Frear, Samuel

618

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A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

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In This Issue

Cover

Researchers at the Pacific Northwest Station are conducting studies to get a better understanding of the ecological benefits large organic debris provides to the stream environment. Read more about it on page 7.

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Control structures—promising defenses against avalanches

by Rick Fletcher
Rocky Mountain Station

Snow avalanches are of increasing concern to land managers and planners throughout the West. Avalanche accidents are on the rise due to escalating development of private mountain residences, roads and highways, and a general increase in outdoor winter recreation. Recorded avalanche accidents in recent years have taken an annual average of 12 lives and caused over $250,000 in property damage and loss.

Scientists with the Rocky Mountain Station's Mountain Snow and Avalanche Research Project at Fort Collins, Colorado, are working to find ways of minimizing the hazard of avalanches to life and property. Pete Martinelli, project leader, says "One problem of increasing concern is the development of second-home, resort, and retirement communities near or in avalanche paths and runout zones (the bottom boundary of an avalanche path where most destruction to life and property occur). In the past, this problem was compounded by a general lack of a systematic approach toward land use planning in hazardous areas. But, this is changing in some mountain communities where land planners and managers are incorporating avalanche defense requirements into their local building codes."

Martinelli says that control structures—objects placed in the path of an avalanche, forcing it to turn, stop, or slow down—are some of the most promising and effective defenses against avalanches. They have been used in Europe and other parts of the world for many years with great success, and are gaining in popularity in the western U.S.

Arthur I. Mears, an avalanche control engineer who has worked with the Rocky Mountain Station's avalanche project, has authored a new report titled "Design Criteria for Avalanche Control Structures in the Runout Zone." In the paper, he has compiled what is known about selecting and designing several types of controls including deflecting, guiding, catching, retarding, and direct protection structures.

Mears says that of the several types of avalanche defenses available, a decision about which is

Earthen mounds are effective if properly placed, and are relatively inexpensive because they are composed of locally available material.

most appropriate in a given situation should be based on several factors, such as whether mobile or fixed objects are threatened, the layout and location of the avalanche path, economic considerations, type of avalanche expected and esthetic factors.

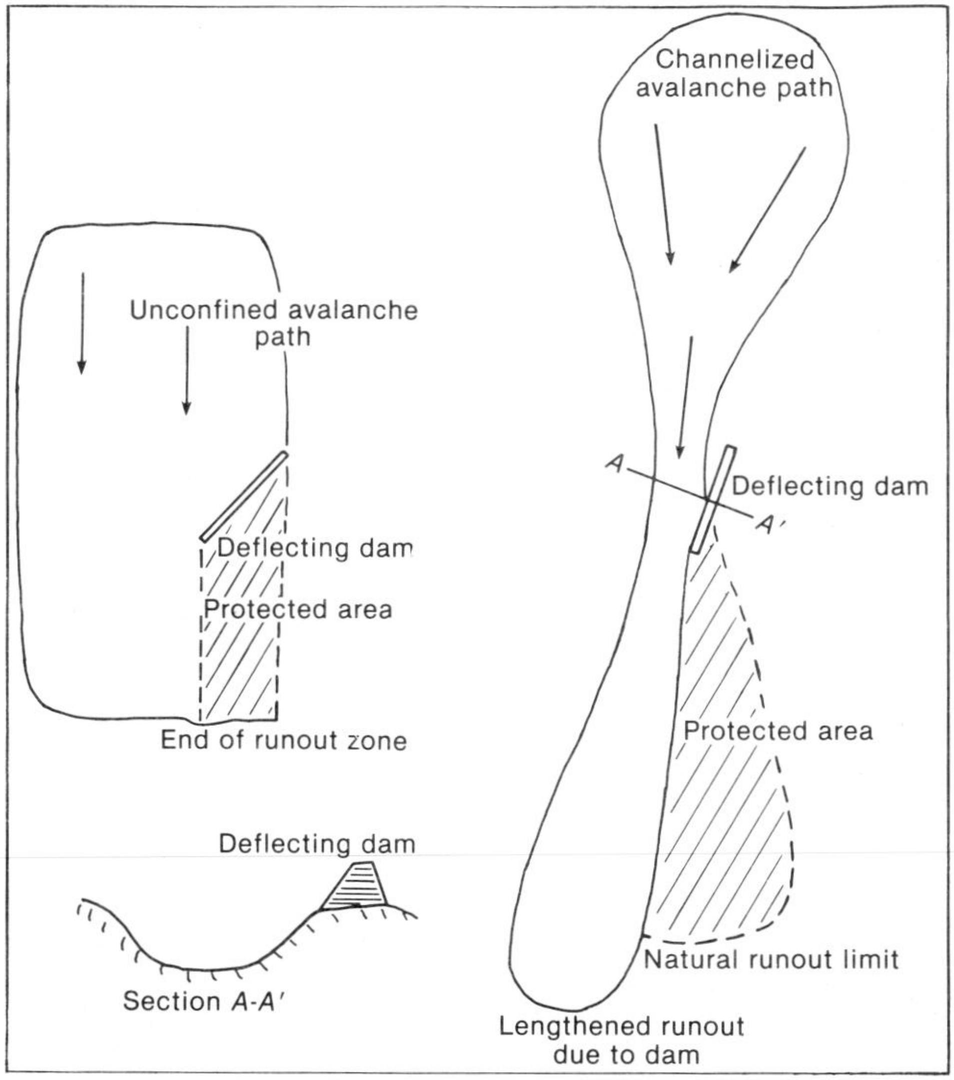
He explains that each area where avalanche hazards exist is unique and no attempt to determine the best type of structure (or even if a structure is appropriate) should be made without professional guidance.

Mears discusses several types of structures in his report. Design criteria for each structure type depends critically upon avalanche flow characteristics that must be computed by analytical techniques. Due to the complexity involved in selecting and designing them only a brief description and purpose will be listed for each. For more detailed information, write the Rocky Mountain Station and request a free copy of the report: *Design Criteria for Avalanche Control Structures in the Runout Zone,* General Technical Report RM-84, by Arthur I. Mears.

Deflecting structures

Large areas in the runout zone can be made relatively hazard-free by carefully designed and located deflecting structures such as dikes, walls, or wedges, made of earth, concrete, or rock, etc.

Deflecting structures are intended to change the direction of flowing avalanches, and have proven most effective in cases where avalanches run down a narrow gully and discharge into a broad open area. These structures are most effective on relatively gentle slopes.



This diagram illustrates the effectiveness of deflecting dams.

Catching structures

Catching structures are intended to stop flowing avalanches, or at least allow only the more diffuse, low-density powder portion of the avalanche to run over the structure and continue into the runout zone. Catching structures are generally more effective on slopes of less than 20 degrees where avalanches lose momentum naturally. They are designed for low-volume, low-speed avalanches, and are therefore effective only in carefully selected areas.

Retarding structures

The purpose of retarding structures is to shorten the distance an avalanche travels by creating friction and modifying the flow characteristics of the avalanche. This is accomplished by placing obstructions in the avalanche's path that cause lateral spreading, decrease the snow depth, and increase frictional resistance as the snow moves downhill.

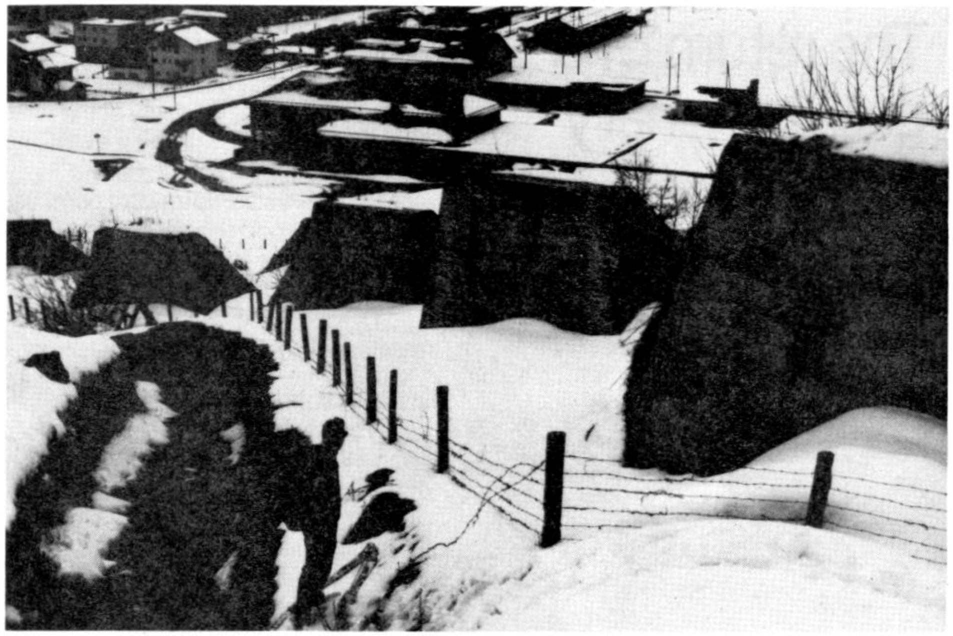
Retarding structures are some of the most effective and economical avalanche defenses available, and work best on gradients of less than 20 degrees in areas where most of the avalanches tend to stop naturally. Because these structures are designed to spread the flow laterally, they are most effective in unconfined areas and not in narrow gully-type situations.

The two types of retarding structures used are earthen mounds and structural breakers (usually made of concrete, stone, etc.). Mears says that earthen mounds are effective if properly placed and are less expensive than structural breakers because they are composed of locally available material that can be pushed into conical piles. Because material must be brought in for construction, structural breakers tend to be more expensive than earthen mounds.

