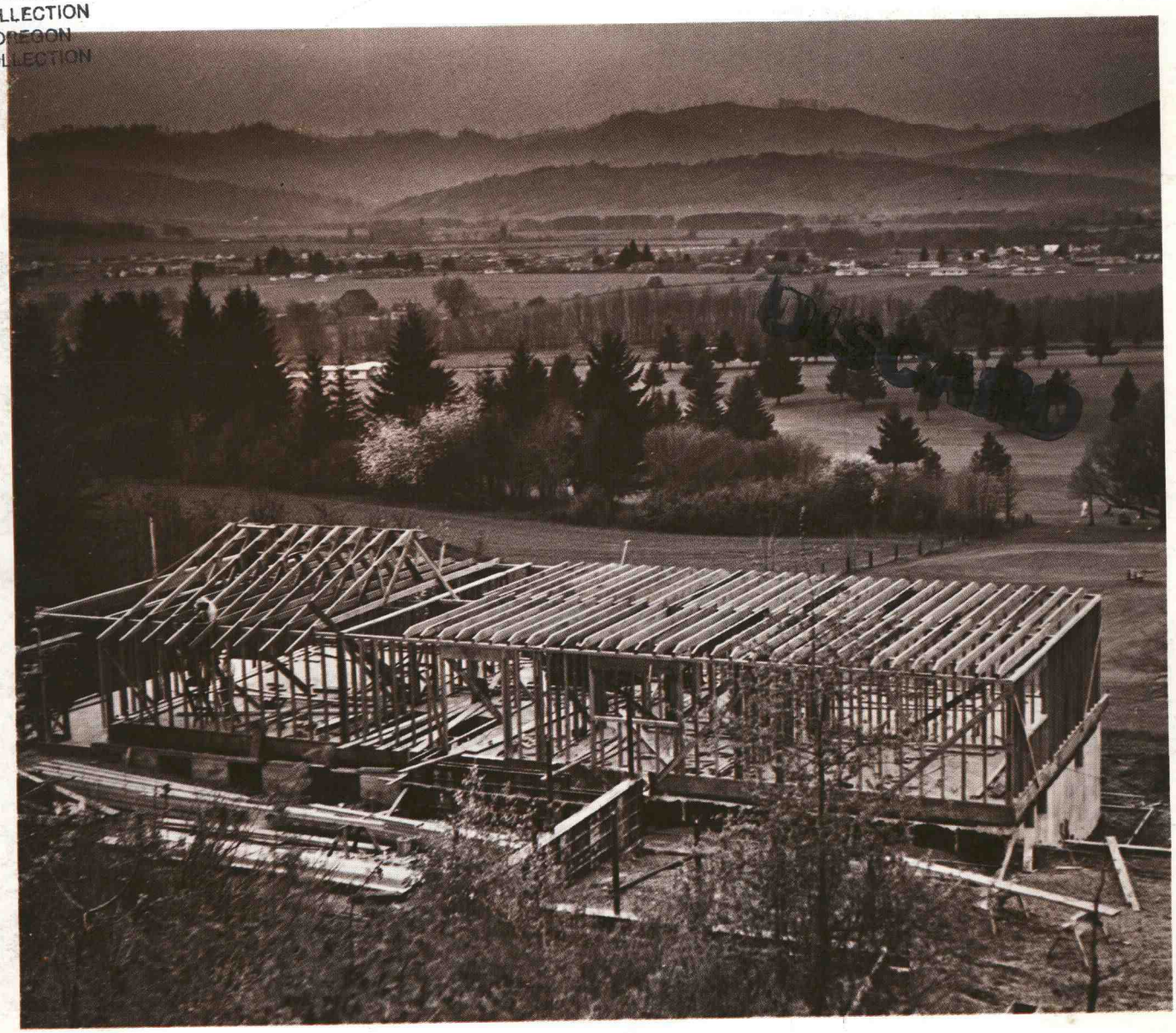
ANNUAL REPORT 1974



FOREST RESEARCH LABORATORY

OREGON STATE UNIVERSITY CORVALLIS

Annual Report

of the

Forest Research Laboratory

Oregon State University

Corvallis, Oregon 97331

December 1974

COVER PHOTOGRAPH

Efficiency in use of dimension lumber is especially important in construction because strength and durability must be maintained without wasting wood. Research is pointing out ways of building comfortable, safe homes at least expense.

Contents

DIRECTOR'S REPORT

What is of critical importance? In Oregon, this question and subsequent stocktaking were on every organization's agenda as 1974 wound to a close. Oregon's forest industries and the State's over-all economy had boomed at record levels early in the year, but by December curtailed production, incomes, and employment were causing cutbacks and a close evaluation of priorities. What can be dropped—and what must be sustained? What is really of critical importance? How do forestry and forestry research rate?

Rarely has the importance of forests and forest-derived employment and income to the health and viability of Oregon's entire economy been so dramatically demonstrated as it was in 1974. The critical importance of the forestry sector is thus obvious! But what about research? Is forestry research of critical importance to that sector? And to the State?

Importance of Forestry Research

Today's forestry research creates the new ideas, facts, and understandings that will comprise the raw material for tomorrow's **new opportunities, wiser decisions,** and **more effective forestry actions.** Both public and private decisions are involved. They will determine the use of Oregon's forests, the rate and methods for harvesting and processing its timber, the rate and success of reforesting brushfields and cutover lands, the protection of its forest streams, scenery, and environment, the productivity of its young forests, the losses to fire, insects, and diseases—indeed, the quality and productivity of the basic resource that supports timber and tourism, Oregon's first and third industries.

Although her forests are of such importance that they are truly a national resource, Oregon's 2.2 million forest users and beneficiaries will be the people most immediately affected by decisions and actions related to their forests. Each of Oregon's 30,000 individual forest landowners will be in-

Directing research efforts, finding sources of funds, and getting the results to those needing them are the responsibility of these men. From left to right, they are Helmuth Resch, Head of Forest Products Department; J. Richard Dilworth, Head of Forest Management Department; Edward H. Heath, Head of Resource Recreation Management Department; Carl H. Stoltenberg, Dean of the School of Forestry and Director of the Forest Research Laboratory; R. M. Kallander, Assistant Dean; Dale N. Bever, Assistant Dean; George W. Brown, Head of Forest Engineering Department; and James T. Krygier, Coordinator of Forestry Extension.

volved. And so will the 89,000 men and women who manage and process her forest harvests.

Will the opportunities, wisdom, and effectiveness of current forest-related actions be adequate for tomorrow's needs? Our Advisory Committee thinks not. They are convinced we must have **wiser** decisions and **more effective** actions. They believe national shortages of energy and raw material will greatly increase and sustain pressures on forests to produce more wood. And they know Oregon's forests provide exceptional potential for expanding the output of this **renewable** raw material. Simultaneously, they also see increasing demands on these forests for more intensive recreational uses, cleaner water, jobs, a high-quality environment, and other forest benefits. They believe forestry research holds a **critically important key** to successfully meeting these increased demands, and thus should be aggressively pursued.

A Coordinated Effort

Clearly, this research job must be shared. Private industry will do much of the research in developing new and improved wood products and manufacturing processes. This is particularly true for the largest companies and for research that provides those companies with competitive advantages that can be retained.

Similarly, the U.S. Forest Service will conduct research to enable wiser management of the national forests, to evaluate forestry issues from a national perspective, and to provide other helpful forestry information to people of the Northwest.

But public research on problems of particular concern to Oregonians is important, too. And that's the special role of the Forest Research Laboratory The following sections of this report highlight progress of our research during 1974, outline the year's extension efforts to get research results to those who need them, and list the publications that record our results.

That the Laboratory's research is accomplished with the assistance of and in cooperation with many others is evident from the list of participants noted on page . Participation by other research organizations improves coordination, participation by research-user groups helps keep research programs on target and accelerates the adoption of results, and joint planning and conduct make public research dollars go farther.

Priorities

The Laboratory's research priorities reflect the counsel of our Research Advisory Committee regarding future forestry-related problems and opportunities. They also reflect our sources of research funds and our abilities to conduct specific studies effectively in relation to other research organizations.

Last year's areas of emphasis are noted in the summary on the final page of this report. In the near future, we expect research on successfully establishing fast-growing seedlings on cutover and brush-covered lands will continue to be of high priority. Severe problems persist for landowners in many areas, and even the most productive soils yield little of value if they grow brush rather than trees.

Our study of Oregon's future timber harvests and of the potential of various forestry practices for altering this future will be of high priority because of its value to the State Department of Forestry—and of its value to citizens in timber-dependent communities for helping them decide which forestry programs will best protect their interests and those of their neighbors.

Research on opportunities for increasing timber harvests by thinning young stands without environmental damage, and to determine the economic, energy, and environmental consequences of alternative logging systems, also will continue to be stressed. Such information will guide landowners when they sell their timber, improve the performance of loggers, and protect the State's water and soil resources.

More efficient structural systems and new processing techniques are two ways Oregon's current timber inventories and harvests are yielding more products and bringing higher incomes to those who are growing, harvesting, and processing them. Because of these wide benefits and the excellent outlook for further progress, we expect to continue assigning a high priority to our research in both of these areas.

Goals

Again in 1975 as in 1974, our research and extension programs will be designed to help Oregon's people obtain increased benefits from their forests. Because persons' objectives differ, we won't try to tell them what their use or management decisions should be. Instead, our extension programs will seek to help Oregon's landowners, plant managers, public officials, and private citizens understand the issues, simultaneously providing them the information needed to make their own wise decisions. Our research will continue to be designed to develop those new ideas, facts, and understandings that tomorrow will enable these groups to confront improved opportunities, to make wiser decisions, and to take more effective actions in use and management of Oregon's forests and in harvesting and processing of her forest products.

Carl H. Stoltenberg

Dean Carl H. Stoltenberg
Director

IN APPRECIATION

Our Laboratory's research achievements are a result of dedicated staff effort supported by numerous contributions from participating individuals and organizations. The nature of these contributions ranges from providing land, test logging operations and materials, manpower, and financial support, to technical reviews and planning assistance. We wish to acknowledge particularly the valuable contributions during 1974 of the following individuals and organizations.

American Can Company
American Hardboard Association
American Plywood Association
Associated Oregon Industries, Inc.
Automated Combustion
The Bauer Brothers Company
J. H. Baxter and Company
Bohemia, Inc.
Boise Cascade Corporation
Bonneville Power Administration
Borden Chemical Company
British Columbia Forest Service
Bureau of Land Management, U.S. Dept. of Interior
Bureau of Sport Fisheries & Wildlife,
U.S. Dept. of Interior
California Redwood Association
Canadian Forest Products Laboratory
(Vancouver and Toronto)
Canadian Forest Products, Ltd.
Canadian Forestry Service
Canadian Wood Council
Lane Carpenter Logging Company
Champion International
CH2M-Hill
Chembond Corporation
Ciba-Geigy Corporation, Agricultural Division
Coe Manufacturing Company
Collier Carbon & Chemical Corporation
Colorado State University
Consumers Power, Incorporated
Detroit Edison Company
Crown Zellerbach Corporation
Crown Zellerbach Canada, Ltd.
Ray Cully
Dow Chemical USA
E. I. Du Pont de Nemours & Company, Inc.
Electric Power Research Institute
Environmental Protection Agency
Eugene Water & Electric Board
Evans Products Company
Farmcraft, Inc.
Fibron Corporation
Forest Grove Light & Power Company
Forest Products Laboratory, U.S. Dept. of Agric.
Forest Service, Region 6, U.S. Dept. of Agric.
The Foxboro Company
Georgia-Pacific Corporation
Georgia Power Company
Giustina Brothers Lumber & Plywood Company
Industrial Forestry Association
International Paper Company
International Biological Program,
National Science Foundation
Irvington Moore
Lee Hunt
Iowa State University
Joslyn Manufacturing and Supply Company
Kaiser Gypsum Company, Inc.,
Insulating Products Division
Edwin Knight
KOGAP Manufacturing Company
Larry Lester

Little River Box Company
MacMillan Bloedel, Ltd.
Major Forest Industries
Maki Welding
Mason, Bruce & Girard
Masonite Corporation
Kenneth McCrae
L. D. McFarland Company
Medford Corporation
Menasha Corporation
MK-RDA, Inc.
Modern Logging Equipment Company
Monsanto Company, Agricultural Division
Moore Mill and Lumber Company
Moore-Oregon
National Defense Education Act
National Science Foundation
National Forest Products Association
Neptune Microfloc, Inc.
Nor-Am Agricultural Products, Inc.
Osmose Wood Preserving Company of America, Inc.
Oregon Agricultural Experiment Station
Oregon State Department of Revenue
Oregon State Forestry Department
Oregon State University:
- Department of Agricultural Chemistry
- Department of Agronomic Crop Science
- Department of Botany
- Department of Civil Engineering
- Department of Entomology
- Department of Fisheries and Wildlife
- Department of Geology
- Department of Mechanical Engineering
- Department of Microbiology
- Department of Military Science
- Department of Rangeland Resources
- Department of Soil Science
- Department of Statistics
- Department of Zoology
- Computer Center
- Extension Service
- Sea Grant College Program
- Water Resources Research Institute

Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Dept. of Agriculture
Pacific Power and Light Company
Permaneer Corporation
Dwight L. Phipps Nursery, Oregon State Forestry Department
Plywood Research Foundation
Pope & Talbot, Inc.
Portland General Electric Company
Port of Siuslaw
Potlatch Forests, Inc.
Publishers Paper Company
Reichhold Chemicals, Inc.
Rex Veneer, Division of Willamette Industries
Rhodia, Inc., Chipman Division
Rosboro Lumber Company
Roseburg Lumber Company
Salem Electric
Simpson Timber Company
Siuslaw National Forest
Southern Pacific Transportation Company
Starker Forests
Stauffer Chemical Company, Agricultural Chemicals Division
Jack Stump
Sun Studs, Inc.
Timber Engineering Company
Timber Products Company
Timber Services Company
Tippetts, Abbett, McCarthy & Stratton, Consulting Engineers
Tomco Forest Industries, Inc.
Trus-joist Corporation
University of British Columbia
University of California
University of Idaho
University of New Hampshire
University of Texas
University of Washington
U.S. Air Force
U.S. Army Corps of Engineers
U.S. Department of the Navy
U.S. Gypsum Company
U.S. Plywood, Division of Champion International
Utah State University
Virginia Electric & Power Company
Warsaw Agricultural University
Washington State Department of Natural Resources
Washington State University
Wasteco, Inc.
West Coast Adhesive Manufacturers Association
West Coast Lumber Inspection Bureau
Western Kraft Company
Western Wood Fibre, Inc.
Western Wood Preservers Institute
Western Wood Products Association
Weyerhaeuser Company
Willamette Industries, Incorporated
Willamina Lumber Company
Woodland Management, Inc.

FOREST ENVIRONMENTAL ENGINEERING RESEARCH

A major challenge continually confronting forest land managers is that of harvesting timber and constructing roads while maintaining a high-quality forest environment. Our research focuses on both aspects of this problem. Research to increase harvesting productivity from logging systems designed to minimize environmental impact is conducted along with research to determine the impact of conventional harvesting systems on soil and water resources. Both types of research are necessary for improvement of forest practices.

During the past year, we analyzed timber harvesting using advanced aerial logging systems in partial cutting and landscape management operations. The use of small skyline systems for thinning young stands also was studied. We continued to study the impact of tractor logging on soil and seedling growth. Two projects focused on the impact of timber harvesting on residue in forest streams and the changes this residue produced in water quality and fish habitat. Other studies increased our understanding of the role of forests in affecting the flow of water and solar energy in our environment.

Subsurface Water Movement

In forests of the Pacific Northwest, water is a most important component of the environment. It acts as a carrier of nutrients and other chemicals through soil to plant communities and forest streams. During intense, winter storms, water also may act as a triggering mechanism for landslides. Two studies led by Dennis Harr are providing information that will help us better understand subsurface water movement and how it affects water quality and slope stability.

One study, financed by the National Science Foundations's International Biological Program, seeks to determine the timing and pathway of subsurface water on a steep slope in the western Cascade Mountains. During the record wet winter of 1973-74, 14 storm events were monitored. Surprisingly, the porous soil mantle beneath the forest stand seldom was saturated. Saturation occurred only after at least 30 millimeters (about 1.2 inches) of rain fell in less than 12 hours. Even under such intensive rainfall, saturation of the soil was not uniform and lasted less than 24 hours. These are highly significant results because they show that soils beneath forests are hydrologically unique. Much of the theory used to explain runoff and water movement will have to be re-evaluated before it can be applied to forest lands. We are continuing to examine the pathway of subsurface water using some highly sophisticated tracer techniques. These studies will be extremely valuable in helping us understand how chemicals applied to the forest move through the soil toward streams.

The impact of subsurface water on slope stability is being studied in the Oregon Coast Range in research sponsored by the Water Resources Research Institute. Again in this study,

Determining the course of subsurface water by tracer techniques will help in understanding movement of chemicals in the forest soil.

saturation was observed only rarely in these forest soils. A saturated zone occurred in the fractured, sandstone bedrock, however. Understanding how this deep saturated zone affects slope stability will help engineers do a better job of road layout and design.

Tractor Logging and Soil Compaction

There is considerable controversy about the impact of tractor logging on the density of forest soil and, in turn, upon tree growth and seedling survival in these areas. A study led by Henry Froehlich seeks to quantify this impact over a range of soil types, soil moisture, and number of trips with a loaded tractor. The study was begun a year ago, funded by the Bureau of Land Management and the McIntire-Stennis program.

First-year results show no significant difference in growth and mortality as a result of the various treatments among 600 Douglas-fir "plug" seedlings planted in fine-textured soil. Survival and growth will be followed for 5 years.

Compaction of forest soil in tractor yarding is being measured to determine its impact on regeneration of trees.

Density profiles have been determined in the soils of skid trails. The impact of small, track-type, thinning tractors is limited to the surface layer down to as much as 12 inches. Coarse soils, or soils with high organic-matter content, are affected least.

Tree, site, and soil conditions were measured on 92 trees in Douglas-fir stands thinned 7-15 years ago. Height, age, growth rate, and crown volume of each tree, its competition from adjacent trees, and the soil density in the surface rooting zone were determined to explain the reasons for wide differences observed in response to thinning. Results from this study will provide information on the long-term impact of soil compaction from thinning with tractors on the growth rate of the residual stand.

Logging Residue and Streams

Logging residue may accumulate in the channels of forest streams after clearcutting, particularly where terrain is steep and timber is defective. Hank Froehlich leads a study to determine the best method for keeping residue out of streams. He is comparing the economic and environmental costs and benefits of buffer strips, cable-assist felling, and conventional felling followed by cleaning the streams.

Benefits of keeping residues out of streams by several different logging methods are being evaluated.

Earlier work documented the amount of residue that accumulated in streams after each felling method and after yarding. Cable-assist felling showed great promise for reducing the amount of residue in streams. During the past year, a detailed study was completed to determine the cost of achieving various degrees of stream protection by these methods.

Production was reduced by cable-assist felling; it took about three times as long to achieve the same production as with conventional felling. Added costs for labor and equipment caused the cable-assist method of felling to be about two and one-half times as expensive as the conventional method. Further study showed, however, that this additional cost was offset by reductions in breakage and stream cleaning with cable-assist felling. On difficult terrain, for example, breakage was reduced 22 percent by this method. Cleaning costs were about one-third of those incurred after conventional felling. Additional gains were observed in log dimensions after cable-assist felling. Logs from the lower 60 percent of the tree were 5 percent longer, and logs from the upper 40 percent of the tree were 18 percent longer by this technique.

Cable-assist felling reduces breakage and leaves less residue in streams than with conventional felling.

The experience gained from this research is being used in other ways. For example, a pictorial guide on residue loading in channels has been prepared for use by the U.S. Forest Service to help their sales administrators assess problems of residue accumulation in stream channels.

