee, professor of fisheries resources, and research associate Dr. Fong-Chian Cheng, aims at increasing the production of Pacific salmon and other valuable fish in Alaskan waters by selective chemical control of the threespine stickleback.

Screening Program

Funded by the Alaska Department of Fish and Game, the research involves the screening of some 2,000 chemicals for selective toxin candidates. Stickleback, air-freighted alive to the campus, and salmon were tested together in bioassay facilities and the selectivity of each chemical noted.

The screening program led to the discovery of one chemical which has good potential for the selective control of stickleback. Present research focuses on the delineation of its biological properties, on the determination of its rate of degradation, and on the development of economical antidotes for neutralization of the compound.

In a separate project, another chemical was discovered by MacPhee and Cheng for the selective control of suckers, which often compose 70 percent or more of the fish biomass in streams. Research on the development of this fish toxin is funded by a Short-Term Applied Research (STAR) grant from the State of Idaho.

Developed Squoxin

Research on selective piscicides is not new for Dr. MacPhee, who, assisted by Mr. R. Ruelle, discovered squoxin, a chemical selectively lethal to squawfish. Since its discovery in 1964, squawfish have been successfully controlled in many Idaho streams. Experimental studies have shown that removal of squawfish increases sport fish survival.

Wildlife Resources

PRESCRIBED BURNING EFFECTS ON ELK DEGESTIBILITY OF BROWSE

Roy A. Nowlin, graduate student
Dr. Kenneth E. Hungerford

Prescribed burning effects on elk browse and the use of browse by elk in northern Idaho have been the focus of several studies in Idaho in recent years. Leege (1969) and Asherin (1973) determined that burning increased the quantity, nutrient quality and big game use of browse, while Hooker (1972) described the effects of prescribed burning on plant communities and the physical and chemical properties of the soil.

A more recent study conducted by graduate student Roy A. Nowlin under the supervision of Dr. Kenneth Hungerford, professor of wildlife, investigated prescribed burning effects on elk in vitro digestibility of key browse species on winter range along the Lochsa River in northern Idaho.

Douglas fir, mountain maple, ocean spray, redstem ceanothus, serviceberry and willow were sampled from burned and unburned paired plots during January and March, 1974. Innoculum (rumen fluid) sources for the study were four wild elk, one penned elk and a dairy cow.

Digestible dry matter, total volatile fatty acid production and molar percents of acetic, proprionic and butyric acids were measured and comparisons were made between burned and unburned plots and between yields of the different innoculum sources.

Of the measurements used, Nowlin found that digestible dry matter (DDM) showed the best positive correlation to comnsumption of browse by elk. However, neither DDM nor volitile fatty acid (VFA) production gave a complete separation of browse species, and mountain maple was consumed in small amounts but showed a high DDM.

There have been several studies in Idaho in recent years on the effects of controlled burns such as this one near Elk River, Idaho, on elk browse and the use of browse by elk. A new study on the effects of prescribed burning on the digestibility of elk browse was completed during 1974.

DDM ranged from 18 to 36 percent, with mountain maple highest, Douglas fir, redstem ceanothus and serviceberry second, willow third, and ocean spray lowest.

Douglas fir showed high DDM and consumption and Nowlin concluded that if consumption of Douglas fir by elk is below the rumen microbe inhibitory threshold, then Douglas fir is a highly digestible browse. Nowlin suggested additional research on the nutrient content and availability of Douglas fir.

Conclusions

In Nowlin's study, prescribed burning significantly increased digestibility of redstem ceanothus by one measurement, serviceberry by two and willow by all three. Nowlin concluded that, with the exception of willow, prescribed burning had no significant overall effect on the digestibility, as measured by either DDM or VFA, of the browse species considered on the Lochsa winter range. Nowlin suggested that digestibility effects alone do not explain the reported increase in elk use of burned sites.

All shrubs studied that were not burned, with the exception of ocean spray, were fairly high in relative digestibility and therefore were good potential sources of energy. Burning made them available to elk in larger quantities (Asherin 1973). Thus, while most browse did not change in digestibility, the net effect was still an increase in the energy available to elk.

A study on the pine marten in the Selway-Bitterroot Wilderness Area focused on the impact of wilderness fires on marten habitat.

WILDLAND FIRE ECOLOGY

AFFECTS MARTEN HABITAT

Gary H. Koehler, graduate student
Dr. Maurice G. Hornocker

In recent years, the U.S. Forest Service has designated several areas in Idaho's Selway-Bitterroot Wilderness as "Fire Management Areas". In these areas, the Forest Service is, as much as possible, allowing the return of the natural fire regime. Forest fires which occur are carefully watched, but not controlled. This program has provided wildlife researchers with a unique opportunity to study the natural role of fire as an influence on wildlife populations.

Wildland fires are cited as one of the destructive forces causing the disappearance of the pine marten from much of its range. How has the marten, a climax forest species, survived in an ecosystem where fire plays such a vital role in directing the evolution of plant and animal communities?

