FOCUS
on Renewable Natural Resources

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

Volume 4 Number 1

We Want You to Know What We Have Learned

When we began this annual series a few years ago, our primary objective was to communicate what we are learning about Idaho's natural renewable resources to a broad public. This includes federal and state legislators and officials, agency personnel, industrial concerns and interested citizens in Idaho, all who provide input for key resource decisions. That objective remains the same. We feel information generated through research should be a keystone in making those decisions. In each issue of FOCUS, we highlight some of the projects currently underway.

Fisheries

Idaho's fisheries resources are among some of the best in the world. However, multiple demands on our water resources are changing the aquatic environment. The minimum stream flow projects (see page 7) are designed to evaluate the effects of reduced stream flow on salmonid egg incubation and on response of fish and microinvertebrate populations. While we must get sound answers to our minimum flow questions, it is imperative that we mitigate for the losses in natural spawning opportunities. The project on steelhead smolt raised by hatcheries attempts to determine the best release schedule of such man-produced smolts to meet the rigors of migration to the sea and eventual return for spawning some 2 to 4 years later. The data from this project will provide information for planning future Idaho hatcheries.

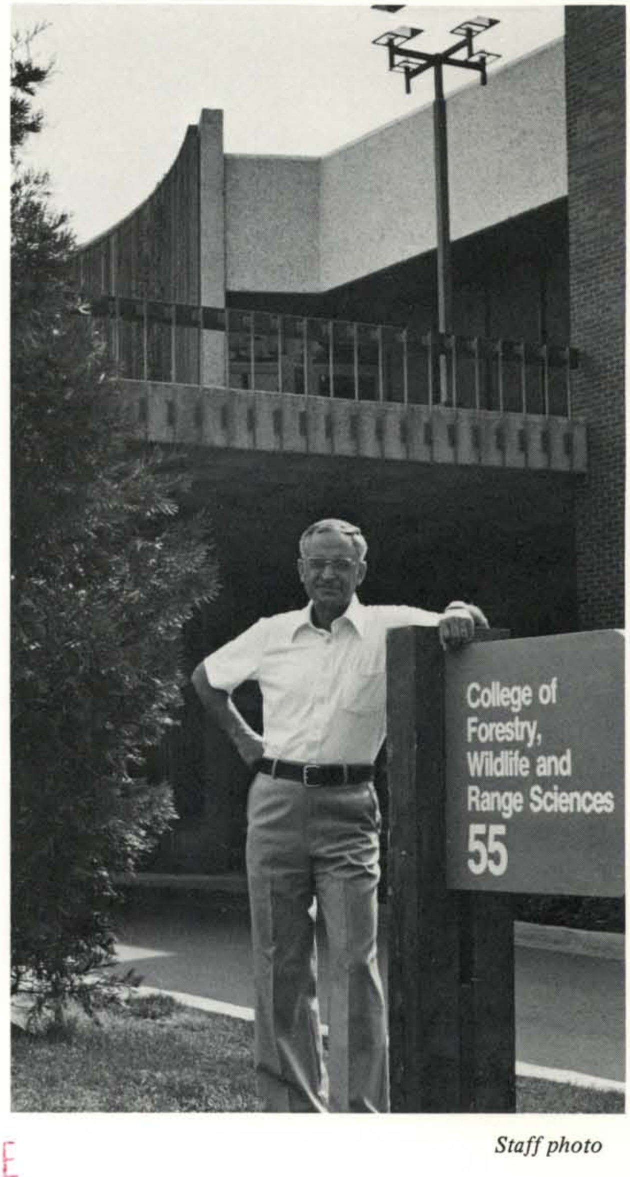
Several other studies in this issue address pressing problems facing our fisheries. For example, increased land management activities, as well as natural processes, are creating varying amounts of siltation in fish spawning grounds. How much siltation can fish tolerate before unacceptable reductions in productivity occur? What important behavioral changes take shape with increasing siltation? The project noted on page 2 addresses these questions. When stocked fry in streams have a less than 10-percent survival rate, the question of possible predation becomes paramount. This is particularly true in streams without vegetative cover affording little or no protection for young fish. The project described on page 5 provides some answers important to proper stream management.

What has happened to our famous Snake River sturgeon? Are their numbers declining as their habitat has changed? If you are concerned about these questions, a sturgeon inventory is described on page 4. Over a 3-year period, some 876 sturgeon were captured. Necessary data were collected, the fish tagged, then released. Results show that small sturgeon are holding their own as long as a catch-and-release program prohibits fish takes.

An important element of our fisheries program is our aquaculture research. Some 35 million pounds of fish are produced in Idaho under intensive fish cultural arrangements. The Forest, Wildlife and Range Experiment Station has a continuing program relating to water management, fish diseases and nutrition. In this issue, pollution-water management questions are discussed. Aquaculture is gaining attention as a viable source of edible protein. Our program is moving forward to meet this challenge.

Timber Management and Economics

In meeting our timber needs, grand fir is one of the most important species to be considered in northern Idaho. This species often begins growth in the forest understory and occurs over a wide range of ecological conditions. Substantial inventories of this species now exist in various age classes. The management of advanced regeneration in



Staff photo

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FOREST, WILDLIFE AND RANGE
EXPERIMENT STATION

John H. Ehrenreich, Director
Ali A. Moslemi, Associate Director

Susan R. Hieb, Editor
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Cover: Studying white sturgeon in the Hells Canyon sections of the Snake River took fisheries researchers into turbulent water. Jetboats aided in the collection of data on sturgeon growth, abundance, distribution and movements. *Rudy R. Ringe photo*

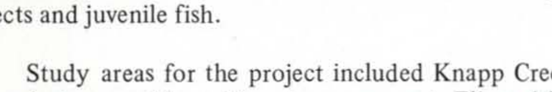
University of Idaho

Fisheries Resources

SEDIMENT AFFECTS FISH, AQUATIC INSECT HABITATS

Coarse sand from granitic base rock in the central Idaho batholith is carried each year into the streams where chinook salmon and steelhead trout are spawned and reared. In 1972, researchers began a study to determine the amounts of fine sediment in streams that are harmful to aquatic insects and juvenile fish.

Study areas for the project included Knapp Creek, a natural stream with rapid water movement; Elk and Bearskin creeks, which meander through wide valleys; and artificial channels at Hayden Creek Research Station. Records were kept of spring snowmelt runoff and summer low-flow periods for 2 years, to determine the applicability of a predictive equation for estimating sediment transport in streams of Idaho's Salmon River drainage.



Fine sediment, defined as particles less than 6 mm in diameter, was found in concentrations of 20 to 75 percent in most streams, through core sampling techniques. Juvenile fish, which hide among cobbles and small rocks in a stream, were affected when the spaces in the substrate were filled with coarse sand. As suitable habitats for both fish and aquatic insects were reduced, the abundance of insects and fish declined.

During the summer months with low flows, little sediment was carried by the streams. Natural streams with large amounts of sediment were found to have fewer aquatic insects, but fish density and size were equal to those in streams with smaller amounts of sediment. When sediment was added to stream pools, fish abundance decreased in proportion to the decrease in pool area. Drift insect abundance did not decrease when sediment was added to laboratory riffles or small sections of a stream.

With maximum stream discharge in 1974, the researchers measured the rates at which transportable sediment was carried by water in the study streams. Transportable sediment was defined as sediment above the protective armor layer of the stream, and was in most cases cleansed from the streams by the runoff.

In studies of insect drift in natural streams which were left alone or artificially cleaned of sediment, the researchers found greater densities of insects in the cleaned segments. Larvae and riffle beetles, which had burrowing habits, were more abundant in the uncleaned sections. Cobbles or coarsely sedimented areas where fine sediment had been cleaned away supported high levels of aquatic insects in the larval and nymphal stages. In Knapp Creek, where water velocity was sufficient to displace fine sediment, colonization by insects took place immediately after the addition of sediment.

Using the laboratory channels, the researchers monitored fish that stayed in unsedimented channels, and in those with varying degrees of sediment. In general, they found that increasing amounts of sediment reduced the number of fish that would remain in the channel, because hiding places among the rocks were silted in, and pools became more shallow. Fish settled quickly into unsedimented habitats and selected territories. During a 35-day test period, fish grew longer and heavier in the unsedimented channel than in the sedimented one.

Sediment which is carried into the mountain valleys in the 16,000 square mile batholith area comes from steep, relatively unstable slopes. The research did not indicate the amount of sediment caused by construction and maintenance of roads or by grazing.

The project was a cooperative effort of the Forest, Wildlife and Range Experiment Station and the Idaho Water Resources Research Institute. It was supported by funds from the Office of Water Research and Technology, the U.S. Fish and Wildlife Service, the University of Idaho and the Idaho Department of Fish and Game.

T.C. Bjornn, Idaho Cooperative Fishery Research Unit leader, was the principal investigator. M.A. Brusven, Entomology; M. Molnau, Agricultural Engineering and J. Milligan, Civil Engineering, were co-principal investigators. Graduate researchers were R. Klamt, of Fisheries Resources; E. Chacho, Civil Engineering; and C. Schaye, Entomology.

Cooperative Fishery Research Unit

Salmonids returning from the ocean to spawn will soon include large percentages of hatchery raised fish. A successful hatchery program is needed to maintain fish runs because of losses that take place at dams along the migration route.

HATCHERY RAISED FISH MAINTAIN STEELHEAD RUNS

Concern over the quality of juvenile steelhead trout raised at the Dworshak National Fish Hatchery has prompted an evaluation of the hatchery raised fish. Personnel of the Idaho Cooperative Fishery Research Unit are engaged in the project, under contract with the U.S. Fish and Wildlife Service.

Before Dworshak Dam was built in 1969, steelhead trout produced in the North Fork of the Clearwater River began their downstream migration and made the transition from living in fresh water, as parr, to silvery-colored smolt able to live in the ocean, according to an inner time schedule. Dworshak National Fish Hatchery, one of two large steelhead hatcheries in the state, now produces the young steelhead needed to perpetuate the run of fish from the Clearwater's North Fork.

Artificially rearing the fish brings a new set of problems. The fish are raised from eggs taken in April and May from returning spawners. Hatchery raised fish must be ready to migrate seaward by the following April, or must be kept an additional year. Wild fish normally leave their Clearwater drainage rearing areas at 2 to 3 years of age, spend 1 or 2 years in the ocean, then return to spawn between the ages of 4 to 6 years. Increasing the water temperature can speed the growth of the young fish, but water too warm may retard the transition from parr to smolt at migration time, according to Professor T.C. Bjornn. If they are ready to migrate on release, the fish move downstream past Lower Granite and other dams, or are collected in facilities operated by the Corps of Engineers and National Marine Fisheries Service.

In 1976 and 1977, a fisheries team under the leadership of Bjornn, Research Associate Rudy R. Ringe and biologist Phil Hiebert, marked 28 different groups of juvenile fish with a cold brand, or a magnetic nose tag and clipped upper fin before releasing them. A sample of fish migrating downstream were recovered at Lower Granite Dam. At that point the fish were checked for general health and marks.

Dworshak Hatchery is producing about 2 million smolts per year, which is more than the wild production of the Clearwater. Survival of the hatchery raised fish from smolt to returning adult has been variable, ranging from 1.1 to 1.0 percent. Investigators have determined that a length of 200 mm (8 inches) is the optimum size at which to release the hatchery reared fish.

Because of losses that take place at dams along the migration route, a successful hatchery program is necessary to maintain steelhead runs. Data from Dworshak Hatchery will aid in the planning of other large hatcheries to be built in Idaho during the next 10 years.

DAMS BRING CHANGE FOR WHITE STURGEON

White sturgeon, the largest freshwater fish in North America, once swam the waters of the Columbia and Snake rivers to the ocean, ranging as far as 100 miles. Today, with dams across the rivers, the life patterns of the sturgeon have been altered.

To discover the effect of the restrictions on sturgeon movement in the rivers, the Idaho Cooperative Fishery Research Unit launched a study of the abundance, growth, distribution and movements of white sturgeon in the Hells Canyon sections of the Snake River in 1972. Daily flow and discharge from Hells Canyon Dam created river level fluctuations of more than 2 feet during the study period. Lower Granite Dam on the Lower Snake River in Washington was completed and filled near the end of the study. Applications pending for more dams in the Hells Canyon portion of the Snake have not been approved. With the inclusion of part of the Hells Canyon area in the wild and scenic rivers system, further dam construction on the Snake must be approved by Congress.

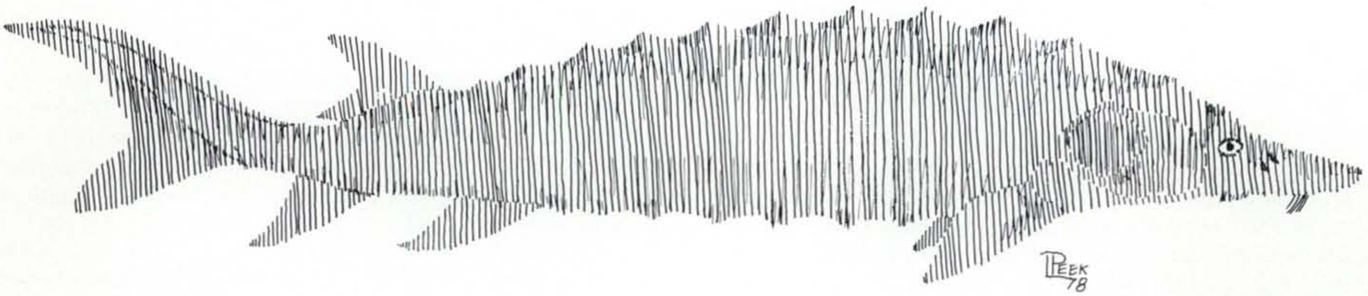
Graduate student John C. Coon and Research Associate Rudy R. Ringe worked on the project under the direction of Fisheries Professor Ted C. Bjornn, capturing 876 sturgeon, then tagging, measuring and releasing them between 1972 and 1975. Of these, 204 were later recaptured, providing information on growth and movements in the river. Sturgeon under 3 feet in length accounted for 86 percent of those caught, with 3-to 6-foot sturgeon making up 4 percent, the smallest number in the survey. Sturgeon over 6 feet in length made up 10 percent of the sample. In the 138 miles of open water researchers estimated a population of 7,000 to 10,500 fish in the 45 to 92 cm (18 to 36 inch) range, 500 fish 91.5 to 183.5 cm (3 to 6 ft), and 700 to 1,000 fish larger than 183 cm (> 6 ft).

Primary holding habitat for the sturgeon was in deep pools between rapids. Small sturgeon preferred big sandy-bottomed holes in the downstream section of the river. The middle Snake River downstream from the Hells Canyon Dam flows through the deepest gorge in North America. Middle-sized and large fish, which were better able to swim in turbulent water, were found near rapids in the canyon.

Researchers fitted 10 sturgeon with transmitters before the filling of the reservoir behind Lower Granite Dam. Of those fitted, nine moved upstream after impoundment. After 4 months, most had been tracked to an area 38.9 km (24.18 miles) above the dam, where there is considerable current, showing a preference for river rather than reservoir environment.

Small sturgeon were relatively abundant in the river but researchers found that sturgeon in the 60 to 75 cm range (23.6 to 29.5 inch) tended to move downstream, probably past some dams. Sturgeon are rarely found in the fish ladders at the dams, and probably do not return to the middle Snake once they have moved downstream past a dam.

The small population of residual fish has exhibited a slower growth rate than occurred before impoundments were formed in the canyon. Three reservoirs at the upper end of Hells Canyon have eliminated large salmonid and lamprey runs, a factor which researchers fear will reduce available food for the sturgeon population. Sturgeon do well with the catch-and-release angler program, which prohibits keeping the fish once they are caught. Maintaining a stable population of sturgeon, though smaller fish, in the middle Snake River appears possible.



FISHERIES PROGRAM HISTORY RECOUNTED

Fisheries Management at the University of Idaho began with the arrival of Virgil S. Pratt in 1950. At that time the fisheries option was associated with the Wildlife Cooperative Research Unit headed by Paul Dalke, now retired as professor emeritus.

Dr. Pratt engineered the fisheries program with energy and enthusiasm, designing a basic curriculum which in depth and breadth was superior to that in some larger and older institutions. The basic courses that were originally required of fisheries students still constitute the program's core with little change.