Direct protection structures

Direct protection structures can be used when individual, isolated objects must be protected from avalanches. This type of defense sometimes involves the reinforcement of building walls to withstand avalanche impact. This has proven to be practical in many cases because the necessary construction can often be incorporated into the design of the building. Direct protection structures are most effective on slopes from 12 to 20 degrees.

With a continued increase in the number of people living in and visiting the mountains, and the upward spiral in real estate costs, land managers and planners are beginning to take a harder look at control structures as avalanche protective measures for mountain communities. Control structures, however, have advantages and disadvantages which must be weighed, while taking into account engineering limits, costs, legal principles, plus a host of other factors. Control structures are not the answer in every situation, but, where appropriate, they can make our mountains safer for all.



These retarding structures were built above a group of army barracks in Switzerland.

Catching structures are built perpendicular to the flow of an avalanche. Unfortunately, this dam is only about 16 feet high and would not hold back a large avalanche.

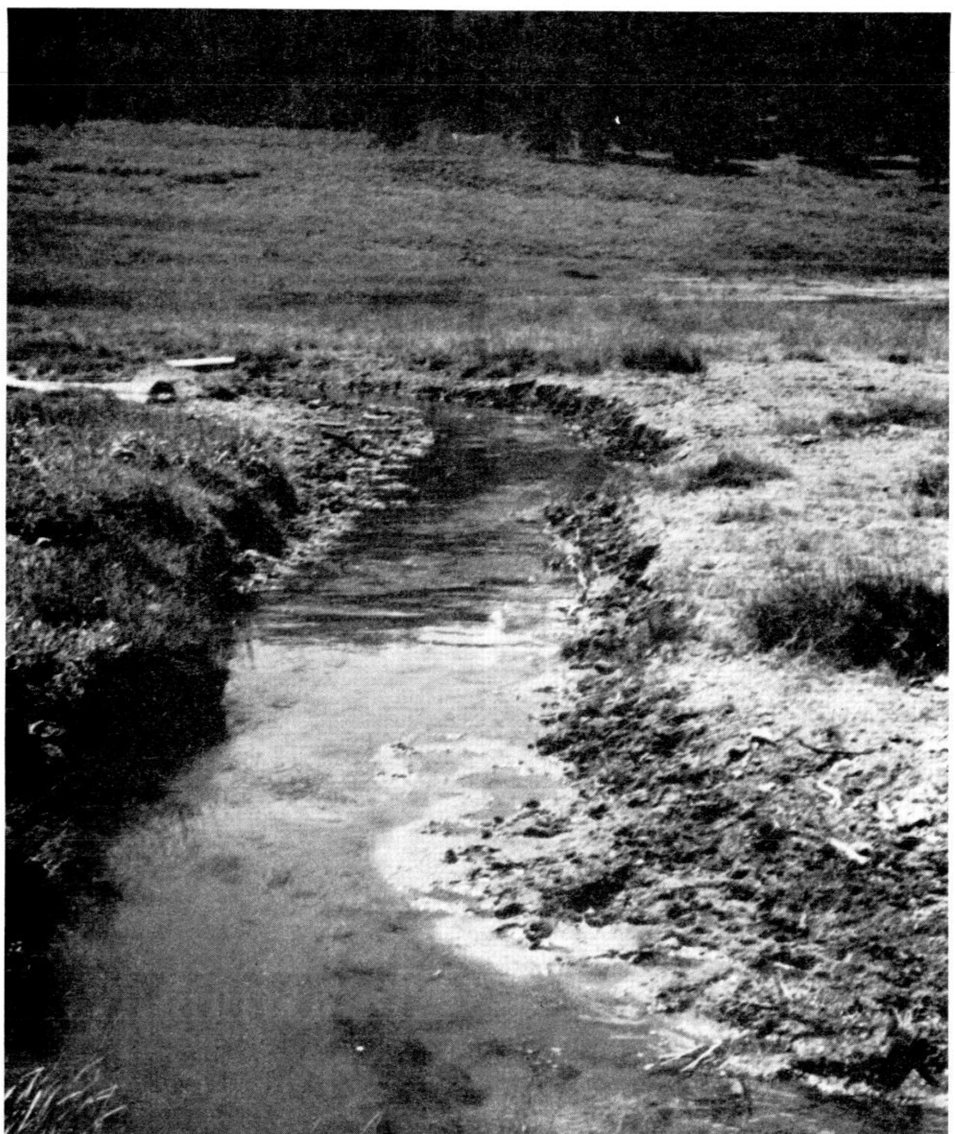
The return of a quality fishery

by Tom Baugh
Intermountain Station

The rivers and streams of Idaho provide habitat for large numbers of anadromous salmon, steelhead and resident trout. In fact, many of the salmon and steelhead which eventually end up as part of the Pacific Ocean and Pacific Northwest commercial and sport fishery are spawned in Idaho. The National Forests and Rangelands of the Gem State and the lands surrounding them are key in the maintenance of this important fishery.

In the past, prior to the period of heavy westward expansion by European man on the North American continent, stream conditions for the production of salmon and steelhead in this mountainous region were ideal. Around the turn of the century human exploitation of the land increased rapidly. As the decades passed, logging, mining, and livestock grazing increased, sometimes stripping hillsides of their vegetation and dumping sediment and mining wastes into the once pristine streams and rivers.

Livestock have trampled this streambank.



In east central Idaho acid water discharged from certain mines was continuing to destroy fish populations. The South Fork of the Salmon River had lost its runs of salmon and steelhead due mainly to fish passage problems at downstream hydroelectric plants and heavy sedimentation from road construction and logging. In addition, livestock, which prefer streamside environments, caused significant deterioriation of riparian habitat with a negative impact on the fishery.

Increasing concern led to research into methods of rehabilitating the watershed and the waters of the South Fork of the Salmon River and reestablishing the habitats needed by salmon in the parts of Idaho where they were once found. A research work unit committed to minimizing nonpoint source pollution in the northern Rocky Mountains was established by the Intermountain Station at the Forestry Sciences Laboratory in Boise, Idaho. The mission of the unit is threefold: to determine the processes influencing pollution and the effectiveness of various control practices; to provide information to predict changes in water quality from alternative land management practices; and to evaluate the effects of various pollutant levels on downstream values.

The scope of the fishery research aspect of this program has been broad, ranging from investigations of the influence of phosphate mining on macroinvertebrates through the effects of sediment particles size on salmonid spawning areas to the impact of livestock grazing on aquatic environments.

Mining impacts

In the past, environmental constraints were not as stringent as they are today. The discovery of a precious metal or needed mineral often led to development without regard for other resources. Both abandoned and active mining sites dot the West, some leaching chemical wastes into streams and rivers. Dissolved heavy metals, commonly found in waters polluted by industrial mining operations, are often toxic to aquatic life. According to Platts, "Toxicity depends on fish species, age, and stages of development, water temperature, pH, dissolved oxygen, and total hardness." Low concentrations of heavy metals can lead to behavioral changes in fish, as well as reproductive failure and fry mortality, High concentrations can lead to the destruction of the fishery. Comparing the responses of various kinds of fish, researchers have found that the salmonids are particularly susceptible to the toxic effects of heavy metals.

The setting for one of the more significant stories related to research and the salmon and steelhead fishery centers around the rugged lands on the South Fork of the Salmon River. As an old timer living on the banks of the Salmon once said, "The river at the lower crossing was so thick with salmon thrashing and darting around that the horses and mules either refused to cross or started a rodeo if forced to enter it." This, however, was not the case by the mid-1960's. Salmon were essentially gone from much of the South Fork. Fifteen percent of the South Fork watershed above the confluence of the Secesh River had been logged. In addition, 622 miles of road had been constructed. Most of the logging or road construction was on unstable or erodible areas near the river or on slopes close by. Logging and related activities had led to an increase in the amount of sediment reaching the river. Estimates indicated that of the 90,000 cubic yards of sediment the South Fork was receiving annually, 64,000 cubic yards came from roads and skid trails.

Acid waters discharged from mining operations damage fishery habitat.

According to Bill Platts, fisheries biologist at the Boise Laboratory, "The life cycle of salmon and steelhead makes them especially susceptible to impacts from man's resource development." In the South Fork, pools once used by adult salmon as holding and resting areas, which were previously deep and clear, were filled with sediment. Smaller pools and riffles used as juvenile rearing areas were also blanketed with fine sediment.

It was apparent that the amount of sediment reaching the river had to be reduced. It had previously been revealed that the natural scouring effect of the river could remove more than 20,000 cubic yards of fine sediment each year. In addition, researchers had found that salmon spawning nests should contain no more than 10-20 percent sand for optimum survival of embryos or fry.

Rehabilitation

Rehabilitation techniques on the South Fork of the Salmon River included the dredging of about 16,000 cubic yards of sediment from one large pool. To reduce future potential erosion, 400 miles of old logging roads were closed and treated by cross ditching, revegetation, removal of culverts and bridges, and removal of road fills in high hazard landslide areas.