A two-year study conducted in the Selway-Bitterroot Wilderness by graduate student Gary M. Koehler, under the direction of Dr. Maurice G. Hornocker, has resulted in a better understanding of the relationships of marten and fire ecology in a wilderness system.

Koehler's study indicates that marten use a variety of forest types throughout the year. During the critical winter period, mature spruce-alpine fir stands receive the highest marten activity. Thus, a large continuous mature forest type may support more marten over space than a mosaic forest type, but it may not over time. Koehler points out that the heavy fire fuel loadings and continuous fuel types associated with large continuous mature forest types may result in larger and hotter fires. Larger and hotter fires result in more marten habitat replacement.

A mosaic of forest types with discontinuous fuel types may result in smaller and cooler fires, which cause less marten habitat replacement. Koehler concludes that a mosaic of forest types, which is maintained by periodic fires in a natural ecosystem, supports the diversity of food items used by marten throughout the year, and results in a continuum of marten habitat through succession.

BIG GAME RESPONSE TO WILDLAND FIRES

Dr. James M. Peek

Dr. James Peek began a study on big game response to wildland fires in 1974 in the Selway-Bitterroot Wilderness Area's White Cap Fire Management Area, where two fires in 1973 burned for over a month on portions of deer and elk winter range.

The initial year of study focused on determining the current status and distribution of the elk population, and on first-year vegetation responses to the fires on ponderosa pine-bunchgrass winter range.

1974 Research

Herbaceous vegetation on the burned sites, especially introduced annuals, responded by increased production over adjacent unburned areas during the growing season following the fires. Shrubs on the burns, especially spirea and snowberry, had attained heights nearly equal to those occurring on unburned sites.

Elk cow-calf ratios of 100:36 (February 1974) and 100:28 (January 1975) indicated only mediocre production and survival of calves in the study area. Calving was distributed across the winter range, and subsequent "nursery groups" of elk were located at artificial and natural licks up the White Cap drainage on summer range. In early summer, elk populations were distributed across the whole White Cap drainage, while in late summer the high elevation cirque basins and drainage heads containing cool, moist stands of mature Engelmann spruce and subalpine fir received highest use.

The vegetation and Wildlife research will be continued, and the study will be expanded to include the responses of white tailed and mule deer to the burns using radio-collared animals.

WILDLIFE RESPONSE TO REST-ROTATION GRAZING SYSTEMS

Dr. James M. Peek
Craig Kvale, graduate student

Rest-rotation grazing systems can provide land managers with a tool for rangeland restoration while retaining livestock grazing. Developed in California, this method is now widely and successfully practiced on rangelands throughout the West.

Little is known, however, about wildlife responses to rest-rotation grazing in Idaho. A rest-rotation system to be applied to the Herd Creek Grazing Allotment on Forest Service and BLM lands along the East Fork of the Salmon River provides an excellent opportunity for study.

Graduate student Craig Kvale and Dr. James Peek, in cooperation with the Idaho Fish and Game Department, U.S. Forest Service and Bureau of Land Management, began in the winter of 1974 by assessing mule deer forage preferences and range use patterns in the study area. When cattle and elk move on to the area during the summer, their forage preferences and range use patterns will also be investigated. As the sites critical to each species and the areas of overlapping use are determined, changes in the vegetation composition and utilization will be monitored.

A herd of elk moves through burned-over seral shrub range near Bad Luck Creek.

1974 Findings

Several findings of interest were reported from the first winter's studies. Mule deer preferred big sagebrush and bluebunch wheatgrass as forage. Both of these forage species constitute a major proportion of the current vegetation on this area and thus can be expected to be altered as the grazing system causes change. A key factor to be determined is whether mule deer forage preferences will also change.

Contrary to most observations which show that south-facing slopes and ridgetops are critical mule deer winter range, in this area the steep north-facing slopes with deepest snows were most used during the winter. This pattern probably is a reflection of range condition, since the north-facing slopes support the most productive vegetation in this area and south-facing slopes on the winter range appear badly deteriorated. As with forage preferences, specific sites preferred for winter range may change as the grazing system continues.

The investigations will focus also on the responses of big game to the presence of concentrations of livestock in the various pastures associated with important wildlife summering areas. While forage use patterns are a major source of information on wildlife-livestock-rangeland interactions, the effect of the physical presence of livestock on wildlife distributions must also be investigated.

It is hoped that the responses of breeding songbird and grouse populations to the rest-rotation system can be included in the continuing study. Changes in songbird species composition and density may provide an index to habitat changes associated with the system.

The whole study will ultimately provide information by which changes in wildlife populations can be predicted. Land managers could then develop refinements in the system to benefit wildlife as well as livestock.

This newly-hatched gosling will grow in four months to be a nine to 12 pound Canada goose.

CANADA GOOSE RESEARCH IN EIGHT STATES AND CANADA

Elwood G. Bizeau
William Krohn, graduate student

The Rocky Mountain population of the Canada goose has a breeding range extending from southern Alberta along both sides of the Continental Divide into northeastern Colorado and northern Utah. This population winters mainly in southeastern Idaho and along the lower Colorado River in Arizona and California.

