FOCUS

on Renewable Natural Resources

Forest, Wildlife and Range Experiment Station
e of Forestry, Wildlife and Range Sciences
Moscow, Idaho 83843

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University of Idaho

From the Associate Director

Management and Conservation Are Inseparable

Leon F. Neuenschwander

At a time when the "sides" in the country's "environmental wars" are often characterized as science and management *versus* the natural world, it is important to remember that in the forestry and wildlife disciplines, and especially in our college, natural resource management, environmental science, and conservation are intricately bound together, and always have been. They cannot be separated. This interwovenness underpins everything we do in the College of Forestry, Wildlife and Range Sciences. It permeates the philosophies our students carry on into the management of the nation's resources after they graduate, in the methods practiced by our over 70 scientists in their research, in the responsibilities inherent in the stewardship advice our extension specialists offer to Idaho landowners. All of these are actions whose consequences will be felt into the next century by millions of people, actions rooted in concepts we are proud to take responsibility for teaching.

Ask any FWR student, professor, alum, or the citizen who calls my office for advice on managing his private forestland. The precept that undergirds our teaching, research, and outreach is simply that conservation is the wise use of our natural resources. This tenet of resource management assumes responsibility, caretaking, caution, knowledge of the consequences of our management decisions, avoidance of waste, objective assessment of natural areas and reasonable restoration of damaged areas, gentle treatment of gentle ecosystems, and balance of all needs—from insect to plant to animal to human. The researchers whose 15 projects are highlighted in this issue of *Focus* presume all of these concerns. As the annual report for the college, *Focus* provides a checking place for readers interested in the ongoing scholarship of the college's five departments: the Department of Fish and Wildlife Resources, of Forest Products, Forest Resources, Range Resources, and Resource Recreation and Tourism.

You will find Mike Scott's Gap Analysis technique spreading like wildfire across the country as almost all states line up to assess how much of our species' and vegetation's richest communities actually occur in established preserves. Scrutinizing GIS maps and satellite data, Scott and more than 200 nationally ranging scientists seek to help decision-makers place preserves where they will do the most good, and avoid controversy and belated "rescues" of endangered plants and wildlife.

Forest Products engineer Harry Lee and colleagues report on their progress training their new "iron horse," a miniature timber skidder that treats the forest gently as its five horsepower removes small logs by remote control.

Alton Campbell provides the ingredients of a recipe for eliminating forest products wastes like pulp and paper sludge: large, someday industrial-scale composting.

And in Hells Canyon, where growing visitor appreciation of the Snake River corridor threatens its very appeal, Ed Krumpe performed something of a first. Using a Forest Service public involvement technique, he helped often savagely competitive user groups reach a consensus about how to manage the resource to meet all of its needs and their needs. They achieved this compromise in record time, and are responsible for the rapid nationwide spread of the technique's use in other river-related management problems.

Obviously, the responsibility for caring for our natural resources belongs to all of us—the scientists, managers, users, and public—and depends on our willingness to work together.

I hope you enjoy this year's *Focus*.

Leon F. Neuenschwander

FOCUS
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1991 Annual Report

Volume 17 September 1992

Research Highlights

Appendix

Idaho Forest, Wildlife and Range Experiment Station

John C. Hendee, *Director*
Leon F. Neuenschwander, *Associate Director*
Richard F. Bottger, *Assistant Director*

Denise Ortiz, *Editor*
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Michal Pierce, *Typesetting*

Cover. Proactive and farsighted: Analyzing—and stopping up—the gaps in preserve protection of species and vegetation types could help us save species *before* they become endangered. The Idaho Gap Analysis is now complete. Photo by Gerry Snyder

Cover Story
Gap Analysis: Blueprint for Proactive Conservation

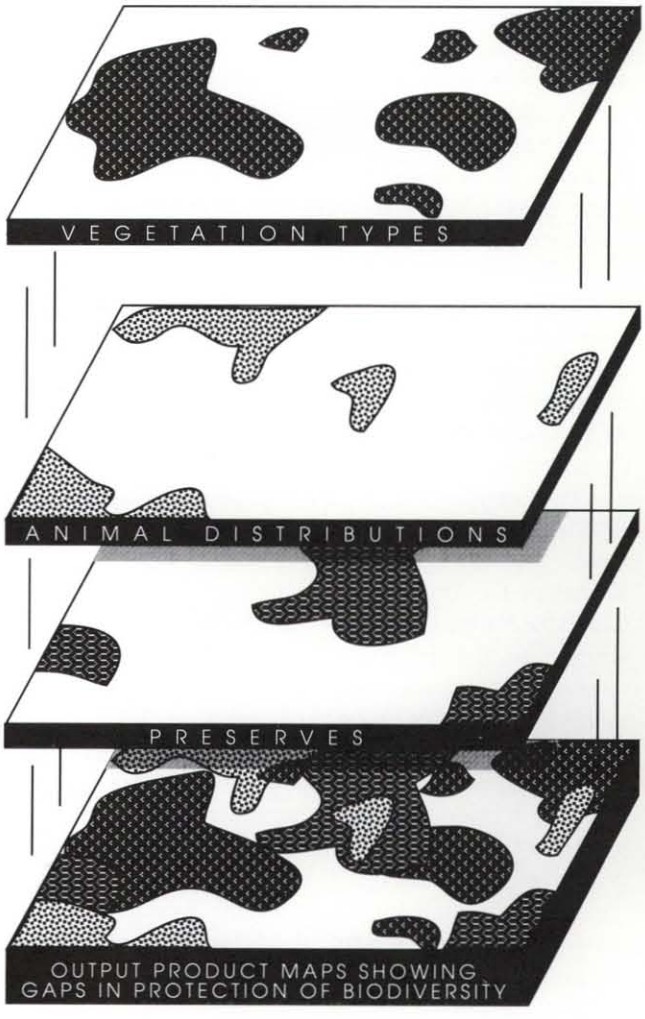
J. Michael Scott and Blair Csuti

Gap Analysis is a proactive approach to protecting biological diversity—the first step in a nationwide program to assess how much existing biological diversity falls within areas managed long-term to protect that diversity. It builds on the strong programs initiated by the Nature Conservancy and individual states, providing focus and direction for conservation efforts. Gap Analysis identifies and classifies biodiversity at the landscape level for states, regions, and ultimately the nation. It does this by simply determining which components of biodiversity occur in managed areas (and are well protected), and which are not.

The method involves mapping the distribution of vertebrate species, vegetation types, land ownership, land management units, and, when available—butterfly species. Gap Analysis depends on state-of-the-art technology including satellite imagery, the computer mapping tool GIS (Geographic Information Systems), and other extant information to digitally map the animals and plant communities in an area.

Specifically, the computer lays a map of vegetation types and another of animal distributions atop a map indicating different types of management areas. Its synthesis of the information from these three is an "output product map," a final map which shows where the most animals live, where vegetation types are found, and of prime importance—where the protected areas occur. Questions the technique can answer include: do biodiversity management areas overlap the areas where the most species exist? And to what extent are all vegetation types represented in existing management areas? To find out, we study the map or "analyze the gaps" to learn where more biodiversity management units might be most effective.

Gap Analysis gives us opportunities to pursue aggressive protection of biodiversity *before* conflicts over resource use reach crisis stages, as has happened with species like the spotted owl and communities like the ancient forests of the northwest. One example of how Gap Analysis could help avert controversy is its current use by Idaho decision-makers to evaluate areas proposed as military bombing ranges.



Gap Analysis was initiated in Idaho in 1987 with a budget of only $10,000 from the Idaho Department of Fish and Game, and has since expanded to include 21 other states, 40 principal investigators, more than 200 graduate students and cooperators, and a budget of $2 million for 1992, with current funding coming primarily from the U.S. Fish and Wildlife Service and the National Fish and Wildlife Foundation. A complete analysis of the entire country could be completed by 1998, at a cost of about 1 penny per acre.

The range of expertise and agency involvement in Gap Analysis has grown to proportions as enormous as the regions it maps. Nationwide, it encompasses university academic departments in wildlife, botany, zoology, biology, geography, and even sociology. It has captured the interest of environmental and remote sensing laboratories, forest and range experiment stations, nature and wildlife conservation groups, natural history museums, and computer corporations like Ramtek in Massachusetts, IBM in Montana,

and Hewlett Packard in Idaho. In California, public utility companies and development corporations have joined in support of the program.

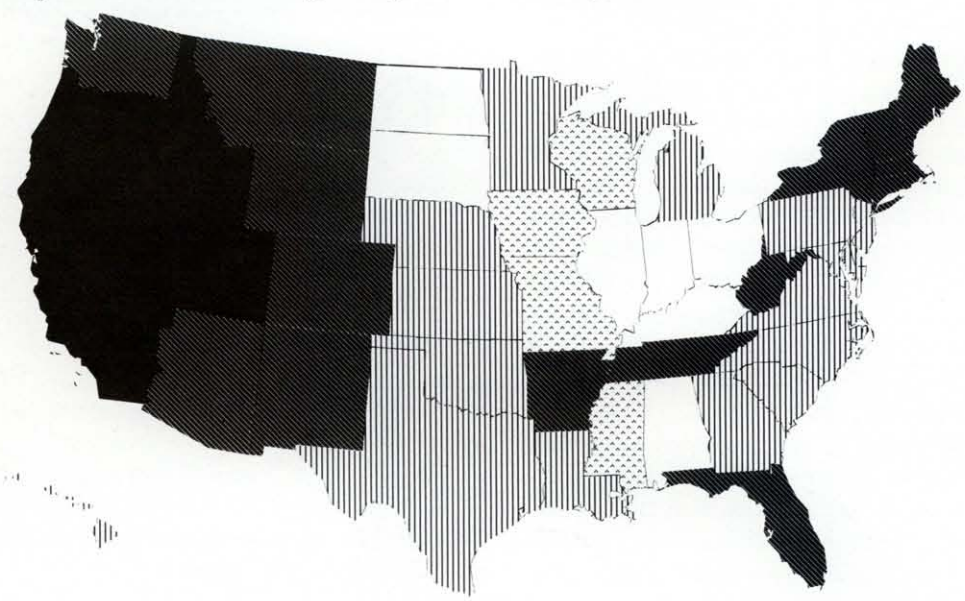
On the government front, Gap Analysis is cooperating with agencies that include the USDA Forest Service, the Center for Advanced Spatial Technology (also Earth Orbiting Satellite Systems), the Environmental Protection Agency, the U.S. Geological Survey, Bureau of Indian Affairs offices, the National Park Service, the Bureau of Land Management, and Natural Heritage Programs in several states. The effort also enlists the aid of state departments of lands, planning, fish and game, environmental quality, and transportation, as well as water districts and departments of tourism and recreation. It has even attracted the participation of local individuals like reserve managers.

The Gap Analysis project for Idaho was completed in 1991 with information from the Bureau of Land Management, the Environmental Protection Agency Water Resources Department, Idaho Department of Fish and Game, the Nature Conservancy, the Soil Conservation Service, and the U.S. Forest Service. We discovered that biodiversity management areas occur very unevenly in relation to the distribution of species and vegetation. For the most part, vegetation types occurring in alpine and subalpine areas appear adequately safeguarded—up to 70 percent are protected in biodiversity managements areas. But with many others we find less than 10 percent protected in biodiversity management areas.

The Idaho study suggests that shifts in current land use practices on federally-owned lands would provide more complete long term protection for a fuller range of vegetation cover types and vertebrate species. These findings, when combined with those of neighboring states, will allow more proactive biodiversity management plans to be put together for each of the nation's ecoregions. If fully implemented, the results of this gap analysis would result in fewer species and vegetation types sinking to an "endangered" or "threatened" status. Gap Analysis will also facilitate biological management plans that extend across political and administrative boundaries.

Focusing on areas rich in species and insuring that all vegetation types are represented in protected areas throughout their geographic ranges offers the most cost-effective way to retain maximum biological diversity in the minimum area. Gap Analysis is an attempt to shift focus from the last minute "emergency room" practices typically employed to save endangered species, to a more proactive, farsighted, community-oriented approach that seeks to "save" species before they become endangered—by maintaining the ecosystems that support them. It is not a substitute for recovery activities, but a technique that should dramatically reduce the numbers of species that become endangered in the first place.

Mike Scott is a research biologist with the U.S. Fish and Wildlife Service, a professor in the Department of Fish and Wildlife Resources, and leader of the Idaho Cooperative Fish and Wildlife Research Unit (housed in the college). Blair Csuti is a research associate and adjunct assistant professor in the same department, as well as a past research associate with the Center for Conservation.



Gap analyses are complete for the above-indicated solid colored states, currently underway for diagonally dotted states, due to start during 1993 for those vertically striped, and high priority states are marked with dot triangles.

Biodiversity—A New Role for the Nursery

David L. Wenny, Minoru Hironaka, John L. Edson

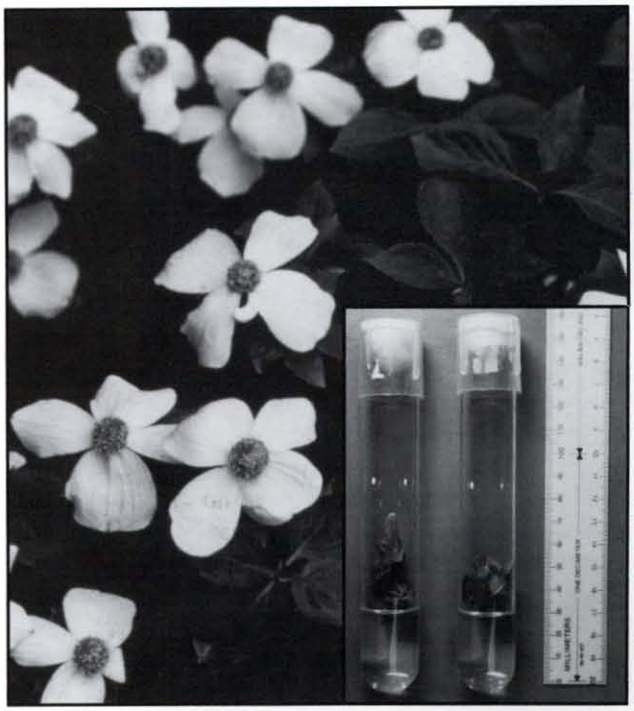
In recent years we have been hearing ominous reports of social misery and biological catastrophe resulting from destabilized ecosystems around the planet. Here in the Pacific Northwest, controversies rage over degraded environments in parts of our forests, fisheries, farms, and rangelands. Most of us have asked ourselves, "What can we do for the environment?"

Many ecologists believe they can restore some stability to damaged ecosystems by replenishing a depleted biodiversity. One strategy to increase species and the genetic diversity of our flora is to cultivate native plants and return them to sites in the wild where they had previously thrived but where they are now absent or in decline. The UI Forest Research Nursery can help in this effort by finding ways to micropropagate plants required for such restoration projects. Micropropagation produces new plants (in test tubes) from very small parts such as shoot tips, embryos, and lateral buds. The method foregoes the problems that often accompany the reproduction of plants sensitive to regeneration, and it allows the production and dissemination of seed from sometimes the single remaining plant of a species.

The nursery has recently expanded its existing micropropagation unit to accelerate propagation studies of white pine, larch, willow, sage, bitterbrush, dogwood, and other species native to the Northwest, as well as potentially valuable exotics such as cold-hardy giant sequoia.

On federal lands, where restoring biodiversity in damaged riparian areas has become a priority, land managers attempt to reduce soil erosion with steamside plantings of species such as Scouler willow. This past summer, we found that greenwood stem cuttings rooted fairly well on a greenhouse mist bench, but the shoots tended to grow horizontally rather than vertically. We are now culturing Scouler microcuttings under sterile and controlled conditions in our laboratory in an effort to produce normal upright plants. At present, the plantlets are undergoing acclimation and evaluation of their growth form.

In southern Idaho, rangeland managers would like to restore sagebrush habitat damaged by invasion of non-native cheatgrass and the associated increase in fire frequency. We have multiplied a valuable browse clone of mountain big sagebrush which resprouts after fire, a species for which



John Edson

John Edson

A spectacular and endangered Idaho native: the Pacific Flowering Dogwood.

we have been able to locate only one plant in the Northwest. We have also micropropagated clones of desert and antelope bitterbrush and continue to develop a protocol to multiply, root, and acclimate the plantlets to greenhouse conditions.

Increasing the size of endangered plant populations has become a special concern. Several decades ago, the spectacular spring bloom and brilliant fall color of one of the rarest and showiest native forest trees of Idaho used to attract admirers to its small territory near the confluence of the Lochsa and Selway Rivers. Unfortunately, the population of the beautiful Pacific flowering dogwood has declined recently. This past year we began experiments to increase the numbers of these individuals by micropropagation and by rooting cuttings. We hope to build a population of healthy plants sufficiently large to return to the wild within the next few years. Perhaps one day, groves of Pacific dogwood will again inspire awe in onlookers every spring and fall in Idaho.

These few examples showcase the new and expanding role the forest nursery has assumed in the wider search for ways to increase biodiversity and protect the state's irreplaceable ecosystems.

David L. Wenny is extension professor of Forest Resources and manager of the University of Idaho Forest Research Nursery. Minoru Hironaka is professor of Range Resources specializing in shrub restoration. John L. Edson is a research associate in the nursery and an experienced tissue culturist.

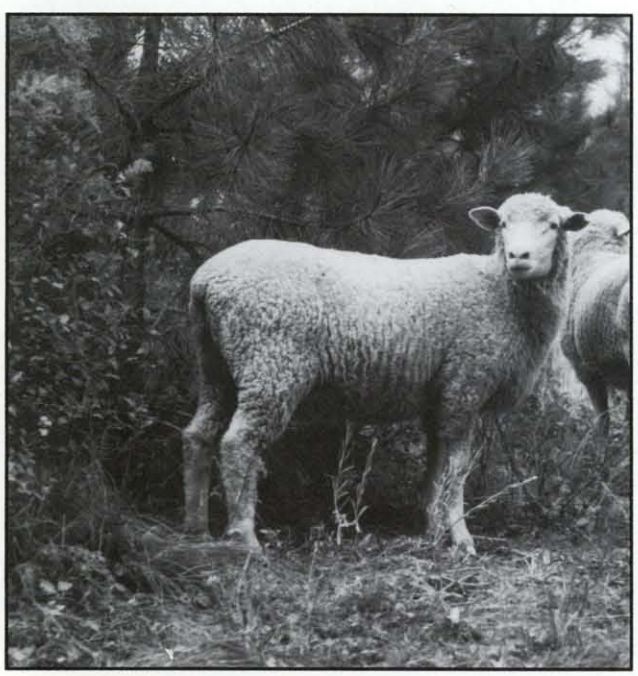
Multiple Use in Sheep's Clothing

Jeffrey C. Mosley, James L. Kingery, Harold L. Osborne, Scott D. McCoy

Early in life people learn to beware of wolves wearing sheep's clothing. Likewise, many natural resource managers have learned that serious conflicts often lurk behind seemingly benign multiple use management policies. But our new study is finding that a promising multiple use management solution may be hiding beneath *real* sheep's clothing. That promising tool is prescribed sheep grazing within conifer plantations.

After trees are harvested from a forest and young tree seedlings are planted in their place, grasses, forbs, and shrubs growing in the tree plantation compete with the tree seedlings for sunlight, water, and nutrients. This is a major factor limiting tree growth within conifer plantations throughout North America. Mechanical and chemical control methods have traditionally been used, but these methods are becoming increasingly cost-prohibitive and socially unpopular.

Prescribed sheep grazing could offer multiple use managers a way to control vegetation in new forests without using mechanical and chemical methods.



Jeffrey Mosley

Responding to this need, we are evaluating prescribed sheep grazing as an alternative method of vegetation control. Because the same herbs and shrubs that restrict tree growth also provide valuable winter forage to wild ungulates, we are also studying the effects of prescribed sheep grazing on deer and elk winter forage. The last piece of the puzzle we are studying is the effect of plantation grazing on sheep performance. This will enable us to assess the economic impacts to livestock producers. Our overall goal is to develop economically viable ways to use prescribed grazing to simultaneously benefit tree growth, sheep production, and wildlife habitat.

Previous research in Oregon and elsewhere has documented that sheep grazing can effectively improve tree growth and nutrient quality of winter forage. However, few reliable guidelines exist that outline the levels of grazing needed to safely achieve these goals. Our research seeks to quantify these thresholds so that prescribed sheep grazing might be more readily applied as a vegetation management tool.

We began our study last summer on the University of Idaho Experimental Forest within a mixed-conifer plantation dominated by Douglas-fir and including some western larch and ponderosa pine. We subdivided the plantation into six small pastures grazed by sheep at six different grazing intensities ranging from no grazing to heavy grazing. The grazing season extended from mid-June through early September. Targhee sheep were provided by Dennis Ownbey, a rancher from nearby Princeton, Idaho.

It is too soon yet to evaluate how tree growth responded to the varying levels of sheep grazing, but preliminary results indicate that browsing damage to the trees was not related to grazing intensity. Instead, the amount of browsing damage depended upon sheep distribution patterns within each pasture. The average daily weight gain of individual sheep declined at higher grazing intensities, but diet botanical composition and diet nutrient quality did not differ among grazing intensities. Declines in weight gain apparently were caused by decreased forage availability which forced sheep to expend more time and energy foraging to meet their nutrient requirements. Early results also indicate that higher sheep grazing intensities reduced winter forage available for elk and deer, but we do not yet know the effects upon nutrient quality of the forage available.

