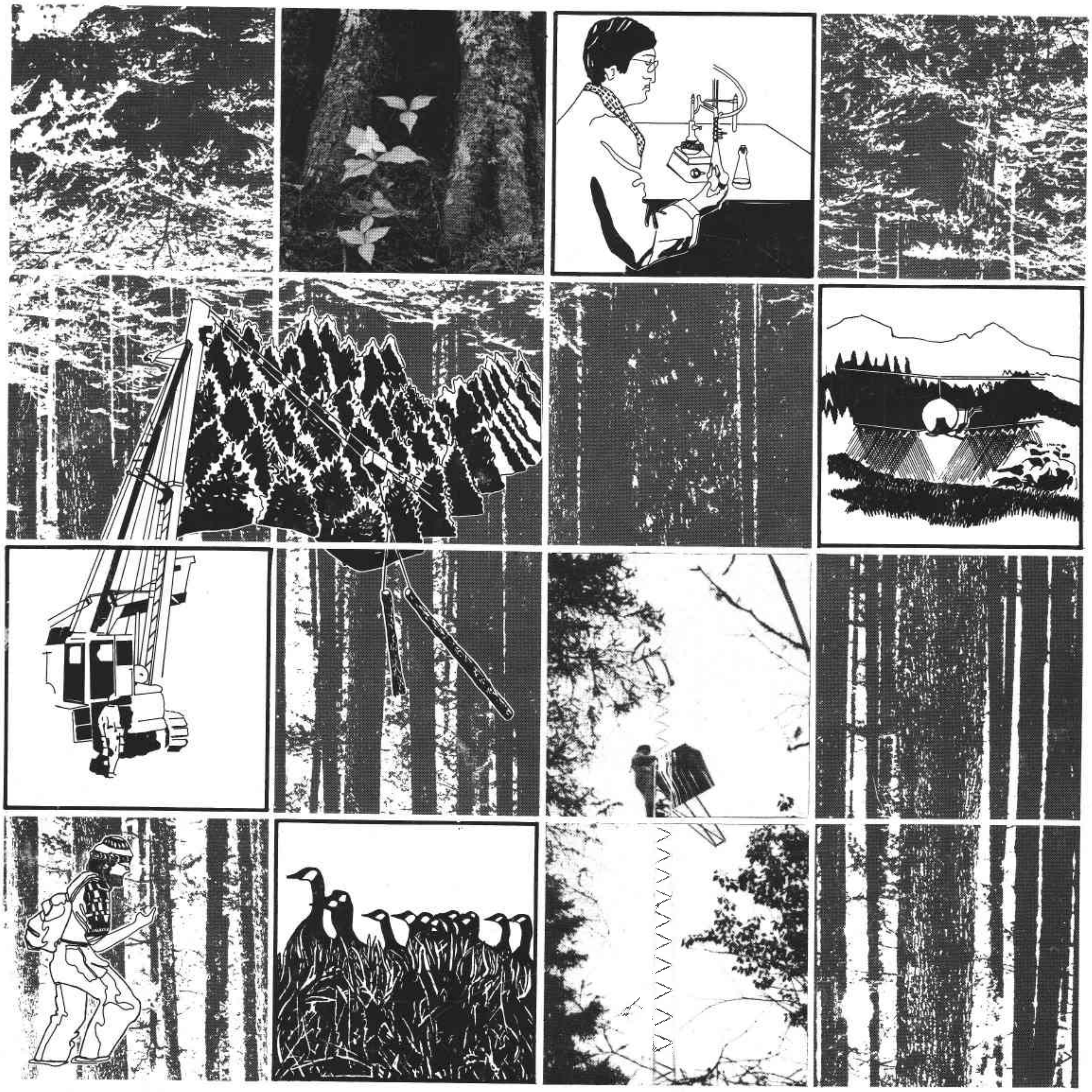
USDA Forest Service General Technical Report PNW-62

The Forester's Almanac 1977



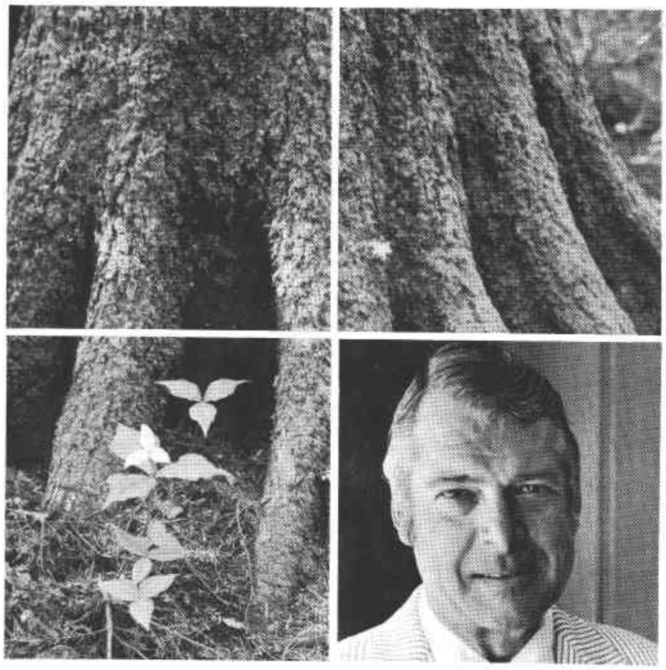
A catalog of publications from Forest Service research in the Pacific Northwest and Alaska—probably more than you've ever wanted to know. Leads about where to find more information on almost any topic: timber measurement, recreation, genetics, fire, insect and disease control, biology, ecology, Research Natural Areas, and much more (not necessarily in that order).

Pacific Northwest Forest and Range Experiment Station
Forest Service, U.S. Department of Agriculture
Portland, Oregon

The Forester's Almanac 1977

a catalog of forestry research publications and other useful information from the

Pacific Northwest Forest and Range Experiment Station
Forest Service, U.S. Department of Agriculture
809 N.E. Sixth Avenue
P.O. Box 3141
Portland, Oregon 97208



Foresters (and others):

Forestry research has been conducted in the Pacific Northwest since the earliest days of forestry. Over the years, scientists and resource managers have learned many things about the forests and how to manage them for man's benefit. This Experiment Station has published literally thousands of reports on various aspects of forest management. But sometimes we get the feeling that too few people know anything about the Experiment Station —who we are, what we do, and how to get more information. In short, we're a little too close to our laboratories and a little too far from the woods.

We may never change that: it's just the nature of our work. But we **can** improve access to information. This publication is an attempt to do just that. I hope you will find the Almanac useful. Keep it on your desk or in some other relatively accessible place. If you use it and like it, let us know. Or call the editors and give them your ideas about how to improve future editions. We want to hear from you.

Robert F. Tarrant

Robert F. Tarrant
Director

ABOUT THE ALMANAC

This is not just another annotated bibliography. True, it contains summaries of many technical publications. But it's also meant for browsing. So you want to know something about a technical field other than your own? It's all here—most everything we've published on subjects as varied as dispersed recreation, skyline logging, forest fungi, and dozens of other topics.

Pick up the Almanac at coffee break, if nothing better comes along. Or read it during staff meetings. Even if you've been in forestry for many years, you should find something new and useful.

Publications, and other information in this catalog, are listed by subject matter in the contents (see page 3). An expanded table of contents is included at the beginning of each chapter. Bibliographies are found at the end of each section. There is also a list of authors so you can find out where to contact a particular scientist for more information.

Not every report the Station has published is included here. We have tried to include most of the reports published by this Experiment Station or written by staff members during the period 1970-76, plus many earlier reports that are especially useful. We have chosen primarily those that are of practical use to field people. But we also wanted to cover the scope of our research program, much of which is basic research. So you'll find references, but not always summaries, to articles that are very technical in nature.

Happy reading!

The Editors

TO ORDER PUBLICATIONS

Unless otherwise indicated, the reports listed here may be ordered from:

Publications Distribution
Pacific Northwest Forest and Range Experiment Station
P.O. Box 3141
Portland, Oregon 97208

Please use the complete reference when ordering. Check the bibliography at the end of each chapter for the correct literature citation. Do **not** use the reference number in parenthesis.

All publications listed here are not available from the Experiment Station. Some are out of print, or will be by the time you see this catalog. Our current policy is to keep publications in stock for 5 years. Only if demand is heavy, are they kept longer. If your request comes back indicating that the publication is out of print or not available, and you really can't do without it, try your local library or the PACFORNET resource library (for authorized users only).

Authors have large egos and tend to keep their reports longer than anyone else. A list of PNW Station authors in the back gives their locations so you can write for a copy.

More recent publications (those published since 1976) are not listed in this catalog. For a list of recent reports, consult the quarterly and annual publication lists (see page 4).

PRODUCED

In Information Services at the Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, Oregon 97208. Phone 503/234-3361, ext. 4992; FTS 429-4992.

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general information

Get on the Mailing List

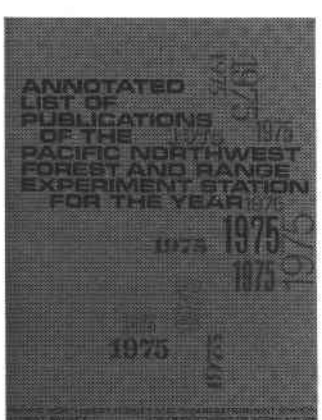
The Station publishes a list of available publications four or five times a year. It goes to the 7,000 or so names on our mailing list. If you get on the mailing list, this is the only report you will get from us automatically. All other publications must be requested individually.

Articles are categorized by subject and author. It pays to learn who is working in the subject area you are interested in, and then look for reports by those people.

To get on the publication list, write or call: Paul Barlow, Editorial Services, Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, Oregon 97208; 503/234-3361, ext. 4924, or FTS 429-4924.

There is also a yearly compilation called the *Annotated List of Publications of the Pacific Northwest Forest and Range Experiment Station.* Just because you get the quarterly list doesn't mean you'll get the annual list too. So if you want it, ask for it specifically.

The quarterly list is great for keeping current with research information, but the annual list is better to file away. These are available currently, and for the past 1 or 2 years.



The Invisible Forest Service

A full-color brochure describes the work of the Pacific Northwest Forest and Range Experiment Station in Oregon, Washington, and Alaska. Designed to acquaint the public with forestry research programs, it is also a useful introduction to forestry research for professionals in the field. Single copies may be obtained by writing to Publications Distribution at this Experiment Station.

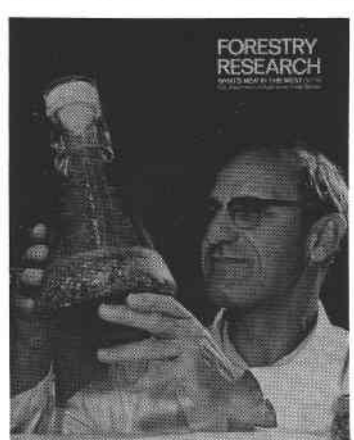
Larger quantities of the publication may be obtained for handout at Forest Service offices in Oregon, Washington, or Alaska. For multiple copies, write or call Information Services at ext. 4992.

Project Brochures

Informational leaflets are available for most research projects. Order by subject matter or name of project (see organizational directory).

In addition, there are brochures on several of the facilities and programs:

- *Sourdough Science* is about forestry research in Alaska.
- *East of the Cascades* describes programs on the east side of the Cascades in Oregon and Washington.
- *The Forestry Sciences Laboratory* is about work underway at the Corvallis, Oregon, laboratory.



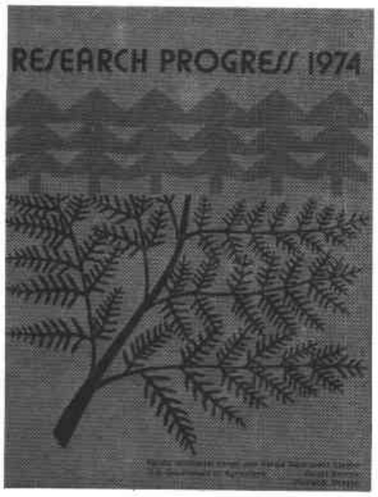
Forestry Research: What's New in the West

The four western Experiment Stations of the Forest Service also publish a magazine format news bulletin (approximately quarterly). It contains information about current research programs, and short articles about new research reports.

This is a report for forest resource managers, or anyone who is interested in forestry research, and it provides a general overview of some of the major new findings that may have application throughout the West.

Single copies of current issues are generally available at Experiment Station headquarters, but it's easier just to get on the mailing list (free of charge):

Forestry Research: What's New in the West
240 West Prospect Street
Fort Collins, Colorado 80521



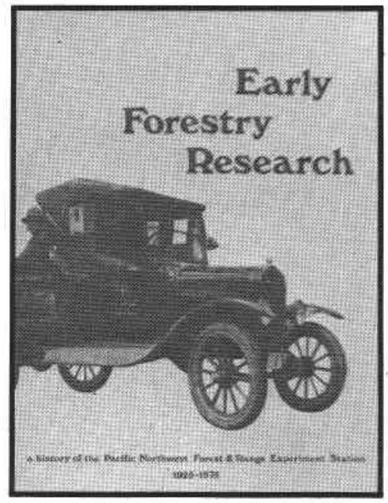
Annual Reports

The Experimental Station also publishes an annual, or nearly annual, progress report, outlining important new research findings. Many of these are still available, and should be requested by year. The latest report is dated 1974.

In lieu of an annual report for 1975, the Station published a historical report, outlining research activities from the beginning of the Station in 1925 to 1975.

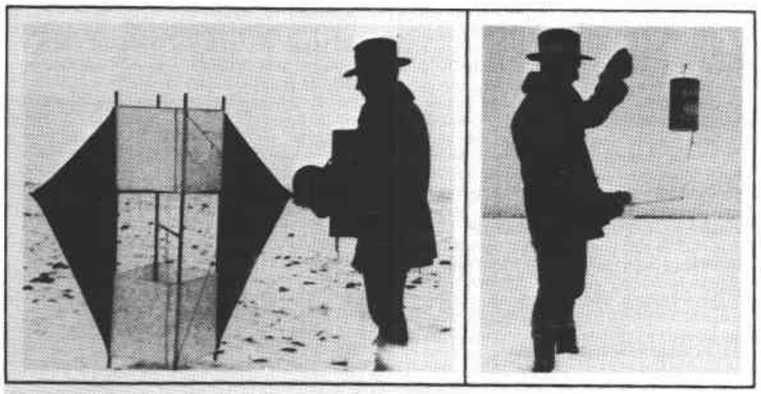
The 32-page report contains a number of amusing anecdotes from the early years of the PNW Station. These include stories about Leo Isaac, the pioneering Douglas-fir scientist who flew a kite to learn more about seed dispersion; stories from Thornton Munger, the Station's first Director; and many more.

One story tells about Munger's insistence on careful budgeting: "Munger put money into expensive items which were essential—a $500 'electrically driven calculating machine' and the little fleet of cars and trucks needed for Station work—but preached Yankee frugality in operating them. McArdle recalled that Munger had the front seat of the Station's first car 'remodeled with hinges so it could be folded back and make a bed. I was supposed to drive off into the bushes and use this instead of hotels,' he said."