Wildlife agencies responsible for the management of Rocky Mountain geese have collected a wide range of information over the past 20 years, but major changes in breeding, molting, migrating and wintering areas, as well as changes in hunter harvest characteristics, have necessitated an in-depth look at the past and present Canada goose population status.

The Idaho Fish and Game Department and the Pacific Flyway Waterfowl Council requested that Elwood Bizeau, assistant leader of the Idaho Cooperative Wildlife Research Unit at the University of Idaho undertake a study of the Rocky Mountain Canada goose population which will result in the development of long-range objectives and guidelines for management.

Bizeau, working with two federal wildlife services and the wildlife agencies of eight states and one Canadian province, will (1) inventory the known breeding and wintering areas and assess their potentials for supporting Canada geese, (2) evaluate population characteristics with special emphasis on distribution, sex and age structure, productivity and survival, and (3) estimate the impacts of hunting through analysis of harvest and banding data.

Computer and Field Work

A back-log of 28,000 goose band recoveries for the Rocky Mountain population of Canada geese have been obtained from the Federal Bird Banding Office at Patuxent, Maryland, and are being banked in the University of Idaho computer for analysis of movements, mortality and hunter harvest during the past two decades. Preliminary aerial reconnaissance of wintering habitats for geese in southern California were made during the fall and winter of 1974. In the spring of 1975, graduate student William B. Krohn, will begin field work on goose breeding areas in the Rocky Mountain states and Alberta.

ECOLOGY OF LEOPARD STUDIED IN AFRICA

Dr. Maurice G. Hornocker
Dr. Ian McT. Cowan, U.B.C.
Dr. Theodore Bailey, Res. Wildl. Bio.

Field studies on the ecology of the leopard were initiated during 1973 in Kruger National Park, Republic of South Africa. The lack of basic ecological information on the leopard, a threatened species, prompted research on this solitary and elusive big cat. As unregulated hunting increases and habitat is lost to human settlement, the need for detailed biological and ecological information on this species becomes more urgent.

Cooperating in this international study are the University of Idaho, the University of British Columbia, the South African National Parks Board and the Nature Conservation Branch of Kruger National Park. Objectives of the research include 1) studying the population dynamics of leopards by determining population density, sex and age composition, breeding age, reproductive capacity, mortality rate and population turnover; 2) determining territory size and

Dr. Theodore Bailey, left, field investigator, and Dr. Maurice Hornocker, leader of the Idaho Cooperative Wildlife Research Unit at the University of Idaho, fit a tranquilized female leopard with a radio collar. An international study on the ecology of the leopard continues at Krugar National Park in the Republic of South Africa.

daily and seasonal movements and relating these to food habits, family composition and population density; and 3) investigating the role of the leopard as a predator, including evaluation of the leopard's impact on populations of prey species, particularly impala.

Study Sites

Kruger National Park, one of the largest and oldest game sanctuaries in Africa, is located in the eastern low veld of the Republic of South Africa and supports a substantial and undisturbed population of leopards. Two areas associated with the Sabie-Sand and Nwaswithskaka Rivers in the southern region of the park were selected as study sites. A large variety of game animals are found in this region and the narrow belts of vegetation bordering the streams are favored habitat for the leopard.

The research team plans to capture all resident leopards in the study areas and fit them with radio transmitter collars. An attempt is made each day to locate all leopards wearing radio collars, combined with visual observations and collection of scats. Additional data are collected on the relative abundance of prey species, seasonal differences in prey numbers and prey habitat.

Over a period of time, radio tracking produces information not only on the movements and home ranges of leopards, but on seasonal shifts in ranges, extent of social interaction, spatial distribution, territorial behavior, activity patterns, habitat usage and food habits.

1974 Report

The researchers report that during 1974, nearly all adult leopards were captured and radiotracked on the two study areas. Starting at the onset of the dry season, many previously uncaptured leopards were captured and fitted with radio collars. In addition, all but one previously captured leopards were recaptured and had their collars replaced. All sex and age classes of leopards, except small young, have been radiotracked and several leopards have been tracked continuously since the study began in August 1973.

Thus far, 23 leopards have been captured 78 times, and of these, 21 have been fitted with 28 different radio collars. Radiotracking periods have varied from a few weeks to 16 months. Except for one female, all adult leopards utilizing the Sabie-Sand study area have been captured, but on the Nwaswithshaka study area two or three remain uncaptured. These are believed to be females with dependent young.

Death and New Life

Five marked leopards have died and three others have probably died since the study began. One leopard was illegally shot or snared, one died of unknown causes, and six, all in poor physical condition and suffering from heavy parasitic infestations, apparently died of starvation.

Apparently only two of eight marked adult females have had young in 16 months and of these, one apparently lost her litter after several weeks. Tracks and behavior suggest, however, that two unmarked females may have had young, and another unmarked female is the mother of a two-year-old marked female.