We are continuing our study and expect final results in Fall of 1993.

Jeffrey Mosley and James Kingery are both assistant professors of range resources. Harold Osborne is associate extension professor of forest resources and manager of the University of Idaho Experimental Forest. Scott McCoy is a research assistant and master's degree candidate in the Department of Range Resources. *Funding for this project is from USDA's McIntire-Stennis grant program.*

The New Idaho Riparian Cooperative

"If there is magic on this planet, it is in the water."—Loren Eisley

Natural Resources Communications Lab

George Belt

Driven primarily by concern for water quality, agency and public interest in the protection and management of riparian areas and associated wetlands has grown substantially over the last decade. Riparian zones are those areas of land adjacent to streams which buffer the interactions of land, water, and animals. Such interactions encompass a wide range of concerns, including, for example, loss of bank stability and riparian vegetation, and loss of fish habitat due to excessive sedimentation. Some of these interactions cause channel instability which can result in flooding, or loss of habitat for wildlife, birds, and small mammals, and loss of wetland areas which buffer flood peaks. And of course the consequential loss of recreation opportunities must also be considered.

Because so many factors—human, animal, and plant—depend on the quality and condition of riparian and wetland areas, these zones must be managed with all factors in mind: to protect fish and other aquatic life, to provide timber and forage, protect water quality, and reduce the downstream impacts of flooding on farms, power generation, and recreation. In response to the concern voiced by professionals and several private and public organizations over the need for improved management and coordinated information exchange, the University of Idaho in 1991 joined with concerned agency personnel to form the Idaho Riparian Cooperative, or IRC.

The IRC has three objectives: one, to develop information and techniques for cost-effective management by both government agencies and private landowners; two, to provide training and outreach activities for the general public as well as public and private landowners; and three, to facilitate the coordination and exchange of technical data among agencies. IRC membership will be open to public and private organizations and individuals interested in riparian and wetland management and willing to provide financial support via annual fees.

Housed within the Idaho Water Resources Research Institute, the IRC will be advised by a steering committee consisting of members nominated by the cooperating agencies and organizations. The college's George Belt, professor of forest resources, will serve as the first director and technical coordinator of the cooperative. Terry Tindall, assistant professor of plant science and extension soil specialist (Twin Falls) in the College of Agriculture, will provide leadership in extension as outreach coordinator.

The cooperative is directing its initial efforts toward two feasibility studies, the first leading to the subsequent development of a riparian classification and water quality monitoring system for all of Idaho. This study will summarize a range of classification techniques now used by state and federal agencies, and will suggest a standard approach for all management agencies in Idaho. Formulating such a standard may even have national implications, as similar cooperatives established in Montana, Arizona, and Utah now seek to address this same problem of lack of uniform methods among their agencies. The second feasibility study will form a basis for the cooperative's outreach program—analyzing existing programs, identifying needs, and formulating an IRC program strategy.

George Belt is a professor of forest resources specializing in forest hydrology and watershed management. He has worked extensively with federal and state agencies on water-related problems in the U.S., and in Thailand and India recently on water resource problems as related to natural resources.

Back to the Future: The Gentle Gallop of Forestry's New "Iron Horse"

Harry Lee, with Editor

A nimble and efficient, strong yet environmentally gentle horse of a new color has come to graze in the Department of Forest Products, and we expect this one to become a prize breed for the local forest products industry.

We call her our "iron horse," a 5-horsepower skidder built in Sweden to handle small wood. About the size of a snowmobile, her impact is low because she is light, traveling on a track with an impact equivalent to that of one horse. Not like the big 140-plus-horsepower machinery commonly used in the U.S., this kind of equipment has been used in Sweden and Finland for six to eight years already. U.S. interest in the machinery shows a shift in the kind of wood American logging companies now seek, a shift in response to growing environmental concerns about the impacts of large machinery logging on the nation's forest ecosystems. The usable commodity is now smaller logs six inches in diameter or less down to two-inch tops, along with the more mature eight-inch-plus stems traditionally cut.

Local processors have indicated that traditional smallwood can produce positive returns for a landowner in terms of profit, while not damaging the stand yet also enhancing its long-term productivity. Indications from buyers are also that there is a future in smallwood.

The past several decades have unfolded for the timber harvesting industry an often-changing history of machinery, starting with horses as skidding "equipment" and evolving into today's huge, highly mechanized operations. But this increasingly larger equipment has also increased environmental impacts like soil disturbance, soil compaction, water quality degradation, and aesthetic degradation, none of which fill the prescription of the New Forestry that now directs forest management in the 1990s. Because of this, the industry may be returning to some of the more basic methods for harvesting the timber resource, casting horses and small-sized equipment in a more active role again.

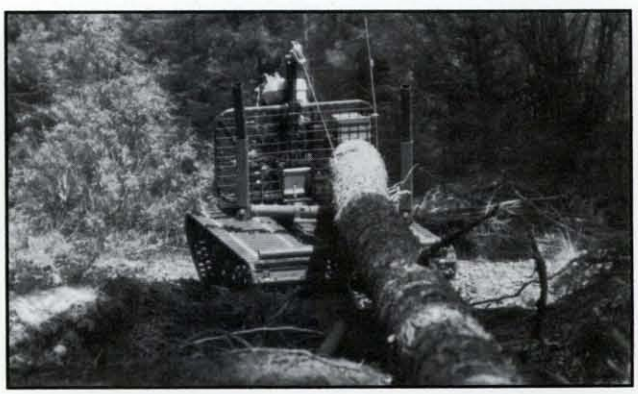
At the other end of the spectrum from the iron horse—and scheduled for a later stage in our research—is the cut-to-length forwarder, an example of new big machinery that in spite of its 14 tons, also imposes very low impact. We are most interested in how this gentler machinery will work in conjunction with New Forestry techniques (New Perspectives, Adaptive Forestry), both for logging on microsites and for the big corporations logging larger tracts of land.

The European cut-to-length forwarder de-limbs and tops logs right at the site (in front of the machine) where it has grabbed, cut, and stacked logs with its giant feller-head-tipped arm. It disperses limbs and tops, eliminating slash piles. In addition, the tops, limbs, needles, and cones that stay at the site ensure future nutrient recycling and increase the chances of natural regeneration.

Used experimentally in the pine plantations of the southern United States, the forwarder's gentle treatment of trees curtails breakage, so all fiber is recovered. The forwarder decreases impact by eliminating the many repeated trips over delicate forest soil by staying in one place, and when it does travel, it does so on top of the debris it has created, which acts as a cushion to the undersoil. It removes trees without disturbing the surrounding stand by hitting other trees; logs are never being dragged—always carried. When a second machine rolls through to pick up the log pile, it travels to the site in the same path as the forwarder. When harvesting on wet ground—where traditional machinery tends to leave rutting when turning—this forwarder holds

Gerry Snyder

Engineering graduate student John Canning finds no particular problem overstepping medium sized stumps.



Gerry Snyder

As with a real horse, the skidder will require that someone "swamp" its pathway so that stumps don't trip it up.

site disturbance to a minimum. And there is virtually no soil compaction.

Starting in October of 1991, we have concentrated our efforts first on the "iron horse." The effort is a cross-disciplinary one, and a new direction for both researchers. We have conducted studies in timber production and environmental effects, in batteries and application of robotic principles to logging equipment, but not in equipment development.

What we have developed in the iron horse is a small, radio-controlled skidder that we created by modifying a small-tracked vehicle made by Husqvarna of Sweden. The five-horsepower engine powers its two tracks and the whole 5.5-foot-long unit weighs only 550 lbs.—light enough for two men to lift. Our iron horse can be started, clutched, steered, and braked by radio control. An added feature is that if radio contact is lost, the skidder brakes and turns itself off. The unit is radio-controlled mainly for safety—the radio takes the operator out of potentially risky situations in the forest, for it can control the iron horse from 200 feet away.

Currently, we are evaluating the iron horse in real logging operations on Bennett Lumber Company lands and the university's Experimental Forest, and have selected plots that will test the skidder in a range of management conditions including pre-commercial and commercial thinning material removal, and small-scale sawlog production. Ultimately, we will be able to present a final design for further development—the best design of a radio-controlled skidder based on our tests and experience.

In a glance to the future, we plan to use the information from our iron horse field test to design a second skidder, also radio-controlled, but with the additional capability of navigating a skid trail without an operator's guidance—a robotic skidder that would steer its own way using sensing equipment after a once-through taught to it by its operator.

Harry Lee is assistant professor of forest products. His partner in research is Dean Edwards, associate professor of mechanical engineering in the College of Engineering. *Their initial work is being funded by Bennett Lumber Company and the Potlatch Corporation.*

Recipe for the Forest Products Industry—*Composting*

Alton G. Campbell

Solid wastes such as pulp and paper sludge and log yard residues cause major disposal problems for the forest products industry. One solution might be to recycle these wastes into a more valuable and safer product—compost.

Composting reduces the mass and volume of the wastes, and thus their handling and trucking costs. The composting process also decreases potential leachate problems, degrades toxic compounds, and improves retention of plant nutrients, thereby enhancing plant growth. Thus, composting could be used to produce a high quality, uniform, and *marketable* product that could become a source of revenue for a mill, rather than an expense.

How exactly can composted wastes improve plant growth? By increasing soil aeration, water-holding capacity, and water infiltration as well as lowering soil bulk density and surface crusting. Composting has been used in horticultural and agronomic crop production, land reclamation, vegetation establishment, and erosion control.

Our research lab, located in the basement of the college, contains several types of reactors (cylindrical fiberglass tanks) used to evaluate and develop composting processes. We begin evaluations in small five-gallon reactors. In these, we examine basic compost variables such as moisture content, carbon-to-nitrogen ratio, nutrient content, and aeration. We then scale the process up to 440-gallon reactors. To monitor the course of composting, we measure temperature, moisture content, carbon-to-nitrogen ratio, cation exchange capacity, and humic content. Typically, we measure heavy metal and plant nutrient content on the initial and final compost. In order to evaluate compost maturity and quality, we test the effects of the final product on the growth of various plants in small growth chambers in the lab or at the university greenhouse.

The objective of our research program is to develop composting processes that could be used to treat and recycle non-toxic organic wastes produced by the forest products and agricultural industries. To date, our research has involved two projects to compost pulp and paper sludge as an alternative to landfilling, and one to compost bluegrass as an alternative to field burning.

Pulp and Paper Sludge Composting

The U.S. pulp and paper industry generates approximately four million dry tons per year of sludge. Traditionally, the vast majority has been landfilled (70 percent in 1988), but environmental concerns and government regulations have made landfills difficult to site and expensive to operate. Composting is an excellent alternative to landfilling or incineration.

In our first project, we composted a combined primary-secondary sludge from a newsprint mill in a laboratory static pile with forced aeration. In the second, we composted a kraft sludge (primary sludge and tailings) amended with wood ash and slaughterhouse paunch in a large field pile. Finally, we evaluated these two composts as either a peat moss substitute or soil amendment for a cottonwood plantation.

After six weeks of composting and curing, tomato plant growth in the newsprint compost improved to 90 percent that of plants grown in peat moss, demonstrating that mechanical pulp/paper mill sludge can be composted to yield a stable product essentially equivalent to peat moss as a plant growth medium. In addition, cation exchange capacity and total humus content strongly correlated with composting time, suggesting that these two properties could be used as a measure of compost maturity at an industrial compost facility.

Growth of tomato plants in the kraft sludge compost improved with the time the sludge had been composted, but growth was still less than in peat moss. Greenhouse growth of poplar trees was unaffected by compost application rates of 80 tons per acre or less. This compost could probably be used safely at high application rates as a mulch, and at lower application rates as a soil amendment. We continue to assess the effect of sludge compost on growth and nutrient uptake of cottonwood.

Bluegrass Composting

Bluegrass residues remaining after seed harvest is a very large problem in northern Idaho and eastern Washington. The current practice is to burn fields after harvest, causing periods of intense pollution in the region and respiratory problems for some people. The goal of our bluegrass research is to develop an on-farm composting process as an alternative to field burning. Our research results so far indicate that unamended bluegrass straw composts very slowly. Without addition of supplemental nutrients, an on-farm composting process would probably require six to 12 months to produce a stable compost. Grinding it to reduce particle size and amending it with manure, sewage sludge, or septage should significantly increase the rate of composting and product quality. Our future research will attempt to develop a more rapid composting process, and to evaluate compost quality.

Straw has been used extensively to compost sewage sludge in many parts of the world. For this reason, bluegrass straw should be an effective bulking agent and carbon source to aid in the composting of sewage sludge and septage. Future collaborative research with local sewage and septage treatment plants may demonstrate a market for bluegrass straw that would also help reduce those two major solid waste problems for northern Idaho.

Log Yard Residue Composting

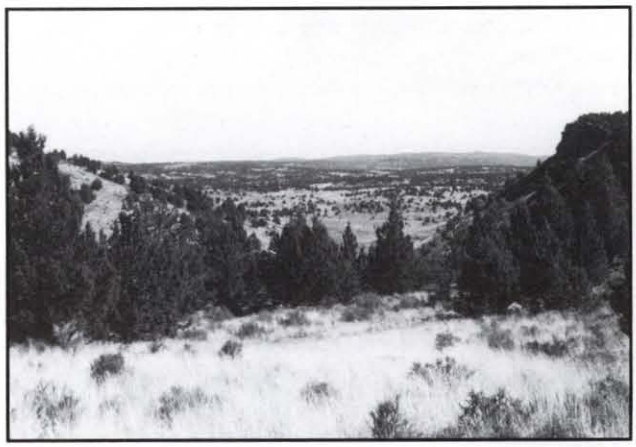
Log yard residue (LYR)—a mixture of soil, rock, bark, and fine organic matter produced in large volumes by forest products companies—would be another candidate for composting, and one which we plan to investigate in the near future. Created when fallen bark in a log yard is broken down and mixed with soil and rock by the movement of heavy equipment, LYR varies significantly from mill to mill in its proportion of rock, soil, and organic matter, as well as particle size, wood species, extent of decay, and moisture content. High ash content limits its use as a boiler fuel and high organic content restricts its use as a fill material. Because of this, most LYR is landfilled, stockpiled, or incinerated. Wood processing plants could easily compost LYR in large piles on site by slightly modifying their present operating procedures. Screened compost could be sold as is or mixed with soil or bark to produce a variety of products. Heavy clay soils would particularly benefit from being amended with this compost.

Another use for this LYR compost is for mining revegetation and reclamation. Over the past 100 years, mining operations in the Silver Valley of northern Idaho have created extensive areas of mine tailings contaminated with heavy metals that constitute a significant health hazard. Revegetation of this area would significantly reduce human exposure to heavy metals, improve aesthetics, and encourage economic development. Previous attempts to revegetate the tailings have failed because of a lack of soil organic matter and exchange sites for plant nutrients. Composted log yard residue could serve as a soil amendment on tailing piles and hillsides to enhance vegetative growth, add organic matter, restore biological activity, improve soil-water retention, reduce wind-transport of metal-contaminated soils, and possibly reduce heavy metal solubility and availability to plants. For this reason, LYR producers ought to consider composting as a method for recycling this waste.

Alton Campbell is an associate professor of forest products. His partners in research have been Regginal R. Engrebretson, forest products graduate student, and Robert R. Tripepi, associate professor in the Plant Science Division, College of Agriculture.

Ernest Ables

Sawtooth National Recreation Area



Stephen Bunting

The Owyhee Canyonlands

A National Park in Idaho?

James G. MacCracken

More than 60 percent of the land in Idaho is managed by the federal government, yet there is currently no national park entirely within its borders. While Idaho does boast two national monuments, a national historic park, and a national reserve, the suggestion repeatedly surfaces that some of the state's federal lands might have the potential to become a national park.

Reasons for establishing a national park in Idaho are varied. National park designation confers special status to an area and can become a matter of local pride and esteem. Additionally, the potential for increased tourism and economic activity is often an assumed benefit, as well as greater resource protection and a shift in management philosophy and emphasis.

The situation becomes even more complicated when opposition to national park designation is as strong as support. Opponents emphasize the potential for resource degradation due to increased tourism and excessive development, and they resist the prohibitions of hunting, grazing, logging, etc. that usually accompany national park status.

Consistent with the Policy Analysis Group's (PAG) mission to provide Idahoans with objective information for making natural resource decisions, we conducted a study that helped sort out the various arguments in the debate over national park designation in Idaho. The report, the eighth in the PAG publication series, also summarizes the proposals that have been made for several areas in the state.

The National Park Service Act of 1916 established the National Park Service (NPS) agency and mandated its dual and often conflicting mission to protect resources *and* provide for outdoor recreation. Acts of Congress create most NPS units, with the exception of national monuments creat-

Craters of the Moon National Monument

Gerry Wright

Hells Canyon National Recreation Area

U.S. Forest Service

ed by the President through public proclamation and national historic sites designated on federal lands by the Secretary of the Interior. Because national park designation is bestowed only by Congress, the action is ultimately a political decision. Once designated, national park areas are managed under a general NPS policy that excludes hunting, trapping, livestock grazing, logging, and other consumptive uses of the land (there are numerous exceptions to this policy).

American national parks are the "crown jewels" of the NPS system. They contain outstanding, exceptional, or rare examples of geology, ecological diversity, plant or animal populations, fossil deposits, and/or scenic areas. The integrity of the areas is vital. They must not be altered, deteriorated, or otherwise impaired in any way that would diminish the public's appreciation of them as distinct land features.

Additions to the National Park System should meet the criteria of *national significance, suitability,* and *feasibility.* Four areas in Idaho have been proposed at one time or another and may qualify for national park designation.

Craters of the Moon National Monument

Craters of the Moon is the only example of a volcanic rift system in the continental United States and was admitted to the NPS system in 1924. The boundary of the monument has since been extended five times to comprise 53,545 acres.

The NPS conducted a feasibility study during 1989-1990 to consider making Craters of the Moon a national park. The study noted that to make a feasible transformation, the monument and a surrounding Bureau of Land Management (BLM) wilderness study area should be designated a national park and that additional nearby BLM land be designated a national preserve. However, even though the area meets the three criteria, the study team recommended that its status remain unchanged because current protection was adequate. Then in 1991, an Idaho Congressman introduced a bill to designate Craters of the Moon as a national park, but no action was taken.

Hells Canyon National Recreation Area

Early in 1992, a citizen conservation group proposed national park and preserve status for this 652,488-acre area located in northern Idaho along the Snake River, an ecologically diverse region encompassing a river canyon deeper than the Grand Canyon of the Colorado. To date, no national recreation area has ever become a national park. Hells Canyon National Recreation Area and surrounding lands are managed by the U.S. Forest Service and would probably meet the three criteria for a national park.

Owyhee Canyonlands

This BLM-controlled southwestern Idaho area would take in 377,560 acres of the Owyhee River and bordering canyonlands in Idaho, Oregon, and Nevada, currently a BLM wilderness study area. The Idaho portion includes 178,295 acres or 47 percent of the total area. A citizen conservation group has proposed national park designation here. Owyhee Canyonlands may also meet the three criteria for national park designation.

Sawtooth National Recreation Area

This area in southcentral Idaho is managed by the U.S. Forest Service. The legislation creating the Sawtooth National Recreation Area directed the NPS to study the area's potential as a national park, and the study team recommended a combined national park/national recreation area status. The U.S. Secretary of the Interior agreed in 1977 that the area was worthy of park status, but declared the proposed national park/national recreation area combination too large and that "sensitive" management by the Forest Service could accomplish the same goals.

National park status coupled with official wilderness designation confers the highest degree of resource protection available to public lands in the United States. With protection of biological diversity rapidly becoming an urgent conservation issue worldwide, biologists have suggested that the designation and design of new national parks be considered in light of the contributions these areas make toward maintaining biodiversity. The practical application of these ideas through the "Gap Analysis" approach (see cover story) may provide additional insights about these four exceptional regions of Idaho.

Jim MacCracken is the new research scientist for the Idaho Forest, Wildlife and Range Policy Analysis Group (PAG), established in 1989 by the Idaho Legislature and housed within the Forest, Wildlife and Range Experiment Station. MacCracken recently completed his Ph.D. in the Department of Fish and Wildlife Resources. Citation: MacCracken, J.G., and J. O'Laughlin. 1992. A National Park for Idaho? Proposals and Possibilities. PAG Report No. 8. Idaho Forest, Wildlife and Range Experiment Station. University of Idaho, Moscow.

