

FOCUS

on Renewable Natural Resources



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University of Idaho

Volume 6

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

Range Management and Service

Research focused at Idaho's rangeland resources is the theme of this year's Focus. The rangeland resource makes a major, yet often neglected, contribution to the state's economy.

The utilization of Idaho's rangeland resource is not new. Lewis and Clark commented on great herds of horses owned by the Nez Perce grazing on these lands at the time of their visit. Cattle and sheep industries boomed with the mining bonanza of the 1800s. Today over 65 percent of the land area in Idaho is grazed by domestic livestock; grazing occurs in every county in Idaho, in desert shrub zones of southern Idaho, as well as in Pacific bunchgrass zones and forested areas of northern Idaho.

During the 1800s and early 1900s public lands were subjected to unlimited use, and some overgrazing resulted. With the advent of a grazing permit system, this use became regulated. During the past three decades, the total Animal Unit Month use on Bureau of Land Management and Forest Service lands has decreased approximately 15 percent. Part of the reduction is explained by the withdrawal of lands from grazing use. Other reductions are due to actual and perceived decline in range condition.

A major direction of the range resource research program at the University of Idaho has been and is to improve range quality and range carrying capacity. Accomplishments in these areas are partially described in the article on Point Springs. Improved procedures for measuring the trend in range condition are helping to more accurately quantify range use. These and other studies provide the foundations for potential increases in red meat production which are being accomplished through coordinated management of public and private rangelands.

During the 1980s the range resource program will continue the two-pronged approach it has successfully used in the past—research programs focused at identifying range management needs combined with a service program that communicates solutions to both public and private rangeland managers. During the year, if you identify a research need in range resource use or any of the college's other natural resource areas, discuss it with us. We depend on your communication to focus our research programs. Let us hear from you.

Charles R. Hatch



Susan Hieb photo

**TO BORROW SEE
OFFICE STAFF
THIS FLOOR**

FOCUS

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Fiscal 1980 Annual Report



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**FOREST, WILDLIFE AND RANGE
EXPERIMENT STATION**

Cover: Moving the cattle to Cold Springs. Lee Sharp photo

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 **University of Idaho**

Range Resources



Riders examine the range in Seven Devils country. *Lee Sharp photo*

RANGE RESEARCH PROGRAM STRESSES CONTINUITY

Edwin W. Tisdale

When the Range staff increased from one to two members in 1948, it became possible to develop a research effort of more than token dimensions. The program begun at that time has grown steadily with high continuity along a few major lines. In retrospect, building new studies on knowledge gained in previous work has afforded a greater understanding of the rangelands of the state.

The first project was an investigation of aerial range reseeding with pelletized seed. Results were largely negative, as the merits of this short-cut method of range reseeding had been greatly oversold by its promoters. Interest generated from the pelletized seed study led to a project dealing with the ecology and productive capacity of sagebrush ranges in the state. This theme has continued as one of the major research efforts of the Department of Range Resources. The earliest work was on a small scale, but in 1954 increased financial support was received through a regional Hatch project (W-25) in cooperation with the College of Agriculture. This project, with revisions, con-

tinued until 1969, developing a fund of knowledge for the large and varied sagebrush-grass region of Idaho. More recently, this work, with support from the USDA Forest Service, has emphasized classification of sagebrush ranges in the state.

Offshoots of this research theme include studies of the growth and development of two major grasses of the sagebrush region, under the International Biological Program; an evaluation of the value of satellite imagery for delineating range types in southern Idaho; and an intensive study of the species and subspecies of big sagebrush (*Artemisia tridentata*).

Investigation of major vegetation types was extended in 1961 to the bunchgrass ranges of northern Idaho, located in the valleys of the Snake and Salmon rivers and their tributaries. This research has been conducted on a small but continuing scale since 1976.

Other developments from the sagebrush-grass study began with a project on the ecology and productivity of associated shrub and woodland range types which led to studies of the western juniper type, mountain mahogany and mountain shrub types, and high elevation forest openings in north central Idaho.

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A second major research theme has dealt with range weeds, plant species which are undesirable because of their unpalatable or toxic characteristics. Studies of the ecology and control of such plants began in 1950 with halogeton (*Halogeton glomeratus*), an annual succulent plant highly toxic to livestock, especially sheep. Serious losses of sheep near Malta in south central Idaho in 1945 increased awareness of the financial impact of range weeds. Another range weed studied in detail, medusahead (*Taeniatherum asperum*), is an introduced annual grass of low palatability which invaded large areas of depleted sagebrush-grass rangeland. A third investigated species, goatweed (*Hypericum perforatum*), is an introduced perennial herb, mildly toxic, but undesirable mainly due to its unpalatable nature and its aggressiveness on grasslands and open forests in northern Idaho. Intensive study of these weeds provided knowledge of their nature and potential needed for developing methods of control. In the case of goatweed, biological control by means of an imported beetle proved highly effective.

An early spinoff from the halogeton project was an investigation into the ecology and productivity of salt-desert shrub ranges, the type most strongly invaded. These studies in turn led to investigations of rehabilitation of these and associated sagebrush range types. The need for suitable methods for managing reseeded ranges brought about long-term grazing studies at Point Springs, and later at Malad and Soda Springs.

Recent research on the use of fire to control sagebrush or other shrub stands which have become too dense for desired forage production represents a continuing phase of the interest in control of undesirable range plants.

RANGELAND CLASSIFICATION SYSTEM DEVELOPING

Minoru Hironaka

The Department of Range Resources, in cooperation with the USDA Forest Service and the Plant and Soil Sciences Department of the College of Agriculture, are developing a habitat type classification scheme for non-forest land. Scientists have confined their work to the sagebrush and mountain brush zones, where they have identified and characterized more than 30 major habitat types and their associated soils. Habitat type classification differs from vegetation type classification in that the habitat type is based on the potential or climax vegetation, rather than the current existing vegetation.

The habitat type and range site classification schemes have much in common. However, by definition, one or more range sites may occur within a habitat type. The major advantage of the habitat type scheme is that the nomenclature of the habitat type is unique. A range site (or ecological site) name may be repeated on different soils and vegetation in different physiographic provinces. Application of the range site classification is restricted geo-

graphically, and difficulty is encountered in interpreting vegetational data on a regional or national scale.

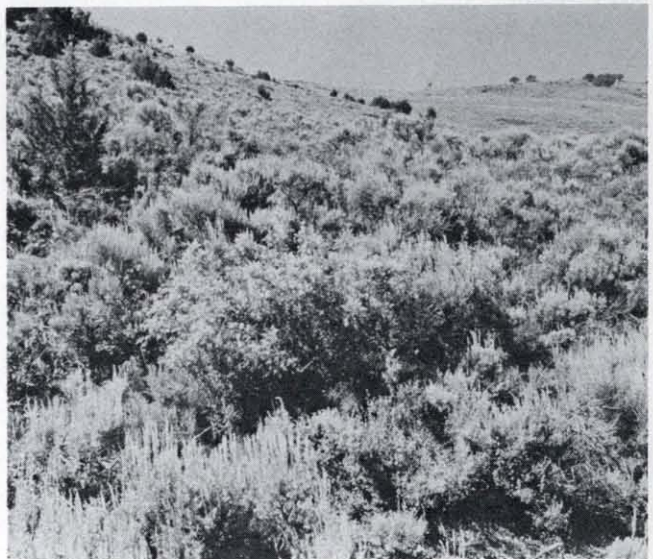
The habitat type classification permits delineation of areas capable of supporting the same basic natural vegetation. Occurrence of the same climax vegetation indicates similar environment. A different climax plant community would indicate a significant difference in the environment.

The role of soils is integral to the development of habitat type classification of rangelands. The basic premise that the same soil body supports or supported the same climax vegetation has been basic to an understanding of soil-vegetation relations. However, because plants are capable of tolerating a range in environmental conditions, similar soil bodies may also support the same climax vegetation. Theoretically, each soil is associated with a particular habitat type. Thus, where examples of climax vegetation are lacking, the soils become increasingly important in identifying the probable potential vegetation.

A land classification based on habitat types alone has limited value to the land manager because much of the current vegetation is not climax. Two classifications are needed—that of the present vegetation and of the climax or potential vegetation.

The basic means of classifying seral or disturbed communities within habitat types are already available. With the development of a conceptual model for secondary succession, scientists can display seral relationships of plant communities with habitat types.

The combined use of the habitat type and associated seral community classifications produces sound basic ecological framework for a resource information storage and retrieval system handling the characteristics, seral status, and probable disturbance response.



Artemisia vaseyana/*Festuca idahoensis* habitat type on open range in eastern Idaho. Lee Sharp photo



Domestic livestock and wildlife both use the steep terrain of the Heavens Gate grazing allotment on the Nez Perce National Forest. Regulating use can protect both the range condition and available forage for deer, elk, and cattle which graze the area. *Mia Smith photo*

REGULATED USE URGED ON BIG GAME, LIVESTOCK RANGE

Mia E. Smith
Kenneth D. Sanders

The Rapid River drainage near Riggins, Idaho, is a major wintering area for mule deer and elk. Part of the drainage lies within a grazing allotment known as Heavens Gate on the Nezperce National Forest. In the mid-1970s, controversy developed over the grazing of domestic livestock on the big game wintering area. Charges were made that excessive numbers of cattle were grazing too long, threatening to destroy some of the best winter range in that region. Since that time, U S D A Forest Service and Idaho Department of Fish and Game personnel, representatives of conservation groups, the Idaho Rangeland Committee, and the permittees have worked together to develop a better management plan for the area.

The Heavens Gate area is located within the eastern edge of the Columbia Intermontane Geomorphic Province on the east slope of the Seven Devils Mountains. In general, the terrain is very steep and dissected by numerous drainages. Vegetation on the study area is representative of the Pacific bunchgrass type with ponderosa pine and Douglas-fir

forests occurring on north slopes and at higher elevations. Logging has occurred in recent years in some of the forest communities.

The diversity of the physiography and vegetation on the Heavens Gate area provides a variety of habitats for wildlife. The lower, more southerly exposed slopes on the resource area are important as big game winter range. Livestock grazing during summer and fall is a traditional use.

Deer numbers in the Heavens Gate area were high in the 1950s and early 1960s, but declined in the late 1960s and early 1970s. This trend has occurred elsewhere in Idaho and the west. A recent aerial census of the Rapid River drainage suggests that both deer and elk numbers are increasing.

In the spring of 1977, range scientist Mia Smith and Professor Kenneth Sanders initiated this project to provide information on the elk, deer, and cattle which graze the Heavens Gate resource area winter range. Objectives of the study were first, to determine the food habits and distribution of big game and cattle; and second, to determine the composition and biomass of available forage.

Two years of field data collected from late May through early December yielded production and composition

figures based on weight measurements by species. Researchers clipped plots both before and after cattle grazing, and collected big game pellets prior to cattle grazing in each pasture. They determined the diets of cattle, deer, and elk by fecal analysis.

Results showed that cattle primarily consumed grasses, although browse consumption was significant on logged pastures, especially during the early part of the grazing season. In winter, deer fed primarily on browse while elk ate approximately equal portions of browse and grasses. Cattle and big game selected the browse species ponderosa pine (*Pinus ponderosa*) and Oregon grape (*Berberis repens*), but cattle consumed these species only in logged pastures and only during certain times of the grazing season. Cattle and deer showed low diet similarity except for these two species.

Although elk and cattle showed greater diet similarity than deer and cattle, this apparently has not been a problem since the elk populations have been continuing to increase. Elk probably forage more widely than the cattle since the terrain is rugged and elk are less affected by steep slopes. Elk and deer forage on the wintering areas during the same season, consuming many of the same species. The potential for competition seems greatest between these two species.

Proper forage allocation and regulation of use will allow domestic livestock and wildlife to coexist on the same range without adverse effects to either animals or range. Elsewhere this approach has resulted in increased forage for both livestock and big game. With the current emphasis on multiple use management, both resource values can and should be accommodated.

RESOURCE APPRAISAL NEEDS SPUR GRASSLANDS STUDY

Edwin W. Tisdale

About one and a half million acres of grassland in the valleys of the Snake and Salmon river systems in north central Idaho constitute an important range resource in our state. Similar vegetation occurs in adjacent parts of Oregon and Washington.

This grassland area is unique in several respects. It spans a great range of elevation from 700 feet in the Snake River valley bottom near Lewiston to 7500 feet or more in the Seven Devils Mountains. Another noticeable feature is the steepness of slope, often 100 percent or over. Well grassed slopes of 50 to 70 percent occupy more than half the area. The rugged topography offers great diversity of aspect, with consequent sharp changes in vegetation, often from grassland to forest on opposite-facing slopes. The

local climate is correspondingly varied, especially in temperature, with hot summers and mild winters at the lower elevations. A rich flora and fauna result from the diversity of habitat and include several plant species unique to the area.

This area provides a prime grazing resource for livestock, deer, elk, and other wildlife. It is particularly valuable for late fall, winter and early spring use because of the mild climate and high nutritive value of the forage. Unrestricted grazing by livestock in the early days of white settlement severely damaged many of the more accessible areas. Livestock use is now better managed. Vegetation of less accessible areas remains in relatively good condition.