In addition to the ecological information from 2270 daily radio location observations, information on leopard feeding, courtship and scent marking behavior has been obtained from 83 visual observations. Since remains of leopard kills seldom last 24 hours after the leopard is through feeding, kills have been difficult to locate. Thirty-three kills, 30 of which were impala, have been examined to date.

Appendix

FWR EXPERIMENT STATION SCIENTISTS

Ables, E. D., Associate Dean and Professor (Wildlife Resources)
Adams, D. L., Associate Professor (Forest Resources)
Allen, G. M., Instructor (Forest Resources)
Anderson, Hal, Research Technician (Forest Resources)
Asherin, Duane, Research Wildlife Biologist
Bailey, Ted, Research Wildlife Biologist
Beachler, L., Research Librarian (Fisheries-Wildlife Resources)
Belt, G. H., Associate Professor (Watershed Management)
Bizeau, E. G., Assistant Leader, Cooperative Wildlife Research Unit and Associate Professor (Wildlife Resources)
Bjornn, T. C., Leader, Cooperative Fishery Unit and Professor (Fisheries Resources)
Bottger, Richard, Assistant to the Directors
Burlison, V., Extension Professor
Canfield, Elmer, Research Forester (Forest Resources)
Chacko, Rosy, Research Scientist (Forest Resources)
Cheng, Fong-Chian, Research Scientist (Fisheries Resources)
Claar, James, Research Associate (Wildlife Resources)
Drewien, Rod, Research Wildlife Biologist
Ehrenreich, J. H., Dean, Director and Professor (Range Ecology)
Erickson, D., Research Technician (Forest Resources)
Falter, C. M., Associate Professor (Fisheries Resources)
Fazio, J. R., Associate Professor (Wildland Recreation)
George, Willard, Research Technician (Wildlife Resources)
Godfrey, E. B., Associate Professor (Forest Economics)
Gordon, Roger, Research Associate (Forest Resources)
Hanley, Donald, Research Associate (Forest Resources)
Harris, Margaret, Research Associate (Forest Resources)
Hash, Howard, Research Associate (Wildlife Resources)
Hatch, C. R., Associate Professor (Forest Resources)
Heller, R. C., Research Professor (Remote Sensing)
Hironaka, M., Professsor (Range Resources)
Hofstrand, A. D., Assistant Professor (Wood Products)
Hornocker, M. G., Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Resources)
Houck, J., Research Technician (Forest Resources)
Houghton, J. E., Assistant Professor (Wood Products)
Howe, J. P., Professor (Wood Products)
Hungerford, K. E., Professor (Wildlife Resources)
Irwin, Larry, Research Associate (Wildlife Resources)
Johnson, David, Public Information Technician
Johnson, F. D., Professor (Forest Ecology)
Johnson, L. R., Assistant Professor (Forest Products)
Jones, R., Research Technician (Forest Resources)
King, J. G., Instructor (Watershed Management)
Klontz, G. W., Professor (Fisheries Resources)
Larson, L., Research Technician (Fisheries Resources)
Lazelle, M., Herbarium Research Associate (Forest Resources)

Leonard, James, Research Technician (Fisheries Resources)
Loewenstein, H., Professor (Forest Soils)
MacPhee, C., Professor (Fisheries Resources)
Mahoney, R., Research Associate (Forest Resources)
McCullough, M., Research Technician (Fisheries Resources)
McFadden, M., Research Forester (Forest Resources)
McNevin, Judy, Research Associate (Wildland Recreation)
Messick, John, Research Associate (1/2-time) (Wildlife Resources)
Mika, Peter, Research Associate (Forest Resources)
Miller, T., Research Associate (Wildlife Resources)
Mitchell, J. E., Assistant Professor (Range Resources)
Moore, James, Research Associate (Forest Resources)
Osborne, Harold, Research Associate (Forest Resources)
Partridge, A. D., Professor (Forest Pathology)
Peek, J. M., Associate Professor (Wildlife Resources)
Peterson, S. R., Assistant Professor (Wildlife Resources)
Pettit, Diane, Communications Expert
Pitkin, F. H., Professor (Forest Resources) and Nurseryman
Pommerening, Edward, Research Associate (Forest Resources)
Prausa, Charles, Research Associate (Forest Resources)
Ringe, Rudy, Research Associate (Fisheries Resources)
Scanlin, David, Research Forester (Forest Resources)
Schenk, J. A., Professor (Forest Entomology)
Seale, R. H., Professor (Forest Resources)
Seidensticker, T., Research Wildlife Biologist (Wildlife Resources)
Sharp, L. A., Professor (Range Resources)
Sowles, K. M., Associate Professor (Wood Products)
Stark, R. W., Dean Graduate School and Professor (Forest Entomology)
Stellmon, Barbara, Lab Technician (Forest Resources)
Stoszek, Karel, Research Scientist (Forest Resources)
Tisdale, E. W., Associate Director and Professor (Range Resources)
Ulliman, J. J., Associate Professor (Remote Sensing)
Walker, Richard, Research Associate (Wildland Recreation)
Wang, C. W., Professor (Forest Genetics)
Wellner, Charles, Research Forester (Forest Resources)
White, R. G., Assistant Leader, Cooperative Fishery Unit and
Assistant Professor (Fisheries Resources)
White, R. S., Assistant Professor (Range Resources)