Pioneering Consensus in Hells Canyon

Edwin E. Krumpe and Lynn McCoy, with Editor

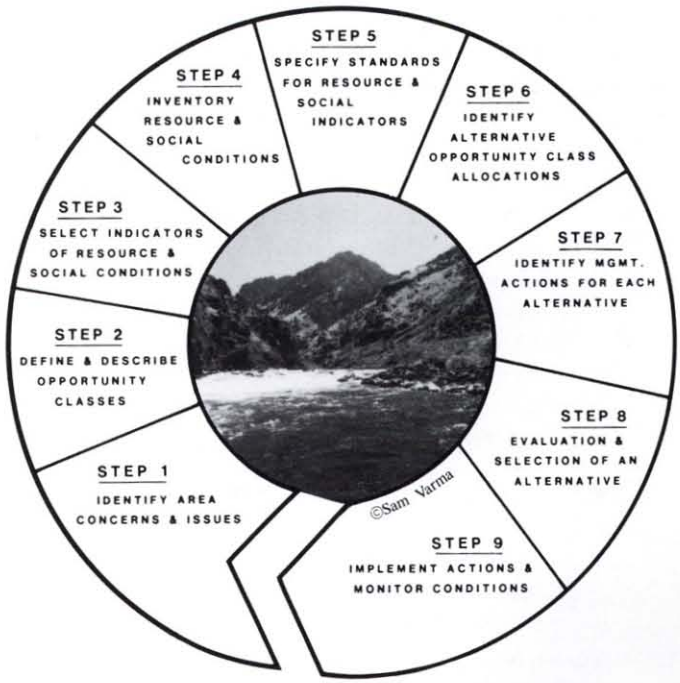
Exciting. Groundbreaking. It is a rare occasion when an academic scientist is given the opportunity to bring research directly into management, to assist members of the public in drafting a management plan for an area vitally important to them, to help put something in place and then see it in actual use for the next few years. That is what we had the fortune of doing from September to September of 1990 to 1991 when the U.S. Forest Service asked us to bring together diverse Snake River user groups so they could prepare a new management plan for that increasingly popular river. The highly visible study stirred up many people and issues, and appeared in newspapers in three states—in the (Portland) *Oregonian,* the Lewiston *Tribune,* and Spokane's *Spokesman Review.*

The center of the ruckus—and of the eventual recreation management plan—is the Snake River corridor that cuts its way through the Hells Canyon National Recreation Area on the Idaho-Oregon border. Managed by the Wallowa-Whitman National Forest, this 67.5-mile section of the Snake is a designated member of the Wild and Scenic River System. Although there are only two gravel roads leading directly to the remote canyon, the river draws 22,000 boaters to its nationally famous waters each year, making for increasingly uneasy interactions among the powerboats, kayaks, and rafts that all share the river.

Enjoyed year-around, this deepest gorge in North America offers some of the most enviable sturgeon fishing in the world, canyon walls decorated with archaeologically invaluable pictographs, and a national reputation for quality white-water sport experiences.

The entire planning process for management of the canyon involved two phases: one, a 1988-1989 survey of users, and two, updating of the river recreation plan via public task force—that was the groundbreaking part.

Data from the study of river users told us that during just the summer of 1988, over 22,000 people floated or powerboated the river, an increase of more than 44 percent from 1979. With the assistance of Visiting Assistant Professor Stewart Allen, we had installed hidden cameras at key access points, flown over the canyon in airplanes to count boaters and visitors, and asked over 2000 users to complete questionnaires, with a response rate of over 77 percent, and including replies from users from 43 states and over 500



The nine-step LAC Planning Process. Center: Hells Canyon.

cities. That study found four primary user groups: private powerboaters, private floaters, commercial powerboat passengers, and commercial float passengers. Other users included anglers, aviators, horsemen, hunters, and hikers.

Working from this information base, the goals of the task force were to reach concensus and develop a management plan that achieves a reasonable balance among the various interests and concerns of the various user groups. Our job was to serve as facilitators, and the task gave us a chance to perfect some public involvement techniques at the same time, including the Limits of Acceptable Change process, or LAC.

LAC is a Forest Service public involvement and planning technique for reaching concensus on management questions. It asks participants to consider: how much change can we tolerate? In applying it to the Hells Canyon Management Plan Public Task force, we charted new territory in adapting it to river management instead of the usual wilderness management situations to which it is usually applied.

A basic premise of LAC is that all human activities cause impact; therefore, some change in conditions is inevitable and management plans should focus on the conditions of the resource (effects of human activities) rather than visitor use numbers. LAC works to define what is and is not achievable or acceptable for the resource and to develop a strategy for preventing unacceptable conditions from occurring. It follows a series of nine steps, and incorporates extensive public involvement.

The Hells Canyon LAC Planning Task Force consisted of 22 members representing agencies such as the U.S. Forest Service, the Bureau of Land Management, Idaho and Oregon state parks, the Idaho Department of Fish and Game, and Oregon Fish and Wildlife. Others represented aircraft users, anglers, community interests (especially the population centers of Lewiston and Clarkston), conservation, the Idaho Power Company, native Americans, and both outfitter and private float and powerboat owners.

Members—from as far as Cambridge and Boise (Idaho) and Portland, Halfway, and Joseph (Oregon)—represented the broad public, but all with different philosophies. With all the strife between these groups before they gathered in the task force, few observers might have expected consensus could ever be reached. Yet even though the process took a year, this was the most quickly completed LAC plan ever in the U.S., since most such processes continue for over two years. As facilitators, we spent literally three to five hours planning for each hour of the 17 eight-hour formal meetings.

We have much praise for the task force members: they contributed copious amounts of time, travel, and hard work—completely volunteer—and all of them compromised for the sake of maintaining the characteristics of the river that draws so many to it.

The task force identified Hells Canyon recreation values as including, among others, high quality fishery, historical and cultural resources, high scenic quality, ruggedness of the canyon, and the economic benefits of tourism to nearby communities. They then generated a second list of items identified as threats to these characteristics: litter, vandalism, fluctuating water levels, and so on.

The LAC Task Force's final recommendation outlines three primary objectives: 1) to provide better river education and etiquette, 2) to maintain the Hells Canyon recreation experience, and 3) to perpetuate the area's natural and cultural resources. From here, the Forest Service will implement the report's recommendations after gleaning public input on the plan as required by the National Environmental Policy Act (NEPA).

Other LAC task forces that have utilized public involvement techniques we developed for Hells Canyon include those addressing the Sawtooth Wilderness questions in Idaho, and the Jedediah Smith, Bridger, and Teton wildernesses in Wyoming.

Application of these techniques since our Hells Canyon experience has spread rapidly across the nation. Managers all over the country are now hungry for this kind of information. Since the completion of our Hells Canyon project, we have been invited to Colorado, Idaho, Oregon, and Utah to conduct workshops on how the process could be adapted in those states to their particular resource problems. When we presented our perspective to a recent American River Management Association meeting, 80 percent of the participants said they planned to apply the LAC process to river management as we did—a first for a process originally designed to create consensus about management for wilderness areas.

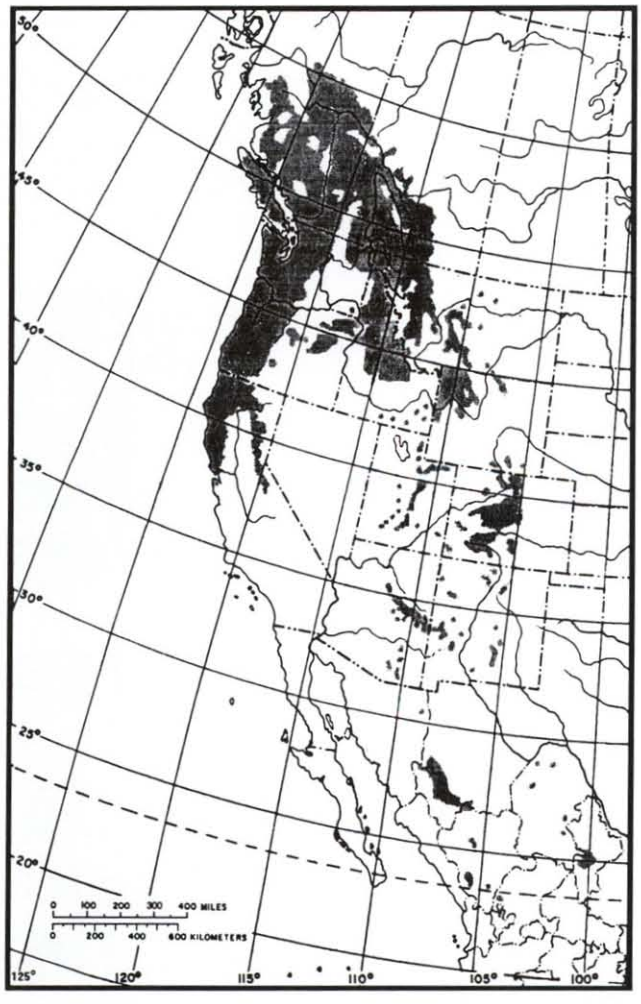
Ed Krumpe is associate professor in the Department of Resource Recreation and Tourism, and principal scientist for the UI Wilderness Research Center. Lynn McCoy is a Master's degree student in the same department. *Their planning process was funded by a USDA Forest Service cooperative agreement. The September 1991 report* Recommended Limits of Acceptable Change Recreation Management Plan for the Snake River *is available from: Wallowa-Whitman National Forest, USDA Forest Service, Clarkston, WA 99403.*

Spendthrifts and Misers: Water-Use Efficiency in Douglas-Fir

John D. Marshall and J.W. Zhang

If you want to understand how trees work, you need to know how leaves work. Leaves take carbon dioxide, a gas with no color, taste, or smell, out of the the atmosphere and make sugars from it using energy from sunlight and a complex system of biochemical machinery. Every schoolchild knows this process as photosysnthesis. The sugars are then used to build roots, leaves, tomatoes, zucchinis—and wood.

Range map of Douglas-fir.



But plants pay a price for carrying out photosynthesis. Wet tissues must be exposed to air to take up CO_2 and therefore large quantities of water are lost to the air. Ever notice how much water you have to put on a plant to get just a little growth? Plants get a lousy deal: they often lose 500 water molecules for every molecule of CO_2 they take up. And that means they may use 100 gallons of water for every pound of weight they gain!

Fortunately, plants differ in how efficiently they use water, and that allows us to breed for individuals with high water-use efficiency (WUE). When such efficient individuals are placed on dry sites, they are able to grow more using the small amount of water available. Agronomists working with unirrigated crops are far ahead of foresters in this process of breeding for WUE, but we're making a start.

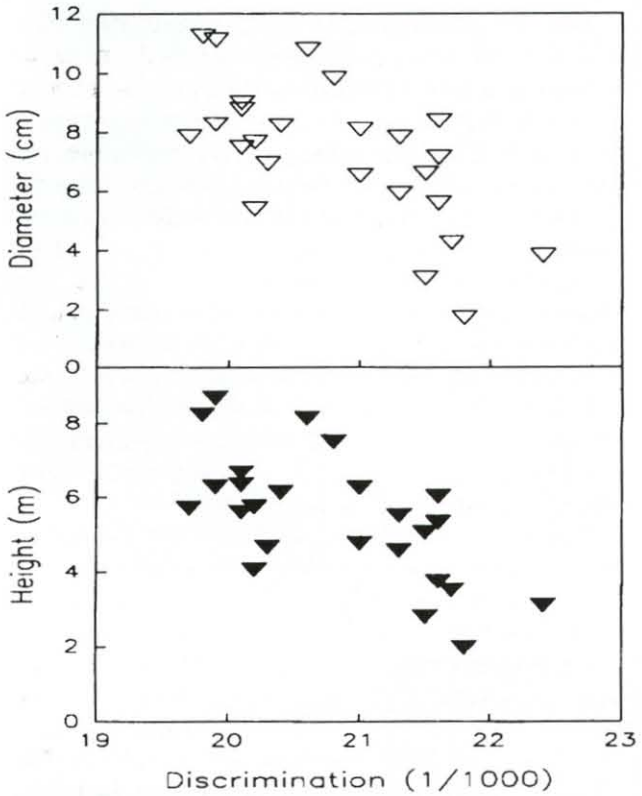
A new method has recently been developed that makes screening for high WUE straightforward and efficient. But to understand it, you need to know a little about the isotopes of carbon.

For many, the word "isotope" means radioactivity, and it is true that some isotopes are radioactive. For example, the carbon in carbon dioxide may be ^{14}C, a radioactive isotope. But only the tiniest trace of the carbon dioxide in the earth's atmosphere contains ^{14}C; 99 percent of the rest is made of ^{12}C. The last 1 percent or so is ^{13}C, which is not radioactive. And here we come to its usefulness.

Plants don't like ^{13}C; they discriminate against it in photosynthesis. But the discrimination varies, and for reasons too complex to elaborate on, the variation in discrimination is related to WUE. Because of this relationship, we can measure the amounts of ^{13}C in a plant's tissue and figure out what its WUE must have been at the time the tissue was growing. The theory and terminology may seem complicated and strange, but use of the technique is simple. You simply collect tissue samples, dry them, grind them, and send them off for analysis (in our case, to the University of Utah Stable Isotopes Ratio Facility for Ecological Research).

We have used this technique in a plantation in southeastern British Columbia on a site where far-sighted foresters planted Douglas-fir seedlings from across western North America. The guest trees grew from seed collected from Mexico, from northern regions almost into the Yukon, and from the coast ranges to Wyoming and New Mexico. What we found surprised us: WUE of the drier climate Douglas-fir was half that of the local trees. We had expected high WUE from the trees adapted to a drier climate.

Trees grown from seed collected in the Cascades, where there's plenty of moisture, were quite efficiently using the water available to them while trees from seed from the drier southern Rockies (Colorado, New Mexico, Ari-



Correlations between carbon isotope discrimination and height or diameter at age 15.

zona) utilized water less efficiently. We have several ideas about why this pattern might have evolved, including greater probability of summer rain in the southern Rockies or lower CO_2 concentrations at their high elevations.

Practically speaking, why should we care about these differences? Because both height and diameter, which are measures of wood production, were directly related to WUE: the misers or efficient trees grew faster than inefficient spendthrift trees. Many questions remain, including: To what degree is water-use efficiency inherited? How would the trees "behave" at their home elevations? And do other conifer species show similar patterns of WUE variation?

We are currently conducting more detailed studies with Douglas-fir seedlings, including some gathered from the "rain forests" near the Pacific coast, in addition to looking at WUE in western larch and ponderosa pine. This information will help determine the extent to which local seed sources adapt to the climate of a site, and may allow us to identify genotypes that can produce more wood on the limited supplies of soil water available in the forests of Idaho and much of the Intermountain West.

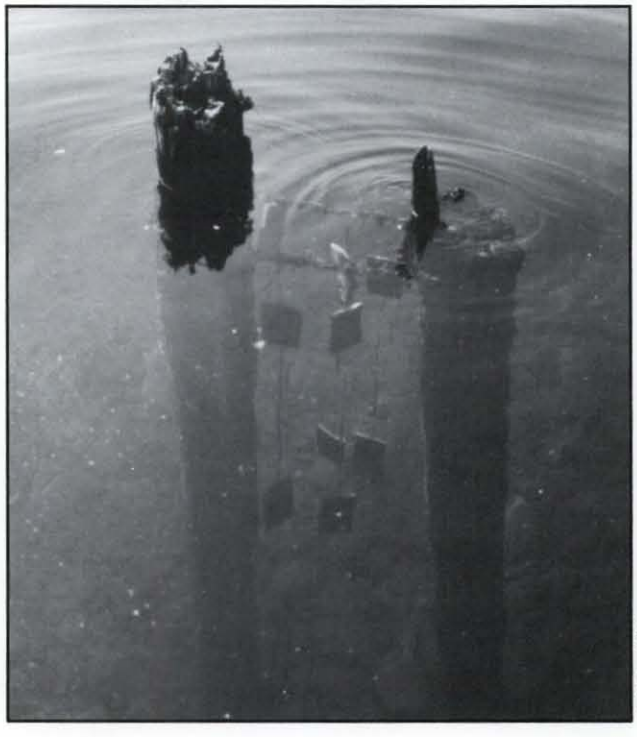
John Marshall is assistant professor of forest resources and Jianwei Zhang is a Ph.D student and research assistant in the same department. *Funding for their project is provided by a McIntire-Stennis grant.*

Loving Our Lakes to Decay

C. Michael Falter

Every lake is destined to die, but the shallower ones go first. Lakes progress through a life cycle from poor nourishment to moderate nourishment, and finally over-nourishment, before eventually filling and becoming land. One hundred years ago northern Idaho's Lake Pend Oreille would have been bluer in color than it is now, and one could have looked down 60-70 feet through its clear waters. Now in summer you can see 25 feet down through light green water—still pretty good compared to most other U.S. lakes. The lake has a long life still ahead of it because of its 1200-foot depth, however increasing density of shallow water aquatic weeds and complaints from homeowners of increasing growth on docks and shoreline areas have raised concerns that the lake is changing at a faster rate than previously expected. Idahoans are perhaps loving their largest lake to a state of decay.

One small obstacle to Falter's study was a kind of good-hearted "vandalism" by the public. Swimmers in the lake would find the experimental tiles and toss them up on shore, thinking they were helping clean the lake.



C. Michael Falter

There are several causes for the pollution in Lake Pend Oreille that is accelerating its "eutrophication" or aging process. Compared to 30 years ago, we are not only running many times the number of boats on Pend Oreille, but the boats probably average more than ten times the horsepower of 30 years ago. Bigger boat engines mean more gas and oil burned and discharged into the lake. Also, Lake Pend Oreille receives all of the Clark Fork River discharge from western Montana, with its heavy load of nutrients and organics that increase eutrophication. In addition, there are the discharges of floathouses, lakeside cabins, and raw or poorly treated sewage into the lake by its many current users.

Since 1986 we have been studying the natural aging process of Lake Pend Oreille. Just completed in 1991, the end goals of our six-year study have been to help determine a long term management plan for the lake. Our results will help the Division of Environmental Quality prioritize critical areas requiring management action at the lake, and has given us a chance to test a more rapid response technique for measuring changes in a lake's aging process.

Our project examined the status of Idaho's largest lake through measurement of the rate of attached algae on natural rocks as well as artificial substrates (underwater surfaces for algae to grow on). Even though no previous near-shore data exist for Lake Pend Oreille, it is evident from visual observation that growth on submersed objects like logs, beer cans, bottles, rocks, etc. has increased over the last decade. The objectives of the study were to assess underwater weed productivity and algal growth on exposed shore and embayment areas of Lake Pend Oreille, *and* to evaluate near-shore indexes as valid measures of long term changes in a lake.

C. Michael Falter

Signs of age: increased algal growth on rocks from the floor of Lake Pend Oreille.

Our technique for assessing lake nutritional status or amount of growth is unusual because it concentrates on the shallow in-shore areas of the lake rather than the deep open waters, as is traditional. Aquatic scientists typically focused study on the middle of lakes, where they anchored in the deep points and took measurements.

But we suspected that changes in lake productivity might show up first in near-shore areas where the boaters, swimmers, nutrient sources, and most of the vegetation is. These changes might go unnoticed because of the conventional emphasis on deep waters. Thus far, our finds have supported this original hypothesis: in-shore algae growth correlates well with degree of watershed and shoreline development.

Previous studies utilized rocks or tiny glass tiles deposited in lakes to capture samples of algal growth by providing an attachment surface for the algae. Our method involved bolting unglazed ceramic tiles to bricks and depositing them in the lake along with rocks for a comparison of natural and artificial attachment materials. The large tiles provide bigger algal samples in contrast to the conventional glass tiles and they better resemble natural lake materials like rocks.

We studied sixteen near-shore sites on Lake Pend Oreille representing both developed and undeveloped shorelines, and both bay and open-water areas. After leaving the tiles at standard depths for certain incubation periods, we retrieved the tiles, scraped them of algae, and analyzed the algae for algal weight and amount of Chlorophyll *a* (a plant pigment that indicates algal production).

The data showed that some of the lake's near-shore areas are in advanced stages of aging (eutrophication), a condition of excessive aquatic plant growth, especially in high-use areas. This excessive plant growth can eventually clog a lake. While open water chemistry indicated the lake was only moderately productive, the more sensitive inshore biotic indicators showed very high eutrophic levels of production. Average Chlorophyll *a* levels at developed sites were more than double those of undeveloped sites.

Preliminary results also reveal that algae monitoring is a useful indicator for detecting early changes in lake productivity; these conditions have been supported by others' work as well on Lake Tahoe. I thing we're on to something: this tool could be especially effective on large lakes where inshore conditions can vary widely from offshore conditions. We will now continue to track these indicators over a few sites on the lake to measure the lake's response to increasing development, better sewage treatment in some areas, or increasing boat traffic.

Our results will be used in combination with other scholars' land use inventories, septic system surveys, open lake studies, and tributary monitoring to quantify the relationships between land uses and resulting lake response.

C. Michael Falter is professor and head of the Department of Fish and Wildlife Resources. He was assisted in his study by Dale Olson, a graduate student in the same department, and Jacob Kann, aquatic resource manager for the Klamath Tribe in Oregon. *Their research was funded by the Division of Environmental Quality (Department of Health and Welfare), the Environmental Protection Agency, and the Idaho Water Research Institute.*

Ponderosa Pine Seedlings—Survivors in a Hostile Environment

Peter F. Kolb and Ronald Robberecht

The first year of a newly germinated tree seedling is the most critical phase of its life. It must successfully compete against an already well established understory plant community for light, water, and nutrients. In addition, it must be able to quickly acclimate to the varying microclimate it has sprouted in. Why do some tree seedlings survive where all others fail? The answers may help protect future forests.