The grassland area has always been of concern to land managers due to its key role in providing winter range, as well as its importance for related values of watershed and recreation. This interest has been increased by the inclusion of much of the Snake River portion of the area in the Hells Canyon National Recreation Area. In addition, parts of the National Recreation Area are, or will be, designated as wilderness. New standards are needed for resource appraisal and management, which depend on basic knowledge of the resource.

The need for more detailed knowledge of these grasslands is the rationale for the present study, begun in 1976. Previous research on the grasslands has been sporadic and confined to particular areas or plant communities. The objectives of the current study by Edwin W. Tisdale, professor emeritus of Range Resources, are to describe and classify the grassland vegetation and to relate differences in vegetation to site factors including topography, climate and soils. Results indicate that classification to habitat type is feasible in spite of the vegetation mosaic created by habitat variation. The grassland types differ from those occurring in the Palouse region north of these river valleys.

Five habitat types in the canyon grasslands have been described in a preliminary classification; several more will probably be recognized with further study. Investigation of habitat factors related to the grassland types shows the importance of topography and soils. Elevation and aspect are both closely related to vegetation type, as are soil depth, stoniness, temperature, organic matter content, and soil color.

Knowledge of habitat types obtained from relatively undisturbed sites should make it possible to classify and ascertain the potential grazing value of other parts of the canyon grasslands, which have been greatly altered by heavy use in the past. The value of this approach has already been demonstrated for forest and sagebrush lands in the state and appears to be applicable to the grasslands.

GRAZING STUDY MARKS 25TH ANNIVERSARY

Lee A. Sharp
Kenneth D. Sanders

One of the longest continuing grazing studies on record marked its 25th anniversary last year, as over 100 livestock operators, agency personnel and former University of Idaho students who had worked on the project turned out to celebrate at the Point Springs Experimental Station. The project, initiated to control a noxious plant, continues to provide valuable long-term grazing and plant vigor data.

Halogeton (*Halogeton glomeratus*), a noxious annual plant highly poisonous to sheep, was introduced into Nevada in the early 1930s. Well suited to the dry, salty rangelands of southern Idaho, halogeton quickly spread on disturbed sites and rangelands in low condition. In the late 1940s, several bands of sheep were lost due to halogeton poisoning.

Congress passed the *Halogeton glomeratus* Control Act in 1952 to fund management practices for its control. In Idaho the Bureau of Land Management preferred reseeding to crested wheatgrass for control rather than spraying with herbicides as was done in some areas. Time has proven reseeding the most effective control practice as it not only

controlled halogeton but also increased forage production 10-15 times over conditions prior to seeding.

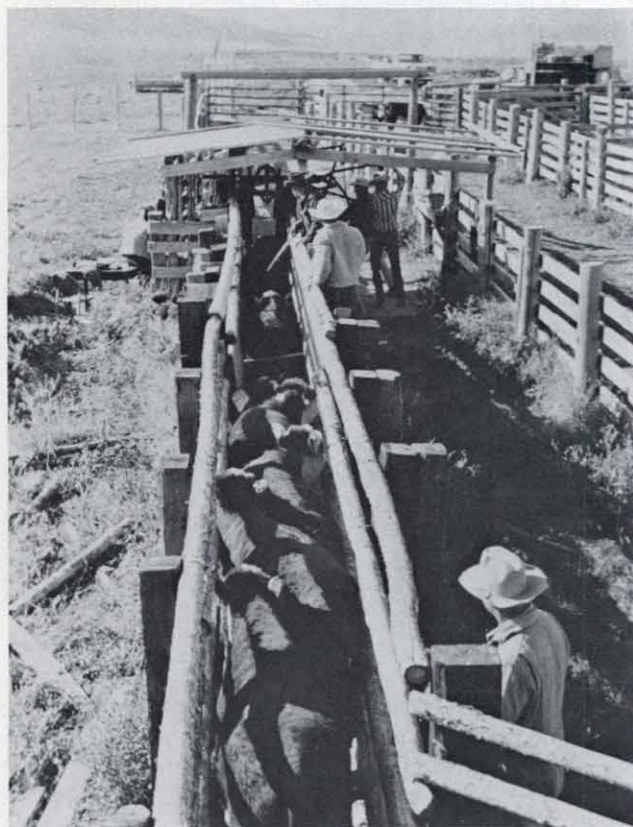
In 1953 the Agricultural Experiment Station and the Forest, Wildlife and Range Experiment Station of the University of Idaho, and the Bureau of Land Management undertook a long-term range experiment to determine the best management practices for crested wheatgrass seedings. They chose a 960-acre Bureau of Land Management seeding in the Raft River Valley, Cassia County, as a study site. In 1954 the University of Idaho, Bureau of Land Management and Point Springs Grazing Association (livestock producers) signed a Memorandum of Understanding, in which the Bureau of Land Management agreed to furnish fencing, water development, corrals and technical assistance; the livestock operators agreed to furnish the livestock and assistance in construction of necessary facilities; and the University agreed to design and conduct a grazing study.

Initial grazing trials began in the spring of 1955 to evaluate light, moderate, and heavy stocking rates during spring or fall grazing. Combined spring and fall grazing were added to the study in 1960. Range scientists measured the effect of the various grazing intensities on plant growth, stand density, nutritive value, forage production, and animal gains. This long-term study has produced information useful in developing management programs on crested wheatgrass rangeland. Some of the more significant findings are listed.

- Precipitation in April, May, and June strongly influences yearly forage production;
- Combining some level of summer or fall grazing with light or moderate spring grazing maintains stand density, forage production and increases nutritive value during all seasons as compared with grazing in only one season;
- Yearling cattle gains generally exceed 2 pounds a day during the spring;
- Early grazing of crested wheatgrass is more detrimental to animal production than to plant vigor; and
- Forage production and plant vigor have been restored to heavily used crested wheatgrass stands by resting a year or two, by deferring during the growing season and/or alternating the timing of grazing during the growing season.

Because of the growth characteristics, tolerance of heavy grazing, and rate at which crested wheatgrass improves vigor and production, a number of alternative grazing programs can be devised. This flexibility enhances management programs for other kinds of rangelands in an operation.

Although it is difficult, if not impossible, to evaluate a grazing treatment in a short-term study, very few grazing studies have been conducted over as long a period as this one. Even more significant is the fact that livestock operators in the Point Springs Grazing Association have furnished livestock throughout the study.



Cattle enter the chute to be weighed at Point Springs.
Lee Sharp photo

Forest Resources

BEETLES DIFFER IN HOST SPECIES PREFERENCE

Molly Stock
Pamela Higby

Over the range of the mountain pine beetle, differences in host species preference occur. In one area beetles may attack one tree species, while in a nearby area with similar trees present, another species might be attacked. These preferences have an underlying genetic basis resulting from beetle adaptation to unique characteristics of different tree species.

Pine and other conifers respond to invading organisms, such as bark beetles, by producing copious amounts of oleoresin containing monoterpenes toxic to bark beetles. Monoterpene vapors from pine oleoresin form one level of tree resistance to these pests. Earlier studies showed a close association between vapor toxicity of pine resins and host relationships of beetles. That is, because host monoterpenes differ markedly among tree species, beetles raised in one kind of tree are less susceptible to the toxic vapors of that tree than beetles raised in another tree species.

Genetic comparisons of mountain pine beetle populations from sites in Utah, Wyoming, South Dakota, Oregon, and Idaho have shown that beetles are closely adapted to the specific host tree in which they are found. Forest Resources Professor Molly Stock and graduate student Pam Higby are now undertaking studies to determine more specifically the differences between beetles in lodgepole pine and ponderosa pine in forests of northern Idaho. This work will help explain how beetles select host trees and will be incorporated into management strategies for this forest pest.

PROTEIN SEPARATION AIDS IN DETECTION OF PARASITES

Molly Stock
Paul Castrovillo

Biological control, the conservation and enhancement of natural enemies of pest insects, is a viable alternative to management tools such as pesticide application. To effectively utilize natural enemies, it is usually necessary to know which beneficial insects are present and at what levels. Many of them are species of parasitic wasps and flies that feed within the host (eventually killing it) and are not

readily visible. Traditional methods of monitoring these enemies center on rearing hosts and counting emerged parasites or, alternatively, dissecting hosts. Both techniques are subject to inherent limitations and biases.

As an outgrowth of their genetic studies of spruce budworms, Forest Resources Professor Molly Stock and graduate student Paul Castrovillo have developed a new screening procedure, using biochemical techniques of protein separation, that can be used to detect the presence of *Glypta fumiferanae*, a common parasitic wasp that kills spruce budworm caterpillars. These parasites, living within their budworm hosts, contain protein types sufficiently different from those of the host to make accurate separation of parasitized and unparasitized budworms possible. Using this technique, measuring the percentage of a budworm population harboring parasites becomes a simple matter. In early comparisons of processing price, time, and space requirements, this method rates highly against traditional techniques. With further refinement, electrophoretic detection of parasites shows promise as a tool usable in western spruce budworm management.

MOUNTAIN PINE BEETLE-FIRE INTERACTION IN PINE TRACED

Leon F. Neuenschwander

The mountain pine beetle, in conjunction with fire, exerts a strong influence on lodgepole pine stand structure. In the absence of fire, beetle epidemics effectively thin stands of pine and hasten succession toward climax. After a fire, lodgepole pine will reoccupy the site if an available seed source is present.

Some investigators have studied the successional pattern of lodgepole pine; yet they have had little success correlating vegetation and fuel succession beyond noting that as stands become overmature, large fuel accumulations result. Largely they have been unsuccessful in defining a relationship in immature and mature stands because of broadly defined stand parameters and large study areas. This study focuses attention on selected habitat types within a small geographic region.

A survey of downed woody fuels conducted last summer in Glacier National Park (on Douglas-fir/pinegrass habitat type) showed promising results in relation to fuel succession and mountain pine beetle epidemics. Researchers sampled stands killed within the last 6 years plus an area killed 25 years ago. To lengthen the time line the agenda

for the 1980 field season included investigation of areas affected by the beetle 50 to 60 years ago in the Swan Valley and the Libby area, regions known to have harbored epidemic beetle populations in the early 1900s. Stands killed by the mountain pine beetle in the *Picea/Vaccinium caespitosum* or the *Picea/Clintonia uniflora* habitat types also will be studied. Hopefully, the combined results will add to an understanding of the beetle-pine-fire interaction.

GENETIC VARIATION EXPLORED IN SECOND-GROWTH REDCEDAR

William R. Gall

Second-growth western redcedar, often considered a weed species in the Northwest, is rating a second look from tree physiologists and geneticists. Forest managers have favored Douglas-fir and white pine over the slower growing, shade-tolerant cedar.

Old-growth cedar in swamps or bogs provides roofing shakes, fencing, and other similar forest products because of its knot-free and rot-resistant qualities and aesthetic value. Researchers are examining the potential of second-growth cedar as the old-growth cedar forests in northern Idaho disappear through use.

Second-growth cedar stands now occur in Idaho on sites where the seral Douglas-fir, larch, or grand fir have been cut or declined with age. These second-growth cedar stands often are 70 to 160 years of age and 8 to 18 inches in diameter at breast height. The net volume of western redcedar growing stock in the northern Rocky Mountains in 1970 was highest for the diameter classes between 9 and 25 inches, according to a USDA Forest Service report, the Rocky Mountain Timber Situation. The timber potential of second-growth cedar may be uncertain, because it contains more knots and less decay-resistant heartwood than the old-growth. As a shade-tolerant species, cedar tends to be slow growing.

On wet sites, where cedar is climax, its slow growth and excessive taper are undesirable for timber production. Cedar grows better on drier, mid-slope sites in fertile, well-drained soil with good structure. Thus, growth characteristics of cedar differ from those of such other timber species as ponderosa pine, which grows best on a site more moist than its climax habitat. Forest managers require much more information on the management of second-growth cedar.

Researchers at the University of Idaho studied growth characteristics in approximately 30 second-growth cedar stands in various parts of northern Idaho during 1979. Preliminary results show that cedar growth rates vary from 3 to 12 rings per inch in trees 70 to 160 years old. These

growth rates were obtained on sites ranging from 2500 to 4300 feet in elevation. Growth rates of 7 to 14 rings per inch have been reported in the literature on comparable sites.

The objectives of this study are to estimate phenotypic variation in taxonomic and commercial characteristics of the parent trees from which cones are to be collected, and to estimate relative amounts of genetic variation in growth characteristics among stands, within stands and among offspring of the same tree. Forest Resources Professor Robert Gall will study genetic variation among seed sources using seedlings grown at three geographic locations in northern Idaho. Cones will be collected from 10 trees each in a minimum of 15 stands during the fall of 1980. Seed from these cones will be grown in containers for 5 months during the spring and summer of 1981. These seedlings will then be planted on replicated plots in each of the three study areas.

Identity of the parent tree will be retained with each seedlot. The following information will be obtained from each of the parent trees: wood specific gravity; percent heartwood; radial growth rate; wood content of thujaplicin (a natural wood preservative); identity and variability of aromatic compounds in the leaves; form class; height; diameter; number of sound seed per cone; number of scales per cone; length of cone; length, width, weight, volume and wing width of seeds; length and width of leaves on lateral branchlets and on leading shoots, and presence or absence of glandular pits on the leaves.