ONGOING RESEARCH PROJECTS

Option	Project Title	Principal Investigator(s)
Forest Resources	Commercial thinning of second-growth forests	D. L. Adams
	Scaling defective cedar logs	D. L. Adams
	Resource inventory and plan for Dworshak project	C. R. Hatch
	Modeling forest biomass	C. R. Hatch
	Ecology of disjunct populations of red alder in Idaho	F. D. Johnson
	IBP coniferous biome study	F. D. Johnson

Option	Project Title	Principal Investigator(s)
Forest Resources (continued)	The effect of Dow Corning silicone antitranspirant on surface evaporation	J. G. King G. H. Belt
	Forest fertilization: Its influence on stands of Douglas-fir and grand fir in Idaho	Howard Loewenstein F. H. Pitkin D. C. Scanlin
	U. of I. Experimental Forest Research	Howard Loewenstein G. M. Allen D. L. Adams E. G. Schuster
	Seedling growth and survival in coniferous species	Howard Loewenstein F. H. Pitkin
	Decays of inland-northwestern timber trees	A. D. Partridge
	Idaho tree diseases and defects	A. D. Partridge
	Disease-insect interactions in forest trees	A. D. Partridge
	Seedling container development	F. H. Pitkin
	Bionomics and control of cone and seed insects	J. A. Schenk
	Influence of natural and manipulated stand characters on *S. ventralis* population and damage level	J. A. Schenk
	Integrated pest management: The principles, strategies and tactics of pest population regulation and control in major crop eco-systems - major pine bark beetles - lodgepole pine	R. W. Stark
	Genetic studies of ponderosa pine	C. W. Wang
	Forest tree breeding in Idaho	C. W. Wang
	The effect of thermal water on tree growth and wood quality	C. W. Wang J. P. Howe

Option	Project Title	Principal Investigator(s)
Range Resources	Analysis of plant communities associated with riparian habitats along the Snake River	Minoru Hironaka
	Investigate multiple use capabilities of forest-associated range in central Idaho batholith	Minoru Hironaka L. A. Sharp
	Application of remote sensing to vegetation and soils	Minoru Hironaka E. W. Tisdale
	Revegetation of mine spoils in northern Idaho	J. E. Mitchell F. H. Pitkin Howard Loewenstein
	Effects of livestock trampling on plant growth and forage productivity	L. A. Sharp
	Evaluation of range seeding	L. A. Sharp
	Grazing management program for native ranges in southeastern Idaho	L. A. Sharp
	Range resources of the West	L. A. Sharp W. E. Folz E. B. Godfrey
	Mineral supplements for control of larkspur poisoning in cattle	L. A. Sharp
	Site relationships and productivity of foothill woodland-shrub grazing lands in Idaho	E. W. Tisdale
Wood Utilization	Influence of forest sites on wood properties of inland Douglas-fir	J. P. Howe
	Development of laminated railroad ties	J. P. Howe
	Characteristics of Idaho forest industry	E. B. Godfrey
	Development of laminated structural lumber	J. P. Howe
Wildland Recreation Management	Quantification of aesthetic values	F. L. Newby
	Off-road vehicle study	E. G. Schuster
	Socio-economic data for land-use planning	E. G. Schuster

Option	Project Title	Principal Investigator(s)
Wildlife Resources	Inventory of riparian habitats and associated wildlife along Columbia and Snake Rivers	D. A. Asherin
	Distribution and density of chukar partridge populations along the Snake River	E. G. Bizeau
	Fire ecology, successional patterns and ungulate relationships in the North Fork of the Flathead River Valley, Glacier National Park	E. G. Bizeau
	Habitat use by wood ducks in North Idaho	E. G. Bizeau
	Ecology of the greater sandhill crane in southeastern Idaho	E. G. Bizeau
	Ecology of the wolverine in northwestern Montana	M. G. Hornocker
	The effects of fire on marten distribution and abundance in the Selway-Bitterroot Wilderness	M. G. Hornocker
	Seasonal and diurnal movements of the black bear in West Central Idaho	M. G. Hornocker
	Ecology of the leopard in Kruger National Park, South Africa	M. G. Hornocker
	Prescribed burning influences on the forage value of key big game browse species	K. E. Hungerford
	Evaluating pocket gopher damage to forest trees in Idaho	K. E. Hungerford
	Habits and habitat of mountain caribou	D. R. Johnson
	Range and migration of the Lochsa elk	R. R. Knight
	Winter movements and behavior of a Pahsimeroi mountain goat herd	J. M. Peek
	Social organization of the moose in northern Idaho	J. M. Peek
	Range use and food habits of mule deer in the Pahsimeroi Valley	J. M. Peek