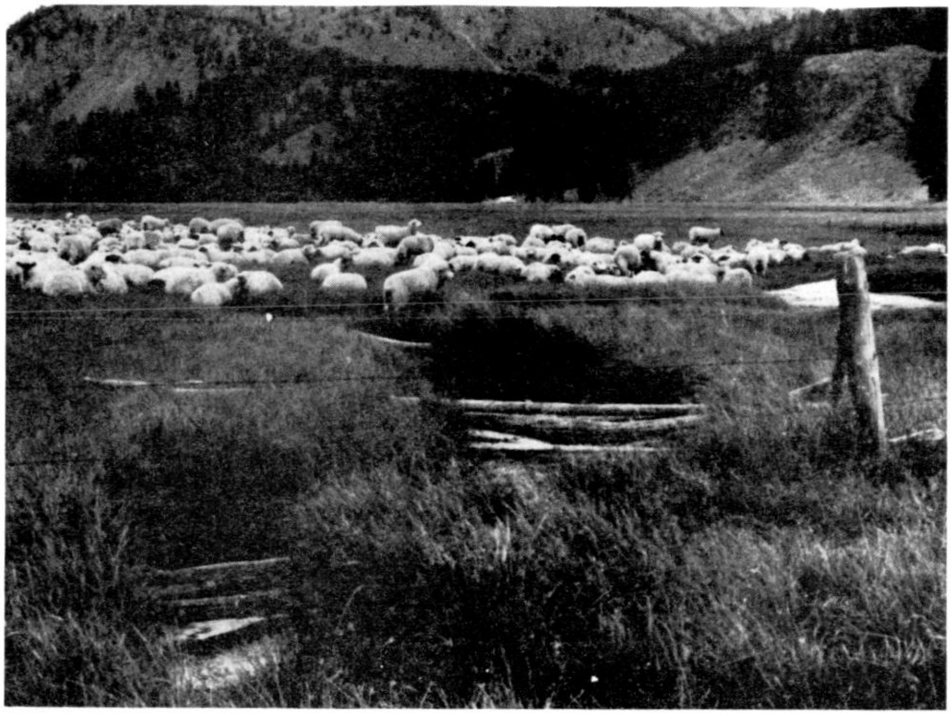
Over the decade from the mid-1960's to the mid-1970's the South Fork, responding to treatment of the watershed, slowly cleansed itself. Since 1976, from 200,000 to 400,000 summer chinook salmon smolts have been stocked in the river. Although the fishery in this river is not what it once was, there is a slow but steady recovery. Salmon are returning to the South Fork and are finding improved conditions.

Livestock impacts

The relationship of livestock and grazing to aquatic environment is complex and far reaching. According to Platts, "Fish need high-quality water. . . . Water cannot be too warm or too cold, too fertile or too infertile, too fast or too slow, or too high or too low in dissolved gasses," In other words, water conditions have to be as close to perfect as possible to support a quality salmonid fishery.

Researchers have found that streamside vegetation can be damaged, changed, or eliminated by overgrazing. Excessive grazing can reduce shade and cover and thus increase water temperatures and siltation. The structure of the stream may be radically altered as erosion of streambanks takes place. Streams modified by livestock grazing are generally wider and shallower, contain more fine sediment and unstable banks, and have higher summer temperatures than natural streams. Each of these factors has a negative impact on fish. In addition, some researchers maintain that the destruction of overhanging streambanks is one of the major factors in the decline of western native trout.

Forewarned with knowledge of what to look for, resource managers can now better modify their grazing practices to minimize negative impacts. Platts points out, however, that a host of questions remain unanswered including the definition of those early indicators that will predict stream habitat disintegration and the development of new grazing innovations to make livestock grazing more compatible with fishery needs.



Livestock are excluded from treatment areas.

In general, the problems threatening the fishery resource are so extensive that it will take years before rehabilitation techniques and alternative resource management strategies are finalized. The work at the Laboratory in Boise is, however, a good beginning toward the rebirth of quality fishery in the Intermountain West.

For additional information refer to one of the following publications, available from the Intermountain Station:

A New Freezing Technique for Sampling Salmonid Redds, Research Paper INT-248, by William S. Platts and Vance E. Penton; *Rearing of Chinook Salmon in Tributaries of the South Fork Salmon River, Idaho,* Research Paper INT-205, by William S. Platts and Fred E. Partridge; *Hydrochemical Influences on the Fishery Within the Phosphate Mining Area of Eastern Idaho,* Research Note INT-246, by William S. Platts and Susan B. Martin; *Aquatic Macroinvertebrates Within the Phosphate Mining Area of Eastern Idaho,* Research Note INT-298, by William S. Platts and Douglas A. Andrews; *Water Quality in an Idaho Stream Degraded by Acid Mine Waters,* General Technical Report INT-67, by William S. Platts and Susan B. Martin; *Riverbed Improves Over Time: South Fork Salmon,* In Symposium on Watershed Management, Vol. 1. American Society of Civil Engineers, by Walter F. Megahan, William S. Platts, and Bert Kulesza.

Ecological benefits of large organic debris in streams

by Samuel T. Frear
Pacific Northwest Station

Large debris creates a stepped stream profile, with a diversity of habitats.

To a casual visitor, a forest stream criss-crossed with large logs, sometimes piled so thick that the stream is completely hidden, appears to be wrong, a waste, and perhaps, unnatural. A stream, it may seem, should flow free, its clear waters reflecting the sun, gurgling over rocks, and passing silently through shaded pools.

Trees that form an arbor over the stream, in time, come to fall in it. The log-choked stream is a natural part of the forest environment.

There are three scientists at the Pacific Northwest Station's Forestry Sciences Laboratory in Corvallis, Oregon who are concerned about increasing public awareness of the values in keeping large organic debris in streams. They are James Sedell, research ecologist; Frederick Swanson, research geologist, and George Leinkaemper, geologist.

Their research is conducted on a case study basis. Selecting small, mountain drainages, they attempt to learn all the events in its life: both from knowlegeable people in the area and from field and aerial photographs, particularly about the debris torrents that periodically sweep down many streams. The streams are mapped in detail showing logs, root wads, trapped sediment, and floated organic debris.

From this work they learn the history and current condition of the streams. Hydrologists, entomologists, fisheries and soil scientists have joined in the study of these mountain streams, learning cause and effect of events that change a stream.

"We have a standard set of measurements so that any study area can be compared with another; there is a real array of information we collect," Lienkaemper explained. "We try to go back to a stream annually to monitor any changes. We now have 5-years of data for several streams."

Sedell has studied 100 years of history of rivers and streams in the Pacific Northwest. "We tend to forget what the natural environment is like," he says. "We lose sight of the fact that debris removal has been a large part of 'stream improvement' for more than 100 years." The results of this removal, largely accomplished between 1870 and 1915, was the loss of fish habitat: fewer pools, wider and shallower streams, fewer off-channel rearing areas, and less complex channels.

The water that forms a stream leads many lives. It begins as a trickle from a high mountain snowfield, and joins others to become small streams plunging through the steep-sloped forest until it meets rivers that eventually reach the sea. Researchers from the Pacific Northwest Station have been studying the role of large debris in small streams, as they cascade down through the Douglas-fir forest: the beginning of the river system.

In these small and intermediate-sized streams, they have found that large organic debris is the principal factor determining both their biological and physical characteristics. Debris enters the stream by blowdown, undercutting of streambanks, and mass movement of soil on adjacent slopes. Debris leaves the stream by flotation at high water or is broken down by organisms into dissolved and fine particulate matter.

This is not always a continuous process. In many instances, input and output take place in sporadic events every few decades or even centuries. These events include major episodes of blowdown, extreme floods, debris torrents, and stream cleanup following logging. In some streams it is a continual give-and-take situation, with a debris accumulation slowly growing in one place while downstream another accumulation may be collapsing and breaking up.

The researchers, in fact, have almost had to rethink their estimates on the stability of streams. Lienkaemper explained that they found logs that had survived a major storm in 1964, yet were moved or broken up by a storm of lesser intensity 13 years later. "We saw, then, that at any point in time a stream may be static, but not stable," he said.

Researchers believe that small streams in moderately stable forested watersheds have contained abundant large organic debris as long as there have been streamside forests. Large debris persists even through major forest fires. Rotting of logs in streams is slow, and large pieces of debris reside in streams for decades, sometimes longer than a century.

The researchers believe that this natural process is vital to the river system, and that people, in the management of the forests through which streams flow, must neither create conditions that will place too much debris in streams nor attempt to clean them out in the belief they are creating a better environment.

This is important, because for many years excessive debris accumulated in streams during logging. Emphasis later was placed on removal of debris from streams. "I hope that our research helps to put large wood debris into perspective, to see that it has multiple values," Swanson said.

Values of stream debris

Large debris in streams increases the "roughness" of the stream channel, causing sediment and organic matter to be trapped and slowing its movement through the stream system. Often the large debris creates a stepped stream profile, with stream energy dissipated in relatively short, steep sections of the channel.

Debris in streams also creates habitat for aquatic organisms both by serving as a substrate in the streambed and by modifying streamflow to form areas where material is deposited. These organisms, called invertebrate fauna, gouge, shred, and scrape the larger organic material and collect and consume fine organic matter in the water. In a small forest stream, more than 50 percent of the stream area may be composed of wood and wood-created habitat, forming a rich area for the many species of invertebrates.

Wood debris often has a direct influence on the size of fish populations. It provides cover and protection from predation. For young salmon and trout, debris provides protected rearing areas as well as cover. Adult salmon often inhabit pools formed by coarse woody debris and spawn in the tailouts of pools formed by debris. Fish production is likely to be highest directly behind debris accumulations and in wood created habitats.

"From a fishery point of view, streams need large timber in them," Sedell said, "not just little streams, but rivers as well." Sedell believes it is well to look back 100 years and understand "nature's" management measures. "Large woody material in streams and rivers was there when we could, in a manner of speaking, walk on the fishes back in the mid 1850's and it is not there now when we are spending millions to enhance fish habitats," he said.