Results of this study will provide forest managers with estimates of the amount of phenotypic variation in important commercial characteristics of cedar in the northern Rockies. Estimates of genetic and environmental components of variation in early seedling growth will serve as a basis for decisions regarding future research, development and management in the species.

INSECTICIDES, SPRAY TIMING AFFECT BUDWORM MORTALITY

Molly Stock
Jo Ellen Force

Western spruce budworm populations differ markedly in their response (percent mortality) to treatment with different insecticides. Techniques for estimating levels of mortality from a particular chemical would be an invaluable aid to forest managers.

Cooperative research between Professor Molly Stock at the University of Idaho and Dr. Jacqueline Robertson at the Pacific Southwest Forest and Range Experiment Station, Berkeley, CA, is leading to improved understanding of the genetic mechanisms underlying budworm response to chemical insecticides. Pilot studies have discovered a relationship between differing proportions of certain gene



Sixth instar spruce budworm larva feeds on grand fir.
Paul Castrovillo photo

types present in different budworm populations and the response of these populations to organophosphate and carbamate insecticides. Researchers are testing whether the response of field populations can be predicted by monitoring genetic levels of tolerance in these populations before spraying. Results of this work will influence insecticide treatment decisions for spruce budworm outbreaks in Idaho.

In related studies, Stock and Robertson have shown that the response of different larval stages of spruce budworm to insecticides differs, and that timing spray application to the age of caterpillars present in an infestation is essential for maximizing treatment effectiveness. Continuing work in this area, a cooperative effort of Stock, Robertson, and Professor Jo Ellen Force at the University of Idaho, includes development of a decision-making guide to spray use, incorporating information on weather, genetic composition of budworm populations, and age of larvae present.

SPRUCE BUDWORM CHARACTERISTICS MAY SIGNAL OUTBREAK PATTERNS

Molly Stock
Paul Castrovillo

Forest Resources Professor Molly Stock and graduate student Paul Castrovillo are characterizing western spruce budworm variation over its entire range in an attempt to correlate genetic markers with important physiological or behavioral traits. This work is funded by the Canada/

United States Spruce Budworms Program, an accelerated research, development, and applications program sponsored by the USDA Forest Service. This broad-based comparison of western spruce budworms uses insect samples from areas as diverse as Alaska, British Columbia, and New Mexico.

Budworm population characteristics of particular interest include: a predisposition to remain at low density levels or to periodically reach epidemic proportions; the ability of certain budworms to feed on alternate host species foliage or trees resistant to attack by the majority of budworms present, and genetic adaptation of particular isolated budworm populations for survival under localized geographic conditions.

Stock and Castrovillo also have instituted an intensive study concentrating on the Payette and Boise National Forests in Idaho—historically one of the major regions of spruce budworm infestation in the Pacific Northwest. The third recorded budworm epidemic began in this area in 1967. By 1978, heavy defoliation was visible over nearly 1 million acres of Idaho forest. Using electrophoretic data in combination with records of budworm defoliation over time the researchers hope to explain particular budworm outbreak patterns, as well as to uncover information which may help predict future trends and aid in management of western spruce budworm damage.

REFORESTATION TESTS FEATURE SEED WAFERS

David L. Adams
Luke Powell

Seed wafer planting of 60,000 lodgepole pine, white spruce and Douglas-fir will be tested this summer as a reforestation method on harvested acreage near Elko, British Columbia.

Forest Resources graduate student Luke Powell and Professor David L. Adams have been working to improve design of a protective pellet of vermiculite, activated carbon and methyl cellulose which will provide a favorable microenvironment for seed germination.

Reforesting land with seed wafers could save labor and transportation costs over both bare root and containerized methods. Seed wafers three-quarters inch in diameter and three-eighths inch thick are dropped and pressed into the ground, where they hold more moisture than silt loam soil, keeping the seed from drying out. For this project, seed and land for the test planting are provided by the cooperator, Crows Nest Forest Products, Ltd., of Elko. Seeds are encapsulated in the wafer in laboratory facilities at the College of Forestry, Wildlife and Range Sciences.

Improved methods of reforestation are vital to the Inland Northwest, where current figures show over 276,085 acres in need of forest planting.

Fishery Resources

EFFECT OF FLOW VARIATION STUDIED ON SALMONID EGGS

Robert C. White
Dudley Reiser

In tests conducted with artificial egg nests, or redds, in Hells Canyon and in four artificial channels at the Hayden Creek Research Station, researchers found that rapid stream flow changes including periods of no flow had little effect on salmonid eggs as long as water was available when the eggs hatched.

Fishery Resources Professor Robert White and graduate student Dudley Reiser conducted the tests for the Water Resources Research Institute, Office of Water Research and Technology, and for the Bonneville Power Administration. Effects of fluctuating flows from hydroelectric power peaking on the Snake River Hells Canyon Dam were studied to determine whether flow fluctuation was in part responsible for the near extinction of Snake River fall chinook salmon.

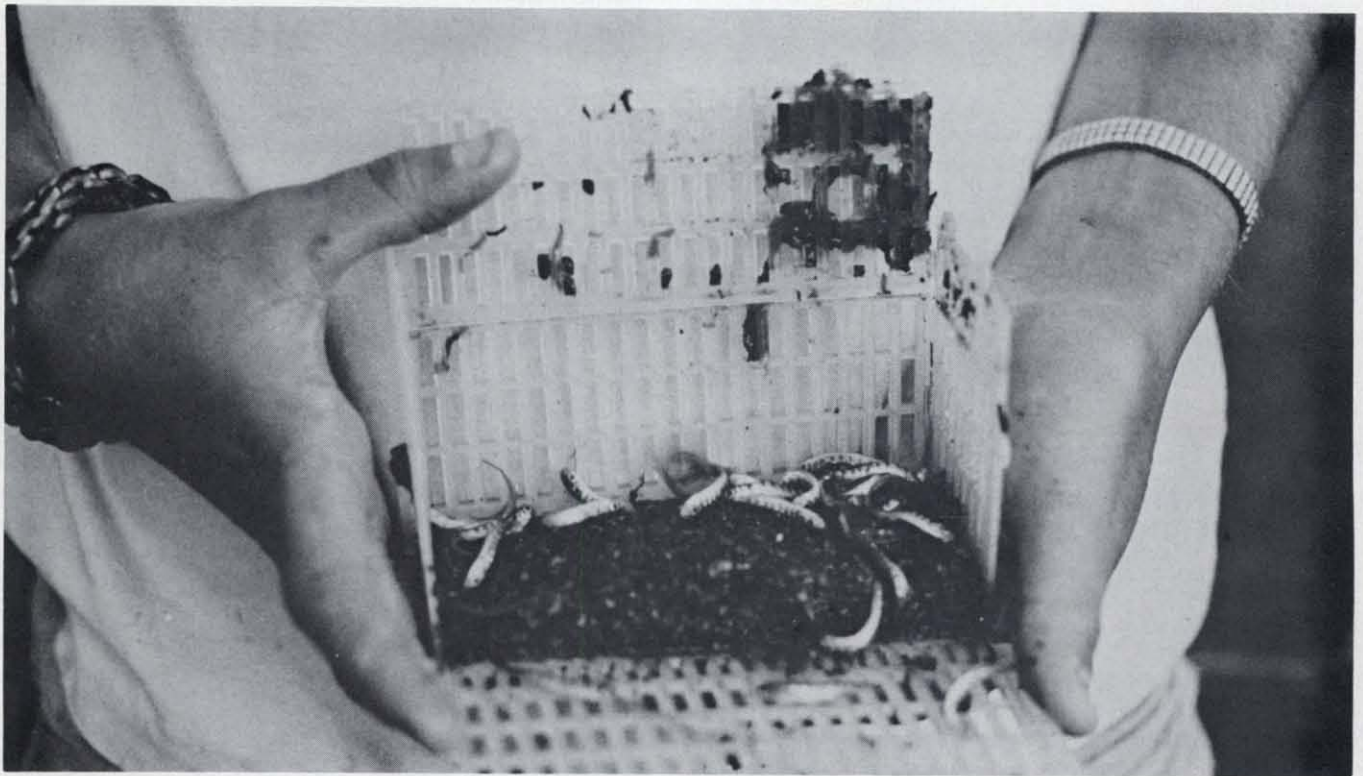
Fall chinook eggs were buried in artificial redds in gravel at four sites in Hells Canyon. Some redds under-

went dewatering—were left above the water line during flow fluctuations. Control redds were not dewatered. Other eggs were exposed to frequent or intermediate dewatering. Similar tests were conducted under laboratory conditions at the Idaho Department of Fish and Game's Hayden Creek Research Station, with 12-hour flow fluctuations.

Under normal conditions, salmon migrate upstream to construct the egg nest in a riffle or depression in the gravel, as deep as 12 inches. After the female covers the eggs, dissolved oxygen reaches the eggs via water traveling through the gravel. The researchers examined the relationship of water flowing over the redds and the velocity of water moving through the gravel to supply needed oxygen and remove waste material and sediment.

Where reduced water flow cut the velocity, researchers found some instances of increased egg mortality and reduced fry quality. Increased sedimentation in the redds, without the cleansing flows, may also increase egg mortality.

The researchers went a step further to see how long egg lots could go without water. Redds dewatered for up to 5 weeks remained viable as long as they did not dry out.



Chinook salmon fry are recovered from an artificial redd during flow fluctuation tests. *Dudley Reiser photo*



Dewatered salmon eggs can remain healthy and viable when maintained in a moist condition. *Dudley Reiser photo*

Extra sediment in the dewatered redds appeared to help keep the eggs moist. The dewatered eggs hatched sooner, because higher temperatures affect hatching time. Low temperatures, to the freezing point, were also expected to affect egg viability in dewatered nests. But although tests were conducted during spring and fall, no low temperature extremes were recorded. Fry quality appeared normal when water was available at the time of hatching.

Following the tests further, researchers monitored fry development from eggs in dewatered and control nests. They concluded that at least through the fry stage, differences in development among the fish were not apparent.

AQUACULTURISTS URGE SYSTEMS ANALYSIS APPROACH

**George W. Klontz
Philip Downey**

Fish culturists who feed their fish more to increase their growth rate may be in for a surprise, according to Fishery Resources graduate student Philip Downey and Professor George Klontz.

Food is only one of at least 54 factors which make up a total aquaculture system. Broadly, these factors comprise fish, water, container, nutrition, and management. Knowledge of how the factors interact is important to hatchery performance. Feeding rate and water flow, for example, directly affect overall production. Increased feeding alone could be detrimental to fish growth by raising ammonia

nitrogen levels in the water, causing the fish to produce more carbon dioxide and increasing solid waste in the pond. All three factors work to decrease oxygen uptake and use by the fish.

The researchers encourage use of a systems analysis approach to assess a particular management strategy's net effect on the system's production.

FISH RUNS ENDANGERED IN INTERMITTENT STREAMS

**Theodore C. Bjornn
John Sigler**

Many streams on the Pacific coast are intermittent in nature. During the wet months, from December to July, the streams run full. In the fall of the year the water level drops; some streams dry up completely. The USDA Forest Service has become concerned that timber operations conducted in the dry months may overlook intermittent streams and displace soil into a streambed.

The intermittent streams are used as spawning and rearing grounds by anadromous salmonids, which return from the sea to spawn when the streams are running. As streamflow in clay-based soils increases, suspended sediment in the water increases.

Graduate student John Sigler and Fishery Resources Professor Ted Bjornn are looking into the problem of fish reared in turbid streams. Sigler said that fish forced to rear as fry or fingerlings in turbid or sediment clouded water may not get enough food because they are sight feeders. The competitive ability of a fish is based on its size. If a fish from a sediment choked stream migrates to a larger, clear stream, it competes at a disadvantage as a smaller fish, continually battling for territory. Smaller fish cannot hold territory and become nomadic, greatly increasing their chances of being eaten, and continue to lose ground to larger fish as they move to the ocean.

Sigler and Bjornn used a commercial bentonite clay which closely resembles coastal clays, but without the impurities, to measure the effects of turbidity on fish. Their findings showed that turbidity reduces both the size of fish and the ability of the fish to feed where they cannot see the food. Levels of turbidity in intermittent coastal streams are higher than those tested in laboratory experiments.

The USDA Forest Service Pacific Northwest Forest and Range Experiment Station at Corvallis sponsored the study to determine if regulations for logging operations on watersheds with intermittent streams need to be strengthened to maintain good water quality.

Forest Products

WOOD QUALITY STUDY TO AID HONDURAN INDUSTRY

Arland D. Hofstrand
Ruben Guevara-M

Wood quality is expressed by its specific gravity or density, percentage of extractives, and fiber length. These parameters are important in the utilization of wood for the manufacture of certain wood and wood-fiber-based products. For example, the pulp and paper industry prefers using species having a high yield of long fibers, and low percentage of extractives. On the other hand, machinability and structural properties, as predicted by specific gravity, are of concern for those users of solid wood.