Option	Project Title	Principal Investigator(s)
Fisheries Resources	The carrying capacity of streams for rearing salmonids as affected by sediment and other components of the habitat	T. C. Bjornn
	Sediment in streams and its effects on aquatic life	T. C. Bjornn
	Evaluation of the effects of Teton Dam and Reservoir on fisheries resources of the Teton River	T. C. Bjornn
	Parr smolt transformation in summer-run steelhead trout and chinook salmon	T. C. Bjornn
	Habitat selection and interaction of cutthroat and steelhead trout	T. C. Bjornn
	Effects of fluctuating and constant water temperature on autecology of steelhead trout	T. C. Bjornn
	Hunter preference survey	T. C. Bjornn
	Evaluation of methods for increasing native cutthroat stocks in northern Idaho	T. C. Bjornn
	Distribution and behavior of Idaho fishes: Yield of seaward migrant chinook salmon and steelhead	T. C. Bjornn
	Dworshak Reservoir limnological studies	C. M. Falter
	Aquatic vegetation survey - Snake River Basin	C. M. Falter
	Idaho fish hatchery survey	G. W. Klontz
	Life history and control of *Philonema agubernaculum*	G. W. Klontz
	Production in a constant temperature trout stream	Craig MacPhee
	Aquatic studies with silicone anti-transpirant	Craig MacPhee
	Development of selective fish toxicants	Craig MacPhee
	Swimming performance of Arctic grayling	Craig MacPhee

Option	Project Title	Principal Investigator(s)
Fisheries Resources (continued)	Effects of controlled water fluctuations on fish and fish food organisms in Hells Canyon, Snake River, Idaho	Craig MacPhee

PUBLICATIONS 1974

Adams, David L. and G. M. Allen. 1974. Lumber production from "Precommercial" thinnings in northern Idaho. FWR Exp. Sta. Station Paper #16. 11 p.

Adams, David L. and E. W. Mogren. 1974. Stocking parameters for lodgepole pine. FWR Exp. Sta. Station Paper #18. 6 p.

Allen, Gerald M., D. L. Adams and C. R. Prausa. 1974. Preliminary volume tables for small trees in northern Idaho. FWR Exp. Sta. Station Note #21. 3 p.

Armour, Carl L. 1974. Serum antigenic differences in spring chinook salmon (Oncorhynchus txhawytscha) from two separate rivers. Trans. Am. Fish. Soc. 103(2):379-382.

Bailey, T. N. 1974. Social organization in a bobcat population. J. Wildl. Manage. 38(3):435-446.

Belt, George H., J. King and E. Bailey. 1974. An instrument system for estimation of evapotranspiration by the eddy correlation method. FWR Exp. Sta. Station Paper #19. 16 p.

Bjornn, T. C., et al. 1974. Sediment in streams and its effects on aquatic life. Idaho. University. Water Resources Research Inst. Res. Tech. Comp. Report OWRR Proj. No. B-025-1DA. 47 p.

Brusven, M. A. and Craig MacPhee. 1974. An evaluation of squoxin on insect drift. Am. Trans. Fish. Soc. 103(2):362-365.

Brusven, M. A. Craig MacPhee, and Russell Biggam. 1974. Snake River flow study. Benthic insects (Effects of water fluctuation on benthic insects) Chapter 5:67-79. IN: Anatomy of a River. Pacific Northwest River Basins Commission. 203 p.

Drewien, R. C., and E. G. Bizeau. 1974. Status and distribution of greater sandhill cranes in the Rocky Mountains. J. Wildl. Manage. 38(4):720-742.

Dudley, Richard G. 1974. Growth of Tilapia of the Kafue Floodplain, Zambia: predicted effects of the Lafue Gorge Dam. Trans. Am. Fish. Soc. 103(2):281-291.

Fazio, James R. and Douglas L. Gilbert. 1974. Mandatory wilderness permits: Some indications of success. J. of Forestry. Vol. 72. No. 12. 4 p.

Griffith, J. S., Jr. 1974. Utilization of invertebrate drift by brook trout (Salvelinus fontinalis) and cutthroat trout (Salmo clarki) in small streams in Idaho. Trans. Am. Fish Soc. 103(3):440-447.

Halbach, T., and C. M. Falter. 1974. The relation of irrigation return flows to water chemistry and periphyton in the Lemhi River Idaho. OWRR Report A-041-IDA.

Heller, R. C., R. C. Aldrich, R. S. Driscoll, R. E. Francis, and F. P. Weber. 1974. An evaluation of ERTS data for forest inventory, range, and stress. Final report to NASA from Pacific Southwest and Rocky Mountain Forest and Range Experiment Stations. 240 p.

Heller, R. C. 1974. Remote sensing as an inventory tool for forest insect surveys. Proc. "Monitoring Forest Environment through Successive Samplings" IUFRO/SAF joint meeting. Syracuse Univ. of N.Y. June 24-26, 1974. pp. 321-343.

Hofstrand, A. D. 1974. Transverse compression of inland Douglas-fir. FWR Exp. Sta. Station Paper No. 13. 15 p.