Initially, only a few students enrolled in the fisheries management option; six students graduated between 1953 and 1957. Fisheries broadened the course offerings in the college and provided supporting courses for students in wildlife and other areas. Disciplines across campus also benefited. A total of four master's students earned their degrees with Dr. Pratt as their advisor and major professor. Following his death in 1957, the Coeur d'Alene Wildlife Federation honored his memory by donating a work of art to the college.

The fisheries program received impetus from the establishment of the Idaho Cooperative Fishery Research Unit at the college in 1963. The Unit was obtained at the request of the university administration and Craig MacPhee, who succeeded Dr. Pratt in 1957.

The Unit was funded jointly by the U.S. Fish and Wildlife Service, the Idaho Department of Fish and Game and the University of Idaho. Donald W. Chapman was the first leader, with Robert Thompson as assistant leader. Theodore C. Bjornn joined the Unit in 1966 as assistant leader, becoming leader in 1973. Robert White became assistant leader in 1974. Unit personnel engage in teaching, research and service and have professorial ranks and other University faculty privileges.

An expansion in undergraduate and graduate level teaching as well as research followed the increase in fisheries faculty.

Problems concerned with reservoirs on the lower Snake River were anticipated. In 1968 C. Michael Falter joined the staff to research the effects of impoundment on steelhead migration in the Snake River. Since then he has spearheaded many projects concerned with water quality and limnology and now teaches in these subject areas. In 1972 William Klontz contributed his expertise in aquaculture and fish disease to the fisheries program. David Bennett arrived as a warmwater fish ecologist in 1975. Presently, we have two visiting scientists on the fisheries team. A. Jim Chacko, a specialist in fish culture and limnology, and Khiet Van Lai, who has had considerable training in fish culture in Japan. Rudy Ringe and James Leonard are Research Associates with the program.

Since its inception the Fisheries Resources program has graduated about 168 students with the B.S. degree, 51 students with the M.S. degree and 19 students with the Ph.D. degree. Many students who major in other fields take supporting courses in fisheries.

Cooperating agencies in research include the U.S. Fish and Wildlife Service, the National Marine Fishery Service, the U.S. Corps of Engineers, the Environmental Protection Agency, and the Idaho Department of Fish and Game. Fisheries personnel have taken their research as far as Alaska and the African continent. Outside funds provide work experience for undergraduate students and fellowships and professional training for graduate students.

Research projects keep the fisheries staff in tune with current developments and provide a wealth of experience to pass on to students in the classroom.

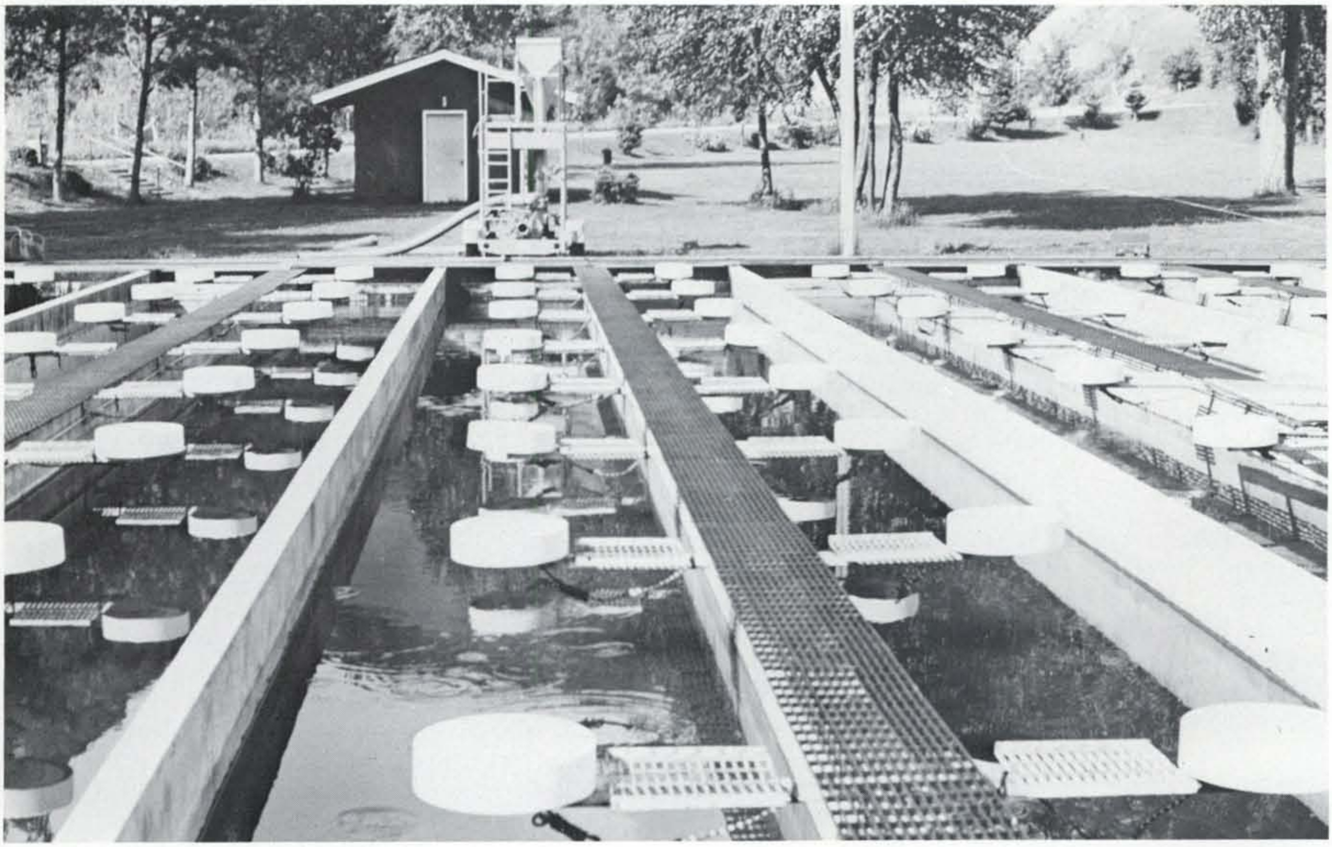
Construction of the forestry building in 1971 provided a light and temperature controlled laboratory facility for growing and experimenting with live fish. Much of the laboratory research involves fish diets, behavior, the effect of sedimentation on egg and fry development and survival and fish bioassay work of various kinds.

PREDATOR FISH KEEP FRY SURVIVAL LOW

Raising fish to stock streams and achieving an increased fish density through stocking, are two different matters, as fishery managers have found out. While fertile streams in the central Idaho area near the Continental Divide have had a first summer fry survival record of 5 to 10 percent, less fertile streams, without vegetative cover, have had such low survival rates, that most are no longer stocked with fry. Graduate researcher Ned Horner and Idaho Cooperative Fishery Research Unit Leader Ted Bjornn began a study in 1975 to determine the role of predation by various fish species in the loss of fry each summer. Cutthroat trout fry were released during the summer of 1975 with the normal predator population present, in Big Springs and Bear Valley creeks–representative fertile, and infertile streams, respectively. About 10 percent of the introduced 1-inch fry survived.

During the summers of 1976 and 1977, large predator fish were removed from the streams before the fry were released. Fry survival rate for both years jumped to about 25 percent. As a part of the study, the behavior of different fry species was evaluated. Steelhead trout and chinook salmon fry were less susceptible to predation than the smaller cutthroat trout. Swimming ability is related to size, and the larger steelhead and chinook fry were able to escape from predators more successfully. Fry tended to head for still pools or vegetative cover, which afforded protection. Fish which were caught in rapidly moving water were often swept away, as they were not large or strong enough to swim against the current.

Observation of predator fish by snorkelling, and examination of the stomach contents showed that some fish were more active as predators. Dolly Varden proved to be the most active predator, followed by brook trout. Rainbow trout and sculpins were also found to have eaten fry, by examination of their stomach contents. Rainbow trout fed actively on the fry only at the time of release, while sculpins were never seen eating the fry.



G. W. Klontz

Mechanical continuous feeders at the Rapid River Salmon Hatchery, Idaho Department of Fish and Game, distribute small amounts of feed at frequent intervals. Matching the habits of fish, this method is less wasteful than one or two large feedings per day.

PROPOSED LIMITS CAUSE PROBLEMS FOR FISHERIES MANAGEMENT

Abatement or reduction of pollutants in ground waters and streams is currently a national priority. The Environmental Protection Agency issued proposed guidelines for effluent limitations in 1974. Permits based on these guidelines have been issued for the past two years.

Although the initial discharge limits for ammonia-nitrogen and solids (both suspended and settleable) were not too restrictive, the limits proposed for the period beginning 1 July 1977 require extensive modification of current fish culture practices at most fish hatcheries and farms. The proposed limits were derived largely from data gathered empirically and are unrealistic in the opinions of many. Current fish culture methodology cannot predict the time at which the limits will be exceeded in a given situation, according to Fisheries Resources Professor George W. Klontz. "In other words, an individual will not know he has exceeded the permitted discharge limitations until he has done so."

Dr. Klontz explained that while fish are nonconsumptive users of water, they do alter the water where they live. The more important biological alterations include: 1) increased nitrogenous compounds, i.e., ammonia-nitrogen, nitrite-nitrogen, and nitrate-nitrogen; 2) increased carbon dioxide and phosphates; 3) increased solids–both suspended and settleable; 4) decreased oxygen; and 5) increased biological oxygen demand (BOD) in an aquatic system.

Three studies have been published of the amounts of waste products generated daily by fish. While each method applied individually seems feasible to use, when all three are applied to the same system, a significant difference among values obtained for each waste product occurs. Further, the methods take into account only the quantity and not the metabolic quality of the diet.

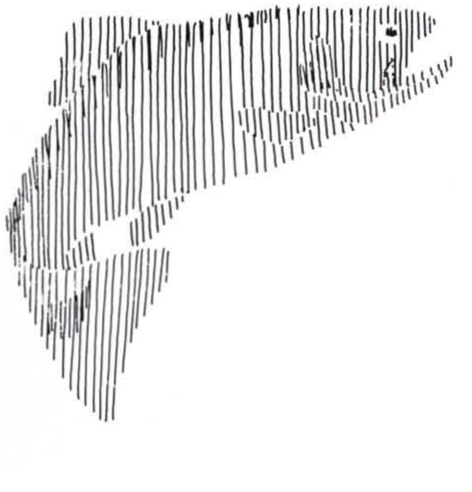
The generation of waste products in an aquaculture facility consists of a complex series of interactions among fish, nutrition, water and management. Simplistically, the fish-nutrition interactions would seem to be the most important, but they are modified drastically by those with and among the other components.

Fisheries researchers at the University of Idaho are engaged in two in-depth projects to describe the pollution production parameters. A simple formula cannot be set down to cover all fish. Fish-related variables are size, species and growth rate. Smaller fish require more oxygen and have a higher metabolic rate than large fish. To equate the amount of food fed to a fish and its resultant weight gain is difficult because a smaller fish will put on more body weight per pound of feed than a larger fish. Nutritional and space requirements also vary among species. Growth weights of fish in commercial or conservation hatcheries differ with regard to growth objectives, e.g., whether the fish are being fed to achieve optimal or normal growth rates.

Nutritionally, the amount of food introduced into hatchery waters, the amount eaten that is converted to salmonid weight gain, and the amount used as energy rather than returned to the water influence the amount of waste generated through the feeding process. How efficiently the feed is used by fish affects the waste load in discharge waters, making estimation difficult. Ideal conversions of feed to poundage often differ from actual utilization. Water temperature, too, affects growth. The metabolic rate for salmonids decreases 5 percent for each degree drop below the preferred water temperature, and the amount of dissolved oxygen in the water changes with both temperature and altitude.

Not only the food, but also the method and frequency of feeding influence the performance of the fish. Frequent feeding wastes less feed than one or two daily feedings. Hand feeding is the least wasteful and the most accurate, but the most costly from a labor standpoint. Mechanical feeders or blowers also have favorable and/or unfavorable qualities. Uneaten feed adds directly to the solid stream discharge waste, and increases the cost of raising fish.

Cleaning the ponds increases the fish carrying capacity by removing sediment. Any fish-disruptive process, known as "working the fish," creates a potential health hazard for the fish, and needs to be undertaken weighing the benefits and effects.



RESEARCHERS TO ASSESS STREAM FLOW NEEDS FOR FISH

Stream systems are declining in quality and extent at a rapid rate in proportion to man's development of water resources for domestic, industrial and irrigation uses and may decline at more rapid rates under proposed energy development programs. Existing and proposed water resource development projects in the western United States will ultimately result in the removal of substantial portions of stream flows during all or portions of the year.

Water resource development entails the modification of a natural hydrologic system to meet man's needs. Changes to be expected as the result of altering water flow within a stream are complex. This complexity is primarily due to the many interactions which may occur both within the stream environment and external to it.

Biologists and managers are under increasing pressure to provide information on the amount of water needed to meet the ecological requirements of fish species and potential loss in terms of fish production, numbers or biomass at various increments of reduced discharge. However, at the present level of knowledge, the effects of reduced discharge upon natural self-sustaining fish populations are poorly understood. The amount of stream flow which can safely be removed without drastically altering the aquatic ecosystem must be determined.

To provide needed information on fauna-discharge relationships, development of a research program addressing instream flow needs of fish and invertebrates was initiated in 1975. Efforts to procure funds for this research culminated in 1977 with two studies being funded by the Office of Water Research and Technology. One study will evaluate effects of reduced stream flow on incubation of salmonid eggs, while the other will focus on response of fish and macroinvertebrate populations to incremental reductions in stream flow. Both studies will utilize a combination laboratory-field approach. Results of these studies will provide legislators and state and federal fisheries management agencies with information which can be used in determining what stream flows should be maintained for optimal fish production, and what will be lost with decreases in discharge. These studies will also serve as the basis for a long-term research effort into instream flow problems.

Fisheries Resources Assistant Professor Robert G. White and graduate researcher Dudley W. Reiser are investigators for the first project. White is joined on the second project by Civil Engineering Associate Professor James H. Milligan, as co-principal investigator, and by Fisheries Resources graduate researchers Allen Bingham, Robert Ruediger and Thomas Vogel.

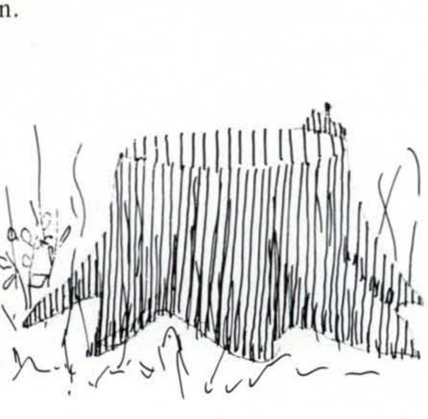
Wildland Recreation Management

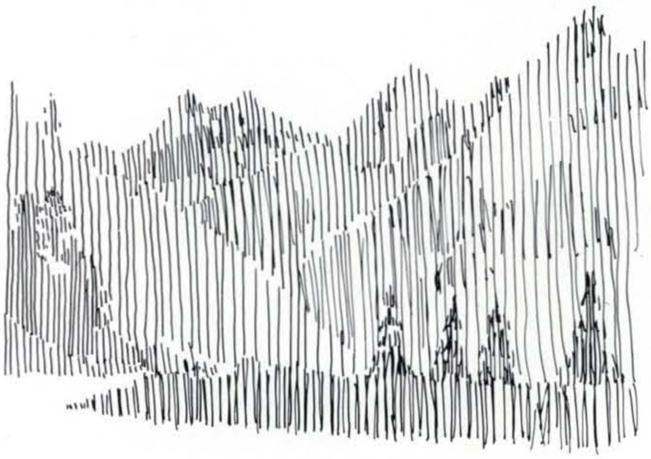
MODEL COMBINES DATA TO PREDICT RECREATION BEHAVIOR

What motivates people to seek and participate in recreation? What expectations do recreationists hold and how do these influence their behaviors? What benefits do people receive from recreation experiences? What is a satisfying recreation experience? These are basic questions that have been asked by recreation researchers for decades. But the research approaches taken to answer these questions have often been atheoretical and isolated from other works. Lately, many researchers have called for the application of social psychological models to problems in recreation.