Forest Products Professor Arland D. Hofstrand and graduate student Ruben Guevara-M are evaluating the wood quality of *Pinus oocarpa* Schiede grown in Honduras. Data from this study will encourage expanded use of this important long-fiber, tropical resource. This project is financed by the Honduran Forest Development Corporation (COHDEFOR), and the Consul General Foster Fellowship Fund.

The immediate benefits of this research will expand forest products industry development in Honduras, which is presently limited to sawmilling and plywood production. Benefits will include: 1) a wider use of *Pinus oocarpa* in the manufacture of particleboard, fiberboard, pulp, and paper; 2) development of new markets for raw materials and products in Japan, Europe, and North America; and 3) attracting foreign investment.

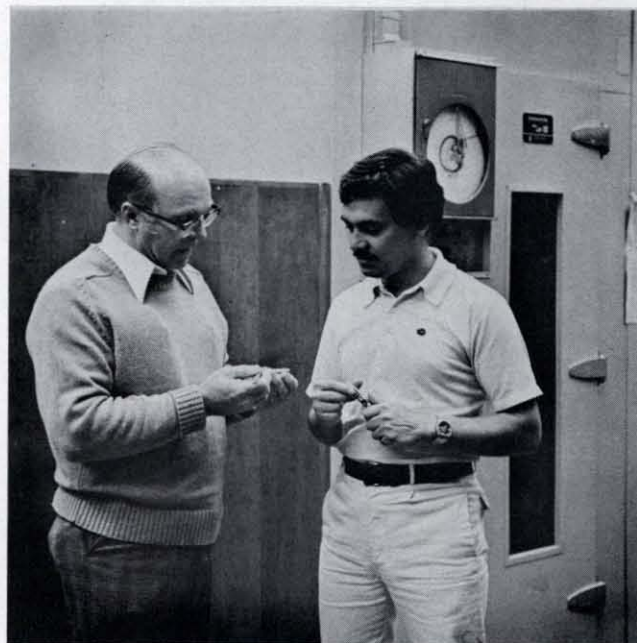
CEMENT EYED AS BINDER FOR PARTICLEBOARD PRODUCTION

Ali A. Moslemi
Arland D. Hofstrand

Ruben Guevara-M
Franco Garcia

Wood composite products have become an increasingly important segment of the forest products industry. The production of particleboard increased from 111 million square feet (3/4 inch basis) in 1956 to over 3.5 billion square feet in 1978. Construction and manufacturing are the major outlets for such products.

Key elements of this growth are decided advantages in both raw material and processing technology. Wood raw material in particleboard uses waste materials from other forest products, such as planer shavings and sawdust. Other



Arland Hofstrand, left, and Ruben Guevara-M examine an 11-mm woodcore of *Pinus oocarpa*, a tree native to Honduras. Franco Garcia photo.

raw material sources include lumber trimmings, scraps, bark, and logging residue. Previously noncommercial species (e.g., aspen and southern hardwoods), cull logs, and other lignocellulosic materials (e.g., baggase and bamboo) are now being used in particleboard manufacture.

Binders, the adhesives which hold the particles together, have primarily been urea formaldehyde or phenol formaldehyde. These petroleum or natural gas base chemical binders, once relatively inexpensive and readily available, are increasing rapidly in price. Their availability may also be affected by supply over the decades ahead.

University of Idaho Forest Products Professors Ali Moslemi and Arland Hofstrand and graduate students Ruben Guevara-M and Franco Garcia are exploring the viability of inorganic binders, specifically portland cement, for the production of structural panels. The intent is to promote sound bond formation between cement and wood particles. The researchers are testing the compatibility of northern Rocky Mountain species with cement through monitoring heat of hydration data. They also plan to examine the effects of various additives on the hydration data.

In the second phase of the project, investigators will focus on a variety of treatments for difficult to bond species.

Initial data indicate that certain additives or treatments can modify the wood raw material to achieve good bonding.

The third phase of the project involves the manufacture of a variety of panels. Dimensional and strength tests will be performed to determine the viability of such panels for structural applications. Bond formation will be examined through the use of scanning electron microscopes on fracture surfaces.

Once this technology is refined, low-grade wood biomass can be used by industry to produce needed structural panels. Such panels, by the very nature of the binder used, would also have improved resistance to fire, moisture and wood-destroying fungi and insects.

CASE DONATES DIESEL FOR SKIDDER STUDY

**Leonard R. Johnson
Walter L. Moden, Jr.**

Research in the operation of wheeled skidders on the University of Idaho Experimental Forest is continuing this year with the donation of a 40-horsepower diesel Case backhoe from the manufacturer. The small skidder, which can go where large ones cannot, has been brought in to

remove small diameter trees left on the ground after pre-commercial thinning. Use of wood residue and timber by-products has increased the value of even the smaller forest trees. Cost and practicality of moving them to a central point is under study.

The diesel backhoe, bigger than the 30-horsepower Case-Davis backhoe used last year, weighs 6050 pounds, very close to the weight of the smaller machine. Leonard Johnson, professor of Forest Products, who is testing the backhoe with Agricultural Engineering Professor Walter Moden in a cooperative project, said that the diesel backhoe has a stronger, more durable frame, which required fewer structure protecting modifications. Bigger wheels give higher ground clearance, a useful feature when working around down timber; the cage design also has been changed. Since adding protection to the backhoe also meant adding weight, the more durable diesel compares favorably. The skidder is a standard line model backhoe, with modifications developed by Agricultural Engineering.

The skidder will be tested on the forest from July through the fall, mostly in lodgepole pine, working with logs 4 to 10 inches in diameter at the butt end. The project is funded through Forest Utilization Research, Agricultural Engineering, and the Forest, Wildlife and Range Experiment Station at the University of Idaho.



Scientists in Forest Products and Agricultural Engineering are using this 40-horsepower Case diesel backhoe to remove small diameter trees from precommercial thinnings on the University of Idaho Experimental Forest. The modified skidder will be tested through the fall logging season. *Leonard Johnson photo*

Wildland Recreation Management

COOPERATIVE PARK STUDIES UNIT JOINS COLLEGE OF FWR

Gary E. Machlis
R. Gerald Wright, Jr.

In August of 1979 the College of Forestry, Wildlife and Range Sciences welcomed the Cooperative Park Studies Unit as a new addition to its research and education responsibility. The Cooperative Park Studies Unit (CPSU) is jointly sponsored and funded by the National Park Service and the University of Idaho. Gary E. Machlis, the CPSU Project Leader, is a social scientist with a background in outdoor recreation, forestry, and human ecology. As a professor in the Department of Wildland Recreation Management, Machlis also teaches graduate level courses.

R. Gerald Wright, Jr., a National Park Service ecologist, will join the program this fall as Unit Leader. Assigned to the Department of Range Resources as a professor, Wright will teach courses in quantitative approaches to natural resources management. His background is in zoology, terrestrial ecology and range systems ecology.

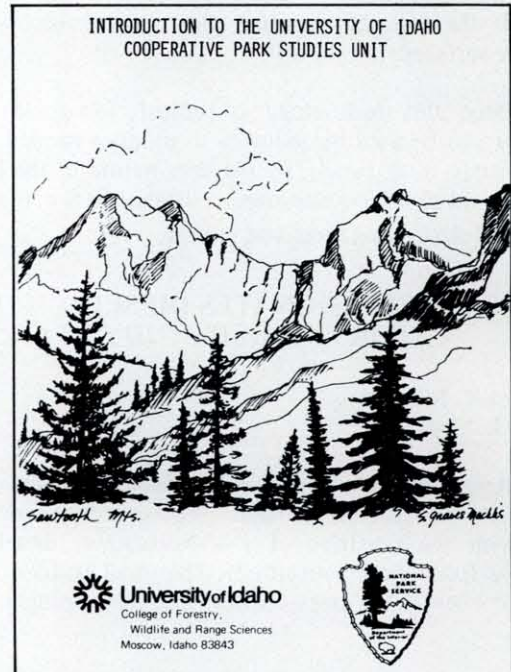
A secretary and two graduate assistants are on the CPSU staff. In addition, the faculty of the Department of Wildland Recreation Management serve as associates. Students are also actively involved in many CPSU activities.

Currently, the CPSU is involved in the application of social science research to recreation management. Active projects include work on tourism, energy issues as they relate to outdoor recreation, interpretation and recreation planning. In addition, the CPSU has an important role in communicating research results to recreation professionals and resource managers. This is accomplished through technical publications, on-site workshops, training sessions, and shortcourses.

COLLEGE OFFERS IDAHO TOUR GUIDE

James R. Fazio

Members of the Department of Wildland Recreation Management have compiled a directory listing Idaho's interpretive and environmental education facilities and sites. The 82-page publication is the result of a survey by Professor James R. Fazio and graduate student Diane Spott. It describes facilities such as self-guiding trails, visitor



centers, wildlife observation areas, and environmental education camps on a county-by-county basis.

According to Fazio, Idaho County contains the most sites with 11, followed by Kootenai with 9 and Ada, Gooding and Latah, each with 6. Twelve counties have no facilities or sites. On a regional basis, the panhandle north of the Salmon River has 48 of the 106 sites.

The survey revealed that outdoor education facilities for the handicapped fare poorly in Idaho. Of 43 self-guiding interpretive trails in the state, only two have been developed for visitors in wheelchairs and only one for the blind.

In addition to narrative descriptions of each site, the directory also summarizes the availability of support facilities such as nearby camp sites, drinking water and rest rooms. It notes whether there is a charge for using the area. Another feature is the description of exemplary environmental education programs in four Idaho school districts and professional education programs offered through the Colleges of Education and Forestry, Wildlife and Range Sciences at the University of Idaho.

The directory, titled "A Guide to Idaho Interpretive and Environmental Education Facilities and Sites," was released last year. Copies are still available at \$3.00 each from: Editorial Office, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID 83843.

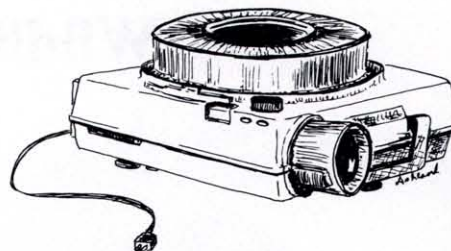
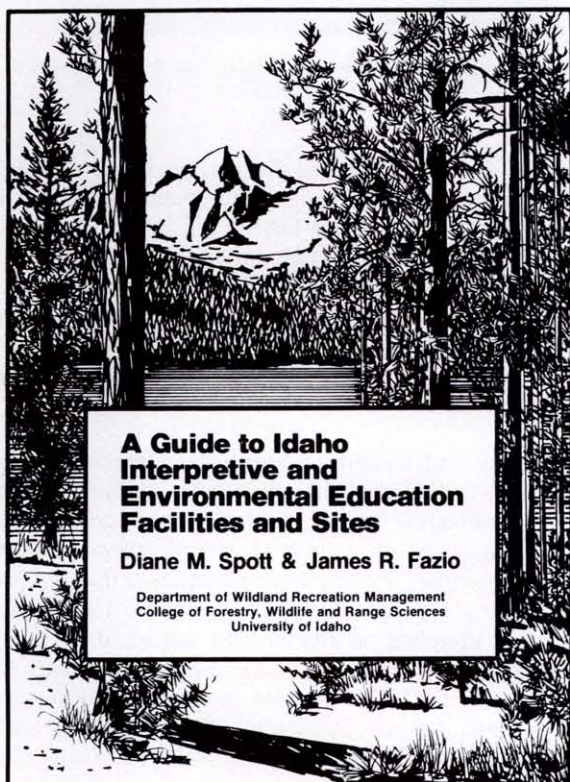
COMPUTER PROGRAMS GUIDE LAND USE PLANNING

William J. McLaughlin
Nina I-Gin Feng

Land use planning is concerned with allocating scarce resources to obtain maximum benefits in diverse use. Many allocations are made on an intuitive basis. Personal preferences are varied, and demand for multiple use is responsible for a shift to a more rational, comprehensive approach to resource decision-making.

Professor William J. McLaughlin of the Department of Wildland Recreation Management and graduate student Nina I-Gin Feng are evaluating two computer techniques: 1) the IMGRID-computer mapping program, and 2) the GOAL-linear optimization program, in making reproducible, quantitatively based, cost effective decisions in land use planning. The results of this exploratory study will provide a planning process using rational and comprehensive choices to achieve multiple land use.

In practice, computer technology plays an important role in implementing quantitative approaches to planning. The IMGRID mapping program can assist the planner in information collection, storage, retrieval and display. The GOAL program is based upon a mathematical model to simulate real management situations. Combining the two provides a fast and reliable guide to the myriad alternatives in land use planning.



SLIDE PROGRAM PRODUCED FOR 4-H FORESTRY

James R. Fazio
Sam H. Ham
David Shaw

Four sound/slide programs produced in the college will be adopted for nationwide use with new forestry 4-H program materials. The sets are the product of graduate student David Shaw of the Department of Wildland Recreation Management. His work was directed by Professors James Fazio and Sam Ham.

The four slide sets are an innovative series that bring to life key concepts in the new 4-H members' and leaders' manuals on "Trees." The Trees program was developed by University of Idaho Extension Forester Emeritus Vernon Burlison as part of a nationwide effort to revamp 4-H forestry into a more modern format. "Trees" provides a basic understanding of the identification and life cycle of trees. It will be followed by units on "Forests" and "Forest Management."