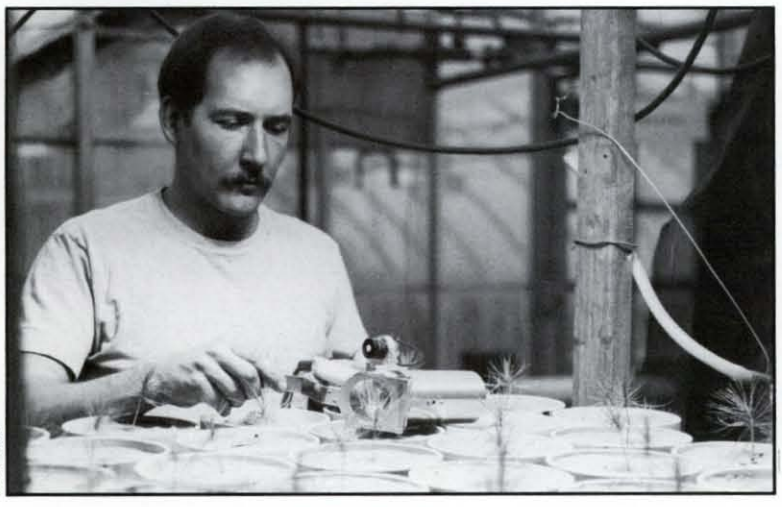
Ponderosa pine (*Pinus ponderosa*) is one of the most versatile, economically important, and ecologically significant components of forest and rangeland ecosystems in the western United States. It generally dominates the ecotones between forest and grasslands, and those relatively dry areas within northwestern forest ecosystems that are difficult to restore after disturbance. Ponderosa pine also occurs as a dominant seral species on more productive forest ecosystems, often when they have been severely disturbed. Comparative studies have shown that an ability to tolerate high temperature and low soil moisture allows ponderosa pine to grow where other tree species fail to become established. Seedling survival however, can be quite poor and sporadic under these environmental conditions.

Natural or human-caused disturbances such as fire or clear-cutting generally change the microclimate of a forest or rangeland ecosystem from a mesic to a more arid and hotter environment. In particular, daytime soil surface temperatures can be substantially higher compared to undisturbed environments. On such disturbed sites, ponderosa pine is important in facilitating restoration. The mechanisms by which this uniquely steadfast tree survives drought and high temperatures form the basis of our study.

Native perennial bunchgrasses, predominantly bluebunch wheatgrass (*Agropyron spicatum*) and Idaho fescue (*Festuca idahoensis*), are often found in association with ponderosa pine, usually on the harsher sites the species occupies. We predicted that competition between bunchgrasses and pine seedlings was responsible for the poor survival rate of naturally-established pine seedlings. But we were also aware that the grasses may act as nurse-plants, shielding pine seedlings from intense sunlight.

The first part of our study was designed to determine the degree of competition between naturally-established pine seedlings and bunchgrasses. At the University of Idaho Experimental Forest we shielded seedling shoots from the bunchgrass canopy with wire mesh to examine aboveground competition for light. We also inserted stainless steel tubes of different lengths in the ground around newly germinated seedlings to protect them from bunchgrass root competition. We found that root competition was most intensive in the upper soil horizons and had a profound effect on tree seedling survival, whereas the effects of shoot competition were negligible. Unprotected seedlings experienced almost 100 percent mortality, while seedlings with 0.3-meter-long root tubes showed only 40 percent mortality.

In addition to the effects of competition, the influence of drought and heat stress may significantly accentuate the degree of mortality in pine seedlings. To examine this, we continuously monitored the temperature of the soil surface, seedling stems, and seedling needles during the summer growing season, and measured the physiological activity



Peter Kolb

How much water are these eight-week-old ponderosa pines losing in the process of photosynthesis? Peter Kolb uses a LiCor porometer to measure the seedlings' changes in humidity.

of seedlings by the transpiration of water from the needles. We also monitored soil water content. We found soil surface temperatures exceeding 75°C, well beyond the heat limit for most plant tissues. However, most seedlings shielded from root competition stayed below 60°C. Plants that suffered from water stress due to natural bunchgrass competition reached temperatures in excess of 65°C, apparently the lethal threshold for heat tolerance in ponderosa pine seedlings. The needles and stems of protected seedlings, having greater soil water availability, remained cooler, presumably as a result of their ability to use water transport as a heat-dissipating mechanism.

To further examine this cooling mechanism, we set up a greenhouse experiment where we can control the transpiration rate and the heat applied to seedling stems. From the data gathered, we hope to model this not-previously investigated aspect of ponderosa pine ecology for future studies.

In another greenhouse study, we are testing the effects of deep versus shallow water sources on overall seedling performance. This will tell us if the extensive root growth of ponderosa pine seedlings has any impact on other seedling functions. These studies aid the understanding of basic plant function, and promise application in the crop sciences as well as forest and range management.

If forest and range resource managers increase selection in other tree species of *pinus ponderosa* characteristics like heat dissipation and the extension of taproots into deeper soil horizons upon germination, they may be able to increase seedling survival and perhaps extend the range of these other species into drier habitats, and thus promote the environmental stability of potentially fragile sites.

Ronald Robberecht is an associate professor and Peter Kolb is a Ph.D. candidate in the Department of Range Resources. *Their 1990-1992 research is being funded with a McIntire-Stennis grant.*

Bear Market for Yellowstone Grizzlies

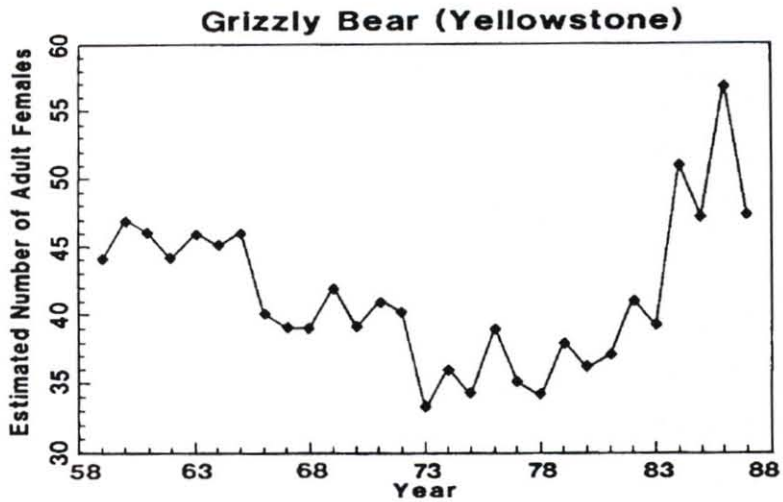
Brian Dennis

Suppose for a moment that the bear counts in the chart represent the net worth of a share of a corporation's stock purchased in 1959. Would you invest in this stock? Better yet, would you sink all of your assets and life savings into this stock?

For the grizzly bear population in the Yellowstone region, there is no choice in the matter. All of that population's eggs, literally, are in this one basket. You see, the figure depicts the estimated total number of adult female grizzlies in the population from 1959 to 1987. While trends are looking up for the grizzlies since the the 1970s, the volatility of their numbers would be enough to scare even the most daring options trader.

Grizzly bears, like all populations in nature, are at the mercy of the elements. Cold, heat, drought, fire, storms, and disease take their toll. Finding enough food to survive these elements and to produce hardy offspring is a constant problem. There are good years and bad years.

In Yellowstone, a severe winter can leave a feast of carcasses on the ground for grizzlies to rebuild their energy on after emerging from their dens in the spring. But a bad crop of whitebark pine nuts in the fall can leave the bears without an important source of calories to store up as fat for the winter. The bears roam far and wide in their foraging, but national park boundaries in the region do not correspond to the ecological ranges of animals. Some grizzly bears wandering outside the boundaries are shot and killed



A Yellowstone bare of bears? That's what unstable population numbers predict for Brian Dennis. Left: Estimated number of adult female grizzly bears in the greater Yellowstone ecosystem, 1959-1987.

by hunters who mistake them for black bears. Encroaching development consumes important habitat outside park boundaries as well. In addition, because an adult female grizzly gives birth to one or two cubs only every three years, *any* deaths occurring in the population have marked impacts on the population's survival chances.

The bottom line: Is the grizzly bear population in the Yellowstone region in danger of extinction? My research leads me to believe that the answer is yes.

For the past three years, I have developed statistical methods for assessing the chances of a species' survival. With data on historical abundances such as illustrated in the figure, I can estimate the chance that a species will drop below a specified lower abundance, and the most likely time the drop would take place. The statistical methods involve estimating the "volatility" of a population's fluctuations and projecting this information through time. I am aided in this study by a background in probability theory and mathematical modelling of animal populations, by Patricia Munholland, a statistician at Montana State University, and by J. Michael Scott, a wildlife biologist and professor of fish and wildlife resources at the University of Idaho.

Our analysis methods are not limited to grizzly bears, but can be applied to many other biological populations for which abundances have been monitored. The National Marine Fisheries Service recently used these methods to assist in their decision to list the northwestern sockeye salmon population as endangered. This and my past work on the minimum critical densities of species were also cited recently by the Interagency Scientific Committee studying the status of the northern spotted owl in the Thomas Report. I am currently working to improve these statistical methods so that they provide more accurate risk assessments.

As for the grizzlies of Yellowstone, their biological clock is ticking. According to our analyses, the population cannot sustain such volatile fluctuations indefinitely. The number of adult females has an estimated 50 percent chance of dropping below 10 bears (a virtual emergency level) within 150 years. The most likely time for that event is around 80 years from now. Such poor survival chances indicate that the population is not viable in the long run. This risk assessment assumes that the available habitat remains at its present size and quality indefinitely. But if further habitat encroachments continue, all bets are off.

Brian Dennis is associate professor of forest resources/mathematics and statistics. He also holds a Ph.D. in ecology.

Fish, Fishermen, and Fisheries: The Cooperative UI Aquaculture Program

Ernest L. Brannon, Joe Cloud, Christine M. Moffitt, Bonnie Jacobsen

At the University of Idaho Aquaculture Institute we have received calls from folks wondering what hours the swimming pool is open, how to locate and dig a well for drinking water, and what crops grow best in water-saturated soil. In a state that produces over 80 percent of the trout in the U.S., Idahoans are surprisingly unfamiliar with this large scale industry. Public knowledge and opinion are important to Idaho aquaculture, and we are bringing a new awareness of the importance of this industry to the state.

Idaho produces 25 to 40 million pounds of trout annually, 90 percent of which comes from five of the almost 100 trout farms in the state. With competition for the U.S. salmonid market growing rapidly out of Norway, Canada, and Chile, Idaho needs to keep up with growth trends just to maintain its share of the market. Through an integrated teaching and research program and a variety of outreach and extension activities, the Aquaculture Institute bolsters the continued growth and economic health of this valuable industry.

Outreach and Extension Activities

Fish Farm Development Workshops. Institute Director Ernest Brannon and other aquaculture professionals throughout the state work together to provide workshops for people interested in starting family-owned fish farms, as well as for established farmers who want to improve their operations. These well-attended events have attracted many requests for additional workshops. To meet these needs, Bill Klontz, experienced aquaculturist and professor in the Department of Fish and Wildlife Resources, is working with us to develop a manual and series of videos on how to operate a fish farm.

Water Quality Studies. For years, fish farmers have been regarded as major contributors of nutrients polluting the mid-Snake River. As a result of increased monitoring requirements by the Department of Environmental Quality, we are conducting a water quality assessment project along Deep Creek, west of Buhl, Idaho. The study is finding that fish farms actually provide some benefits to receiving water by settling out sediment that would pollute the water-

ways. In general, levels of ammonia are reduced to background concentrations before the effluent leaves the farms, and nitrates and nitrites are often lower in the effluent than in the water supply flowing to the farm. Only phosphates show some increased concentrations in farm operations, and these can be reduced through biofiltration with settling basins. Oxygen recharge trials are also underway at selected sites, and fish farmers are already enjoying an improved image.

Aquaculture Database. The 12-state Western Regional Aquaculture Consortium (WRAC) is funding the development of an electronic aquaculture database at the university, available free of charge and 24 hours a day to anyone with access to a computer and modem. Located at the Aquaculture Institute, the electronic bibliography now contains over 8000 references on all aspects of aquaculture and fish management, including hard-to-find gray literature like bulletins, small newsletters, or BPA completion reports, for example. In addition, a hard copy and video library are also being established, and WRAC Librarian Selma Nielsen regularly helps callers with their information needs, including some small scale research by phone request.

Aquaculture Newsletter. The Aquaculture Institute publishes the quarterly *Idaho Aquaculture News* that offers information on the institute's activities, Idaho fish farmers, Idaho Department of Fish and Game hatcheries, the Idaho Aquaculture Association, as well as state and federal regulations that affect the industry. The newsletter currently enjoys a statewide circulation of more than 500, with a popularity expanding out of state as well.

Off-Campus Aquaculture Research

South Idaho Aquaculture Research Center. One of our highest priorities is to develop research capability in southern Idaho to support the industry in the state. To that end, we are planning to build an Aquaculture Research Center in the Hagerman Valley on the Snake River.

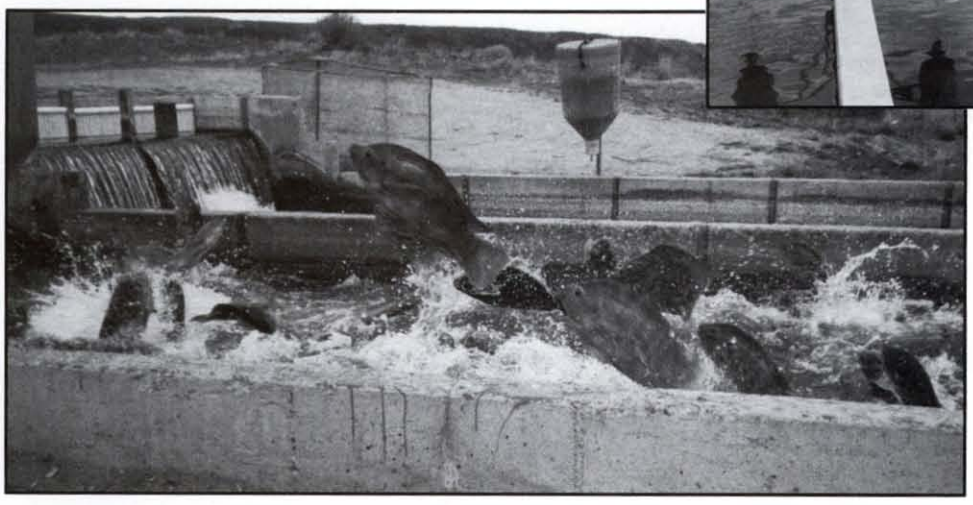
Tunison Laboratory of Fish Nutrition. Robert Winfree, director of the U.S. Fish and Wildlife Service (USFWS) Hagerman Field Station Fish Laboratory, has invited us to participate in funded cooperative research by providing graduate and post-doctoral students. We will use this excellent opportunity to enhance our aquaculture nutrition program with substantial technical and laboratory support not available on campus, and to build a strong liaison between the University of Idaho and USFWS.

On-Campus Research

Endangered Species. Ernest Brannon, along with other faculty and staff from the university and nearby Washington State University, are studying genetic behavior differences among sockeye and kokanee from different locations in the Pacific Northwest, and specifically in Redfish Lake of the Uppper Salmon River. Funded by the Bonneville Power Administration (BPA), the study was undertaken when sockeye salmon in the Columbia and Snake rivers were designated "endangered."

Gamete Preservation. Joe Cloud of the university's Department of Biological Sciences, in cooperation with Gary Thor-

Mike Casten



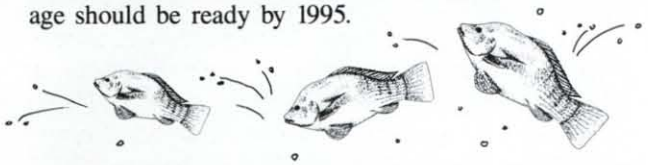
Mike Casten

At top, some of the feeder-latticed "raceways" where fish grow up at the Hagerman National Fish Hatchery. Bottom: frolicking 2- to 3-foot-long Tilapia at the Leo Ray Catfish-Tilapia Fish Farm.

gaard of Washington State University's Department of Zoology and Genetics, has been developing sperm preservation techniques that can be used to preserve the genetic composition of rare or endangered species. Redfish Lake sockeye salmon sperm was preserved in the fall of 1991, and has exhibited subsequent fertility as high as 55 percent. The sperm bank will prove invaluable in the preservation and restoration of Idaho's fisheries resources.

Bacterial Kidney Disease. Bacterial kidney disease (BKD) has given rise to major losses in fish farm operations, causing pen farmers to switch to rearing more disease-resistant Atlantic salmon. Christine Moffitt of the Department of Fish and Wildlife Resources is conducting a study of BKD in the new 14-tank Aquaculture Wet Lab and the wet labs in the College of Forestry, Wildlife and Range Sciences Building.

As fish culturists have known for years, Moffitt hopes to prove that erythromycin, an antibiotic used widely in both human and veterinary medicine, is effective in controlling BKD in salmon. However, the Food and Drug Administration (FDA) has not approved the drug for use in the food fish industry. Currently in the third year of a six-year project funded by BPA, Moffitt is developing strategies for treatment of juvenile and adult salmon with erythromycin. Her research team is performing tests of efficacy, animal safety, human safety, and an environmental assessment of the effects of erythromycin when disposed of by fish into the surrounding water. The tests require carefully controlled conditions and strict accounting—laboratory practices of such high standard the data generated will stand scrutiny by the FDA and impel them to register the product for treatment of Northwest salmon. The final drug registration package should be ready by 1995.



Fish have always made an important contribution to the state's economy, and Idaho must strive to remain a leader in U.S. fish production to maintain the economic and cultural benefits to the state. We're proud of the men and women who make our programs successful—and, through their successes, Idaho and her fish and fishermen.

Ernest L. Brannon is professor of fish and wildlife resources and director of the University of Idaho Aquaculture Institute. Christine M. Moffitt is adjunct associate professor and research scientist in the Department of Fish and Wildlife Resources. Bonnie Jacobsen is secretary/office coordinator of the Aquaculture Institute and editor of the Idaho Aquaculture News. *Joe Cloud is professor of zoology in the Department of Biological Sciences. The new Aquaculture Lab on the University of Idaho campus was operational by 1991, and houses up to 320 adult chinook salmon in tanks 12 feet in diameter and three feet deep.*

Wilderness—Assessing Change in a Changing World

Jeffrey J. Yeo

"Agspic is a . . .5, posa . . .3, balsamorhiza . . .a 5." I was shouting plant canopy cover values to Jim Peek, professor of wildlife resources, his large straw hat just visible over the tops of the bunchgrasses. The "agspic" is *Agropyron spicatum,* bluebunch wheatgrass—the principal bunchgrass of the area; "posa" is *Poa sandbergii,* Sandberg's bluegrass, another important grass; and "balsamorhiza" is *Balsamorhiza sagittata,* arrowleaf balsamroot, a dominant forb. I shouted to make sure I could be heard, also to keep Jim awake. It was a warm day after hours on horseback to reach the site.

We were sampling plant communities in the heart of the Frank Church-River of No Return Wilderness. Our effort is to describe the nonforested vegetation of the region in an attempt to interpret the causes of vegetation changes observed over the past 60-70 years on low elevation ranges along the Middle Fork of the Salmon River and the Big Creek Drainage.

In addition to plant compositional changes, we're gathering plant cover and productivity data. In an area so remote, we tend to think change happens slowly, if at all, and that those changes that do happen "have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable. . ." (Wilderness Act of 1964). But our wilderness areas are dynamic systems and, at least in Idaho, they have human histories which we must include in our thinking when we attempt to study them.

"It was the wildest country I've ever seen. . . Few, if any areas in the United States, offer the opportunities of this section for hunting and fishing," marvelled Idaho Governor Baldridge in 1930. Dave Lewis, first known white man in Big Creek and homesteader of what is today the University of Idaho's Wilderness Field Station at Taylor Ranch on Big Creek, guided Governor Baldridge around the Middle Fork of the Salmon River country. The governor's statement inspired the establishment of the Idaho Primitive Area, the foundation of today's Frank Church-River of No Return Wilderness. The following spring, 1931, thousands of deer lay dead from starvation in the Big Creek Drainage as well as along the Middle Fork.

How things change. . .

Earlier, in 1928, U.S. Forest Ranger Malm, in cooperation with the U.S. Biological Survey, intitiated the first detailed studies of mule deer and range condition along the Middle Fork of the Salmon River. The following year U.S. Forest Ranger Warren Bolles (UI class of 1926) continued the studies which were to last five years. Range exclosures were constructed beginning in 1930 to assess the effects of overgrazing by deer and livestock on the range condition, and the resulting large winter mortality of deer. This was a surprising development because less than a decade earlier, forest rangers, sportsmen, and the Idaho Game Commissioner had been concerned that low mule deer populations foreshadowed their disappearance from the Middle Fork country. In 1925, the Middle Fork Game Preserve had been established to protect deer populations, but the preserve lasted only a decade because in less than five years deer populations had grown to such levels that range condition was declining. Soil loss and shrub mortality were transforming shrub communities to grass communities over large expanses.

"During the winter 1928-9 deep, crusted snow forced all the deer onto the low range in the canyon bottom," wrote Forest Ranger L.T. Gutzman and State Conservation Officer G. Richardson. "There was not sufficient browse to sustain the large deer concentration which resulted in upwards of 1,500 deer dying from starvation." Hundreds of cattle also died that winter and some ranchers sold their operations and left the back country. "Browse and vegetation ground cover were overgrazed resulting in a reduced carrying capacity of the area," Gutzman and Richardson continued. "The game preserve was opened to hunting during the fall of 1934. . .[but] The hunters refused to go in after one deer." In subsequent years, two-deer hunts and introduction of elk were used to lure more hunters into Idaho's Primitive Area.