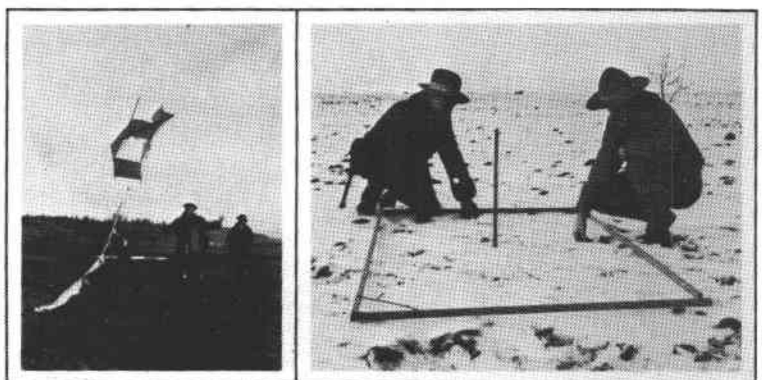


Order the history booklet by the following citation:

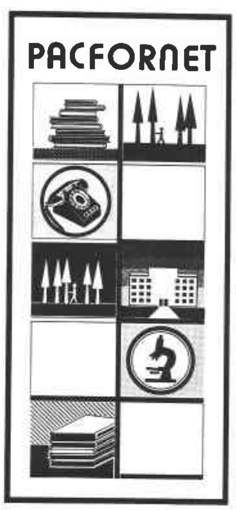
Doig, Ivan. 1976. Early Forestry Research. USDA For. Serv. Pac. Northwest For. and Range Exp. Stn., Misc. Publ., 32 p.



Leo Isaac, pioneer forest researcher, prepares to fly his kite to measure the flight of Douglas-fir seeds on the wind. Oatmeal carton held the seeds.



Up goes the kite! At right, Isaac and co-worker check the snow-covered ground for seeds. By the kite experiments, Isaac eventually helped disprove the theory that Douglas-fir seeds are stored in the duff, and learned that seeds usually don't fall more than a quarter mile from their source.



PACFORNET

Through a cooperative agreement, resource managers in several different organizations have access to forestry-related information through an information system called PACFORNET.

PACFORNET provides the latest scientific and technical literature to forestry professionals in five west coast states: Alaska, Washington, Oregon, California, and Hawaii. It is not a traditional reference library. Rather, it is a large information network with access to many technical information sources.

FOR A BROCHURE, WHICH INCLUDES A LIST OF WHO MAY USE PACFORNET, AND HOW, WRITE: Information Services, Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, Oregon 97208.

Services of PACFORNET include the monthly alert which lists new publications added to the system. Users in Alaska, Washington, and Oregon can get on the mailing list for the monthly alert through:

PACFORNET North
Forest Resources Library AQ-15
University of Washington 61-9719
Seattle, Washington 98195

Users in California are served by:

PACFORNET South
PSW Science Literature Service
P.O. Box 245
Berkeley, California 94701

research facilities

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headquarters

PNW: Research Headquarters

The Pacific Northwest Forest and Range Experiment Station, headquartered in Portland, Oregon, is the administrative hub of a research program that has eight laboratories in three western states. Research activities span the length of the continent, from the tundra of interior Alaska, through the dense coastal forests of Alaska, Oregon and Washington, and into the semi-arid zone east of the Cascades.

Administrative offices for this research network are located in the Forum Building in northeast Portland. The mailing address is P.O. Box 3141, Portland, Oregon 97208, phone: 503/234-3361 or FTS 429 + extension. This address and phone number will reach the following:

Director: Robert F. Tarrant
(ext. 4907)

Deputy Director: Robert A. Hann
(ext. 4908)

Assistant Director for Planning and Applications:
Eldon Estep (ext. 4908)

Assistant Director, Central Research Units:
Donald F. Flora (ext. 4928)

Assistant Director, North Research Units:
vacant

Assistant Director, South Research Units:
Robert M. Romancier (located in Corvallis; phone 503/757-4381 or FTS 420-4381—see page 8)

Assistant Director for Research Support Services:
Charles J. Petersen (ext. 4909)

Biometrician: John W. Hazard (ext. 4948)

Administrative Officer: Barbara Hague
(ext. 4950)

Architect: A.P. DiBenedetto (ext. 4905)

Editor: George M. Hansen (ext. 4927)

Public Information Officer: Louise Parker
(ext. 4992)

In addition to the Director and his staff, the Portland office also houses several research programs not found at other Station field locations:

Program Manager for Forest Residues:
Edward H. Clarke (ext. 4811)

Economics of Forest Land Management:
Roger D. Fight (ext. 4931)

Foreign Trade Analysis:
David Darr (ext. 4931)

Timber Measurement and Management Planning in the Northwest:
Dean S. DeBell, Acting Project Leader
(see Olympia Laboratory, page 8)

Multi-Resource Supply Analysis for the Pacific Coast States:
Charles Van Sickle (ext. 4935)

Timber Quality and Product Yield Potential of Western Softwood Resource:
Richard O. Woodfin, Jr. (ext. 4966)

laboratories

East of the Cascades

It's a different world on the other side of the mountains. For this reason, PNW has established three laboratories in Oregon and Washington to investigate forest, range, and brushland ecosystems east of the Cascades.

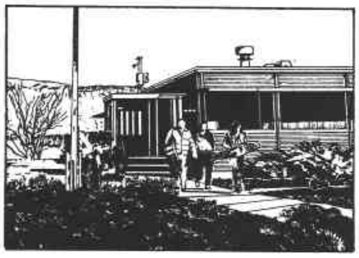
The laboratories are located at Wentachee, Washington, and La Grande and Bend, Oregon. In Wenatchee, the emphasis is on watershed research. In La Grande, scientists are specializing on wildlife and range problems. Fire and timber are the focus of the research at Bend.

Addresses and phone numbers for each of the three east-side labs are as follows:

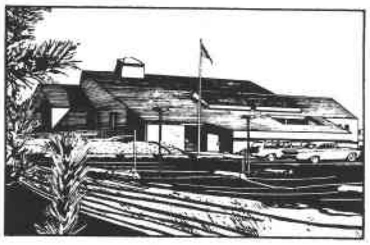
Forest Hydrology Laboratory
1133 N. Western Avenue
Wenatchee WA 98801
Phone: 509/662-4315
FTS: 390-0315

Range and Wildlife Habitat Laboratory
"C" and Gekeler Lane
Rt. 2, Box 2315
La Grande OR 97850
Phone: 503/963-7122
FTS: 221-0111

Silviculture Laboratory
1027 NW Trenton Avenue
Bend OR 97701
Phone: 503/382-6922
FTS: 422-6283



Wenatchee



La Grande

Bend

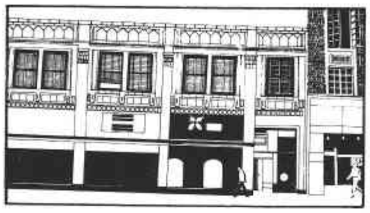
An information brochure on the research programs at the three laboratories is available from Information Services, PNW Station, P.O. Box 3141, Portland OR 97208. Ask for *Forest and Range Research —East of the Cascades.*

Following are the major research units and project leaders at each laboratory:

Water Yield—Improvement and Erosion Control—Interior River Basin Forests—Arthur R. Tiedemann, Wenatchee, Washington.

Wildlife Habitat and Range Ecosystem Research—Jack W. Thomas, La Grande, Oregon.

Silviculture of Interior Forest Types—Robert E. Martin, Bend, Oregon.



Seattle

An office at 4507 University Way in Seattle, Washington, houses two PNW research programs. The building can hardly be called a laboratory. The location, in the University District in Seattle, was chosen because of it's proximity to the University of Washington.

The full address is Pacific Northwest Forest and Range Experiment Station, 4507 University Way NE, Seattle, Washington 98105. Phone: 206/442 + extension. Extension 7817 will get Wildland Recreation, 7815—Forest Residues, and 7814—Forest Engineering. FTS users should dial 399 + the extension.

Following are the major research units and project leaders:

Wildland Recreation Research, Roger Clark.

Logging Systems for Fragile Mountain Terrain, Hilton H. Lysons.

Sourdough Science

Scientists from the Forestry Sciences Laboratory in Juneau and the Institute of Northern Forestry in Fairbanks are working to learn more about the complex world of the Alaskan forests.

Both laboratories are making significant contributions to man's knowledge of these extensive forests. The information is being used by federal, state, and local agencies and native corporations to plan environmentally sound forest resource management programs.

The mission of the Forestry Sciences Laboratory in Juneau is to determine the relationships which exist between various components of the coastal forest ecosystem. To accomplish this task, scientists are working in the areas of timber harvest, fisheries biology, timber stand regeneration, forest insect and disease problems, and other related areas.

The forests of interior Alaska differ from those along the coast. For this reason, scientists at the Institute of Northern Forestry in Fairbanks are faced with different research problems. Wildfire is one of the major keys to an understanding of the life history of the forests of the interior. Other research areas include wildlife habitat, silvicultural systems, and forest insect and disease research.

The Forestry Sciences Laboratory is located in the Federal Building in downtown Juneau. Address: P.O. Box 909, Juneau AK 99802. Phone: 907/586-7301.

The Institute of Northern Forestry is located in Fairbanks, Alaska, adjacent to the University of Alaska. Address: Institute of Northern Forestry, Fairbanks AK 99701. Phone: 907/479-7313.

FTS users can dial a special number in Seattle, Washington, (8-399-0150) and furnish the operator with the number of either lab.

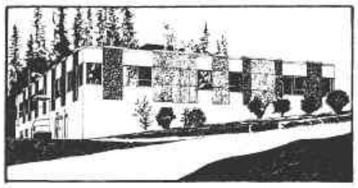
An information brochure, *Sourdough Science,* is available from Information Services, PNW Experiment Station, P.O. Box 3141, Portland OR 97208.

The following are the major project areas and project leaders at both laboratories:

Ecology of Southeastern Alaska Forests—Donald C. Schmiege, Juneau.

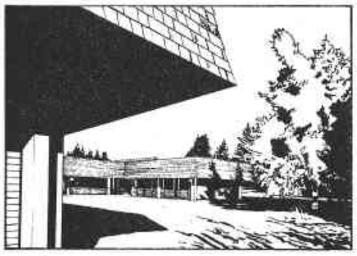
Ecology and Management of the Taiga (Subarctic Forests)—C. Theodore Dyrness, Fairbanks.

Forest Survey for Alaska—O. Keith Hutchison, Juneau.



Fairbanks

Juneau



Olympia's Forestry Sciences Laboratory

There are over 25 million acres of commercial forest land in Oregon and Washington including an estimated twelve million acres of Douglas-fir, western hemlock and associated species. Each year the demands on these forested lands increase. At PNW's Forestry Sciences Laboratory in Olympia, scientists are studying the intensive culture of Douglas-fir. Researchers are looking at the relationship of growing space to maximum tree growth and the effects of fertilization on increasing the productivity of the Douglas-fir forests.

The Forestry Sciences Laboratory can be reached by writing to 3625 - 93rd Ave. SW, Olympia WA 98502. Phone: 206/753-9470, FTS: 434-9470. The only research unit presently at Olympia is the Intensive Culture of Douglas-fir and Associated Species directed by Dean S. DeBell.

Corvallis Phase I Lab

Forestry Sciences Laboratory
Corvallis, Oregon

The Corvallis Laboratory is the largest of six field locations of the Experiment Station and the second largest Forest Service research facility in the country.

The laboratory is located next to the School of Forestry on the Oregon State University campus. Address: 3200 Jefferson Way, Corvallis OR 97331. Phone: 503/752-4211 or FTS: 420 + extension. Extension 4381 will get Assistant Director Robert M. Romancier.

Major aspects of the research program at Corvallis include: forest genetics, ecology, silviculture, insect and disease problems, reforestation systems, chemicals in the forest environment, watershed protection, anadromous fish habitat, and economics research.

The laboratory was formally dedicated in 1962. A close relationship is maintained between the scientists at the laboratory and the university, stimulating cooperative research throughout the scientific community.

An information brochure is available from the Information Office, PNW Experiment Station, P.O. Box 3141, Portland, Oregon 97208.

The following are the major research units and project leaders:

Reforestation Systems in the Pacific Northwest—Ronald E. Stewart (ext. 4464).

Ecological Basis for Management of Northwest Coniferous Forests—Jerry F. Franklin (ext. 4587).

Breeding Northwest Trees—Roy R. Silen (ext. 4235).

Managed Forest Watersheds in the Douglas-fir Region—Logan A. Norris (ext. 4586).

Population Ecology and Impacts of Forest Insects of the Pacific Northwest—Boyd E. Wickman (ext. 4263).

Diseases of Western Forest Insects—Clarence G. Thompson (ext. 4240).

Physiology and Behavior of Forest Insects of the Pacific Northwest—Gary E. Daterman (ext. 4224).

Strategies for Forest Disease Control—Earl E. Nelson (ext. 4285).

Mycorrhizal Applications in Ecosystem Management—James M. Trappe (ext. 4220).

Economics of Regional and Local Impacts of Forest Resource Management Decisions—Con Schallau

experimental forests and ranges

introduction

In 1930, the Forest Service began to establish experimental areas where Forest Service scientists could carry out long- and short-term field studies. These experimental areas have been selected to represent important forest or range types. All are under the administrative control and protection of the government agency or private owner, but agreements provide that the Experiment Stations control management activities to make sure they are compatible with research objectives.

In addition to accommodating studies of many kinds, experimental areas also provide settings in which to demonstrate forestry practices on a commercial scale to managers of both public and private forest lands.

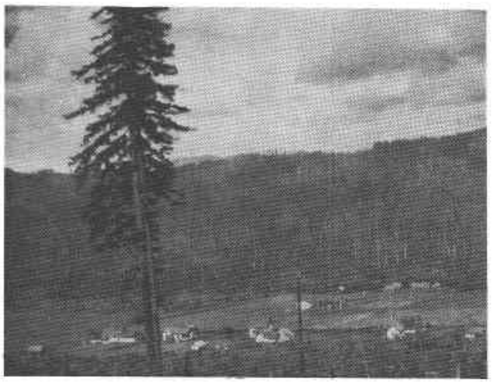
Often, as research provides knowledge about the ecology and silviculture of forests, the kinds of studies carried out on a particular experimental area change. New forest management problems demand solutions, or new directions for research are indicated by past findings. Many studies continue for decades and data thus accumulated make the areas even more valuable for subsequent studies.

western oregon & washington

wind river experimental forest

Established in 1933
Size: 10,185 acres
Elevation: 1,100-4,000 feet
Vegetation: Douglas-fir, western hemlock
Location: Gifford Pinchot National Forest, Washington

The most historic of the western Experimental Forests is in the Wind River Valley, north of Carson, Washington. It was here that forestry research in the Pacific Northwest began in 1910, with studies at the Wind River Nursery to improve nursery and forest planting practices. The nursery had been established a few years earlier to supply trees to reforest the valley which had lost most of its old-growth timber in a severe fire in 1902.

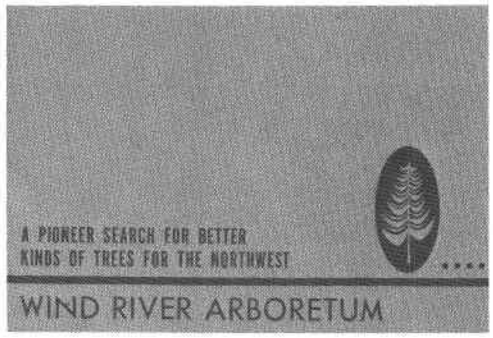


Wind River Station and Nursery, 1914.