Shaw's challenge in developing the visual aids was to make them both interesting and educational for youngsters 9 to 10 years old and easy for 4-H club leaders to use. His solution was a set of four slide programs with tapes that can be used either manually or with playback equipment that automatically advances the slides. Instead of using the traditional documentary style, Shaw created a talking tree which makes friends with two 4-H youngsters working on forestry projects. The tree guides them through their projects, illustrating difficult terms and important concepts related to the topics: 1) What a tree is and how it grows, 2) How trees reproduce, 3) General tree identification, and 4) Why trees are important. The sets are being duplicated by the Cooperative Extension Service and will be distributed by the 4-H state and national office. A fifth set, on identifying trees of the northern Rocky Mountains, is currently being produced as a local supplement to the national series. Production of the sets was made possible by grants from Boise Cascade, Diamond International, and Potlatch corporations.

Shaw plans to use the sets to test the effectiveness of different narration styles in communicating with young people through audio-visual media.

Wildlife Resources



Sharp-tailed grouse are fitted with radio transmitters and followed through use of a directional antenna to determine their habitat preference. Raymond Bosch, left, attaches a leg band. *Lisa Strassheim photo*

SHARP-TAILED GROUSE RESPOND TO SAGEBRUSH REDUCTION

Winifred B. Kessler
Raymond P. Bosch

When the native sharp-tailed grouse staged a comeback in parts of southeastern Idaho, research scientists took to the field to find out why. Sharptails, once a common game bird in Idaho's sagebrush-grassland zone, suffered a severe decline in numbers during the first half of this century, forcing the closure of hunting seasons.

Utah research in the 1930s and 1940s concluded that extensive agricultural development and poor range management practices caused the rapid decline. Its habitat gone, the grouse population continued to lose ground in numbers and distribution even with protection from hunting.

Then in the early 1960s, sharptail numbers in southeastern Idaho again began to climb. Hunting seasons have

reopened. In 1978, Winifred Kessler, professor of Wildlife Resources, and graduate student Raymond Bosch began a study of sharp-tailed grouse habitat use in Oneida County, on the Curlew National Grassland, where the USDA Forest Service manipulates sagebrush with herbicides, fire, and mechanical devices. Study objectives are to assess sharptail response to specific sagebrush control methods, and to provide grouse management recommendations for land management agencies.

To determine habitat preferences, researchers trapped grouse and equipped them with radio transmitters, then followed individual birds by using a directional antenna. The tracking data are combined with detailed analyses of plant communities. Preliminary results show that sharptails avoid overmature sagebrush and respond to its reduction. Vegetation sampling on treated and untreated fields indicates a marked increase in grasses and weedy plants after sagebrush control. The increase in plants provides more ground cover for the sharptails. Chicks especially profit from the increase in plants, which aside from cover, may yield more insects, an important summer food source for

young birds. Protecting key wintering areas will also provide favorable habitat during severe weather, and ensure grouse survival.

Research results will aid land management agencies in maintaining sharp-tailed grouse habitat in Idaho. Range-land habitat can be managed to encourage sharptail increases in density and distribution. The USDA Forest Service, the Idaho Department of Fish and Game, the Idaho Research Council, and the Forest, Wildlife and Range Experiment Station have provided personnel and financial support for the project. Data from this study can be used by biologists to assess other areas in the sagebrush-grassland zone of the intermountain west for reintroduction of sharptails. The cooperation of these agencies exemplifies the benefits of multiple use management on Idaho's public lands.

DEER RANGE MANAGED TO COMPENSATE FOR DAM

**James M. Peek
Guy Woods**

Creation of 10 hydroelectric and water storage dams on the Columbia River system in British Columbia has eliminated or greatly reduced wildlife habitat and fishery resources with the flooding of more than 500 miles of valley bottomlands.

When a water license was granted to the British Columbia Hydro and Power Authority in 1975 for construction of a dam on the Pend Oreille River, the authority awarded 1.8 million dollars to the British Columbia Fish and Wildlife Branch for loss of white-tailed deer winter range. As the lower portions of the winter range are flooded, deer are expected to make heavier use of higher portions of the range. Money awarded for loss of flooded range is being used to purchase more range area at higher elevations and to manage those portions of the winter range which will receive intensive use by whitetails.

Guy Woods, a graduate student in Wildlife Resources, has been directly involved in development of research and management plans for the valley whitetails over a 6-year period. Part of his assignment has been to work with the British Columbia Hydro and Power Authority staff to reduce the impact of construction activity on the estimated 1100 white-tailed deer. The main purpose of his study was to collect detailed data on winter habitat selection patterns.

Eleven deer were radio collared and located on both summer and winter ranges. During the winter of 1977-1978, eight of the deer were located three times a day. In mid-November, deer began to move toward the winter range, and most had reached the winter range by late December to mid-January. Migration distances varied from 1 to 18 airline miles. The deer remained on the winter range until mid to late April, about 3 to 4 weeks after the

snow melted. The deer dispersed primarily to the north, with a few moving to the east, west, and south of the winter range.

Locations were made in summer to establish migration routes and summer range habitat use patterns. The summer range was approximately 20 times greater than the area occupied in winter. A year-round pattern of habitat use was obtained from this work, with emphasis on the effect of the dam on deer migration in winter. Topographic factors and vegetation were measured on the home range of each deer.

Winter habitat selection patterns are being examined under the direction of Wildlife Resources Professor James Peek. A computer program which compares habitat availability and use by the deer was developed by Wildlife Resources Professor E. O. Garton for this project.

Study results will be used to complete habitat management plans for the Pend Oreille winter range. The plan forms the basis for a long-term program to manipulate vegetation to benefit deer. Logging, tree planting, grazing and fire will all be used in the program depending on the point in the forest rotation and the habitat desired.

BIRD POPULATIONS EYED FOR SPRUCE BUDWORM CONTROL

Edward O. Garton

Outbreaks of a forest insect, the spruce budworm, have caused considerable tree damage in coniferous forests of North America in the past. In an effort to control the outbreaks, researchers from both the United States and Canada are working in a cooperative Forest Service program to determine what steps should be taken to manage this troublesome insect.

Wildlife Professor Edward O. Garton is directing a study of the birds and mammals that feed on the budworm in two areas—the Okanogan National Forest of northern Washington, and the Payette National Forest around McCall, Idaho.

Data collected during 1979 indicated that almost all songbirds living in forested areas of the Northwest feed heavily on budworms. Certain species, such as evening grosbeaks and pine siskins, increase in abundance 10 to 20 times on sites infested with budworms. The potential role of these birds in controlling budworm seems strong.

Future studies will attempt to determine whether populations of these birds could be managed to help prevent outbreaks of budworm and other forest insect pests. If feasible, use of birds as predators could lessen the need for broad scale use of pesticides in forest management.

Wilderness Research Center

CENTER OFFERS VARIETY OF RESEARCH OPPORTUNITIES

The University of Idaho Wilderness Research Center, through the cooperation of state and federal land management agencies, offers access to wilderness research facilities in Idaho and surrounding states. Founded in 1972, the Center operates three permanent field stations—on Payette Lake at McCall; Taylor Ranch, located in the River of No Return Wilderness Area; and the Clark Fork Ranger Station in the northern Idaho panhandle. The Center is coordinated by the College of Forestry, Wildlife and Range Sciences.

The Center encompasses both educational and research programs, leading to a broader understanding of natural ecosystems and man's relationship to them. Multidisciplinary research strengths support studies in the following areas:

- Wildlife - natural population regulation, competitive relationships, ecology of rare and endangered species.
- Fire - chronological history, impacts, plant successional responses, animal responses.
- Mountain Lakes and Streams - natural dynamics, including limnology and aquatic life.
- Forests - dynamics of forest stands, including the role of natural disturbances.
- Grasslands - ecology of mountain meadows, ecological succession and concept of steady state.
- Genetic Resources - comparative studies of genetic diversity in unmanaged and managed populations of plants and animals.
- Wilderness Use - research to measure human impacts, to define limits of use and to develop methods for reducing impact through effective management practices.
- Social Research - studies to further understand man's psychological relationship to nature, including the areas of philosophy and aesthetics.

COMPUTER MANUAL AIDS IN WILDERNESS USE PLANNING

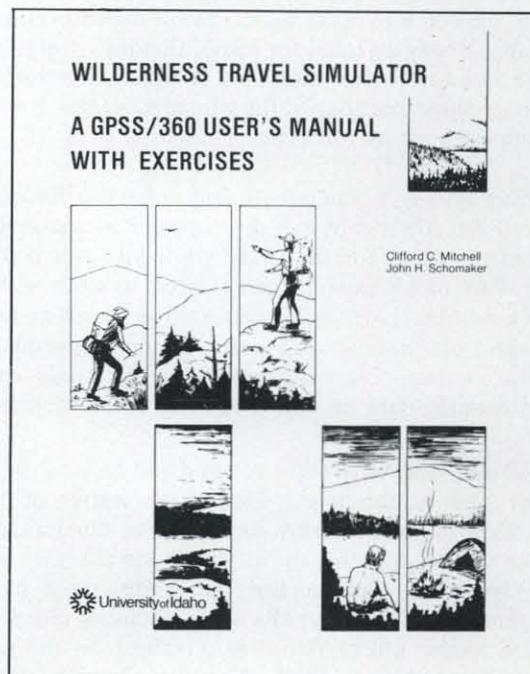
Studying animal behavior in an undisturbed setting has long been the purview of the wildlife biologist. Over the past two decades, rural and urban dwellers have turned to outdoor recreation, including wilderness hiking, in such

numbers that researchers are now looking at man in the wilderness.

The wilderness traffic simulator is a computer program designed to help wilderness managers understand the amount, type and distribution of use they can expect in a wilderness under different people-management strategies. The program is written in IBM's General Purpose Simulation System (GPSS) V.

Former graduate student Clifford Mitchell and Professor John Schomaker of the Department of Wildland Recreation Management at the University of Idaho have completed a computer manual for the program. The 74-page textbook, "Wilderness Travel Simulator - A GPSS/360 User's Manual with Exercises," is designed particularly for use in wilderness or wildland recreation management courses at the college level. The manual introduces some basic wilderness management concepts and explains the required input data, the model output, and the procedures and techniques of data analysis. The concept of simulation modeling and wilderness management is discussed in conjunction with the wilderness traffic simulation model.

Published by the University of Idaho's Forest, Wildlife and Range Experiment Station, the manual will be available for purchase this fall.



Continuing Education/Extension

ECONOMIC ANALYSIS MODEL AIDS WOODLAND OWNERS

Owners of private woodland acreages can now have a computer determine yields, profits and compare costs for alternative management practices on their individual stands through a program developed at the University of Idaho.

The U.S. Department of Agriculture - Forest Service, Intermountain Forest and Range Experiment Station developed a computer model which projects forest stand growth responses for the northern Rocky Mountains known as the Stand Prognosis Model (Stage 1973). Until recently, the model, used by managers of large forested areas, could not assess the economic benefits of the various practices.

With the development of an economic analysis model by the University of Idaho Forest, Wildlife and Range Experiment Station scientists in 1978, in cooperation with the Intermountain Forest and Range Experiment Station, a more comprehensive picture of forest yield patterns became available, but still for a limited audience.

The workshop approach was selected as the best way to introduce the model to foresters who manage privately owned woodlands, and woodland owners throughout the state. The first workshop was held in August. Demand dictated a second program, held early in April. During these two sessions, 100 professional foresters have been taught how and where to apply the model. Forest economist E. Lee Medema and Extension Forester Donald P. Hanley expect the workshops to have a multiplier effect. "We can't work with all the individuals who would like to see alternative yield projections for their timber stands. By teaching the techniques to consulting foresters, we can make the technology available to a great many more people," Medema said.

As Extension Forester, Hanley provides small landowners with a listing of consulting foresters on request. Interested landowners may also request a list of those individuals in their area who have taken the Stand Prognosis Model Workshop, which Hanley anticipates will be given on a yearly basis to update techniques and incorporate model changes.

The Prognosis Model is applicable to all commercial forest tree species in Idaho. It is most accurate when used in the grand fir/cedar/hemlock ecosystem of northern Idaho, eastern Washington, and western Montana. Tree species recognized by the model include western white pine, western larch, Douglas-fir, grand fir, western hemlock, western redcedar, lodgepole pine, Englemann spruce, subalpine fir and ponderosa pine.

The projection is based on the environmental and economic conditions of a particular stand. Yields are estimated for the owner's harvest schedule, providing results specific to the stand surveyed and not based on average stand values.

Computer work will be handled at the university, so that foresters do not need computer access. Prepared data sheets will be keypunched and run on the computer by trained personnel at low cost to the forester. The resulting printout will provide timber yields and dollar estimates of management alternatives, which the small landowner can put to work.

During the workshops, foresters were introduced to the data requirements and proper data gathering techniques which will be used to program the computer. Instructors explained the interpretation of computer results from the model.

The modified computer program which makes the economic analysis model available to the public, and its link to the Stand Prognosis Model have been developed by Medema and Professor Charles R. Hatch, Associate Director of the State of Idaho's Forest, Wildlife and Range Experiment Station. Users manuals have also been prepared for the computer programs.