Accumulations of coarse woody debris function as filtering devices, reducing the amount of fine sediments in downstream gravel areas. This filtration increases the production of food organisms for fish.

A further value of large debris in streams is its impact on the form and structure, or morphology, of a stream's channel. This is a complex relationship because the wood may cause widening and narrowing, deepening and shallowing, and stabilization and destabilization at different points along the channel bed and banks. This diversity of channel form results in diversity of habitat for aquatic organisms. In larger streams where most debris floats out, the debris plays a rather minor role in the stream environment.

Debris jams often are enormous, as this one in a Western Oregon stream.

Geography is a large variable affecting the role of debris in streams. The role will be different when topography, climate, soil and plant communities—to name a few—are different. Thus the concentration, stability and function of debris is likely to vary significantly, calling for different management strategies. The researchers' work in western Oregon and Washington sugggests that the role of debris in streams is extremely important and that there is a necessity for a general understanding of its significance in each area.

Debris removal can be harmful

What would be the long-term consequences in the Pacific Northwest if large organic debris was eliminated from streams? The researchers believe that many small streams would become "channelized" on bedrock or stable boulder pavement. A stream which previously had flowed over a series of steps formed by logs would assume a more uniform steep profile. The diversity of a stream habitat would decrease as the biologically productive pools formed by debris were eliminated. Increased water velocity would speed up the transport of fine organic matter, reducing opportunities for organisms to process it. In the intermediate size streams and rivers, debris would no longer form complex habitats at the river bends and riverbanks. The biologically rich overflow channels and sloughs formed by water surging around big wood in streams would become fewer. As a result, removal of large debris may reduce long-term productivity and increase the rate of sediment movement from headwater streams to the main river system.

Forest management activities can influence addition or removal of material and increase the probability of debris torrents which can flush channels down to bedrock. Studies in the Cascade Range indicate that most of these channel flushing events begin as small landslides on hillslopes. Management of debris torrents should begin with minimizing road and hillslope failures, not with channel cleanup, PNW researchers believe.

Debris torrents have occurred in forested areas where no logging has taken place, but forest clearcutting and road construction can increase the frequency of these events. Inventories of two western Oregon watersheds revealed that the frequency of debris torrents increased four and nine times for clearcuts and 40 and 130 times for road rights-of-way. Most of these roads were constructed before 1970, so the effects of modern road construction methods cannot be evaluated until there is a major storm that "tests" the newer roads. Repeated logging along headwater streams without buffer strips can prevent small streams from accumulating large organic debris loads.

These factors are substantially altering the character of small and intermediate sized streams in large areas of the Pacific Northwest. Neither the extent of these alterations nor the long-term biological consequences are clearly understood.

Guidelines now being used

There are, however, some general guidelines already being practiced by many forest managers to help minimize the impacts of human activity on the stream environment:

1. Minimize or eliminate input of new material to a stream during logging operations and road construction.

2. Consider biological factors when deciding whether to clean a stream.

3. Do not disturb pre-existing, stable pieces of large debris in a stream. Stability of large debris is enhanced by leaving the root wads connected.

4. Recognize the trade-offs of buffer strips along a stream. They are the future source of large debris for the stream as well as shade and litter for invertebrates.

The management of massive debris jams presents special problems. There seems to be a strong concern among land managers to remove jams because, although they do occur naturally, some are monuments to past mistakes. But there are distinct advantages to leaving the jams alone. The question often is one of releasing large volumes of sediment in a hurry, or allowing it naturally and slowly to be routed downstream. In time, the jams will deteriorate of their own accord.

"Removing logs from a large jam can also be a little like the game of pick-up sticks," Geologist Lienkaemper said. "You never know just which piece is the key that will cause the whole jam to come down."

There is much yet to be learned about large organic debris, the researchers report. "We are working toward a whole drainage view," Swanson said.

A small creek scoured out by a debris torrent

"Much of our stream and riparian research is centered on local reaches and short sections of channels. Managers are asking more and more questions about cumulative impacts within a drainage."

Lienkaemper believes it is important, too, to look at the role of debris in larger streams, but this work is just beginning. Initial results indicate that large woody debris has different functions in large rivers, but these functions are also vital to the health of fisheries and riparian resources. The main concern is for the stability of the stream: balancing protection of downstream structures such as bridges, roads, and culverts against the desirability of maintaining large debris in streams. Researchers are working on criteria for judging stability of debris pieces in small and intermediate sized streams to permit managers to plan a stable reach that includes some debris.

One basic theme arises from this research: every forested stream needs large wood. Otherwise, there is no single, simple set of rules which can be applied throughout western Oregon, much less throughout the West. Each site presents a different set of conditions of stream biology, channel gradients, stream debris, conditions of surrounding timber stand, abundance and sizes of bedload, and slope stability in the drainage. The complexity of the stream environment means that each site must be treated individually. Stream management problems call for a high degree of cooperation between specialist and administrative personnel.

Copies of *Physical Consequences of Large Organic Debris in Pacific Northwest Streams,* General Technical Report PNW-69, by Frederick J. Swanson and George W. Lienkaemper; *History, Physical Effects, and Management Implication of Large Organic Debris in Western Oregon Streams,* General Technical Report PNW-56, by Frederick J. Swanson, George W. Lienkaemper and James R. Sedell; and *Ecological Characteristics of Old-Growth Douglas-fir Forests,* General Technical Report PNW-118, by Jerry F. Franklin et al. are available from the Publications Department, Pacific Northwest Station.

Managing California's young-growth forests

by Marcia Wood
Pacific Southwest Station

Over the past few summers, technicians working for Research Forester Leroy Dolph of Redding, California, have carefully measured hundreds of young trees in the Sierra Nevada. From their records, Dolph will be able to estimate how fast each sample tree grew, how much wood it contained, and how fast similar trees—in similar forests—might grow in the future.

Dolph's analysis of growth and yield is one of more than 30 different studies that he and other scientists in the Pacific Southwest Station's Silviculture of Sierra Nevada Conifer Types Research Unit are currently conducting. Research Unit Leader Doug Roy says the studies will provide guidelines on how to manage young-growth stands of ponderosa pine, Douglas-fir, red fir, white fir and mixed-conifers in the Sierra Nevada. He explains, "We want to know how to manage every stage of a forest's development—from the time it is established, through the time it is harvested—so that the forest is as productive as possible."

Here's a brief look at some of this research.

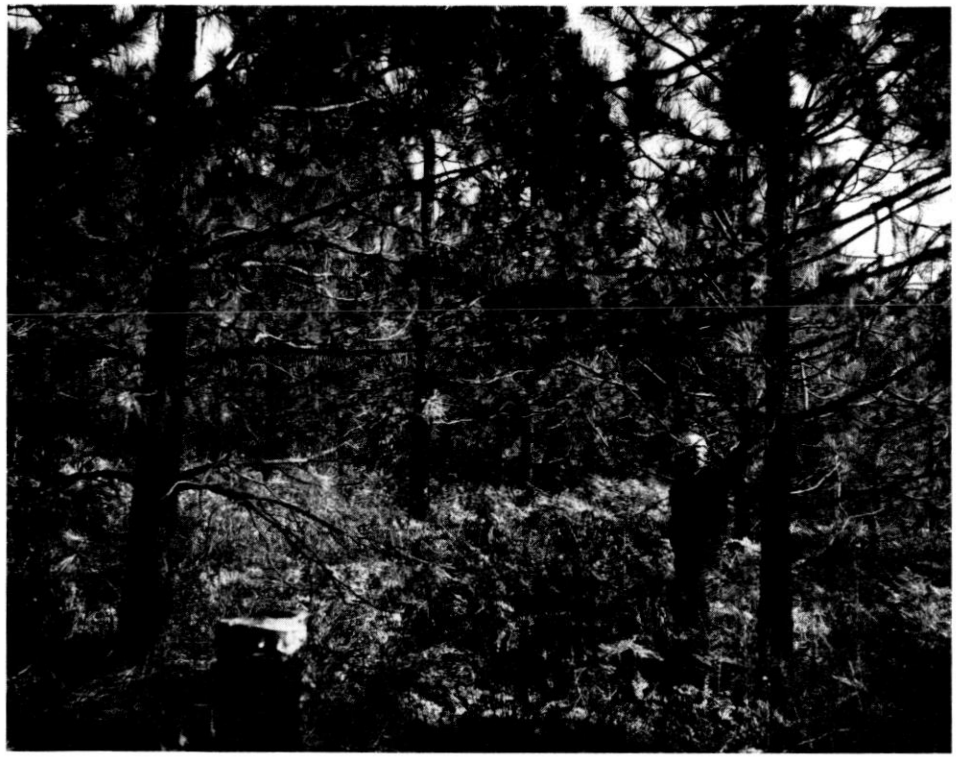
Growth and yield

Leroy Dolph is estimating future growth of mixed-conifer forests—stands that are composed of Douglas-fir, white fir, ponderosa pine, sugar pine, and incense-cedar. The work is particularly challenging because most techniques for estimating growth are designed for stands in which all trees are the same age and the same species. Mixed-conifer stands are irregular, and the distribution of the 5 component species can change drastically from one end of the Sierra Nevada to the other. "There's more Douglas-fir in the northern end that in the southern end of the mixed-conifer type, for example," Dolph says. "These differences in stand composition, along with differences in soils, elevation, weather, and similar factors, mean we have to take measurements from representative sites throughout the Sierra Nevada." So far, the field crews have cut more than 650 trees, and have taken at least 50 different measurements of each. They expect to sample at least 200 more trees before Dolph will have enough information to use in projecting the expected growth of each of the species. These growth models will be used with stand growth equations (developed by Intermountain Experiment Station researcher Al Stage) to project overall growth of young stands. If some trees are going to be removed, to enhance growth of others, the calculations can be adjusted to show the effects of these thinnings.