Leaving buffer strips of timber between clearcut units and streams is becoming a common practice in the Pacific Northwest. They provide protection to the stream from logging residue and shade the stream, keeping water temperatures cool. Trees left in these strips, however, are subject to mortality and windthrow into the stream. A second study led by Froehlich is designed to quantify windthrow and mortality in buffer strips left 3-6 years ago in old-growth Douglas-fir. Preliminary results show severe blowdown in some strips and considerable mortality in others. Results from this study will be used to help design buffer strips for long-term effectiveness.

Logging Residue and Water Quality

The impact of logging residue on water quality in streams was determined in two studies led by George Brown. In the first study, a series of

Three years after leaving a buffer strip, quality of the stream is being measured.

Severe blowdown occurs in some buffer strips.

laboratory analyses of the effect of logging slash on dissolved oxygen showed that significant reductions could occur if needles and leaves were allowed to accumulate in streams. Fresh needles and leaves have a rather high potential for pollution. The greatest reduction in oxygen levels occurs in the first two weeks, with little long-term effect. The study also showed that the impact was greater if water temperatures were increased. After this laboratory analysis, a mathematical model was developed for simulating the effect on water quality downstream from a clearcutting where slash has been allowed to accumulate. The model is designed to provide land managers with a better understanding of both on-site and downstream impacts of timber harvesting.

The movement of logging slash into spawning beds was studied in a second project financed by the Water Resources Research Institute. Even under the controlled conditions of this study, movement of slash into gravel was so extremely variable that we could not develop reliable methods for predicting accumulation. Separating natural from man-caused accumulations appears not to be feasible at this time.

Forests and Energy Exchange

The exchange of energy between forest stands and the atmosphere is an important factor influencing the character of both the forest and the hydrologic environment. Understanding the processes by which this energy exchange takes place is the objective of a study led by Lloyd Gay. Microclimatological methods used to explain energy exchange over low-growing vegetation, such as crops, were not satisfactory when applied to forests. The reason seems to be that the forest canopy is aerodynamically rougher than crops, and its more diffuse structure acts as an efficient trap for energy. Methods were developed during this study to provide consistent values for energy exchange for forest stands. Results of this study will enhance our understanding of water use by forests and also provide methods for improved evaluation of seedling environment.

Advanced Timber-Harvesting Systems

The use of aerial systems for timber harvesting in environmentally sensitive situations is becoming more common. Last year, for example, about 200 million board feet of timber were removed by helicopter logging from national forest lands in the Pacific Northwest. About one billion board feet of timber were removed from these lands with skylines. Little is known, however, about the operating efficiency of helicopters or other aerial systems.

Earlier work focused on the use of helicopters, skylines, and balloons in clearcutting. During the past year, Dennis Dykstra continued his research on these systems, but evaluated their use in partial cutting and for harvesting landscape-design units as well as the normal clearcutting configuration. He obtained information on the use of three aerial logging systems, which included a Skagit GT-3, a short-reach, mobile running skyline with lateral yarding capability, a Sikorsky S64E heavy-lift helicopter, and a 530,000-cubic-foot, natural-shaped balloon rigged in a highlead configuration.

A detailed record of time and motion was kept on yarding cycles. This information will be used to evaluate how yarding was influenced by number of pieces hooked, size of the logs, ground slope, crew size, and several other variables. Guidelines will be developed to assist resource managers in appraising the cost of these systems as well as help them in logging-system prescription or layout. The analysis also will seek to isolate factors that

Study of aerial logging systems in partial cuttings included a short-reach, mobile running skyline (left) and a heavy-lift helicopter (right).

show promise for improving the operating efficiency of these logging systems. This research is financed by the Pacific Northwest Forest and Range Experiment Station.

Skyline Thinning in Young Stands

Intensive management of forest lands in Oregon depends upon maximizing the growth of trees on almost every acre. Periodic thinning of young stands is one way to stimulate growth. Silviculturalists are able to make prescriptions for thinnings and the forest products industry is gearing up to handle smaller material. Yet, between the forest and the mill, there is a large gap in our knowledge about the most efficient and environmentally sound methods for harvesting and transporting small trees. This problem is being studied by Dean Aulerich.

Earlier work on thinning young stands with skylines indicated that a large portion of the yarding time was spent on getting the log from the interior of the stand to the skyline road for yarding to the landing. As a result, research during the past year concentrated on evaluating a system for pre-bunching logs with a small, single-drum yarder that has a low initial investment.

The use of small yarders for thinning with skylines also is being studied. A conceptual design of a small cable-yarding system has been completed. Initial design specifications are under review. European cable systems are also under study to determine their applicability to Oregon forests.

FOREST MANAGEMENT RESEARCH

Identifying ways of increasing the State's timber supply is a major goal of research in forest management. Contributing to this goal are 63 studies in young-growth management, forest regeneration and site rehabilitation, tree improvement, forest protection, economics, and forest measurements including photogrammetry. Some of these projects are conducted cooperatively with public and private agencies and seek to serve alike owners of large and small woodlands.

Regeneration

Foresters in Oregon are under legal, economic, and social pressures to assure successful reforestation on each harvested acre or other nonproductive commercial forest areas. Oregon's Forest Practices Act requires regeneration after logging that meets standards developed by the State Forester. Needs of the State's most important industry for raw material add urgency and importance to the problem of reforestation. The public's increased environmental awareness and insistence that our natural resources be managed effectively and in the best interests of society add to the responsibilities of the forest land manager.

Successful reforestation can be accomplished on favorable sites by natural means, or through planting suitable tree seedlings, without much difficulty. But serious problems arise on severe sites, where better solutions are a major thrust of the Laboratory's program.

Measuring with a porometer the ability of a tree to control loss of water aids the forester in determining which species to plant for best regeneration on dry sites.

Three critical areas that usually determine success or failure of seedling establishment are the condition of the planted seedling, seedling handling and planting, and the environment at the planting site. The condition of planting stock frequently is neglected. Yet, our research results show that proper physiological condition in general and dormancy in particular are critical in achieving successful reforestation.

A team of scientists, including Denis Lavender, Richard Hermann, Joe Zaerr, and Brian Cleary, has been studying the physiology of Douglas-fir and ponderosa pine seedlings for many years. Their work has produced a body of knowledge now available to nurserymen and foresters for use in growing better seedlings and help for success in planting. A study of seedling dormancy and survival has been a major area of concern.

Nursery conditions. Nursery environment has a substantial effect on the potential performance of seedlings. This relation is illustrated by Figures 1 and 2, which show problems associated with date of lifting and seedling dormancy in two groups of seedlings grown under two different nursery regimes (I and II). For the seedlings grown in nursery environment I, second-year height growth was complete by mid-July, but in nursery environment II, the seedlings were given high levels of moisture and nutrients throughout August and September and height growth continued during this period (Figure 1). The potential survival of the seedlings in these two groups is drastically different when planted in areas of moderate environmental stress. Although both groups of seedlings have a low potential for survival after lifting and outplanting during late summer and early fall, only those seedlings in environment I have a high potential for survival and growth when lifted between December and March 1 (Figure 2).

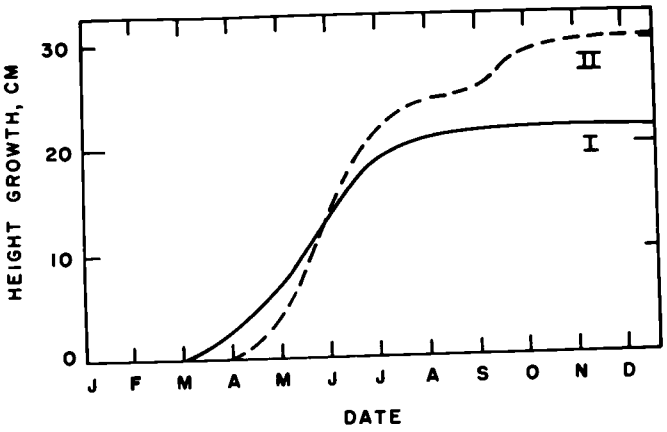


Figure 1. Seedlings properly hardened by moisture control (I) were not so tall after two seasons in the nursery as were seedlings that had been watered and fertilized generously (II), but hardened seedlings survived better after planting (Figure 2).

Figure 2 also illustrates the effect of failure to harden the seedlings and the advantages of lifting seedlings between early December and late February. If seedlings must be lifted before early December, seedling survival may be increased by lifting seedlings from beds where irrigation was reduced about July 1; planting only on favorable north slopes; planting no more than 2 days after lifting; and wrenching seedlings during summer and early fall.

Seedling dormancy. Data obtained from laboratory trials and from empirical evaluation of nursery-grown seedlings have demonstrated that "dormancy" in Douglas-fir is not a single resting phase, but a series of physiological states, each with distinct characteristics and requirements. This resting period may be divided into four physiological phases:

DORMANCY INDUCTION from early or mid-July to mid- or late September. During this period terminal buds are initiated, developed, and after-ripened largely in response to moisture stress. If plants are well watered, or exposed to long photoperiods, the buds may break and the seedlings produce a second or third "flush" of growth.

DORMANCY DEEPENING from mid- or late September to mid-November. Plants in this state have well-formed buds that will resume growth only slowly or not at all in response to a favorable environment. Seedlings in this state are susceptible to damage from dessication, cold storage, or any disturbance caused by normal nursery handling.

DORMANT PHASE from early or mid-December until mid-February. Plants in this state have much resistance to environmental stress.

POST DORMANCY from mid-February until bud burst in spring. Seedlings gradually lose their resistance to environmental stress and will grow if placed in a favorable environment.

Nursery practices must be designed to insure that each phase is complete. Only then will the seedlings have maximum potential for growth and survival after transplanting to a field site.

Irrigation. Nursery practices recommended to fulfill all of the seedling's requirements for dormancy are intended to create a favorable environment during each phase. Nursery irrigation schedules should be tailored to produce a moderate moisture stress in both first- and second-year seedlings between mid-July and the initiation of fall rains. This recommendation may appear to conflict with the need to cool nursery beds by irrigation during hot days (85 F or more). The cooling effect of water, however, is achieved largely through evaporation from the soil surface and seedling foliage. Therefore, frequently spaced, light irrigations, where moisture does not penetrate to the rooting zone, are most efficient at cooling while maintaining a moderate level of seedling moisture stress. This treatment also allows seedlings to maintain high levels of photosynthesis.

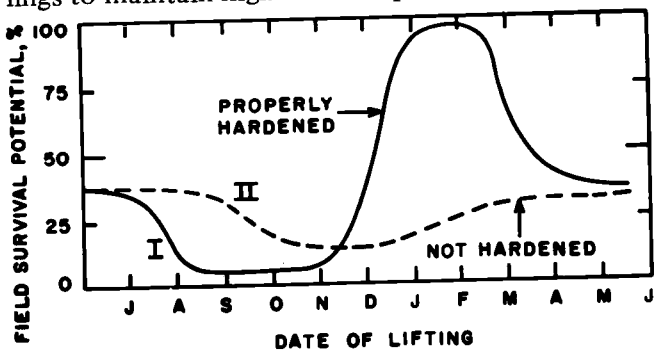


Figure 2. Properly hardened seedlings (I) have greater potential for surviving lifting and planting in winter than have unhardened seedlings (II).

Storage. Research data demonstrate that properly controlled, cold, dark storage is not damaging to seedlings lifted between mid-December and late February. In fact, seedlings lifted and stored in late February may be the only practical solution for regeneration of high-elevation areas with bare-root stock in the spring. Foresters should be aware, however, that production nurseries generally do not have the same degree of control over the storage of millions of seedlings that is possible with experimental material. Unless production facilities are upgraded, reforestation projects should be planned to utilize seedlings with a shortest possible storage period.

Containerized seedlings. The concept of producing planting stock in containers and maintaining the seedlings in greenhouses, at least during the period of active seedling growth, appeals to foresters because this technique permits production of seedlings large enough to outplant on many forest sites within one year; a probable reduction in planting shock through minimal disturbance of seedling root systems at time of planting; reproduction of planting stock of uniform sizes; and increased speed of planting. In theory, the system permits greater flexibility in reforestation, as seedlings may be germinated any time between early winter and late spring, grown to plantable size, and outplanted from mid-fall until mid-spring of the following year. These advantages often have not been realized because the importance of seedling dormancy has been overlooked. Hundreds of thousands of containerized seedlings have failed during recent years as systems for their use have been developed. Many of these trees would have survived if the seedlings had been physiologically ready for the field environment. The physiological constraints mentioned earlier must be satisfied if seedlings grown in greenhouses are to achieve maximum survival and growth after outplanting.

Seedlings grown in containers in greenhouses should be hardened off just as with nursery-grown seedlings to increase their ability to survive after planting.

Tables 1 and 2 present suggested schedules for seedling production in greenhouses to assure that the seedling physiology enhances the establishment of successful plantations. Conditions such as moderate moisture stress or maintenance in Table 1 may be difficult to achieve in practice, but even approximations should stimulate development of desired seedling physiology.

Lifting seedlings between mid-December and mid-February has another advantage in that a seedling in full dormancy when removed from the bed is more tolerant to exposure during planting (Figure 3).

Growth regulators. Zaerr, Lavender, and Hermann, in studying growth regulators, have found that xylem sap collected with a pressure-chamber apparatus contains a class of compounds known as

Table 1. Greenhouse Schedule for Seedlings to Be Outplanted in the Fall.

Period	Activity
Dec 15–Jan15	Germinate seed
Jan 15–Jun 15	Active growth
Jan 15–Apr 1	1,000 ft-candles 14 hr daily
Jun 15–Aug 1	Induce dormancy & resting buds
	A. Moderate moisture stress
	B. 8-10 hr daily photoperiod
	C. Low nitrogen in nutrients
Aug 1–Oct 15	Maintenance
	10-hr photoperiod daily
	55 F to 75 F daily

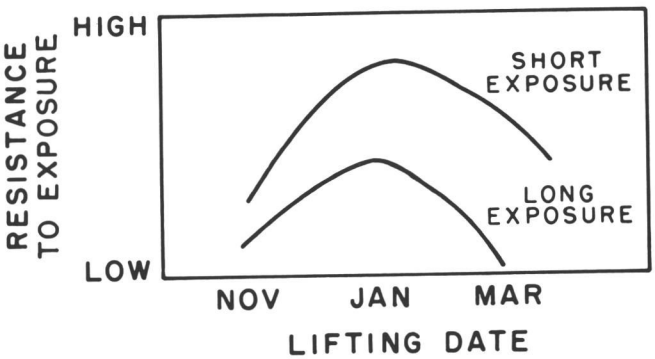


Figure 3. Resistance to exposure of seedlings between lifting and planting is improved if they are lifted when fully dormant.

gibberellins. The substances are active in controlling growth processes in plants, and they appear to be related to the breaking of dormancy in the spring in Douglas-fir, a factor important in frost resistance. A larger pressure chamber was constructed to obtain the large quantities of xylem sap required for precise identification of the regulators involved. Sap has been collected, frozen, and stored for analysis next year. In our first experiment, four small pressure chambers could produce about 30 milliliters of xylem sap in half an hour from a single tree.

Use of xylem sap for studying growth regulators is convenient and useful in understanding how trees control their growth internally. The development of nursery-grown seedlings that have reached full dormancy by early fall so that successful outplanting can be accomplished is an important goal of this project. The ability to manipulate the appropriate growth regulators controlling dormancy seems to hold the greatest promise.

Table 2. Greenhouse Schedule for Seedlings to Be Outplanted in the Spring.

Period	Activity
Feb 1–Mar 1	Germinate seed
Mar 1–Aug 1	Active growth No light added
Aug 1–Sep 15	Induce dormancy & resting buds A. Moderate moisture stress B. 8-10 hr daily photoperiod C. Low nitrogen in nutrients
Sep 15–Nov 15	Maintenance 10-hr photoperiod daily 55 F to 75 F daily
Until outplanted	Maintenance 40 F

A few tenths of a milliliter of xylem sap can be collected from a shoot or root when under pressure in the chamber shown. The instrument ordinarily is used to measure plant moisture stress.

Determination of the physiological condition of seedlings before outplanting would be of great value to foresters. Various methods based on morphological characteristics of the seedlings have been explored, but satisfactory results have not been attained. Hermann and Zaerr have developed a system by which sample seedlings are placed in a growth chamber under favorable conditions for immediate growth. After two to four weeks of observation, a fairly accurate prediction can be made of seedling performance after outplanting.

Alternative to clearcutting. Richard Waring and Robert S. Logan conducted a study to test an alternative to clearcutting in Douglas-fir stands that would favor subsequent regeneration. Twelve hundred bare-rooted Douglas-fir 2-0 seedlings per treatment were underplanted beneath a partly thinned (basal area, 180 sq. ft. per acre) and unthinned (basal area, 340 sq. ft. per acre) old-growth stands on a droughty south slope in the

When the tree shown is in the chamber under pressure up to 300 pounds per square inch, as much as 50 milliliters of xylem sap is forced out of the protruding cut end. Such quantities are needed for precise determination of growth regulators.

Coast Range west of Corvallis, Oregon. A third planting was made on an old, unsuccessfully regenerated clearcutting on the same slope. The seedlings were monitored for height growth, moisture stress, and radiation received. More than 60 percent of the seedlings survived the droughty summer. The greatest survival was at 30 percent of full sunlight, with only a slight decrease in survival at 7 percent.

Results substantiate findings of previous studies. Recommendations are that on hot, droughty sites, the overstory of mature timber be thinned before underplanting to obtain a stand basal area of 100-150 square feet per acre. After establishing the underplanting, the remaining overstory should be removed.

Young-growth Management

Oregon's commercial forests are in transition. The wild old-growth stands are being replaced by young stands that lend themselves to intensive culture. Management of these stands must be programmed to produce raw materials that meet the increasing needs of industry, and to provide for nontimber uses by society. The Forest Research Laboratory has conducted research in young-growth management for more than 24 years. Results have been made available to professional foresters and small woodland owners through publications, short courses, and field tours. Alan Berg and John Bell are currently providing leadership in young-growth management.

Thinning. Preliminary analysis of thinning regimes on experimental plots near Burnt Woods, Oregon, points out some of the advantages of maintaining low levels of basal area in managing young Douglas-fir. The area was thinned first in 1959 at age 23 years to remove merchantable trees that were limby or had a defect such as excessive sweep or crooks. In a second thinning in 1961, smaller understory trees were removed as a pulpwood harvest, and all thinned plots were reduced to about 160 square feet of basal area per acre. Thinnings were repeated in 1966 to reduce plots to basal areas of 160-190, 130-160, and 100-130 square feet. Thinnings were made in 1970 to maintain those levels. Essentially, the goal was to reduce stand density to the lower limit of basal area in each schedule and then allow each stand to grow to the higher limit before thinning.

Data in Table 3 show that thinned plots had a much higher net basal area per acre than the unthinned control after 14 years of treatment. Thinning provides the opportunity to salvage trees that would otherwise be lost. Also, the gross basal area is larger on the treated plots, although differences are not great. Table 4 shows the average growth in basal area per acre per year for each of three years after the last thinning. Again, the thinned plots showed a significant increase in growth rate over the unthinned stand and a decrease in mortality. The differences in growth rates between thinned plots were not significant. The data for growth in dbh, shown in Table 5, indicate for the 14-year test period a rather uniform increase in diameter increment as the level of growing stock was reduced. The denser stands showed a decrease in average dbh and the diameter

Table 3. Changes of Basal Area in Square Feet per Acre of Trees on Experimental Plots at Burnt Woods.

Basal area level	Net in 1973	Thinned out 1959-1973	Mortality	Gross
Control	263	None	59	322
160-190	186	122	42	350
130-160	151	173	13	337
100-130	122	185	22	329

Table 4. Annual Growth Measured by Increase in Basal Area in Square Feet per Acre on Experimental Plots at Burnt Woods from 1970 to 1973, the Period after Last Treatment Thinning.