Wildland Recreation Management Assistant Professor John H. Schomaker and graduate researcher David Cockrell are making an effort to answer this call. They are systematically applying a social psychological model developed by Martin Fishbein and Icek Ajzen to problems in recreation. This model is well grounded in the expectancy theory approach to human motivation and has been applied to practical problems in other fields. The model uses data concerning beliefs, attitudes, and intentions in a precise formulation to predict behavior. An extension of the model suggests methods for changing behavior through persuasive communications.

The applications of the Fishbein and Ajzen model to management situations are numerous. By specifying the determinants of a behavioral intention, the model can offer insights into who participates in what activities and why. Some of these determinants of participation are subject to management control. The model may also offer clarification of the elements of a "quality recreation experience" and help us to understand what constitutes satisfaction.





The first task in utilization of this model is its application to previous social psychological research findings in recreation. This stage is presently underway. Issues under investigation from the Fishbein and Ajzen approach include studies of satisfaction in recreation, motivation and benefits of participation in recreation activities, substitutability of recreation experiences, and the dynamics of social groups in leisure activities. This effort will result in a theoretical paper to be completed early in 1978.

A second stage of the project will test the model through an examination of the variables in a recreation field setting. This empirical research was begun during the summer of 1977 by Stacy Young, an undergraduate researcher supported by a grant from the University of Idaho Wilderness Research Center. Her exploratory study assessed the wilderness users' beliefs about various aspects of wilderness. This work will be extended during the summer of 1978 as the complete model is tested.

The project, supported by McIntire-Stennis funds, should serve two valuable purposes, offering recreation professionals insights into the dynamics of recreation behavior and providing integrated concepts for recreation researchers. It is hoped that the model will help to explain previous research findings, aid in the planning and management of quality recreation experiences, and generate new hypotheses from a coherent framework.

Wildlife Resources

WILDLIFE SURVEY SHOWS DEER, ELK, WOODPECKER USE

A wildlife land habitat inventory conducted on Bureau of Land Management holdings north of St. Maries in 1977 provides the first mapping of the area according to wildlife use, and offers direction for its management.

The study was conducted by a research team from the College of Forestry, Wildlife and Range Sciences, under a cooperative agreement with the Bureau of Land Management and the U.S. Fish and Wildlife Service. Wildlife Resources researcher Jeffrey A. Keay and Assistant Professor Edward O. Garton were principal investigators.

Elk and deer use were monitored on 1142 stands in the rugged Rochat Peak study area between the Coeur d'Alene and St. Joe rivers in northern Idaho. The area is characterized by sharp ridges and deep V-shaped valleys, with heavy winter snowfall in the mountains. The stands, broken into 13 inventory areas, were delineated on aerial photographs in planning the project.

The area is still recovering from serious fire damage in the early 1900s. Seral shrub communities exist in many areas 60 years after fire disturbance. Mature timber was found on 57 percent of the sites, and shrub fields on 24 percent. Grand fir/pachistima habitat was located on 30 percent of the stands, Douglas-fir/ninebark on 25 percent, and mountain hemlock/beargrass on 24 percent.

The land supports big game summer range, spring green-up areas for early feeding, and one large tract of high quality elk and deer winter habitat. Several stands were identified which may be important for calving and rut. Nine of 13 inventory areas had snags in the size range preferred by the pileated woodpecker. Other woodpeckers, hawks and owls, are cavity nesting species which also make use of snags.

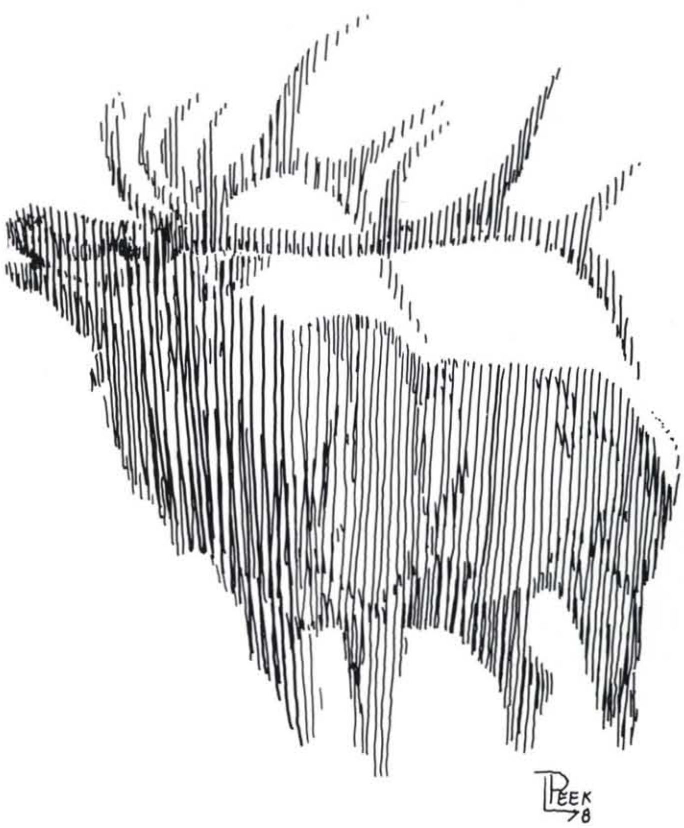
The Federal Land Policy and Management Act of 1976 directed the Bureau of Land Management to manage public lands under its control in accord with multiple land use. With surrounding land heavily influenced by the economic market, researchers noted that the Bureau's holdings have high potential as wildlife refuge.

DIET LAB FACILITATES FOOD HABITS ANALYSIS ON ANTELOPE

Knowledge of the food habits of a species is one of the most important, and difficult, kinds of information that a wildlife biologist needs to collect. Traditional methods necessitate killing animals for stomach content analysis.

Use of an alternative technique, analysis of fecal material, is now possible through the Range Resources' new Dietary Analytical Lab. Technician Wayne Kasworm identifies food items consumed by big game and domestic livestock by means of microscopic examination of food materials surviving the digestive process. Plant materials can be identified to species by virtue of characteristic cell shapes and arrangements, microscopic hairlike structures, and other features.

Before this microhistological technique can be applied to a given animal species, it must be validated by



running checks with the standard stomach-analysis techniques. This standardization process corrects for any differential digestion that has occurred on consumed food items. These relationships have been worked out for cattle, deer, elk, bighorn sheep, some game birds, and several other species. Wildlife Resources Assistant Professor Winifred Kessler is comparing rumen and fecal samples of pronghorn antelope, with the aim of validating fecal analysis for the species.

The advantages of the technique to future pronghorn research should be clear:

- Food habits can be studied without killing or otherwise disturbing the animals in their natural setting;
- Sample sizes can be greatly increased;
- The food habits of entire populations, rather than of just a few selected individuals, can be studied; and
- The investigation can be conducted continuously over an indefinite time period.

TAGGED OTTER TRACKED IN WEST-CENTRAL IDAHO

Setting out to discover more about the river otter led graduate researcher Wayne Melquist and Cooperative Wildlife Research Unit Leader Maurice Hornocker into west-central Idaho in 1977. The river otter is being considered for threatened or endangered status by the U.S. Secretary of the Interior, and information from basic investigations is critical for sound decision making and the management of wild species. The study area for the project included the North Fork Payette River, from its origin to Cascade Reservoir, and Lake Fork Creek from Brown's Pond to the reservoir. River otter food habits, movement, social organization, condition, and population density were examined during the course of the study. Data were collected from visual observations and radiotracking on foraging, feeding, grooming, socializing, traveling, playing, resting, and searching for other members of the group.

Eighteen otter were captured or recaptured by trapping, mostly during late spring, summer and fall. A total of 13 otter were tagged with external radio collars. A radio was surgically implanted in one juvenile male otter. While some tagged otter spent extended periods at one location, two others were tracked from the Payette River drainage to the Salmon River drainage, and to Lake Fork Creek, distances of 31 km and 35 km, respectively.

A variety of den sites were used by the tagged otter, including beaver dens, houses and tunnels, rock talus along lakes and streams, and road rip-rap (rock fill). Certain sites were used more frequently than others, and some by several different animals. One female used 11 different sites, but only 5 of these more than once. An old beaver tunnel was used by six otter, often concurrently.

Otter scats were collected and analyzed to determine food habits and predator-prey relationships. Partial analysis indicated a correlation of prey items in the diet with presence and abundance of prey species.

Simultaneous radiotracking of different age, sex and social groups provided information on the social organization of the river otter. Frequent observations of adult and subadult males and females and family groups in the same area suggest that these animals have a high degree of tolerance for each other. During the nonbreeding period there was no evidence of territoriality. Mutual avoidance of adults of the same sex did not appear to exist.

Radiotracking, the occurrence of sign, and visual observations provided evidence that otter use portions of their range on a seasonal basis. During the winter, otter spent very little time in sections of the lakes and streams that were ice-covered. At other times of the year, their presence in certain portions of the study area appeared to be related to prey abundance and availability. During 1977, researchers estimated a minimum of 15 otter on Payette River, or one otter for every 3.6 km of waterway. On Lake Fork Creek, they estimated a minimum of 11 otter, or one for every 2.6 km of waterway.

The otter population within the study area appeared healthy. Although factors regulating the population density are not entirely understood, protection given the river otter through a statewide closure of trapping in 1972 has probably contributed to their numbers.

SNAG STUDY PINPOINTS WILDLIFE HABITAT TREES

Snags on forested lands have become increasingly important in the past few years. Baseline studies indicate many hole-nesting species of birds rely solely on snags for their livelihood. For this reason many believe all snags should be left standing. However, fire policy, safety procedures, firewood cutters and the timber industry require the felling of many snags. With these conflicting interests it is necessary to determine the value of snags before management plans can be developed. The USDA Forest Service has implemented snag management plans for many of its districts.

At present transects are being run to ascertain the number of snags and volume of dead standing material on the University of Idaho Experimental Forest, north of Moscow, Idaho. The area is characteristic of much of northern Idaho and results from the study could easily be applied elsewhere in the state. Information gained from these transects includes a survey of snag use by wildlife. Some snags appear especially important to woodpeckers and other hole-nesting birds, while others receive little or no wildlife use. Non-essential snags could be removed without any adverse effect on wildlife populations. Some snags which offer sound merchantable wood can be used by the wood products industry. Good woodpecker habitat is necessary to forest maintenance. Woodpeckers consume large numbers of forest insects, some of which are harmful to growing trees.

Information gained from this study will aid in the development of a sound management plan for snags on the University of Idaho Experimental Forest and other similar areas and set guidelines for interested private landholders. Wildlife Resources graduate researcher Gordon D. Bunch and Associate Professor Steven R. Peterson are the principal investigators.

BOBCAT NUMBERS DECLINE IN ACCESSIBLE AREAS

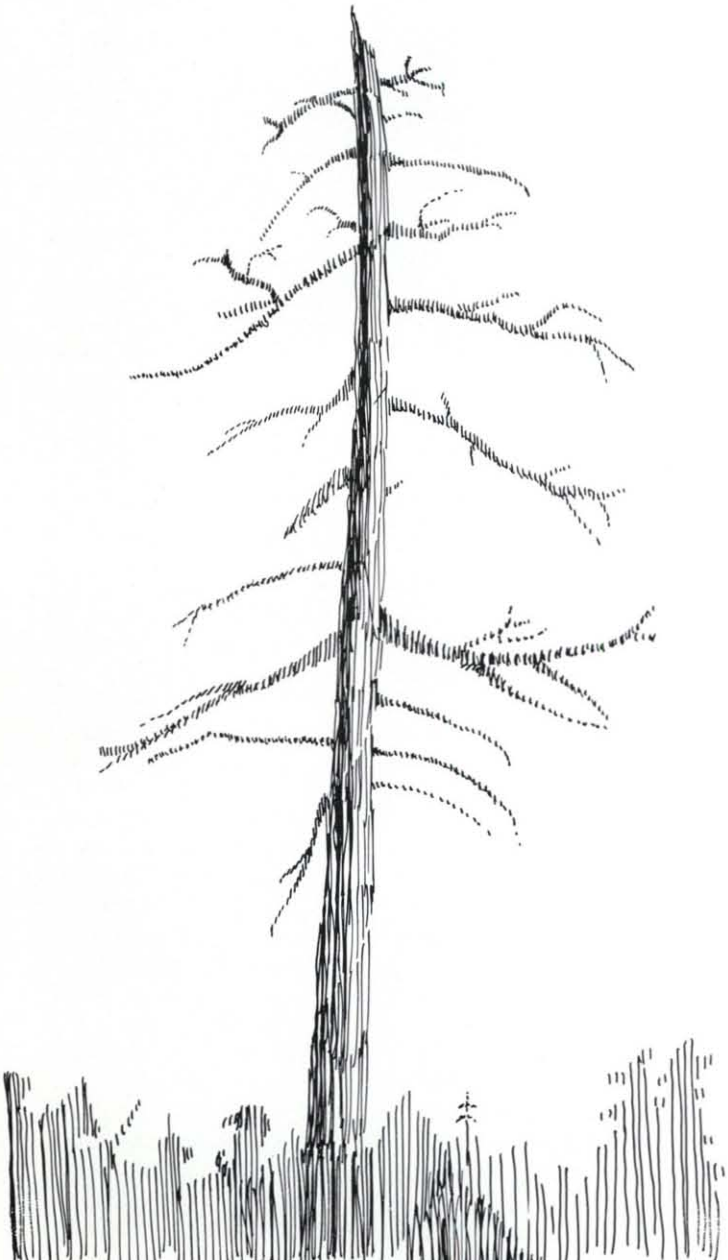
Combining the mailed questionnaire and personal interview techniques to gather information on bobcat harvests, changes in bobcat abundance and opinions on possible management regulations, Wildlife Resources Professor Ernest D. Ables and graduate researcher Donna Rounds covered many parts of Idaho during the summer of 1977. During their interviews with 48 trappers and houndsmen, and 9 game biologists and conservation officers, the researchers obtained detailed information on the status of local bobcat populations. According to those interviewed, bobcats have declined in numbers throughout Idaho in areas accessible to trappers and houndsmen. Some felt the population has been severely reduced, usually citing trapping and hunting pressure as responsible. A decline in rabbits, ground-nesting birds and other bobcat prey species populations were also considered a factor by many. The decline

in prey populations coincided with the increase in the value of the bobcat pelt. The researchers also contacted 28 fur-dealers to determine the volume of pelts handled during 1976 and 1977.

A planned survey of bobcat dens was limited by known whereabouts of dens. Nine dens located by Theodore Bailey, wildlife biologist, during a study of bobcat social organization on the Idaho National Engineering Laboratory in southern Idaho, were visited in June and again in August. No signs of occupancy were found on either visit. Researchers believe that scarcity of prey is responsible. The rabbit population declined sharply in 1971, and is just beginning to recover, according to security personnel at the site.

Although the study is not yet complete, it has already contributed to the management of bobcats in Idaho. Information derived from questionnaires and interviews and sent to the Idaho Department of Fish and Game was later used to formulate regulations for the 1977-1978 trapping season. From the 527 questionnaires first returned, 380 respondents agreed that there was a need to limit the take of bobcats, 88 disagreed, and 59 were neutral. Management suggestions made during the interviews ranged from a trapping season with no other restrictions, to statewide closure until the bobcat returns to former population levels.

Forest Products



PHYSICAL PROPERTIES COMPARED FOR LIVE, DEAD WHITE PINE

Physical properties of live and dead western white pine were compared on 12 areas in northern Idaho by Forest Products graduate researcher Glenn L. Gernert and Associate Professor Arland D. Hofstrand.

Dead standing, dead down, and live western white pine were sampled in specific gravity and shrinkage tests. Measurements for each physical property were analyzed statistically using the analysis of covariance. The researchers used moisture content and specific gravity variables in testing shrinkage, and moisture content alone in testing specific gravity.

Although significant differences were recorded among findings on different sample areas, no significant difference at the 5 percent level was observed between means of dead standing, dead down or live trees for shrinkage or specific gravity. Moisture content means were calculated at 42, 33 and 73 percent, respectively, for the three categories.

DEAD WHITE PINE MAY BE PROFITABLE

The dead white pine utilization project conducted by Kjell A. Christophersen and John P. Howe is now in its second phase, which emphasizes economic feasibility. As dead white pine deteriorates, volume and quality grade suffer for conventional uses. It was hypothesized that the characteristics which degrade the quality of conventional lumber would enhance the value of the speciality products manufactured from it. In short, it is possible to capitalize on the presence of defects and turn them into profitable products such as interior panelling, cabinetry, picture framing, and furniture. A cursory survey of the markets for such products indicates a large potential. Only a few producers are making specialty products out of distressed wood, primarily ponderosa pine and lodgepole pine, and their returns are high. No similar processing of dead white pine has been detected.