Controlling brush

Brush can strongly influence the growth that Dolph is measuring. Redding scientists Phil McDonald, Bill Oliver, and Bob Neal are determining how stands of mixed-conifers and plantations of ponderosa and Douglas-fir are affected by such hardy competitors as manzanita, snowbrush, rabbitbrush, deerbrush, or Sierra gooseberry. In a study that dates back to 1964, Phil McDonald is providing information on the detrimental effects of long-term competition from brush. The study site—a ponderosa pine plantation—has poor soils and too little moisture at critical times of the year. At the outset of the study, and in follow-up treatments, some study plots were completely cleared of the dense cover of brush; others were left with a light or medium cover, or the original dense cover. "The results are striking," McDonald reports. "Pine seedlings in the brush-free plots are taller and have fuller crowns that their counterparts on the brushy sites. Seedlings in the dense brush show little growth, if any, because of the combination of adverse conditions—including competition from brush and damage from insects. Apparently on sites with inadequate moisture, you must remove brush not only when you first install the plantation, but also at regular intervals afterwards, if you want to get maximum growth of the tree seedlings." McDonald has found that California needlegrass may be a good natural control. "Needlegrass invades brush-free areas and through some means that we haven't yet identified, seems to inhibit germination of brush seeds," he explains. "We hope to learn more about this."

In other research, McDonald is helping with a program to evaluate alternatives to the herbicide 2,4,5-T. He plans to try a variety of treatments on plantations of ponderosa pine and Douglas-fir, including spraying plots with chemicals that are safer than 2,4,5-T, or using hand tools and hand labor to remove shrubs. Costs for single treatments and for initial and followup treatments will be calculated, to determine how much has to be spent to release potential crop trees from brush.



Using measurements made by Technician Ross Cole (at right), Research Forester Bill Oliver estimates that ponderosa pines spaced 15 feet apart on brush-free sites will be commercial size at 23 years; on brushy sites, it will probably take an additional 11 years for trees grown at the same 15- by 15-foot spacing to reach commercial size.

Other findings

Research Forester Bill Oliver also is monitoring long-term competition between brush and ponderosa pine, as part of a study of how far apart pine seedlings should be spaced in plantations. His study was installed at the Challenge Experimental Forest in northern California, where abundant rainfall; deep, rich soils; and level terrain make growing conditions idea for ponderosa pine. Conditions at Challenge are representative of those on about 1.5 million acres of forest land along the west-side Sierra Nevada. For the experiment, seedlings were planted at 5 different spacings, ranging from 6- by 6-feet to 18-by 18-feet. All brush was removed before the seedlings were planted. On some plots, invading brush was removed; on others, shrubs were left undisturbed. "When we measured the plots 14 years after the site was planted, we found that you can lose the equivalent of 3 years of diameter growth in ponderosa pine if the seedlings have to compete with brush," he reports. "Based on the results so far, my estimate is that if you don't control the brush as you go, you have to plan on carrying the stand 10 to 12 years longer, in order for the trees to reach a marketable size."

Brush has also been of concern to Research Forester Bob Neal in several of his studies of how to establish (regenerate) new forests of ponderosa pine. For one experiment, he used different amounts of seed and different methods for preparing seedbeds on clearcut sites at the Challenge Experimental Forest. "Our results show that direct seeding (spreading seed over cleared areas) of about 1 pound of seed per acre is sufficient for regenerating clearcuts." On some plots, small and defective trees and logging leftovers (including twigs, branches, and other natural debris, or "slash") were piled into windrows for later burning. "Windrowing, when compared to leaving the slash in place—for broadcast burning—produced a greater amount of ideal seedbed," Neal says.

"Mineral soil is the best seedbed for ponderosa pine, and more of it is exposed when slash is piled than when it is left in place." In measuring the effects of brush, Neal found that one species, bear-clover, was "detrimental—in any amount—to ponderosa pine." But another shrub—deerbrush—"sometimes seems to be beneficial; under certain conditions, it 'fixes' nitrogen, converting it into a form that can be used by the pine seedlings." Neal recommends direct seeding for regenerating ponderosa pine on good sites, similar to those at Challenge. "It works, it is cheaper than planting seedlings, and it can be used for the two out of every three years that seed crops from parent trees aren't going to be sufficient for natural regeneration."

Neal also is determining how delays in seeding affect the number and the growth of those seedlings that are eventually established. "The biggest problem seems to be the longevity of brush seed," he says. "Brush seed lives for decades on the forest floor, while seed of most conifers must germinate within the first year after seedfall. If brush already has occupied a site for a couple of years, the conifer seedlings probably aren't going to make it. As time passes after logging, the brush occupies more and more of the area. The locations where it's possible to establish ponderosa pine become fewer in number and smaller in size. In some cases, even a one-year delay in getting pine regeneration started can be disastrous."

Thinning and nutrients

Bill Oliver and Research Forester Bob Powers are working together on an experiment that will show how thinning and applications of fertilizer affect the way nitrogen, phosphorus, potassium, and other minerals that trees need are cycled through the forest ecosystem. Their study site is a sapling and pole-sized stand of red fir, growing at Pumice Stone Mountain in the Klamath National Forest in northern California. "The volcanic soils at Pumice Stone are typical of those found in the red fir region of the Cascade Range in northern California, Oregon, and Washington," Powers says. "If there are any really sterile soils in the West, they are these pumice soils." The Pumice Stone stand was thinned to two different stand densities; selected plots were fertilized with about 270 pounds per acre of nitrogen. In measurements made 3 years after thinning, Powers and Oliver found that applying fertilizer increased tree growth anywhere from about 20 to 55 percent. "Even on the unthinned plots, where stands were extremely dense and trees were under tremendous competition with each other, the fir still showed nearly 20 percent increase in growth in response to fertilization," Powers says.

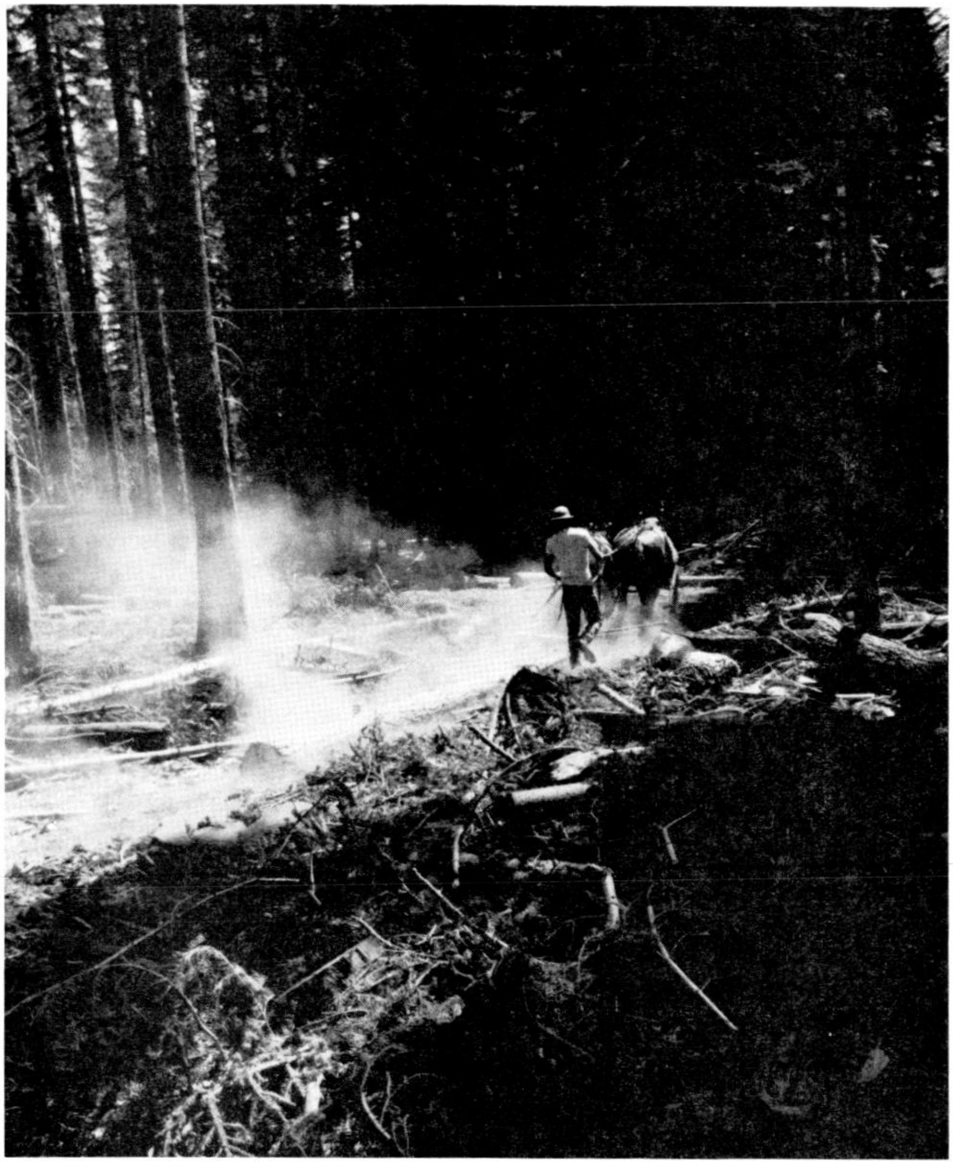
Other nutrient studies

In addition to the work at Pumice Stone, Powers is conducting a series of experiments that will show how trees and forest soils on a full range of commercial forest sites will respond to fertilizer. Known as the California Forest Soil Fertility Program, this 10-year effort is designed to provide guidelines for estimating the amount of tree growth that may occur—as a result of fertilization—on various sites, and to produce tests that can be used to identify nutrient deficiencies. Fertilizer trials are underway at more than 40 locations, covering all major timber types in northern California except redwood. The National Forest System's Pacific Southwest Region is co-sponsoring the Program.