The workshops were sponsored by the Cooperative Extension Service and the College of Forestry, Wildlife and Range Sciences of the University of Idaho, and by the USDA Forest Service Intermountain Forest and Range Experiment Station and the Idaho Woodland Council.

WILDLAND RECREATION MANAGEMENT EXPANDS PROGRAM OFFERINGS

In the Department of Wildland Recreation Management, education extends far beyond the classroom walls. For the past 6 years a growing number of shortcourses have been offered to serve practicing professionals throughout Idaho and the Northwest. The Communications Short-course offers recreation and natural resource managers a chance to obtain skill training probably not available when they were in college. The course includes creating automated sound/slide shows, use of videotape and sophisticated dissolve slide equipment, plus a variety of sessions in the basics of public relations and use of the mass media.

A variation on the communications program was offered in June as the Fire Information Officer's Short-

course. This course focused on the special needs of communicating with media representatives and the public during times of emergency. Simulation exercises prepared specialists to set up and operate information centers at fire camps or other disaster scenes. Professor James Fazio directed both of these courses.

A Workshop on Public Involvement was offered in response to the recent surge of activity in this area. The course attempts to meet the needs of natural resource managers faced with involving the public in management decisions. Professor William McLaughlin directed this course.

Another regular continuing education project is the annual Maintenance Management School under the direction of Professor Joseph Hoffman. Conducted in cooperation with the National Recreation and Parks Association, this popular course attracted nearly 100 participants in February

despite travel and budget cuts being experienced by many park and recreation agencies.

The most recent addition to the department's offerings is a cooperative effort with the National Park Service. Directed by Professor Gary Machlis, Cooperative Park Studies Unit Project Leader, this continuing education program is a unique "package" of topics available anytime, anyplace. Machlis offers workshops on three topics that he will teach either on campus, at an agency's location, or some other location convenient to the parties requesting the courses. His courses are flexible in length, ranging from 1 hour to 1 day or longer depending on the depth of training desired. Topics include *Understanding the Park Visitor*, *Interpretation for Special Populations*, and *Energy and Outdoor Recreation*.

Information on any of these programs may be obtained from the course instructor or the department head. The department also welcomes suggestions for other courses.

SHORTCOURSES, WORKSHOPS AND SEMINARS

Throughout the year, research scientists in the College of Forestry, Wildlife and Range Sciences conduct workshops, shortcourses and seminars on campus and throughout Idaho and the West. Continuing Education programs which were sponsored by the college, or for which college departments served as co-sponsor or cooperator over the last year are shown below. Many of the shortcourses and workshops are offered on an annual basis. Further information may be obtained from the Office of Continuing Education, University of Idaho, Moscow, ID 83843.

1979		
July 25	Southern Idaho Sawmill Clinic - Idaho Falls	April 3-4 April 15 April 17-19 April 21-25
August 23-24	Stand Prognosis Model Workshop	April 21-28 April 22 - May 5
September 10-14	Remote Sensing for Natural Resources - A Symposium	
September 16-23	University of Idaho Natural Resource Camp for Youth - Alpine, WY	
October 5-7	Wildlife Ecology Workshop - Boise	May 12-23
October 22 - November 16	Continuing Education in Forest Ecology and Silviculture (CEFES)	
October 29 - November 2	Fish Health Management - Branson, MO	June 5
1980		
February 3-8	Pacific Northwest Parks and Recreation Maintenance and Management School - Port Townsend, WA	June 9-12 June 15-20
February 11-15	Aerial Photo Interpretation / Aerial Photography Workshop	June 26-27
February 13	Latah Soil Conservation District (SCD) Woodland Workshop - Bovill, Deary	July 28 - August 1
February 26-28	Pacific Northwest Range Shortcourse - McNary, OR	
March 4-6	Continuing Education Workshop for Wildlife Biologists - Boise	August 6-8
March 18-20	Hungarian Partridge Workshop	October 20 - November 14
		Stand Prognosis Model Workshop Southern Idaho Sawmill Clinic - Boise Wildlife Ecology Workshop - Pocatello Forest Stream Habitat and Land Use Planning Workshop Natural Resources Week Shade Tree Workshops - Montpelier, Pocatello, Burley, Twin Falls, Hailey, Payette, Boise, Lapwai, Lewiston, Coeur d'Alene, Orofino
		Pilot Program of Continuing Education in Wildlife Ecology and Management
		Lewis County SCD Woodland Workshop - Craigmont Fire Information Officers Shortcourse University of Idaho Natural Resource Camp for Youth - Ketchum Southwest Idaho Woodland Workshop - Donnelly
		Tree Problem Diagnostic Workshops - Lewiston, Weiser, Boise, Fairfield, Gooding, Paris, Preston, American Falls, Hailey
		North American Quantitative Forest Genetics Group - Coeur d'Alene
		Continuing Education in Forest Ecology and Silviculture (CEFES)

Appendix

EXPERIMENT STATION SCIENTISTS

Stoszek, Milena J.	Director of the Nutritional Lab and Research Associate Professor
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DEPARTMENT OF FISHERY RESOURCES

Beleau, Marshall	Research Scientist Fish health management
Bennett, David H.	Associate Professor Warmwater fishery management, fish ecology
Bjornn, Theodore C.	Leader, Cooperative Fishery Research Unit and Professor Fish ecology and management
Chacko, A. Jim	Research Assistant Professor
Falter, C. Michael	Professor Reservoir limnology, stream ecology
Gay, Robert	Research Associate
Klontz, George W.	Department Head and Professor Diseases and rearing problems of aquatic animals
MacPhee, Craig	Professor Fish behavior, ecology, toxicology
Mitchell, Bradley D.	Visiting Assistant Research Professor
Ringe, Rudy R.	Research Associate
White, Robert C.	Assistant Leader, Cooperative Fishery Research Unit and Associate Professor Fish ecology and management

DEPARTMENT OF FOREST PRODUCTS

Christophersen, Kjell A.	Assistant Professor Natural resource economics
Force, Jo Ellen	Assistant Professor Modeling, land use planning, biometry
Hofstrand, Arland D.	Professor Anatomy and mechanical properties of wood

Howe, John P.	Professor Emeritus Wood science and technology
Johnson, Leonard R.	Associate Professor Forest engineering, industrial engineering, mathematical modeling
Moslemi, Ali A.	Coordinator of Graduate Programs and Professor Panel products technology, wood residue utilization, energy
Sowles, Kenneth M.	Department Head and Professor Forest products utilization and marketing

DEPARTMENT OF FOREST RESOURCES

Adams, David L.	Department Head, Summer Camp Director, and Professor Silviculture, forest management (growth and yield)
Anderson, Hal N.	Research Associate
Befort, William A.	Research Associate
Belt, George H.	Professor Hydrology, meteorology, planning, forest management
Brunsfeld, Steven	Research Associate
Burlison, Vernon H.	Extension Forester Emeritus and Extension Professor Emeritus
Burnell, Donald G.	Research Scientist
Canfield, Elmer R.	Professor Emeritus Forest pathology
Crookston, Nicholas L., II	Research Associate
Deters, Merrill E.	Professor Emeritus Forest silviculture
Fins, Lauren	Executive Secretary, Inland Empire Tree Improvement Cooperative and Assistant Professor Forest genetics
Forrest, Steven	Research Technician
Gall, William R.	Assistant Professor Statistical design and analysis of forest genetics research, forest tree physiology
Goudie, James W.	Research Associate
Hanley, Donald P.	Extension Forester and Assistant Extension Professor
Hatch, Charles R.	FWR Experiment Station Associate Director and Professor Mathematical stand modeling
Heller, Robert C.	Research Professor Remote sensing, photo interpretation, forest entomology surveys, and evaluation

Johnson, Frederic D.	Professor Forest synecology, autecology, phytogeography
Laursen, Steven B.	Research Technician
Leonard, James M.	Research Associate
Loewenstein, Howard	FWR Experiment Station Assistant Director and Professor Forest soils and tree nutrition
Mahoney, Ronald L.	Research Associate
McKetta, Charles W.	FWR Experiment Station Economist and Assistant Professor Timber production economics
McMurtray, Maggie	Research Instructor
McNamee, Peter	Research Associate
Medema, E. Lee	Assistant Professor Forest resource economics, forest policy, stumpage market analysis
Mika, Peter G.	Research Associate
Mitchell, Kenneth J.	Associate Professor Modeling growth and yield of coniferous stands
Moore, James A.	Assistant Professor Silviculture, quantitative methods, forest production
Neuenschwander, Leon F.	Associate Professor Fire ecology, prescribed burning, general ecology
Osborne, Harold L.	Manager, University of Idaho Experimental Forest and Research Instructor
Partridge, Arthur D.	Professor Forest pathology
Scanlin, David C.	Research Assistant Professor Soil fertility and soil-site relationships with tree growth
Schenk, John A.	Professor Forest entomology
Seale, Robert H.	Professor Emeritus Forest economics
Skille, Jack	Research Associate
Srivastava, Nilema	Research Associate
Stark, Ronald W.	Coordinator of Special Programs and Professor Entomology
Stock, Mary W.	Associate Research Professor Insect physiology, ecology, population genetics
Stoszek, Karel J.	Professor Silviculture, forest protection and forest entomology

Ulliman, Joseph J.	Professor Aerial photography, mapping, aerial photo interpretation and remote sensing
Vander Ploeg, James	Research Technician
Wang, Chi-Wu	Professor Emeritus Forest genetics
Wenny, David L.	Forest Nursery Manager and Assistant Professor Regeneration

DEPARTMENT OF RANGE RESOURCES

Bunting, Steven C.	Assistant Professor Fire ecology, range ecology
Ehrenreich, John H.	Dean, College of Forestry, Wildlife and Range Sciences, FWR Experiment Station Director and Professor
Hironaka, Minoru	Professor Range ecology, synecology and autecology
Kingery, James L.	Instructor Range improvements and natural resource policy and economics
Mitchell, John E.	Assistant Professor Range ecology
Sanders, Kenneth D.	Associate Professor Range management
Sharp, Lee A.	Department Head and Professor Grazing practices, rangeland policy considerations, range improvements
Smith, Mia E.	Instructor
Tidwell, David	Range Coordinator
Tisdale, Edwin W.	Professor Emeritus Range resource evaluation and management, native range vegetation types, ecology of range weeds, and vegetation habitat relationships
Wright, R. Gerald, Jr.	Associate Professor Range systems ecology, simulation modeling

DEPARTMENT OF WILDLAND RECREATION MANAGEMENT

Fazio, James R.	Department Head and Associate Professor Communication and principles of natural resource management, environmental interpretation, continuing education delivery systems and conservation history
Ham, Sam H.	Instructor Interpretation, communication, environmental education

Hoffman, Joseph E., Jr.	Associate Professor Recreation management, economics of recreation, and recreation preferences
Krumpe, Edwin E.	Assistant Professor Social psychology, decision processes in recreation, communications and interpretation
Machlis, Gary E.	Cooperative Park Studies Unit Leader and Assistant Professor Interpretation, human ecology, environmental sociology
McLaughlin, William J.	Assistant Professor Regional and recreation planning methods, citizen participation, recreation behavior, and perception and visual resource management

DEPARTMENT OF WILDLIFE RESOURCES

Ables, Ernest D.	Associate Dean, College of Forestry, Wildlife and Range Sciences, and Professor Wildlife ecology, especially animal behavior and radio-tracking techniques
Bizeau, Elwood G.	Assistant Leader, Cooperative Wildlife Research Unit and Professor Birds, principally waterfowl and marsh
Dalke, Paul D.	Professor Emeritus Wildlife management
Drewien, Roderick C.	Research Wildlife Biologist Wildlife, migratory birds, endangered species
Garton, Edward O.	Assistant Professor Wildlife population biology, systems ecology
Hornocker, Maurice G.	Leader, Cooperative Wildlife Research Unit and Professor Population ecology and predator-prey interactions
Hungerford, Kenneth E.	Professor Emeritus Wildlife management
Kessler, Winifred B.	Assistant Professor Range management/wildlife relationships
Nelson, Lewis, Jr.	Coordinator of Continuing Education and Employment and Associate Professor Continuing education
Nelson, Louis	Research Associate
Peek, James M.	Professor Big game management and habitat relationships
Peterson, Steven R.	Department Head and Associate Professor Waterfowl ecology and nongame wildlife management
Scott, Michael	Research Associate

UNIVERSITY OF IDAHO EXPERIMENTAL FOREST AND FOREST NURSERY

Osborne, Harold L.	Manager, University of Idaho Experimental Forest and Research Instructor
Reggear, Robert C.	Assistant Manager, University of Idaho Experimental Forest and Logging Superintendent
Strong, Allan E.	Assistant Logging Superintendent and Forester
Lohse, Gerald L.	Inventory Forester, log scaler
Wenny, David L.	Forest Nursery Manager and Assistant Professor
Meyer, James	Nursery Technician
Parkin, Charles	Greenhouse Technician

ADMINISTRATIVE SERVICES

Archer, Jeanne M.	Assistant to the Coordinator of Continuing Education and Employment
Bottger, Richard F.	Director of Administrative Services
George, Willard L.	Research Electronics Technician
Hieb, Susan R.	FWR Experiment Station Editor
Kaufman, Betty M.	Special Projects Coordinator
Merkel, Albert L.	Assistant to the Dean for International Programs
Savage, George H.	FWR Experiment Station Editor

IN MEMORIAM

November 13, 1979	Franklin Harry Pitkin	Professor of Forestry Emeritus Experimental Forest Manager and Forest Nursery Superintendent (1939-1979)
April 20, 1980	Dwight S. Jeffers	Dean Emeritus and Professor of Forestry Emeritus (Dean, School of Forestry 1935-1953)
June 16, 1980	Arlow Francis Lewis	Assistant Manager of Taylor Ranch (1969-1980)

RESEARCH PROJECTS AND INVESTIGATORS

This listing of projects shows the range of work in progress through the experiment station; it is not a publication listing. To save space, abbreviated project titles are given. If additional information is needed, please write to the principal investigators or to the Associate Director, Forest, Wildlife and Range Experiment Station, University of Idaho.