The economic feasibility portion of the study will include the identification of each production step from raw material to distribution of the final product with corresponding cost and benefit measurements. Each step will be analyzed separately and collectively to determine optimal economic production sequencing and level of capitalization. Christophersen and Howe are Assistant Professor and Professor, respectively, of Wood Products.

M. Hironaka

Vast acres of sagebrush in the Intermountain west often are burned when rangeland is cleared for reseeding or cultivation. *Artemisia tridentata* ssp. *wyomingensis,* the most common sagebrush on dry rangelands, was harvested, chipped, and processed into paper using the kraft process.

CHIPPED SAGEBRUSH YIELDS PAPER PULP

Much of the rangeland in the Intermountain Region of the west is covered with sagebrush, which is usually burned when rangeland is cleared for cultivation or for range reseeding. Forest Products Professor John P. Howe and Chemical Engineering Professor Andrew J. Chase of the University of Maine initiated a project to determine the technical feasibility of making paper from sagebrush.

A sample of Wyoming big sagebrush, *Artemisia tridentata,* subspecies *wyomingensis,* was harvested south of Boise, Idaho, in Ada County on the Snake River Plain. This subspecies was chosen because it is the most common type of sagebrush to be found on the drier rangelands of the Intermountain Region.

The sample consisted of "above ground" components of the sagebrush and included leaves that remained on the plants after shipment to the laboratory.

The sagebrush was "chipped," using a drum chipper. The material was then winnowed to remove dirt which had been embedded in the bark and very fine particles of bark and wood formed in the chipping operation. The remaining material, probably 99 percent of the sagebrush as received, was sufficient for two pulpings by the kraft process.

Cook no. 1 used conditions of chemical to wood ratio and cooking time less severe than would be common for pulping of conventional hardwood chips. It was thought that the open structure and small average particle size of the sagebrush chips might result in rapid chemical penetration and reaction. However, the resulting pulp was extremely undercooked. The relatively high chemical consumption showed that insufficient chemical was charged initially; consequently the average chemical concentration in the digester was low.

For cook no. 2 the chemical charge was increased to give an initial chemical to wood ratio of 0.2 pounds of alkali per pound of wood, and cooking time was increased from 1 to 2 hours. The result was a higher yield of acceptable pulp. The chemical consumption was low, indicating that the chemical charge was higher than necessary.

The study cannot be considered conclusive because of insufficient material for establishing optimum pulping conditions. However, sagebrush can be pulped successfully by the kraft process. Significant yield of fiber can be realized, probably within the 30 to 40 percent range, although pulp yields and strengths will probably be lower than those realized from more conventional raw materials.

A comprehensive study of the pulping variables and of other pulping processes would undoubtedly give the sagebrush a better showing than was accomplished in this brief study.

Forest Resources

WATER QUALITY GUIDELINES TO ALTER FOREST PRACTICES

Scientists from a broad range of disciplines in the University of Idaho's Forest, Wildlife and Range Experiment Station have undertaken a sweeping, statewide program to evaluate and improve forest practices that affect water quality within the state.

Setting water quality standards is just one function of the forest practices project. Current laws, specifically the Idaho Forest Practices Act of 1974, and the Rules and Regulations of 1978, will be examined in terms of their potential effectiveness in maintaining these standards. The crux will come in developing standards and keeping regulations flexible to deal with wide variations which exist in pristine water quality.

Technology now exists which would allow forest managers to enter and work within a forest ecosystem without causing more than natural variation in water quality. Choosing the best forest practices for the ecology of each site needs to be encouraged. An education/extension program, recommendations for changes in forest practice regulations and a training program on enforcement and administration of the Forest Practices Act will be by-products of the project.

The interdisciplinary research team is headed by John H. Ehrenreich, Dean of the College of Forestry, Wildlife and Range Sciences, as project director. Professor Arthur D. Partridge, Forest Resources, is project coordinator. Members of the team and their areas of specialization include Professors David L. Adams, Forest Resources; David H. Bennett and C. Michael Falter, Aquatic Biology; Kjell A. Christophersen, Charles W. McKetta and E. Lee Medema, Forest Economics; Leonard R. Johnson, Forest Engineering; John G. King, Hydrology; Howard Loewenstein, Soils; Kenneth M. Sowles, Forest Policy and Administration; and E. Woody Trihey, Water Resources. Larry Dawson served as a technician to the project.

Agency contracts for forest practices were reviewed, along with all manuals, handouts, guides and procedures to determine their ability to maintain water quality during and after each forest practice. Federal, state and private contracts were compared for effectiveness.

Representative operations were studied on federal, state and private land to identify existing management practices, high environmental risk areas and water quality problems. Site evaluations from this portion of the project formed the basis for state management guidelines. For those sites which did not meet the required standards, additional manpower, training and administration needs have been estimated which would bring the area up to the guidelines.

Existing studies and information from the site evaluations have been used to determine which regulations do or do not ensure maintenance of water quality. Additional regulations have been suggested where necessary, while some have been eliminated. Management control practices such as buffer strips, road treatment measuring and road density have been studied for their effect on water quality. Costs and benefits of the rules and regulations have been evaluated. Suggested amendments have been drafted to be stringent enough to maintain proposed water quality standards while being enforceable, and economically feasible.

PHOTO INTERPRETATION KEYS MADE FOR CROPS, TIMBER

Researchers in the College's Remote Sensing Unit have produced a calendar of Idaho cropping practices by region, and a photo interpretation key to forest cover types in west central Idaho through subprojects of the Pacific Northwest Regional Commission's Remote Sensing Demonstration project. The project was partly funded by a National Science Foundation Undergraduate Research Participation Grant.

The cropping calendar and photo interpretation key were developed for use in a survey of irrigated croplands by the Department of Water Resources, and for a forest inventory conducted by the Department of Lands, respectively. Satellite imagery, high and low aerial photography and ground checks were utilized in the projects.

In attempting to identify crop types using the different levels of imagery, investigators requested a guide showing which crops grew at what times for different sections of Idaho. Mark Shelton, an entomology student, developed and mailed a crop questionnaire to all County Cooperative Extension Agents and Soil Conservation Service representatives in Idaho. The questionnaire requested the plowing, planting, fertilizing, irrigating and harvesting times for each county or region by crop, and also the soil types, slope, aspect, row width, field size, types of irrigation and crop rotation practices.

The resulting information constitutes the first statewide comprehensive crop survey. Using this guide, remote sensing interpreters will be able to determine the probable crop for a particular region, and its stage in the growing season.

A photo interpretation key to forest cover types and timber volume was developed by graduate researcher Bill Befort and Paul Luther, an NSF undergraduate research participant, for use in the Department of Lands survey of 8 million acres of forest land in west-central Idaho.

The larger study by the Department of Lands, using a multistage sampling approach, with LANDSAT satellite imagery, NASA high altitude U-2 photography, and larger scale resource aerial photography, is being conducted with the cooperation of the National Aeronautics and Space Administration and the U.S. Geological Survey. To develop the photo interpretation key, U.S. Forest Service resource photography was used as the basic imagery, along with large scale 70-mm aerial photos taken on overflights by the College's remote sensing unit. Terrestrial color stereo photos and ground information for the project were collected by Befort.

A descriptive, well-illustrated manual, "Airphoto Guide to Forest Cover Types in West-central Idaho," is one product of the study. Aerial photo volume tables also were developed for a composite cover type, ponderosa pine, Douglas-fir and "mixed" cover types. The tables were developed by regression of field-measured height and photo-estimated crown coverage on gross merchantable volume data from 444 plots previously cruised by the Department of Lands.

The information was put into table form using a matrix of height in feet versus percentage crown closure, and shows the cubic foot volume for those entries. The table equation is also given.

MANAGEMENT CAN BALANCE TIMBER GROWTH/PROFITS

Idaho commercial forest plantations, both actual and hypothetical, are being examined by computer for financial productivity. Using a stand prognosis model developed by Albert R. Stage (1973) in conjunction with an economic model, researchers applied a variety of treatments to timber stand conditions on 117 case studies and 39 hypothetical plantations, then followed their projected development. Use of planting, precommercial and commercial thinning, overstory removal and fertilization in various combinations resulted in different levels of fiber and sawtimber output. Each of the 1560 possible yield horizons was examined for its economic potential.

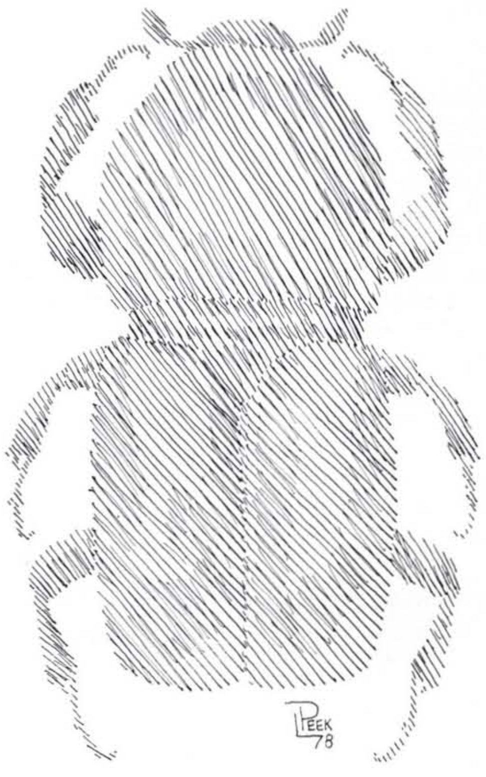
While some intensive silvicultural treatments, i.e., planting and precommercial thinning, may increase wood yields, they may lead to net losses as investments. Choosing to grow trees until they reach a maximum number of board feet, rather than harvesting them as soon as their size makes that option profitable, may significantly lower potential stumpage revenues.

In spite of record high urea-nitrogen prices, fertilization combined with commercial thinning showed surprising promise. An economic analysis of fertilization projects within the Experiment Station has been proposed to rigorously test that result.

Each stand in the study had at least one option which resulted in positive net present returns, according to Forest Resources Professor Charles R. Hatch, and Assistant Professors Kjell A. Christophersen, Charles W. McKetta, and E. Lee Medema. Study results showed that Idaho forests can be financially productive. Idaho timber production potential is high relative to other Rocky Mountain states.

This type of analysis is dependent on its assumptions of basic economic conditions. The use of a 5-percent discount rate is particularly critical to the results. A complete sensitivity analysis is included to enable the reader to evaluate the credibility of the study findings and adjust it to individual conditions.

This economic analysis of Idaho Forest Productivity could be expanded for analyses of critical Idaho forest policy issues, practical timber supply projections, and forest investments. The research and findings are being rewritten as an experiment station bulletin for public distribution.



HAZARD RATING MODELS AID FOREST MANAGERS

Forest resources researchers began work in 1972 both to develop a rating system for stand hazards and to determine the influence of silvicultural practices on fir engraver beetle populations and damage trends. The project focus has broadened to include analysis of the inter-relationships of the beetle community by structure and dynamics, stand density and diversity, intensity of harvest cutting, slash accumulation and logging practices, understory vegetation, cone and seed production and loss, stand regeneration and residual tree growth.

Models have been developed and validated by Professors John A. Schenk and David L. Adams, Research Assistant Professor James A. Moore and Research Associate Ronald L. Mahoney. The original of these models (the Stand Hazard Rating) offers the land manager assistance in treatment decisions by rating grand fir stands for fir-engraver caused tree mortality hazard. It is based on the relationship between stand density and tree species diversity and is easily calculated using standard forest cruise data. This model has been refined and validated using additional experimental stands. Further validation in stands of different geographical and ecological character is planned.

A second model rates grand fir growing sites by their susceptibility to fir-engraver caused tree mortality. This rating system is based on the moistness of the site as expressed in the composition of understory vegetation. It has been established that grand fir is more susceptible to attack and subsequent mortality on sites at the drier end of its ecological range. Interpretation of this phenomenon will continue, using additional data from studies of tree mortality in relation to forest habitat types and post-logging examination of understory vegetation.

The effects of logging practices and slash accumulation on beetle population levels and community structure, grand fir mortality levels, stand regeneration, understory plants, and cone and seed production and loss are being assessed by graduate students involved in this project. These studies involved collection of pre-logging and post-logging data from stands harvested at two levels of cut intensity. Further refinement of the Stand Hazard Rating Model will make use of the density and diversity data from each stand.

A growth projection model has been designed to assess tree growth response relative to growing space after logging, and to relate probability of beetle attack to competition. Data analyses are in progress. The outcome will aid in decisions relating to pre-commercial as well as commercial cutting systems.

Dr. Adams is attempting to compare the effects of the various harvest intensities on stand regeneration and subsequent site conditions. This information will be valuable to foresters as they calculate a compromise between maximum profits from harvest operations and optimum stocking of regeneration for the new stand.

TREE GROWTH GUIDE AND MODEL PLANNED

In a cooperative study, researchers have found that advanced regeneration, trees growing under the forest canopy in a suppressed condition, make up a larger part of North Idaho forest stocking than previously expected.

Graduate researcher Dennis E. Ferguson and Forest Resources Professor David L. Adams, in cooperation with the Intermountain Forest and Range Experiment Station of the USDA Forest Service, will be concentrating on growth response of advanced grand fir, a species which often begins growth in the forest understory over a wide range of ecological conditions.

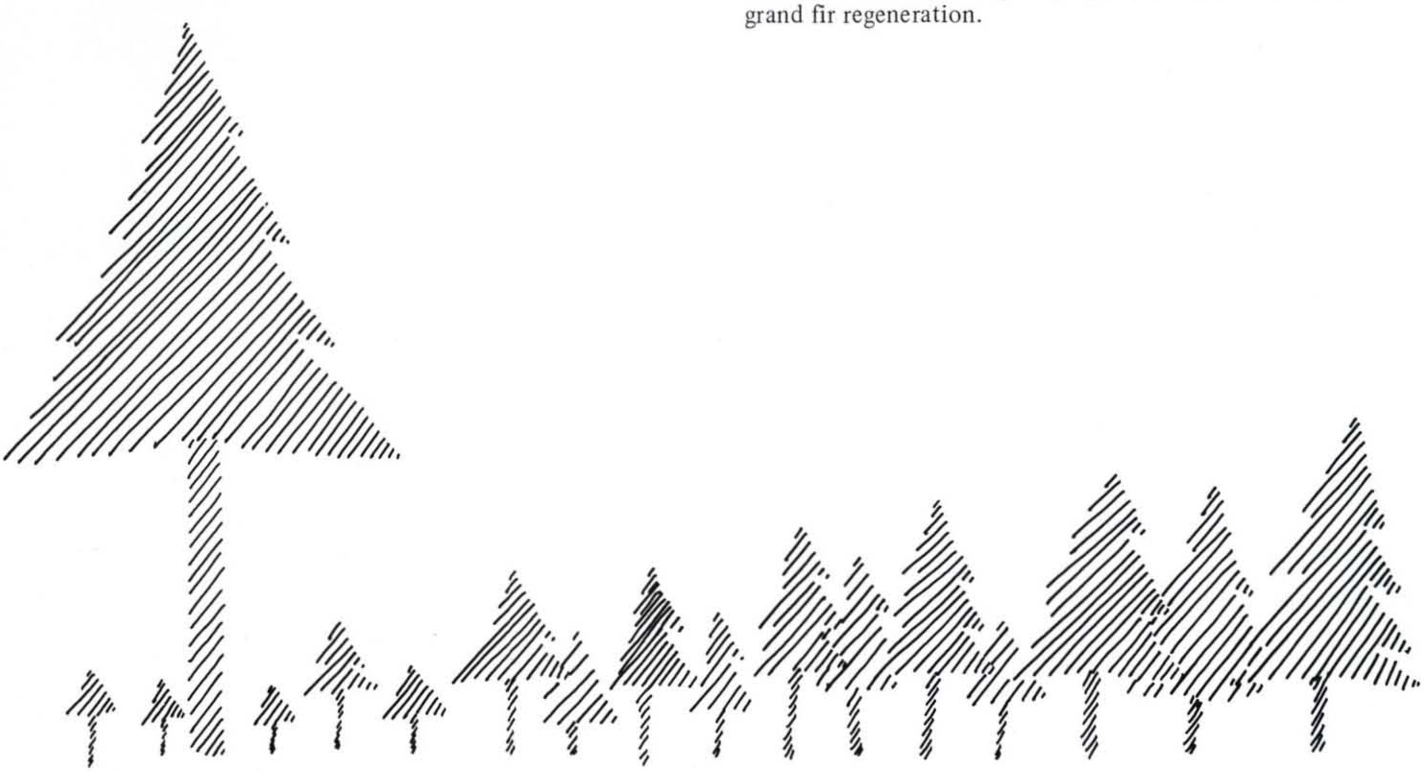
Under shelterwood regeneration, a new crop of trees germinates and becomes established as advanced regeneration before the final harvest of the previous crop.