However, at the same time management efforts attempted to reduce deer populations through hunting, federal and state managment agencies continued to pay for intensive predator control. The then-Idaho National Forest hired Dave Lewis to kill predators and he achieved national renown for his prowess. The Idaho Department of Fish and Game hired hunters (at $120/month plus $20 bounty for each cougar) to reduce predators. Warren Bolles reported 29 cougars, 87 coyotes, and 24 bobcats killed during winter 1929-1930 around the Middle Fork Game Preserve. In 1948-1949 Pat Reed and Rod Donelly spent the winter at the Flying B Ranch along the Middle Fork where they took 50 cougars, returning the following year to catch the last one they knew of in the area.

By 1951, managers considered the Middle Fork the most depleted game range in Idaho. Yet despite major die-offs in previous decades, mule deer populations were high

Nationally renowned hunter Dave Lewis (right) and friend with a wide variety of predators' hides taken in the backcountry (tacked to the cabin behind). Hunters in the area stalked bear, cougar, coyote, and bobcat.

at about 10,000 deer by the 1960s. Idaho Cooperative Wildlife Research Unit Leader Paul Dalke and his UI graduate students continued assessment of the deer winter range. They reported that mule deer populations were retarding browse reproduction and that the range trend continued towards an increase of grasses and a decrease of shrubs. With mixed success the Forest Service then planted bitterbrush to improve range condition for deer.

During the same decade, UI Wildlife Professor Maurice Hornocker's Big Creek studies suggested that cougar predation played a limited role in reducing deer and elk numbers since cougar populations controlled their own numbers through territoriality, but that they might play a significant role in resting ranges by causing deer and elk to move away from areas after cougars had made a kill. The Idaho Department of Fish and Game in cooperation with the Forest Service spent years distributing tons of salt on ranges in the Middle Fork as well as on winter ranges in the Selway (now the Selway-Bitterroot Wilderness) to lure deer and elk off the most heavily grazed winter ranges and provide some range relief. They were unsuccessful, however cougars were protected from indiscriminate killing as a result of Hornocker's research.

Human effects on the central Idaho wilderness have been a mere blip in evolutionary time. But we need to know whether this blip has had far-reaching impacts on the processes that define the wilderness. We are entering a new era in human impacts on our environments, impacts that for the past century have been generated, observed, and felt locally. Now changes in global climate and thinning of

the ozone layer over large portions of the earth threaten processes remote from their origins. Here at Taylor Ranch, we have begun a long term cooperative agreement with the Rocky Mountain Experiment Station's Interior West Global Change Program to be part of a worldwide effort to monitor global warming, acid deposition, and air-borne pollutants.

Jim Peek and I continue long term monitoring of plant succession in the Frank Church-River of No Return Wilderness. We now have a record spanning 60 years of plant succession in the area. Student interns at the field station help with the sampling. And in wilderness, we use the same means of getting around as Rangers Malm, Bolles, and Gutzman did 60 years ago—on foot and horseback.

Jeffrey Yeo is adjunct assistant professor of wildlife resources and scientist/manager of the Taylor Ranch Wilderness Field Station (seven miles upstream from the Middle Fork) in the Frank Church-River of No Return Wilderness. Taylor Ranch is one of the only such research stations within a wilderness area in the world.

Dave Lewis scrapbook (documents and photographs) stored in Special Collections and Archives, University of Idaho Library.

Homesteader Dave Lewis, first known white man on Big Creek, next to the sod-roofed cabin built in 1900. The cabin no longer stands at the Taylor Ranch Field Station, but the Douglas-fir does. Photo taken about 1918-1920.

Arbor Day Seeks FWR Expertise

James R. Fazio

Most readers probably recognize the National Arbor Day Foundation as the organization John Denver plugs in his television public service announcements. You may also know it from the mail solicitations that offer TEN FREE TREES if you join. While it is true that this non-profit, educational organization is a master of large scale media and direct mail campaigns that promote tree planting and care, its programs do not end there. The foundation also sponsors the Tree City USA network in cooperation with the USDA Forest Service and the National Association of State Foresters; provides kits to school teachers to keep alive the tradition of Arbor Day and to add substance to conservation education programs; holds a summer camp for children; maintains a demonstration orchard and retail store; and sponsors an annual awards program to honor individuals and organizations who have contributed nationally or internationally to environmental stewardship related to trees.

In the organization's short 20-year history, its membership has grown to over one million people, a success built through a careful strategy that concentrates on communicating with large segments of the public in a way that can be understood, and about issues important to them. Specifically, the message focuses on planting more trees and caring properly for those that we have, especially in urban areas.

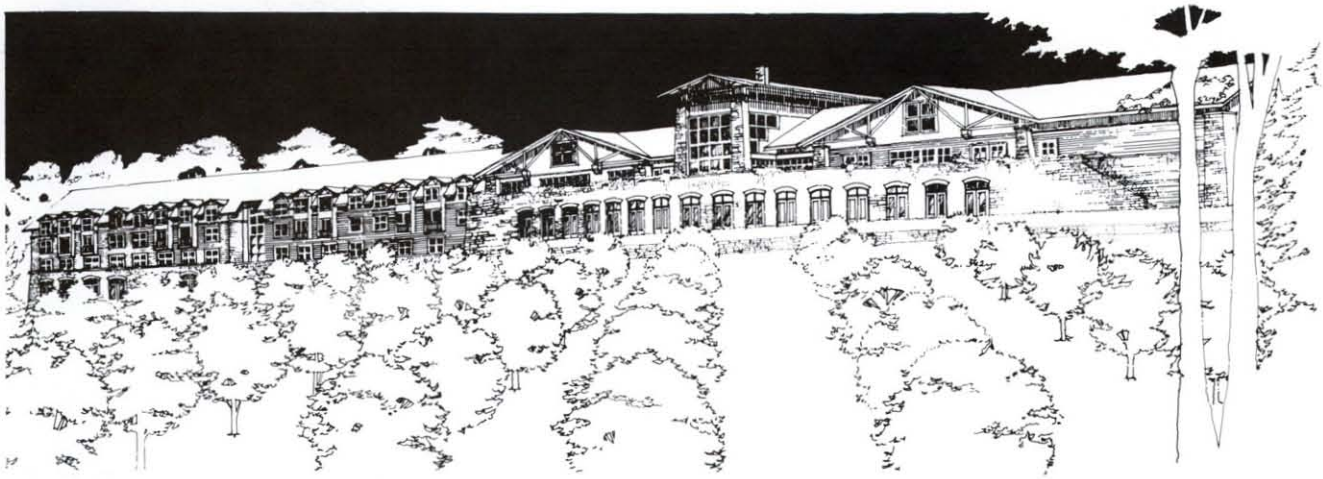
In 1989, the foundation decided to advance beyond the limitations of mass media information campaigns and attempt to provide more in-depth education to individuals who can make a difference. The educational mission expanded beyond tree planting and care to take on all aspects of environmental stewardship related in any way to trees.

To accomplish this, The Arbor Day Institute was created in 1990 to serve as the training and continuing education arm of the foundation. At the same time, designs were completed for an extraordinary $14 million conference center to be built on 240 acres of the foundation's farm property at the edge of Nebraska City, Nebraska, adjoining the historic home of J. Sterling Morton, founder of Arbor Day.

The conference center will serve as home base for the institute, as well as a unique meeting place for other groups. It will be operated as a model of environmental consciousness where anyone who attends a meeting or stops in for a meal will be exposed to valuable information about trees and conservation. The building's interior wall displays will explain the use of wood in construction, and will offer interactive video units, in-room television programs about trees, literature, and exhibits presenting tree-related information. Interpretive trails outside will wend their ways among a wide range of demonstration plantings from windbreaks and a fuelwood plantation to wildlife plots, working orchards, and a historic orchard where antique apple varieties will be grown and preserved.

In 1990, through a 3-year contract with the college, I was asked to develop the programs and teaching materials for the new institute. This exciting assignment has called on me to develop the institute's guiding principles, design the first programs, work out marketing strategies, write educational and promotional materials, conduct evaluations, and generally get the project off to a good start.

Encircled with historic orchards of antique apple varieties, wildlife plots, and interpretive trails, the new Arbor Day Institute Conference Center and property will offer arboriphiles and others an eden of tree-related information.



The institute's mission is to help close the gap between what is known about the best practices of tree care and what is actually practiced, and to act as a forum and facilitator for issues surrounding environmental stewardship. Whenever possible, the institute will work in partnership with government agencies or through grants from other organizations to achieve these goals.

Our first programs have included nationwide workshops on how construction activities can be designed and implemented without destroying trees, how to recognize and prevent hazard trees, and how to conduct street and park tree inventories as a basis for improved urban forestry. The institute's first venture as an issues forum was its sponsorship of a national conference last November on using wood wastes and fast-growing trees as renewable sources of energy.

The institute has also initiated correspondence courses for tree care professionals and lay citizens, and a travel study program to introduce people firsthand to international problems and opportunities such as those linked to rain forest issues.

A program we hope will become a hallmark of the institute is the National Urban Forestry School. This is a series of three one-week workshops spread over either two or three years. The school provides an opportunity for individuals with a traditional forestry education to more successfully work in the urban or community environment. With urban forestry rapidly growing into one of the foremost segments of the profession, and with most foresters having virtually no training in this area, this is potentially one of the institute's most important contributions.

Creation of the institute by The National Arbor Day Foundation reflects the kind of extraordinary vision that has made it such a successful and beneficial conservation organization. Being involved in the leadership of the newest venture is a challenge unique in both scope and timing, and it is an opportunity that reflects well on the reputation and sought-after expertise of the College of Forestry, Wildlife and Range Sciences.

James Fazio is a professor in the Department of Resource Recreation and Tourism, and is working on contract at The National Arbor Day Foundation's Arbor Day Institute in Lincoln, Nebraska for 1990-1993. He is also editor of the foundation's Tree City USA Bulletin *and a columnist in* Arbor Day.

Appendix

Experiment Station Scientists

Department of Fish and Wildlife Resources

Ables, Ernest D.
Professor
Associate Dean for Academics and Continuing Education
Wildlife ecology, especially animal behavior and radiotelemetry techniques

Bennett, David H.
Professor
Warmwater fishery management, fish ecology, fish population dynamics

Bizeau, Elwood G.
Professor Emeritus
Associate, Wildlife Research Institute
Birds, principally waterfowl and marsh

Bjornn, Theodore C.
Professor
Assistant Leader, Idaho Cooperative Fish and Wildlife Research Unit
Management and ecology of wild and hatchery salmonids

Brannon, Ernest L.
Professor
Director, University of Idaho Aquaculture Program
Fish culture, fish behavior, salmonid life history, sturgeon life history

Congleton, James L.
Associate Professor
Assistant Leader, Idaho Cooperative Fish and Wildlife Research Unit
Fish immunology, stress physiology

Csuti, Blair A.
Adjunct Associate Professor, Idaho Cooperative Fish and Wildlife Research Unit
Strategies for the selection and design of nature reserves, endangered species conservation, wildlife/habitat relationships

Falter, C. Michael
Professor and Department Head
Reservoir limnology, stream ecology, lake management, aquatic pollution ecology

Garton, Edward O.
Professor
Wildlife population biology, systems ecology, census methods, statistical analysis

Hornocker, Maurice G.
Professor
Director, Wildlife Research Institute
Population ecology, predator-prey interactions

Hungerford, Kenneth E.
Professor Emeritus
Wildlife management

Hunt, Joel
Research Associate

Jepson, Michael
Scientific Aide
Fish physiology, statistical analysis

Kaiser, Horst
Visiting Scientist

Keith, Robert M.
Research Associate
Fishery biology, statistical analysis

Klontz, George W.
Professor
Aquatic animal medicine, aquaculture

Kress, Albert (Duke)
Research Technician

MacPhee, Craig
Professor Emeritus
Fish behavior, ecology, toxicology

Moffitt, Christine M.
Adjunct Associate Professor
Research Scientist
Ecology, health, and management of anadromous salmonids; use of therapeutic substances to treat fish diseases

Nelson, Lewis, Jr.
Extension Professor
Continuing education, communications/public relations, environmental education

Peek, James M.
Professor
Big game ecology and management, habitat relationships

Peery, Chris
Research Associate
Adult salmon and steelhead passages at dams

Ratti, John T.
Adjunct Associate Professor
Avian ecology; behavioral, evolutionary, and population ecology; habitat analysis

Reese, Kerry P.
Associate Professor
Wetland, waterfowl, and upland game ecology and management; nongame wildlife

Riggers, Brian
Scientific Aide
Limnology, river ecology

Ringe, Rudy R.
Research Associate, Idaho Cooperative Fish and Wildlife Research Unit
Anadromous fish ecology and management

Rubin, Stephen A.
Research Associate
Salmonid ecology

Scarnecchia, Dennis L.
Associate Professor
Salmon, trout, and paddlefish research; fish populations and community ecology in large rivers, streams, and natural lakes

Scott, J. Michael
Professor
Leader, Idaho Cooperative Fish and Wildlife Research Unit
Ecology and management of nongame and endangered species, estimating animal numbers, systems approaches to conservation biology and ecology

Setter, Ann L.
Research Associate
Fish culture, sturgeon life history, electrophoresis

Volkman, Jed
Research Technician

Wright, R. Gerald, Jr.
Professor
Project Leader (Biology), Cooperative Park Studies Unit
Wildlife habitat management, national park wildlife management, natural resource data management and geographic information systems

Yeo, Jeffrey J.
Adjunct Assistant Professor
Scientist/Manager, Taylor Ranch Wilderness Research Center
Big game ecology and management, wilderness ecology and management

Department of Forest Products

Bottger, Richard F.
Adjunct Associate Professor
Director of Administrative Services
Assistant Director, Idaho Forest, Wildlife and Range Experiment Station
Business and personnel management

Campbell, Alton G.
Associate Professor
Pulp and paper science, waste treatment and resource recovery

Folk, Richard L.
Adjunct Assistant Professor
Research Scientist
Bioenergy, silviculture/wood quality, utilization of wood products wood processing wastes

Gorman, Thomas M.
Assistant Professor
Wood construction and design, physical properties of wood, secondary wood products manufacturing, moisture problems in wood-frame houses

Johnson, Leonard R.
Professor and Department Head
Adjunct Professor, Forest Resources
Systems and cost analysis of timber harvesting operations, recovery and processing of small timber and forest residue

Lee, Harry W.
Assistant Professor
Harvesting systems, road design, site productivity, soil-water relationships

Moslemi, Ali A.
Professor
Director, Graduate Programs
Wood particle composites, wood technology

O'Laughlin, Jay
Adjunct Professor
Adjunct Professor, Forest Resources
Director, Policy Analysis Group
Natural resources economics and policy analysis, structural changes in wood-based industries

Steinhagen, H. Peter
Associate Professor
On sabbatical in Chile
Drying of lumber and wood particulates, heat transfer in frozen and nonfrozen wood systems, wood energy, wood preservation

Wagner, Francis G.
Professor
Operations research and management science techniques applied to primary and secondary wood products manufacture

Department of Forest Resources

Adams, David L.
Professor
Silviculture, growth and yield, New Forestry (Adaptive Forestry)

Appelgren, Ross
Assistant Manager/Logging Superintendant, University of Idaho Experimental Forest
Logging systems

Belt, George H.
Professor
Director, Idaho Riparian Cooperative
Forest hydrology and watershed management, social forestry, agroforestry

Brunsfeld, Steven J.
Assistant Professor
Director, Forestry, Wildlife and Range Sciences Research Herbarium
Vegetation ecology, autecology, molecular genetics, rare plant biology

Experiment Station Scientists

Burlison, Vernon H.
Extension Forester Emeritus
Extension Professor Emeritus

Canfield, Elmer R.
Associate Professor Emeritus
Forest pathology

Carree, Yvonne
Forestry Extension Associate
Forestry extension, hardwood growth and management

Dennis, Brian
Associate Professor
Statistical ecology, biometrics, mathematical modeling

Dumroese, R. Kasten
Research Associate
Forest nursery technology and production, nursery management

Edson, John L.
Research Associate, Forest Research Nursery
Vegetative propagation, biotechnology, seedling production

Fins, Lauren
Professor
Director, Inland Empire Tree Improvement Cooperative
Genetic improvement of forest trees, effects of forest management on genetic resources, genetic architecture of forest tree species and populations

Force, Jo Ellen
Professor
Forest planning and policy, particularly the role of people and other social science aspects; social forestry and international development

Hatch, Charles R.
Professor
On leave in Islamabad, Pakistan, for Winrock Consulting Agency
Forest mensuration and statistics

Hendee, John C.
Professor
Professor, Resource Recreation and Tourism
Dean, College of Forestry, Wildlife and Range Sciences
Director, Idaho Forest, Wildlife and Range Experiment Station
Director, Taylor Ranch Wilderness Field Station
Director, Wilderness Research Center
Human behavior aspects of resource management—public involvement, conflict resolution, social impact analysis; wilderness, recreation, wildlife, and forest policy and management; use of natural environments for personal growth, therapy, and leadership development

Johnson, Frederic D.
Professor Emeritus
Autecology, synecology, and phytogeography—emphasis on northern Rockies and on forest lands and woody plants; dendrology—temperate and tropical

Johnson, Leonard R.
Adjunct Professor
Professor and Department Head, Forest Products
Systems and cost analysis of timber harvesting operations, recovery and processing of small timber and forest residue

Littlejohn, Margaret E.
Western Coordinator, Visitor Services Project
(National Park Service duty stationed in Cooperative Park Studies Unit)

Loewenstein, Howard
Professor Emeritus
Forest soils and tree nutrition

Lotan, James E.
Adjunct Professor
Research Scientist
Silviculture and fire management

Machlis, Gary E.
Professor
Adjunct Professor, Resource Recreation and Tourism
Project Leader (Sociology), Cooperative Park Studies Unit
Sociology of natural resources, human ecology

Madison, Dwight
Eastern Coordinator, Visitor Services Project
(National Park Service duty stationed in Cooperative Park Studies Unit)

Mahler, Robert
Adjunct Associate Professor
Associate Professor, Soil Sciences (Department of Plant, Soil, and Entomological Sciences, College of Agriculture)
Soil fertility, plant nutrition

Mahoney, Ronald L.
Associate Extension Professor
Extension Forester, UI Cooperative Extension Service
Silviculture and management of non-industrial private forests, natural resources education for youth

Marshall, John D.
Assistant Professor
Tree physiology, ecophysiology

Mattson, Kim G.
Research Assistant Professor
Forest ecology

McKetta, Charles W.
Associate Professor
Economist, Idaho Forest, Wildlife and Range Experiment Station
Timber investments, forest policy, international forestry, fire and fuel management economics, forest taxation

Medema, E. Lee
Associate Professor
Natural resources economics (investment analysis, agroforestry, international forestry)

Mika, Peter G.
Research Associate
Biometrics, forest nutrition

Moore, James A.
Professor
Director, Intermountain Forest Tree Nutrition Cooperative
Various aspects of forest growth and yield modeling, mineral nutrition of forest trees, influence of nutritional status on primary forest productivity

Morgan, Penelope
Associate Professor
Director, Prescribed Burning Program
Fire ecology and management, silviculture and forest ecology, ecological modeling

Mousseaux, Mark
Seed Specialist, University of Idaho Forest Research Nursery

Neuenschwander, Leon F.
Professor
Adjunct Professor, Range Resources
Associate Dean for Research and International Programs
Associate Director, Idaho Forest, Wildlife and Range Experiment Station
Forest and range ecology, fire management, prescribed burning, site preparation for conifer release

O'Laughlin, J.
Adjunct Professor
Adjunct Professor, Forest Products
Director, Policy Analysis Group
Natural resource economics and policy analysis, structural changes in wood-based industries

Osborne, Harold L.
Associate Extension Professor
Manager, University of Idaho Experimental Forest
Rocky Mountain silviculture, log scaling and timber cruising, forest resource inventories

Partridge, Arthur D.
Professor
Insect/disease interactions, nursery problems, urban tree problems

Pym, Geneva E.
Research Technician
Quantitative and qualitative analysis

Quick, Ken
Greenhouse Assistant, University of Idaho Forest Research Nursery

Robison, M. Henry
Adjunct Assistant Professor
Assistant Professor, Agricultural Economics (Department of Agricultural Economics and Rural Sociology, College of Agriculture)
Urban and regional economics, natural resources and environmental economics

Rust, Marc
Research Associate
Genetic improvement of forest trees, application of computer technology to forestry

Schenk, John A.
Professor Emeritus
Forest entomology (insect bionomics, silviculture, and biological control)

Schnepf, Chris
Adjunct Assistant Extension Professor

Seale, Robert H.
Professor Emeritus
Forest economics

Shaw, Terry M.
Research Associate, Intermountain Forest Tree Nutrition Cooperative
Forest resource inventories and data base management, forest nutrition, nutrition/disease interaction

Stark, Ronald W.
Professor Emeritus
Population dynamics and integrated pest management of forest insects