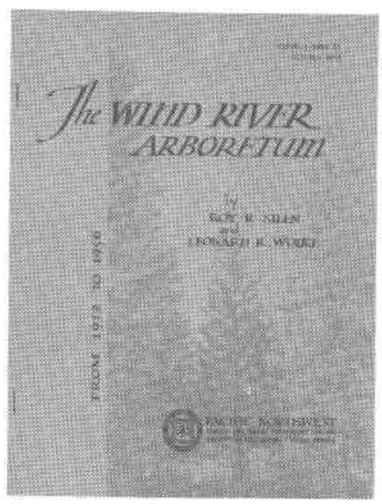
In 1913 the Wind River Forest Experiment Station was established, and studies were conducted in tree growth and heredity, forest management, and fire protection. In 1924, when the Pacific Northwest Forest and Range Experiment Station was established (with headquarters in Portland, Oregon), the Wind River Station became a field laboratory of the new regional research agency. In 1933, the area was officially designated as the Wind River Experimental Forest.

Many techniques for managing Douglas-fir and hemlock forests have developed from studies done on the Experimental Forest. Growth and heredity studies established as early as 1912 are still furnishing information on genetics and tree growth. The Experimental Forest includes an 1,180-acre Research Natural Area, established in 1934, and the Wind River Arboretum, established in 1912.

A brochure on the Experimental Forest (1) and information on several of the important studies can be obtained at the Wind River Ranger Station or by writing to Information Services at the PNW Experiment Station.



A Pioneer Search for Better Trees (2), a brochure about the arboretum, describes how trees from all temperate parts of the world were planted to compare their growth with native northwest species and what happened to them. Progress of the arboretum trees from 1912 to 1956 is summarized in a publication by Roy Silen and Leonard Woike (3). The major conclusion—as most foresters now know—is that native trees are better adapted to the site and grow best in the long run.



h.j. andrews experimental forest

Established in 1948
Size: 15,000 acres
Elevation: 1,500-5,000 feet
Vegetation: Douglas-fir
Location: Willamette National Forest, Oregon

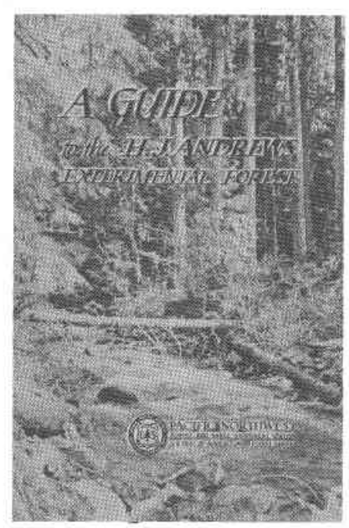
This Experimental Forest lies along the west slope of the Cascade Range, about 50 miles east of Springfield, Oregon, and occupies the entire 22½-square-mile drainage of Lookout Creek, a tributary of the McKenzie River.

At the time the forest was established for forest management studies, access was by foot or horseback. To facilitate a timber harvest program in the early 1950's, an extensive road plan was developed to reach planned harvest areas. Since that time, many studies of salvage logging methods, time-cost effectiveness, forest regeneration, genetic adaptability of seed to site, and forest protection from wind, fire, disease, and insects have been carried out.

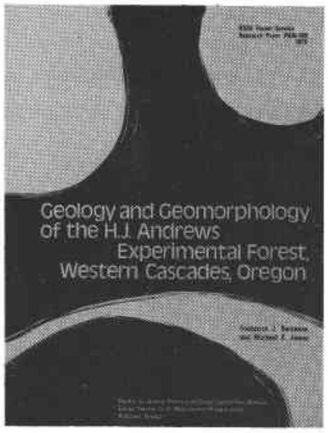
The first watershed study in the Pacific Northwest was begun here in 1952, when trapezoidal flumes were installed on each of three small drainages. Additional watershed studies were instrumented in 1963 and 1968. One of these (watershed 10) is the most intensively studied in the world. Data gathered here is used to relate forest management activities to soil and nutrient losses and to set standards for forest water quality.

University researchers working under the Coniferous Forest Biome of the International Biological Program have extensive studies covering the full range of ecological processes and forest conditions of the Experimental Forest. Much of this effort has been directed toward basic soil and nutrient studies of the Douglas-fir forests in watershed 10.

A descriptive guide to the Experimental Forest, published in 1959, is available (4).



Of the several hundred scientific papers published from research conducted at the H.J. Andrews Experimental Forest, three are recommended for basic information about the vegetation, soils, and geology. A preliminary classification of forest communities is provided in a 1974 publication, *A Preliminary Classification of Forest Communities in the Central Portion of the Western Cascades in Oregon,* by C.T. Dyrness, J.F. Franklin, and W.H. Moir (5).



Geology and Geomorphology of the H.J. Andrews Experimental Forest, Western Cascades, Oregon, by Frederick Swanson and Michael James (6)

The development and productivity of forest ecosystems is closely linked with the action of geologic and geomorphic processes on the landscape, particularly in areas such as the western Cascades, where erosion rates are high and deep-seated and shallow mass soil movements are frequent. An understanding of these processes is important to forest managers because land management activities may increase erosion and soil movement. This 13-page paper summarizes the recent geomorphic history of the Experimental Forest.

Also see *A Checklist of Vascular Plants on the H.J. Andrews Experimental Forest, Western Oregon,* by Jerry Franklin and Ted Dyrness (7). This publication is based on the results of intensive plant collecting which began on the forest in 1958. It lists 480 categories of plants and indicates in which of the two primary vegetative zones (western hemlock and Pacific silver fir) they are found.

cascade head experimental forest

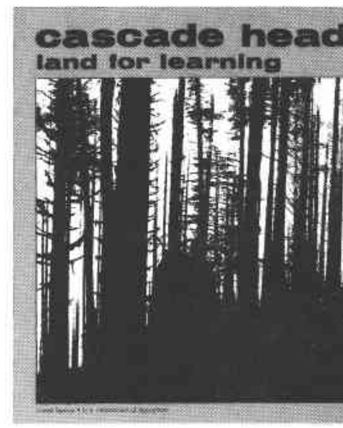
Established in 1934
Size: 11,890 acres
Elevation: 0-1,750 feet
Vegetation: Western hemlock, Sitka spruce
Location: Siuslaw National Forest, Oregon

A high ridge jutting into the Pacific Ocean on the central Oregon coast is the spectacular setting for the Cascade Head Experimental Forest, established for studies of forest management in typical fogbelt coastal forests. Situated between the Salmon River estuary and the town of Neskowin, it is representative of coastal forests that extend 1,800 miles from California into Alaska.

Research began with establishment of permanent plots to measure the yield of Sitka spruce-western hemlock, Douglas-fir, and alder stands. Later experimental cuttings of commerical size were made, and planting, brush control, and wind damage have been studied. Studies were gradually expanded to include all aspects of the ecology of fast-growing spruce-hemlock forests, from seed fall to nutrient cycling.

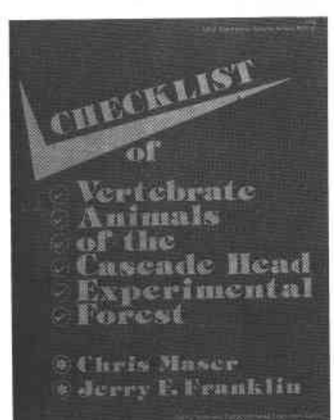
In 1941, the Neskowin Crest Research Natural Area was established on 700 acres of the Experimental Forest to preserve spruce and hemlock stands along the Pacific Ocean for research and education.

In December 1974, a new dimension was added to research in the Experimental Forest when the western portion of the forest was included in the 8,900-acre Cascade Head Scenic-Research Area established by Congress. The Scenic-Research Area preserves Cascade Head and Salmon River estuary immediately to the south for basic ecological research, scenic enjoyment, and educational purposes. This designation is expected to stimulate and expand research and demonstration in the Experimental Forest.



Cascade Head: Land for Learning, a descriptive brochure about the Scenic-Research Area published in 1976, contains information about the Experimental Forest (8).

A list of 64 reports of studies carried out on the Experimental Forest is available from Information Services at Station headquarters in Portland.



Checklist of Vertebrate Animals of the Cascade Head Experimental Forest, by Chris Maser and Jerry Franklin is an annotated checklist of 9 amphibians, 2 reptiles, 35 birds, and 40 mammals found on the Experimental Forest (9).

south umpqua experimental forest

Established in 1951
Size: 600 acres
Elevation: 2,375-3,520 feet
Vegetation: Mixed conifer
Location: Umpqua National Forest, Oregon

The Umpqua Experimental Forest is about 50 miles southeast of Roseburg, Oregon, and consists of the watersheds of four tributaries to the South Umpqua River. The area is representative of the southwest Oregon mixed conifer timber type, consisting of Douglas-fir mixed with sugar and ponderosa pine. This forest type extends from the North-South Umpqua River divide south into California.

South Umpqua Falls

Drainage basin studies began in 1961 with measurements of natural conditions on the four watersheds. In 1969, studies of nutrient and soil balance were begun to assess the possible long-term impacts of timber harvesting on forest productivity.

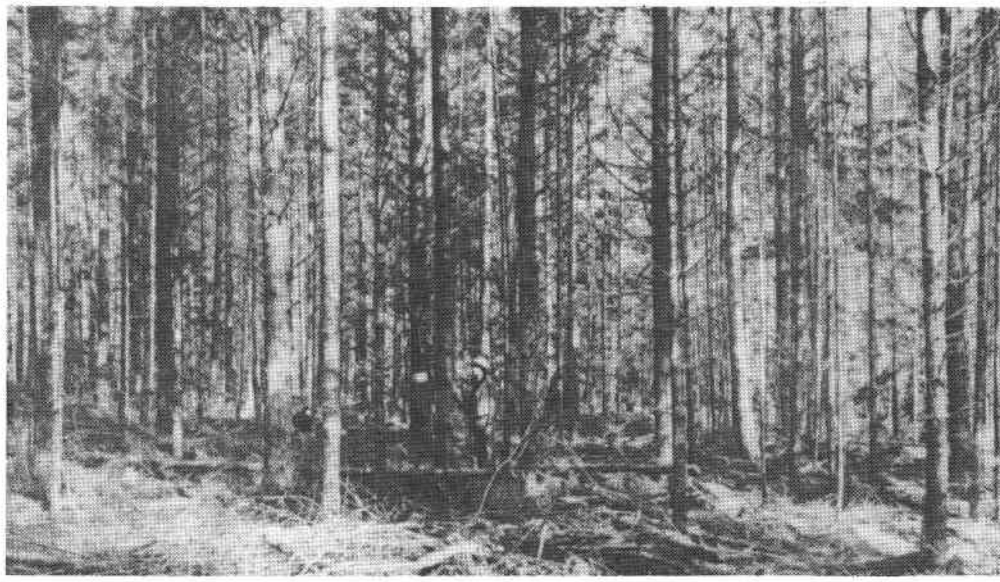
Roads were constructed on three of the watersheds in 1971, and in 1972 the timber was harvested in large clearcuts on one watershed, small clearcuts on another, and shelterwood cuts on the third. The fourth was left uncut as a control.

In 1976, the Environmental Protection Agency joined in a cooperative study of the effect of timber harvesting on the potential for algae production in water downstream from timber harvest areas.

voight creek experimental forest

Established in 1947
Size: 230 acres
Elevation: 830-1,140 feet
Vegetation: Douglas-fir
Location: Southwest Washington

Located on forest land belonging to the St. Regis Paper Company southwest of Tacoma, Washington, the Voight Creek Experimental Forest was established for studies and demonstrations of forest management in second-growth Douglas-fir. At the time the Forest was established, trees were 37 years old. They had originated after clearcutting and repeated burns.



General view of area thinned in 1949—Plot 9, Compt. A-l.

Studies have been made of the effects of thinning on tree and stand growth and yield, on stem form and crown development of individual trees, and on seed production and litterfall.

Other studies have concerned the labor requirements and costs of thinning, the financial aspects of pruning, and the relationships between thinning and tree damage from various sources.

More recently, fertilizer has been applied to some of the plots to determine its effect on tree and stand growth in previously thinned and unthinned stands approaching harvest age.

bull run experimental watershed

Established in 1957
Size: 945 acres
Elevation: 2,750-3,560 feet
Vegetation: Douglas-fir, western hemlock
Location: Mt. Hood National Forest, Oregon

The experimental watershed consists of the drainages of three unnamed branches of Fox Creek, a tributary of the South Fork of the Bull Run River. The area is located within the 142,000-acre Bull Run Reserve, which was set aside by Presidential proclamation in 1892 to protect the water supply of the City of Portland. The reserve is managed by the Mt. Hood National Forest.

Timber cutting was begun in 1957 in a program designed to prevent natural wildfires within the reserve. Watershed studies were begun the same year to evaluate the effects of timber harvesting on water supply, water quality, and soil and nutrient balance. Three drainage basins were instrumented for this purpose in 1957.

mccleary experimental forest

Established in 1948
Size: 340 acres
Elevation: 300-600 feet
Vegetation: Douglas-fir
Location: Southwest Washington

This forest was established on forest land of the Simpson Timber Company west of Olympia, Washington, to investigate thinning as a means of increasing the recoverable volume of young-growth stands, primarily Douglas-fir. Trees on the eastern portion of the Forest originated after a severe burn and were 55 years old when the Experimental Forest was established. Younger trees (age 39) originated following logging on the western portion of the forest.

The effects of light and frequent thinning on growth and yield have been studied. In addition, logging costs and production rates have been investigated.

Other studies have covered mortality salvage, crown and stem development of individual trees, and natural regeneration. Currently, the use of various fertilizers to improve tree growth is being investigated on some of the plots.

A Guide to the McCleary Experimental Forest, a descriptive folder prepared in 1954 is available (10).

eastern oregon & washington

starkey experimental forest & range

Established 1940
Size: 27,000 acres
Elevation: 3,680-5,000 feet
Vegetation: Ponderosa pine, Douglas-fir, western larch
Location: Wallowa-Whitman National Forest, Oregon

Located southwest of La Grande, Oregon, in the Blue Mountains, the Starkey Experimental Forest and Range has been grazed by livestock since the middle 1860's and administered as a grazing allotment by the Forest Service since 1907. Grazing management research by Station scientists began in 1940. In 1954, studies in watershed management, forest ecology, and livestock-big game relationships were begun. More recently, studies of soil fertility, non-game wildlife, silvicultural methods, prescribed burning, recreation, and effects of grazing on riparian habitats have been added.

pringlè falls experimental forest

Established 1931-1954
Size: 11,055 acres
Elevation: 4,000-6,230 feet
Vegetation: Ponderosa, lodgepole, and sugar pine, and white fir
Location: Deschutes National Forest, Oregon

Located about 35 miles south of Bend, Oregon, the Pringle Falls Experimental Forest is composed of two units: The Pringle Butte unit of 7,540 acres, established in 1931; and the Lookout Mountain unit of 3,515 acres, established in 1937.

The Forest is primarily ponderosa and lodgepole pine, mixed with white fir, noble fir, and some Douglas-fir and sugar pine at higher elevations on north slopes.

The Pringle Falls Research Natural Area, established in 1936, and located in the Pringle Butte unit, consists of 560 acres of typical old-growth ponderosa pine and 600 acres of lodgepole pine.