Unplanned advanced regeneration may also occur in stands which are not fully utilizing a site. This may be caused by a stand breaking up naturally, through windthrow, fire, disease, insects or similar causes; by poor stocking in the present rotation; or by natural succession. This condition has been termed a crude shelterwood regeneration method, differing from a true shelterwood cutting in several ways. It is not deliberate, and regeneration may not be released, or allowed to grow, when it is biologically best for each tree. The regeneration period is extended, with trees retained under the canopy becoming suppressed.

Response of these trees, when released, will depend on their environmental conditions before and after the release. Advantages of advanced regeneration include establishment, reduced stocking costs and shortened rotation. On the negative side, shock to newly exposed trees often results in mortality, stagnation or slow growth rates.

Researchers will be trying to discover whether advanced regeneration provides the land manager with results equal to those obtained under alternative methods, and whether advanced regeneration existing in a stand scheduled for harvest can be used for composition of the next rotation.

The researchers hope to furnish a field guide for land managers to the probable response of advanced grand fir regeneration following release, and to develop a mathematical model predicting height growth of released advanced grand fir regeneration.



David L. Adams

Use of a portable oscilloscope and square-wave generator may offer nurserymen a precise method to tell when seedlings enter dormancy. Strong signals are received, above, from a live, healthy tree sample.

WAVE SIGNALS MAY SHOW PLANT STATUS

If living and dead plant tissues modify induced wave signals in different patterns, researchers in the Forest, Wildlife and Range Experiment Station may be able to distinguish dormant, living plants from dead ones.

Graduate researcher David L. Wenny and Forest Resources Professor David L. Adams are testing waveform output obtained from a portable oscilloscope and square-wave generator as a potential tool for determining physiological status of tree seedlings. Other studies have indicated that induced square-wave signals are altered by a plant's physiological state as they pass through its tissues.

Use of such a technique would be valuable in determining the precise onset of dormancy for nursery operators. Seedling trees are planted while dormant to reduce stress and achieve better survival rates. Nurserymen must wait until dormancy begins to lift the seedlings safely for transportation to short-term storage, or a planting site.

Visually, dormancy begins with the formation of the terminal bud and ends with bud burst. Because dead and dormant plants often look the same, methods are being studied to establish the condition of the plant in a non-destructive manner.

The demand for genetically improved planting stock has shown a remarkable increase in recent years, and will continue to expand. Last year, approximately 21 million seedlings were produced by Idaho's forest tree nurseries.

Prompt regeneration of forest stands following harvest or wildfire is an essential part of accelerated forest management in Idaho. Management, both public and private, is placing a much greater emphasis on artificial regeneration, with special attention to planting.

As site preparation and planting costs now commonly exceed $65 per acre, and many thousands of acres need reforestation, the success of a planting operation is of great concern. Cutover lands should be restocked promptly using the seedlings and methods that will offer the greatest potential for success, and thereby meet management objectives at minimum cost.

Precise knowledge of a plant's physiological status at the time of planting would give nurserymen better control, lengthen the planting season, and increase the seedling survival rate.

Range Resources

HABITAT TYPE CLASSIFICATION TESTING SCHEDULED IN SOUTHERN IDAHO

A habitat type classification that is applicable to nearly 18 million acres of rangeland in southern Idaho has been developed and will be rigorously field tested during the coming year. The classification applies to the major habitat types of the sagebrush and mountain brush zones, all non-forest vegetation.

The habitat type classification is based on the landscape's ecological potential rather than its vegetative characteristics which may be drastically modified by fire, grazing and other disturbances. The habitat type and its attendant community types would provide the land manager with additional information for making management decisions that cannot be obtained from the range type classification.

Tentatively, 28 habitat types that support various species of *Artemisia* and 5 habitat types in the mountain brush type have been identified by Professors Minoru Hironaka and Maynard Fosberg of Range Resources and Plant and Soil Sciences, respectively. A key to their classification has been prepared and characterization of each identified habitat type is in progress.

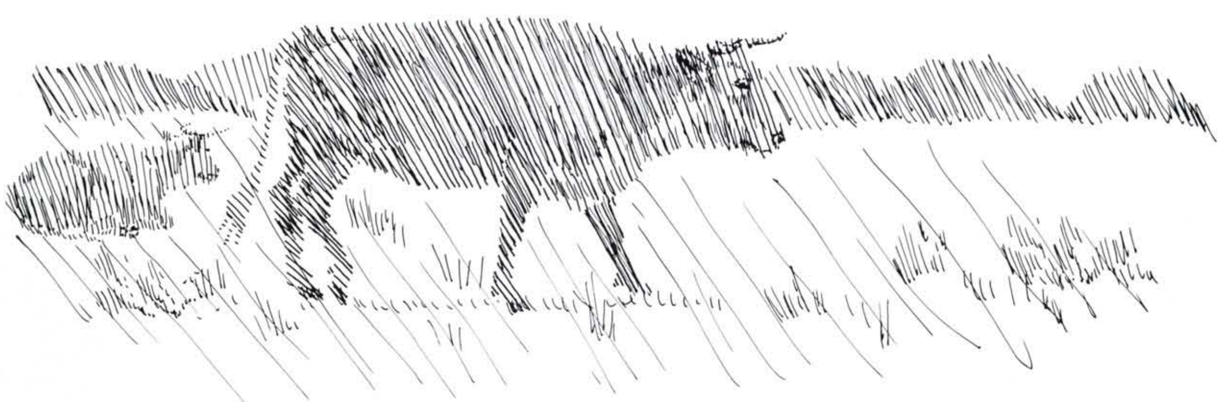
The classification is based on the dominant shrub and perennial understory species. Variation in the lesser species composition and productivity within habitat types results mainly from the broad range of conditions under which the same combinations of shrub and understory dominants occur. Disturbance adds further complexity to the within habitat type variation.

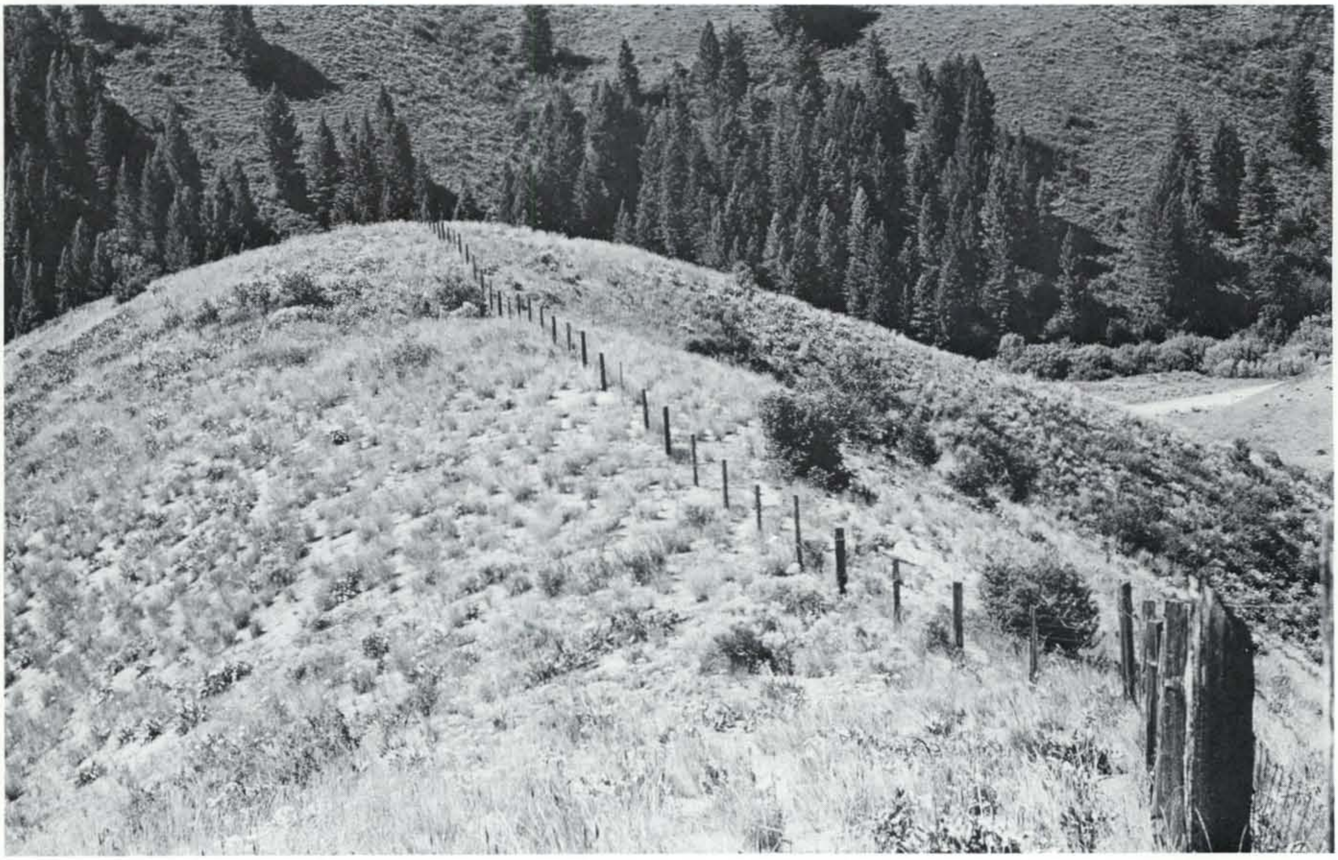
Because pristine examples of habitat types in southern Idaho are rare, the investigators assumed that all examined stands had been disturbed, though to a varying degree. They also operated on the premise that a particular soil body supports or supported a single climax plant community.

The use of soils information is an integral part of this project, as there is a high correlation between the habitat type and soils, and the vegetation that is present. Although more than one soil can support the same climax plant community, all areas of the same soil belong to the same habitat type regardless of the vegetation they presently support. Thus, a habitat type may include more than one soil, but only a single climax plant community. With proper interpretation the community types and their probable successional sequence within a habitat type can be deduced.

Use of the habitat type system permits landscape classification on the basis of vegetation that it can support in its natural state. This provides the land manager with a useful reference not only to the land's present productivity, but also to its potential. The classification also offers a basis for a storage and retrieval system capable of providing information on responses to management practices useful to other areas of the same habitat type. Documentation of management responses by habitat type would be invaluable to managers who wished to follow up the results of their predecessors.

This classification is a first approximation. As more information becomes available and reduction in the variability within habitat types is deemed necessary for more intensive management, additional habitat types or phases can be recognized.





Annette S. Voth

Patterns of natural revegetation are compared on grazed and ungrazed study plots of sagebrush/bunchgrass rangeland on the Boise National Forest. The Wood Creek exclosure, above, is located on the Boise District.

PLANT SUCCESSION TRACED ON GRAZED, UNGRAZED LAND

Long term changes in sagebrush-bunchgrass vegetation on once heavily grazed rangeland are being investigated by Range Resources Assistant Professor Kenneth Sanders and graduate researcher Annette Voth in cooperation with the USDA Forest Service.

Rangelands on the Boise National Forest were heavily grazed by cattle, sheep, and horses in the early 1900's. The result was significant deterioration of vegetation, soil and watersheds. In 1930, concern over this deterioration led to construction of several domestic livestock exclosures with permanent study plots located in both grazed and ungrazed areas. Studies were initiated at that time to determine the extent to which natural revegetation of these rangelands would occur.

Since 1930 these plots have been studied periodically, the most recent study having been conducted in 1955. The current study, which was initiated in part to determine if continued maintenance of the exclosures is justifiable, will encompass both data collected during the summer of 1977 and data collected over the past 50 years.

This 50-year time span in data on several specific areas is a relatively rare feature among successional studies. Commonly, the researcher must attempt to pick several areas for which similar vegetation potentials exist, examine these at one point in time, and then make inferences about succession on a single area through time.

Because the study was initiated early (1930) in the development of range management as a science, many of the methods used have long since been discarded and replaced by newer techniques. Among these techniques are the use of a pantograph for charting vegetation and the ten/tenths method of cover estimation. Familiarity with old methods and with their strengths and weaknesses is a prerequisite to understanding early work; the transforming and combining of old and new information to extract the maximum available information is a challenging task.

Aims of the study include identification of patterns of secondary succession both on areas which for the most part have been continuously grazed since the early 1900's and on areas from which grazing has been excluded since 1930. Comparisons between grazed and ungrazed areas also will be made. Hopefully, this knowledge will lead to better grazing management and, consequently, more productive rangelands.

Appendix

EXPERIMENT STATION SCIENTISTS

Ables, Ernest D., Associate Dean and Professor (Wildlife Resources)
Adams, David L., Professor and Chairman (Forest Resources)
Allen, Harriet, Research Technician (Wildlife Resources)
Anderson, Hal N., Research Technician (Forest Resources)
Asherin, Duane A., Research Wildlife Biologist
Bailey, Theodore N., Research Wildlife Biologist
Belt, George H., Professor (Forest Resources)
Bennett, David H., Assistant Professor (Fisheries Resources)
Bizeau, Elwood G., Assistant Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Resources)
Bjornn, Theodore C., Leader, Cooperative Fishery Research Unit and Professor (Fisheries Resources)
Booth, D. Terrance, Range Research Scientist
Bottger, Richard F., Assistant to the Directors
Burlison, Vernon H., Extension Forester and Extension Professor
Canfield, Elmer R., Associate Professor (Forest Resources)
Chacko, A. Jim, Visiting Assistant Professor (Fisheries Resources)
Cholewa, Anita F., Herbarium Research Technician (Forest Resources)
Christophersen, Kjell A., Assistant Professor (Forest Products)
Crookston, Nicholas L., II, Research Associate (Forest Resources)
Dalke, Paul D., Emeritus Professor (Wildlife Resources)
Deters, Merrill E., Emeritus Professor (Forest Resources)
Drewien, Roderick C., Research Wildlife Biologist
Eckroth, Wallace, Assistant Forest Nursery Supervisor
Ehrenreich, John H., Dean, Experiment Station Director and Professor (Range Resources)
Erickson, David A., Research Technician (Forest Resources)
Falter, C. Michael, Professor (Fisheries Resources)
Fazio, James R., Associate Professor and Chairman (Wildland Recreation Management)
Gadwa, Laurii A., Librarian (Wildlife and Fisheries Resources)
Garton, Edward O., Assistant Professor (Wildlife Resources)
George, Willard L., Research Technician (Wildlife Resources)
Gordon, Roger R., Research Associate (Forest Resources)
Hanley, Donald P., Research Instructor (Forest Resources)
Ham, Sam H., Instructor (Wildland Recreation Management)
Hash, Howard S., Research Associate (Wildlife Resources)
Hatch, Charles R., Experiment Station Statistician and Professor (Forest Resources)
Heller, Robert C., Research Professor (Forest Resources)
Hieb, Susan R., Experiment Station Editor
Hironaka, Minoru, Professor (Range Resources)
Hoffman, Joseph E., Associate Professor (Wildland Recreation Management)
Hofstrand, Arland D., Associate Professor and Chairman (Forest Products)
Hornocker, Maurice G., Leader, Cooperative Wildlife Research Unit and Professor (Wildlife Resources)
Houck, Geoffrey L., Research Technician (Forest Resources)
Howe, John P., Professor (Forest Products)
Hungerford, Kenneth E., Professor (Wildlife Resources)
Irwin, Larry L., Research Instructor (Wildlife Resources)
Johnson, Frederic D., Professor (Forest Resources)
Johnson, Leonard R., Associate Professor (Forest Products)
Kasworm, Wayne F., Research Technician (Range Resources)
Kaufman, Betty M., Special Projects Coordinator