Stiff, Charles T.
Assistant Professor
Mensuration, growth, and yield modeling and simulation; forest inventory, site productivity, international forestry

Stock, Molly W.
Professor
Artificial intelligence/expert systems applications in natural resource management, human-computer interactions, biosystematics and population genetics of forest insects

Stoszek, Karl J.
Professor
On leave in Vienna, Austria
Forest protection, silviculture

Ulliman, Joseph J.
Professor and Department Head
Co-Director, UI Remote Sensing Research Unit
Director, Forestry, Wildlife and Range Sciences Remote Sensing Center
Aerial photographic interpretation, mapping and remote sensing

Verbyla, David L.
Visiting Assistant Professor
Digital remote sensing, aerial photography, geographic information systems applications in natural resources

Wenny, David L.
Professor
Manager, University of Idaho Forest Research Nursery
Forest nursery technology and production, seedling physiology and quality, forest regeneration

Department of Range Resources

Bunting, Stephen C.
Professor
Fire ecology, range ecology, range management

Doescher, Paul S.
Visiting Assistant Professor
Range ecology, forest grazing

Ehrenreich, John H.
Professor
Agroforestry, international forest and range management, range ecology

Hironaka, Minoru
Professor
Range ecology, rangeland classification, soil-plant relationships

Johnson, Kendall L.
Professor and Department Head
Shrubland ecology and management, range extension

Kingery, James L.
Assistant Professor
Forest grazing policy and management, rangeland rehabilitation, range management

Mosley, Jeffrey C.
Assistant Professor
Grazing management of wild and domestic ungulates, foraging behavior, livestock-wildlife relations

Neuenschwander, Leon F.
Adjunct Professor
Professor, Forest Resources
Associate Dean for Research and International Programs
Associate Director, Idaho Forest, Wildlife and Range Experiment Station
Forest and range ecology, fire management, prescribed burning, site preparation for conifer release

Rimbey, Neil R.
Adjunct Professor
Extension Range Economist, Southwest Idaho Research and Extension Center
Rangeland economics and policy

Robberecht, Ronald
Associate Professor
Ecophysiology, autecology, range ecology

Sanders, Kenneth D.
Professor
Extension Range Specialist, Twin Falls Research and Extension Center
Manager, Lee A. Sharp Experimental Area
Range extension, range livestock nutrition, grazing systems

Sharp, Lee A.
Professor Emeritus
Integrated range resource management, range management planning, grazing systems

Tisdale, Edwin W.
Professor Emeritus
Vegetation classification, vegetation habitat relationships

Department of Resource Recreation and Tourism

Fazio, James R.
Professor
On three-year contract as director of The National Arbor Day Foundation Eduational Institute in Lincoln, Nebraska
Resource communication, environmental interpretation, conservation history, urban and community forestry, continuing education

Ham, Sam H.
Professor
Director, Natural Resources Communications Laboratory
Environmental education and interpretation, natural resource communication, natural resource tourism, reserve management in developing Latin American countries

Harris, Charles C.
Associate Professor
Resource management, policy, and planning; organizational psychology of resource management; natural resource tourism, impacts, and market analysis; recreation and amenity economics

Hendee, John C.
Professor
Professor, Forest Resources
Dean, College of Forestry, Wildlife and Range Sciences
Director, Idaho Forest, Wildlife and Range Experiment Station
Director, Taylor Ranch Wilderness Field Station
Director, Wilderness Research Center
Human behavior aspects of resource management—public involvement, conflict resolution, social impact analysis; wilderness, recreation, wildlife, and forest policy and management; use of natural environments for personal growth, therapy, and leadership development

Hunt, John D.
Professor and Department Head
Tourism planning, development, marketing, and management; integration of natural resource uses with tourism and recreation development; tourism and recreation development

Krumpe, Edwin E.
Associate Professor
Principal Scientist, UI Wilderness Research Center
Wilderness and dispersed recreation management, recreation and tourism behavior and the decision process, interpretation and communication, administration, facilities management

Machlis, Gary E.
Adjunct Professor
Professor, Forest Resources
Project Leader (Sociology), Cooperative Park Studies Unit
Sociology of natural resources, human ecology

McLaughlin, William J.
Professor
Regional planning including natural resources, nature conservation, tourism, economic development, group facilitation for decision-making and conflict resolution

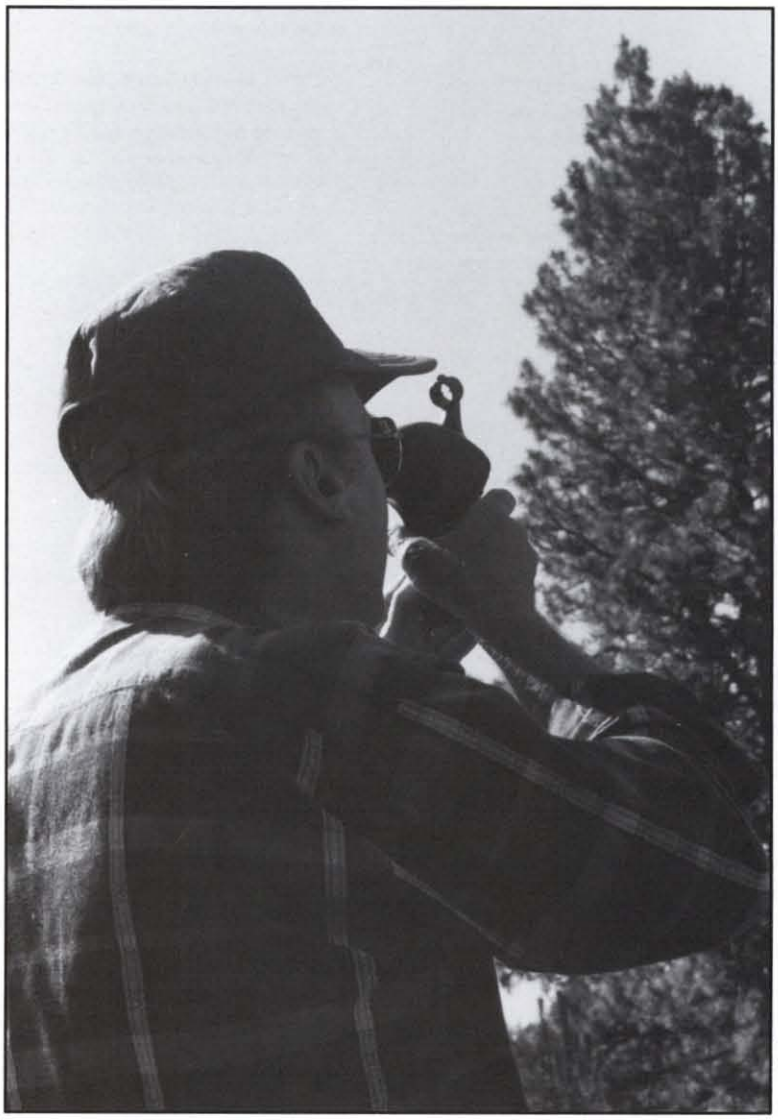
Sanyal, Nick
Adjunct Assistant Professor
Research Scientist
Recreation planning, recreation behavior, human dimensions of fish and wildlife management, research methodologies, survey research

Savage, George
Adjunct Associate Professor
Managing Editor and Director, FWR Information Services
Natural resource literature, scientific writing, report preparation, and other aspects of print media communication

Policy Analysis Group (PAG)

O'Laughlin, Jay
Director
Adjunct Professor, Forest Products
Adjunct Professor, Forest Resources
Natural resource economics and policy analysis, structural changes in wood-based industries

MacCracken, James G.
Research Scientist
Natural resource policy, wildlife-habitat relationships, plant ecology, predator-prey interactions



Gerry Snyder

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Research Projects and Investigations

This listing shows the range of work in progress through the Idaho Forest, Wildlife and Range Experiment Station. For additional information, please write to the principal investigators or to the Associate Director, Idaho Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, Idaho 83843.

Department of Fish and Wildlife Resources

Comparison of behaviors between elk populations in Yellowstone National Park. E.D. Ables

Effects of in-water disposal of dredged materials on fish and benthic communities in Lower Granite Reservoir, Idaho and Washington. D.H. Bennett

Developing an index of biotic integrity to assess stream health. D.H. Bennett

Thermal and velocity characteristics of the lower Snake River Reservoirs. D.H. Bennett

Identification of factors limiting sport fish production in the Pend Oreille River, Washington and Idaho. D.H. Bennett, J. Garrett

Ecology of northern pike in Coeur d'Alene Lake, Idaho. D.H. Bennett

Ecology and abundance of fall chinook salmon in Lower Granite and Little Goose Reservoirs, Washington. D.H. Bennett, T. Curet

Ecology and abundance of white sturgeon in Lower Granite Reservoir, Washington. D.H. Bennett, K. Lepla

Habitat preferences of juvenile white sturgeon from the Snake River with emphasis on the role of Lower Granite Reservoir on their life cycle. D.H. Bennett

Fishery and habitat survey of the Pend Oreille River. D.H. Bennett, J. Dupont

Monitoring fish community activity at disposal and references sites in Lower Granite Reservoir, Washington. D.H. Bennett

Habitat features that affect stream productivity. T.C. Bjornn

Supplementation of wild salmon and steelhead. T.C. Bjornn

Hatchery versus wild steelhead in supplementation. T.C. Bjornn, S. Rubin

Survival of salmonid embryos in natural redds. T.C. Bjornn

Passage of adult chinook salmon and steelhead at the Lower Snake River Dam and Reservoir projects. T.C. Bjornn, K. Tolotti, R. Ringe, P. Keniry, J. Hunt

Assessment of fish abundance and habitat in the Coeur d'Alene River. T.C. Bjornn, J. Hunt

Substrate composition and trout survival relationships. T.C. Bjornn

Response of salmonids to riparian vegetation and instream cover modification in the second-growth forest streams of southeast Alaska. T. C. Bjornn, M. Brusven, R. M. Keith, N. Hetrick

An evaluation of supplementation of natural chinook salmon stocks. T.C. Bjornn

Spawning behavior of wild and hatchery salmon. T.C. Bjornn, P. Sankovich

Interaction of coho salmon with resident cutthroat trout and Dolly Varden in the Slippery Creek Drainage, Kuiu Island, Alaska. P. Porter, T.C. Bjornn

The perpetual oversight of hatchery programs. E. L. Brannon

A plan of action for salmon and steelhead transport in the Columbia River system. E.L. Brannon

Assessment of fish farm effluent impact on Deep Creek water quality. E.L. Brannon

Analysis of status and nature of sockeye salmon and Kokanee in Stanley Basin Lakes. E.L. Brannon

Study of white sturgeon life history and genetics. E.L. Brannon

Genetic analysis of *Oncorhynchus nerka*. E.L. Brannon

Assessment of fish farm effluent impact on Billingsly Creek water quality. E.L. Brannon

Control of bacterial kidney disease: nonspecific resistance factors in chinook salmon. J.L. Congleton, D. Siegal

Control of infectious hematopoietic necrosis virus: antiviral effects of the trout macrophage. J.L. Congleton, B. Sun

Stress response of chinook salmon smolts collected and transported from Snake River Dams. J.L. Congleton, T. Mosey

Influence of growth rate on maturation schedules for Kokanee salmon. J.L. Congleton, D.L. Scarnecchia, E. Reiland

Biology of potentially endangered Snake River mollusks. C.M. Falter

Limnology of Payette Lake, Idaho. C.M. Falter

Algae toxicity in Black Lake, Idaho. C.M. Falter

Nutrient loading and limnology of Twin Lakes, Idaho. C.M. Falter

Lake management plan for Lake Cocolalla and Pend Oreille Lake, Idaho. C.M. Falter

Aquatic ecology of the Spokane River. C.M. Falter

Population ecology of trumpeter swans and whooping cranes. E.O. Garton

Impact of wolf reintroduction on Yellowstone elk, deer, and bison populations. E.O. Garton

Aerial census methods for elk, mule deer, and bighorn sheep. E.O. Garton

Estimating minimum viable meta-populations for rare animals. E.O. Garton

Dietary selection of pocket-gophers in north-central Idaho. E.O. Garton

Impact of timber harvests on woodpecker populations. E.O. Garton

Ecology of white-headed woodpeckers in eastern Oregon. E.O. Garton

Regulating growth of finfish by feeding regimen. G.W. Klontz

Use of erythromycin to control bacterial kidney disease in chinook salmon. C.M. Moffitt

Behavioral and physiological components of smoltification in chinook salmon and steelhead trout. C.M. Moffitt

Development of methods to assess smolt quality in hatchery-reared salmon and steelhead trout. C.M. Moffitt

Fish and Wildlife Ecology Workshop. L. Nelson

Advanced Project Learning Tree Workshop. L. Nelson

Principles of Wildlife Management workshops. L. Nelson

Seasonal habitat use and group dynamics of translocated woodland caribou into the southern Selkirk Mountains of Idaho. J.M. Peek, L. Allen-Johnson

Ecology of bull moose in Copper River Delta, Alaska. J.M. Peek

Ecology of bull elk in Yellowstone National Park. J.M. Peek

Conceptual plan for waterfowl habitat preservation in the Intermountain West. J.T. Ratti

Determining the impact of climate change on the distribution of Pacific Northwest plants and animals. J.T. Ratti, R.A. Black, J.M. Scott

Habitat suitability index model for Columbian sharp-tailed grouse. K.P. Reese, D. Meints, J.W. Connelly, T.P. Hemker, A.R. Sands

Autecology of Big Desert sage grouse. K.P. Reese, R. Fischer

Ecology of Merriam's wild turkeys in southwestern Idaho. K.P. Reese, W.L. Bodie, J. O'Neill

Winter ecology and nutritional status of Columbian sharp-tailed grouse in southeastern Idaho. K.P. Reese, J. Schneider, M. Ulliman

Vegetation response to fire on the Big Desert of Idaho. K.P. Reese

Seasonal habitat use and movements of sympatric shrub-steppe female tetraonids in southeastern Idaho. K.P. Reese, J.W. Connelly, T. Apa

Cottonwood turkey study. K.P. Reese, F. Edelmann

Seasonal habitat use, population characteristics, and management of quail in north/central Idaho. K.P. Reese, P.E. Heekin

Northern spotted owl nesting habitat use in California. K.P. Reese, L.B. Folliard

Wildlife use of the Pend Oreille River Reservoir in northeast Washington. K.P. Reese

Life history and ecology of Umpqua spring chinook salmon. D.L. Scarnecchia

Yellowstone River and Lake Sakakawea paddlefish investigations. D.L. Scarnecchia

Bull trout ecology in northern Idaho. D.L. Scarnecchia

Analysis of life history strategies of Icelandic stocks of Atlantic salmon in relation to environmental factors. D.L. Scarnecchia

Gap Analysis of biodiversity protection in Oregon. J.M. Scott, B. Csuti

Gap Analysis of biodiversity protection in Idaho. J.M. Scott, S. Caicco, H. Anderson, C. Groves

Species content of nature preserves. B. Butterfield, J.M. Scott

Review of endangered species recovery planning. J.M. Scott, P. Hayward

Proactive approaches to sustaining biodiversity. J.M. Scott

Preserve design in North America. J.M. Scott

A Gap Analysis of the significant plant and animal resources contained in and adjacent to proposed northwest national parks. R.G. Wright

Development of population models and tests of population control techniques on mountain goats at Olympic National Park. R.G. Wright

Development of computerized natural resource data management systems for Pacific Northwest Parks. R.G. Wright

Analysis of historic vegetational change at Craters of the Moon. R.G. Wright

A conceptual model of factors regulating ungulate populations in U.S. national parks. R.G. Wright

A synthesis of research and knowledge about non-ungulate non-migratory vertebrates in national parks. R.G. Wright

Development of a grazing management plan at City of Rocks National Reserve. R.G. Wright, S.C. Bunting

A riparian zone/water resources study at Craters of the Moon. R.G. Wright, C.M. Falter

Application of GIS to land use planning and resources management at Lake Chelan National Recreation Area. R.G. Wright

Analysis of the management implications of the long-term moose/wolf research program at Isle Royale National Park. R.G. Wright

History of the Lochsa elk population and management. J.J. Yeo

Long-term wildlife population and habitat monitoring. J.J. Yeo

Bighorn sheep range carrying capacity. J.J. Yeo

Department of Forest Products

Land application and composting of pulp and paper sludge. A.G. Campbell, R. Tripepi

Composting of bluegrass residues. A.G. Campbell, R. Tripepi

Land application of log yard waste. A.G. Campbell, R.L. Folk

Wood ash as soil additive and liming agent. A.G. Campbell, R.L. Folk

Log yard residues for reclamation of the Silver Valley. A.G. Campbell, S. McGeehan, D. Naylor

Application of wood ash on agricultural lands. A.G. Campbell, R.L. Folk

Technical and economic feasibility of producing densified fuel wood (wood pellets) from small equipment for small and local markets. R.L. Folk, R.L. Govett

Assessment of wood pellet fuel quality and characteristics for Idaho and the Intermountain West. R.L. Folk, R.L. Govett

Cubic measurement in forestry. R.L. Folk, L.R. Johnson

Kiln drying cants for log home construction. T.M. Gorman, H.P. Steinhagen

Bending strength of vertically laminated house logs. T.M. Gorman

Properties of laminated veneer lumber made from interior species. T.M. Gorman

Value-added wood products. T.M. Gorman

Insulation value of logs for home construction. T.M. Gorman

Simulation and analysis of mobile merchandizing centers. L.R. Johnson

Recovery and processing of forest residues. L.R. Johnson

Timber harvesting under Adaptive Forestry prescriptions. L.R. Johnson

Soil disturbance from low cost line machines. H.W. Lee

Costs of producing firewood from recovered slash. H.W. Lee

Woodland owners utilization guide. H.W. Lee

Environmental impacts on site productivity from increased utilization of biomass for energy and fiber. H.W. Lee

The use of kraft and TMP pulp sludge in mineral-bonded composites. A.A. Moslemi

The use of carbon dioxide gas injection on the properties of cement-bonded fiber composites. A.A. Moslemi

The use of recycled fiber for fiber-cement composites. A.A. Moslemi

Development of a computerized heat transfer model for frozen and non-frozen logs. H.P. Steinhagen

Heat conditioning of veneer blocks. H.P. Steinhagen

Production economics and process control: Computer-based expert systems. F.G. Wagner

Use of short waves for wood defect detection. F.G. Wagner

Wood property enhancement: Predicting warp in southern pine lumber. F.G. Wagner

Graphical analysis of forest products. F.G. Wagner

Development of Micro-MSUSP: microcomputer-based simulation program for sawmills. F.G. Wagner

Department of Forest Resources

Performance of planted western redcedar seedlings based upon microsite characteristics. D.L. Adams, C. Lansing, R. Graham

Fall planting schedules for the northern Rocky Mountains. D.L. Adams, T. Catlin, R. Graham

Physiological relationships between low light intensity, foliar nitrogen, and susceptibility of Douglas-fir to *Armillaria ostovae*. D.L. Adams, A. Koehn, G. MacDonald

Effects of residual overstory tree retention on establishment and growth of natural regeneration. D.L. Adams, A. Schlenker, D. Ferguson

Soils of the Grand Fir Mosaic. D.L. Adams, M. Sommer

Investigations of the Grand Fir Mosaic ecosystem. D.L. Adams, D. Ferguson

Yakima River fishery enhancement project. D.L. Adams, D. Green

Site quality evaluation for ponderosa pine in windbreaks on the Great Plains. D.L. Adams, L. Townsend

The response of advance Douglas-fir regeneration to overstory removal. D.L. Adams, C. Maranto, D. Ferguson

Silvopastoral systems in the Ecuadorian highlands. D.L. Adams, M. Garrison

Implications of Adaptive Forestry practices on the University of Idaho Experimental Forest. D.L. Adams, H. Whitlach, H.L. Osborne

The role of carbon storage in forest habitat types of the Rocky Mountain ecosystems. D.L. Adams, T. Jain, R. Graham

Riparian buffer strip design. G.H. Belt

Development of a physical process model for predicting evotranspiration from rangeland. G.H. Belt

Molecular genetics and ecology of bitterbrush. S.J. Brunsfeld

Ecology and reproductive biology of *Epipactis gigantea* in the northern Rocky Mountains. M. Mantas, S.J. Brunsfeld

Documenting genetic races of ponderosa pine using ribosomal DNA sequence data. S.J. Brunsfeld

Assessment of the genetic resources of Idaho's relict populations of Pacific dogwood. S.J. Brunsfeld

Genetics and ecology of *Asarum wagneri*. C. Baldwin, S.J. Brunsfeld

Role of understory vegetation in nutrient cycling. J. Nelson, S.J. Brunsfeld

Phylogenetic relationships of *Taxodiacae* and *Cupressaceae:* Evidence from rbcL DNA sequence. S.J. Brunsfeld

Stochastic population modelling in conservation biology. B. Dennis

Modelling insect phenology. B. Dennis

Evaluating waste water from a container nursery and subsequent treatment in a constructed wetland. R.K. Dumroese

Testing the pathogenicity of *Cylindrocarpon* in a container nursery. R.K. Dumroese

Evaluating the biocontrol agent Mycostop for control of *Fusarium* root disease on container-grown Douglas-fir. R.K. Dumroese

The oxygen and carbon dioxide levels in western white pine seed and subsequent germination. R.K. Dumroese