Studies of the silviculture and management of eastside timber species have been carried out on the Forest since its establishment. These include growth and mortality, levels of growing stock, thinning, brush control, methods of cutting, and prescribed burning.

entiat experimental forest

Established in 1971
Size: 5,040 acres
Elevation: 1,800-7,000 feet
Vegetation: (pre-fire) Ponderosa pine, Douglas-fir, lodgepole pine, western redcedar, and whitebark pine
Location: Wenatchee National Forest, Washington

In 1957, the area that is now the Entiat Experimental Forest was selected for studies of water yield from forest land, water quality, vegetation succession, and site productivity in response to specific forest practices. Gaging stations were constructed on the watersheds of three adjoining tributaries of the Entiat River about 45 miles from Wenatchee, Washington.

On August 24, 1970, a lightning-caused forest fire burned 45,000 acres of the experimental watersheds, and the hydrologic studies had to be reoriented from their original objectives. Most of the timber was gone. However, researchers redesigned their studies to evaluate both the effects of fire on the environment and ways of rehabilitating areas damaged by fire. The shift in research emphasis was possible because almost 10 years of hydrologic measurements were available and gages and other installations were still usable.

Studies of the effect of fire and revegetation of burned areas continue to provide guidelines for land managers faced with erosion and other problems that follow large fires. See a descriptive brochure about the Experimental Forest titled, *Operation Phoenix,* by Thomas M. Baugh (11).

southeast alaska

maybeso experimental forest

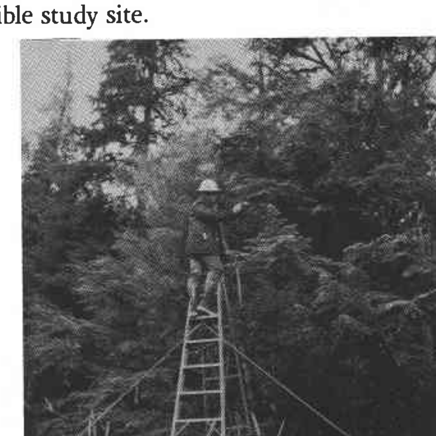
Established in 1956
Size: 11,102 acres
Elevation: 0-3,392 feet
Vegetation: Western hemlock, Sitka spruce, western redcedar, and Alaska cedar
Location: Tongass National Forest, Alaska

The Maybeso Creek watershed on Prince of Wales Island was selected in 1949 for studies of the effects of logging on the spawning of pink and chum salmon because it contained a variety of timber stand conditions, a suitable stream, and was soon to be logged. Much of the early Forest Service research on salmon spawning habitat was done here. These studies were concluded in 1966, when fish habitat research shifted from major stream channels to small tributary streams.

After the timber on 2,500 acres of the Experimental Forest was removed by clearcutting, studies of natural regeneration were carried out between 1955 and 1962. Research on soil movements and their relation to logging practices was begun following a large scale soil mass movement in the Maybeso Valley in 1961. These studies have produced information which is now guiding cutting practices on the Tongass National Forest.

Active research on the Experimental Forest is now limited to studies of management of young, even-aged stands of western hemlock and Sitka spruce. This research is expected to increase as the stands mature and silvicultural and logging methods can be tested and demonstrated.

In 1969 the Experimental Forest was reduced by about 320 acres to provide for a state ferry terminal and a highway on a portion of the forest. The area is now accessible by ferry and is on a growing road system on Prince of Wales Island, making it an accessible study site.



young bay experimental forest

Established in 1959
Size: 6,425 acres
Elevation: 0-3,604 feet
Vegetation: Western hemlock, Sitka spruce
Location: Admiralty Island, Alaska

Two streams on steep terrain on the northeastern shore of Admiralty Island were selected in 1958 for studies of the spawning habitat for pink and chum salmon. Gaging stations were installed to record water levels and temperatures.

Studies of spawning habitat have been carried out since 1966, using an artificial stream channel in which discharge, velocity, gradient, gravel composition, and amount and type of sedimentation can be controlled.

While allowing control of these stream variables, the artificial channel maintains the characteristics of a natural stream, and techniques developed there can be applied to fish habitat studies in natural streams.

interior alaska

bonanza creek experimental forest

Established in 1964
Size: 12,500 acres
Elevation: 400-1,300 feet
Vegetation: White and black spruce, paper birch, aspen, balsam poplar, and tamarack
Location: West of Fairbanks, Alaska

Located on land managed by the Alaska State Division of Lands, Department of Natural Resources, the forest contains a variety of upland, lowland, muskeg, and flood plain forests, a portion of the Tanana River and two islands, one with a 300-year-old stand of white spruce.

Early research on the Experimental Forest consisted of monitoring the ecological processes of undisturbed forest ecosystems. Studies to evaluate the effects of timber harvesting and fire on forest types were begun in 1971, and in 1975 studies of hardwood regeneration were added. A 1976 grant from the National Science Foundation will fund additional monitoring.

caribou-poker creeks research watershed

Established in 1969
Size: 40.8 square miles
Elevation: 700-2,525 feet
Vegetation: Black spruce, aspen, birch, alder, white spruce
Location: 20 miles north of Fairbanks, Alaska

Poker Creek, with its tributary, Caribou Creek, rises in the high ridges of Poker Dome and drains into the Chatanika River at Poker Flats. The watersheds drain an area of 40.5 square miles, are well covered with timber, and include both north-facing (permafrost) and south-facing (non-permafrost) basins.

Development of the research area was a cooperative effort by 12 agencies and university departments, coordinated through the Inter-Agency Technical Committee for Alaska. It is the only permafrost-dominated subarctic area in the United States which is dedicated to hydrology and environmental research. This basin has been designated an Experimental Ecological Reserve by The Institute of Ecology.

Most efforts to date have been oriented toward collecting baseline data, making inventories, and improving ground access to the area.

research natural areas

In 1927, the Forest Service set aside a 4,500-acre ponderosa pine forest in Arizona for scientific study. The action was taken partly in response to proposals by early Forest Service officials to preserve examples of the typical timber types as reference points and guides for future forest studies. The officials feared that all primeval forest stands might someday disappear.

Action to preserve areas in the Pacific Northwest got underway in 1927 also, with formation of the Pacific Northwest Research Natural Area Committee. Thornton Munger, Station Director, was the first chairman of the committee.

Since that beginning in 1927, other federal land management agencies have joined the Forest Service in a cooperative program to establish a nationwide system of reserves to represent not only all timber types but all major ecosystems. Other public agencies and private organizations have joined the movement to preserve natural areas.

The purpose of these areas is to provide natural scientists with a place to study plants, animals, environments, and ecological processes which have not been altered by man's activities. The areas also serve as benchmarks for assessing the extent of man's impact on diverse environments and as preserves of gene pools for plant and animal species.

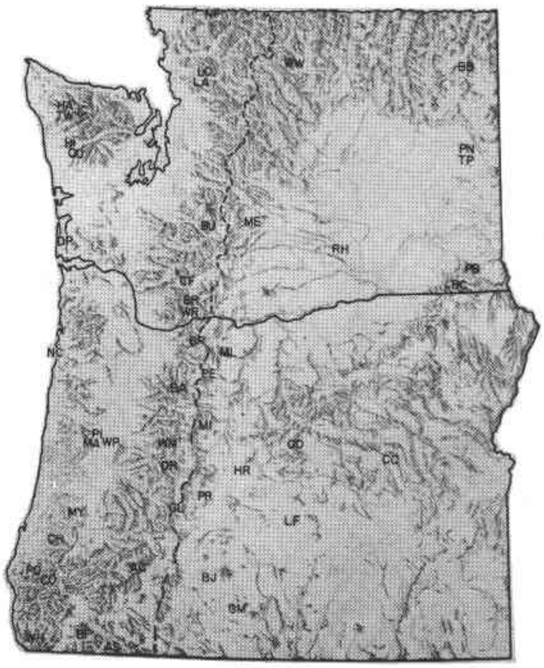
Wheeler Creek, A Milestone

On May 3, 1973, in the southwest corner of Oregon, the Forest Service held a special ceremony to mark the designation of the 100th Research Natural Area on National Forest land. Visitors gathered in a cathedral-like grove of redwoods to dedicate the Wheeler Creek Research Natural Area. The area was added to the natural area system to represent coast redwood (*Sequoia sempervirens*) growing at the northern limit of its range.

Federal Research Natural Areas in Oregon and Washington: A Guidebook for Scientists and Educators, by Franklin, Hall, Dyrness, and Maser (12)

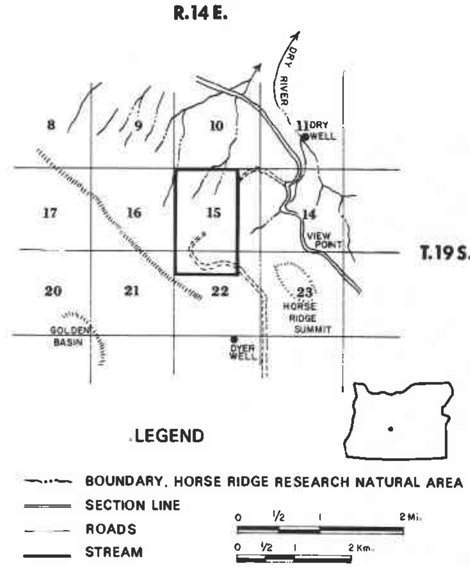
This guide provides detailed descriptions of physical and biological features of 48 Research Natural Areas in Oregon and Washington. It includes maps, photographs, and indices to areas by vegetation type and plant and animal species. It also includes instructions to scientists on use of the areas. Descriptions of newly added areas are published as supplements to the guide.

Typical closed stand of Oregon white oak near summit of Pigeon Butte.



Geographic distribution of established Federal Research Natural Areas in Oregon and Washington.

The most abundant mammal on the natural area (Rattlesnake Hills), the Great Basin pocket mouse, (Perognathus parvus).



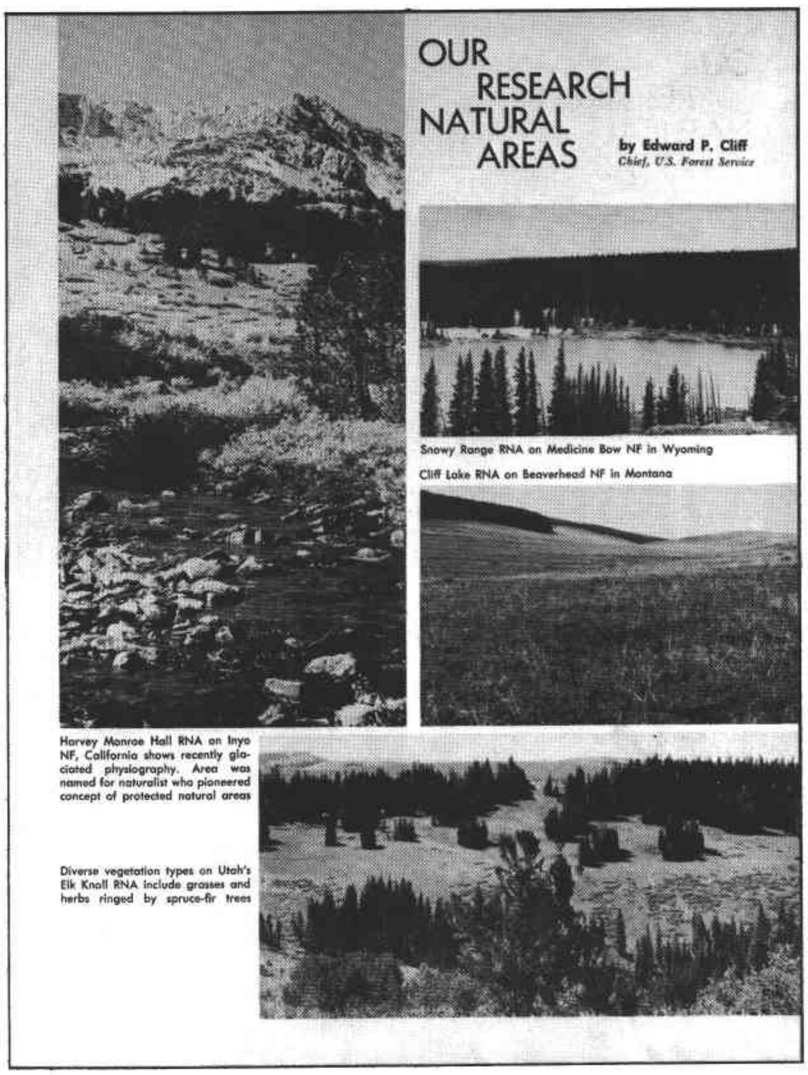
Horse Ridge Research Natural Area, Deschutes County, Oregon.

Research Natural Area Needs in the Pacific Northwest, by C.T. Dyrness, et al. (13)

A master plan for a comprehensive system of Research Natural Areas for Oregon and Washington is outlined in this 1975 publication. It is the first such plan for any part of the United States. By defining the scope and content of a minimal scientific preserve system, the book provides assistance to federal, state, and local agencies in preparing comprehensive land-use plans. It describes 316 types of areas needed (in addition to the 60 areas established at the time of publication) to complete an adequate system of reserves for the two states. It has become the standard reference for all public and private natural area efforts in the Pacific Northwest.

More on Natural Areas

Reprints of short articles about Research Natural Areas provide additional information. These include one by Franklin, Jenkins, and Romancier on the contribution of Research Natural Areas to environmental quality programs(14); another by Romancier on the need for coordinated action to inventory and set aside additional areas(15); one by Moir which summarizes the history and extent of the movement, and includes 35 references and notes dating from 1899 (16); and one by Cliff on the Forest Service program of Research Natural Areas(17).



OUR RESEARCH NATURAL AREAS

by Edward P. Cliff
Chief, U.S. Forest Service

Snowy Range RNA on Medicine Bow NF in Wyoming

Cliff Lake RNA on Beaverhead NF in Montana

Harvey Monroe Hall RNA on Inyo NF, California shows recently glaciated physiography. Area was named for naturalist who pioneered concept of protected natural areas

Diverse vegetation types on Utah's Elk Knoll RNA include grasses and herbs ringed by spruce-fir trees

research facilities–bibliography

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ecosystems, classification

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Contents

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plant keys

Important Plants on National Forest Ranges of Eastern Oregon and Eastern Washington, by Elbert H. Reid (1)

Simple keys and descriptions are given on the occurrence and forage value of important plants on the national forest ranges of eastern Oregon and eastern Washington. Published in May 1942, it is still a useful guide which has not been updated. Species are listed only if they are important range plants or are abundant on the range.

Identification of Rotten Logs in the Coastal Forests of Oregon and Washington, by Don Minore (3)

Why on earth would anyone want to identify a rotten log? Certainly not to sell it at the mill. But perhaps as an aid in studying the success (or lack of success) of young seedlings growing on rotten logs.

This is a publication for a special kind of forest scientist—one who studies forest regeneration, especially in coastal areas of the Pacific Northwest. In the Olympic rain forest, more than 70 percent of the spruce and hemlock reproduction is on rotten logs. There it may be important for researchers to know what species of log is best suited for growing young trees.

This guide should make field identification easier. It provides a key and species descriptions for decaying logs of the most common Oregon and Washington coastal species: Sitka spruce, western hemlock, Douglas-fir, the true firs, western redcedar, red alder, and bigleaf maple.