Keay, Jeffrey A., Research Technician (Wildlife Resources)
Kessler, Winifred B., Assistant Professor (Wildlife Resources)
Kibbee, Darline L., Wilderness Research Center Editor
King, John G., Assistant Professor (Forest Resources)
Kingery, James L., Instructor/Research Associate (Range Resources)
Klontz, George W., Professor (Fisheries Resources)
Koehler, Gary, Research Technician (Wildlife Resources)
Kulhavy, David L., Research Associate (Forest Resources)
Lai, Khiet V., Visiting Assistant Professor (Fisheries Resources)
Larson, Roy E., Research Technician (Fisheries Resources)
Leonard, James M., Research Associate (Fisheries Resources)
Lewis, Arlow, Caretaker, Taylor Ranch
Loewenstein, Howard, Experiment Station Asssitant Director and Professor (Forest Resources)
MacPhee, Craig, Professor and Chairman (Fisheries Resources)
Mahoney, Ronald L., Research Associate (Forest Resources)
McFadden, Max W., Research Forester (Forest Resources)
McKetta, Charles W., Experiment Station Economist and Assistant Professor (Forest Resources)
McLaughlin, William J., Assistant Professor (Wildland Recreation Management)
Medema, E. Lee, Assistant Professor (Forest Resources)
Mika, Peter G., Research Associate (Forest Resources)
Mitchell, John E., Assistant Professor (Range Resources)
Mitchell, Kenneth J., Associate Professor (Forest Resources)
Moore, James A., Research Instructor (Forest Resources)
Moslemi, Ali A., Associate Dean, Experiment Station Associate Director, Coordinator of Graduate Programs, Professor (Forest Products)
Neuenschwander, Leon F., Assistant Professor (Forest Resources)
Orme, Mark, Research Associate (Wildlife Resources)
Osborne, Harold L., Research Associate (Forest Resources)
Partridge, Arthur D., Professor (Forest Resources)
Peek, James M., Associate Professor and Chairman (Wildlife Resources)
Peterson, Steven R., Associate Professor and Chairman-elect (Wildlife Resources)
Pitkin, Franklin H., Professor (Forest Resources), Experimental Forest Manager and Forest Nursery Superintendent
Pitkin, George G., Assistant Forest Supervisor
Pommerening, Edward, Research Associate (Forest Resources)
Reggear, Robert C., Experimental Forest Assistant Manager
Riggs, Robert A., Research Associate (Wildlife Resources)
Ringe, Rudy, R., Research Associate (Fisheries Resources)
Sanders, Kenneth D., Associate Professor (Range Resources)
Scanlin, David C., Research Assistant Professor (Forest Resources)
Schenk, John A., Professor (Forest Resources)
Schomaker, John H., Assistant Professor (Wildland Recreation Management)
Seale, Robert H., Emeritus Professor (Forest Resources)
Sharp, Lee A., Professor and Chairman (Range Resources)
Sowles, Kenneth M., Professor (Forest Products), Assistant Dean, Coordinator of International Programs
Stark, Ronald W., Professor (Forest Resources)
Stellmon, Barbara B., Lab Technician (Forest Resources)
Stock, Mary W., Assistant Professor (Forest Resources)
Stoszek, Karel J., Associate Professor (Forest Resources)
Stoszek, Milena J., Research Scientist (Wildlife Resources)
Thurow, Thomas, Research Technician, Taylor Ranch
Tisdale, Edwin W., Emeritus Professor (Range Resources)
Ulliman, Joseph J., Associate Professor (Forest Resources)
Vogel, Thomas S., Laboratory Technician (Fisheries Resources)
Wagner, James R., Research Technician (Forest Resources)
Wang, Chi-Wu, Professor (Forest Resources)
White, Robert G., Assistant Leader, Cooperative Fishery Research Unit and Assistant Professor (Fisheries Resources)

RESEARCH PROJECTS AND INVESTIGATORS

To save space, abbreviated project titles are given. If additional information is needed, please write to the principal investigators or the Office of Associate Dean for Research.

FISHERIES RESOURCES

Response of selected salmonids to flow reductions in artificial stream channels. D. H. Bennett.

Development of a generalized model to predict spawning success of fishes in reservoirs with fluctuating water levels. D. H. Bennett.

Response of mosquitofish to thermal effluents. D. H. Bennett.

Special angling regulations in management of cutthroat trout. T. C. Bjornn.

The carrying capacity of streams for rearing salmonids as affected by sediment and other components of the habitat. T. C. Bjornn.

Wolf Lodge Creek cutthroat trout studies. T. C. Bjornn.

A study of adult chinook salmon and steelhead trout "losses" in the McNary Pool area of the Columbia and Snake rivers. T. C. Bjornn.

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

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

Evaluation of various hatchery rearing conditions on the seaward migration of steelhead trout. T. C. Bjornn.

Density of juvenile steelhead and salmon in the Lochsa and Selway rivers, Idaho. T. C. Bjornn.

Survival and emergence of salmon and trout embryos and fry in gravel-sand mixture. T. C. Bjornn.

A study of the aquatic resources of Silver Creek at the Nature Conservancy site. T. C. Bjornn.

Food habits and distribution of rainbow trout (*Salmo gairdneri*) and cutthroat trout (*Salmo clarki*) in Lake Koocanusa, Montana. T. C. Bjornn.

Trapping of fall chinook at Ice Harbor Dam. T. C. Bjornn, R. R. Ringe.

Survey of selected North Idaho streams. T. C. Bjornn, R. R. Ringe.

Lower Snake River limnology. C. M. Falter.

Efficacy of selected antibiotics in the prevention and control of bacterial kidney disease. G. W. Klontz.

Factors controlling Dworshak Reservoir productivity. C. M. Falter.

Conversion of U.S. Coast Guard launch to limnological research vessel. C. M. Falter.

Limnologic evaluation and zooplankton dynamics of Lake Koocanusa, northwest Montana. C. M. Falter.

Evaluation of biofilter factors. G. W. Klontz.

Aquaculture discharge quality. G. W. Klontz.

Foodfish production in Idaho. G. W. Klontz.

Epidemiology of respiratory disease of juvenile anadromous salmonids. G. W. Klontz.

Selective chemicals for the control of threespine stickleback. C. MacPhee.

Selective chemicals for the control of suckers. C. MacPhee.

Chemical fire retardants. T. H. Blahm, C. MacPhee.

Downstream transportation of salmonid smolts and adult returns. W. J. Ebel, C. MacPhee.

Potential effects of peaking on fish and aquatic macroinvertebrates in South Fork Boise River below Anderson Ranch Dam. R. G. White.

Effects of reduced nighttime flows on adult chinook salmon and steelhead trout in the lower Snake River. R. G. White.

Effects of reduced stream discharge on fish and aquatic macroinvertebrate populations. R. G. White.

Effects of altered flow regimes, temperatures and river impoundment on adult steelhead trout and chinook salmon. R. G. White.

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

A survey of existing information on Franklin D. Roosevelt Lake. R. G. White, D. H. Bennett.

WILDLAND RECREATION MANAGEMENT

Wilderness information sources and channels utilized by recreationists in the Selway-Bitterroot Wilderness Area. J. R. Fazio.

Effectiveness of two audio-visual techniques in environmental interpretation. T. Miles, J. R. Fazio.

An analysis of economic and social factors of skiing in Idaho. J. E. Hoffman.

An analysis of economic and social factors of state parks in Idaho. J. E. Hoffman.

Relative value of water-related outdoor recreation activities. J. E. Hoffman.

An examination of visual analysis methodologies. W. J. McLaughlin.

Computerized wilderness bibliography. J. H. Schomaker.

Computer modeling in wilderness management education. J. H. Schomaker.

A conceptual framework for understanding recreation – Fishbein model and wilderness recreational use. J. H. Schomaker.

WILDLIFE RESOURCES

Behavior and migration of bobcats in Idaho. E. D. Ables.

Inventory of riparian habitats and associated wildlife along the lower Clearwater River and Dworshak Reservoir. M. Orme, M. G. Hornocker, E. G. Bizeau.

The Rocky Mountain population of the Great Basin Canada goose. E. G. Bizeau.

Reestablishing whooping cranes in the western United States. E. G. Bizeau, R. C. Drewien.

Experimental transplanting of wild wood duck broods in northern Idaho. E. G. Bizeau.

Analysis of the forest bird population changes associated with use of Orthene insecticides. E. O. Garton.

Inventory of wildlife habitat on public lands in North Idaho. E. O. Garton, J. A. Keay.

Dietary selection in omnivorous birds. E. O. Garton.

Ecology of the leopard in Kruger National Park. M. G. Hornocker.

Ecology of the wolverine in northwestern Montana. M. G. Hornocker, H. S. Hash.

Predator-prey relationships on the Snake River Birds of Prey Natural Area. M. G. Hornocker.

Population characteristics and dynamics of river otters in west-central Idaho. M. G. Hornocker.

Reproduction, movements and food habits of great blue herons in southern Idaho. M. G. Hornocker.

Mountain beaver behavior and nutrition analysis. K. E. Hungerford.

Transmission of tree root diseases by pocket gophers. K. E. Hungerford.

Land management practices and sharp-tailed grouse in southeastern Idaho. W. B. Kessler.

Comparative evaluation of pronghorn food habits techniques. W. B. Kessler.

Experimental technique for analyzing trace nutrient content of pronghorn tissues. W. B. Kessler, M. J. Stoszek.

Effects of rest-rotation grazing systems upon wildlife populations, East Fork Salmon River. J. M. Peek.

Relationship of productivity and biomass of forest communities and associated ungulates to forest fire. J. M. Peek.

Habitat selection patterns of grizzly bears in Glacier National Park. J. M. Peek.

White-tailed deer habitat selection patterns. J. M. Peek.

Raptor nesting and feeding behavior in the Snake River Birds of Prey Natural Area. S. R. Peterson.

Ecology of the Hungarian partridge on the Palouse Prairie. S. R. Peterson.

Resource partitioning among woodpeckers in the Blue Mountains of Oregon. S. R. Peterson.

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

FOREST PRODUCTS

Physical properties of western white pine. A. D. Hofstrand.

Technical and economic practicality of dowel-laminating crossties before drying. J. P. Howe.

Influence of forest sites on wood properties of inland Douglas-fir. J. P. Howe.

Comparison of concrete and wood for crossties. J. P. Howe.

Laminated crossarms from low grade 1 x 4-inch boards. J. P. Howe.

Technical and economic practicality of new lumber products made from Idaho's dead pine trees. J. P. Howe, K. A. Christophersen.

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

Idaho forest data base. C. W. McKetta, K. A. Christophersen, E. L. Medema.

Compilation of growth and yield data. A. A. Moslemi.

Wood utilization by the southern pulp and paper industry. J. D. Rushton, J. P. Howe.

Idaho Statewide 208 water quality management project. K. M. Sowles, A. D. Partridge, J. H. Ehrenreich.

FOREST RESOURCES

Scaling defective cedar logs. D. L. Adams.

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

Management of advanced grand fir regeneration. D. L. Adams.

Fugitive dust emission from haul roads associated with surface mining. G. H. Belt.

Predicting the effects of forest practices on streamflow using the equivalent clearcut area model. G. H. Belt.

Analysis of mass wasting in the Anyang watershed near Seoul, Korea. G. H. Belt.

Wood-inhabiting fungi. E. R. Canfield.

The impact of artificial defoliation of forest trees. E. R. Canfield, A. D. Partridge.

Investment analysis of Idaho's commercial forest land: An individual stand approach. K. A. Christophersen, C. R. Hatch, C. W. McKetta, E. L. Medema.

Administration of McIntire-Stennis programs. J. H. Ehrenreich.

Evaluation of Forest Practices Act in relation to water quality. J. H. Ehrenreich.

Intensive culture of forests of redcedar, western hemlock and grand fir habitat types. J. H. Ehrenreich, D. L. Adams, J. M. Peek, H. Loewenstein, K. J. Stoszek, S. R. Peterson, D. C. Scanlin, J. A. Moore, L. L. Irwin, D. P. Hanley.

Crown ratio models. C. R. Hatch.

Forest inventory management information system, BIA Flathead Agency. C. R. Hatch, G. L. Houck.

Classification of tree and stand variables into foliage biomass estimates. C. R. Hatch.

Inventory of irrigated lands on selected areas in southern Idaho. R. C. Heller.

Identification of preferred Douglas-fir tussock moth sites. R. C. Heller, J. J. Ulliman.

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

Natural regeneration of western redcedar. F. D. Johnson.

Riparian vegetation in eastern central Idaho. F. D. Johnson.

Autecology and synecology of six endangered forest plants. F. D. Johnson.

Natural sedimentation rates from forested watersheds. J. G. King.

Development and field application of techniques for monitoring sediment from forest roads. J. G. King.

Biological relationships of high mountain streams in the Gallatin and Madison river basins, Montana. J. G. King.

Investigation of pretreatment snow ablation in a Horse Creek watershed. J. G. King.

The effects of compaction on water movement in a forest soil from desorption data. H. Loewenstein.

University of Idaho Experimental Forest research. H. Loewenstein, D. L. Adams.

Forest fertilization: Its influence on stands of Douglas-fir and grand fir in Idaho. H. Loewenstein, F. H. Pitkin.

Seedling growth and survival in coniferous species. H. Loewenstein, F. H. Pitkin.

Critical levels of nutrients in forest trees as determined by hydroponic culture. H. Loewenstein, D. C. Scanlin.

Impacts of Forest Service timber sales on a timber dependent community – the Nezperce case. E. L. Medema.

Weed control with Roundup (glyphosate). P. G. Mika, H. L. Osborne.

Impact of initial density and juvenile spacing on yield. K. J. Mitchell.

Construction of lodgepole pine yield tables for Idaho. K. J. Mitchell.

Fire management in the cold desert. L. F. Neuenschwander.
  a) Fire induced autecology on shrubs of the cold desert and surrounding forests.
  b) Prescribed burning in sagebrush during the winter.

Understory burning in forests in northern Idaho. L. F. Neuenschwander.
  a) General fire – prescription in ponderosa pine.
  b) Grazing – fire interactions in Douglas-fir/ninebark.
  c) Burning characteristics of four trees along a moisture gradient.

The effect of fire on the herbaceous layer in Douglas-fir/physocarpus. L. F. Neuenschwander.

The effect of 30 years of grazing on the University of Idaho Experimental Forest. L. F. Neuenschwander.

A hypothesis for a mechanism of autogenic secondary succession in a tobosa grassland. L. F. Neuenschwander.

Disease-insect interactions in forest trees. A. D. Partridge, E. R. Canfield.

Idaho tree diseases and defects. A. D. Partridge, E. R. Canfield.

Techniques to identify, quantify and predict decays and diseases of timber in the inland northwest. A. D. Partridge, E. R. Canfield.

Evaluation of ponderosa pine thinning response in relation to available growing space. J. A. Moore, D. P. Hanley.

Mass production of lodgepole and jackpine hybrids. F. H. Pitkin, H. Loewenstein.

Revegetation of areas affected by mining in Idaho. F. H. Pitkin, H. Loewenstein, J. E. Mitchell.

Bionomics and impact of the cone and seed insects of Idaho forest tree species. J. A. Schenk.

The influence of grand fir stand characters and management practices on bark beetle population and damage levels, stand regeneration and growth. J. A. Schenk, J. A. Moore, D. L. Adams, R. L. Mahoney.

Hazard rating lodgepole pine stands for mountain pine beetle. J. A. Schenk, R. L. Mahoney.

Integrated pest management: for control of major pine bark beetles. R. W. Stark.

Host conditions and insect relationships of lodgepole pine and mountain pine beetles. K. J. Stoszek.

Physiological environment of grand fir in relation to DFTM hazard sites. K. J. Stoszek, P. G. Mika, H. L. Osborne.

Relationship of site and stand attributes and management practices to Douglas-fir tussock moth epidemics. K. J. Stoszek, J. A. Moore, P. G. Mika, H. L. Osborne.

Aerial photo interpretation key for west-central Idaho. J. J. Ulliman.

Aerial photo volume table for west-central Idaho. J. J. Ulliman.

Occurrence of farming practices in Idaho: with special reference to remote sensing. J. J. Ulliman.

Practical application of aerial photography, aerial photo interpretation to land management needs. J. J. Ulliman, R. C. Heller.