Hooker, Larry L., and E. W. Tisdale. 1974. Effects of prescribed burning on a seral brush community in northern Idaho. FWR Exp. Sta. Station Paper #14. 11 p.

Howe, J. P. 1974. An interim report on producing laminated 2 x 4's from 1 x 4 boards. Idaho Forest Industries, Coeur d'Alene, Idaho.

Howe, John P. 1974. Relationships of climate to the specific gravity of four Costa Rican hardwoods: An exploratory study. Wood and Fiber. Vol. 5, No. 4. Winter 1974. p. 347-352.

Krausman, P. R., E. D. Ables, and C. M. McGinnis. 1974. Deer identification through pellet pH. J. Wildl. Manage. 38(3): 572-573.

MacPhee, Craig and M. A. Brusven. 1974. Catchability and feeding habits of fish. Chapter 6:81-84. IN: Anatomy of a River. Pacific Northwest River Basins Commission. 203 pp.

MacPhee, Craig and Fong-Chian Cheng. 1974. Aquatic studies with silicone antitranspirant. Job performance report. Dow-Corning Corporation. 8 p.

MacPhee, Craig and Fong-Chian Cheng. 1974. Determination and development of toxicants selectively lethal to the threespine stickleback. Job performance report. Alaska Fish and Game Department. Contract No. 1508:28 p.

MacPhee, Craig and Fong-Chian Cheng. 1974. Development of selective fish toxins. Job I-d. Project F-64-R-3. Factors affecting degradation of squoxin and toxicity of squoxin to six fish species. Job Performance Report. 33 p. Multilith.

Meinzer, W. P., D. N. Ueckert, and J. T. Flinders. 1974. Coyote food habits in brush infested rangelands. Texas Tech Univ. Noxious Brush and Weed Control Res. Highlights 5:34-35.

Messick, J. P. 1974. Effects of pesticide applications on ringnecked pheasants. J. Wildl. Manage. In press.

Messick, J. P., E. G. Bizeau, W. W. Benson, and W. H. Mullins. 1974. Aerial pesticide applications and ring-necked pheasants. J. Wildl. Manage. 38(4):679-685.

Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38(3): 541-545.

Norman, C. M., H. Loewenstein, and F. H. Pitkin. 1974. Effects of light intensity on survival and growth of grand fir seedlings. FWR Exp. Sta. Station Paper #17. 12 p.

Peek, J. M. 1974. A review of moose food habit studies in North America. Naturalist Can. 101:195-215.

_____. 1974. On the nature of winter habitats of Shiras moose. Naturalist Can. 101:131-141.

_____. 1974. Initial response of moose to a forest fire in northeastern Minnesota. Am. Midl. Nat. 91(2):435-438,

_____, R. E. LeResche and D. R. Stevens. 1974. Dynamics of moose aggregations in Alaska, Minnesota and Montana. Jour. Mamm. 55(1):126-137.

Renwald, J. D., J. T. Flinders and H. A. Wright. 1974. Prescribed burning for quail management on mesquite-tobosa rangelands. Texas Tech Univ. Noxious Brush and Weed Control Res. Highlights 5:37.

Ringe, Rudy R., J. Coon. 1974. Sturgeon fishing. IN: Anatomy of a River: Chapter 9. Pacific Northwest River Basins Commission Report, Vancouver, Washington. p. 107-112.

Schuster, E. G., W. Koss and E. Godfrey. 1974. Employment and wages in Idaho's forest products industry. FWR Exp. Sta. Infor. Series #5. 46 p.

Seidensticker, J. C. IV, M. G. Hornocker, W. W. Wiles and J. P. Messick. 1973 (pub. 1974). Mountain lion social organization in the Idaho Primitive Area. Wildl. Monogr. Ser. No. 35. 60 pp.

Vaughn, H. W., R. R. Knight and F. W. Frank. 1973 (pub. 1974). A study of reproduction disease and physiological blood and serum values in Idaho elk. J. Wildl. Diseases 9:296-301.

Wang, Chi-Wu and R. K. Patee. 1974. Variation in seed characteristics, and seedling growth of open pollinated ponderosa pine progenies. FWR Exp. Sta. Station Paper No. 15. 11 p.

Watts, F. J. and C. MacPhee. 1973. Swimming performance of Arctic grayling. Proc. of the 21st Annual Hydraulics Division Specialty Conference, Hydraulic Engineering and the Environment. Held at Montana State Univ., Bozeman, MT. p. 11-20.

Will, G. C. 1973 (pub. 1974). Hunting success on northern Idaho white-tailed deer, 1969-1971. Northwest Sci. 47(4):250-255.

PhD Dissertations

Drewien, Roderick C. 1974. Ecology of Rocky Mountain greater sandhill cranes. 70 p.

Francis, John K., Jr. 1974. Available nitrogen in a fertilized grand fir stand. 69 p.

Kirtibutr, Nit. 1974. The bionomics of Pityokteines elegans swaine in grand fir in northern Idaho. 92 p.

Lee, Ming-Jen. 1974. Isolation of races and physiological study of Western White Pine Blister Rust. 3 papers, 86 p.