DEPARTMENT OF FISHERY RESOURCES

Fish culture using geothermal water. M.H. Bealeu

Isolated fish liver perfusion. M.H. Bealeu

Examination of spawning ecology and early life history of kokanee salmon in Coeur d'Alene Lake. D.H. Bennett

Status of the warmwater fishery and the potential of improving warmwater fish habitat in the Lower Snake reservoirs. D.H. Bennett

The fishes of the Savannah River National Environmental Research Park. D.H. Bennett

Juvenile emigration of lahontan cutthroat trout in the Truckee River—Pyramid Lake system. D.H. Bennett, T.C. Bjornn

Effects of chronic turbidity on feeding, growth, and social interaction of steelhead trout and coho salmon. T.C. Bjornn

Wild trout-hatchery trout relationships. T.C. Bjornn

Maintenance of fisheries resources with enlargement of the powerhouse at Minidoka Dam. T.C. Bjornn

Vancouver Island steelhead angler behavior, opinions and preferences toward artificial enhancement. T.C. Bjornn

Comparative characteristics of wild and hatchery Clearwater River steelhead trout. T.C. Bjornn

The food habits and distribution of rainbow and cutthroat trout in Lake Koocanusa, Montana. T.C. Bjornn

Biological status report on Columbia Basin spring, summer and fall chinook and coho salmon. T.C. Bjornn

A study of fisheries resources in the Gospel-Hump area of central Idaho. T.C. Bjornn

Abundance, growth, distribution and movements of white sturgeon in the Snake River from Shoshone Falls downstream to C.J. Strike Dam. T.C. Bjornn

Evaluation of pilot rearing programs for steelhead at Dworshak and Hagerman National Fish hatcheries. T.C. Bjornn

Instream flow needs for select streams in Payette National Forest. T.C. Bjornn

Role of short distance migration on the homing of salmon and steelhead. T.C. Bjornn

Effects of additional peaking from a fourth generator at Dworshak Dam on public recreational use and safety along the Clearwater River. T.C. Bjornn

Habitat selection and species interactions of juvenile bull trout and westslope cutthroat trout in selected tributaries of the upper Flathead River system. T.C. Bjornn

Habitat selection, spawning behavior and early life history of northern squawfish with inferences to Colorado squawfish. T.C. Bjornn

Effects of physical properties on spawning site selection by fall chinook salmon below Priest Rapids Dam, Washington. T.C. Bjornn

Sedimentation and productivity of salmonid streams. T.C. Bjornn, M.A. Brusven, J.H. Milligan

Developing culture and spawning techniques of Colorado squawfish. A.J. Chacko

Waste load allocations and aquatic ecology of the Spokane River. C.M. Falter

Impacts of nonpoint source loading on streams of the Craig Mountain watershed. C.M. Falter

A study to abolish the carrier states of bacterial kidney disease and furunculosis in anadromous salmonids. G.W. Klontz, M.H. Bealeu

Control of bacterial kidney disease in spring chinook salmon. G.W. Klontz

A systems analysis approach to evaluating aquaculture facilities. G.W. Klontz

Acute toxicity of selected chemicals to the Colorado squawfish, an endangered species. C. MacPhee, M.H. Bealeu

Trace mineral imbalances in hatchery fish. M.J. Stoszek, C. MacPhee

Development and application of a methodology for recommending salmonid egg incubation flows. R.G. White

Effects of power peaking on fall chinook egg incubation and hatching. R.G. White

Effects of sediment on incubation emergence and quality of chinook salmon and steelhead trout embryo and fry. R.G. White, T.C. Bjornn

Effects of reduced stream discharge on fish and aquatic macroinvertebrate populations. R.G. White, D.H. Bennett

Development and validation of habitat-standing crop functions for select fish and fish-food organisms. R.G. White, J.H. Milligan, M.A. Brusven, E.O. Garton

DEPARTMENT OF FOREST PRODUCTS

Technical and economic practicability of new lumber products made from dead white pine. K.A. Christophersen

Investment analysis of forest management alternatives and estimates of differences in income potential resulting from financially, rather than biologically, derived rotation ages on northern Idaho Department of Lands commercial forest acreage. K.A. Christophersen

Model integration for Gospel-Hump multi-purpose resource development plan. J.E. Force

Demonstration of thermal water utilization in forestry. J.P. Howe, C.W. Wang

Skidding systems to match small-log utilization machines. L.R. Johnson

Implementation of a logging simulation model (SAPLOS). L.R. Johnson

Soil compaction study. L.R. Johnson, H.L. Osborne

Use of linear programming on northern Idaho harvest scheduling problems. C.W. McKetta, H.L. Osborne

Structural board with wood particles and inorganic binders. A.A. Moslemi, A.D. Hofstrand

DEPARTMENT OF FOREST RESOURCES

The use of seed wafers in reforestation. D.L. Adams

Evaluation of plantation growth in the grand fir, cedar, hemlock ecosystem. D.L. Adams, D.P. Hanley

Shade effects on western redcedar seedlings. D.L. Adams, R.L. Mahoney

Prediction of seedling physiological status through waveform analysis. D.L. Adams, D.L. Wenny

Fugitive dust emission from surface mining. G.H. Belt

Evapotranspiration models. G.H. Belt

Annotated plant list of the University of Idaho Experimental Forest. S. Brunsfeld, H.L. Osborne

Development of models of spruce budworm defoliation induced changes in tree yield and form. D.G. Burnell

Models of local dispersal mechanisms for spruce budworm populations. D.G. Burnell

Selection of cold-hardy giant sequoia clones. L. Fins

Comparison of rootability of cuttings from outcrossed and selfed ponderosa pine and Douglas-fir seedlings. L. Fins

Genetic resistance of western larch to larch casebearer. L. Fins

Assessment of genetic differences between coastal and inland western white pine using electrophoresis of isozymes. L. Fins

Reproductive isolation among and within yellow poplar (*Liriodendron tulipifera* L.) populations. W.R. Gall

What is cold hardiness? A biochemical study in Douglas-fir (*Pseudotsuga menziesii*). W.R. Gall

Variability in foliar monoterpenes of two *Artemisia* taxa. W.R. Gall

Genetics of western redcedar (*Thuja plicata* Donn.) W.R. Gall

Biomass studies in lodgepole pine. J. Goudie

Plantation development. D.P. Hanley, D.L. Adams

Development of a retrieval system mapping routine. C.R. Hatch

Idaho forest inventory data update. C.R. Hatch

Development of information retrieval system for Pakistan. C.R. Hatch

Evaluation, development and implementation of a forest inventory analysis system. C.R. Hatch

Idaho LANDSAT application program advanced remote sensing course. R.C. Heller, J.J. Ulliman

LANDSAT applications project: big game winter range inventory. R.C. Heller, M. Hironaka, J.J. Ulliman

Use of photo interpretation and remote sensing techniques to establish hazard rating criteria for spruce budworm susceptible stands. R.C. Heller, J.J. Ulliman, H.N. Anderson

Development of methods for using high altitude aerial photography. R.C. Heller, J.J. Ulliman, W.A. Befort

Classification of vegetation in northern Florida from LANDSAT data using VICAR/IBIS computer program. R.C. Heller, K.M. Schuchard, D.E. Hall

Ecology and distribution of Idaho woody plants. F.D. Johnson

Regeneration of western redcedar, ecology of cedar groves. F.D. Johnson

Classification of north Idaho bogs. F.D. Johnson

Wetland habitat classification of Yellowstone National Park. F.D. Johnson

Ecology of Pacific yew. F.D. Johnson, R. Crawford

Bioassay of selected Idaho forest soils. H. Loewenstein

Legume-conifer interrelationships. H. Loewenstein

Deficiency symptoms and critical levels of nutrients in Douglas-fir. H. Loewenstein

Containerized western redcedar seedling establishment and growth. H. Loewenstein

Tree growth and response to fertilization as indicated by soil and foliar nutrient levels and environmental factors. H. Loewenstein, D.C. Scanlin

- Guidelines for silvicultural prescriptions. R.L. Mahoney, J.A. Moore, J.J. Ulliman
- Economic evaluation of management practices in uneven-aged forests. C.W. McKetta
- The stability rationale: economic implications of an even flow constraint in forest management. C.W. McKetta
- Procedure for estimating fire management input costs. C.W. McKetta
- Effect of alternative local tax systems on forest investment. C.W. McKetta
- Use of linear programming on northern Idaho harvest scheduling problems. C.W. McKetta, H.L. Osborne
- On-site erosion on natural and disturbed soils and natural bedload sediment production and delivery efficiency of important land types in the Gospel-Hump Area. M. McMurtry
- Economic analysis of intensive forest management. E.L. Medema
- Changes in labor intensities in the lumber producing industries. E.L. Medema
- Effect of Douglas-fir tussock moth defoliation on juvenile coniferous tree growth and development and stand dynamics. J.A. Moore
- Linking shrub, forb and grass models to the prognosis model for stand development. J.A. Moore
- Influence of grand fir stand characters and management practices on bark beetle population and damage levels, stand regeneration and growth. J.A. Moore
- Assessing effects of larch casebearer defoliation on growth of larch in juvenile cultures. J.A. Moore, K.J. Stoszek
- Evaluating prescribed understory fire in shelterwoods. J.A. Moore, L.F. Neuenschwander, H.L. Osborne
- Fire ecology of the spruce-fir zone of northern Idaho. L.F. Neuenschwander
- Succession of fuels and vegetation following bark beetle outbreak. L.F. Neuenschwander
- Fire ecology of north Idaho. L.F. Neuenschwander
- Response of vegetation and sage grouse to prescribed burning in a sagebrush/Idaho fescue habitat type. L.F. Neuenschwander
- Fire as a silvicultural tool in ponderosa pine. L.F. Neuenschwander
- University of Idaho Experimental Forest timber inventory for management planning. H.L. Osborne
- Survey methods for root-disease centers. A.D. Partridge
- Wood-inhabiting fungi. A.D. Partridge
- Disease-insect descriptions and keys. A.D. Partridge
- Disease-insect interactions in forest trees. A.D. Partridge
- Idaho tree diseases and defects. A.D. Partridge
- Techniques to identify, quantify and predict decays and diseases of timber in the inland northwest. A.D. Partridge
- Decays and cavity-nesting birds. A.D. Partridge, E.L. Bull
- Influence of prescribed burning in seral ponderosa pine on cone and seed losses to insects and tree mortality by bark beetles in northern Idaho. J.A. Schenk, L.F. Neuenschwander, J. Johnson, R. Safay
- Influence of grand fir slash condition on success of attack and brood development of the fir engraver. J.A. Schenk, J.A. Moore, S.B. Laursen
- Evaluation of effects of road construction on hydrology and sedimentation. J. Skille
- Evaluation of effects of road construction on aquatic fauna and flora. J. Skille
- Spruce budworm population model. R.W. Stark
- Linkage of spruce budworm model to prognosis model. R.W. Stark
- Population dynamics of larch casebearer. R.W. Stark
- Pest management on Colville lands with emphasis on larch casebearer. R.W. Stark, D.G. Burnell
- Genetic markers for quality control of a western spruce budworm colony. M.W. Stock
- Genetic characteristics of western spruce budworm associated with geographic distribution and density levels. M.W. Stock
- Genetic relationships among *Choristoneura* species: a taxonomic study. M.W. Stock
- Detection of insecticide tolerant western spruce budworm colonies. M.W. Stock
- Genetic effects of host species and food quantity on the mountain pine beetle. M.W. Stock
- Needle retention characteristics of Douglas-fir, grand fir, subalpine fir and Engelmann spruce. K.J. Stoszek
- Effects of boron stress on predisposition of coniferous seedlings to *Armillariella mellea*. K.J. Stoszek, G.L. Lohse
- Physiological indices of grand fir stands. K.J. Stoszek, P.G. Mika
- Western pine-shoot borer on the Nezperce, Payette and Boise National Forests. K.J. Stoszek, P.G. Mika, J.A. Moore
- The relationship of western spruce budworm outbreaks to site/stand attributes, development and management history. K.J. Stoszek, P.G. Mika, J.A. Moore
- Marking pens for aerial photographs and transparency material. J.J. Ulliman
- Use of large scale aerial photographs for wildlife habitat inventories in coniferous forest habitats, central Idaho. J.J. Ulliman, E.O. Garton
- Remote sensing for detecting time trends in bottom sediments in the South Fork of the Salmon River. J.J. Ulliman, R.C. Heller