A major concern in all of the studies involving the addition of nitrogen fertilizer to the forest ecosystem is the possibility that the treatments will increase the amount of the nitrate form of nitrogen, and that this nitrate will eventually end up in drinking water. Powers studied soil water chemistry on all of the fertilized study plots, and found that nitrate concentrations "rarely even approached or exceeded the U.S. Environmental Protection Agency and U.S. Public Health Service limit of nitrate in drinking water."

Prescribed burns

The nutrient composition of a forest also can be affected by prescribed burns—carefully controlled fires that are used to get rid of the hazardous buildup of natural fuels, to prepare a site for planting or natural seeding, or for other purposes. Changes in the nutrient composition of tree and soils will be among the factors that Research Forester Phil Weatherspoon will monitor in a series of some 20 prescribed burns in young-growth forests of white fir, California red fir, and mixed conifers. For each fire, he will determine: How much woody debris was consumed? How much new fuel (such as small trees that were killed by the fire) was added to the site? Did the fire damage crop trees? How was tree growth affected? Did the fire cause brush seeds to germinate, and increase the brush problem on the site? Weatherspoon will use the results of these experiments to predict the effects that prescribed fires will have, given certain site and stand conditions, preburn fuel and weather conditions, and fire characteristics.



Horse logging—how much does it cost? Does it cause less wear and tear on crop trees than other logging methods? These are some of the questions that the Jennie Springs experiment is designed to answer.

Jennie Springs venture

Weatherspoon also will help with a comprehensive study at a site known as Jennie Springs, where a young stand of white fir is being thinned and a series of experiments, including using different stocking levels, fertilization treatments, and slash disposal techniques, are being installed. "The Jennie Springs study should give us some good information on how to bring a 'wild' stand into management," says Research Forester Bill Oliver, who is coordinating all of the Jennie Springs studies. The stand is being thinned to four different stocking levels.

Weatherspoon's part will be to determine the effects of prescribed burning. On some plots, he will burn both before logging, to reduce the amount of natural fuel that has accumulated, and then again after logging, to get rid of the logging debris. Bob Powers' job at Jennie Springs will be to determine how applying different kinds of fertilizers, and removing different amounts of branches and foliage, affects tree growth and nutrient cycling. "Branches and foliage are rich in nutrients," he explains. "As these tree parts decompose, the minerals they contain are returned to the stand. We want to find out whether increased use—in the future—of branches and foliage will deplete forests of needed nutrients." Bill Oliver will be responsible for determining which stocking levels give the best growth.

Logging at Jennie Springs started in September 1981. The harvest was somewhat unusual, in that teams of mules and draft horses—instead of mechanical skidders—were used to haul logs out of the woods. "We think we will avoid much of the damage that you normally get when you try to maneuver heavy equipment around in true fir," says Research Forester Jim Laacke, whose idea it was to use horse logging. "Our concern is for the trees that are left in the stand after logging. Fir has thin bark and is easily damaged: once the bark is scraped off, the tree is much more vulnerable to attack by insects or diseases."

Logging Swain Mountain

Perhaps even more ambitious than the Jennie Springs experiment is Laacke's plan to log half of the 6,000-acre Swain Mountain Experimental Forest, to convert the old-growth stands of red fir and white fir there to a young-growth forest. "With so much of California's commercial timberland now in young-growth management, it only seems appropriate that we concentrate on problems of young-growth management at Swain Mountain. We hope to make Swain a demonstration site, where foresters can get ideas that they can use in their own areas." Plans call for the Forest to be logged in a series of shelterwood cuttings, in which 5, 10, or 15 trees will be left on each acre as a source of seed or shelter for the new stand. Studies of natural and artificial regeneration, fertilization, thinning, prescribed burning, and other techniques for intensively managing the fir forest will start shortly after logging. Perhaps more strongly that any other aspect of the Redding program, the dramatic move to convert Swain Mountain emphasizes the Unit's commitment to develop the best possible guidelines on how to increase the productivity of northern California's young-growth forests.

Veneer bolt spinout—A problem of the past

by Jane Suleski
Forest Products Laboratory

Veneer plays an extremely significant role in the forest products industry. Each year, approximately 700 million cubic feet of wood goes into veneer production, the majority of which is used in plywood. In 1979, plywood accounted for 13 percent of the total volume of all wood products and 33 percent of the total value. In comparison, lumber accounted for 76 percent of the total volume and 60 percent of the total value. While lumber has almost six times the volume of plywood, it has only twice the value. When considering the U.S. panel products industry, plywood accounts for about 65 percent of the volume and 80 percent of the value.

Because veneer products represent such a substantial portion of U.S. wood products, maximum recovery of veneer improves timber utilization and is important economically. Throughout the industry, however, three major problems continue to reduce veneer yields—spinout, large core size and unpeelable logs.

Spinout occurs when the torque needed to peel the log is greater than the amount that the chucks can transmit. When the wood fails, the chucks spin free and the log becomes useless for veneer peeling. Reports show this happens in about 5 to 8 percent of the logs peeled for veneer.

A related problem is that a relatively large core remains after usual veneer peeling. The size of the core is determined by the chuck size. Obviously core size can be reduced by using smaller chucks, but this increases the chances of spinout. Although efforts have been made to solve this problem by redesigning the chucks and using dual chucks, neither has eliminated spinout or the large core that remains.

The third major problem with conventional veneer peeling is that logs with bad centers are unpeelable. Estimates are that 20 to 25 percent of all logs are incapable of being peeled using existing technology. These logs cannot be adequately gripped by the chucks. Consequently, they are relegated to sawtimber, the chipper or are left in the woods.

To improve veneer yields, researchers at the Forest Products Laboratory (FPL) in Madison, Wisconsin, have developed equipment to provide auxiliary torque to veneer bolts. The powered back-up roll (PBR) provides torque to the outer surface of the log as it is peeled. Thus, lathe chucks are not the only source of torque available to turn the log. Since less torque is required from the chucks, the probability of spinout is reduced. Also, the PBR enables smaller chucks to be used. This means the core size will be small and presently unpeelable logs can be peeled.

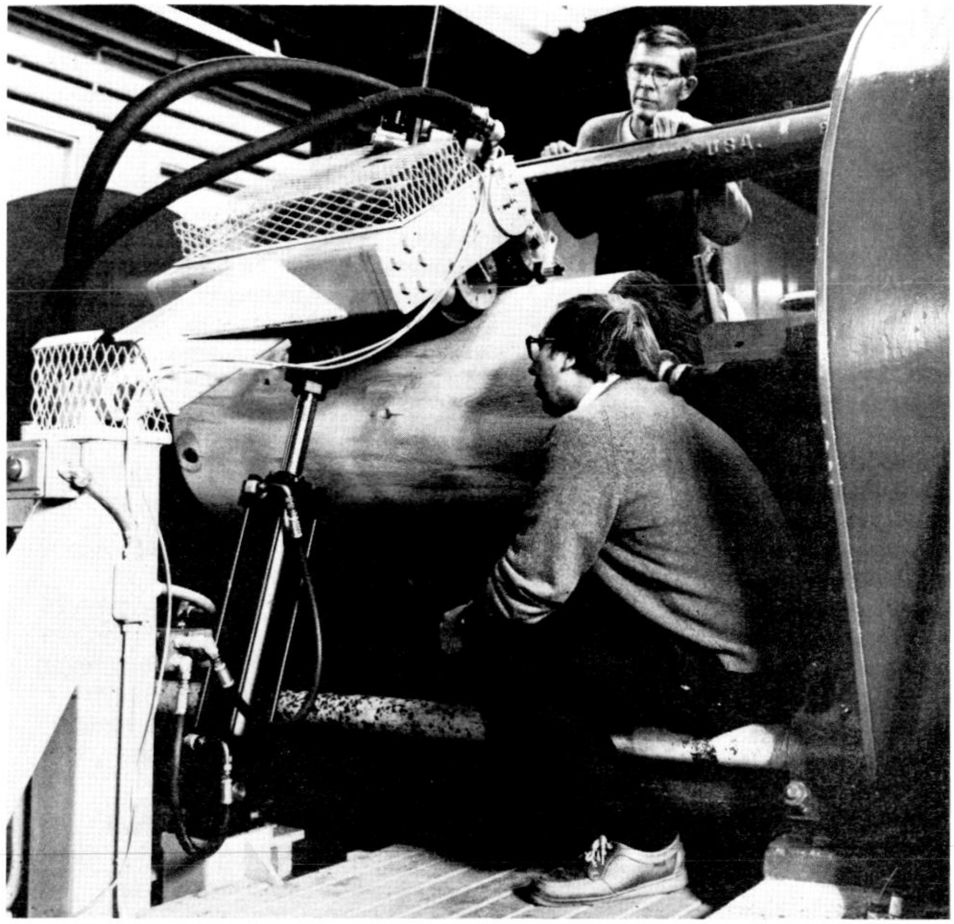
"The powered back-up roll is designed to be compatible with modern industrial lathes and peripheral equipment," says FPL Research Engineer Frank Fronczak, who conceived the process almost four years ago. The PBR transmits torque by using two hydraulically powered rollers that turn against the log surface. Made from steel tubing, the rollers are coated with DuPont brand Adiprene—a urethane rubber material used because of its relatively high strength, coefficient of friction and abrasion resistance. The resiliance of the surface coating provides a relatively large contact area between the rollers and the log. This enables significant torque to be transmitted without damaging the veneer.