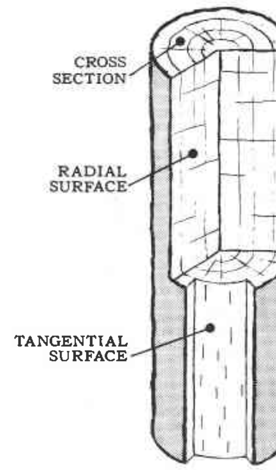
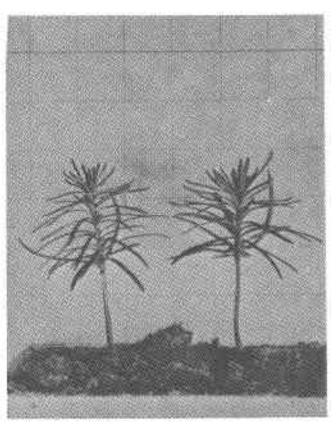


Diagram of cutting planes. Annual rings appear as straight lines on a radial surface. On a tangential surface, annual rings are not evident.

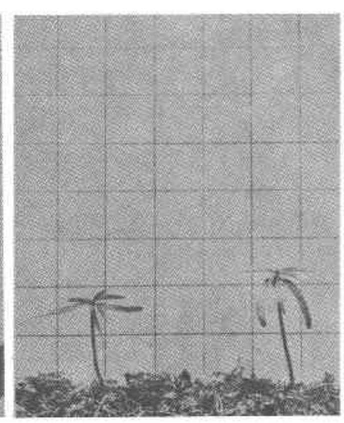
A Guide to Seedling Identification for 25 Conifers of the Pacific Northwest, by Jerry F. Franklin (2)

Identification of very young seedlings of Pacific Northwest conifers has been difficult because they often occur in mixture in forest stands. In addition, descriptions of seedling characteristics previously available are scattered, incomplete, and in some cases, inaccurate.

This is a guide for the identification of young seedlings. It consists of a key to the seeding characteristics of 25 important conifers of the Pacific Northwest. Supplemental descriptions and photos are also provided. The key and descriptions are based on the characteristics of very young seedlings—that is, from the time seedcoats are initially shed until either (1) cotyledons are shed, or (2) the second season of growth starts.



Shasta red fir



Pacific yew

Western redcedar

At the end of the first growing season.

Key to Important Woody Plants of Eastern Oregon and Washington, by Doris W. Hayes and George A. Garrison (4)

Winter, spring, summer, and fall, big-game biologists, forest rangers, hunters, and recreationists are on the mountain trails of eastern Oregon and Washington. A knowledge of browse plants, numerous in this region, is increasingly important. This key represents an attempt to meet the demand for a shrub key based on twig or leaf characters and prepared in laymen's language.

Scientific or Latin names are given for each species in addition to common names. Most species are listed, but a few (for example, some of the less common willows) have been omitted on purpose. Also, botanists have not explored all of the Okanogan highlands, the Blue Mountains, and the east slope of the Cascades, so some shrubs found there may be missing in this key.

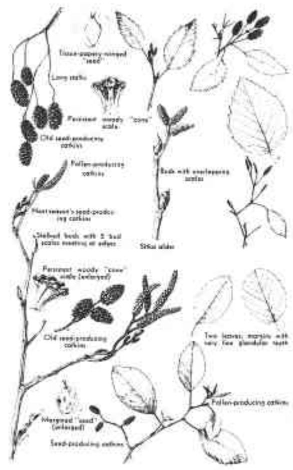
For standard information on these plants, the reader may also refer to the following:

Abrams, Leroy. *Illustrated Flora of the Pacific States.* (Three volumes.)

Gilkey, Helen. *Handbook of Northwest Flowering Plants.*

Hitchcock, Cronquist, Owenbey, and Thompson. *Vascular Plants of the Pacific Northwest.* A five-volume (very expensive) edition that has now been shortened into a single volume (less expensive).

Hitchcock, C. Leo, and Arthur Cronquist, *Flora of the Pacific Northwest, an illustrated manual.*



White Alder (detail)

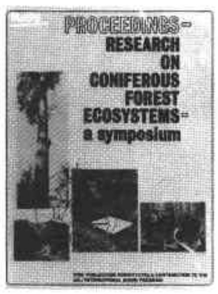
research

Early Stages of Plant Succession Following Logging and Burning in the Western Cascades of Oregon, by C.T. Dyrness (5)

What are the ecological changes that occur following logging and burning in the western Cascades of Oregon? This study, conducted in the H.J. Andrews Experimental Forest, may help foresters make decisions about timber harvesting.

The degree of disturbance from logging and burning apparently has a strong influence on successional trends. In places where the soil was undisturbed, species such as *Acer circinatum, Oxalis oregana,* and *Gaultheira shallon* dominated. Areas disturbed by logging, but unburned, supported a wide variety of both residual and invader species. Light to severely burned sites were mainly occupied by brush or herbaceous species such as *Ceanothus velutinus, Epilobium angustifolium,* and *E. paniculatum.*

Recovery of the preexisting vegetation following logging was fairly rapid. Of the species common to the sites prior to logging, only 13 percent had not come back 5 years after logging.



Proceedings—Research on Coniferous Forest Ecosystems — A Symposium (6)

This volume, 322 pages, contains the Proceedings of a symposium: "Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP."

The research program organized under the Coniferous Forest Biome is probably the largest and most comprehensive single effort at ecosystem analysis being carried out in the Western United States. Despite its youthful state there is great interest among ecologists both within and beyond the Biome "boundaries" in the conceptual basis for the Biome's program and present and planned research.

This symposium highlights the concepts and plans underlying major segments of the Biome program and the numerous new insights, techniques, and data which are resulting from the varied research activities.

AN INSIGHT TO "INSIGHTS"

Scattered throughout this publication are a series of feature articles. These have previously appeared in a national, regional, or local magazine or newspaper. These articles, called "insights," deal with specific aspects of PNW research programs in Oregon, Washington, and Alaska. The articles do not present a comprehensive picture of the scope of PNW's research programs, but they are individual titles in a mosaic of all of the possible stories which could be written about PNW research. That would fill volumes larger than this one.

The articles are printed in italic type and are found in the right-hand column of odd numbered pages. Just follow the tracks and have a pleasant and informative trip.

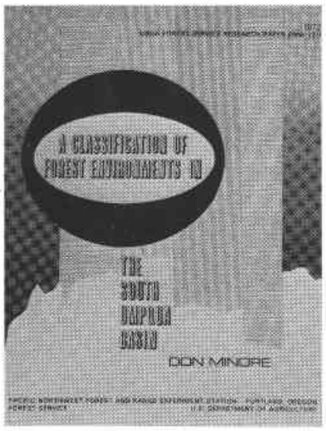
THE MOOSE AND THE HARE
by Thomas Michael Baugh

Aesop may have missed one of the best animal stories of all time by limiting his travels to Greece. If the venerable sage had wandered north and west a few thousand miles, he would have found himself in the interior of Alaska. Being observant, Aesop might have noted an interesting relationship between two four-footed animals of the far north. If so, the opening line of his fable might have gone something like this: "Once there was a moose and a hare, and they both loved the willow."

During the summer, the moose and the hare have little in common. Food appears to be plentiful and the two species have different summer diets. The picture changes in the winter months in areas which have been burned by wildfire and which have a high snowshoe hare population. Food is less abundant and as the snow begins to pile up both of these animals turn to willow shrubs and other hardwoods in order to survive.

Forest Service biologist Jerry Wolff of the Institute of Northern Forestry in Fairbanks, Alaska, began to study the food habits of moose and snowshoe hares following a forest fire which occurred near Fairbanks in 1971. Jerry points out that "in Alaska, fire is the main disturbance which creates new habitats." In fact, browse, including willow, is much more plentiful for moose in the open areas which result from wildfire.

Willow is a hardy shrub which has the ability to withstand heavy browse damage and still grow succulent new shoots each spring. It also has the ability to regenerate quickly in the first few years following a fire. Moose are attracted to the brushy hardwoods and



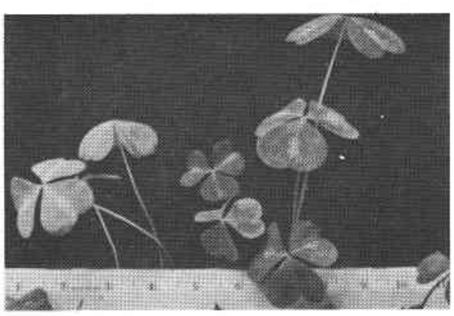
A Classification of Forest Environments in the South Umpqua Basin, by Don Minore (7)

A classification of forest environments is necessary in order to get optimum results from forest management practices.

This classification of forest environments in the South Umpqua basin is based upon species' presence and the measurement or estimation of five environmental factors that are basic to plant growth: elevation, temperature, moisture, solar radiation, and soil type.

The classification is a first step—a tool to be used in further work. Silvicultural prescriptions should be tried and evaluated for each environment. In this way, a catalog of successful and unsuccessful treatments will be available for each environmental class.

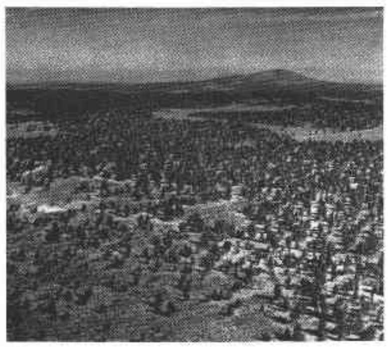
Psoralea physodes



Oxalis

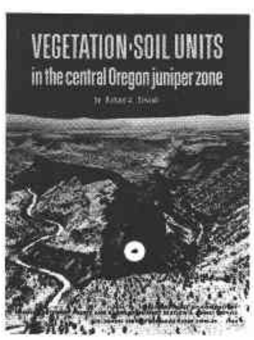
Vegetation-Soil Units in the Central Oregon Juniper Zone, by Richard S. Driscoll (8)

The central Oregon juniper zone includes approximately 108,000 acres in Crook, Deschutes, and Jefferson Counties where western juniper is a major component of the vegetation. This area is one of three physiographic subdivisions of the Northwest representative of the pinyon-juniper zone in the Western United States. Although no pinyon pines occur in the Oregon area, other features are similar to the broad parent zone. The climate is characterized by high summer temperatures, cool winters, high winds, low relative humidity, and low annual precipitation. In the study area, the zone grades to the ponderosa pine zone, where moisture is more effective, and to the sagebrush or grassland zones of less effective moisture.

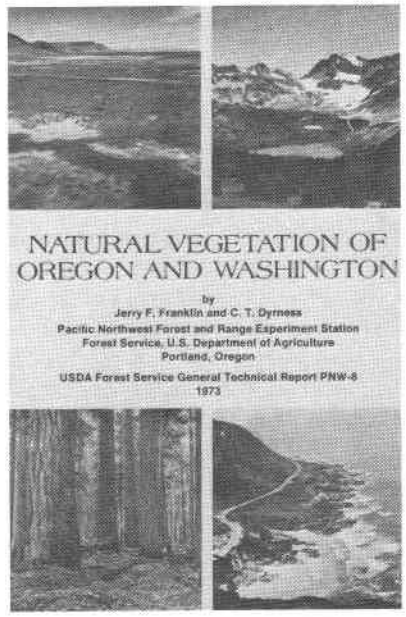


Juniper zone

The juniper zone has three physiographic subdivisions based on soil parent materials. One of these—the country around Redmond and Prineville—was studied here. In this area, soils are derived from wind-laid and mixed igneous and pumice sands or, where these materials do not comprise the actual parent material, pumice is scattered throughout the soil profile. The pumice probably originated from Mount Mazama (site of Crater Lake), 100 miles southwest of Bend, when the volcano exploded approximately 8,000 years ago. Some pumice may have originated from more recent eruptions of Newberry Crater (site of Paulina and East Lakes), located 25 miles south of Bend. The igneous sands, mostly from andesite, rhyolite, or basalt, were transported from dry lakebeds by southwesterly winds.



plant communities



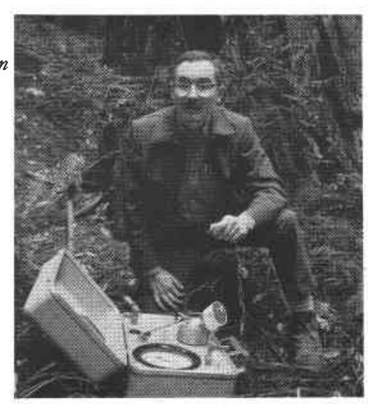
Natural Vegetation of Oregon and Washington, by Jerry F. Franklin and C.T. Dyrness (9)

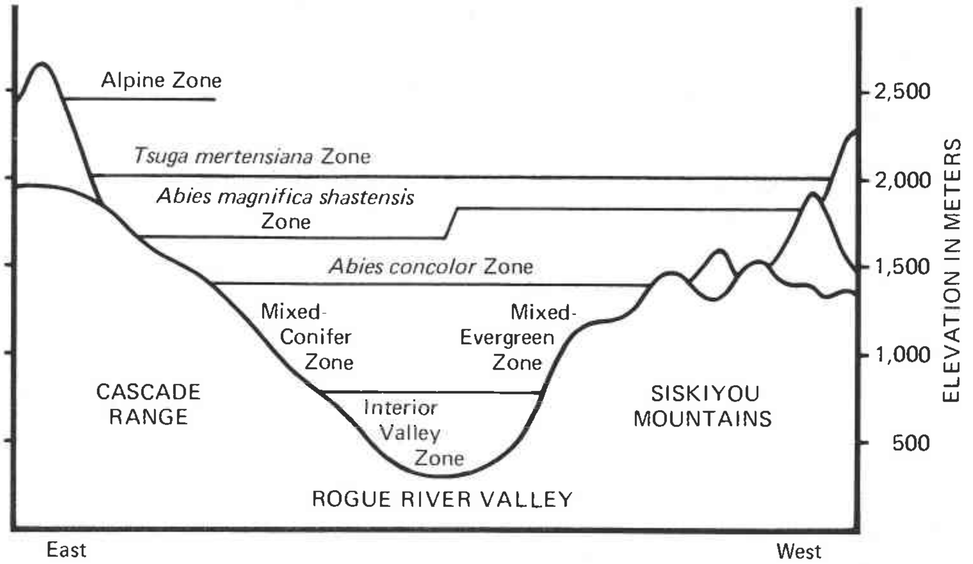
A major work (417 pages) describing the major vegetational units of Oregon and Washington and their environmental relationships. Descriptions of each vegetation zone include composition and succession, as well as plant variations associated with environmental differences.

Available for sale only ($4.65) from the Superintendent of Documents, Book Store, Room 1056, Federal Office Bldg., 909 First Avenue, Seattle, Wash. 98104. Order by Stock Number 0101-00329.

See also *A Preliminary Classification of Forest Communities in the Central Portion of the Western Cascades in Oregon,* by C.T. Dyrness, J.F. Franklin, and W.H. Moir (10). It describes the characteristics of 23 forest communities and relationships among them. Obtain through PACFORNET or regional libraries.

Jerry Franklin





Arrangement of vegetation zones in the Cascade Range and western Siskiyou Mountains of southwestern Oregon.

Abies magnifica shastensis

Abies amabilis *zone*

Pinus albicaulis

Mudflows are common features near the major volcanoes in the Cascade Range. This mudflow, at Kautz Creek (near Mount Rainier, Washington), occurred in 1947, burying and killing the original forest.

spend the winter cropping the shoots and branches produced during the growing season. Research has found that willow is a necessary component of the taiga, or sub-arctic forest, ecosystem. In discussing the food used by the plant-eating mammals, or "primary consumers," Jerry says that, ". . . willow is probably the most important with respect to primary consumers such as moose and hares."