Basal area level	Net	Mortality	Gross
Control	5.157	1.154	6.301
160-190	7.352	None	7.352
130-160	6.919	None	6.919
100-130	7.516	None	7.516

increment for the 3-year period following the 1970 thinning as compared to the average increment for the full 14-year period.

Alder and nitrogen. Alder generally is considered a weed species when found in a conifer stand. A spin-off from one of Berg's thinning studies indicated this was not always true. In 1955, a 62-year-old Douglas-fir stand at Wilark, Columbia County, Oregon, was thinned heavily as part of a study in management of young Douglas-fir. The 80 Douglas-fir trees per acre remaining after thinning were spaced widely to create an open canopy.

Soon after thinning, a dense understory of red alder was established by seed from adjacent mature alder. Because of the openness of the Douglas-fir overstory, the alder grew rapidly. By the spring of 1972, however, the alder understory was deteriorating and many of the alder trees were dead. At that time, samples of soil with and without understory stands of alder were collected and analyzed for total nitrogen. Assuming the commonly used estimate of 2 million pounds of soil in the top six inches of soil, the red alder added 200 pounds of total nitrogen to the soil under light alder understory and 789 pounds to the soil under heavy alder. This is the equivalent of adding 435 and 1,696 pounds of urea per acre to the soil (Table 6).

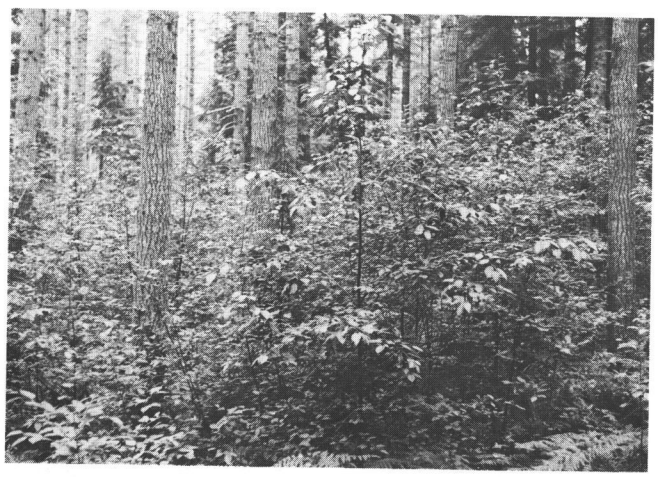
Heavily thinned plots of young Douglas-fir (left) showed an increase in growth rate and a decrease in mortality compared to crowded unthinned plots (right). In June 1973, this thinned plot had 180 trees, 150 square feet of basal area per acre, and average diameter of trees was 12.4 inches. The unthinned plot had 470 trees with average diameter of 10.1 inches and 260 square feet of basal area per acre.

Table 5. Annual Growth Measured by Increase in Average Diameter, Breast High, of Douglas-fir Trees on Experimental Plots at Burnt Woods.

Basal area level *Sq ft per acre*	Annual growth 1959-1973 *In.*	Annual growth 1970-1973 *In.*	Rate change, 1970-1973 *In.*	Avg dbh, 1973 *In.*	Trees per acre, 1973	Trees with slowed growth[1]
Control	0.139	0.100	-0.039	9.8	510	475
160-190	0.234	0.205	-0.029	10.7	300	220
130-160	0.234	0.270	+0.027	11.8	200	50
100-130	0.320	0.397	+0.077	12.4	145	0

[1] Reduced rate of growth in diameter for 1970-1973, compared to average for 1959-1973.

Nitrogen leaching. Studies by Michael Newton of leaching of soil nutrients associated with disturbances to alder-dominated watersheds in the Coast Range indicate that nutrient leakage is not a serious problem after clearcutting, burning, or herbicide application. Nitrate, especially, was shown to lose mobility in cold, wet soils by converting to the ammonium form. Lack of rainfall during the warm season reduces ion mobility during the period of nitrate abundance. Base levels of ions in the alder-dominated watersheds were very high. Only one, bicarbonate, showed abnormal response to treatment. This response to clearcutting and herbicide application accounted for a small release of total ions, however, because the increase was of short duration and occurred only during the summer low flow.



Young red alder at the peak of its development under stand of thinned Douglas-fir at Wilark. Western redcedar and western hemlock are in the understory in the background.

Table 6. Nitrogen Content per Acre of the Top Six Inches of Soil in Young Douglas-fir Stands, Some with Red Alder Understory.

Alder understory	Nitrogen added *Pounds*	Equivalent in 46% urea *Pounds*
None	None	None
Light	200	435
Heavy	780	1,696

Chemical thinning. Newton found that distribution of organic arsenical herbicides used in commercial and pre-commercial thinning of conifers is partly manageable. The chemicals are distributed in the ecosystem so as to have little interaction with soils and ecosystem productivity. Fall injections of arsenicals cause the least amount of arsenic to be deposited immediately in forest litter for a given amount applied. Furthermore, fall treatments with MSMA (monosodium methanearsonate) are the most effective in producing a silviculturally acceptable result. Spring applications cause a larger percentage of the herbicide to go into foliage, hence into litter, and also tend to top-kill trees. Cacodylic acid applied in both spring and fall tends to concentrate in foliage in a manner similar to MSMA in spring. The fall season produces results with MSMA that are apparently reproducible from late September through February.

Under no circumstances are amounts of arsenic used in pre-commercial thinning likely to add more than 1½ pounds of arsenic per acre to the ecosystem. Natural levels of arsenic in soils and vegetation are high enough so that the residual effects of such an addition probably will be substantially below biologically detectable limits. Moreover, the natural functioning of microorganisms appears to direct all arsenic into an "arsenic cycle," in which there is a perpetual redistribution of natural as well as introduced arsenicals. Problems with long-term residues appear unlikely.

Vine maple. A study of the life history of vine maple indicated that this species has an important role as a component of old-growth stands and as a pioneer sprouter on clearcuttings. As a pioneer, it grows more rapidly than conifers and dominates spots that grow together to form solid stands if conifers have not become dominant in the openings. If dominated by conifers, vine maple decreases in importance, but does not become extinct. It has the ability to remain alive by dying back to its large stems and remaining viable in sprouts that are capable of responding to small increases in light as individual conifers die in stands. As conifer stands mature, these sprouts form the nucleus of clumps that spread by layering.

Little regeneration of vine maple originates from seed. Few stems persist for more than 130 years, but many clones are thought to remain viable for much longer through layering. In 450-year-old Douglas-fir stands in largely decadent condition, shrubs ranged from 1 to 2.5 percent of the biomass of the stand. Thus, brush understory cover is unlikely to be a substantial resource in relation to overstory species. Its role in mineral cycling is slightly more than proportional to its biomass, but minor in relation to the dominant cover.

Understory after thinning. A study by graduate student Jerome Witler to determine the response of understory vegetation to thinning intensity in a young-growth Douglas-fir forest at Black Rock revealed that herbaceous species were the most responsive to thinning, with the highest cover in the moderately heavy and heavy thinnings. Oregon grape and a moss were the dominant species in natural stands, but bracken fern and the same moss dominated all thinning treatments. Herbs showing the greatest increases with thinning were bracken fern, pale blue-bell, varied-leaf collomia, white hawkweed, and some grasses. Trends in understory biomass were similar to those for cover and frequency.

Woody plants were scattered widely throughout the thinned stands, often growing in clumps with many young erect stems. Such clumps did not occur in natural stands. Vine maple, California hazel, ocean spray, and to a lesser extent, Pacific dogwood follow this pattern.

In general, although cover and frequency of woody plants showed no clear response to thinning, biomass estimates showed a trend toward

Growth of herbaceous species and clumps of woody plants are evident in heavily thinned plots (left) of Douglas-fir at Black Rock, compared to scarcity of such understory in unthinned plots (right).

increased woody vegetation with thinning intensity.

Pesticide residues. Warren Webb is studying the transport and distribution of pesticides in the forest ecosystem. Using DYNAMO, a simulation language, he developed a computer model that simulates dynamics of pesticide residues in forest ecosystems. Information from the literature and from contributing scientists was used to construct the model. Processes such as pesticide volatilization, absorption by plants, and microbial breakdown were incorporated along with ecosystem processes and characteristics, which include litterfall, precipitation and temperature regimes, and leaf-canopy density and litter accumulation. Data for the model were developed from experimental sites in Oregon and Southern California. Movement of 2,4-D, picloram, and 2,4,5-T have been simulated for a Southern California chaparrel ecosystem and a red alder ecosystem in Western Oregon. Presently, the output utility is limited and several validation experiments have been initiated to refine the model.

Pesticides have proved to be effective and economical in dealing with many pests that can reduce the productivity of forest lands. There is concern, however, that the side effects caused by the unused pesticide, or the residue, may be harmful to nontarget organisms. A model that has been developed for the state of movement and fate of residues simulates the dynamics of two herbicides commonly used in weed control on forest lands. This model is easily adapted to many forest habitats and to different chemicals and rates of broadcast application. At present, it forms a structure for placing priorities on field and laboratory experiments that are needed to advance our understanding of pesticide-residue dynamics. The output of the model can be used as a first approximation of the time that the two herbicides will reside in the forest environment after a spray application.

Environment and growth. Waring and Webb have determined the effect of seasonal and environmental change on net photosynthesis and movement of photoassimilated carbon in Douglas-fir seedlings. Movement of photoassimilated carbon into the root system was related closely to soil temperature during periods when the soil contained much water. In August, low soil water reduced translocation to the roots below that expected from soil temperature, although translocation was still considerable. New needles and roots were the major "sinks" for photoassimilated carbon throughout the year, principally because they are the major components of seedlings. The requirement of various vegetative tissues for photoassimilated carbon, based on tissue per unit, was variable and was related closely to the phenology during the growing season. In the dormant season, requirements for carbon in the shoot increased, but requirements in the roots decreased. Tree seedlings are planted in a wide variety of environments. The results reported here will help us understand the effect of environment on growth of seedlings during the first, critical year of establishment in plantations.

Drought resistance. A study by Waring and Steve Running showed various responses of leaf conductance to increasing plant moisture stress. Sitka spruce appeared to exhibit little control over its water loss, which might partially explain its limited range along the moist coastal belt of the Pacific Ocean. Western hemlock exhibits moderate control at high stress. Douglas-fir, grand fir, and ponderosa pine all show significant control of transpiration, often beginning by early August on dry sites. These results find application in understanding and modelling tree growth, forest hydrology, and nutrient cycling along with species adaptations to various environments.

Tree Improvement

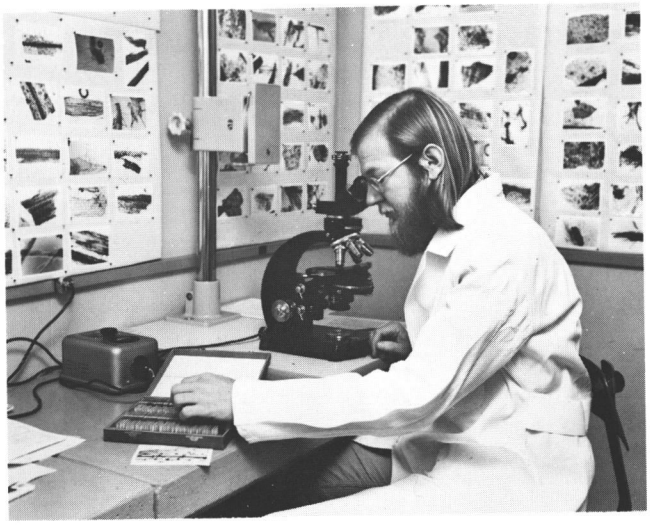
A study in genetic variation in western hemlock is being conducted by Kim Ching and doctoral candidate William Pope. The specific objective is to determine genetic variability among samples of western hemlock in response to a combination of temperature and day-length conditions under controlled environmental conditions. Second-year results indicate there is a significant interaction effect among seed source, root temperature, air temperature, thermoperiod, and air-root temperature. Generally, 15 C root temperature and air temperature of 23 C during the day and 18 C at night appear to be optimum. This information can

be used in the production of containerized western hemlock seedlings under a "controlled-environment" condition.

Hybridization studies are of high priority in our program. Ching, with support of the Bureau of Land Management, is conducting studies to better understand the physiology of pollen. Previous studies have shown that the content of adenosine phosphates (AP) of germinating seeds reflects growth, organogenesis, and morphogenesis. This study has shown that in air-dried pollen of Douglas-fir, western hemlock, and noble fir, the adenosine triphosphate (ATP) content is correlated significantly with germinability. Because of the simplicity and rapidity of this assay procedure, the ATP content can be used to check the viability of pollen stored for artificial pollination without the delay that actual germination on agar or liquid media would require. For example, if a lot of Douglas-fir pollen contains more than 5n moles ATP in 10 mg, then the lot is highly viable and can be used for pollination work.

We have just added another specimen oddity to our Breeding Archives for future study on flowering, a cone-producing 3-year-old Douglas-fir seedling. This seedling was among the many thousands of interprovenance hybrids that we produced during the last few years. It is a product of crossing one of the trees originated from the Shelton area in Washington with pollen collected from a tree with Sugar Loaf Mountain origin on Vancouver Island, Canada. According to the literature regarding cone formation, the seed cone bud of this young plant must have developed at the tender age of 1½ years.

A study of branching angle by Kim Ching indicated the probability of inheritance of branching angle may be very low in wild populations of Douglas-fir.



Plant species eaten by pocket gophers are determined by inspection of plant fragments with a microscope and comparison with photomicrographs displayed for ready reference.

Forest Protection

Animals. The pocket gopher, a serious threat to reforestation in the pine and mixed conifer regions of Oregon, is being studied in cooperation with industry and public agencies.

Hugh Black and Douglas Burton, graduate research assistant, are studying the feeding habits of the mazama pocket gopher in southcentral Oregon in cooperation with the Weyerhaeuser Company, the U.S. Forest Service, and the U.S. Fish and Wildlife Service.

Photomicrographs of plant tissues of all grasses, forbs, and shrubs identified on the study area were used as reference for identification of plants that occur in the gopher's diet. Because most plants have characteristic cellular and tissue structures, these become "recognition items." Recognition items consisted of fragments of plant tissue with constant characteristics, which may be recognized as belonging to the species and part of the plant eaten.

Preliminary results of stomach contents indicate that annual and perennial grasses are an important component of the gopher's diet, especially in winter. Dietary analyses also reveal a positive correlation between availability of food plants and the gopher's food habits. This information will be useful in planning site treatment before and after planting to provide conditions more favorable for trees and less favorable for gophers.

In southwestern Oregon, Black and Edward Hooven are studying the effects of habitat changes after herbicide treatments on small-mammal communities, with emphasis on pocket gophers. Herbicides were applied to 10-year-old clearcuttings before planting in 1972 to control grasses only, forbs and shrubs only, or all vegetation. Herbicide

treatments were repeated in October each year after 1972. A marked reduction in activity of pocket gophers occurred on all treated plots as compared with untreated, although there was a lag of about one year between initial treatment and the decline of gopher activity. Gophers caused severe damage to planted seedlings during this period. Control of grasses with atrazine and simazine was more effective in reducing gopher density than was control of forbs and shrubs with 2,4-D. But combined treatment with atrazine, simazine, and 2,4-D eliminated most vegetation from treated areas. This created favorable conditions for trees, but unfavorable habitat for gophers. Few gophers were found on these areas 2 years after treatment.

Both investigators are interested in learning how forestry practices affect wildlife, and in cooperation with Publishers Forest Products Company, they have begun studies of effects of "brown-and-burn" treatment on mountain beavers. Preliminary observations on a site in the Coast Range of western Oregon, which was sprayed and burned in the summer of 1974, indicate that this treatment greatly disrupted mountain beaver habitat. It caused a marked reduction in density and shifting of activity, but remaining animals maintained themselves on sparse herbage that developed after burning. Removal of slash and vegetative cover, however, helped in locating burrow systems to apply measures for direct control.

Recent restrictions on use of pesticides on forest lands, including use of most rodenticides on public lands, has renewed interest in alleviation of animal damage by means of habitat alteration and by use of less toxic rodenticides. Black and Hooven, in cooperation with the Velsicol Chemical Corporation, tested effectiveness of an anticoagulant-treated bait to control damage by mountain beavers. Diphacinone, the anticoagulant chemical tested, is less hazardous than strychnine and other toxicants that have been used to control mountain beavers. Results of bioassays and field evaluation of anticoagulant-treated baits were not promising, however. Baits tested, which are registered for commensal rodent control, were not accepted readily by mountain beavers or wood rats and were not effective in controlling mountain beavers in the field.

An ironic consequence of intensive practices in forest management advocated today may be increasing losses to disease in future forest generations. Everett Hansen has been working with U.S. Forest Service scientists and industrial foresters to assess this possibility and develop management alternatives for diseased stands.

Fungi. Laminated root rot, a fungus disease, causes more loss to Douglas-fir every year than the tussock moth did in its peak year, 1973. *Poria weirii*, the cause of laminated root rot, has two features that ensure its survival in the natural forest and cause increasing concern to the forest manager. First, the fungus spreads slowly but relentlessly along root systems and second, it can survive in decayed roots for long periods and then infect roots of a new tree generation as they contact the old. Laminated root rot is a natural part of western forests, and does not threaten the forest as a whole. The opening created by the disease quickly fills with brush and the fungus gradually dies out at the center of the opening as it slowly spreads to surrounding trees. The natural forest ecosystem is not upset by the disease, but our economic expectations are not accounted for in the

Herbicide treatment of clearcuttings in southwestern Oregon reduces damage by making the area unattractive to pocket gophers. The common mullein pictured is resistant to herbicides, so impact of the treatment is lessened somewhat.

balance between fungus and fir. Key features of intensive forest management, such as short rotations, brush control, and immediate replanting seem to favor fungus survival and may lead to still greater losses.

The goal of the cooperative research is to study the mechanisms of survival and spread of *Poria* so that we may design control strategies. Red alder is not attacked by *Poria* and produces biochemical changes in the soil that inhibit this fungus. Field plots have been established to test the effectiveness of pure alder stands and mixed alder-fir stands in reducing losses. Field study of *Poria* in Douglas-fir plantations showed that mixtures of red alder did not reduce initial losses, but longer study periods will be required to check on possible reduction of future disease spread.

We must learn how long *Poria* can survive in infected roots of different sizes so we can evaluate possible control strategies. As a first step toward this goal, 74 stumps of trees harvested 20 years ago were excavated. These stumps were selected because they showed signs of past infection; *Poria* was still alive in 94 percent of them. Although the fungus survived for 20 years, it was dying in the stumps, and surface growth, which seems to be necessary for spread, was gone from most of the roots. These results must be checked on stumps of different ages, but they do suggest that laminated root rot is not as indestructible as we have thought.

Insects. In Julius Rudinsky's study of chemical insect attractants, the antiaggregative pheromone of the Douglas-fir beetle, 3-methyl-2-cyclohexen-1-one(MCH), was identified as the major fraction of the antiaggregative pheromone of the spruce beetle. A slow-release granular formulation of MCH, which was field tested on downed Douglas-fir and Sitka spruce trees in western Oregon, reduced attack only briefly with Douglas-fir beetle but by 93.3 percent for 5 weeks with the spruce beetle. As in previous tests, glass vials of liquid MCH almost totally prevented attack on both species. Practical use of a granular formulation appears feasible, but the rate of release must be improved for the Douglas-fir beetle.

Economics

Preliminary comparisons for 1973 show that costs of manufacturing plywood appear to be considerably less for wood and labor in the South than in the Northwest, according to a study by Charles Sutherland. Labor cost per thousand square feet of plywood was about half as high in the South and wood costs were about 15 percent less. Overhead and other fixed costs were higher in the South and offset to some extent Southern cost advantages for labor and wood.