Genetic studies of ponderosa pine. C. W. Wang.

ERDA Raft River geothermal water ground heating and biomass production. C. W. Wang.

Cooperative ponderosa pine improvement program of southern Idaho. C. W. Wang.

Cooperative forest-tree improvement program for the Inland Empire Region. C. W. Wang.

Demonstration of thermal water utilization in forestry, Arco and Hanford projects. C. W. Wang, J. P. Howe.

RANGE RESOURCES

Mine spoil revegetation. T. Booth.

Habitat type classification for grasslands and shrublands of southern Idaho. M. Hironaka, M. A. Fosberg.

Effect of animal grazing on water quality of non-point runoff. J. E. Mitchell.

Revegetation of mine spoils in northern Idaho. J. E. Mitchell, F. H. Pitkin, H. Loewenstein.

Successional patterns of vegetation in Boise National Forest. K. D. Sanders.

Livestock-big game relations on winter range, Little Salmon River Drainage, Idaho. K. D. Sanders, L. A. Sharp.

Effects of caribou carrion on arctic tundra plant composition, yield, and soil-plant nutrient regimes. L. A. Sharp.

An investigation of multiple-use capabilities of forest-associated range in the Central Idaho Batholith. L. A. Sharp, M. Hironaka.

Evaluation of range seeding. L. A. Sharp, K. D. Sanders.

Rangeland development and improvement in Idaho. L. A. Sharp, K. D. Sanders.

Ecology of the grasslands of the Snake River and Salmon River systems in Idaho. E. W. Tisdale, M. Hironaka.

1977 PUBLICATIONS AND REPORTS

Ables, E.D. ed. 1977. The axis deer in Texas. Kleberg Studies in Natural Resources Monograph. Texas A&M Agr. Exp. Sta. College Station, 86 pp.

*Selected as the outstanding publication for 1977 by the Texas Chapter of The Wildlife Society.

———. 1977. Chapter 1–Introduction. Pages 7-23 *in* E.D. Ables ed., The axis deer in Texas. Kleberg Studies in Natural Resources Monograph. Texas A&M Agr. Exp. Sta. College Station.

Ables, E.D., and E.R. Fuchs. 1977. Chapter 6–Conclusions. Pages 79-84 *in* E.D. Ables ed. The axis deer in Texas. Kleberg Studies in Natural Resources Monograph. Texas A&M Agr. Exp. Sta. College Station.

Adams, D.L. 1977. The effects of management on timber productivity. Pages 13-17 *in* V.H. Burlison coord. Proc. Woodland Economics and Taxation Workshop. Moscow, ID. March 15-17. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow.

Befort, W.A., and J.J. Ulliman. 1977. Airphoto guide to forest cover types in west central Idaho. Final rep. to Idaho Dept. Lands and Pac. NW Regional Comm. 140 pp.

———. 1977. Aerial photo volume tables for west central Idaho. Final rep. to Idaho Dept. Lands and Pac. NW Regional Comm. 4 pp.

Befort, W.A., R.C. Heller, and J.J. Ulliman. 1977. Idaho land-use mapping from LANDSAT transparencies. Forest, Wildl. and Range Exp. Sta. Note. No. 28, Univ. of Idaho. 4 pp.

Belt, G.H., J.G. King, and H.F. Haupt. 1977. Augmenting summer streamflow by use of a silicone antitranspirant. Water Resources Res. 13(2):267-272.

Bennett, D.H., and R.G. White. 1977. A survey of existing literature on Franklin D. Roosevelt Lake. Completion rep. to Bureau of Reclamation. 94 pp.

Bjornn, T.C. 1977. Mixed stocks of wild and hatchery steelhead trout: a management problem in Idaho. Proc. Genetic Implications of Steelhead Management Symp. Arcata, CA. May. 21 pp.

Bjornn, T.C., and T.H. Johnson. 1977. Wild trout management, an Idaho experience. Wild Trout Symp. San Jose, CA. February. 15 pp.

Bjornn, T.C., T.H. Johnson, and R.F. Thurow. 1977. Angling versus natural mortality in Idaho cutthroat trout populations. Nat. Symp. Catch-and-Release Fishing as Management Tool. Arcata, CA. Sept. 7-8. 14 pp.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Milligan, R.A. Klamt, E. Chacko, and C. Schay. 1977. Transport of granitic sediment in streams and its effects on insects and fish. Forest, Wildl. and Range Exp. Sta. Bull. No. 17. Univ. of Idaho, Moscow. 43 pp.

Burlison, V. H. coord. 1977. Proc. Woodland Economics and Taxation Workshop. Moscow, ID. March 15-17. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow. 90 pp.

Burlison, V.H. 1977. Timber management alternatives for nonindustrial private forest owners. Pages 86-90 *in* V.H. Burlison coord. Proc. Woodland Economics and Taxation Workshop. Moscow, ID. March 15-17. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow.

Carter, D.B., H. Loewenstein, and F.H. Pitkin. 1977. Amelioration and revegetation of smelter contaminated soils in the Coeur d'Alene mining district of northern Idaho. Proc. Can. Land Reclamation Assoc. Edmonton, Alta.

Church, F. 1977. Wilderness in a balanced land use framework. Wilderness Res. Center Distinguished Lectureship No. 1. University of Idaho, Moscow. March 21. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow, 18 pp.

College of Forestry, Wildlife and Range Sciences. 1977. The undergraduate program. College of Forest, Wildl. and Range Sci. Univ. of Idaho, Moscow. 52 pp.

Coon, J.C., R.R. Ringe, and T.C. Bjornn. 1977. Abundance, growth, distribution and movements of white sturgeon in the Mid-Snake River. Research Tech. Completion Rep. Office of Water Resources and Technology, USDI. 63 pp.

Crookston, N.L., R.W. Stark, and D.L. Adams. 1977. Outbreaks of Mountain pine beetle in northwestern lodgepole pine forests–1945 to 1975. (Map enclosed) Forest, Wildl. and Range Exp. Sta. Bull. No. 22. Univ. of Idaho, Moscow. 7 pp.

Falter, C.M., J.M. Leonard, J.M. Skille, F.M. Stowell, A.J. Lingg, S.J. Berry Martin, and L.G. Hersman. 1977. Early limnology of Dworshak Reservoir. Final rep. to U.S. Army Corps of Engineers, Walla Walla, WA. 195 pp.

Fazio, J.R. 1977. Construction of interpretive trails by youth groups. The Interpreter VIII. (4):17-19.

Fazio, J.R. ed. 1977. Proc. Idaho Trails Symp.: river and trail restrictions–new approach to recreation in Idaho? Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow. 60 pp.

Fazio, J.R., and L.A. Belli. 1977. Characteristics of nonconsumptive wildlife users in Idaho. Pages 117-128 *in* Trans. 42nd N. Amer. Wildl. and Natur. Resources Conf. Atlanta, GA. March 5-9. Wildl. Manag. Inst. Washington, D. C.

Fazio, J.R., and W.W. Bramlette. 1977. Communicating with the wilderness user. Final rep. to Pac. NW Regional Comm. 167 pp.

Foin, T.C., E.O. Garton, C.W. Bowen, J.M. Everingham, R.O. Schultz and B. Holton, Jr. 1977. Quantitative studies of visitor impacts on environments of Yosemite National Park, California and their implications for park management policy. J. Environ. Manage. 5(1):1-22.

Forest, Wildlife and Range Experiment Station. 1977. Focus on Renewable Natural Resources. 3(1). Forest, Wildl. and Range Exp. Sta. 1976 Annu. Rep. Univ. of Idaho, Moscow. 40 pp.

Frederick, D.J., and A.D. Partridge. 1977. Indicators of decay in the grand fir/white fir complex in central Idaho. NW Sci. 51(4): 282-292.

Garton, E.O. 1977. Analysis of the forest bird population changes associated with use of orthene insecticides. Final rep. to U.S. Fish and Wildl. Serv. 72 pp.

Garton, E.O., C.W. Bowen, and T.C. Foin. 1977. The impact of visitors on small mammal communities of Yosemite National Park. *In* T.C. Foin, ed. Visitor impacts on national parks: The Yosemite ecological impact study. Inst. Ecol. Pub. No. 10:44-50. Univ. of California, Davis.

Garton, E.O., B. Hall and T.C. Foin. 1977. The impact of a campground on the bird community of a lodgepole pine forest. *In* T.C. Foin, ed., Visitor impacts on national parks: The Yosemite ecological impact study. Inst. Ecol. Pub. No. 10: 37-43. Univ. of California, Davis.

Gordon, R.R. and Pommerening, E. 1977. Surface environment and mining termination report–Kellogg, Idaho. 61 pp.

Hatch, C.R. 1977. Productivity of Idaho timberlands with special reference to the nonindustrial private forests. Pages 8-13 *in* V.H. Burlison coord. Proc. Woodland Economics and Taxation Workshop. Moscow, ID. March 15-17. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow.

Hatch, C.R., G.M. Allen, G.L. Houck, and K.M. Sowles. 1976. Timber supply projections for the state of Idaho. Forest, Wildl. and Range Exp. Sta. Bull. No. 15. Univ. of Idaho, Moscow. 19 pp.

Hayman, D., and J.G. King. 1977. Periphyton communities of high mountain streams in the Gallatin and Madison basins of Montana. Report to U.S. Forest Serv. Intermt. Forest and Range Exp. Sta.

Heller, R.C. 1977. Insect and disease management through stand management–a reality? Defoliator solutions. *In* Proc. West. Forestry and Conserv. Assoc. Meeting. Seattle, WA. Nov. 30.

______. Passive remote sensing for range evaluations. *In* Abstracts of Papers. 30th Annu. Meeting. Portland, OR. Feb. 14-17. Soc. Range Manage. 59 pp.

______. Overview of remote sensing for natural resources. *In* Proc. Remote Sensing Symp. Natur. Resources. Utah State Univ. Logan, Utah. April 21-22.

Heller, R.C., and W.A. Miller. 1977. Color infrared photos define site conditions favorable for Douglas-fir tussock moth outbreaks. Pages 43-52 *in* R.S. Driscoll chm. Aerial Color Photography in the Plant Sciences and Related Fields. Proc. 6th Biennial Workshop. Colo. State Univ. Ft. Collins. Aug. 9-11. Forest, Wildl. and Range Exp. Sta Publ. Univ. of Idaho, Moscow. Soc. Amer. Forest., Amer. Soc. of Photogrammetry, and Colo. State Univ.

Heller, R.C., and P.J. Murphy. 1977. An investigation of remote sensing techniques to estimate boating use during summer months on selected Idaho lakes. Report to Idaho Dept. of Parks and Recreation.

Henderson, D.M., F.D. Johnson, P. Packard, and R. Steele. 1977. Endangered and threatened plants of Idaho. Forest, Wildl. and Range Exp. Sta. Bull. No. 21. Univ. of Idaho, Moscow, 72 pp.

Hoffman, J.E., Jr. 1977. Relative value of selected outdoor recreation activity areas. Pages 27-31 *in* State-of-the-Art Methods for Research, Planning, and Determining the Benefits of Outdoor Recreation. USDA Forest Serv. Gen. Tech. Rep. PSW-20. Pac. SW Forest and Range Exp. Sta.

______. 1977. Socio-economic analysis of facility-resource zones at Interstate and Willow River State Parks, Wisconsin, Ph.D. Diss. College of Forestry. Univ. of Minnesota, St. Paul. 243 pp.

Hopper, K.R., E.O. Garton, L. Thorpe and T. Long. 1977. A simulation model of starling population dynamics and control in California. Report No. 1 to Starling Task Force, Univ. of California, Davis. 48 pp.

Hornocker, M.G. 1977. Mountain lions, mule deer, and elk. *In* N. Amer. Big Game. Boone and Crockett Club. R. Donnelley and Sons, Co. Chicago. 367 pp.

Howe, J.P. 1977. Kinds of material currently available but underutilized in the forest and rangelands of Idaho and adjacent areas. Final rep. to Energy Res. and Development Admin. 51 pp.

Howe, J.P., A.J. Chase, and A.A. Moslemi. 1977. Paper qualities of some woods of Iran. Final rep. to government of Iran. 17 pp.

Irving, J.S., F.S. Elle, and T.C. Bjornn. 1977. The fish populations and fishery in the Teton River prior to impoundment by Teton Dam. Report to Bureau of Reclamation. 97 pp.

Johnson, D.R., D.R. Miller, and J.M. Peek. 1977. Guidelines for human activity within the range of mountain caribou. Forest, Wildl. and Range Exp. Sta. Misc. Pub. No. 3. Univ. of Idaho, Moscow. 5 pp.

Johnson, L.R., G. Simmons, and J. Peterson. 1977. Unconventional energy sources. Northwest Energy Policy Project, Pac. NW Regional Comm. Nat. Tech. Information Serv. 275 pp.

Keay, J.A. and E.O. Garton. 1977. Terrestrial wildlife habitat inventory of BLM lands in Northern Idaho. Final rep. to U.S. Fish and Wildl. Serv. 55 pp.

Kirtibutr, N., and J.A. Schenk. 1977. Differentiation of larval *Pityokteines elegans* and *Scolytus ventralis*. Can. Entomol. 109:381-383.

Klontz, G.W. 1977. Some thoughts on how pollutants discharged from fish hatcheries are generated. Salmonid 1(3):8-10, 18.

Koehler, G.M. and M.G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterroot Wilderness. J. Wildl. Manage. 41(3):500-505.

Medema, E.L. 1977. Price uncertainty in asset markets: an economic evaluation of U.S. Forest Service stumpage rate adjustment policies and procedures. Ph.D. Diss. Univ. of Washington, Seattle. 177 pp.

McLaughlin, W.J. 1977. The Indian Hills experiment–a case study of transactive planning theory. Ph.D. Diss. Colorado State University. Ft. Collins, CO. 306 pp.

McMaster, K.M., R.G. White, R.R. Ringe, and T.C. Bjornn. 1977. Effects of reduced nighttime flows on upstream migration of adult chinook salmon and steelhead trout in the lower Snake River. Project completion rep. U.S. Army Corps of Engineers. 64 pp.

Mendel, G., and S.R. Peterson. 1977. The Hungarian partridge in Idaho. Pages 108-116 *in* Proc. Hungarian Partridge Workshop. Minot, ND. Feb. 28-March 3.

Mitchell, J.E., J.H. Schomaker, and D.B. Propst. 1977. Off-road vehicle users in Idaho: distribution and activity. Forest, Wildl. and Range Exp. Sta. Bull. No. 20. Univ. of Idaho, Moscow. 23 pp.

Mitchell, K.J. 1977. Impact of initial density and juvenile spawning on yield. Report to Forest Productivity Comm. British Columbia Forest Serv. 30 pp.

Moden, W.L., J.W. Garthe, and F.H. Pitkin. 1977. A mechanically fed containerized seedling transplanter. Trans. Amer. Soc. Agr. Engr. 20(1):38-41.

Moslemi, A.A. 1977. Woodland economics and taxation: a workshop. Welcome. Page 1 *in* V.H. Burlison coord. Proc. Woodland Economics and Taxation Workshop. Moscow, ID. March 15-17. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow.

______. 1977. A decade of resource decisions in Idaho. Introduction to Focus on Renewable Natural Resources 3(1). Forest, Wildl. and Range Exp. Sta. 1976 Annu. Rep. Univ. of Idaho, Moscow.

Mullins, W. and W.G. Bizeau. 1977. Summer food habits of sandhill cranes in Idaho. The Auk, 95:175-178.

Neuenschwander, L.F. 1977. General fire prescription parameters for ponderosa pine. Final rep. to USDA Intermtn. Forest and Range Exp. Sta. Fire in Multiple-Use Manage. Res., Development and Application Program. 12 pp.

Neuenschwander, L.F. 1977. The fire induced autecology of selected shrubs of the cold desert and surrounding forests: A state-of-the-art review. USDA Intermtn. Forest and Range Exp. Sta. Fire in Multiple-Use Manage. Res., Development and Application Program. 30 pp.

Neuenschwander, L.F. 1977. The effect of fireline construction on Green Mountain. Final rep. to Bureau of Land Manage. 10 pp.

Neuenschwander, L.F., T.L. Whigham, and H.A. Wright. 1977. Autogenic succession following burning in a tobosagrass-mesquite community. Noxious Brush and Weed Control Res. Highlights. Texas Tech. Univ., Lubbock, TX. 8:14.