Normally, snowshoe hares are at home in denser cover than that provided by willow in burned-over areas. Perhaps they feel exposed to predators such as hawks, owls, and lynx. They prefer the mature spruce or mixed deciduous forests which provide both food and cover. During low population times, snowshoe hares "were found only in the densest spruce and mature willow stands," Jerry indicates.

This situation changes when the snowshoe hare populations increase to a high point in their population cycle. This was the case on the burned land north of Fairbanks during the two winters between 1971 and 1973. Because of high numbers the hares ate themselves out of hearth and home. They were forced to move from the areas of high tree density into the burned area. The moose were thus joined by the hares at the free lunch provided by the prolific willow. On occasion, browsing was so heavy that the willows were girdled near the bottom of the stems where the hares were feeding.

How did all of this browsing and gnawing affect the willows? Jerry has found that in order to grow, plants must be able to respond positively to continuous browse damage. Willows are apparently well adapted for this task. They are able to recover each growing season from the previous winter's clipping. In addition, willow growth in burned areas is significantly higher than growth in unburned areas. This is due to lack of competition from other plants and additional soil nutrients. Browsed branches provide almost twice as much new growth each season as their unbrowsed counterparts.

The process cannot go on forever. Willow can withstand heavy browsing for more than 10 consecutive years, but after that the growth rate will decrease. Nature provides for even this situation. By the time the willow has reached its maximum productivity, forest trees are taking over. The vegetative cover changes to healthy, young forests. However, chances are very good that wildfire has struck someplace else continuing this fascinating cycle of nature in the northern forests.

end
next "insight" page 23

ecosystems, classification–bibliography

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economics

See also: Silviculture

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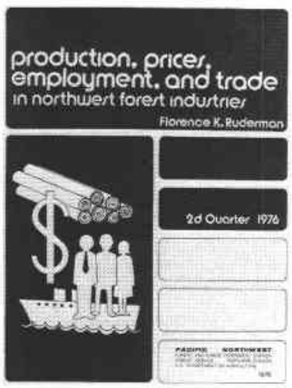
general

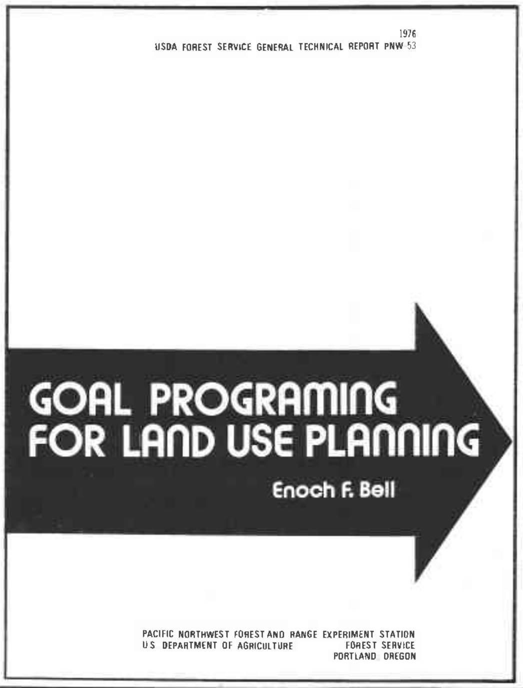


Production, Prices, Employment, and Trade in Northwest Forest Industries, by Florence K. Ruderman (1)

A quarterly report that presents current information on the timber situation in Alaska, Washington, Oregon, California, Montana, Idaho, and British Columbia, including data on lumber and plywood production and prices; timber harvest; employment in forest products industries; international trade in logs, pulpwood, chips, lumber, and plywood; volume and average prices of stumpage sold by public agencies; and other related items.

To Get on the Mailing List:

Ask for the Quarterly Report, and write or call: Paul Barlow, Editorial Services, Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, OR 97208. Phone: 503/234-3361, ext. 4924, or FTS: 8-429-4924.



Goal Programming for Land Use Planning, by Enoch Bell (2)

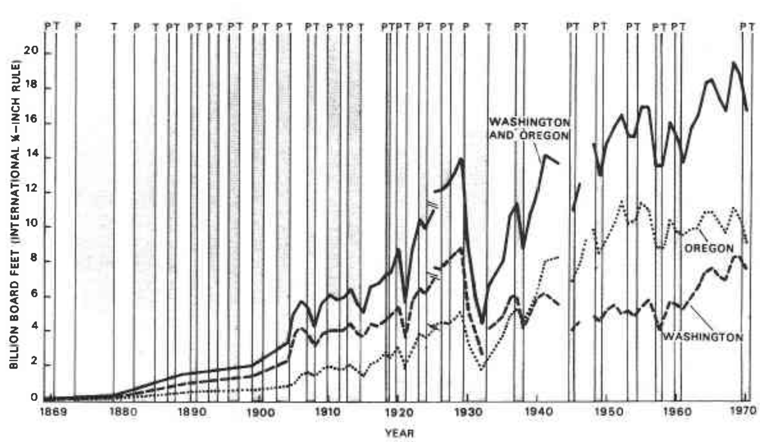
Goal programming has generated considerable interest as a tool for land use planning in multiple goal situations. It does present problems in terms of somewhat difficult data requirements—linearity in its usual form, possible inferior solutions, and lack of explicit recognition of trade-offs. Yet it also presents opportunities for handling complex situations, quickly portraying alternatives, allowing more than one goal, and simulating the ''satisficing'' decision framework. Goal programming has been used on a few national forests and seems to have provided a useful service to the planners in analyzing their alternatives in these instances. However, it is not a panacea for poor planning and must be used with full recognition of its shortcomings.

timber harvest

Log Production in Washington and Oregon—An Historical Perspective, by Brian R. Wall (3)

The Pacific Northwest Forest and Range Experiment Station has collected and published log production data for many years. These data have been of interest to foresters, resource analysts, economists, business and government leaders, legislators, and the academic community. The last comprehensive historical log production data compilation series for Oregon and Washington was published in 1950, covering the period 1925-48 (Moravets 1950). This study updates that report, presenting data by county for 1925-70 and by county and ownership class for the 1949-70 period.

Oregon and Washington combined produce about one-quarter of the Nation's domestic roundwood. In 1970, total log production for the two states amounted to 16.9 billion board feet. The two states reached a combined record annual timber harvest. The long-term trend in timber harvest for the Pacific Northwest has been a rising one since the mid-1800's even though there have been some sharp fluctuations.



Log production in Oregon and Washington, 1869-1970.

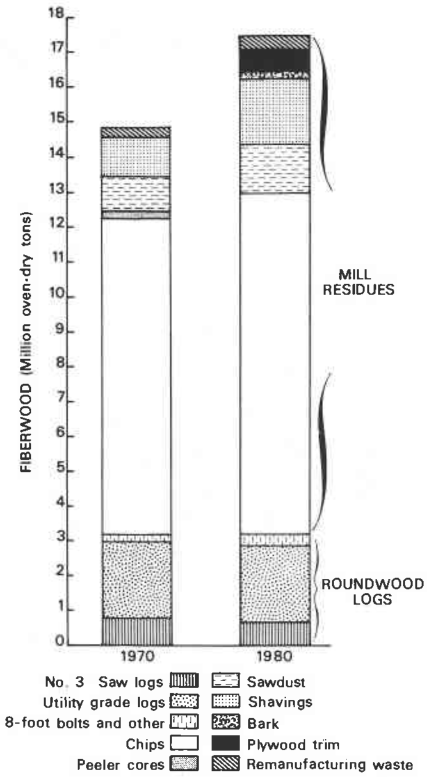
Relationship of Log Production in Oregon and Washington to Economic Conditions, by Brian R. Wall (4)

Increasing demand for timber has put upward pressure on log production in Oregon and Washington. Fluctuations in log production result primarily from changes in national demand for wood products. The log production cycle with respect to business conditions has become countercyclical since World War II. During the 1949-69 period, annual changes in housing starts were significantly related to changes in national forest stumpage prices for all species. Annual stumpage price changes were significantly related to annual changes in log production.

Fiberwood Use in Washington, Oregon, and California, 1970-80, by John W. Austin (5)

This report is based on a survey of pulpmills, board mills, and felt mills in Washington, Oregon, and California in 1970 and 1971. Pulpmill capacity is expected to rise 10 percent over 1970 capacity by 1980; particle board capacity will rise by 80 percent; hardboard up 32 percent; and insulation board up 17 percent. Capacity expansion is limited by pollution control requirements and final product market.

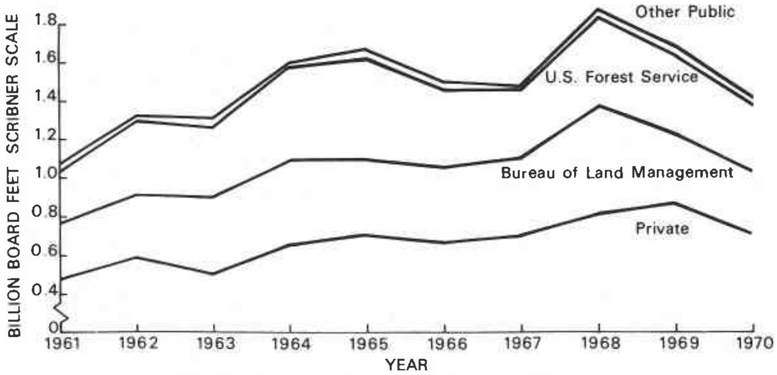
Wood use in these mills is expected to increase 19 percent to 17.7 million ovendry tons per year by 1980. Fiberwood consumption should continue to follow the current pattern, most of the wood coming from sawmill and plywood residues. Under assumptions of declining timber harvest and increasing log exports, lumber and plywood production will also decline, and with it the amount of mill residue available. Pulp and board plants will have to consider alternative sources of material—possibly from thinnings and logging residues.



Current and expected fiberwood use, Washington, Oregon, and California, 1970 and 1980.

Douglas County, Oregon: Potential Economic Impacts of a Changing Timber Resource Base, by David R. Darr and Roger D. Fight (6)

Available projections for Douglas County, Oregon, show that timber harvest from private lands is expected to decline. Forest Service and Bureau of Land Management timber harvest may change over time as priorities and funding change. Identification of the local economic impact of changes in timber harvest is necessary for planning to adjust to projected impacts. An input-output technique was used to estimate for each local sector the impact of the following on sales: Change in demand for forest products; change in Forest Service or Bureau of Land Management appropriations; changes in private, Forest Service, or Bureau of Land Management timber harvest; and a decline in private harvest offset by an increase in Forest Service and Bureau of Land Management harvest. The model used in the analysis can be used to test the effectiveness of new industries, or changes in existing industries, in offsetting projected impacts of changes in timber-oriented industries or agencies.



Douglas County timber harvest by ownership, 1961-70.

Timber Harvest in Oregon and Washington

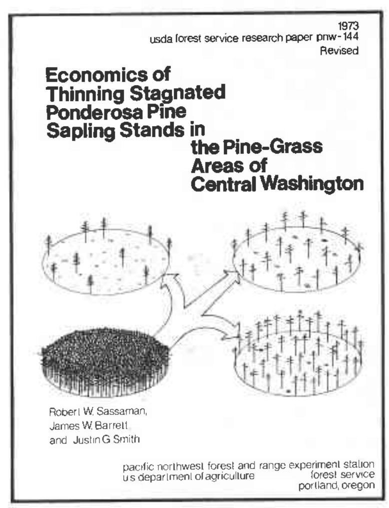
Each year the Experiment Station publishes a resource bulletin outlining timber harvest data for Oregon and Washington. The two-page report shows trends in timber harvest and gives statistics by half state for private, federal, state, and other public lands. When ordering, specify year and state.

thinning

Precommercial Thinning Pays

To thin or not to thin, that is the question. It's all a matter of economics. In this study in the pine-grass region of central Washington, the economics of several treatments were considered: thinning at three stand densities (250, 125, and 62 trees per acre), clearcutting vs. shelterwood cuts, the allowable cut effect, and planting forage to increase economic returns.

In general, economic returns were greatest when the allowable cut effect (ACE) is included, when stands were thinned to 125 trees per acre, in clearcutting rather than shelterwood, and when forage was planted to increase the economic yields.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Revised

Economics of Thinning Stagnated Ponderosa Pine Sapling Stands in the Pine-Grass Areas of Central Washington

Robert W. Sassaman, James W. Barrett, and Justin G. Smith

pacific northwest forest and range experiment station
u.s. department of agriculture
forest service
portland, oregon

Economics of Thinning Stagnated Ponderosa Pine Sapling Stands in the Pine-Grass Areas of Central Washington, by Robert W. Sassaman, James W. Barrett, and Justin G. Smith (7)

Bob Randall

Operations Research and Thinning

An opportunity to save dollars in large thinning projects exists by using an operations research approach. In this study, a mathematical programing technique was used as a base for planning commercial thinning operations. The technique is demonstrated, tested, and compared with other planning methods.

The study utilized information from a Bureau of Land Management special study area of 50,000 acres in western Oregon. The resulting publication provides managers with an improved framework for documenting information, optimizing thinning programs, and testing the consequences of different planning strategies and situations. Although it did not yield dramatic dollar gains in this case, the potential exists for obtaining sizable benefits, particularly in larger, more complex planning situations.

A major obstacle to implementing this approach would be in finding or training qualified people and the initial cost of establishing the system.

An Operations Research Approach to Douglas-fir Thinning, by Robert M. Randall (8)

Economics of Thinning

This study examines four alternative assumptions about the relationship of stumpage price to tree diameter and shows the impact of these assumptions on the financial evaluation of commercial and precommercial thinning in Douglas-fir. The study demonstrates that care should be taken in selecting the price-diameter assumption used to evaluate forest management activities. The results show that not only can the assumption influence the priority of projects selected and the estimates of benefits expected, but that it can be decisive in influencing a project's financial feasibility.

See *Douglas-fir Thinning Values Sensitive to Price-Diameter Relationships*, by Robert M. Randall and David R. Darr (9)

Economics of Forest Range

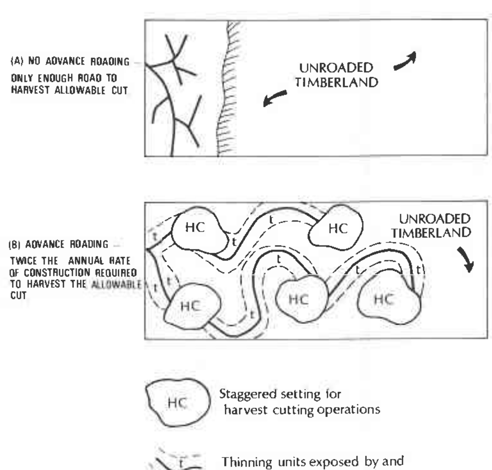
After a decision has been made to precommercially thin a stand of ponderosa pine, it may be advantageous to invest additional funds to increase forage production. Economists have developed a method for figuring the potential rate of investment return in such thinning projects. It is based on the adjusted market value of an Animal Unit Month (AUM) of public grazing and the capital costs of forage production over and above the usual expenses related to thinning.

For details, see *A Tool for Estimating the Financial Returns on Forage Grasses Seeded in Thinned Ponderosa Pine*, by Robert W. Sassaman and Roger D. Fight (10)

road building

An Economic Analysis of Accelerated Road Construction on the Bureau of Land Management's Tillamook Resource Area, by Con H. Schallau (11)

A study was conducted on the Bureau of Land Management's 50,000-acre Tillamook Resource Area to determine the economic feasibility of accelerated roadbuilding. At the time of the study (1970), approximately 15 miles of logging roads were being constructed annually. A plan was proposed to double the rate of road construction to 30 miles per year. Accelerated roadbuilding was found not economically feasible. In fact, investment in such an accelerated program would earn a minus 1.25 percent rate of return. Although advanced roading would increase timber production and timber revenues, the additional revenues would not be enough to compensate for higher maintenance, timber sale administration, and interest charges.