Southern mills have more favorable freight rates for plywood shipped to East and Midwest markets. Rates to Denver from Shreveport, Louisiana, are about equal to those charged from Portland,

The laminated root rot, *Poria weirii*, killed the two 18-year-old trees on the left after their roots grew across an infected root of the 20-year-old stump.

No galleries of the Sitka spruce beetle were on this log protected by the antiattractant MCH. Unprotected logs were attacked, as evidenced by galleries.

Oregon, to Denver. An analysis of the economic data gathered for this study will be available in 1975.

A study of the urban-dwelling, nonindustrial forest landowners in Western Oregon showed that this type of owner is older, more highly educated, and earns higher incomes than the average Oregon citizen. Kent Downing also found that most of the owners are male and a higher proportion work in professional, managerial, and related occupations. Reasons for ownership, membership in forestry organizations, degree of management activity practices, income from the forest lands, knowledge and use of forestry services, and type of technical information desired varied significantly with size of ownership. Results also showed that most of the acreage controlled by this type of owner is under the control of a small number of people (Table 7). This suggests to service foresters, extension specialists, and other educational and action agencies working with nonindustrial owners that to have the greatest impact on forests, programs might be directed toward owners with 100 acres or more. Timber tax records available at county assessors' offices provide a convenient way to obtain the names and addresses of these owners and to stratify ownerships by size.

Table 7. Urban-dwelling, Nonindustrial Owners of Forest Lands in Benton, Lincoln, Multnomah, and Washington Counties, Classified by Area Owned by Respondents to Survey.

Forested acres owned	Percentage of respondents *Percent*	Percentage of total acres owned *Percent*
100 or less	76	20
101–500	19	27
500 or more	5	53

FOREST PRODUCTS RESEARCH

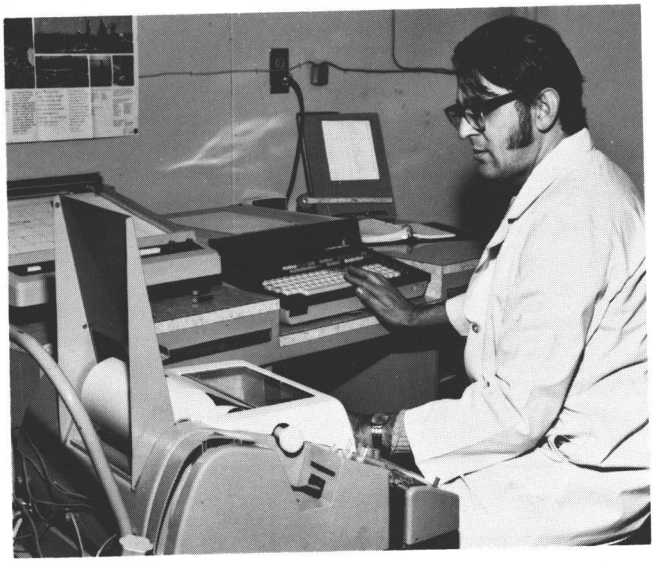
Major research in forest products in 1974 is reported here in four sections dealing with engineering and design, assuring performance, residue use, and processing chemically or mechanically.

TIMBER ENGINEERING AND DESIGN

Stud Walls

Stud walls are basic vertical elements in many residential and commercial buildings. Current design procedures are overly simplified because they are based on the assumption that the structurally complex stud wall system behaves as a set of individual studs acting as pinned beam-columns. Anton Polensek, George Atherton, and Stanley Corder are the research engineers who are developing improved design procedures. They developed a theoretical analysis for wood-stud and steel-stud walls by the finite-element method. The method is based on a mathematical model that considers the stud wall as an assembly of I-beam-column elements accounting for the partial composite action of studs and wall coverings; and plate elements accounting for the load sharing. A comprehensive computer program has been prepared to compute the maximum deflection and stresses and the ultimate lateral load that the wall can sustain in addition to constant vertical loads. The method and the computer program were verified by analyzing laboratory-tested, full-size wall panels and comparing theoretical and experimental results.

To analyze the wall, elastic and geometric properties and wall components and connections must be known. Properties not available in the literature, such as modulus of elasticity, shear modulus, and Poisson's ratio for the materials used for the wall coverings, and the connector modulus of nails and screws connecting studs and wall coverings were evaluated experimentally.



A new computer program, verified by tests, allows computation of various physical properties of wall panels.

Floor Vibrations

Establishment of levels of human acceptance of floor vibrations in occupied dwellings is desired by regulatory agencies and timber trade associations. George Atherton and Stanley Corder are working toward that goal and toward the development of an appropriate test method for floor vibration. They analyzed impact and walking time-

The impact of a weight on a floor causes vibrations that can be correllated with the effects of a person walking on the floor. This easily made test can give a measure of whether or not the floor's vibrations will be pleasant or objectionable.

displacement traces from 24 full-size dwelling floors for amplitude, frequency, and damping ratio. Static variables also were measured or calculated. More than 25 variables or combinations of these variables were found to be related to human response to vibration. Those variables that correlate best with human response will be used to characterize vibration in subsequent pilot tests of human response to vibration in about 25 occupied dwellings.

Fire-Retardant Treatments

Treatment with fire-retardant chemicals influences the strength of wood. The magnitude of this strength reduction often is not known fully. Therefore, Robert Graham, wood preservation specialist, tested fire retardant-treated beams in bending 15 years after their treatment. Specimens previously had been tested 1, 3, and 6 years after treatment. Modulus of rupture, modulus of elasticity, and work to maximum load were affected by storage time and type of fire retardant, but not by the amount of fire retardant retained, which ranged from about 1 to 5 pounds per cubic foot. Strength properties were unchanged during 3 years of storage, but were lower after 6 years. Within the time span under study, fire retardants reduced modulus of rupture up to 13 percent, modulus of elasticity up to 6 percent, and work to maximum load up to 32 percent.

A recently started series of tests on dimension lumber glued up of two pieces selected to have one edge strong in tension may indicate a way of providing strong joists from narrow pieces.

Roof Diaphragms

Strength and stiffness of roof diaphragms constructed of edge-glued decking were investigated by James Johnson, wood technologist. He obtained deflection curves for three diaphragms with different percentages of adhesive and one without. Adhesive placed between decking boards to resist shear improved the stiffness of the roof sections considerably and made them several times as stiff as a similar roof section without adhesive.

Considering only maximum load, the diaphragm with 26 percent of the decking glued together was most "efficient," as it was two-thirds as strong as the roof section with 100 percent gluing; the diaphragm with 59 percent gluing was five-sixths as strong as the root section with all decking glued. Even after maximum load, or "failure" induced by testing, the roof sections with adhesive retained good stiffness and near-maximum loads, which is especially important for structures in earthquake areas.

Tensile Strength

Effect of size on tensile strength of clear Douglas-fir and hem-fir dimension lumber has not been established, as it has for bending strength. Wood technologists Robert Kunesh and James Johnson tested nominal 2-inch-thick clear dimension lumber of 10 percent moisture content in tension parallel to the grain. Tensile stress of Douglas-fir decreased as width increased, and average values from pieces 4 and 10 inches wide were significantly different. A similar trend for hem-fir lumber was not great enough to be statistically significant. Although mean values for specific gravity and modulus of elasticity in flatwise bending were significantly higher for Douglas-fir, averages of tensile stress for the two groups of species were not significantly different.

ASSURING THE PERFORMANCE OF WOOD PRODUCTS

Stopping Decay

Controlling decay of wood with volatile chemicals is a research goal for Robert Graham, wood preservation specialist, and Malcolm Corden, pathologist. They cooperate closely with utility companies

throughout the United States, the Federal Sea Grant Program, and wood preservation companies. They found that treating decaying Douglas-fir poles with various fumigants 5 years ago kept the material almost free of decay fungi, although the population of nondecay fungi was increasing. Chloropicrin was most effective, Vorlex was intermediate, and Vapam was less effective in controlling fungi. Poles treated in 1973 to evaluate effectiveness of different amounts of fumigants and summer or winter treatment were sampled, and the cores will be bioassayed. Closed-tube assay disclosed fungitoxic vapors in poles about 8 feet above and below the ground line and within one-quarter inch of the surface of seasoning checks. The estimated residual protection will remain within poles for between 5 and 10 years, depending on the fumigant used. Piling that were decaying below the cut-off top were treated with fumigants and capped with a cold-tar cement incorporating Fibreglas cloth. They will be bioassayed annually to evaluate effectiveness of treatments.

The role of decay and nondecay fungi in the reinvasion of fumigant-treated wood also was studied. Eighteen genera of fungi, including three decay fungi, have been isolated from Douglas-fir poles in western Oregon. Four identified and two unidentified decay fungi were isolated from waterfront structures along the Oregon coast. Some nondecay fungi colonized wood rapidly in initial studies.

To make such observations and obtain these data, development of good bioassay procedures was necessary. Now, fumigant vapors can be detected in wood by their effect on growth of decay fungus innoculum on nutrient media in a closed-tube assay. The amount of pentachlorophenol in wood can be estimated by measuring the distance between the wood sample and the margin of a colony of decay fungus growing on nutrient media for 3 weeks; that is, by a zone-of-inhibition assay. Additional of Benomyl to the nutrient media and to wood favors outgrowth of decay fungi and suppresses outgrowth of nondecay fungi.

Hardboard Siding

Exterior exposure of hardboard siding was monitored by Raymond Currier, wood technologist, in cooperation with many manufacturers over the last 10 years. Changes in appearance of samples exposed on a test fence and of physical properties after various exposure periods were reported. To evaluate the quality of various finishes, new samples of prefinished hardboard lap siding were placed on the test fence and are being subjected to various accelerated weathering tests. Their physical properties were determined before accelerated aging and will be tested again afterwards.

Durability of Wood Products

Treated and untreated wood products are being evaluated for durability by Donald Miller, wood technologist. His work includes the performance of railroad crossties. Inspection of cross ties in tests at various sites in Oregon, California, Nevada, and Arizona showed several Oregon timber species rendering excellent service. Now, after 20 years in a mainline tract at a site with high potential for decay, first evidence of appreciable decay was obtained. Decay occurred at one site only and was mostly in

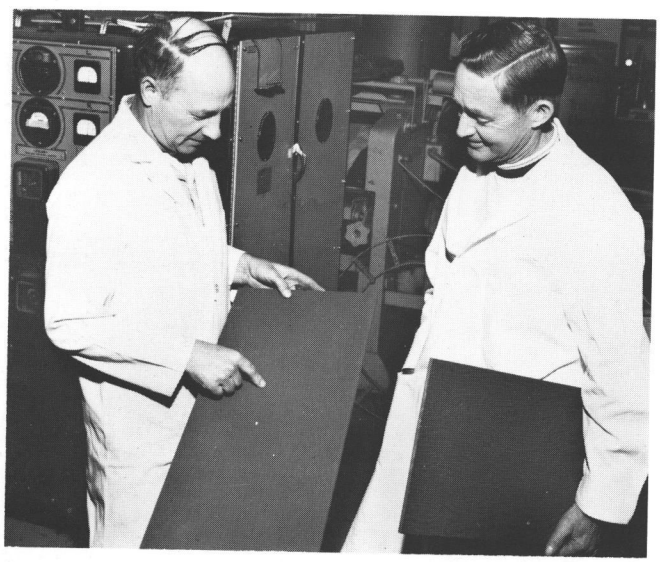
Bits of wood from various locations inside a Douglas-fir pole are kept in a nutrient medium so fungi present will grow until they can be identified.

ties of western hemlock, spruce, and white fir. Because these less costly woods are of interest as substitutes for Douglas-fir ties, these findings were reported to the American Wood Preservers' Association.

RESIDUE UTILIZATION

Energy from Residues

Forest industries can lessen the impact from high prices for energy by burning wood residues. Research Engineer Stanley Corder has collected information on historical and current uses of wood fuel, on present steam-generation equipment and air-pollution-control equipment, on physical and technical considerations in combustion, and on economic comparisons of wood-bark fuels with other fuels. A conference on "Wood and Bark Residues for Energy" had an attendance of about 175 persons, mainly from industry. A start was made on a manual to provide information to operators of boiler plants using residue fuels. Planning assistance also was provided for a future national conference that will be concerned with using wood and bark for energy.



Prefinished hardboard lap siding is exposed to severe conditions such as heat, moisture, and ultraviolet light in a weatherometer (in the background). The tests will give a measure of service life.

Chipping Slash

Treatments to assist debarking of chipped roundwood slash became of interest when paper companies wanted to assure the quality of their pulp, as well as use segregated bark as a fuel. Donald Miller explored methods for minimizing bark content. He evaluated injections into standing trees of an herbicide, monosodium methanearsonate (MSMA), that may weaken the bark attachment to wood, as well as heating chips with steam or hot water to assist in removing bark. Douglas-fir, western hemlock, lodgepole pine, and ponderosa pine were tested.

As barky wood dries, bark becomes attached about five times more firmly than on fresh material. This relation proved to be reversible. Continued heating in steam progressively weakened the bond. Compression debarking reduced bark in chips to less than 5 percent; presteaming was beneficial. Preharvest injection with MSMA definitely weakened bark attachment.

Bark Fibers in Plastics

Mechanically refined Douglas-fir bark fiber was used experimentally for reinforcement of plastics by Miller and J. D. Wellons. Such use may aid in increasing the value of bark beyond that as a fuel. Pressureized-disc refined fiber increased impact strength of phenolic and polypropylene moldings. As fiber content increased from 0 to 30 percent, strength of phenolic moldings increased linearly from 0.3 to 0.6 foot-pounds per inch. Strength of polypropylene increased from 1.7 to 3.1 foot-pounds per inch as fiber content increased from 0 to 20 percent; then decreased to 2.8 foot-pounds per inch at 30 percent.

To increase yield of refined fiber, additional amounts of poor-quality fiber were included in moldings of fiber-polypropylene. Strength of all moldings, including controls with no fiber, was unusually low, and effects of fiber content were not detectable. Attempts to improve fiber yield as well as quality by refining bark at reduced steam pressure resulted in excessive amounts of broken fiber. Trials will continue with various refiner-plate patterns.

Bark in Composition Boards

Bonding mechanisms in bark composition boards were investigated by Wellons to aid in producing new and improved bark composition boards. He found that Douglas-fir bark furnish can be consolidated at 350 degrees F to form a "hardboard" having strength properties about 20 percent less than specified in relevant commercial standards. This "self-bonding" resulted from thermoplastic molding of cork particles around fibrous elements. Resulting boards were not acceptable in creep resistance if substantial quantities of cork were included. The thermoplastic nature of the cork dominated the behaviour of Douglas-fir bark during various particle-reduction processes. Attempts to chemically enhance the self-bonding of these bark particles were discontinued because the cork was penetrated so slowly by reagents. The tentative conclusion was that thermoplastic particles would have to be crosslinked internally before acceptable board properties could be obtained.

Using the cork and fiber fractions of Douglas-fir bark separately in composites offered some opportunities. Cork particles formed acceptable low-density panels, some of them bonded with a foamed adhesive. The bast fibers separated cleanly from other bark components during steam-pressurized refining.

Bark Cork

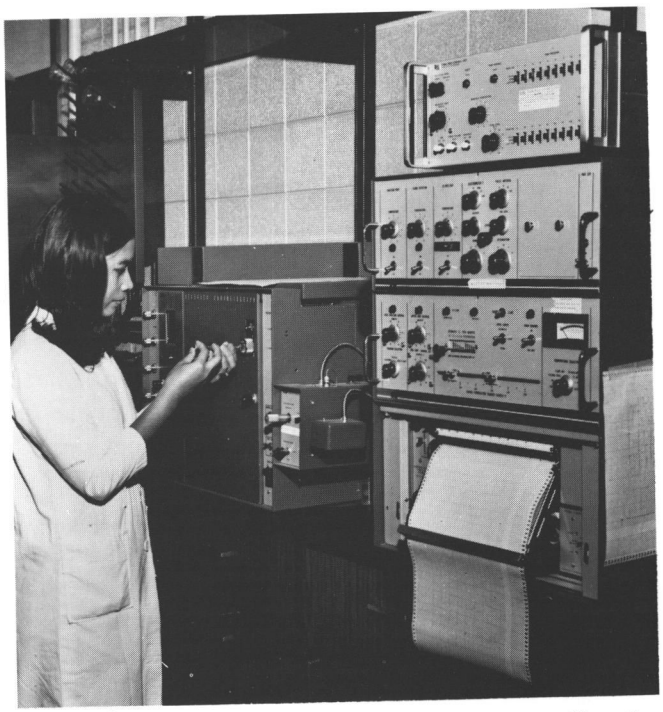
The anatomy of cork cells in Douglas-fir bark might be a key to utilization of the bark in commercial products. Robert Krahmer, wood anatomist, therefore investigated heat and chemical treatments required to expand the crushed cork cells for physical study of the cell wall and chemical analyses of its constituents.

Bark Chemistry

Phenolics and phenolic acids from Douglas-fir bark become more interesting in part because of increased prices for phenolic adhesives. Murray Laver, organic chemist, in investigating the basic chemical structures, has isolated a tannin. Thioglycolysis of the methylated tannin showed that the tannin was composed of catechin and of epicatechin units linked through the four positions of one unit to an undetermined position of another. The linkage is probably a carbon-to-carbon bond rather than an ether bond. Laver also has isolated intact, undegraded sterol and ferutic acid esters from the N-hexane-soluble components of Douglas-fir bark. The components also contain some terpenes, alcohols, and other easily volatilized components.

By alkaline degradation of hemicelluloses in Douglas-fir bark, Laver established the presence of 4-*O*-methyl-*D*-glucuronic acid in a xylan. He also determined the kinetics of alkaline degradation of xylan. The results showed slow degradation, which stopped after 19 percent of the xylan had been degraded. A mannan-rich fraction has been isolated from the bark, and the kinetics of alkaline degradation of the polymer is under study.

Red stain in wood of red alder caused losses of quality in lumber and chips for many years. Laver concluded that the coloring matter is the same in wood and bark and set out to determine the chemical nature of the compounds and to develop procedures for treating and handling red alder wood to prevent red stain. A cold acetone extract of red alder bark yielded a condensed tannin fraction that is a polymer of epicatechin linked C-C 4,6-(4,8-) and



Elvira Fernandez, graduate student, studies by gas-liquid chromatography the alkaline degradation of hemicelluloses in Douglas-fir bark.

a diarylheptanoid xyloside. He named the polymer Oregonin. Oregonin, 1,7-*bis*(3,4-dihydroxyphenyl) heptane-3-one-5-xylopyranoside, represents a new type of glycoside compound.

Physical Use of Bark

Physical utilization of bark waste by Wood Technologist Ray Currier focused on bark pelleting, bark molding, fuel bricks, and use of bark on soil. He investigated the preparation of bark pellets in a series of experiments designed to control such variables as particle size and configuration, moisture content, and addition of chemical agents. This basic information may be applied directly to future commercial ventures such as fuel production, or pelleting bark mixed with fertilizer or other chemical for agricultural applications.