The torque can be controlled by regulating the pressure drop across the motor with a servo-valve and servo-controller or supply pressure to the motor can be maintained constant by a manually operated relief valve.

"To evaluate the effectiveness of the PBR, we established a comprehensive test program," explains Fronczak. "Objectives were to measure the torque provided by the PBR, evaluate the quality of the veneer peeled using the PBR, evaluate the roller coating material and develop criteria for optimum controls of the PBR," he adds. West coast Douglas-fir was used. Veneer thicknesses tested were 1/32, 1/16 and 1/10 inch.

The measured torque was the torque actually provided by the lathe. A value for the PBR torque was the difference in torque readings between regular peeling and peeling with the PBR. The PBR provided 100 percent of the torque required to peel 1/32 and 1/16 inch veneer from 4 foot bolts and about 85 percent of the torque for 1/10 inch veneer. The logs were kept green, but were not heated.

"Although the PBR actually provided all the torque to peel thin veneer, we originally felt that if 10 percent of the total required torque could be provided by the PBR, it would be a worth while investment," Fronczak points out.



The quality of the veneer peeled using PBR was compared to that using conventional technology. The comparison was based on uniformity of thickness, surface smoothness and finished appearance. The objective was to determine if the rollers damaged or scuffed the veneer. The results indicated veneer quality and thickness were not affected by the PBR. The roller surface showed no signs of wear.

Success with the PBR has attracted interest from lathe equipment manufacturers and veneer-plywood producers. Some of these industries are cooperating with the FPL on a plan to install a production model in an actual mill operation.

Future research will explore the possibility of peeling veneer without chucks driving the log—providing all of the torque from the PBR. Another study will deal with peeling thick veneer, from 3/16 inch on up. This may spur the development of new veneer products and thus reinforce the already important role that veneer plays in the forest products industry.

New publications

To Order Publications

Single copies of publications referred to in this magazine are available without charge from the issuing station unless another source is indicated. When requesting a publication, give author, title and number.

Genetics research technique reviewed

One of the easiest, fastest, and least expensive ways to determine the genetic composition of forest trees is a technique known as isozyme analysis. This is the opinion of M. Thompson Conkle, a research geneticist with the Pacific Southwest Station and a leader in the use of isozyme analysis in forest genetics research.

Conkle is Technical Coordinator of a new collection of papers on isozyme research. The publication, *Proceedings of the Symposium on Isozymes of North American Forest Trees and Forest Insects, July 27, 1979, Berkeley, California,* General Technical Report PSW-48, is now available from the Pacific Southwest Station.

The Proceedings represent the work of scientists from the U.S., Canada, and Australia. The 10 reports include general discussions of isozyme analysis, and descriptions of the use of the technique for monitoring and protecting genetic diversity and for designing tree breeding programs. Past applications of the approach for evaluating the genetic make-up of Sitka spruce, quaking aspen, Douglas-fir, and several pines—including knobcone, lodgepole, loblolly, Jeffrey, sugar, and ponderosa—are also described.

Also discussed is the use of isozyme analysis in forest insect research, as a method to evaluate genetic differences among regional populations of such species as the western spruce budworm, Douglas-fir tussock moth, or Douglas-fir beetle. The variations are important because they may affect the way that pest species respond to insecticides or to other control methods.

In isozyme research, the proteins, or enzymes, in either the tree seeds or in the insect bodies are analyzed. Because protein formation is a function of genes, information gained from analyzing the proteins provides, in turn, clues to the genetic makeup of the tree or insect.

Further information about the procedures involved in isozyme analysis is presented in the Proceedings. Copies may be requested from the Publications Distribution Section, Pacific Southwest Station.

DFSIM—a new simulator for managed stands of coastal Douglas-fir

A new computer program for estimating yields of managed stands of coastal Douglas-fir has been developed at the Pacific Northwest Station in cooperation with Weyerhaeuser Company and other public and private companies and agencies. Called DFSIM (Douglas-fir Simulator), the program was develop from field data contributed by 13 organizations.

DFSIM has a much better data base than previous stand simulators, is more flexible and can represent a wider range of stand conditions. The simulator produces yield tables which take into account the effects of initial spacing, precommercial and commercial thinning, and nitrogen fertilization.

A new publication describes the data base for the program, construction and operation of the simulator, limitations of the program, and potential for future development.

Copies of *A New Stand Simulator for Coast Douglas-fir: DFSIM User's Guide,* General Technical Report PNW-128, by Robert O. Curtis, Gary W. Clendenen, and Donald J. DeMars, are available from the Pacific Northwest Station. The computer program itself is available from the authors at the Forestry Sciences Laboratory, 3625 93rd Avenue, S.W., Olympia, WA 98502.

A field test of Engelmann spruce seed sources

It is not uncommon for high altitude spruce plantations in the Rockies to fail because of environmental and biotic factors. However, results from a study done on a subalpine plantation show that Engelmann spruce, planted from 20 sources throughout North America, averaged 73 percent survival after 10 years, with sources from northern latitudes and low elevations exhibiting better height growth. Plantation success was attributed to proper planting techniques and yearly maintenance procedures.

If you would like to know more about the study, including planting methods and materials, survival results, height growth, and study conclusions, write the Rocky Mountain Station for your free copy of *An Engelmann Spruce Seed Source Study in the Central Rockies,* Research Paper RM-231, by Wayne D. Shepperd, Richard M. Jeffers, and Frank Ronco, Jr.

Sampling the pinyon-juniper woodlands

Although pinyon-juniper woodlands cover vast areas in the western United States, only recently has attention been given to assessing their wood resources.

A new report issued by the Intermountain Station explains, in detail, how point sampling and line-intersect sampling can be used to determine biomass, growth rates, and other characteristics of singleleaf pinyon-Utah juniper stands.

The procedure, described in *Point and Line-Intersect Sampling in Pinyon-Juniper Woodlands,* General Technical Report INT-104, FR28, uses two different, but related, methods for selecting sample trees. Which method to use depends primarily on the characteristics of the stand to be sampled. If the stand contains a high proportion of juniper or if the pinyon stems are irregular or difficult to see at stump height, the line-intersect method is the proper choice. But it is difficult to use the line-intersect method in some older stands because the tree crowns are sparse and irregular and reach their maximum spread at heights well above the ground. Here, the point method is the clear choice.

The procedures apply to simple situations as well as the more complex. For example, to estimate the pinyon cordwood volume in a stand, it is only necessary to lay out a few transect lines and determine the heights and stump diameters of the intersected pinyon trees.

Authors of the report are Richard Meeuwig, leader of the Intermountain Station's Pinyon-juniper Ecology and Management research work unit at the Renewable Resources Center, University of Nevada, Reno; and Jerry Budy, assistant professor of forestry at the University.

Meeuwig says, at first glance, the report may seem to be a complicated series of equations and tables and contains elements that may, at present, be of little interest to most woodland managers. But as use and management of pinyon-juniper woodlands intensifies, these procedures will become important aids to effective management of the woodlands.

Two new reports published in anadromous fish series

Forest managers interested in improving habitat for anadromous fish will find help in two new publications from the Pacific Northwest Station. The two reports, *Effects of Mining* and *Effects of Livestock Grazing* are part of a series being published by the Station.

In *Effects of Mining,* General Technical Report PNW-119, by Susan B. Martin and William S. Platts of the Intermountain Station, the major effects of mining on fish habitat are identified as: excessive sedimentation, changes in pH, and addition of toxic heavy metals to the water. Excessive sediment can eliminate habitat for aquatic insects, reduce the permeability of spawning gravels, and block the interchanges of subsurface and surface waters. A favorable pH range for fish is generally 6.5 to 8.7 Fish can exist for short periods at slightly above and below this range, but extended periods at higher or lower levels is probably harmful. Toxic metals commonly released by mining are arsenic, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, and zinc. These metals, singly or in combination, can cause mortality, or cause fish to avoid polluted areas.

Effects of Livestock Grazing, General Technical Report PNW-124, by William S. Platts summarizes the available literature on the effects of livestock grazing on streams and their riparian environments. Since livestock concentrate along streams, they can have an adverse effect on the fisheries resource. Management guidelines are given.

Four other reports in the series are also available: *Habitat Requirements of Anadromous Salmonids,* General Technical Report PNW-96, *Impacts of Natural Events,* General Technical Report PNW-104, *Planning Forest Roads to Protect Salmonid Habitat,* General Technical Report PNW-109, and *Processing Mills and Camps,* General Technical Report PNW-113.

Tree improvement programs analyzed

A recent economic analysis has shown that two major tree improvement programs underway in California and the Pacific Northwest "appear to be quite profitable." The report, *A Break Even Cost-benefit Analysis of West Coast Tree Improvement Programs,* Research paper PSW-156, is one of the first to look at both the biological and economic factors in tree improvement programs for long-rotation western conifers. It was prepared by Research Geneticist F. Thomas Ledig of the Pacific Southwest Station and Economist Richard L. Porterfield of Champion International Corporation.