Harvesting the annual allowable cut from a continually receding "wall of timber." "A" requires less road construction than "B", advance roading.

PROTECTING WATER SUPPLIES
by Thomas Michael Baugh

Man has been using the forests of the North American continent for thousands of years. This use began with the native peoples, expanded with European colonization, and accelerated with the development of the modern timber industry.

During the past 50 years the focus of forest use has changed from simple logging to total forest management. Part of the management picture involves the use of chemicals to fertilize, protect, or otherwise control the growth of plants in the forest. Chemical use, in this age of heightened environmental awareness, is controversial. The long-term environmental effects of substances such as the herbicide 2,4,5-T are being increasingly questioned.

The PNW Station, through its Forestry Sciences Laboratory in Corvallis, Oregon, is involved in an intensive effort to determine the effects of herbicides, pesticides, and fire retardents on forest environments.

The goals of the program are to provide hard-pressed forest resource managers with guidelines for the safe application of chemicals and to develop a scientific basis for the formulation of environmentally acceptable forest spray policies.

The long-term benefits of this work are not limited to the resource manager. Regulatory agencies need information concerning the environmental effects of chemicals if they are to act in the best interests of the public. The public, itself, will benefit from a safer environment and added protection for our Nation's forests.

Dr. Logan Norris, who heads a chemical behavior and impact research program at the Forestry Sciences Laboratory, believes that "the use of chemicals in modern forestry is increasing in scope and importance along with the sophistication of management and the need to protect and enhance forest values." Norris feels that the use of chemicals will continue to grow in importance as "land managers are faced with a steadily increasing demand for all forest products . . . from a steadily decreasing amount of land."

Chemicals are presently used for a variety of purposes in managed forest ecosystems. DDT is one of the more obvious examples of a chemical whose use became necessary

Who Says Accelerated Roadbuilding Pays? by Con H. Schallau (12)

Accelerated road construction is uneconomical for public timber production units in the Douglas-fir region of Oregon and Washington.

That conclusion is based on a study of three accelerated roadbuilding programs. In one of those areas, on the 50,000-acre Tillamook Resource Area, the financial return dropped from 0.8 percent when 15 miles of road were constructed per year to 0.3 percent when 30 miles of road were constructed.

The author says that recommendations 30, 33, and 36, calling for accelerated road construction and maximum net returns to the Federal Treasury, are inconsistent.

Accelerated Roadbuilding on the North Umpqua—An Economic Analysis, by Brian R. Payne (13)

Accelerated roadbuilding was found to be economically unjustifiable on an old-growth unit of the Umpqua National Forest in Oregon. An important benefit of faster roadbuilding is the earlier removal of both salvable dead timber and current mortality. Although this would have increased the projected annual timber harvest on the North Umpqua unit, the economic gain is negligible. The study reports that the rates of financial return increase by only about one-tenth of 1 percent for four accelerated road construction alternatives considered in the study.

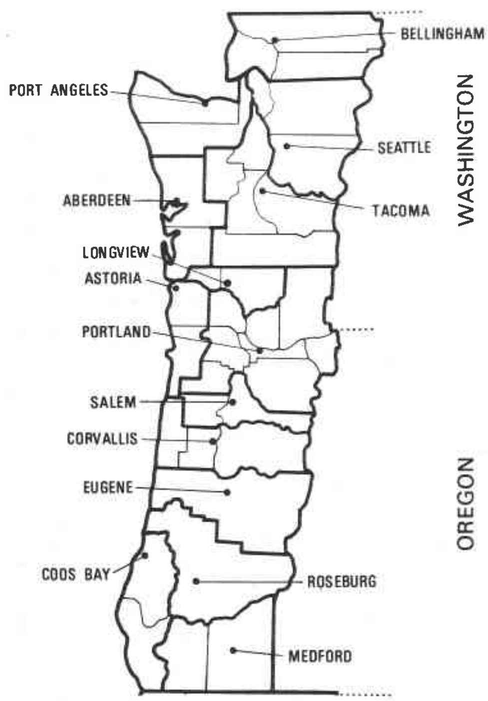
employment

Employment Implications of Projected Timber Output in the Douglas-fir Region, 1970-2000, by Brian R. Wall (14)

The demand for timber in the United States is increasing. Under present levels of timber management, the timber products output in the Douglas-fir region is expected to decline by the year 2000. Based on this projection and on a changing forest industry and increased labor productivity, employment in the timber-based industries in the Douglas-fir region is projected to drop 45 percent between 1970 and the year 2000. Employment-wood consumption relationships are a major factor influencing employment projections, although declining timber products output and a high level of log exports are also important.

Importance of Timber-Based Employment to the Douglas-fir Region, 1959 to 1971, by Wilbur R. Maki and Dennis L. Schweitzer (15)

Even though there were substantial increases in total employment in the Douglas-fir region from 1959-1971, employment in timber-dependent industries declined slightly. Only three of the 14 economic areas in the region matched national employment gains in these industries. Although economies that were highly dependent upon timber in 1959 still were in 1971, in nearly every instance a smaller proportion of economic base employment was concentrated in the timber-dependent industries.



Economic areas and growth centers in Douglas-fir region of Oregon and Washington.

A Technique and Relationships for Projections of Employment in the Pacific Coast Forest Products Industries, by Brian R. Wall and Daniel D. Oswald (16)

The purpose of this paper is to provide local and regional planners, public officials, labor representatives, and others with information and a method to help translate future levels of timber supply and wood use by industries into future levels of direct forest industrial employment in Washington, Oregon, and California.

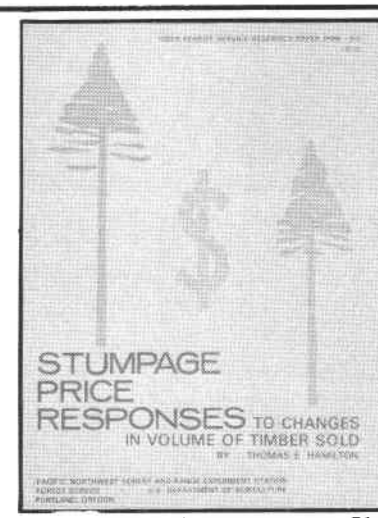
The paper has three major sections: (a) gives equations for estimating future employment in the primary wood-using industries, (b) presents recent trends in total employment as a background against which to evaluate and adjust projections based on wood industry alone, and (c) the seasonal variations of forest industry employment.

stumpage and log value

Log Prices in Western Washington and Northwestern Oregon, 1963-73, by Thomas C. Adams (17)

Average log prices are reported for seven principal timber species of western Washington and northwestern Oregon, for the years 1963-73. For water and inland sales, these prices rose from 86.8 to 232.6 percent over this period; and for export sales, from 361.0 to 732.0 percent.

The U.S. wholesale price index during this period rose 43.4 percent for lumber and 125.0 percent for all commodities.

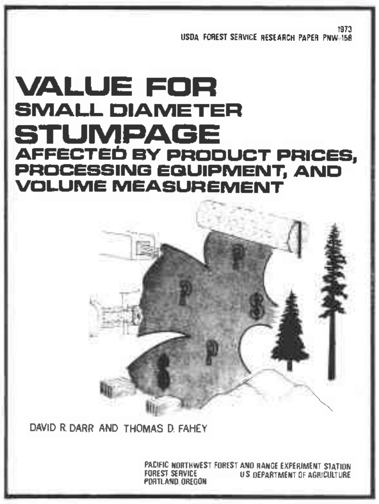


Stumpage Price Responses to Changes in Volume of Timber Sold, by Thomas E. Hamilton (18)

Stumpage prices on timber from national forests in the Douglas-fir region have shown a long-term increasing trend which is expected to continue until the mid-1980's. In the short term, stumpage prices have fluctuated considerably. An examination of the region's stumpage market indicates that shifts in demand for wood products, rather than changes in the quantity of stumpage offered for sale, are the primary determinants of these short-term price fluctuations.

Brian Wall

Stumpage Price—Does It Vary by Tree Diameter? by David R. Darr (19)
This study shows that the relationship between stumpage price and tree diameter tends to vary between areas, and over time for a given area. Relative importance of tree diameter in explaining stumpage price variation tends to decrease when tree diameters are greater than 20 inches. Cost-reducing processes are being adopted by firms for small-diameter timber. As these new processes are adopted, small-diameter stumpage prices in the area should increase relative to large-diameter stumpage prices.



Value for Small Diameter Stumpage Affected by Product Prices, Processing Equipment, and Volume Measurement, by David R. Darr and Thomas D. Fahey (20)

Factors that affect the stumpage price for small diameter timber can affect utilization and land management options for this stumpage. Type of milling process and method of lumber pricing and log volume determination were found to have potential for affecting price of small diameter stumpage. The study shows that a Chip-N-Saw operator could pay up to $15.40 per thousand board feet, Scribner scale, more for stumpage than could a band mill sawing similar products. Standard and better lumber pricing rather than pricing by individual grade reduced the margin available to bid for stumpage. Scribner scale consistently had less volume than International scale. Cubic volume measurements were in all cases more precise as predictors of lumber tally than either International or Scribner scale. Relating log diameter to recovery factor consistently improved the accuracy of the prediction. This was true for both Forest Service and Scaling Bureau measurements. These factors should be considered by the land manager and timber purchaser when they evaluate management options sensitive to stumpage price.

Douglas-fir Thinning Values Sensitive to Price-Diameter Relationships, by Robert M. Randall and David R. Darr (21)

Assumptions about the price-diameter relationship of small logs can be important in setting priorities among projects and determining the financial feasibility of commercial and precommercial thinning operations. This paper shows how present value can be influenced by any one of four alternative assumptions about price-diameter relationships, thus influencing decisions about thinning Douglas-fir.

Timber Value—A Matter of Choice, A Study of How End Use Assumptions Affect Timber Values, by John H. Beuter (22)

The relationship between estimated timber values and actual timber prices is discussed. Timber values are related to how, where, and when the timber is used. An analysis demonstrates the relative values of a typical Douglas-fir stand under assumptions about timber use.

Lumber Potential for Cull Logs in the Pacific Northwest, by Thomas A. Snellgrove and David R. Darr (23)

Cull logs are currently used by the lumber, veneer, and pulp industries in Washington and Oregon. Cull log volume left after logging in western Washington and western Oregon amounts to, at most, 10 percent of the log volume consumed by the lumber industry in the two states. However, the potential for increased use of cull logs in the lumber industry is constrained by cyclic variations in product prices.

The potential for increased lumber production from West Coast Douglas-fir cull logs can be used in stretching timber supplies and reducing logging residue. Even though about 47 percent of the gross cubic volume of cull logs could be manufactured into lumber, the lumber produced would be in low grades.

The authors conclude from this study that the economic feasibility of using cull logs for lumber manufacture is marginal except in times of extremely high lumber prices. Lumber price cycles, and similar cycles in prices of products of pulp and plywood industries which compete for the cull log raw material, tend to work against development of lumber processing capacity and residue reduction programs designed specifically for cull logs.

during the most recent outbreak of the Douglas-fir tussock moth. Because of the controversial nature of DDT, the group headed by Norris is testing other substances with insect control possibilities, and evaluating their effects on the environment.

The control of forest insect pests is only a part of the broad picture of the use of chemicals. The common use of 2,4-D, amitrole, 2,4,5-T, and picloram in chemical brush control have given rise to concern about their impact on organisms in brush control areas. Part of the research program at the Forestry Sciences Laboratory has been to assess the probability of the toxic effects these herbicides might have in various fish, birds, and animals.

Norris points out that two factors determine the degree of toxic hazard posed by herbicide use. These are: the toxicity of the chemical and the likelihood that non-target organisms will be exposed to toxic doses. He says that a long history of field use and research experience indicates that the "common brush control chemicals can be used with a minimum hazard to the quality of our environment" and to non-target organisms.

Resource managers are particularly concerned about the effects of chemicals in forest streams. Stream water is the habitat for many biological communities and is a critical commodity for man and other downstream users. In extensive tests conducted throughout Oregon, researchers have found some herbicide residue in nearly all streams which run through or adjacent to treated areas. While the highest concentrations occurred shortly after application, they never exceeded 0.1 ppm and persisted for only a few hours. The greatest probability of stream contamination occurs through the direct application of chemicals to the water, either by the intentional inclusion of streams in spray areas or drift of spray material from nearby areas. Norris feels these are planning and application problems which can be easily avoided. He says, "... if you don't want chemicals in the water, then don't put them there."

Although the picture for herbicide use is bright, there are several factors which should be carefully considered. The direct application of herbicides to marshy areas can lead to high-level, persistent concentrations of chemicals in nearby streams. Norris cautions that "special care must be taken to avoid treatment of such areas." To date, research has found that another possible problem, chemical leaching throughout the soil,

Potential Responses of Softwood Markets to the Monongahela Decision, by Darius Adams and others (24)

The authors describe the potential effects that a nationwide application of the Monongahela decision would have on softwood stumpage prices, timber harvest levels, lumber and plywood production and prices, and imports of softwood lumber from Canada. The effects are estimated for the period 1980-2000 by use of a simulation model.

Nationwide application of the Monongahela decision would reduce national forest harvests and cause U.S. lumber and plywood prices to rise 15 to 20 percent more over the next two decades than would be expected under current timber flow policy. Softwood stumpage prices would increase 35 to 45 percent over the same period.

Price effects of the reduction in national forest output would be partly offset by increased harvest on private lands and increased imports of lumber from Canada. Stumpage prices would increase most on the West Coast, accentuating the trend toward concentration of lumber and plywood production in the South.

log exports

Log Exports Summarized

Each month research economist Dave Darr gathers together the available statistics on log exports and prepares a press release that gives export statistics for Oregon, Washington, northern California, and Alaska. Information in the report includes the volume of shipments and their value.

To get on the mailing list, write: Information Services, U.S. Forest Service, P.O. Box 3141, Portland, OR 97208.

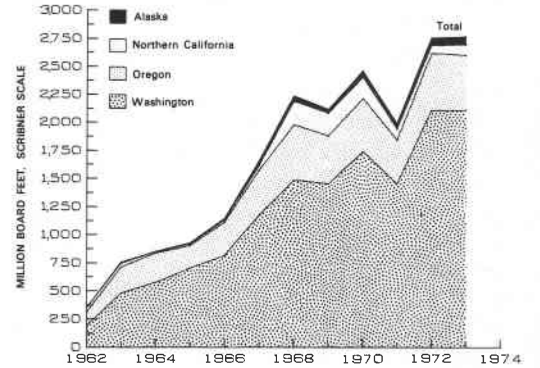
Dave Darr

Softwood Log Exports and the Value and Employment Issues, by David R. Darr (25)

The value and employment trade-offs involved in exporting versus logs domestic manufacture are only part of the broader debate over softwood log exports.

Direct employment per thousand board feet of logs processed in Washington and Oregon in 1973 was 4.72 man-hours for the log export industry, 12.58 for the lumber industry, and 19.47 for the veneer and plywood industry.

Relative export values were higher in 1970 and 1973; domestic values were higher in other years over the period 1965-73.



Softwood log exports from the Alaska, northern California, Oregon, and Washington Customs Districts, 1962-73.