CHEMICAL AND MECHANICAL PROCESSING

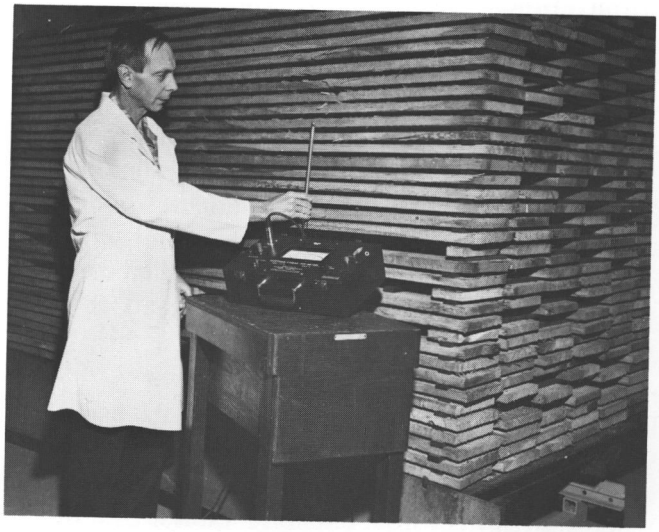
Fluorescence of Pulp Liquors

Fundamental aspects of fluorescence of pulping liquors have been investigated by Water Bublitz, pulp and paper chemist. Preliminary results indicate that measuring fluorescence is an excellent method of following the course of pulping. Intensity of fluorescence at 430 nanometers wavelength in the ultraviolet is linearly proportional to the concentration of lignin in waste liquor and indirectly proportional to the amount of lignin removed from wood. With proper calibration, fluorescence of liquor removed from a digester during a cook could be used to estimate accurately the yield of the cook at any given time. Differences in fluorescent behaviors of waste liquors from different wood species have been much less pronounced. Peak excitation and fluorescent wavelengths are nearly the same for most species studied, but intensities are somewhat species dependent. Peak wavelengths of fluorescence are pH sensitive and can be shifted with change in pH; this seems to be the major difference in fluorescence between acid sulfite and alkaline Kraft waste liquors. Fluorescences of lignin model compounds are remarkably similar, with minor differentiation caused by addition of functional groups.

Pulping Oregon Woods

Environmental and genetic effects on pulping characteristics of Oregon woods were investigated by Walter Bublitz and M. D. McKimmy. Bublitz reported on the effect of certain flavanoids on bleaching of Douglas-fir refiner groundwood and on seedling characteristics and Kraft pulping properties of young Douglas-fir. Efforts to utilize Douglas-fir chips for refiner groundwood have encountered problems because the groundwood produced has been darker in color and more difficult to bleach than refiner groundwood from western hemlock, which is the traditional material. Quercetin was found to be extremely detrimental to color of both unbleached and bleached groundwood. Dihydroquercetin, however, has negligible effects on bleaching in concentrations up to 4 percent.

A Kraft pulping study was made on 13-year-old Douglas-fir thinnings from an experimental plantation to determine whether quality of tree and wood in later years can be predicted accurately from properties of 2-year-old seedlings. A comparison with properties of pulp made from older trees showed no significant differences for pulp yields, Kappa numbers, and other common strength factors. Commercial implications are that pulp from



Speed of air blown between courses of lumber in a dry kiln affects the drying rate. Air speed was measured with the device shown here to learn the influence of sticker thickness on drying rate of western hemlock.

Douglas-fir thinnings may be used profitably by the Kraft linerboard industry, and that seedling characteristics may help in selecting trees with properties best suited to pulp and paper usage.

Kiln Drying Western Hemlock

Moisture content problems in kiln-dried western hemlock lumber were recognized by Charles Kozlik in his work with lumber producers. He investigated systematic sampling procedures with a portable electric moisture meter for testing moisture content of hem-fir lumber to meet the American Lumber Standards specification ALS PS 20-70 for moisture content. None of these procedures appeared technically feasible, so mills will have extreme difficulty in insuring that no more than 5 percent of their hem-fir lumber exceeds 19 percent moisture content. Green specimens, containing various amounts of wet areas, have been collected and kiln dried by common commercial practice. Widths and thicknesses were measured on wet and normal heartwood areas before and after kiln drying. The specimens are allowed to equalize to 12 and subsequently to 6 percent moisture content for remeasurement of their dimensions. This will give an indication of how much subsequent shrinkage must be expected.

Drying Poles

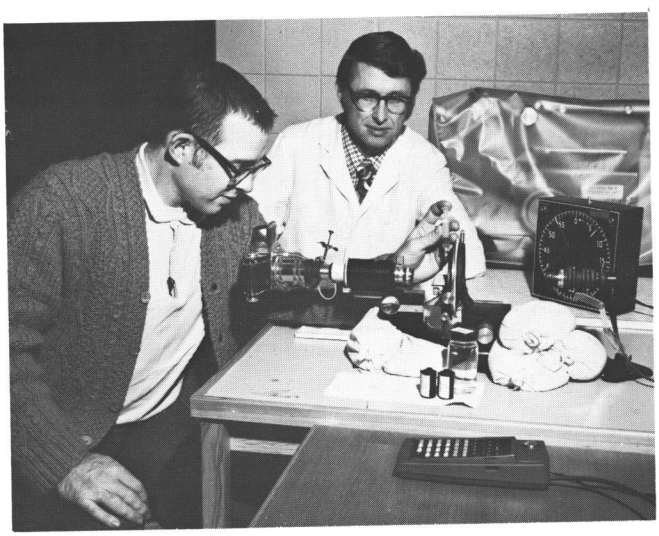
Kiln-drying schedules for Douglas-fir poles should aid wood-preserving companies in promoting rapid drying in preparation for pressure impregnation. Kozlik and Robert Graham cooperate in determining the effect of kiln conditions on checking and color of poles in service and strength of small, clear specimens cut from the poles. One year after exposure, moisture contents to 3 inches in depth were recorded in the area where initial measurements were made. Length, depth, and width of prominent checks after kiln drying and checks developing during outdoor exposure were recorded. Work in progress will determine modulus of rupture and modulus of elasticity in static bending and treatability with oil-borne preservatives.

Veneer Drying

Computer simulation of softwood veneer drying was developed as a decisionmaking tool. Helmuth Resch made computer runs that suggest advantages through sorting green veneer according to thickness, specific gravity (that is, species), and initial moisture content. Rapid initial drying followed by redrying of veneer that remained too wet appears less expensive in production than slow drying of all veneers in only one pass through the dryer.

Gluing Asian Hardwoods

Gluing characteristics of Southeast Asian hardwoods became of real importance when the foreign species were glued to native Douglas-fir. Krahmer and Wellons attempted to establish a basis for segregating Southeast Asian Diptocarp veneers into their respective genera and species and to determine the cause of delamination of plywood made from veneer of selected Diptocarp genera. They were able to segregate veneers of these woods into genera only, by characteristics such as color, size and frequency of vessels, distribution of gum ducts, and reaction of extractives with ferric salt solutions. Delamination of keruing and kapur veneers is believed to result from a combination of high density and high extractive content. Adhesive penetration into the veneers was extremely shallow, and keruing was wetted by alkaline solutions with difficulty. Kapur



Wettability of veneer from Southeast Asian hardwoods is being measured and photographed here in a study of means to improve their gluing qualities when combined with Douglas-fir.

was wetted readily, but contained high concentrations of water and alcohol-soluble extractives that accelerated gelling of the adhesive resin, which prevented adequate penetration. In addition, ether-soluble extractives from kapur inhibited cure of phenolic adhesives.

To develop methods of improving adhesive bonding to Southeast Asian hardwood veneers, considerable quantities of veneer certified as to origin and species are needed. Arrangements were made with the Philippine and Malaysian Forest Service to include lauan-meranti, apitong-keruing, and kapur in future investigations.

Research on Composition Boards

Research needs of the composition board industry were surveyed by James Wilson, a new leader for research on these products. Twenty manufacturers were contacted throughout Oregon. Also, discussions were held with representatives of adhesive companies and other research institutions active in composition board development. The two main problems identified as being common with all board manufacturers are cost and availability of wood furnish and cost and availability of adhesives. Other needs for information regarding processes and products are related to reduction techniques of wood furnish, resin efficiency, pressing, and more in-line monitoring of all process variables, as well as in-line quality control, faster test methods, improved surface and edge properties, improved dimensional stability, overlays, and preservatives and fire retardants.

Hedging in Forest Products

Basis charts and trading strategies for hedging western lumber and plywood are being investigated by Robert McMahon, forest economist. He developed a plotting routine to construct basic charts and obtain statistics on lumber price data for 1974. Initial charts have been drawn; minor modifications to the program must be completed before producing the entire run of basic charts. Initial hedging guidelines and strategies are being developed.

FORESTRY EXTENSION

"Send them good, practical teachers," insisted Bill Greeley a quarter of a century ago as he debated the problems of the small woodland owner with Lyle Watts, then chief of the U.S. Forest Service. This incident occurred about the time the first short course was offered to practicing foresters by our School of Forestry.

Our extension program is following Bill Greeley's advice to provide practical educational opportunities to forestry clientele and the public. The methods are varied, but include short courses, conferences, workshops, day and evening meetings, field tours, demonstrations, trials, and the use of news media. Whatever the method, we hope the results provide practical gains such as insight, new knowledge, and skills to help in improving resource decisions, as well as benefiting individuals and communities.

SHORT COURSES AND WORKSHOPS

The wide variety of short courses and special programs during 1974 are shown in the accompanying table.

A total of 1,228 people were in attendance, not counting contacts made in special county programs. The dominant change over past years is the trend toward greater delivery off-campus, made possible by the addition of two extension specialist positions authorized by the last legislature.

Almost 600 people participated at eight off-campus locations. To illustrate the continuing trend, by the time you read this, about 600 small woodland owners will have participated in some 60 evening sessions at seven locations in western Oregon during 1975.

AUDIO-VISUALS

The use of audio-visuals, principally slide-tape units, was recognized some time ago as being an important attribute to undergraduate programs. With the help of the Louis and Maud Hill Family Foundation in 1973, we launched into supplying this type of instructional opportunity to our clients around the state.

Use of tape-slide units has grown rapidly. To June 1973, 2,600 people had used our self-learning slide-tape units. The total now exceeds 10,000, with over 6,000 users in 1974 alone.

RADIO AND TELEVISION

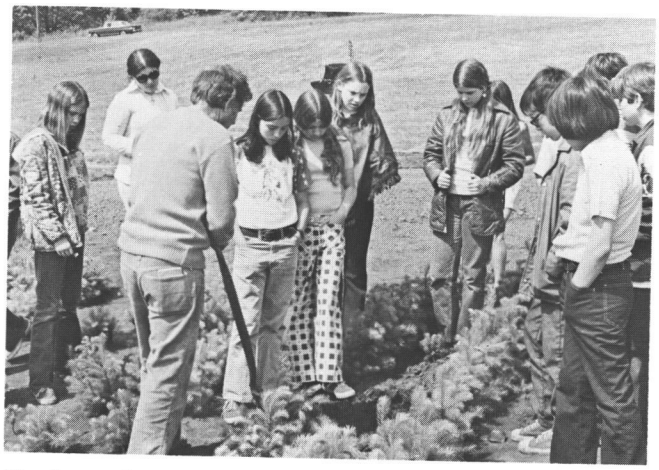
Radio became a significant means of informing the public during 1974, although full utility has not been made of this medium for state-wide use. Television has been useful in bringing key points to the public, such as precautions in gathering fuelwood.

During the year, 28 faculty members delivered 32 topics in 5-8 minute segments over radio KOAC. A wide variety of topics was covered, such as the role of the wood-using industry in Oregon's economy; better forests through genetics; fertilizing forest stands; advanced logging systems yarding study; stream pollution in logging; wood products markets soften; designing with wood for long service and low maintenance; using wood and bark residues for energy; and forest taxation.

PUBLICATIONS

Extension publications are available as fact sheets, circulars, bulletins, special reports, and

Foresters and loggers prepare to examine small-wood harvesting on extension tour at McDonald Forest near Corvallis.



Sixth-grade students learn about survival and growth of tree seedlings in a forest nursery.

newsletters. Those seven reports published during the year are listed in the last section of the publication. Those available are increasingly problem-oriented, as, for example: Charles Sutherland's The Forest Property Tax Law in Western Oregon; Brian Cleary's After the Tussock Moth—Salvage, Rehabilitation and Protection; and John Garland's Gathering Fuelwood for Home Heating.

Educational contributions are being made by Gary Sanders and others to the newsletters of the Pacific Northwest Christmas Tree Association and the Small Woodlands Newsletter. Mervyn Filipponi's recreation newsletter is published by extension for a variety of recreational interests and uses. And Oregon's first comprehensive forestry extension newsletter, Forestry Update, will be initiated in 1975.

COUNTY PROGRAMS

A variety of educational opportunities were available in different counties of the state. These include tours, demonstrations, workshops, evening programs, and walk-ins and telephone advisories on forestry problems and youth education.

Teaching contacts by agents and specialists numbered more than 10,000 on reforestation, stand and financial management of Christmas tree production, logging methods, watershed protection, resource recreation, product uses, and others.

Examples of a field tour and meetings were those conducted by logging specialist John Garland on uses of mini-yarders with a total audience of 260; Saturday planting days conducted by agents emphasizing correct planting methods; and twilight tours for Christmas tree growers.

Two youth programs are carried out at the county level largely by volunteers and 4-H agents: 4-H Forestry; and Forestry School Tours.

The 4-H Forestry programs have 1,680 boys and girls in the Forester, 4-H Advanced Scientist, and Tree Farmer educational units. About 75 volunteers assisted in the program.

Forest School Tours were conducted this year with 800 adult volunteers. About 17,000 students from fourth to seventh grades attended. Topics ranged from fire control to appropriate cutting practices.

CONFERENCES, SHORT COURSES, WORKSHOPS IN 1974

Subject	Director(s)	Days	Attendance
Forest Engineering			
Demonstration: Harvesting Small Wood	Garland	12	256
Forest Engineering Institute	O'Leary	50	28
Forest Engineering Institute	O'Leary	50	29
Production Planning for Woods Operations	Garland, Aulerich	4	36
Quantitative Analysis for Woods Operations	Garland	7	80
Forest Management			
Aerial Photo-Remote Sensing	Paine	4	40
Dendrometry–Three-P Sampling	Bell	3	20
Forest Ecology*	Robinson	2	
Reforestation-Rehabilitation, S.W. Ore.	Cleary	2	72
Reforestation-Rehabilitation, Corvallis	Newton	2	79
Variable Probability Sampling– Variable Plot and Three-P	Bell	5	43
Young-Growth Management	Berg	5	58
Forest Products			
Business Use for Lumber and Plywood Futures	McMahon	1	26
Futures Trading	McMahon	1	76
How to Hedge with Lumber and Plywood Futures	McMahon	1	75
Lumber Drying	Kozlik	5	31
Plywood Adhesives and Adhesion	Wellons	2	33
Veneer Drying	Currier	2	42
Wood and Bark Residues for Energy	Corder	1	177
Forest Recreation			
Forest Recreation Problems	Downing	2	27
			1,228

*A cooperative program sponsored by Tall Timbers Research Station, Oregon State University and University of Washington.

AUDIO-VISUAL MATERIALS

Forestry specialists of Oregon State University have prepared several audio-visual learning packages for public and professional use. Voices on audio tape and illustrations on slides provide explanations with personal quality. You may rent or buy these educational presentations from the School of Forestry. Information about content, price, and audience is listed with each item.

Each slide-tape program includes a set of slides, an audio tape, a written script, and instructions for use. If you don't have the necessary equipment, you usually can rent or purchase it from your nearest camera or hi-fi shop. We will send information about equipment on request.

The audio tapes are available in either cassette or reel-to-reel format.

For rentals, the fee is $8.00 for three days' use. Sales prices are listed opposite the catalog number for each title.

WOOD STRUCTURE
564 S-T $68

A detailed explanation of the anatomy of wood, including the openings through which preservatives can enter and move, places where preservatives are retained in wood, and why wood shrinks and swells. Excellent color illustrations help clarify the complex structure of wood.

Audience. Wood-preserving plant personnel; suppliers and users of wood products; preservative suppliers; architects; builders; and schools of forestry, engineering, and architecture.

Author. Robert L. Krahmer, Forest Products Department.

35 min., 114 slides.

HOW WOOD DRIES
565 S-T $50

This unit is on the important aspects of wood drying: The role of the fiber walls in swelling and shrinking of wood, the dynamics of water movement at wood surfaces, the movement of water through wood, and the effects of moisture changes on wood. The final section deals with changes in moisture content of Douglas-fir poles during air seasoning, pressure processing, and use.

Audience. Wood-preserving plant personnel; suppliers and users of wood products; preservative suppliers; architects; builders; and schools of forestry, engineering and architecture.

Authors. Leif D. Espenas and Robert D. Graham, Forest Products Department.

30 min., 76 slides.

PENETRATION OF LIQUIDS INTO WOOD
566 S-T $52

This unit deals with the theoretical aspects of fluid flow as related to the treating process. It describes the role of structural elements of wood in the movement of preservatives through wood. The presentation has a section on practical aspects of treating wood to customer specifications.

Audience. Wood-preserving plant personnel; suppliers and users of wood products; preservative suppliers; architects; builders; and schools of forestry, engineering, and architecture.

Authors. Richard T. Lin, Donald J. Miller, Robert D. Graham, Forest Products Department.

20 min., 80 slides.

PRESSURE WOOD-PRESERVING PROCESSES
567 S-T $70

Specialists show the versatility of pressure-treated wood products in use and the status of the wood preserving industry in the United States. One section shows how the various components of a treating plant work together in the treating process, and how a charge of Douglas-fir poles actually is treated.

Audience. Wood-preserving plant personnel; suppliers and users of wood products; preservative suppliers; architects; builders; and schools of forestry, engineering, and architecture.

Author. Robert D. Graham, Forest Products Department

Consultants. Arthur Morton, plant superintendent, L. D. McFarland Co.; Jack W. Williams, former plant manager, J. H. Baxter & Co.

24 min., 119 slides.

WOOD PRESERVATION MINICOURSE
578 S-T $82
50 min., 144 slides

WOOD PRESERVATION MICROCOURSE
593 S-T $52
22 min., 80 slides

Two condensed versions of the four units on wood preservation; Wood Structure, How Wood Dries, Penetration of Liquids into Wood, and Pressure Wood-Preserving Processes. Each consists of a brief explanation of the

principal concepts of the structure, drying, and pressure-treating of wood.

Author. Robert D. Graham, Forest Products Department.

STAINING OF WOOD AND ITS PREVENTION
590 S-T $51

In this slide-tape, you'll see how fungi can cause discolorations and decay and how other types of discoloration are produced. You'll also learn about termites and insects that inhabit wood. The presentation also includes information on methods for preventing and controlling discoloration of wood.

Audience. Intended primarily to assist kiln operators in producing bright, stable, attractive lumber. Also of interest to sawmill managers, architects, suppliers of anti-stain chemicals, and others concerned with the conversion of trees into lumber.

Authors. R. D. Graham and T. C. Scheffer, Forest Products Department.

22 min., 78 slides.

PREVENTING AND STOPPING INTERNAL DECAY OF POLES
681 S-T $52

This slide-tape describes factors that contribute to the internal decay of poles. You'll see practices to prevent internal decay of new poles and to stop internal decay of poles in service. Tests demonstrate agricultural fumigants placed in holes in Douglas-fir poles will stop decay, probably for at least five years. The findings make feasible the use of many western woods for poles regardless of the depth of their sapwood or the treatability of their heartwood.

Audience. Users and suppliers of wood poles, schools of forestry.

Authors. R. D. Graham and T. C. Scheffer, Forest Products Department.

30 min., 80 slides.

HERBICIDES: AN INTRODUCTION TO THE USE AND IMPACT OF SPRAYED CHEMICALS
667 S-T $48

How and when to apply commonly used herbicides for the reclamation of brushfields and the reduction of vegetative competition. The fate of sprayed chemicals is discussed in terms of volatilization, degradation, aerial drifting, and leaching through the soil. Also included is a discussion of the toxicity of certain herbicides to animals.

Audience. Foresters and others concerned with forest practices.

Author. Warren Webb, Forest Management Department.

17 min., 69 slides.