DEPARTMENT OF RANGE RESOURCES

- Seasonal variation in the flammability of redberry juniper. S.C. Bunting
- Fire intensity and vegetational development in Douglas-fir/ninebark habitats. S.C. Bunting
- The vegetation of the Guadalupe Mountains. S.C. Bunting
- Prescribed burning in specific habitat types. S.C. Bunting
- Evaluation of the frequency plot method as an improving technique for the measurement of a successional trend. S.C. Bunting, M. Hironaka
- Prescribed burning in western juniper habitats. S.C. Bunting, L.F. Neuenschwander
- Habitat type classification for grassland and shrublands in southern Idaho. M. Hironaka
- Management alternatives on state owned rangelands. J. Kingery
- Competition between seeded grass and tree seedlings on forest plantations. J.E. Mitchell
- Livestock grazing management studies, Point Springs Experimental Pastures. K.D. Sanders
- Idaho rangeland development and improvement. K.D. Sanders
- Evaluation of range improvement practices. L.A. Sharp
- Ecology of salt-desert shrub rangelands. L.A. Sharp
- Idaho range cooperative project. L.A. Sharp
- Ecology of grasslands of the Snake and Salmon River systems in Idaho. E.W. Tisdale
- Review of literature on sagebrush vegetation of North America. E.W. Tisdale, M. Hironaka

DEPARTMENT OF WILDLAND RECREATION MANAGEMENT

- Natural resources and public relations. J.R. Fazio
- Nationwide survey of use of information and education in natural resource management agencies. J.R. Fazio
- Comparative evaluation of two self-guiding interpretive trail techniques in Yellowstone National Park. J.R. Fazio
- Conceptual design of exhibits to interpret the Idaho National Environmental Research Park. J.R. Fazio
- Director of Pacific Northwest Parks and Recreation Maintenance Management School. J.E. Hoffman
- National park system for People's Republic of China. G.E. Machlis
- Examination of visitors from outside the United States to national parks in the west and Pacific Northwest. G.E. Machlis

Energy and State Comprehensive and Outdoor Recreation Plan (SCORP) planning for Idaho State parks. G.E. Machlis

Social indicators for Olympic National Park. G.E. Machlis

National parks historical photographs project. G.E. Machlis

Choices and satisfactions of river recreationists—a comparative study of five rivers. W.J. McLaughlin

McCall citizen participation project. W.J. McLaughlin

User survey project—backcountry and snowmobile users. W.J. McLaughlin

Lostine Canyon planning project. W.J. McLaughlin

Flathead River Study—A cooperative effort among USDA Forest Service, USDI National Park Service and colleges of forestry. W.J. McLaughlin

DEPARTMENT OF WILDLIFE RESOURCES

- Behavior, dispersal and altitudinal migration of bobcats in Idaho. E.D. Ables
- Black-tailed deer fawn production and survival on northern Vancouver Island with special reference to wolf predation. E.D. Ables
- Ecology of the wood duck in north Idaho. E.G. Bizeau
- The Rocky Mountain population of the western Canada goose. E.G. Bizeau
- Experimental release of captive-reared sandhill cranes on Grays Lake, Idaho. E.G. Bizeau
- Re-establishment of the whooping crane in western United States. E.G. Bizeau, R. Drewien
- Role of avian and mammalian predators in population dynamics of western spruce budworm. E.O. Garton
- Resource partitioning in owls of the Idaho Primitive Area. E.O. Garton
- Computer programs for estimating population abundance and mortality and natality rates. E.O. Garton
- Simulation models for use in wildlife population analysis management. E.O. Garton
- Ecology of mink in west-central Idaho. M.G. Hornocker
- Ecology of badgers on the Snake River Birds of Prey Natural Area, Idaho. M.G. Hornocker
- Population characteristics and dynamics of river otters in west-central Idaho. M.G. Hornocker
- Analysis of predator-prey interactions on the Salmon tract, Twin Falls, Idaho. M.G. Hornocker
- Land management practices and sharp-tailed grouse in southeastern Idaho. W.B. Kessler

Winter ecology of nongame birds in Idaho Primitive Area. W.B. Kessler

Reintroduction of Columbian sharp-tailed grouse on the National Bison Range, Montana. W.B. Kessler

Identification of indicator nongame bird species for habitats of the Wasatch National Forest, Utah. W.B. Kessler

Responses of big game to a rest-rotation grazing system. J.M. Peek

Movement patterns and determinants of habitat use of big game in northern Idaho. J.M. Peek

Response of bighorn sheep to Ship Island fire, Salmon River. J.M. Peek

The value of snags on the University of Idaho Experimental Forest. S.R. Peterson

Ruffed-blue grouse habitat relationships in southeastern Idaho. S.R. Peterson

Resource partitioning among woodpeckers. S.R. Peterson

Crippling losses of waterfowl in firing line hunting. S.R. Peterson

Raptor inventory of the Vale District, Bureau of Land Management, Oregon. S.R. Peterson

Nutritional requirements and behavior of mountain beaver. M.J. Stoszek

FISCAL 1980 PUBLICATIONS AND REPORTS

Copies of Forest, Wildlife and Range Experiment Station publications and reprints of some journal articles are available from the authors. Reports issued in fulfillment of contracts are not available for distribution.

DEPARTMENT OF FISHERY RESOURCES

Bennett, D.H. 1979. Behavioral thermoregulation of largemouth bass (*Micropterus salmoides*) in a reservoir receiving thermal effluent. Arch. Hydrobiologie 86:193-203.

———. 1979. Probable walleye (*Stizostedion vitreum*) habitation in the Snake River and tributaries of Idaho. Completion rep. to Idaho Water Resources Res. Inst. 44 pp.

Bennett, D.H., C.M. Falter, and R.G. White. 1979. Environmental review of the Snake River (Jackson Lake to river mouth) and selected tributaries (Henrys Fork, lower Boise River and upper Salmon River). Completion rep. to U.S. Army Corps of Eng. Portland, OR. 324 pp.

Bennett, D.H., R.F. Raleigh, and O.E. Maughan. 1979. Effects of pumped storage project operations on the spawning success of centrarchid fishes in Leesville Lake, Virginia. Pages 125-134 in E.E. Driver, and W.O. Wunderlich, eds. International Symposium on the Environmental Effects of Hydraulic Engineering Works.

Bennett, D.H., R.G. White, P.M. Bratovich, H. Hansel, W. Knox, and D. Palmer. 1979. Status of the warmwater fishery and the potential of improving warmwater fish habitat in the lower Snake reservoirs. In U.S. Army Corps of Eng. Annu. Rep.

Bjornn, T.C., and N. Horner. 1980. Biological criteria for classification of Pacific salmon and steelhead as threatened or endangered under the Endangered Species Act. Special rep. to Nat. Marine Fisheries Serv. Seattle, WA. 24 pp.

———. 1980. Artificial propagation of Pacific salmon and steelhead in relation to the Endangered Species Act. Special rep. to the Nat. Marine Fisheries Serv. Seattle, WA. 13 pp.

Bjornn, T.C., and R.R. Ringe. 1980. Evaluation of steelhead trout losses in the McNary pool area of the Columbia and Snake rivers, 1962-1979. Final rep. Pac. NW Reg. Comm. Forest, Wildlife and Range Exp. Sta. Univ. of Idaho, Moscow. 76 pp.

Bjornn, T.C., J. King, and J. Lukens. 1979. Evaluation of pilot rearing program for steelhead trout at Hagerman and Dworshak National Fish hatcheries. Completion rep. to Walla Walla Dist., U.S. Army Corps Eng. 48 pp.

Bjornn, T.C., R.R. Ringe, and J. King. 1979. Marking and monitoring of the seaward migration of Snake River fall chinook salmon reared at Hagerman National Fish Hatchery, 1979. Completion rep. to U.S. Fish and Wildl. Serv. Boise. 4 pp.

———. 1979. Marking and monitoring of the seaward migration of spring chinook salmon reared at Kooskia National Fish Hatchery, 1979. Completion rep. to U.S. Fish and Wildl. Serv. Boise. 4 pp.

Bjornn, T.C., M.A. Brusven, J.H. Milligan, R.C. Konopacky, and S.T. Rose. 1979. Granitic sediments and salmonid stream productivity: a synthesis of information. Rep. for Environmental Protection Agency. 90 pp.

Chacko, A.J. 1979. Parasites causing diseases in fish. Pages 46-70 in Klontz, G.W. 1979. Fish Health Management. 2 Vols. Department of Fishery Resources and Office of Continuing Education, Univ. of Idaho, Moscow.

Falter, C.M., and J.S. Irving. 1980. Plankton ecology of Lake Koocanusa. Final rep. to U.S. Army Corps of Eng. Seattle. 50 pp.

Funk, W., and C.M. Falter. 1980. Limnology of the lower Snake River, Idaho-Washington. Final rep. to U.S. Army Corps of Eng. Walla Walla. 144 pp. plus Appendix.

- Gibbons, J.W., G. Keaton, J.P. Schubauer, J.L. Greene, D.H. Bennett, J.R. McAuliffe, and R.R. Sharitz. 1979. Unusual population size structure in freshwater turtles on barrier islands. *Georgia J. of Sci.* 37:155-159.
- Goodyear, C.P., and D.H. Bennett. Sun compass orientation of immature bluegill. *Trans. Amer. Fish. Soc.* 108:555-559.
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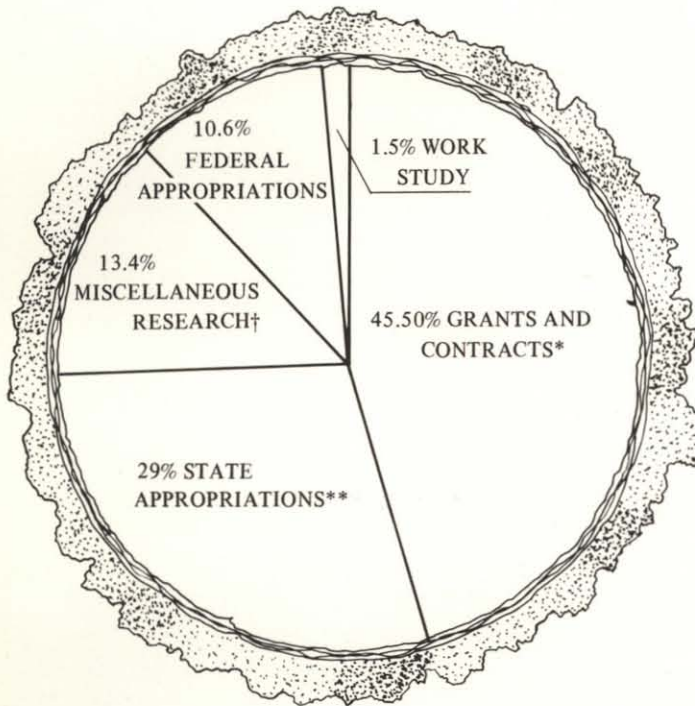
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Fiscal Year 1980 Financial Picture



Research expenditures, shown by funding source, totaled \$3,925,000 for the Fiscal Year 1979-80.

* Includes "in-kind" funds

** Includes FWR Experiment Station, Wildlife, Fisheries, Wilderness and Forest Utilization Research

† Includes Forestry Nursery, Experimental Forest, Idaho Research Foundation, Taylor Ranch, WICHE, and Alumni Account

Agency and Funding Support

Abbott Laboratories
 Alaska Fish and Game Department
 American Fishing Tackle Manufacturing Association
 American Forest Institute
 Anaconda Forest Products
 Bennett Lumber Company
 Boise Cascade Corporation
 Boise National Forest
 British Columbia Forest Service
 Bunker Hill Company
 Carney Company
 Clearwater National Forest
 Colville Confederated Tribes
 Crown Zellerbach
 Curtis Berklund
 Diamond International Corporation
 Dow Corning
 Environmental Protection Agency
 Greater Shoshone County, Inc.
 Idaho Department of Fish and Game
 Idaho Department of Health and Welfare
 Idaho Department of Parks and Recreation
 Idaho Department of Public Lands
 Idaho Fish Food Industry
 Idaho Forest Industries
 Idaho Nuclear Energy Commission
 Idaho Power Company
 Idaho Research Foundation, Inc.
 Idaho Water Resources Board
 Idaho Water Resources/Research Institute
 Inland Empire Paper Company
 Inland Empire Tree Improvement Cooperative
 Lucky Peak Nursery
 Montana Fish and Wildlife
 Morrison-Knudsen Company
 National Oceanic and Atmospheric Administration
 National Science Foundation

National Wildlife Federation
 Nature Conservancy
 New York Zoological Society
 Northern Pacific Railway
 North Idaho Forestry Association
 Pacific Northwest Power Company
 Pacific Northwest Regional Commission
 Pack River Lumber Company
 Payette National Forest
 Potlatch Corporation
 South Idaho Forestry Association
 Stilling Trust
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