For the study, the researchers selected the ponderosa pine portion of the tree improvement program used on the National Forests of California, and the industry-sponsored Progressive Tree Improvement Program for Douglas-fir in Oregon and Washington. The goal of both programs is to use seed from superior parent trees to establish plantations of vigorous trees that out-produce their "wild" counterparts.

The economic factors used in the analysis include an interest rate of 8 percent and current and anticipated stumpage prices. For the ponderosa pine program, Ledig and Porterfield concluded that "a fixed rate of return of 8 percent on investment appears feasible by using a short rotation of 50 to 60 years, instead of 120 years, or by accompanying tree improvement with periodic thinning." They note, "Only a 6.3 percent improvement in volume over that produced in a normal, unimproved plantation will bring an 8 percent return on investment. And, based on experience with other tree species—especially the southern pines—6.3 percent seems easy to obtain."

Costs for the Pacific Northwest Program are lower, and only a 1.8 percent volume improvement is needed to provide the 8 percent return on investment. A second phase of the program would require even less volume improvement (0.8 percent) to break even.

The authors stess that interest rates, length of rotation, thinning, and site index have a greater effect on the expected profit of both programs than such factors as the size of the seed collection or breeding zone. With reasonable interest rates, however, along with realistic increases in stumpage prices, and good silviculture, Ledig and Porterfield expect that the costs of both programs can be justified.

Futher details are in the Report, which is available from the Publications Distribution Section, Pacific Southwest Station.

Literature on sagebrush

Sagebrush, at one time considered worthy only of eradication, is now recognized as one of the most important shrubs in western North America.

Shrubby *Artemisia* (Sagebrush) species are associated with over 200 million acres in the western United States alone. Management and research decisions often require a literature review to obtain information about the expected effect of certain management practices on the ecology and biology of sagebrush.

Such a review is now available in *A Computerized Bibliography of Selected Sagebrush Species (Genus Artemisia) in Western North America,* General Technical Report INT-102-FR28, published by the Intermountain Station. Authors are Roy O. Harniss, range scientist for the Intermountain Station; Stephen J. Harvey, currently completing his M.S. in plant ecology at Montana State University, Bozeman; and Robert B. Murray, a range scientist at the U.S. Sheep Experiment Station, Dubois, Idaho.

The three scientists have compiled and indexed the literature on sagebrush from the 1800's to 1980. Biological abstracts, herbage abstracts, dissertation abstracts, and the bibliographies of papers were used to compile the citations. Articles directly concerning sagebrush or sagebrush-dominated communities are the core of the bibliography.

Write to the Intermountain Station for a copy.

Predicting fire behavior from photos of residue

In 1976, the Pacific Northwest Station began publishing a series of publications which use color photos to describe and categorize forest residue. Station researchers have now carried this idea a step further to relate residue photos to fire hazard. Three new publications provide tables for predicting the rate of fire spread, flame length, and resistance to control of various levels of residue shown in photos, under varied environmental conditions, in selected timber types. The new publications are designed for use with three photo series on residue published between 1976 and 1979.

The new publications are available from the Pacific Northwest Station, but only one of the older companion reports is still available. The new publication is given first in the following list, along with the companion report in parentheses.

Predictions of Fire Behavior and Resistance to Control for Use with Photo Series for the Sierra Mixed Conifer Type and the Sierra True fir Type, General Technical Report PNW-114, by Franklin R. Ward and David V. Sandberg *(Photo Series for Quantifying Forest Residues in the Sierra Mixed Conifer Type and Sierra True Fir Type,* General Technical Report PNW-95, by Wayne G. Maxwell and Franklin R. Ward; available only in libraries).

Predictions of Fire Behavior and Resistance to Control for Use with Photo Series for the Ponderosa Pine Type, Ponderosa Pine and Associated Species Type, and Lodgepole Pine Type, General Technical Report PNW-115, by Franklin R. Ward and David V. Sandberg *(Photo Series for Quantifying Forest Residues in the Ponderosa Pine and Associated Species Type, Lodgepole Pine Type,* General Technical Report PNW-52, by Wayne G. Maxwell and Franklin R. Ward; limited supply at the Government Bookstore in Seattle, Washington).

Predictions of Fire Behavior and Resistance to Control for Use with Photo Series for the Douglas-fir—Hemlock Type and the Coastal Douglas-fir—Hardwood Type, General Technical Report PNW-116, by David V. Sandberg and Franklin R. Ward *(Photo Series for Quantifying Forest Residues in the Coastal Douglas-fir—Hemlock Type and Coastal Douglas-fir—hardwood Type,* General Technical Report PNW-51, by Wayne G. Maxwell and Franklin R. Ward; available only in libraries.)

Ecology of wetland vegetation described

Thousands of impoundments in the form of coal strip mine ponds, stockdams, and dugouts have been constructed where natural wetlands are largely absent in the Northern Great Plains. With proper land management, these wetlands can provide excellent wildlife and fish habitat, water sources for irrigation, livestock, and recreational opportunities.

Current information on the ecology of wetland vegetation and associated environmental factors has been consolidated in a new paper published by the Rocky Mountain Station. The report describes the need for intensified management plans for strip mine ponds, stockdams, and dugouts; the formation and physical characteristics of these diversified rangeland ecosystems; the history of wetland vegetation studies; major environmental factors functioning on constructed impoundments; and the interaction between environmental factors and wetland plant communities.

For your copy of this paper, write the Rocky Mountain Station and request *Wetland Vegetation, Environmental Factors, and Their Interaction in Strip Mine Ponds, Stockdams, and Natural Wetlands,* General Technical Report RM-85, by Richard A. Olson.

Analyzing yarding costs

The key factor in estimating the costs of yarding timber is the relationship between the combined costs of owning and operating equipment and the production rate, or volume of timber brought to the landing per unit of time. Estimating and comparing costs of alternative yarding systems can now be done easily by using computer programs developed at the Pacific Northwest Station and described in a new publication.

In addition to the computer programs, the report includes a detailed analysis of the yarding cost structure on which the programs are based. The machine rate, or cost per hour, is made up of ownership costs (depreciation, interest, licenses, etc.) and operating costs (labor and supervision, maintenance, fuel, tires, lines and rigging, etc.). The production rate is figured on the average log volume per turn and number of turns per hour. Thus, equipment that costs more initially because it has features that reduce yarding cycle time and delays may be a better buy because it increases productivity.

The programs were developed on a Hewlett-Packard 97 or 67 calculator and a 9845A desk-top computer, using BASIC language.

Copies of *Computer Assisted Yarding Cost Analysis,* General Technical Report PNW-108, by Ronald W. Mifflin, are available from the Pacific Northwest Station.

Pheromones are commercially produced

The study of pheromones has moved out of the laboratory and into the forest as a commercially available product for managers to control one forest pest—the western pine shoot borer.

Synthetic sex pheromones—odorous chemicals that attract the male of the species—may be obtained from Albany International Corp., Controlled Release Division, Needham Heights, Mass., and Health-Chem Corp., Hircon Division, of New York City. These products represent two of the first registrations of pheromones for commercial application against forest insects.

The pheromone was identified and developed by the behavioral chemicals research project at the Pacific Northwest Forest and Range Experiment Station, in Corvallis, Oregon. Research cooperators were Weyerhaeuser Co., Oregon Graduate Center, Pacific Southwest Forest and Range Experiment Station, and the Forest Pest Management Division of the Pacific Northwest Region of the Forest Service.

Western pine shoot borers are a problem in plantations of ponderosa and jeffrey pines, causing reduced height growth. The synthetic pheromone—which is non-toxic and has no adverse effects on other animals or plants—is a duplicate of the female borer's natural sex attractant. The pheromone chemicals are encapsulated in plastic particles which are then mixed with an adhesive to make them stick on trees. The plastic material slows the release rate of the pheromone so the application remains active throughout the 2-month adult-stage of the borer's life cycle. The pheromone odor disorients male borers so they cannot locate their female counterparts for mating. This disruption of the reproductive cycle leads to fewer insects and a reduction in damage.

The pheromone treatments are usually applied to large plantations by aircraft, but a system is also available for ground application. Applications are expected to cost $10-20 an acre. One application every 3 to 5 years in young plantations is considered adequate to control damage.

Computer programs aid fire planning

When are weather conditions right for prescribed fire? This question is usually best answered by using information in climatological records, e.g., analysis of such data can describe an area's average weather and likely deviations from an average situation.

Despite this information's obvious value, fire managers rarely have had the means to easily analyze climatological data when planning fire use. This is due, in part at least, to the tedious nature of the task. It is also due, in part, to weather data problems: missing records, lack of data during spring and fall; and, in some cases, unreliable information resulting from poor observation and poor weather station maintenance.

The Intermountain Station has published a report describing a user-oriented computer system that fire managers can use to quickly and easily analyze climatological data to predict the probable occurrence of the right conditions for prescribed fire. Two separate computer programs, RX-WTHR and RXBURN, make up the system. Both programs are designed to use National Fire Weather Data Library climatological data. Features of these programs include: adjustment of fuel moistures from the weather station site to the fire site; a newly developed duff moisture model; and the capability to simultaneously consider up to 15 prescription factors. Step-by-step instructions are included in *A Computer System for Scheduling Fire Use, Part 1: The System,* General Technical Report INT-91-FR28, by Larry S. Bradshaw and William C. Fischer.

A computer terminal operator's manual for the programs has been published as a separate General Technical Report, INT-100, also by Bradshaw and Fischer.

Both publications are available from the Intermountain Station.

If you know of someone who would be interested in this publication, he or she can be added to the mailing list by filling out the coupon below and mailing it to us.

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