LOGGING AND WATER QUALITY
684 S-T $63

This presentation includes a detailed discussion of specific water quality problems and how they may be influenced by timber harvesting. Problems of sedimentation, dissolved oxygen content, water temperature, and natural nutrients are related to harvesting practices. Illustrations of forest practices include clearcutting, patch cutting, buffer strips, roadbuilding, and removal of logging debris from streams.

Audience. Foresters and others concerned with forest practices.

Author. R. D. Harr, Forest Engineering Department.

34 min., 106 slides.

FOREST PRACTICES AND STREAMFLOW
653 S-T $51

This presentation details how water moves through the hydrologic cycle and which parts of the cycle may be altered by forest activities. The soil-water system, evapotranspiration, and streamflow are discussed in relation to clearcut logging, roadbuilding, and prescribed burning.

Audience. Foresters and others concerned with forest practices.

Author. R. D. Harr, Forest Engineering Department.

34 min., 78 slides.

HEDGING WITH LUMBER FUTURES
579 S-T $49

Benefits of hedging are defined for lumber wholesalers, producers, retail distributors, and such large-volume users as residential and commercial builders. The sell-hedge and buy-hedge, normal and inverted markets, and what is meant by basis are explained by examples. The program may be custom fitted to the needs of the users.

Audience. Industry, commodity houses, education.

Author. Robert O. McMahon, Extension Forest Products Marketing.

30 min., 72 slides.

OSHA AND OREGON'S FOREST PRODUCTS INDUSTRY
690.1 S-T $47

This presentation describes provisions of the Occupational Safety and Health Act of 1970 relating to the forest products industry in Oregon, as administered by the Oregon Safe Employment Act. Discussion includes administrative

and enforcement agencies and the inspection procedures they follow. The program describes the steps a small firm will have to take to meet regulations and the penalties invoked for noncompliance.

Audience. Small forest products operators, unions, and safety personnel.

Author. M. D. M.Kimmy, Forest Products Department.

25 min., 80 slides.

NOISE PROBLEMS IN THE FOREST PRODUCTS INDUSTRY
690.2 S-T $47

The reasons behind the new federal noise regulations are demonstrated in this slide-tape. Physiological problems encountered under high noise levels are discussed. Coverage includes a description of audiometric testing and recording procedures to protect the mill operator from increasing claims of hearing loss by employees.

Audience. Mill management and union personnel with emphasis on the small forest products operator.

Authors. M. D. McKimmy, Carl Brumback, Forest Products Department.

18 min., 69 slides.

NOISE CONTROL IN THE FOREST PRODUCTS INDUSTRY
690.3 S-T $48

This program discusses techniques by which a small mill operator can meet present and future regulations. Permanent solutions are presented for existing mill situations, some of which require simple and inexpensive procedures. Sophisticated methods applicable in complex problems of noise are discussed.

Audience. Small forest products operators and safety personnel.

Authors. M. D. McKimmy, Carl Brumback, Forest Products Department.

18 min., 72 slides.

CAREERS IN FORESTRY
45 S-T $46

Interesting aspects of a career in professional forestry are described in this presentation. Challenges and oportunities available to the forest manag er, forest engineer, forest products specialist, and forest science researcher are discussed.

Audience. School guidance counselors and offices; occupational counseling centers; career day programs.

16 min., 69 slides.

FOREST ECOLOGY: AN UPDATING
706.1 S-T $44

This presentation is designed for field foresters who have been out of school for more than ten years. It defines some modern concepts of ecology that relate to forestry, such as forest communities, homeostasis, and allelopathy. Using clearcutting as an example, it discusses the effects of forest practices on mycorrhizal and other relationships, energy fixation and flow, mineral cycling, and animal populations.

Audience. Practicing foresters.

Author. William K. Ferrell, Forest Management Department.

17 min., 64 slides.

FOREST ECOLOGY: TROPHIC LEVELS, FOOD CHAINS, AND ENERGY FLOW
706.2 S-T $43

This presentation discusses the concepts of trophic levels, food chains, and energy flow, and relates them to forestry and the practice of clearcutting. Other ecological concepts are also introduced with each of the main ideas; for example, energy fixation and thermodynamics with energy flow.

Audience. Practicing foresters.

Author. William K. Ferrell, Forest Management Department.

14 min., 63 slides.

CLEARCUTTING–PROFESSIONALS LOOK AT THE ECOLOGY OF TIMBER HARVESTING
644 F Rent only $7.25

A program originally given on KOAC Educational Television, and now available on 16-mm color film from the Oregon Division of Continuing Education, Film Library. Provides a perspective of ecological conditions for several forest types; the rationale of clearcutting and partial cutting, and impacts of clearcutting. Professionals present their views. Aerial views of cutting methods and forest types are shown.

Audience. General.

Director. James T. Krygier, Forestry Extension; William Smith, Extension Communication.

30 min., 16-mm color.

DECIPHERING FOREST ENVIRONMENTS IN THE SISKIYOUS.
709 S-T $49

Audience. Forestry students, professional foresters, and forestry technicians practicing regeneration techniques.

Author. Robert S. Logan, Richard H. Waring, Forest Management Department.

18 min., 74 slides.

PUBLICATIONS

The following list includes current publications on forestry and forestry-related research from all departments at Oregon State University. For convenience, they are sorted into three divisions by subject: Forest Engineering, Forest Management, and Forest Products. Inquiries for publications NOT from authors in the School of Forestry should be addressed to the author's department, which is enclosed in parentheses.

FOREST ENVIRONMENTAL ENGINEERING

Aulerich, D. E. "TRIALS AND TRIBULATIONS IN SKYLINE LOGGING." IN: Proceedings, Skyline Logging Symposium. Univ. of Washington. P. 19-21. 1974. (For. Res. Lab.)

For forest engineers and loggers. Describes problems in layout and operation of skyline systems, including tailholds, deflection, accuracy of topographic maps, and developing logging crews to understand these problems. Suggests techniques for solving these problems. Useful for planning skyline logging.

Aulerich, D. E., K. N. Johnson, and H. Froehlich. "TRACTORS OR SKYLINES: WHAT'S BEST FOR THINNING YOUNG-GROWTH DOUGLAS-FIR?" For. Industries 101(12):42-45. November 1974. (For. Res. Lab.)

For forest engineers, loggers, and forest managers. Compares production rates, costs, revenues, and stand and site impacts using tractors and skylines to thin young Douglas-fir stands on various slopes and thinned at various intensities. Useful for comparing the performance of these two systems.

Brown, George. "IMPACT OF YOUNG-GROWTH MANAGEMENT ON FOREST STREAMS." IN: Managing Young Forests in the Douglas-Fir Region. A. B. Berg, ed. School of For. Symposium Proc. P. 65-75. July 1974. (For. Res. Lab.)

For forest managers, loggers, and forest engineers. Provides estimates of changes in water yield and water quality after typical young-growth management in the Pacific Northwest. Useful for evaluating consequences of thinning and fertilization.

Brown, George W. "FISH HABITAT." IN: Environmental Effects of Forest Residues Management in the Pacific Northwest. O. P. Cramer and J. M. Pieravich, eds. U.S. Dept. of Agric., Forest Service, Pacific N.W. For. and Range Expt. Station. Portland, Oregon. P. E1-E15. December 1974. (For. Res. Lab.)

For forest managers and others interested in residue management and impact on streams. Summarizes past research on accumulation of residue in streams and impacts of residue accumulation on water quality, the stream channel, and fish habitat. Provides estimates of impact of residue treatment on fish habitat. Useful background information for residue treatment.

Dykstra, Dennis P. "THE PANSY BASIN STUDY: COMPARING YARDING RATES AND COSTS FOR HELICOPTER, BALLOON, AND CABLE SYSTEMS." Loggers Handbook 34:20-23, 158, 160, 164, 176, 178. 1974. (For. Res. Lab.)

For forest engineers and loggers. Compares yarding rates and costs of systems using time-study techniques. Identifies critical parameters of logging units and systems that affect production. Useful for comparing performance of six systems over a range of conditions.

Fritschen, L. J., L. W. Gay, and H. R. Holbo. "ESTIMATING EVAPOTRANSPIRATION FROM FORESTS BY METEOROLOGICAL AND LYSIMETRIC METHODS." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5. P. 35-40. 1974. (For. Res. Lab.)

For microclimatologists, hydrologists, and forest ecologists. Provides techniques for construction of lysimeters around trees. Compares lysimetric estimates of evapotranspiration with those obtained using Bowen ratio and aerodynamic methods. Useful for planning evapotranspiration experiments and comparing methods for predicting evapotranspiration.

Froehlich, Henry. "SOIL COMPACTION: IMPLICATION FOR YOUNG-GROWTH MANAGEMENT." IN: Managing Young Forests in the Douglas-Fir Region. A. B. Berg, ed. School of For. Symposium Proc. P. 49-64. July 1974. (For. Res. Lab.)

For forest managers, loggers, and forest engineers. Describes the importance of soil density for growth of seedlings and young stands, the impact of harvesting on soil density, and the implication for forest productivity. Useful in evaluating harvest techniques to be used in young stands.

Garvin, William F. THE INTRUSION OF LOGGING DEBRIS INTO ARTIFICIAL GRAVEL STREAMBEDS. Water Resources Res. Institute, Oregon State Univ. Corvallis. WRRI-27. 79 p. September 1974. (Water Resources Res. Inst.)

For hydrologists and fishery biologists. Quantifies the amount of organic intrusion into stream gravels under various flow regimes. Also describes the extreme variation observed under controlled conditions. Useful for studying or monitoring the impact of logging on streams.

Gay, L. W. and H. R. Holbo. STUDIES OF THE FOREST ENERGY BUDGET. Water Resources Res. Inst., Oregon State Univ., Corvallis. WRRI-24. 34 p. March 1974. (For. Res. Lab.)

For microclimatologists, hydrologists, and forest ecologists. Provides fundamental information on energy-exchange processes for forests in the Pacific Northwest. Compares values obtained in a Douglas-fir forest with other studies around the world. Is the first study ever to provide replicate measurements of energy budget within a stand. Also compares results of Bowen ratio and aerodynamic methods. Useful for understanding response of forests to environment, modification of environment by forests, and evapotranspiration.

Jemison, G. M. and M. S. Louden. "MANAGEMENT AND RESEARCH IMPLICATIONS." IN: Environmental Effects of Forest Residues Management in the Pacific Northwest. O. P. Cramer and J. M. Pieravich, eds. U.S. Dept. of Agric., Forest Service, Pacific N.W. For. and Range Expt. Station. Portland, Oregon. P. A1-A33. December 1974. (For. Res. Lab.)

For forest managers. Summarizes the state of knowledge about forest residue and how it can be managed. Also provides a summary of research needed to answer key management questions. Useful background information in developing residue-control programs.

Lembersky, M. R. and K. N. Johnson. AN INFINITE-HORIZON, MARKOV-DECISION-PROCESS APPROACH TO OPTIMAL MANAGEMENT POLICIES FOR YOUNG-GROWTH STANDS. Tech. Report 41, Dept. of Statistics and Dept. of Forest Engineering, Oregon State Univ. 44 p. 1974. (Depts. of Statistics and For. Engineering)

For forest managers and scientists in operations research, mensuration, or biometrics. Describes a method for evaluating alternative management practices for young forests in terms of maximization of expected total discounted return. Permits comparison of growth, mortality, yield, and stumpage price as a function of dbh, number of trees per acre, and market condition. Useful for developing management plans for young forests.

O'Leary, John E. "TIMBER EXTRACTION TO THE ROADSIDE BY USE OF CABLEWAYS." IN: Technology of Forestry. R. Plochmann, ed. Second International Exposition of the Technology of Forestry and Forest Industries, Munich, West Germany. Drueck-Ring, Munich. 37 p. June 1974. (School of Forestry)

For loggers and forest engineers. Costs, variables affecting costs, and advantages and disadvantages of major systems of cable logging. Useful in planning logging and in comparing the merits of different systems.

O'Leary, John. "A NEW CONCEPT FOR THINNING STEEP GROUND." IN: Managing Young Forests in the Douglas-Fir Region. A. B. Berg, ed. School of For. Symposium Proc. P. 37-48. July 1974. (For. Res. Lab.)

For forest managers, loggers, and forest engineers. Describes Norwegian methods for thinning forests on steep ground using a skyline called the Vinje system. Useful for understanding the specifications, costs, and production of this system.

Ponce, Stanley L. "THE BIOCHEMICAL OXYGEN DEMAND OF FINELY DIVIDED LOGGING DEBRIS IN STREAM WATER." Water Resources Res. 10(5):983-988. October 1974. (For. Res. Lab.)

For scientists interested in water quality and pollution problems. Provides detailed information on BOD rates for Douglas-fir, western hemlock, and red alder leaves, chemical composition and leaching rate for leachates from leaves, and toxicity of leachates to fish. Useful for understanding pollution potential of logging slash in small streams.

Ponce, S. L. and G. W. Brown. DEMAND FOR DISSOLVED OXYGEN EXERTED BY FINELY DIVIDED LOGGING DEBRIS IN STREAMS. For. Res. Lab., Res. Paper 19. 10 p. October 1974. (For. Res. Lab.)

For foresters, loggers, fisheries biologists, and others interested in forest practices and impacts on streams. Provides a general summary of the effect of logging slash from Douglas-fir, western hemlock, and red alder on dissolved oxygen in streams. Also provides some management recommendations for controlling this impact. Useful for developing techniques and programs to control impacts of logging along streams.

Sinner, H. U. "SIMULATING SKYLINE YARDING IN THINNING YOUNG FORESTS." IN: IUFRO Conference Proceedings, Planning Systems and Control. IUFRO Joint Meeting, Divisions 3 and 4. October 1973. Freiburg, West Germany. p. 82-104. 1974. (Dept. of For. Engineering)

For forest engineers and loggers. Production analysis of a small skyline yarder used in thinning. Describes a simulation model to predict production as a function of skyline distance, lateral distance, logs per turn, slope, thinning intensity, and crew size. Useful for predicting production for a given system or comparing production for different yarding systems.

FOREST MANAGEMENT

Bhella, H. S. and A. N. Roberts. "THE INFLUENCE OF PHOTOPERIOD AND ROOTING TEMPERATURE ON ROOTING OF DOUGLAS-FIR (*Pseudotsuga menziesii* (Mirb.) Franco)." J. American Soc. of Horticultural Science 99(6):551-555. 1974. (Dept. of Horticulture)

For researchers on root regeneration of conifers. Discusses interactions of photoperiod and temperature of rooting medium on rooting at various seasons.

Bell, John F. "CHOICE OF VALUES FOR THE CONCOMITANT VARIABLE IN THREE-P SAMPLING." IN: Proc., International Union of For. Res. Organizations. Vancouver, B.C. P. 185-189. August 1973. (For. Res. Lab.)

For foresters interested in mensuration and young-growth management. Explains use of arbitrary x-values rather than actual quick estimates to reduce the estimated variance of the estimated total.

Berg, Alan B., ed. MANAGING YOUNG FORESTS IN THE DOUGLAS-FIR REGION. School of For., Symposium Proc. $6.00. 234 p. July 1974. (For. Res. Lab.)

For foresters in charge of young-growth management. Contains articles on economics, taxes, planning, thinning, fertilization, physiology, soil compaction, and forest streams. Examples of thinning are described.

Beuter, John Herman. "FAREWELL TO THE SIMPLE FORMULA—AN INTRODUCTION." J. Forestry 72(4):212-213. April 1974. (For. Res. Lab.)

For foresters in general. The article makes a few points about forest regulation and introduces the working group session on economics and policy of the annual meeting in 1973 of the Society of American Foresters.

Beuter, John H. "ECONOMIC IMPACT OF ENVIRONMENTAL RESTRICTIONS." IN: Wildlife and Forest Management. H. C. Black, ed. School of For. Symposium Proc. P. 227-232. September 1974. (For. Res. Lab.)

For land-use planners and forest land managers. Discusses environmental restrictions in the context of free enterprise and

raises the issue of choosing between two "good" environments, such as one that favors wildlife or one that favors timber production.

Beuter, J. H. and J. K. Handy. ECONOMIC GUIDELINES TO REFORESTATION FOR DIFFERENT OWNERSHIPS. For. Res. Lab. Res. Paper 23. 72 p. November 1974. (For. Res. Lab.)

For forest land managers and forestry investment analysts. Presents guidelines for helping an owner decide how much he can afford to pay for reforesting good-quality land in the Douglas-fir region.

Bever, Dale N. " 'DENDRO': AN UNSTRUCTURED APPROACH." J. Forestry 72(6):362-364. June 1974. (For. Res. Lab.)

For all professional foresters, but primarily for forestry professors. A new approach to teaching forestry subjects, especially dendrology, by personalized self instruction. Advantages and disadvantages are listed.

Black, Hugh C. "ANIMAL-DAMAGE CONTROL ON FOREST LANDS." IN: Forest Pesticides and Their Safe Use as Management Tools. Washington State Univ., Oregon State Univ., Cooperative Ext. Services and U.S. Dept. of Agric., Forest Service, Pacific N.W. For. and Range Expt. Station, Portland, Oregon. 31 p. April 1974. (For. Res. Lab.)

For foresters and pesticide operators. Reviews control of animal damage to seeds, seedlings, and trees. Reports status of rodenticides.

Black, Hugh C., ed. WILDLIFE AND FOREST MANAGEMENT. School of For., Symposium Proc. $6.00. 236 p. September 1974. (For. Res. Lab.)

For foresters, wildlife biologists, forest land managers. Twenty-seven articles on forestry-wildlife relations describe wildlife as resource and as nuisance in the forest, protection of wildlife and protection of seeds and seedlings, and new directions in practices.

Black, H. C. and E. F. Hooven. "RESPONSE OF SMALL-MAMMAL COMMUNITIES TO HABITAT CHANGES IN WESTERN OREGON." IN: Wildlife and Forest Management. H. C. Black, ed. School of For. Symposium Proc. P. 177-186. September 1974. (For. Res. Lab.)

For foresters, wildlife biologists, and resource managers. Summarizes response of small mammals to fire, clearcutting, or herbicide application.

Blackman, G. E., J. D. Fryer, A. Lang, and M. Newton. "THE EFFECTS OF HERBICIDES IN SOUTH VIETNAM." IN: Persistance and Disappearance of Herbicides in Tropical Soils. National Academy of Sciences. 59 p. 1974. (Dept. of Microbiology and For. Res. Lab.)

For Congress, agronomists, soils researchers. Describes biological significance of herbicide residues in mangrove forests, upland crops, and rice paddies. Indicates rates of degradation of phenoxy herbicides and Picloram under flooding and saline conditions, and in upland forests and crops.

Cleary, B. and R. Greaves. "HARVESTING AND REFORESTATION—ARE THEY COMPATIBLE?" Loggers Handbook 34:32-33. 1974. (For. Res. Lab.)

For foresters and owners of small woodlands. Discusses matching harvesting techniques to local environmental conditions to enhance seedling establishment.

Corliss, John F. SOIL SURVEY. ALSEA AREA, OREGON. U.S. Dept. of Agric., Soil Conservation Service and Forest Service; U.S. Dept. of Int., Bureau of Land Management; Ore. Board of Natural Resources; and Oregon Agric. Expt. Sta., Ore. State Univ., Corvallis. 82 p. 1973. (Dept. of Soil Science)

For foresters, farmers, land planners. Describes and maps the soils series in the Alsea River basin.

Danielson, H. R. and D. F. Grabe. "STORAGE OF NOBLE FIR SEED." Proc. Assoc. Official Seed Analysts 63:161-165. Technical Paper 3715, Oregon Agric. Experiment Station. 1973. (Dept. of Agronomic Crop Science)

For seed scientists and managers of forest nurseries. At 4 percent moisture content, noble fir seed can be stored for 2 years at temperatures below 20 C, but as moisture content increases up to 12 percent, storage temperature must be lowered to maintain viability.