Miller, Daniel Lee. 1974. Root decays and their indicators in Idaho grand fir. 32 p. (a collection of papers)

Masters Theses

Abulah, Sule S. 1973. Wallboard of cement and wood particles. 60 p.

Erickson, Glen E. 1974. Habitat preferences of wood ducks (Aix sponsa) in northern Idaho. 32 p.

Froeming, Dennis K. 1974. Herbage production and forest cover in the Pseudotsuga menziesii-symphoricarpos habitat type of northern Idaho. 39 p.

Halbach, Thomas. 1974. The relation of irrigation return flows to water chemistry and perithyton in the Lemhi River, Idaho. 60 p.

Irwin, Larry L. 1974. Relationships between deer and moose on a burn in northeastern Minnesota. 51 p.

Klein, Allen D. 1974. Grand fir inner bark carbohydrates affected by bark beetle-root disease interaction. 25 p.

Knowles, Kenneth. 1974. An evaluation of larkspur poisoning in cattle and the trampling damage that occurs during grazing on a summer range in eastern Idaho. 101 p.

Krisnabamrung, Wichitr. 1974. Strength and dimensional stability of electrically oriented particleboard from Western Redcedar mill waste. 70 p.

Kulhavy, David L. 1974. Cone and seed insects of grand and subalpine fir in northern Idaho. 79 p.

Money, Dennis L. 1974. Mule deer habitat use in the Pahsimeroi Valley, Idaho. 50 p.

Mullins, William H. 1974. Summer food habits, chemical contaminants and distribution of the greater sandhill crane. 2 papers, 14 p. and 8 p.

Nowlin, Roy A. 1974. Prescribed burning effects on In Vitro digestibility of elk browse. 27 p.

FUNDING SUPPORT

During the calendar year 1974, the Forest, Wildlife and Range Experiment Station received funding from a variety of sources. The State of Idaho provides regular budgetary support for the Station each year. In addition, the Forest Utilization Research program, funded by the State of Idaho, provided special funding for a series of research programs dealing with urgent forest utilization problems facing the state of Idaho.

The Cooperative State Research Service, of the United States Department of Agriculture, provided funding through the McIntire-Stennis Act of 1962 for a series of projects primarily dealing with forest fertilization, disease and insects and forest-wildlife relationships. The United States Fish and Wildlife Service of the Department of the Interior and the Idaho Fish and Game Department provide regular funding for the Cooperative Wildlife Unit and the Cooperative Fisheries Unit.

In addition grant funds were made available by a variety of federal and state agencies and private corporations and organizations. The Forest, Wildlife and Range Experiment Station expresses its appreciation for the funding, and for the support provided by the agencies already indicated and the followings which provided grant support:

Abbott Laboratories
Aerojet Nuclear Company
Agricultural Research Service (USDA)
Alaska Fish and Game Department
Allied Chemical Corporation
American Forest Institute
Anaconda Forest Products
Army Corps of Engineers
Bennett Lumber Company
Boise Cascade
Boise National Forest
Boone and Crockett Club
Bunker Hill Company
Bureau of Land Management (USDI)
Clearwater National Forest
Cooperative State Research Service (USDA)
C.P. Clare Company
Diamond International
Don Diehl
Dow Corning
Greater Shoshone County, Inc.
Idaho Citizens Grazing Association
Idaho Department of Public Lands
Idaho Fish Food Industry
Idaho Fish and Game Department
Idaho Forest Industries
Idaho Nuclear Energy Commission
Idaho Power Company
Idaho Research Foundation, Inc.
Idaho State Parks and Recreation
Idaho Water Resources Board
Idaho Water Resources/Research Institute
Inland Empire Paper Company
Intermountain Forest and Range Experiment Station, U.S. Forest Service
Lucky Peek Nursery
Morrison-Knudsen Company, Inc.
National Science Foundation
New York Zoological Society
Northeastern Forest Experiment Stations, U.S. Forest Service
Northern Pacific Railway
North Idaho Forestry Association
Ohio Agriculture Research and Development Center
Pacific Northwest Forest and Range Experiment Station, U.S. Forest Service
Pacific Northwest Power Company
Pacific Northwest Regional Commission
Pack River Lumber Company
Payette National Forest
Potlatch Corporation
Public Land Law Review Commission
Rachelwood Wildlife Research Preserve
South Idaho Forestry Association
Stillinger Trust
St. Regis Paper Company
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service
University of Massachusetts (Peace Corps)
University of Oregon (Pacific NW Regional Commission)
University of Washington (National Science Foundation)
Welder Wildlife Foundation
Weyerhaeuser Company
Wildlife Management Institute

University of Idaho

Forest, Wildlife and Range Experiment Station
College of Forestry, Wildlife and Range Sciences
Moscow, Idaho

COVER PHOTO:
A young subalpine fir
grows in the protection of a
white bark pine hollowed out by fire
Professor Frederic Johnson photographed
this combination at the 6,500 foot elevation
at Duck Lake, Payette National Forest.