Branch-like habit in western larch stecklings. J.L. Edson, D.L. Wenny, L. Fins

Selection of giant sequoia genotypes for ornamental planting in the Inland Northwest. L. Fins

Creating a clone bank of cold-hardy giant sequoia. L. Fins, D.L. Wenny, J.L. Edson

Response of western larch clones to hexazinone. L. Fins, D.L. Wenny, J.L. Edson, J. Mandzak

Comparisons of cone production on grafts, root cuttings, and seedlings of western larch. L. Fins

Efficiency of early selection of Douglas-fir for improved growth rates. L. Fins, M. Rust

Genetic variation in shoot growth in western larch. L. Fins, J.W. Zhang

Genetic variation in nutrient content among Douglas-fir families. L. Fins, V. McKee

Empirical studies on public participation in forest planning activities: Who participates, why, and how. J.E. Force, L. Marten, W.J. McLaughlin

Community social change in resource-dependent communities. J.E. Force, G.E. Machlis, D. Alpe

Research Projects and Investigations

Forestry and global climate change—a literature review for the UNCED Conference. J.E. Force, D. Forester

Use of non-timber forest products in Mali. J.E. Force, M. Gakou

Use of wilderness and natural environments for personal growth and leadership development. J.C. Hendee

Benefits and costs of conservation corps programs. J.C. Hendee

Textbook: Introduction to Forest and Renewable Resource Management (McGraw-Hill). J.C. Hendee, G. Sharpe, W. Sharpe

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

Pan-tropical trees—identification, distribution, and use. F.D. Johnson

Relationship between site productivity and vegetation in the upland pine forests of central Honduras. F.D. Johnson, C.T. Stiff, D.O. Hernandez

Community stability and timber-dependent communities in the Pacific Northwest. G.E. Machlis, J.E. Force

Galapagos Islands Human Ecosystem Project. G.E. Machlis

Relations between strangers: A new theory of resource use. G.E. Machlis

Socioeconomic forces influencing biodiversity loss. G.E. Machlis

The sociology of risk. G.E. Machlis

Field trials of elite black cherry. R.L. Mahoney

High value hardwoods for the Pacific Northwest. R.L. Mahoney

Computer-assisted learning for environmental education. R.L. Mahoney

Gas exchange and carbon budgets of xylem-tapping mistletoes and their hosts. J.D. Marshall

Water-use efficiency differences among provenances of western conifers. J.D. Marshall

Differences in water sources among tree species in northern Idaho. J.D. Marshall

Scaling of root respiration estimates to partition root respiration from soil respiration. J.D. Marshall

Use of carbon isotopes in tree rings to detect physiological responses to increasing atmospheric CO_2. J.D. Marshall

Comparison of leaf-area estimation techniques. J.D. Marshall

Nitrogen and potassium nutrition in relation to susceptibility of Douglas-fir to *Armillaria* infection. J.D. Marshall

Chilean forest industry structure. C.W. McKetta

Econometric analysis of Chilean forest products trade. C.W. McKetta

Elasticities of price transmission in imperfect markets. C.W. McKetta

Fire suppression cost estimation. C.W. McKetta

Alaskan forest products transportation. C.W. McKetta

Investment analysis of fuelwood plantations in Sri Lanka. E.L. Medema

Comparison of tree establishment techniques in south and southeast Asia: Plantlets versus seedlings. E.L. Medema

Growth response of forests to intermediate silvicultural treatments. J.A. Moore

Mineral nutrition of forest trees in the Intermountain Northwest. J.A. Moore

Testing and development of site index and height growth models. J.A. Moore

Testing and development of forest growth and yield simulators in the Intermountain Northwest. J.A. Moore

Modelling early succession following logging and burning of dense coniferous forests. P. Morgan

Fire ecology of whitebark pine: Stand development, cone production, and future forest health. P. Morgan

Protecting people and developments from wildland fires in Grand Teton National Park. P. Morgan

Autecology of overstory and understory plants. L.F. Neuenschwander

Fire effects and processes in forest ecosystems. L.F. Neuenschwander

Regeneration of forest and range important species. L.F. Neuenschwander

Horselogging applied to the Group Selection Harvest Regeneration Method. H.L. Osborne

Herbicide potential for managing forest vegetation: Chemicals suitable for site preparation and conifer release. H.L. Osborne

Vegetation control for ponderosa pine seedling establishment on Conservation Reserve Program lands. H.L. Osborne

Electron microscopy of root-disease fungi. A.D. Partridge

Seedling problems in nurseries and plantations. A.D. Partridge

Frequency and damage by urban tree pests in Idaho. A.D. Partridge

Root bag damage to "dimension stock." A.D. Partridge

Defect estimators for standing timber. A.D. Partridge

Composite estimators for predicting individual tree height. C.T. Stiff, A. Samih, and J.D. Newberry

The northern Rocky Mountain version of the Timber Resource Inventory Model—TRIM. C.T. Stiff, C.W. McKetta, R.O. Barkley

An evaluation and comparison of two distance-independent forest projection models in the Inland Northwest. C.T. Stiff, D.A. Patterson

Growth and yield models for *Pinus oocarpa* Schiede stands in central Honduras. C.T. Stiff

Soil site models for *Pinus oocarpa* Schiede stands in central Honduras. C.T. Stiff, M.C. Valdes

Effects of fugitive cement kiln dust on forest productivity. C.T. Stiff, C.M. Stiff

Simultaneous height and diameter increment models for second-growth Douglas-fir in the Inland Northwest. C.T. Stiff, W. Zhang, J.A. Moore

Development of expert systems for natural resource management. M.W. Stock

Studies of computer use by foresters. M.W. Stock

Effects of stress on the genetics of bark beetle populations. M.W. Stock

Development and demonstration of New Perspective (adaptive, ecosystem- and land-based) forest management approach. K.J. Stoszek

Response of high-graded ponderosa pine stands to simulated uneven-aged and selection silviculture. K.J. Stoszek

Silvicultural guidelines for blister rust-infected white pine stands. K.J. Stoszek

Evaluation of afforestation and reforestation attempts of savannas. K.J. Stoszek

Assessing the causes and effects of deforestation in Panama. K.J. Stoszek

Evaluation selection silviculture prospects in selectively logged ponderosa pine stands of Washington. K.J. Stoszek

Jackson Hole mapping expansion. J.J. Ulliman

Small format aerial photography. J.J. Ulliman

Model to correct for topographic effects on digital remotely sensed data. A. Fahsi, J.J. Ulliman

Wetland change detection using Landsat-5 TM data in Jackson Hole, Wyoming. S-H. Koung, J.J. Ulliman

Use of Landsat thematic mapper data for updating Idaho Gap Analysis vegetation map. D.L. Verbyla, L. Halbrook

Automated delineation of climatic zones within Gap Analysis vegetation polygons. D.L. Verbyla, D. Unger

Forest road inventory using satellite data. D.L. Verbyla, R. Jazovli, D. Murphy

Application of thermal satellite data to climate warming research. D.L. Verbyla, D. Unger

High resolution digital remote sensing of stressed conifers. D.L. Verbyla

Monitoring of sediment sources within the Priest Lake Watershed. D.L. Verbyla

Chemical root pruning of seedlings to enhance egress. D.L. Wenny

Micropropagation of difficult-to-regenerate plant species. D.L. Wenny, J.L. Edson

Nursery management software. D. L. Wenny

Plantation microsite selection. D.L. Wenny

Vegetative propagation of western white pine by rooted branch cuttings and rooted fascicles. D.L. Wenny, L. Fins, J.L. Edson, R. Tripepi

Micropropagation and rooting stem cuttings of Scouler willow. D.L. Wenny, J.L. Edson

Comparing biomass and root plug development of plantlets and rooted cuttings of hybrid poplar. D.L. Wenny, J.L. Edson

Micropropagation of a fire-resistant clone of mountain big sagebrush. D.L. Wenny, M. Hironaka, J.L. Edson

Rooting cuttings of Rocky Mountain juniper. D.L. Wenny, J.L. Edson, R.K. Dumroese

Conserving Idaho's Pacific dogwood through micropropagation and rooting of shoot tip cuttings. D.L. Wenny, J.L. Edson

Developing cultural practices to promote growth and survival of micropropagated plantlets. D.L. Wenny, J.L. Edson

Department of Range Resources

Sampling methodology associated with range condition and trend. S.C. Bunting

Genetic improvement of selected native range shrubs. M. Hironaka

Revegetation of pipeline disturbances. K.L. Johnson

Long-term ecological change of shortgrass prairie. K.L. Johnson

Photographic studies of vegetation change. K.L. Johnson

Relationship of animal use to tree establishment, survival, and growth in plantation settings. J.L. Kingery

Animal damage and plantation performance. J.L. Kingery

Assessing production and utilization techniques for herbaceous vegetation. J.L. Kingery

Sheep grazing as a silvicultural tool in conifer plantations. J.L. Kingery, J.C. Mosley, H.L. Osborne, S.D. McCoy

Influence of riparian herbage on water quality of rangeland streams. J.C. Mosley, C.M. Falter, T.A. Lance

Habitat use and diet selection by Chihuahuan pronghorns. J.C. Mosley, E.L. Smith

Diet nutrient quality of elk inhabiting a semi-arid environment. J.C. Mosley, D.C. Stohmeyer, J.M. Peek

Sheep grazing strategies for deer and elk habitat improvement. J.C. Mosley, J.L. Kingery, K.J. Crane

Factors influencing mortality of crested wheatgrass. J.C. Mosley, K.D. Sanders, M.V. Spaulding

Fecal bacterial ratios for quantifying riparian utilization by sympatric ungulates. J.C. Mosley, G.A. Bohach, N.W. Darby

Physiological ecology of arctic tundra plants: Freezing tolerance and cold acclimation. R. Robberecht

Mechanisms of competition between bunchgrasses and tree seedlings during forest regeneration. R. Robberecht

Ecophysiology and mechanisms of plant competition for adventive species in disturbed rangelands. R. Robberecht

Reseeding arid rangelands. K.D. Sanders

Short duration grazing system on crested wheatgrass. K.D. Sanders

Control of broom-snakeweed on rangelands. K.D. Sanders

Effect of drought on crested wheatgrass. K.D. Sanders, Jeff Mosley, M. Spaulding

Evaluation of salt-desert shrub communities through time. L.A. Sharp

Ecology and classification of Pacific Northwest grasslands. E.W. Tisdale

Department of Resource Recreation and Tourism

Environmental Interpretation: A Practical Guide for People with Big Ideas and Small Budgets (textbook). S.H. Ham

Antecedents to environmental education commitment among elementary school teachers. S.H. Ham

Development of program evaluation methods for forest interpreters. S.H. Ham

Organizational change and its impact on resource management policy analysis and decision-making. C.C. Harris

Integration of psychology and economics in valuation of public amenity resources. C.C. Harris

Development of methodologies for comprehensive tourism and recreation participation. J.D. Hunt

Relation of national tourism office expenditures to tourist visitation. J.D. Hunt

Tourism and the recreation choice process in Idaho. E.E. Krumpe

Management plan for interpretive and visitor services at Kirkwood Historic Ranch. E.E. Krumpe

Strategies and methods for local governments to encourage and assess tourism development. W.J. McLaughlin, et al

Development of procedures and methodologies to expand and replicate the Idaho Leisure Travel and Recreation Study. W.J. McLaughlin, J. Hunt, N. Sanyal, C.C. Harris

Lower Salmon River planning. W.J. McLaughlin

Case study of the economic development and nature conservation programs used in French regional natural parks. W.J. McLaughlin

Segmentation and specialization of Idaho anglers: Understanding angler preferences for experience and setting. N. Sanyal, W.J. McLaughlin

Policy Analysis Group (PAG)

Forest riparian buffer zone design for water quality protection: Analysis of scientific literature. G. Belt, J. O'Laughlin

Analysis of the potential for a national park in Idaho. J. MacCracken, J. O'Laughlin

Analysis of fundamental issues in the design of natural resource public opinion surveys in Idaho. W.J. McLaughlin, J. Freemuth, J. O'Laughlin

Analysis of methods for determining minimum instream flows for recreation. T. Merrill, J. O'Laughlin

Analysis of forest health conditions in Idaho. J. O'Laughlin, J. MacCracken

Master's Theses

Ballard, G.L. Habitat relationships and physiological condition of mountain sheep in Morgan Creek, east-central Idaho. *Major professor: J.M. Peek*

Brelsford, M.A.J. Effects of grazing by elk on winter wheat and winter rapeseed, and the effects of simulated elk use on winter wheat in northern Idaho. *Major professor: J.M. Peek*

Burton, D.R. Iodophor water hardening of salmonid eggs: The effects on egg survival and early rearing of water hardening steelhead trout and cutthroat trout eggs in two iodophors. *Major professor: G.W. Klontz*

Carree, Y. The potential for black cherry (*Prunus serotina* Ehrh.) as an alternative tree species for timber, wildlife habitat and conservation plantings for the Inland Northwest. *Major professor: R.L. Mahoney*

Costa, D.A. Ecuadorian and non-Ecuadorian visitors to the Galapagos Islands, Ecuador: A comparison. *Major professor: G.E. Machlis*

Damiba, T.E. Size, impacts and managerial implications of the Nazinga Game Ranch elephant population in Burkina Faso, West Africa. *Major professor: E.D. Ables*

Danso, A.A. Alley cropping rice (*Oryza sativa* var. *Barafita*) and maize (*Zea mays* var. *Jeka*) with cassia (Cassia siamea) in the Gambia. *Major professor: P. Morgan*

De Groot, J.R. Yield of ponderosa pine seedlings following broadcast and spot hexazinone applications. *Major professor: J.A. Moore*

De La Garza, J.L. The rainbow trout market in Mexico City. *Major professor: G.W. Klontz*

Dumas, B.C. Effects of scarification and stratification on shadscale germination. *Major professor: M. Hironaka*

Ehrenreich, J., Jr. A transaction evidence stumpage appraisal model for the Idaho Department of Lands Clearwater area. *Major professor: C.W. McKetta*

El Meslouhi, M.R. Using digital elevation model data in a geographic information system to correct for topographical influences in synthetic aperture radar data. *Major professor: J.J. Ulliman*

Hatch, D.R. Factors limiting largemouth bass in Long Lake, Spokane County, Washington. *Major professor: D.H. Bennett*

Honghan, Huang. Wood ash as a liming agent and soil additive for growth of corn and wheat: Field studies. *Major professor: A.G. Campbell*

Jones, J.L. Habitat use of fisher in northcentral Idaho. *Major professor: E.O. Garton*

Josaitis, R.M. The effects of western juniper occupancy on changes in soil characteristics in relation to shrub and grass establishment in Owyhee County, Idaho. *Major professor: S.C. Bunting*

Keith, R.M. Response of juvenile salmonids to riparian and instream cover modifications in small streams flowing through second-growth forests of southeast Alaska. *Major professor: T.C. Bjornn*

Kelly, B.T. Carnivore scat analysis: An evaluation of existing techniques and the development of predictive models of prey consumed. *Major professor: E.O. Garton*

Lea, S.M. The resprouting response of individual ninebark shrubs to heating from high, medium, and low severity burn, and slipping treatments. *Major professor: P. Morgan*

Liter, M.D. Factors limiting largemouth bass in Box Canyon Reservoir, Washington. *Major professor: D.H. Bennett*

Machrouh, A. Using a geographic information system to determine ponderosa pine suitability classes on the University of Idaho Experimental Forest. *Major professor: J.J. Ulliman*

Mangala, P.M. The compatibilities of pulp and paper sludges with portland cement. *Major professor: A.A. Moslemi*

McCusker, J.B. Effects of regional cultural differences on interactions between grazing permittees and the Bureau of Land Management. *Major professor: J.E. Force*

Meints, D.R. Seasonal movements, habitat use, and productivity of Columbian sharp-tailed grouse in southeastern Idaho. *Major professor: K.P. Reese*

Ndour, B. Criteria for agroforestry research planning in the developing countries: A Delphi study. *Major professor: J.E. Force*

Robertson, M.D. Winter ecology of migratory sage grouse and associated effects of prescribed fire in southeastern Idaho. *Major professor: K.P. Reese*

Sargeant, G.A. Thermoregulation by mule deer at the Arid Lands Ecology Reserve, south-central Washington. *Major professor: J.M. Peek*

Shetty, G. Effect of boron on cell differentiation and biosynthesis of phenols and lignin. *Major professor: A.G. Campbell*

Simpson, M.L. The subalpine fir-beargrass habitat type. *Major professor: F.D. Johnson*

Sommer, M. Soils of the Grand Fir Mosaic. *Major professor: D.L. Adams*

Sutherland, D.S. Child-to-parent transfer of environmental ideology in Costa Rican families. *Major professor: S.H. Ham*

Tan, C.E. Developing, implementing and evaluating an agency-outfitter partnership to provide information services for boaters on the Lower Salmon River in Idaho. *Major professor: W.J. McLaughlin*

Tanimoto, P.D. Applications of geographical information systems to the management of Lake Chelan National Recreation Area. *Major professor: R.G. Wright*

Vieto, R. J. A linear programming model for the economic analysis of silvopastoral systems with interactive outputs: Adapting FORPLAN for the Nez Perce tribal forest-grazing case. *Major professor: C. W. McKetta*

Warren, C.D. Ecotypic response and habitat use of woodland caribou translocated to the southern Selkirk Mountains, northern Idaho. *Major professor: J.T. Ratti*

Yamane, H. Protecting people and developments from wildland fires in Grand Teton National Park. *Major professor: P. Morgan*

Zhang, Y. Occurrence and quantity of infectious hematopoietic necrosis virus in the water supply and rearing units for steelhead trout at Dworshak National Fish Hatchery. *Major professor: J.L. Congleton*

Ph.D. Dissertations

Ferguson, D.E. Investigations on the Grand Fir Mosaic ecosystem of northern Idaho. *Major professor: D.L. Adams*

Folk, R.L. Small-scale densified wood fuel manufacture and utilization in the Intermountain West. *Major professor: R.L. Govett*

Monda, M.J. Reproductive ecology of tundra swans on the Arctic National Wildlife Refuge, Alaska. *Major professor: J.T. Ratti*

Sanyal, N. The conceptual and empirical development of a model of hunting pressure. *Major professor: W.J. McLaughlin*

Continuing Education and Outreach

Faculty in the College of Forestry, Wildlife and Range Sciences conduct continuing education programs for natural resource professionals and outreach programs for the public on campus, at the Clark Fork and McCall Field Campuses, and throughout Idaho and the West. The college offered the following continuing education and outreach programs during 1991. Most programs scheduled for 1992 are also listed.

More information is available from Continuing Education, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, Idaho, 83843, (208) 885-6441.