Dilworth, J. Richard. LOG SCALING AND TIMBER CRUISING. O.S.U. Bookstores, Inc. 476 p. Revised 1974. (School of Forestry)

For foresters and mensurationists. A basic text and reference.

Dilworth, J. R. and J. F. Bell. VARIABLE PROBABILITY SAMPLING: VARIABLE PLOT AND THREE-P. O.S.U. Bookstores, Inc. 130 p. Revised 1974. (School of Forestry)

For foresters and timber cruisers. Text and reference for help in cruising.

Emmingham, W. H. "SIMULATION OF PHOTOSYNTHESIS: ITS POTENTIAL IN LAND USE MANAGEMENT." Abstract 133, N.W. Science Program and Abstracts. 1974. (U.S.I.B.P., C.F.B., For. Res. Lab.)

For forest scientists.

Emmingham, W. H. and R. H. Waring. "CONIFER GROWTH UNDER DIFFERENT LIGHT ENVIRONMENTS IN THE SISKIYOU MOUNTAINS OF SOUTHWESTERN OREGON." N.W. Science 47:88-99. 1974. (U.S.I.B.P., C.F.B., For. Res. Lab.)

For foresters and land managers.

Franklin, J. F. and R. H. Waring. "PREDICTING SHORT AND LONG TERM CHANGES IN THE FUNCTION AND STRUCTURE OF TEMPERATE FOREST ECOSYSTEMS." IN: Proc., First International Congress of Ecology, the Hague. P. 228-232. 1974. (U.S.I.B.P., C.F.B., For. Res. Lab.)

For foresters. Illustrates application of ecosystem research by predicting forest succession, growth, and effects of logging on water and sediment.

Furniss, M. M., G. E. Daterman, L. N. Kline, M. D. McGregor, G. C. Trostle, L. F. Pettinger, and J. A. Rudinsky. "EFFECTIVENESS OF THE DOUGLAS-FIR BEETLE ANTIAGGREGATIVE PHEROMONE METHYLCYCLOHEXENONE AT THREE CONCENTRATIONS AND SPACINGS AROUND FELLED HOST TREES."

Canadian Entomol. 106:381-392. 1974. (Dept. of Entomology)

For foresters and entomologists. Gives results of field tests of Douglas-fir beetle antiattractants.

Grier, C. C., D. W. Cole, C. T. Dyrness, and R. L. Fredriksen. "NUTRIENT CYCLING IN 37- AND 450-YEAR-OLD DOUGLAS-FIR ECOSYSTEMS." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5, U.S./I.B.P., C.F.B. P. 21-34. 1974. (For. Res. Lab. and Forestry Science Lab., U.S. Forest Service)

For researchers in forest ecology. Compares growth and nutrient use in young and old stands.

Grier, C. C. and R. H. Waring. "CONIFER FOLIAGE MASS RELATED TO SAPWOOD AREA." For. Science 20(3):205-206. 1974. (For. Res. Lab.)

For mensurationists and forest ecologists. Relates foliage to cross-sectional area of water-conducting tissue in the tree stem.

Groman, William. "WORLD-WIDE SCOPE AND TRENDS IN FOREST FERTILIZATION." IN: Managing Young Forests in the Douglas-Fir Region. A. B. Berg, ed. School of For. Symposium Proc. P. 27-35. July 1974. (For. Res. Lab.)

For foresters. Current status and trends of forest fertilization in 16 countries, with emphasis on the Douglas-fir region.

Haque, R. and V. H. Freed. "BEHAVIOR OF PESTICIDES IN THE ENVIRONMENT: ENVIRONMENTAL CHEMODYNAMICS." Residue Reviews 52:89-116. 1974. (Dept. of Agricultural Chemistry)

For forest scientists and pesticide applicators.

Hermann, Richard K. "ROOT GROWTH OF PONDEROSA PINE IN SOILS OF VOLCANIC ORIGIN." IN: Ecology and Physiology of Root Growth. International Symposium Proc., Potsdam, Germany. P. 247-253. 1974. (For. Res. Lab.)

For researchers in root growth. Temperature and texture of soil are related to development and growth of roots in pumice soil.

Hermann, R. K. and D. P. Lavender. " THE ROLE OF NEEDLES IN FROST DAMAGE." N.W. Science Program and Abstracts. Abstract 56. 1974. (For. Res. Lab.)

For forest physiologists. Leaves are suggested as receptors for signals triggering physiological changes leading to frost hardiness of the tree.

Hermann, R. K., D. P. Lavender, and J. Zaerr. "ROLE OF PHYSIOLOGY IN YOUNG-GROWTH MANAGEMENT." IN: Managing Young Forests in the Douglas-Fir Region. A. B. Berg, ed. School of For. Symposium Proc. P. 77-104. July 1974. (For. Res. Lab.)

For foresters. Vital physiological processes such as photosynthesis and respiration are important to management of Douglas-fir and western hemlock.

Hines, W. W. and C. E. Land. "BLACK-TAILED DEER AND DOUGLAS-FIR REGENERATION IN THE COAST RANGE OF OREGON." IN: Wildlife and Forest Management in the Pacific Northwest. H. C. Black, ed. School of For. Symposium Proc. P. 121-132. September 1974. (Dept. of Statistics)

For managers of wildlife and timberland. Describes browsing of Douglas-fir by a regulated herd of deer in a 340-acre enclosure. Evaluates impact of intensive forest management on deer densities and damage to regeneration.

Kline, L. N., R. F. Schmitz, J. A. Rudinsky, and M. M. Furniss. "REPRESSION OF SPRUCE BEETLE (COLEOPTERA) ATTRACTION BY METHYLCYCLOHEXENONE IN IDAHO." Canadian Entomol. 106:485-491. 1974. (Dept. of Entomology)

For foresters and entomologists. Field tests show this substance protects spruce logs against beetle attacks.

Landforce, Andrew S. HOW TO CATCH BLUEGILL SUNFISH AND LARGEMOUTH BASS. FS 123, Extension Service, Oregon State University. 2 p. Reprinted January 1974. (Extension Service)

For forest recreationists.

Lavender, Denis P. "THE GROWTH AND DEVELOPMENT OF CHRISTMAS TREES AS RELATED TO WEATHER AND NUTRITION." IN: Christmas Tree Production Problems. Cooperative Ext. Service, Oregon State Univ. Special Report 154. P. 1-6. June 1963. (For. Res. Lab.)

For Christmas tree growers. Discusses roles of the major nutritive elements in tree growth, effects of storage and date of lifting on survival and vigor of Douglas-fir seedlings, and suitability of low elevations for plantations of conifers originating at high elevations.

Lavender, Denis P. "PHYSIOLOGY OF DORMANT DOUGLAS-FIR (*Pseudotsuga menziesii* (Mirb.) Franco) SEEDLINGS." Third North Amer. For. Biology Workshop. Colorado State Univ., Fort Collins. Abstract 10. September 1974. (For. Res. Lab.)

For tree physiologists. Douglas-fir seedlings require a period of short, mild days between development of the winter resting bud and start of winter chilling.

Lavender, D. P., R. K. Hermann, M. Newton, and J. B. Zaerr. "FOREST PHYSIOLOGY AND PLANNING FOR TIMBER PRODUCTION." IN: Proc., Foresters in Land-Use Planning. 275 p. Soc. Amer. Foresters. Portland, Oregon. P. 228-246. 1974. (For. Res. Lab.)

For foresters and forest biologists. Summarizes contributions of physiologists to production of vigorous forest stands.

Libbey, L. M., M. E. Morgan, T. B. Putnam, and J. A. Rudinsky. "PHEROMONES RELEASED DURING INTER- AND INTRA-SEX RESPONSE OF THE SCOLYTID BEETLE *Dendroctonus brevicomis*." J. Insect Physiol. 20:1667-1671. 1974. (Dept. of Entomology)

For entomologists. New substances of the western pine beetle pheromone were identified and released at different rates in various behavioral situations.

Lovejoy, B. P. and H. C. Black. "GROWTH AND WEIGHT OF THE MOUNTAIN BEAVER, *Aplodontia rufa pacifica*."

J. Mammalogy 55(2):364-369. May 1974. (For. Res. Lab.)

For biologists and foresters. Describes development from 2 months to maturity. Structure of mountain beaver populations are reported.

McCreary, D. D., D. P. Lavender, and Y. Tanaka. "PHOTOPERIODIC RESPONSE OF DOUGLAS-FIR (*Pseudotsuga menziesii*) AND PONDEROSA PINE (*Pinus ponderosa*) SEEDLINGS." N.W. Science 47th Annual Meeting, Univ. of British Columbia. Vancouver, B.C. Abstract 55. P. 10. May 1974. (For. Res. Lab.)

For forest biologists. Describes the effects of supplemental light on growth of Douglas-fir and ponderosa pine seedlings and defines minimal intensity to maintain vigorous growth.

Newton, Michael. "MIXING HERBICIDES FOR OPTIMUM WEED CONTROL IN PACIFIC NORTHWEST CONIFERS." Down To Earth 30(1):13-17. Summer 1974. (For. Res. Lab.)

For foresters. Illustrates how various mixtures of herbicides can be applied to alleviate biological problems with reduced cost and disturbance.

Newton, Michael. "FOREST MANAGEMENT FOR MINIMUM CONFLICT." IN: Wildlife and Forest Management. H. C. Black, ed. School of For. Symposium Proc. P. 233-236. September 1974. (For. Res. Lab.)

For wildlife managers and foresters. Examines some unusual approaches to satisfying mutual objectives without serious conflict in management.

Newton, M., B. Starker, and G. Blanchard. TERRACE PLANTING IN THE OREGON COAST RANGE: SOME IMPLICATIONS. For. Res. Lab. Res. Paper 20. 7 p. February 1974. (For. Res. Lab.)

For foresters. Discloses how survival and growth of Douglas-fir after 9 years in the Coast Range were affected by aspect, planting method, and placement in terraces.

Randall, R. M. and C. F. Sutherland, Jr. MARKETING OREGON-PRODUCED POLES AND PILING. Research Paper 24. 15 p. December 1974. (For. Res. Lab.)

For forestland managers and timber producers. Manufacturing steps, customers, sales procedures, and industry problems are described.

Reed, K. L. and R. H. Waring. "COUPLING OF ENVIRONMENT TO PLANT RESPONSE: A SIMULATION MODEL OF TRANSPIRATION." Contribution 6, Coniferous Forest Biome, U.S./I.B.P. Ecology 55(1):62-72. Winter 1974. (For. Res. Lab.)

For ecologists and foresters. Ranks forest communities in regard to water use. Provides an index to separate sites with low evaporation from those where soil drought is important.

Roberts, A. N., B. J. Tomasovic, and L. H. Fuchigami. "INTENSITY OF BUD DORMANCY IN DOUGLAS FIR AND ITS RELATION TO SCALE REMOVAL AND ROOTING ABILITY." Physiologia Plantarum 31(3):211-216. 1974. (Dept. of Horticulture)

For researchers on root regeneration of conifers. Quantitative evaluation of dormancy from onset to removal using standard SD and LD environments and the influence of bud scales on dormancy. Relates dormancy to rootability of cuttings.

Roth, Lewis F. "JUVENILE SUSCEPTIBILITY OF PONDEROSA PINE TO DWARF MISTLETOE." Phytopathology 64:689-692. 1974. (Dept. of Botany)

For forest pathologists and foresters.

Rowe, K. E. and K. K. Ching. "PROVENANCE STUDY OF DOUGLAS-FIR IN THE PACIFIC NORTHWEST REGION. II. FIELD PERFORMANCE AT AGE NINE." Silvae Genetica 22(4):115-119. 1973. (For. Res. Lab.)

For foresters and forest geneticists. Describes performance of Douglas-fir from 17 seed sources outplanted at 10 locations from Vancouver Island, British Columbia, to northern California.

Rudinsky, J. A., M. E. Morgan, L. M. Libbey, and T. B. Putnam. "ADDITIONAL COMPONENTS OF THE DOUGLAS-FIR (COL. SCOLYTIDAE) AGGREGATIVE PHEROMONE AND THEIR POSSIBLE UTILITY IN PEST CONTROL." Z. ang. Ent. 76:65-77. 1974. (Dept. of Entomology)

For entomologists and foresters. Three new substances in pheromones of the Douglas-fir beetle have been identified and tested in field and laboratory.

Rudinsky, J. A., M. E. Morgan, L. M. Libbey, and T. B. Putnam. "ANTIAGGREGATIVE RIVALRY PHEROMONE OF THE MOUNTAIN PINE BEETLE, AND A NEW ARRESTANT OF THE SOUTHERN PINE BEETLE." Environ. Entomol. 3:90-94. 1974. (Dept. of Entomology)

For entomologists. Describes newly identified substances of the pheromones of the mountain pine beetle and the southern pine beetle.

Rudinsky, J. A., C. Sartwell, Jr., T. M. Graves, and M. E. Morgan. "GRANULAR FORMULATION OF METHYLCYCLOHEXENONE: AN ANTIAGGREGATIVE PHEROMONE OF THE DOUGLAS-FIR AND SPRUCE BARK BEETLES (COL., SCOLYTIDAE)." Z. ang. Ent. 75:254-263. 1974. (Dept. of Entomology)

For entomologists and foresters. The pheromone, incorporated into granules, was applied in field to protect Douglas-fir and spruces. Results are presented.

Running, S. W., R. H. Waring, and R. A. Rydell. "PHYSIOLOGICAL CONTROL OF WATER FLUX IN CONIFERS." Contribution 138, U.S./I.B.P., Coniferous Forest Biome. Oecologia 1975. (For. Res. Lab.)

For ecologists and foresters. Rooting volume and sapwood storage are important in permitting transpiration to occur near potential rate in dry summers. Explains how young trees, compared to large trees, can transpire more water per unit area of foliage in the spring, but when drought occurs, reduce their transpiration more.

Santantonio, D. and R. K. Hermann. "ROOT BIOMASS OF OLD-GROWTH DOUGLAS-FIR." N.W. Science Fourth Annual Meeting, Univ. of British Columbia, Vancouver, B.C. Abstract 83. P. 15. U.S./I.B.P., C.F.B. May 1974. (For. Res. Lab.)

For researchers. Describes methods for estimating biomass of large and small roots.

Sedell, J. R., F. J. Triska, J. D. Hall, N. H. Anderson, and J. H. Lyford. "SOURCES AND FATES OF ORGANIC INPUTS IN CONIFEROUS FOREST STREAM." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5. P. 57-69. 1974. (Depts. of Fisheries and Wildlife, Entomology, and General Science)

For forest and stream biologists. A budget for particulate organic matter in a small stream among conifers shows tremendous capacity for streams to retain litter and process it biologically.

Sollins, P., R. H. Waring, and D. W. Cole. "A SYSTEMATIC FRAMEWORK FOR MODELING AND STUDYING THE PHYSIOLOGY OF A CONIFEROUS FOREST ECOSYSTEM." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5. P. 7-20. Contribution 60, U.S./I.B.P., Coniferous Forest Biome. 1974. (For. Res. Lab.)

For foresters and biologists. A conceptual structure for coupling movement of carbon, water, and minerals through forest stands and a base for a computer simulation model to predict growth, decomposition, litterfall, root turnover, hydrology, and nutrient cycling.

Strand, Mary Ann. "CANOPY FOOD CHAIN IN A CONIFEROUS FOREST WATERSHED." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5. P. 41-47. 1974. (For. Res. Lab.)

For foresters and entomologists. Divides the canopy food chain into nine functional groups, five of which are invertebrates. Estimates total consumption and secondary production by birds and grazing insects. Diet of the birds was 75 percent insects.

Streeby, Larry. "SOME ECONOMIC ASPECTS OF THINNING." IN: Managing Young Forests in the Douglas-Fir Region. A. B. Berg, ed. School of For. Symposium Proc. P. 141-155. July 1974. (For. Res. Lab.)

For timber managers. Improved information on inventory and from research is needed. Management strategies for flexible operations to meet changing market conditions are needed.

Sutherland, Charles F., Jr. THE FOREST PROPERTY TAX LAW IN WESTERN OREGON: ALTERNATIVES FOR THE SMALL WOODLANDS OWNER. Special Report 425, Extension Service, Oregon State Univ. 10 p. November 1974. (Extension Service)

For owners of small woodlands. Describes the Western Oregon Ad Valorem Tax and two optional property tax laws.

Sweet, G. B., J. B. Zaerr, and D. P. Lavender. "THE EFFECT OF SOME MANIPULATIONS ON THE LEVEL OF GIBBERELLINS IN SEEDLING DOUGLAS-FIR." IN: Mechanisms of Regulation of Plant Growth. R. L. Bieleski, A. R. Ferguson, and M. M. Cresswell, eds. Royal Soc. of New Zealand. Bull. 12. P. 709-713. 1974. (For. Res. Lab.)

For plant physiologists. Concentrations of gibberellin, a growth hormone, change in the xylem sap when roots are disturbed. Explanations are hypothesized.

Unterscheutz, P., W. F. Ruetz, R. R. Geppert, and W. K. Ferrell. "THE EFFECT OF AGE, PRE-CONDITIONING, AND WATER STRESS ON THE TRANSPIRATION RATES OF DOUGLAS-FIR (*Pseudotsuga menziesii*) SEEDLINGS OF SEVERAL ECOTYPES." Physiol. Plant. 32:214-221. 1974. (For. Res. Lab.)

For ecologists, physiologists, and other forest scientists. Seedlings grown from seed from a dry environment had higher transpiration under low moisture stress and lower transpiration under high moister stress than similar seedlings from seed from a wet environment.

Vohs, Paul A. "DYNAMICS OF FOREST-WILDLIFE COMMUNITIES." IN: Wildlife and Forest Management in the Pacific Northwest. H. C. Black, ed. School of For. Symposium Proc. P. 15-20. September 1974. (Dept. of Fisheries and Wildlife)

For foresters and wildlife specialists. Wildlife in the forest will change with successional changes in the plant community; some species thrive after clearcutting and burning, others require climax vegetation. Some species are threatened by intensive forest management.

Wagner, S. L. and P. H. Weswig. "ARSENIC IN BLOOD AND URINE OF FOREST WORKERS AS INDICES OF EXPOSURE TO CACODYLIC ACID." Archives of Environmental Health 28:77-79. 1974. (Dept. of Agricultural Chemistry)

For public health workers.

Waring, R. H. "STRUCTURE AND FUNCTION OF THE CONIFEROUS FOREST BIOME ORGANIZATION." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5. P. 1-6. Contribution 59, U.S./I.B.P., Coniferous Forest Biome. 1974. (For. Res. Lab.)

For those interested in team management. Describes evolution of a research organization from many loosely coordinated projects reflecting disciplines to a few integrated ecological projects.

Waring, R. H. and R. L. Edmonds, eds. INTEGRATED RESEARCH IN THE CONIFEROUS FOREST BIOME. Coniferous Forest Biome, Univ. of Washington AR-10, Seattle. Symposium Proc. Bull. 5. 96 p. 1974. (For. Res. Lab.)

For foresters and scientists. Eight articles on modeling forest growth, hydrology and mineral cycling, biomass and mineral use of young and old forests, relating vegetation classes to environment, canopy food chains, estimating evapotranspiration, importance of litter for life in streams, and research on four lakes in Washington.

Webb, Warren L. "A LABORATORY CONTROLLED ENVIRONMENT SYSTEM FOR MEASURING CO^2 EXCHANGE OF SMALL PLANT COMMUNITIES." IN: Proc., Gaseous Exchange Methodology. B. Dinger and F. Harris, eds. Interbiome Workshop, Oak Ridge National Laboratories. Oak Ridge, Tennessee. P. 69-78. U.S./I.B.P., C.F.B. July 1973. (For. Res. Lab.)

For plant physiologists.