Niloufari, P. 1977. Traditional wooden buildings in Iran. Forest, Wildl. and Range Exp. Sta. Note. No. 30. Univ. of Idaho, Moscow. 2 pp.

Ogden, V.T., and M.G. Hornocker. 1977. Nesting density and success of prairie falcons in southwestern Idaho. J. Wildl. Manage. 41(1):1-11.

Partridge, A.D., E.R. Canfield, and R.J. Chacko. 1977. Forest Pathology Outline. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow. 236 pp.

Peek, J.M. 1976. Summary comments: mule deer panel. Proc. West. Assoc. State Game and Fish Comm. 56:437-438. Sun Valley, ID. July 26-29.

Peek, J.M., F.D. Johnson, and N.N. Pence. 1977. Successional trends in a seral ponderosa pine/bitterbrush community related to grazing by livestock, wildlife and to fire. J. Range Manage. 31(1):49-53.

Peterson, S.R. 1977. Waterfowl use of Uinta Mountain wetlands in Utah. J. Wildl. Manage. 41(1):112-117.

Peterson, S.R., and R.S. Ellarson. 1977. Food habits of oldsquaws wintering on Lake Michigan. Wilson Bull. 89(1):81-91.

Pitkin, F.H. 1977. The college forest. Forest, Wildl. and Range Exp. Sta. Univ. of Idaho, Moscow. 24 pp.

Propst, D.B., J.H. Schomaker, and J.E. Mitchell. 1977. Attitudes of Idaho off-road vehicle users and managers. Forest, Wildl. and Range Exp. Sta. Bull. No. 23. Univ. of Idaho, Moscow. 29 pp.

Sanders, K.D. ed. 1977. Idaho Section Newsletter. Soc. Range Manage. Nos. 1-4.

Schenk, J.A., J.A. Moore, D.L. Adams, and R.L. Mahoney. 1977. A preliminary hazard rating of grand fir stands for mortality by the fir engraver. Forest Sci. 23(1):103-110.

Schroeder, W.F. 1977. Management by court decree. Forest, Wildl. and Range Exp. Sta. Misc. Pub. No. 4. Univ. of Idaho, Moscow. 12 pp.

Sharp, L.A., and K.D. Sanders. 1977. A program of rangeland development and improvement. Report to Pac. NW Regional Comm. 153 pp.

Stark, R.W. 1977. Integrated pest management in forest practice. J. Forest. 75(5):251-254.

Stark, R.W. chm. 1977. The Bases for Integrated Pest Management. Proc. 16th IUFRO World Congr. Group 6. Oslo, Norway. June 24, 1976. Forest, Wildl. and Range Exp. Sta. Spec. Pub. Univ. of Idaho, Moscow. 28 pp.

Stoszek, K.J. 1977. Factors influencing tree and stand susceptibility to Douglas-fir tussock moth attack. Bull. Entomol. Soc. Amer. 23(3):171-172.

______. 1977. Protection concerns in plantation establishment. 1977. *In* D.M. Baumgartner and R. Boyd eds. Proc. Conf. Tree Planting in the Inland Northwest. Washington State Univ., Pullman. February 1976. Washington State Univ. Coop. Ext. Serv.

Stoszek, K.J., H.L. Osborne, P.G. Mika, and J.A. Moore. 1977. The relationships of site and stand attributes and management practices to Douglas-fir tussock moth epidemics. Final rep. USDA–Douglas-Fir Tussock Moth Research and Development. 49 pp.

Stoszek, M.J., J.E. Oldfield, P.H. Weswig, and G. Carter. 1977. Effect of tall fescue, quackgrass and copper supplementation on copper metabolism and gains of beef cattle. Abstr. Page 127 *in* American Society of Animal Science. Abstracts 69th Annu. Meeting Univ. of Wisconsin, Madison. July 23-27.

Ulliman, J.J. 1976. Experimental forest map. College of Forest, Wildl. and Range Sci. Univ. of Idaho, Moscow.

______. 1977. Undergraduate research participation grant. Final rep. to Nat. Sci. Foundation. 11 pp.

Ulliman, J.J. and D.W. French. 1977. Detection of oak wilt with color IR aerial photography. Photogrammetric Engr. and Remote Sensing 43(10):1267-1272.

White, R.G. 1977. Predicted effects of water withdrawal on the fish populations of the Teton River, Idaho. Completion rep. Bureau of Reclamation. 47 pp.

Winward, A.H., and E.W. Tisdale. 1977. Taxonomy of the *Artemesia tridentata* complex in Idaho. Forest, Wildl. and Range Exp. Sta. Bull. No. 19. Univ. of Idaho, Moscow. 15 pp.

Wittinger, W.T., W.L. Pengelly, L.L. Irwin, and J.M. Peek. 1977. A 20-year record of shrub succession in logged areas in the cedar-hemlock zone of northern Idaho. NW Sci. 51(3):161-171.

Zahedi, K. and P. Niloufari. 1977. The brown-tail moth in the Caspian forests of Iran. Forest, Wildl. and Range Exp. Sta. Note No. 29, Univ. of Idaho, Moscow. 2 pp.

PH.D. DISSERTATIONS

Brown, Harold Gilson. 1977. Relationships of Douglas-fir seedling growth, soil P-fixing capacity, and site productivity to properties of soils in northern Idaho.

Hahn, Peter Karl Jacob. 1977. Effects of fluctuating and constant temperatures on behavior of steelhead trout (*Salmo gairdneri*).

Hanson, David Lee. 1977. Habitat selection and spatial interaction in allopatric and sympatric populations of cutthroat and steelhead trout.

Hobbs, Stephen Douglas. 1977. Environmental factors and vegetation related to wood decaying fungi in northern Idaho.

Krohn, William Barry. 1977. The Rocky Mountain population of the western Canada goose: its distribution, habitats, and management.

Kulhavy, David Lumir. 1977. The root and stem diseases, bark beetle complex and their interactions in standing western white pine in Idaho.

Larson, Milo James. 1977. Regeneration of meadow-associated forest stands of central north Idaho.

Skille, Jack Marvin. 1977. Epilimnial phytoplankton losses and zooplankton population dynamics in Dworshak Reservoir, 1973-1974.

MASTER'S THESES

Amos, Kevin Hanley. 1977. The control of bacterial kidney disease in spring chinook salmon.

Belli, Lawrence Alan. 1977. Survey of nonconsumptive wildlife users in Idaho.

Bramlette, William Wales. 1977. Communication characteristics and knowledge levels of Selway-Bitterroot Wilderness users.

Brown, Mark Wendell. 1977. A partial life table for the larch casebearer (*Coleophora laricella* (Lepidoptera: Coleophoridae)), with notes on egg dispersion.

Carter, Daniel Bradley. 1977. Amelioration and revegetation of smelter-contaminated soils in the Coeur d'Alene mining district of northern Idaho.

Cholewa, Anita Felice. 1977. Successional relationships of vegetational composition to logging, burning, and grazing in the Douglas-fir/Physocarpus habitat type of northern Idaho.

Coombs. Elizabeth Anne Kellogg. 1977. The impact of camping on vegetation in the Bighorn Crags, Idaho Primitive Area.

Crookston, Nicholas Lee II. 1977. Mountain pine beetle (*Dendroctonus ponderosae* Hopkins (*Coleoptera: Scolytidae*)) outbreaks in lodgepole pine (*Pinus contorta* Dougl.) and application of a climatic hazard rating to the Pacific Northwest.

Damon, William Earl, Jr. 1977. Simulation of a skidding machine designed for use in small diameter stands.

Frounfelker, Carl Richard. 1977. Prey selection of the great horned owl with reference to habitat and prey availability.

Gadwa, Gary William. 1977. Experimental transplanting of wild wood duck hens and broods in northern Idaho.

Graham, Patrick James. 1977. Juvenile steelhead trout densities in the Lochsa and Selway River drainages.

Green, Daniel Fred. 1977. Can potential recreation areas be inventoried in the office and what is the effect of travel distance upon recreation use.

Hansen, John Eric. 1977. Revegetation of toxic soils surrounding lead and zinc smelters.

Hartwig, Philip Michael. 1977. Soil effect on the tree diameter growth of a cedar/hemlock habitat type in northern Idaho.

Hensel, William Arthur. 1977. Wyssen skyline logging in northern Idaho and central Washington.

Hershey, Terry Joseph. 1976. Skunk habitat use in relation to nesting waterfowl in Manitoba.

Johnson, Thom Hoadley. 1977. Catch-and-release and trophy-fish angling regulations in the management of cutthroat trout populations and fisheries in northern Idaho streams.

Keay, Jeffrey Alan. 1977. Relationship of habitat use patterns and forage preferences of white-tailed and mule deer to post-fire vegetation, upper Selway River, Idaho.

Lambeth, Ronald Eugene. 1977. The Columbia ground squirrel in subalpine forest openings in the Idaho batholith.

Mahoney, Ronald Lynn. 1977. Classifying lodgepole pine stands as resistant or susceptible to mountain pine beetle.

McCuddin, Michael Ennis. 1977. Survival of salmon and trout embryos and fry in gravel-sand mixtures.

Murphy, Philip James. 1977. Monitoring recreational activities on six Idaho lakes using remote sensing techniques.

Pierce, Glenn Scott. 1977. Spawning migration and population structure of longnose sucker (*Catostomus catostomus*) in Alaska.

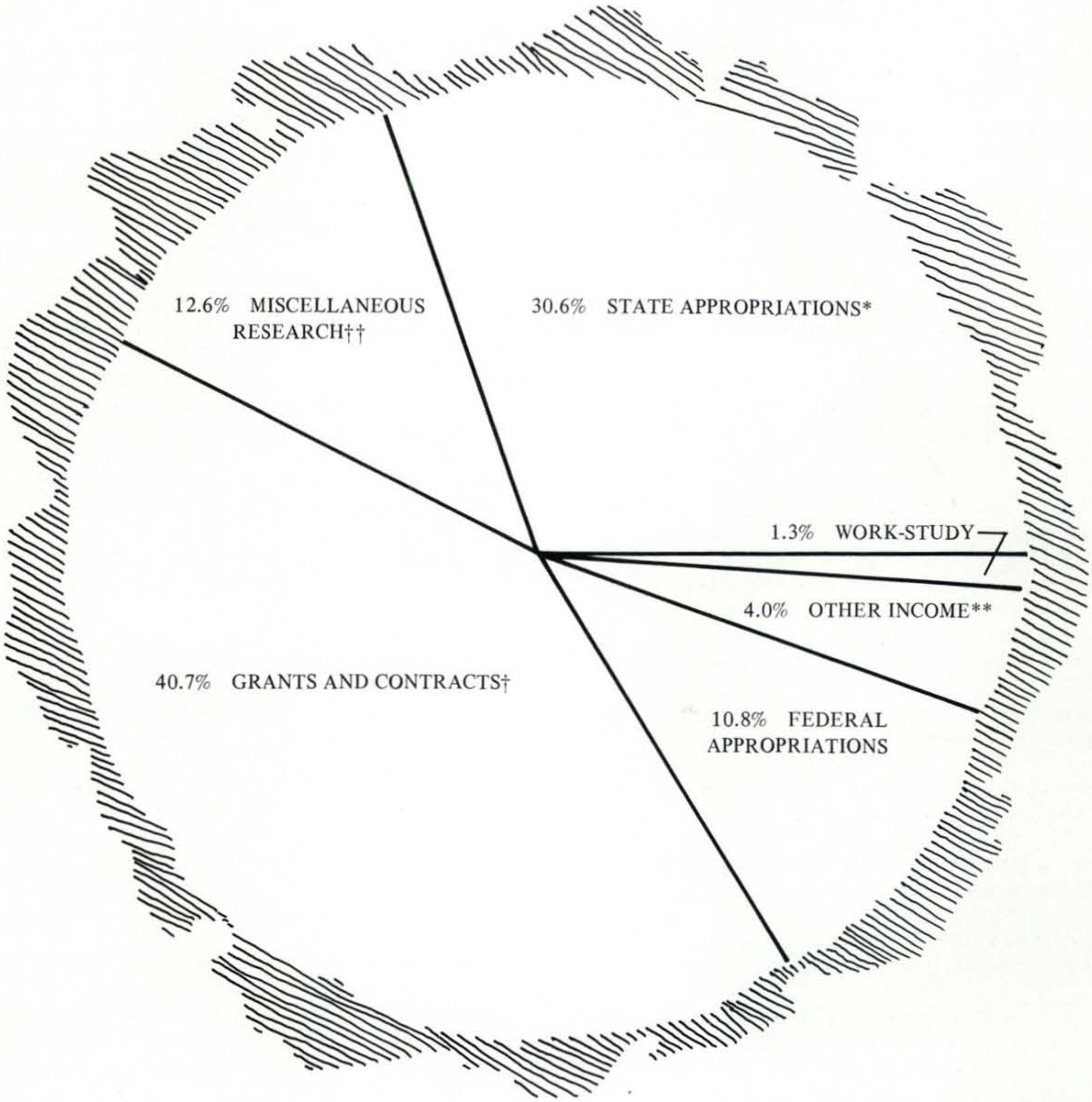
Ramirez, Pedro, Jr. 1977. Small mammal populations in different-aged clearcuts and uncut forests in northwestern Montana.

Reynolds, Doyle Gene. 1977. Home range activities and reproduction of black bears in west-central Idaho.

Riggs, Robert Alexander. 1977. Winter habitat use patterns and populations of bighorn sheep in Glacier National Park.

Wagner, Roberto Exequiel. 1977. *Verticicladiella* species associated with *Hylurgops porosus* LeConte (Coleoptera: Scolytidae) in lodgepole pine.

The Financial Picture for Fiscal Year 1978



Research expenditures, shown above by funding source, totaled $3,213,500 for the Fiscal Year 1977-1978.

* Includes FWR Experiment Station, Wildlife, Fisheries, Wilderness and Forest Utilization Research
** Includes Taylor Ranch, WICHE, Alumni Account, and Peace Corps
† Includes "in-kind" funds
†† Includes Forest Nursery, Experimental Forest and Idaho Research Foundation

grand fir and impact of silvicultural practices on fir engraver, a severely damaging beetle, are featured on page 16.

How about the economics of what we grow? Is it wise to wait 50 to 80 years to grow sawlogs? What are the returns on investment under various situations typical of Idaho conditions? Our project on Idaho timber productivity addresses these questions. Furthermore, it deals with the financial advisability of such cultural practices as pre-commercial thinning and fertilization. In financial terms, dollars per acre count more than timber size and volume on a given tract of land. Financial maturity rather than biological maturity is the key to consider in timberland management.

Range and Wildlife

Several projects feature work being done on Idaho's two key resources–its rangeland and wildlife. A major project deals with habitat typing some 18 million acres of southern Idaho range. This technique develops methodology to identify habitat types within this vast area, based on its ecological potential. This research will provide information for managing each area in accordance with its potential for range productivity.

Competition for rangeland use between livestock and wildlife is increasing. There are areas which both livestock and wildlife use for forage. The Forest, Wildlife and Range Experiment Station has now established a dietary analysis lab which can examine fecal samples to detect dietary competition.

Game species have generally dominated our wildlife research. We continue to provide research data on the various aspects of their biology and habitat requirements. The study on bobcats is an example. The Idaho Department of Fish and Game is keenly interested in proper management of this species. The data produced in this research has already been used in setting the trapping regulations for bobcats.

Interest in non-game species of wildlife is gradually increasing. Several projects are now underway on birds of prey, songbirds and other non-game wildlife. The project in this issue deals with the need to protect and enhance the habitat for snag inhabiting birds, e.g., woodpeckers, through proper snag management. In future issues, we will feature work on other non-game species.

I invite your thoughts, criticisms and comments as you look over this issue.

A. A. Moslemi

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U.S.D.A. Forest Service, Intermountain Forest and Range Experiment Station
U.S.D.A. Forest Service, Northeastern Forest Experiment Station
U.S.D.A. Forest Service, Pacific Northwest Forest and Range Experiment Station
U.S.D.A. Soil Conservation Service
U.S. Department of Commerce
U.S.D.I. Bureau of Indian Affairs
U.S.D.I. Bureau of Land Management
U.S.D.I. Bureau of Reclamation
U.S.D.I. Fish and Wildlife Service
U.S. Department of Navy/Naval Undersea Center
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