Continuing Education

1991

January 7-11	Microcomputer Applications in Fish and Wildlife Biology—Moscow
January 9-11	Forest Products Academy: The Industry—An Overview for Non-Forest Products Executives—Boise
February	Improved Pasture Management—Arco
February	Genetics Education in Northwestern Ecosystems (G.E.N.E.), USFS Region I-Inland Empire—Pullman, Washington
February 4-7	BIA/Tribal Executive Leadership for Natural Resource Management—Moscow
February 7	Trout Culture Workshop—Bonners Ferry
February 12-14	Pacific Northwest Range Management Shortcourse: Managing Herbs and Shrubs for Multiple Uses (with Washington State University, Oregon State University)—Moscow
February 18-21	Workshop: Statistical Methods and Data Analysis for Fish and Wildlife Biologists—Moscow
February 20	Trout Culture Workshop—Pocatello
February 22-25	Fish Farming Workshop (for British Columbia Trout Grower's Association)—Chilliwack, British Columbia
February 25-March 1	13th Annual Aerial Photography/Remote Sensing Workshop—Moscow
February 26-27	Fire Behavior (Session I)—Moscow
February 27	Improved Pasture Management—Arco
February 27-28	Fire Behavior (Session II)—Moscow
March 5-6	Eighth Annual Inland Empire Forest Engineering Conference—Moscow
March 12-13	Monitoring/Coordinated Resource Management Workshop—Challis
March 14	Inland Empire Tree Improvement Cooperative (IET-IC) Annual Meeting and Workshop—Post Falls
March 18-21	National Bioenergy Conference—Coeur d'Alene
March 22-23	Advances in Commercial Trout Fishing—Charlottetown, Prince Edward Island, Canada
March 26-27	Regional Non-Industrial Private Forestry (NIPF) Woodland Marketing Workshop: Marketing Your Timberland in the 90s—Moscow
April	Range Monitoring Workshop—Arco
April 1-2	Fish and Wildlife Leadership and Communications Workshop—Moscow
April 1-12	Leadership and Communications Workshop (for USFS Professionals), restricted enrollment—Moscow
April 5-7	Interpersonal Communication Skills for Natural Resource Managers—Clark Fork
April 6-10	Wood Products Academy: Level I (Basic Course)—Moscow
April 8-12	Wood Products Academy Shortcourse: The Industry Forest Products Academy for Non-Forest Products Executives—Moscow
April 17	Log Manufacturing and Scaling Workshop (for Konkolville Lumber Company)—Orofino
April 23-25	Wood Products Academy Shortcourse: The Industry Forest Products Academy for Non-Forest Products Executives—Boise
June	Habitat Typing and Basic Community Ecology—Grangeville
June	Habitat Typing and Basic Community Ecology—Wallace
June	Central Idaho Natural Resource Conservation Workshop—Ketchum
June-July	Training Program for Southeast Asia Nature Preserve Managers (for World Wildlife Fund)—Moscow
June 17-21	Wood Products Academy Shortcourse: An Introduction to Quality Control—Moscow
June 24-28	Satellite Remote Sensing for Natural Resource Management (Workshop A)—Moscow
June 24-August 2	Land Use Planning for Community Forestry and Natural Resource Development—Moscow
July	Habitat Typing and Basic Community Ecology—Bonners Ferry
July	Management Implications for Habitat Types—Coeur d'Alene
July 7-13	Fish and Wildlife Ecology Workshop (for teachers)—McCall
July 11-12	We Grow Full Circle—A Field Tour of Working Forests—McCall
July 16-17	Southwest Idaho Shade Tree Workshop—Boise
August 1-September 26	UI/Honduras Forestry Field Training Course—Moscow
August 5-9	Satellite Remote Sensing for Natural Resource Management (Workshop B)—Moscow
August 20	Monitoring Workshop—Challis
August 24	Monitoring Workshop (with Idaho Cattle Association)—Twin Falls

September	Conference on Environmental Questions and Utilization Alternatives with Wood—Moscow
September	Wood Products Academy Shortcourse: The Industry—An Overview for Non-Forest Products Executives—Coeur d'Alene
September 17	Tree Planting Workshop—Kamiah
September 18	Tree Planting Workshop—Orofino
September 19-20	Forest Management for Idaho's Future—Moscow
September 24	Tree Planting Workshop—Grangeville
October 1-2	Intermountain Container Seedling Growers Association Meeting—Post Falls
October 14-18	Tenth Annual Inland Empire Dry Kiln Workshop—Moscow
October 20-November 8	CEFES: Continuing Education in Forest Ecology and Silviculture—Moscow
November 7-8	Recycling and Utilizing Forest Products Wastes—North Idaho College, Coeur d'Alene
November 19-20	Big Game Depredation—Moscow
November 20	Federal Income Tax Strategies for Timber Owners—Moscow
December 2-6	Natural Resource Management for National Park Service Personnel—Moscow
December 4-6	Wood Products Academy: An Introduction to Quality Control—Moscow
December 19-20	Wood Pellet Manufacturing, Quality Control, and Marketing Workshop—Lewiston
December 19-20	Wildlife Depredation Shortcourse (with College of Agriculture)—Moscow

1992

January 27-31	Biostatistics Workshop (with U.S. Fish and Wildlife Service and National Fisheries Academy)—Albuquerque, New Mexico
February 3	Native American Natural Resource Leadership Workshop—Moscow
February 4	Wilderness Management Workshop—Boise
February 18	Wilderness Management Workshop—Boise
February 21, 22, 28	Principles of Wildlife Management Workshop—Colville
February 24-28	Statistical Methods and Data Analysis for Fish and Wildlife Biologists—Boise
February 27	Genetics Education in Northwestern Ecosystems (G.E.N.E.), USFS Region I-Inland Empire—Pullman, Washington
February 27-28	Wood Products Academy: Marketing and New Products—Coeur d'Alene
March 2-6	Applications of Multivariate Statistical Methods to Fish and Wildlife Biology (with Idaho Power Co. and Idaho Dept. of Fish and Game)—Boise
March 3	Wilderness Management Workshop—Boise
March 3-4	Ninth Annual Inland Empire Forest Engineering Conference—Moscow
March 12	IETIC Annual Meeting and Workshop: Forest Tree Breeding—Variation, Gains, and Traits—Post Falls
March 21-22	Fish Farming Workshop—British Columbia, Canada
March 23-24	Regional Non-Industrial Private Forestry (NIPF) Woodland Marketing Workshop—Moscow
March 23-24	Stewardship Planning Workshop—Moscow
March 23-27	14th Annual Aerial Photography/Remote Sensing Workshop—Moscow
March 24	Wilderness Management Workshop—Boise
March 30-April 2	Vegetation Management Workshop: Managing Herbs and Shrubs for Multiple Uses—Boise
March 30-April 10	Leadership and Communications Workshop (for USFS Professionals)—Moscow
April	Wildlife Management Workshop—Boise
April	Fish Management Workshop—Boise
April 3-5	Interpersonal Communication Skills for Resource Professionals—Clark Fork
April 6-10	Wood Products Academy: Basic Course—Moscow
April 7-10	Windbreak Workshop—Twin Falls
May 18	Logger Safety Training Workshop (for Boise Cascade)—Emmett
June	Central Idaho Natural Resource Conservation Workshop—Ketchum
June-August	Logger Safety Training Workshops—Idaho state
June 1-5	1992 Satellite Remote Sensing for Natural Resources Management—Moscow
June 1-July 10	Training Program for Southeast Asia Wildlife Preserve Managers (for World Wildlife Fund)—Moscow
June 8-July 17	Land Use Planning for Community Forestry and Natural Resource Development—Moscow
June 9-10	Wood Panel and Lumber Composites: Technology and Market Opportunities—Spokane, Washington
June 16-17	Workshop on Manufacture and Marketing of Wood Pellets—Lewiston
June 22-26	Forest Habitat Types of Northern Idaho and Basic Community Ecology (for USFS)—Shoshone Station, Wallace
July 5-6	Wilderness Ecology: UI Wilderness Research Institute—McCall
July 6-10	Forest Habitat Types of Northern Idaho and Basic Community Ecology (for USFS)—Fenn Ranger Station
July 7	Southern Idaho Insect and Disease Workshop—American Falls
July 7-13	Fish and Wildlife Ecology Workshop (for teachers)—McCall
July 8	Southern Idaho Insect and Disease Workshop—Preston

July 9	Southern Idaho Insect and Disease Workshop—Idaho Falls
July 23-24	We Grow Full Circle—A Field Tour of Working Forests—McCall
July 23-24	Adaptive Forestry Workshop—Moscow
July 30-September 26	UI/Honduras Forestry Field Training Course—Moscow
August 2-8	Advanced Project Learning Tree—Clark Fork
September (tentative)	Wood Products Academy Shortcourse: An Introduction to Quality Control—Moscow
September 12-13	Capturing Public Judgement (Planning and Facilitation Skills for Successful Public Involvement)—McCall
September 17-18	Public Involvement and Meeting Facilitation Skills—McCall
September 26	Community Forest Stewardship Day—Moscow
September 28-30	3rd International Inorganic-Bonded Wood & Fiber Composite Materials Conference—Spokane, Washington
October (tentative)	Wood Products Academy: Basic Course—Moscow
October	Hardwood Conference—location TBA
October 9-11	Interpersonal Skills for Natural Resource Managers—McCall
October 14-18	Eleventh Annual Inland Empire Dry Kiln Workshop—Moscow

Outreach

1991

March 16	History of North Idaho—Clark Fork
April 13	Fishing for the Big Ones—Clark Fork
April 27	Tree Planting—Moscow
May 2-3	Modern Aboriculture—Nebraska City, Nebraska
May 11	Community Forestry Day—Moscow
May 11	Fishing for the Big Ones—Clark Fork
May 16-18	Building with Trees—Washington, D.C.
May 18	For Bird Lovers Only—Clark Fork
May 25-26	Spring Bird Identification—McCall
June 1	Spring Mushrooms—Clark Fork
June 5	State FFA Forestry Contest—Moscow
June 8	Spring Mushrooms—Clark Fork
June 9	Ethnobotany—Clark Fork
June 20-21	Building with Trees—Minneapolis, Minnesota
June 24-25	Building with Trees—Seattle/Tacoma, Washington
July 10	History and Archaeology of Warren's Chinese Occupation—McCall
July 13	Wildflower Identification—McCall
July 28	Outdoor Photography—Clark Fork
August 5-9	Drawing from Nature—McCall
August 10	Water Color Painting from Nature—Clark Fork
August 11	Water Color Painting from Nature—Clark Fork
August 24	Water Color Painting from Nature—Clark Fork
September 7	Deforestation in the Highlands of South America—McCall
September 7	Fossil Collecting and Geologic Tour of the Lake Pend Oreille Area—Clark Fork
September 8	Fossil Collecting and Geologic Tour of the Lake Pend Oreille Area (repeat)—Clark Fork
September 24-27	From Management to Leadership—McCall
October 4-5	Astronomy—Clark Fork
October 26-27	Writing Creatively or Stretching the Truth and Getting It into Print—Clark Fork
November 23	Christmas Crafts—Clark Fork

1992

February 23-28	National Urban Forestry School (Session I)—Nebraska City, Nebraska
March 7	Dinosaurs—Clark Fork
March 28	Fishing for the Big Ones—Clark Fork
April 11	Fishing for the Big Ones—Clark Fork
April 26	History of North Idaho—Clark Fork
May 9	For Bird Lovers Only—Clark Fork
May 10	For Bird Lovers Only—Clark Fork
May 21-22	Modern Aboriculture—Kansas City, Missouri
June 6	Mushrooms—Clark Fork
June 12-14	New Writers Workshop: How to Write About the Good Earth for Publication—Nebraska City, Nebraska
June 27	Wildflower Identification—McCall
June 27	Ethnobotanic Aspects of Alien Plant Species, The Wonderful World of Weeds—Clark Fork
June 28	Ethnobotany—Clark Fork
July 8	History and Archaeology of Warren's Chinese Occupation—McCall
August 1-2	Water Color Painting from Nature—Clark Fork
August 1-5	Drawing from Nature—McCall
August 2-9	On the Trail of Lewis and Clark—Lolo Trail
September 17-18	Solving Management Dilemmas—McCall
September 19	Fossil Collecting and Geologic Tour of the Lake Pend Oreille Area—Clark Fork
September 20	Fossil Collecting and Geologic Tour of the Lake Pend Oreille Area (repeat)—Clark Fork
September 27-October 2	National Urban Forestry School (Session II)—Nebraska City, Nebraska
October 3-4	Getting Published—Clark Fork
October 9	Building with Trees Workshop—Newport Beach, California

October 13	Building with Trees Workshop—Sacramento, California
October 15	Building with Trees Workshop—Seattle, Washington
October 17	North Idaho Folklore—Clark Fork
October 18	Native American Culture and Myths—Clark Fork
November 8	The Fascinating World of Rocks and Minerals—Clark Fork
November 12	Building with Trees—Chicago, Illinois
November 16	Building with Trees—Orlando, Florida

Robert Govett

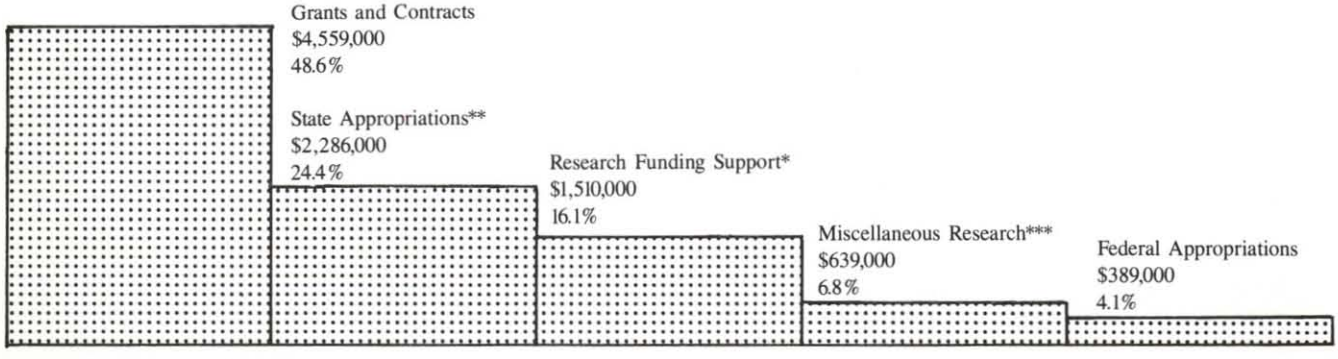
Agency and Funding Support

Agency for International Development
Agriculture Research Service
Alaska Fish and Game Department
American-Scandinavian Foundation
Bennett Lumber Company
Boise Cascade Corporation
Boise National Forest
Bonneville Power Administration
Boone and Crockett Club
Champion Timberlands
Clearwater National Forest
Clearwater-Potlatch Timber Protective Association, Inc.
Clearwater Resource Conservation and Development Council
Colorado State University
Colville Confederated Tribes
Cooperative State Research Service
Curt Berklund
Energy/Development International
Environmental Protection Agency
Evergreen Forest Products
Flathead National Forest
Foundation for North American Wild Sheep
Glacier National Park
Government of Honduras
Hoff Companies
Hunter Valley Research Foundation
Idaho Department of Commerce
Idaho Department of Fish and Game
Idaho Department of Lands
Idaho Department of Parks and Recreation
Idaho Fish Food Industry
Idaho Forest Industries
Idaho National Engineering Laboratory
Idaho Nuclear Energy Commission
Idaho Research Foundation, Inc.
Idaho Travel Council
Idaho Water Resources Board
Idaho Water Resources Research Institute
Inland Empire Paper Company
Inland Empire Tree Improvement Cooperative
Inland Northwest Growth and Yield Cooperative
Intermountain Forest Industries Association
Jefferson National Expansion Historical Association, Inc.
Konkolville Lumber
Lake Superior Construction, Inc.
Lake Superior Forest Products, Inc.
Latah County
Montana Fish and Wildlife
Montana State University
National Aeronautics and Space Administration
National Arbor Day Foundation
National Fish and Wildlife Foundation
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
National Rifle Association of America
National Wildlife Federation
North Atlantic Treaty Organization
North Idaho Forestry Association
Northwest Area Foundation
Kevin O'Sullivan
Pacific Northwest Power Company
Pack River Lumber Company
Payette National Forest
Pheasants Forever
Potlatch Corporation
PUD #1, Pend Oreille County
QB Corporation
Riley Creek Lumber
Rocky Mountain Elk Foundation
Roger Guernsey
Shearer Lumber
Simpson Timber Company
South Idaho Forestry Association
Stillinger Trust
St. Regis Paper Company
Timberline Software
TJ International
U.S. Army Corps of Engineers
USDA Cooperative Research
USDA Extension Service
USDA Forest Service, Intermountain Forest and Range Experiment Station
USDA Forest Service, Northeastern Forest Experiment Station
USDA Forest Service, Pacific Northwest Forest and Range Experiment Station
USDA Office of International Cooperation and Development
U.S. Department of Commerce
U.S. Department of Energy
U.S. Department of Navy/Naval Undersea Center
USDI Bureau of Indian Affairs
USDI Bureau of Land Management
USDI Bureau of Reclamation
USDI Fish and Wildlife Service
USDI National Park Service
Universidad Nacional, Republica de Costa Rica
University of Alaska
University of Idaho Experimental Forest
University of Idaho Forest Research Nursery
University of Minnesota
University of Montana
University of Washington
Washington State Department of Natural Resources
Washington State University
Washington Water Power Company
Rob and Bessie Welder Wildlife Foundation
Western Forestry and Conservation Assoc.
West One
Weyerhaeuser Company
The Wilderness Society
Wildlife Management Institute
The Wildlife Society
Winrock International Institute

Fiscal Year 1991 Financial Picture

Research income, shown by funding source, totaled $9,383,000 for the fiscal year 1990-91.

*Includes overhead allowances, external matching, outside federal unit support, and external cooperative research support
**Includes FWR Experiment Station, Wildlife, Wilderness, and Forest Utilization Research
***Includes Forest Research Nursery, Experimental Forest, Idaho Research Foundation, Taylor Ranch, and Clark Fork Field Campus



Productivity: 1988-1991

	Departments					
	Fish & Wildlife Resources	**Forest Products**	**Forest Resources**	**Range Resources**	**Resource Recreation and Tourism**	**Total**
1988						
Research FTE's[1]	2.5	1.9	6.4	1.5	0.7	13
Books	0	0	2	0	0	2
Chapters in Books	1	0	2	0	1	4
Refereed Publications	20	6	25	4	4	59
Other Publications	27	15	56	1	17	116
1989						
Research FTE's	2.5	1.9	6.4	1.5	0.7	13
Books	0	0	2	0	0	2
Chapters in Books	6	7	11	9	3	36
Refereed Publications	18	9	23	4	7	61
Other Publications	30	11	46	5	26	118
1990						
Research FTE's	3	1.9	6.9	1.5	1.3	14.6
Books	0	2	3	0	0	5
Chapters in Books	1	0	2	1	2	6
Refereed Publications	26	13	34	4	8	85
Other Publications	31	23	72	10	25	161
1991						
Research FTE's[2]	4.85	3.62	9.99	4.27	2.88	25.61
Books	2	2	3	0	0	7
Chapters in Books	16	6	19	4	6	51
Refereed Publications	23	21	23[3]	3	3	73
Other Publications	32	7	44	3	25	111

[1] FTE = the equivalent of one full-time faculty employee paid from CFWR Experiment Station state funds.
[2] Starting in 1991, these figures will reflect budget book numbers, not figures found in faculty activity reports, as previously.
[3] PAG reports are calculated with Forest Resources publications: 2 refereed and 9 "other" in 1991.

Since its inception in 1909, the College of Forestry, Wildlife and Range Sciences at the University of Idaho has become one of the oldest and most highly regarded natural resource schools in the United States. As part of the state's land grant institution, the college serves the state through teaching, research, and service. College research is administered through the Idaho Forest, Wildlife and Range Experiment Station, established by the Idaho legislature in 1939 to conduct research on the state's renewable resources.

The experiment station has the equivalent of 25.61 full-time researchers funded by the state of Idaho. However, all 70 of the college's faculty members conduct research, as do most of its 175 graduate students. The faculty spend about one-third of their time on research, much of it paid for through outside grants and contracts.

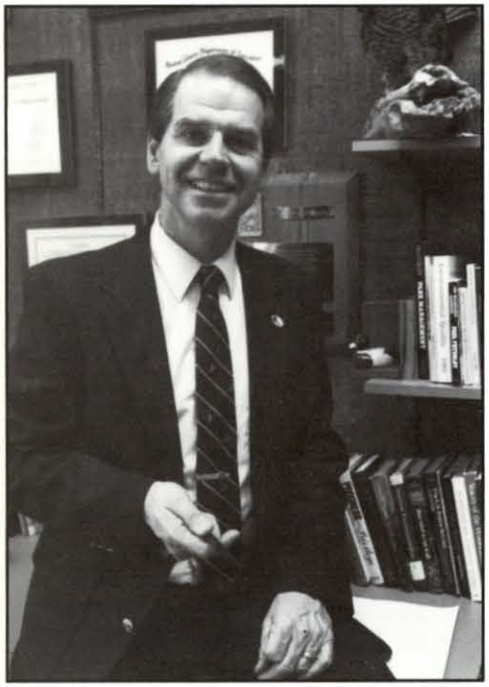
During the 1991 fiscal year, income from outside grants and contracts totalled $6.45 million. State appropriations for research at the experiment station amounted to an additional $2.3 million. For every dollar appropriated by the state for experiment station research during fiscal 1991, faculty grants and contracts brought in $2.80.

Changes: 1987-1991

	1987 vs. 1991 Percent Change	**5-year Total**
Graduate Student Enrollment	+786%	720
Outside Grants & Contracts[4]	+379%	$17.95 million
Books	+233%	19
Chapters in Books	+850%	103
Refereed Publications	-13%	362
Other Publications	+165%	573

[4] Fiscal years

From the Director



John C. Hendee

Interconnected Challenges, Disciplines, and Solutions

The College of Forestry, Wildlife and Range Sciences has a long history of melding together different natural resource disciplines under one roof. Our five departments mirror the diversity and complexity of the natural resource management challenges facing Idaho, our country, and the world. The importance of our diversity has never been greater. Even as I write, the faculty is working to further blend the curriculum so that students, whether they major in Fisheries or Wildlife, Forestry, Range, or Recreation, possess an integrated view of the interconnections among natural resources.

This interdisciplinary attitude also extends to our research program. The 288 active studies in the Forest, Wildlife and Range Experiment Station reflect the faculty's diverse yet increasingly intermingled view. New topics are emerging in our research and teaching, such as biodiversity and conservation biology in wildlife management, "new forestry", and "ecosystem management" in forest resources. The goal is to support management of the entire forest ecosystem, more than just game for hunting, or timber for harvest. This broader view of forest yields includes such issues as water availability and quality, esthetics, oxygen production, and habitat for fish and wildlife. As researchers, our scientists helped push these themes to the forefront of natural resource management, and as teachers they disseminate their new information to its future practitioners.

Thus our focus on integration reaches beyond the topics we teach and study—to a concern for actively blending teaching and research. Current debates about teaching versus research in higher education are ironic, since without research we would have only a fraction of the faculty, and a small portion of the diverse curricula we now offer. Our faculty are deeply committed to teaching and research. Research is an integral part of the learning process for both faculty and students. As this issue of *Focus* illustrates, we're teaching things today we didn't know about five years ago. The faculty who participate in the discovery process through research and share their discoveries with students are the ones who teach new knowledge first.

It's the integration of our disciplines, and the balancing of teaching and research, that guarantees our college and our graduates a bright future. Sound environmental science and understanding natural resource interrelationships are key elements for conservation and natural resource management. These elements are essential for dealing with tomorrow's challenges—challenges our graduates are well prepared to meet.

John C. Hendee

University of Idaho

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