Webb, W. L., M. Newton, and D. Starr. "CARBON DIOXIDE EXCHANGE OF *Alnus rubra*: A MATHEMATICAL MODEL." Oecologia 17:281-291. 1974. (For. Res. Lab.)

For plant physiologists and ecologists. A mathematical model fitted to data from 40 red alder seedlings for steady-state combinations of light and temperature to predict carbon dioxide exchange for conditions occurring in a diurnal cycle.

Wick, W. Q. and A. S. Landforce. MOLE AND GOPHER CONTROL. Ext. Bulletin 804, Extension Service, Oregon State University. 15 p. Reprinted January 1974. (Extension Service)

For land managers.

Yang, J. C., T. M. Ching, and K. K. Ching. "ELECTROPHONETIC VARIATIONS OF LEUCINE AMINOPEPTIDASE AND GLUTAMATE OXALOACETATE TRANSAMINASE IN DOUGLAS-FIR." Third North American Forestry Biology Workshop. Colorado State Univ., Fort Collins, Colorado. Abstract 32. September 1974. (For. Res. Lab.)

For seed specialists.

Youmans, R. C., D. R. Darr, R. Fight, and D. L. Schweitzer. DOUGLAS COUNTY OREGON: STRUCTURE OF A TIMBER COUNTY ECONOMY. Oregon State Univ., Agric. Expt. Sta. Information Circ. 645. 25 p. December 1973. (Dept. of Agricultural Economics)

For forest land managers and the general public. Details the economy of Douglas County in 1970. The information should be helpful in appraising policy alternatives in terms of their economic impact.

Zaerr, J. B. and D. P. Lavender. "PHYSIOLOGICAL CHANGES IN DOUGLAS-FIR SEEDLINGS DURING DORMANCY." First N. Amer. For. Biology Workshop. Dept. of For. East Lansing, Michigan. Abstract. August 1970. (For. Res. Lab.)

Forest scientists. Reports rate of net photosynthesis, root growth, and date of bud burst of Douglas-fir seedlings as affected by photoperiod the previous fall.

Zaerr, J. B., D. P. Lavender, R. K. Hermann, and G. B. Sweet. "FACTORS AFFECTING ROOT GROWTH IN DOUGLAS-FIR SEEDLINGS." Abstract. Plant Physiology 51 (Supplement):20. June 1973. (For. Res. Lab.)

For plant physiologists. Effects of day length, temperature, and removal of buds or leaves on subsequent root growth are reported. Control by shoots of root growth was stressed.

Zaerr, J. B. and D. P. Lavender. "THE EFFECTS OF CERTAIN CULTURAL AND ENVIRONMENTAL TREATMENTS UPON THE GROWTH OF ROOTS OF DOUGLAS-FIR (*Pseudotsuga menziesii* (Mirb.) Franco) SEEDLINGS." IN: Ecology and Physiology of Root growth. Symposium Proc. Potsdam, Germany. P. 27-32. September 1974. (For. Res. Lab.)

For forest scientists, botanists, plant physiologists. Summarizes work in the Forest Research Laboratory on root growth of Douglas-fir.

Zaerr, J. B., G. B. Sweet, D. P. Lavender, and R. K. Hermann. "NURSERY PRACTICES AND LEVELS OF CERTAIN GROWTH REGULATORY COMPOUNDS IN DOUGLAS-FIR (*Pseudotsuga menziesii* (Mirb.) Franco) SEEDLINGS." N.W. Science 46th Annual Meeting. Whitman College. Walla Walla, Washington. Abstract 45. P. 38. March 1973. (For. Res. Lab.)

For foresters, scientists, and biologists. Describes changes in gibberellins and cytokinins in the xylem sap with nursery practices. Levels of growth regulators are stressed for the dormant season.

Zobel, D. B., W. A. McKee, G. M. Hawk, and C. T. Dyrness. "CORRELATION OF FOREST COMMUNITIES WITH ENVIRONMENT AND PHENOLOGY ON THE H. J. ANDREWS EXPERIMENTAL FOREST, OREGON." IN: Integrated Research in the Coniferous Forest Biome. R. H. Waring and R. L. Edmonds, eds. Univ. of Washington, Seattle. Symposium Proc. Bull. 5. P. 48-56. 1974. (Dept. of Botany)

For biologists. Relates phenology and vegetation composition of 14 forest communities to temperature, plant moisture stress, and foliar nutrition.

FOREST PRODUCTS

Bublitz, Walter J. PULPING CHARACTERISTICS OF WILLAMETTE VALLEY GRASS STRAWS. Oregon State Univ., Agric. Expt. Station, Corvallis. Station Bull. 617. 26 p. November 1974. (Agric. Expt. Station)

For pulp mill operators and grass seed producers. Pulp for corrugating medium may be produced from annual ryegrass straw by the neutral sulfite semichemical (NSSC) process. Yields are comparable to those from wood, 65-75 percent, and strength and performance characteristics of the medium are nearly on par with NSSC hardwood pulp. Unbleached soda pulps with yields of 50 to 55 percent form clean, strong, and well-bonded sheets and could be blended with softwood pulp to improve the tensile and bursting strength of paper. Other grass species were investigated as well.

Bublitz, W. J. and S. N. Chia. "SEEDLING CHARACTERISTICS AND KRAFT PULPING PROPERTIES OF YOUNG DOUGLAS-FIR. For. Products J. 24(3):48-52. March 1974. (For. Res. Lab.)

For timber managers, pulp mill operators, and forest geneticists. Height of second-year growth and frequency of branching were selection characteristics for two-year-old Douglas-fir seedlings established in an experimental plantation. At the age of 13 years, some trees were thinned out and pulped. Differences in tensile and bursting strength by nursery of origin and by branch count were observed. No differences were found for pulp yields, Kappa numbers, and other strength factors.

Bublitz, W. J. and T. Y. Meng. "THE EFFECT OF CERTAIN FLAVONOIDS ON THE BLEACHING OF DOUGLAS FIR REFINER GROUNDWOOD." Pulp and Paper 75(3):T91-T96. March 1974. (For. Res. Lab.)

For timber managers and pulp mill operators. Sapwood of Douglas-fir may be utilized for refiner groundwood, but heartwood imparts a strong yellowish cast to the pulp. Heartwood bleachability is inversely related to pulp freeness. Quercetin lowers brightness, but only minor amounts are present.

Cautyna, A. J. and R. Schmall. COMPARISON OF SOURCE PARTICULATE EMISSION MEASUREMENT METHODS FOR COMBINATION FUEL-FIRED BOILERS. National Council of the Paper Industry for Air and Stream Improvement (NCASI). Tech. Bull. 75. 36 p. August 1974. (Engineering Experiment Station)

For operators of wood-burning boiler furnaces. Describes a simple, in-stack filtration procedure as a suitable alternative for the filtration section of the EPA particle-sampling procedure where stack gas is always hotter than the dew point.

Corder, Stanley E. "WOOD-BARK RESIDUE IS SOURCE OF PLANT ENERGY." Forest Industries 101(2):34-36. February 1974. (For. Res. Lab.)

For mill operators. Average conversion factors for estimating residues produced from the manufacture of lumber and plywood are presented and the heat contents of wood and bark discussed. A comparison is made of the amount of oil and natural gas to match the energy in forest products residues.

Espenas, Leif D. "LONGITUDINAL SHRINKAGE OF WESTERN REDCEDAR, WESTERN HEMLOCK, AND TRUE FIR." Tech. Note. For. Products J. 24(10):46-48. October 1974. (For. Res. Lab.)

For dry kiln operators and lumber users. The average longitudinal shrinkage of these three species from green to ovendry ranged from about 0.2 to 0.3 percent. Most shrinkage occurred between 12 and 0 percent moisture content. Estimates of maximum shrinkage and movement are given for exterior and interior exposure.

Graham, R. D. "STOPPING INTERNAL WOOD POLE DECAY." Transmission and Distribution. P. 58-62. September 1974. (For. Res. Lab.)

Volatile chemicals are effective in controlling decay in standing Douglas-fir poles. Vapam, Vorlex, and chloropicrin were about equally effective in eliminating decay fungi, but chloropicrin was most effective in maintaining the total fungal population at low levels.

Johnson, James W. "STRENGTH AND STIFFNESS OF ROOF DIAPHRAGMS WITH DIFFERENT PERCENTAGES OF THE DECKING EDGE-GLUED." Tech. Note. For. Products J. 24(4):36-37. April 1974. (For. Res. Lab.)

For builders, engineers, and architects. Elastomeric adhesive placed between the decking boards to resist shear improved the stiffness of root sections, and load-deflection curves show that difference in stiffness increased as load increased. Advantages in construction are resistance to high wind loads and earthquakes as well as lower costs of assembly.

Johnson, W. W. and R. O. McMahon. "FUTURE OUTLOOK FOR OREGON'S PARTICLEBOARD INDUSTRY." For. Products J. 24(1):13-15. January 1974. (For. Res. Lab.)

For particleboard producers. Some expansion of the industry, competing demands for raw materials, estimated reduction of lumber production in Oregon, increased procurement and processing costs of coarse residues, and market competition from other regions may curtail the present growth rate to an estimated level in 1980 of 1.3 billion square feet.

Karchesy, J. J., M. L. Laver, D. F. Barofsky, and E. Barofsky. "STRUCTURE OF OREGONIN, A NATURAL DIARYLHEPTANOID XYLOSIDE." J. of the Chemical Society, Chem. Communications. P. 649-650. 1974. (For. Res. Lab.)

For wood chemists. Freshly cut wood and bark of red alder will stain red-orange. Investigations of precursors to this staining phenomenon revealed the presence of a novel diarylheptanoid xyloside, which was named Oregonin. The chemical structure of this material was determined.

Kozlik, C. J. "EFFECT OF TEMPERATURE, TIME, AND DRYING MEDIUM ON THE STRENGTH AND GLUABILITY OF DOUGLAS-FIR AND SOUTHERN PINE VENEER." For. Products J. 24(2):46-53. February 1974. (For. Res. Lab.)

For sawmill operators, builders, and engineers. Drying with air and superheated steam at temperatures of 350, 600, and 800 F does not significantly alter modulus of rupture and modulus of elasticity. Longer drying time has some effect on the gluability of veneer.

Kunesh, R. H. and J. W. Johnson. "EFFECT OF SIZE ON TENSILE STRENGTH OF CLEAR DOUGLAS-FIR AND HEM-FIR DIMENSION LUMBER." For. Products J. 24(8):33-36. August 1974. (For. Res. Lab.)

For timber engineers and wood technologists. Nominal 2- by 4-, 6-, 8-, and 10-inch clear, coast Douglas-fir and hem-fir dimension lumber was tested in tension parallel to the grain at 10 percent moisture content. Tensile stress of Douglas-fir decreases as width increases. This trend is less pronounced in hem-fir lumber. Although specific gravity and modulus of elasticity in flatwise bending are higher for Douglas-fir, average tensile stress for the species is not significantly different.

Laity, W. W., G. H. Atherton, and J. R. Welty. "COMPARISONS OF AIR AND STEAM AS VENEER DRYING MEDIA." For. Products J. 24(6):21-29. June 1974. (For. Res. Lab.)

For veneer and plywood producers. Veneer samples of Douglas-fir and southern pine sapwood dry faster in air than in steam at 350 F, but drying is more rapid in steam than in air at 600 F. Impingement of the drying medium at 90 degrees to the veneer surface is more effective in drying than flow parallel to the surface.

Laver, M. L., C. -H. Chen, J. V. Zerrudo, and Y. -C. L. Lai. "CARBOHYDRATES OF THE INNER BARK OF *Pseudotsuga menziesii*." Phytochemistry 13:1891-1896. 1974. (For. Res. Lab.)

For wood chemists and operators of integrated mills. The isolated holocellulose fraction of the inner bark is composed of acid-insoluble lignin, 3.1 percent; acid-soluble lignin, 4.1 percent; *L*-arabinose, 2.6 percent; *D*-xylose, 6.3 percent; *D*-mannose, 9.5 percent; *D*-galactose, 2.3 percent; and *D*-glucose, 61.1 percent. The configurations of these sugars were positively established by the preparation of crystalline derivatives.

Lin, Richard T. "WOOD AS AN ORTHOTROPIC DIELECTRIC MATERIAL." Wood and Fiber 5(3):226-236. Fall 1973. (For. Res. Lab.)

For wood technologists and wood physicists. Dielectric coefficients of western hemlock wood were determined at various

angles of grain. The maximum appeared at the grain angle of 30 degrees in the longitudinal-radial plane and at 15 degrees in the longitudinal-tangential plane. This continuity in the relation between the logarithm of dielectric properties and moisture content was observed at 6 to 10 percent and 30 to 40 percent moisture content. Density of wood has little effect.

McMahon, Robert O. "COMMODITY FUTURES: QUESTIONS YOU MAY NOT HAVE ASKED ABOUT HEDGING'S FUTURE IN YOUR FIRM." Forest Industries 101(2):34-36. February 1974. (For. Res. Lab.)

For managers of forest products mills. The questions presented actually were asked by participants of an extension workshop and were selected to illustrate valid concerns managers entertain about this new business tool. The answers reflect principles that should govern managerial decisions about trading strategy.

Miller, D. J., J. D. Wellons, R. L. Krahmer, and P. H. Short. "REINFORCING PLASTICS WITH DOUGLAS-FIR BARK FIBER." For. Products J. 24(8):18-23. August 1974. (For. Res. Lab.)

For plastics manufacturers and wood products producers. Douglas-fir bark was pressurized-disc refined at 25, 50, 75, and 100 psi steam pressure. Fiber recovered amounted to 13 percent of bark weight; yields conceivably may be increased to 18 percent. Fibers average about 1 millimeter, with a length-diameter ratio of 16. Impact strength of general-purpose phenolic molding compound increases from 0.3 to 0.7 foot-pound per inch as fiber content of moldings increases from 0 to 20 percent.

Ruppert, W. J. and R. D. Graham. UTILIZATION OF WESTERN HEMLOCK AND WESTERN FIRS FOR POLES AND PILES. For. Res. Lab. Res. Paper 22. 27 p. February 1974. (For. Res. Lab.)

For users and producers of poles and piling. Use of western hemlock and western firs for poles and piling is encouraged through information compiled on their availability and characteristics. The latter are discussed in relation to Standard 05.1 of the American National Standards Institute and Standard D 25-70 of the American Society for Testing and Materials. Implications for their preservative treatment by pressure processes are discussed.

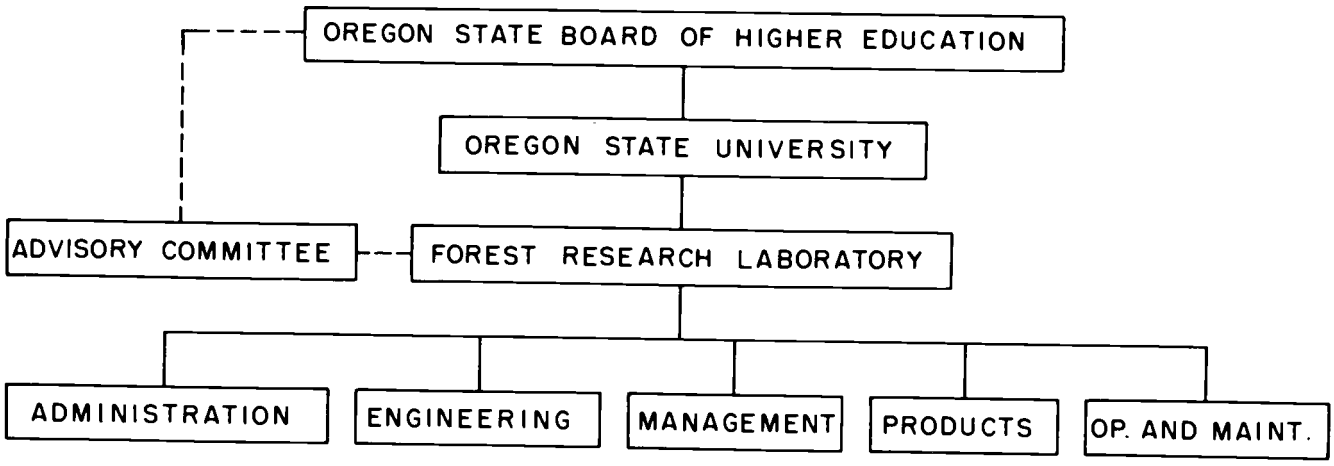
Scheffer, T. C. and A. F. Verrall. PRINCIPLES FOR PROTECTING WOOD BUILDINGS FROM DECAY. U.S. Dept. of Agric., Forest Service, For. Products Lab., Res. Paper FPL 190. 56 p. 1973. (For. Res. Lab.)

For house builders, remodelers, and owners. Describes damage by decay fungi in wooden buildings and means to control or avoid such damage by construction methods or treatments to wood.

Schmall, R. and A. L. Caron. INVESTIGATION OF SOURCE PARTICULATE MEASUREMENT PROCEDURES, PARTICLE SIZES AND PRACTICES CONTROL TECHNOLOGY FOR WOOD FUEL-FIRED BOILERS. National Council of the Paper Industry for Air and Stream Improvement (NCASI). Tech. Bull. 72. 41 p. May 1974. (Engineering Experiment Station)

For manufacturers of boilers for wood fuels and operators of mills with such boilers. Describes types of wood-burning boilers and effects of their design and operation on nature and amount of particulate matter emitted. Control of particulate matter is detailed.

ORGANIZATION CHART
FOREST RESEARCH LABORATORY



FOREST RESEARCH LABORATORY ADVISORY COMMITTEE

Archie D. Craft,
State Director,
Bureau of Land Management
729 N.E. Oregon Street
Portland, Oregon 97232

Vern L. Gurnsey,
Vice President,
Timber and Timberlands
Boise Cascade Corporation
Box 200, Boise, Idaho 83701

Frank R. Gilchrist,
President
Gilchrist Timber Company
Gilchrist, Oregon 97737

Amos A. Horner,
President,
Tomco, Incorporated
Post Office Box 145
Sweet Home, Oregon 97386

Howard E. Hunt,
Vice President, Willamette Region,
Weyerhaeuser Company
Box 275, Springfield, Oregon 97477

Gene D. Knudson,
President,
Willamette Industries, Inc.
First National Bank Tower
1300 S.W. 5th Avenue
Portland, Oregon 97201

S. V. McQueen,
President,
KOGAP Manufacturing Company
Post Office Box 1608
Medford, Oregon 97501

Charence W. Richen,
Vice President,
Crown Zellerbach Corporation
1500 S.W. First Avenue
Portland, Oregon 97201

Theodore A. Schlapfer,
Regional Forester,
Region 6, U.S. Forest Service
319 S.W. Pine Street
Portland, Oregon 97201

J. E. Schroeder,
State Forester,
Oregon State Department of Forestry
2600 State Street
Salem, Oregon 97310

Fred Sohn,
President,
Sun Studs, Inc.
Box 1127, Roseburg, Oregon 97470

L. L. Stewart,
President,
Bohemia, Inc.
2280 Oakmont Way
Eugene, Oregon 97401

CONSOLIDATED STATEMENT OF INCOME AND EXPENSES
Forest Research Laboratory, Oregon State University
July 1, 1973, to June 30, 1974

Income	
State General Fund	$454,754
Forest Products Harvest Tax	586,910
McIntire-Stennis Funds	212,314
Gift, grant, and contract research funds	133,202
Other	82,178
Total income	$1,469,358
Expenses	
Forest regeneration and genetics	280,176
Young-growth management and protection	148,251
Economics and land use	83,163
Forest environmental engineering	146,959
Wood and bark residue use	65,230
Wood processing and product improvement	222,412
Wood product performance	101,746
Wood structure design efficiency	100,797
Administration	196,934
Physical plant operation and maintenance	83,480
Total expenses	$1,429,148
Balance forward, June 30, 1974	$40,210