The Morse Amendment and Federal Timber Sales, by John W. Austin (26)

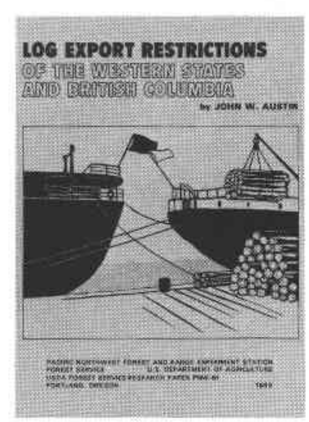
Log export from the West Coast has been a heated issue for several years. In recognition of this, Part IV of the Foreign Assistance Ace of 1968 (Morse Amendment) limited log exports from federal lands west of 100th meridian to not more than 350 million board feet. This amendment was due to expire on December 31, 1971, but the Housing and Urban Development Act of 1970 extended the export restrictions through 1973. This article provides some insight into how the Morse Amendment has been applied to U.S. Forest Service and Bureau of Land Management lands, and how it has been affecting the export of federal timber.

The Jones Act and the Douglas-fir Region Softwood Lumber Industry in Perspective, by John W. Austin and David R. Darr (27)

Because of the Jones Act, foreign flagships cannot be used for intercoastal shipment of lumber in the United States. As a result, British Columbia producers have a transportation cost advantage in competing with west coast U.S. producers for east coast markets. In the context of the total competitive environment between the two areas, however, other factors—especially stumpage price differences—may override this advantage. If exempted from the Jones Act, Pacific Northwest softwood producers would have to prepare for assemly of cargo and development of east coast markets to take full advantage of lower-cost foreign flag vessels. Evaluation of the impact of the Jones Act should be within the context of the Act's objectives, the need for waterborne as opposed to other transportation modes, and the market forces which determine competition with British Columbia.

Log Export Policy: Theory vs. Reality, by Thomas E. Hamilton (28)

A good, short summary of some of the issues and policies involved in the log export question, a situation too complex to summarize quickly. Hamilton indicates in summary that our policies should be directed toward long-term achievement of whatever goals are deemed most important, an approach that would prevent short-term actions undertaken only after a problem has become serious.



LOG EXPORT RESTRICTIONS OF THE WESTERN STATES AND BRITISH COLUMBIA

by JOHN W. AUSTIN

Log Export Restrictions of the Western States and British Columbia, by John W. Austin (29)

The volume of logs exported from the Pacific Northwest has been widely publicized in the past few years. These exports, with the strong domestic market for wood products, have resulted in increasing demands on the Pacific Northwest's timber resources. In response to these pressures, various log export restrictions and primary manufacturing requirements for timber products have been proposed and enacted. This paper presents the main provisions of these export restrictions.

is a slow process which only moves small amounts of chemicals short distances through the ecosystem. In addition, overland flow seldom occurs. Most of the herbicide which is applied eventually enters the forest floor where microorganisms degrade the herbicides to harmless material in a short time.

Fertilization is another chemical use which is increasing rapidly on forested lands. Dr. Duane Moore, a colleague of Norris, points out that between 1963 and 1969, over 90,000 acres were fertilized in western Oregon and Washington. This increased to 100,000 acres a year by 1971 and the rate continues to climb. Fertilization contributes to increased growth rates helping to meet the demand for wood fiber.

Are we involved in a trade-off between increased wood fiber and decreased water quality? This question was studied on the South Umpqua Experimental Forest in southwestern Oregon and at 28 other sites in western Oregon and Washington which have received urea fertilizers.

Moore reports that these applications have not resulted in toxic chemical levels during the first year following treatment. It's important to note that all of the fertilizer levels measured by Moore in forest streams were well within the limits established as acceptable for human consumption. The information presently available is only preliminary and does not answer all the questions. Moore says that "more complete information is needed on the effects of forest fertilization on the total nitrogen budget, mobilization, movement, and nutrient cycling before we can totally define the nature and extent of the impact of fertilizer on the forest environment."

The necessity for managed forests will increase as the demand for wood fiber and other forest products increases. It's safe to assume that the number of acres treated with chemicals will continue to grow. At the same time, the public has a right to know that the treatment of forest environments will not violate public health standards and create health hazards. The research of the Managed Forests Watershed Unit at the Forestry Sciences Laboratory is contributing to the knowledge necessary to meet forest products demand and insure a healthy environment.

end

next "insight" page 31

Price Impacts of Log Export Restrictions Under Alternative Assumptions, by Richard W. Haynes (30)

What effect would a ban on log exports have on the price of softwood lumber and stumpage? The answer to that question is explored in a 1976 report, given various assumptions about the market for softwood lumber.

The author says that following a ban on log exports, western softwood lumber prices would either decrease as much as 16 percent or increase by as much as 17 percent depending on the direction of the supply shift.

The equivalent changes in the stumpage market would be 26 and 29 percent, respectively.

U.S. Forest Products Trade Policies: What are the Options? by David R. Darr (31)

Analysis of U.S. trade policy necessarily involves many sensitive issues. The author's evaluation of these issues may not correspond with U.S. Forest Service or other federal policy. The author has prepared this paper because of the wide interest in the subject matter. It is intended for use as a background report and should interest members of the forest products industries and others who are affected by forest products trade policies.

Trade and other policies are being considered by the U.S. Forest Service according to the terms of the Forest and Rangeland Renewable Resources Planning Act of 1974. This paper describes the issues involved in the question, "Should we or should we not attempt to reduce net imports of forest products?" There is no clear rationale, either in theory or in existing U.S. trade policy, for balancing imports and exports of a commodity.

In terms of volume, net imports of forest products amount to about 12 percent of U.S. consumption. The value of imports exceeds the value of exports by about $1.5 billion. Most of U.S. softwood imports come from Canada and hardwoods from South Korea, Taiwan, Japan, and the Philippines. Japan and the Common Market countries are the major markets for U.S. forest products exports.

Without a change in trade policy, net imports of forest products may increase. Constraints on options for increasing exports or decreasing imports limit the feasibility of policies designed to change existing and expected trade patterns.

The author suggests that policies should be weighed in terms of their effects on both international and domestic goals. Most effects of changes in either import or export policies would be due to increases in the relative prices of forest products.

allowable cuts

Sensitivity of Allowable Cuts to Intensive Management, by Roger D. Fight and Dennis L. Schweitzer (32)

The Forest Service and the Bureau of Land Management are both using some form of even flow management to establish timber harvesting programs. These agencies are faced with several questions about the effects of growth-stimulating treatments, such as precommercial thinning, on the even flow production of timber resources.

The four most pressing considerations are: (a) How will the allowable cut be changed by growth-stimulating treatments? (b) Will the change in allowable cut equal the change in annual growth attributable to the treatment? (c) Will the cut continue to change in proportion to changes in annual growth as these successive changes are made? (e.g., as fertilization and genetics are added to precommercial and commercial thinning), and (d) How are answers to these questions affected by the volume and age-class distribution of initial inventory?

PNW researchers Roger Fight and Dennis Schweitzer evaluated regeneration periods, thinning yield, genetic improvement, fertilization, and changes in base acreage against the questions listed above in order to determine the effect on allowable cut.

In general, the results of the study indicate that allowable cut responds more to changes in long-term growth where there is a high initial inventory that can support a level of harvest above the growth in merchantable stands for a long period during which growth is building up.

This is just one of six conclusions reached in the report. The implications of this kind of research on long range resource management make this study a reading must for those involved in planning large-scale timber harvest programs.

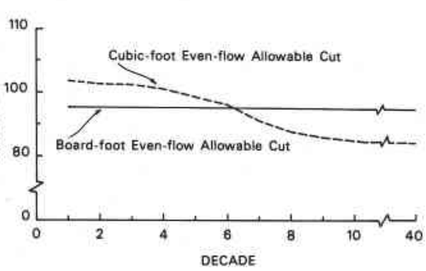
ACE, The Two-Edged Sword, by Enoch Bell, Roger Fight, and Robert Randall (33)

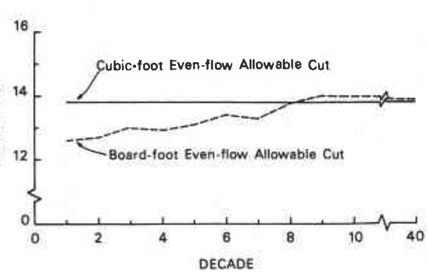
The potential for misusing ACE by applying it selectively for only one type of investment was recognized by PNW researchers Enoch Bell, Roger Fight, and Robert Randall. They demonstrated that ACE can sometimes drastically reduce the value of benefits especially those associated with fire, insect, and disease protection of old-growth inventories. They conclude that if ACE is used by an agency for evaluating investments of one type then it must be used for all investments. The authors point out that ACE, like the two-edged sword, can cut in both directions.

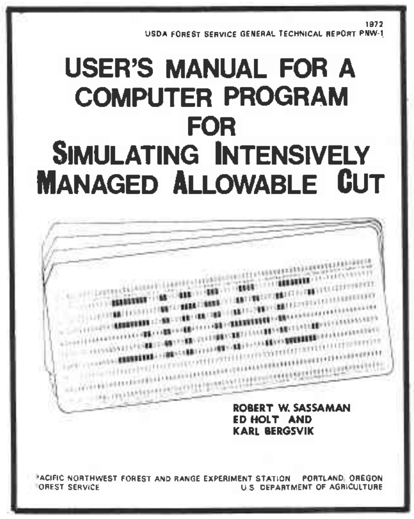
The allowable cut effect is clearly an important issue in forestry. However, its role in forest management and policy decisions is still in dispute.

What If We Calculate the Allowable Cut in Cubic Feet? by Roger D. Fight and Dennis L. Schweitzer (34)

According to PNW researchers, allowable cuts on federal lands are increased when timber harvest levels are computed in cubic feet. PNW researchers Roger Fight and Dennis Schweitzer have found that with smaller trees, we will have to cut more cubic volume in the future than in 1974 to recover an equal volume in board feet. This assumes that cubic-foot volume computations become the standard.







1972
USDA FOREST SERVICE GENERAL TECHNICAL REPORT PNW-1

USER'S MANUAL FOR A COMPUTER PROGRAM FOR SIMULATING INTENSIVELY MANAGED ALLOWABLE CUT

ROBERT W. SASSAMAN
ED HOLT AND
KARL BERGSVIK

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION PORTLAND, OREGON
FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

User's Manual for a Computer Program for Simulating Intensively Managed Allowable Cut, by Robert W. Sassaman, Ed Holt, and Karl Bergsvik (35)

This program presents detailed operating instructions for SIMAC, a computerized forest simulation model which calculates the allowable cut assuming volume regulation. for forests with intensively managed stands. A sample program, included in the publication, illustrates the required inputs and expected output.

Uncertainty in Timber Planning

Many people consider forestry a risky enterprise, partly because of the long waiting periods involved. Error in predicting future events is of particular concern when allowable cut levels are set for timber. Most timber planners treat estimates of growth and other factors as if they were known with certainty, but hedge their guesses by frequent replanning, keeping options open.

When plans are revised the cut may be adjusted up or down. If the social cost of a shift in one direction is expected to be greater than the cost of an equal change in the other direction, or if one direction seems more likely than the other, an explicit risk strategy may be appropriate. Some sources of social cost and several risk strategies are described in *Coping With Uncertainty—A Conceptual Approach for Timber Management Planning* by Bell and Fight (36).

Bob Sassaman

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mensuration

See also:
Silviculture
Timber Quality
Alaska

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Contents — Page

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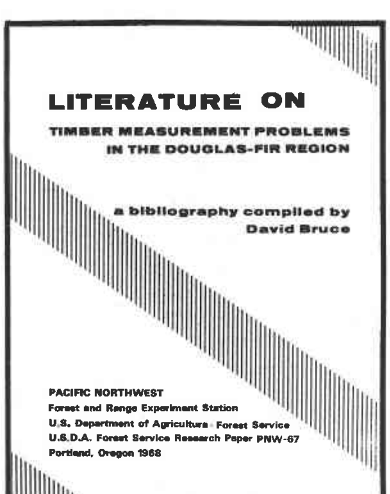
Background

The title of a popular book asks the question, "How Do You Spank a Porcupine?" The answer is, "Very carefully." This same answer applies to the techniques used to measure millions of acres of timber throughout the Pacific Northwest. Timber resources are constantly changing. Old-growth forests are providing timber in increasing amounts, and uses are being found for species previously neglected by the forest products industry.

The application of the techniques of computer science has had a profound effect on forest mensuration. The skillful use of computers has made possible the analysis of a large volume of data. Researchers are now able to provide increasingly reliable data on tree growth. This has been used to update older, hand-computed growth and yield tables. Computers have also been used in the development of new mensuration techniques.

PNW researchers have been involved in developing measurement techniques and volume estimates of timber potential for many years. Many of the products of their work—yield tables, volume equations, stem analyses, and log scaling techniques—are documented in this section of the Almanac.

Those who want a quick summary of research on forest mensuration in the Pacific Northwest should obtain a copy of the information leaflet, *Timber Measurement and Management Planning in the Northwest* (1). The objectives of forest mensuration research at the PNW Station include the development of improved techniques for accurately measuring forest trees, the prediction of timber yield through tree growth, the estimation of volume, the diversity of products wood fiber can produce, and the development of forest management plans.



Literature on Timber Measurement Problems in the Douglas-fir Region, a bibliography by David Bruce (2)

This 28-page bibliography, published in 1968, was prepared as part of an analysis of measurement problems in the Douglas-fir region of Oregon and Washington. It includes publications on the subject of tree and log measurement, with the exception of taper, volume and yield tables, and some standard forestry texts that made no specific reference to regional measurement problems. It also includes many publications that describe measurement systems or problems elsewhere in the United States and Canada and a few foreign publications that cover subjects not located in the American literature. A subject matter index is included.

Volume & Yield Tables

In 1969, PNW mensurationist Robert O. Curtis stated that the objective of yield studies is to predict stand development as affected by the passage of time, and by site and cultural treatment. "Normal yield tables no longer meet our needs. . . . We need yield tables for managed stands," he said (3). Curtis points to the need for alternative approaches to the development of managed stand yield tables based, in part, on measurement of yield over a period of time.

New publications, with current measurement data, are now replacing older volume tables (4). These studies represent a wide range of species and span the Pacific Northwest and Alaska. Volume equations have been published for second-growth Douglas-fir (5); old-growth western redcedar and Alaska-cedar in southeast Alaska (6); white spruce, balsam poplar, and paper birch in the Kuskokwim River Valley in Alaska (7); and red alder (8).

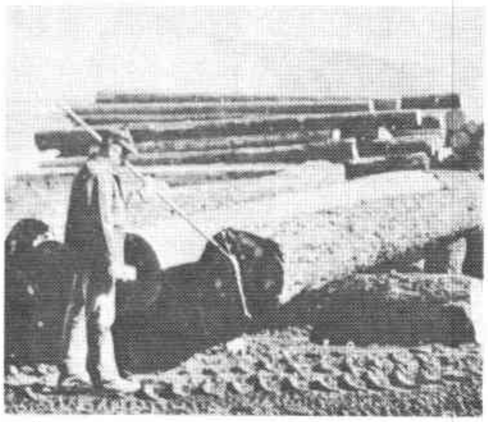
Studies of timber yield exist for red alder (9), western hemlock (10), ponderosa pine (11), different age and stand compositions of Douglas-fir (12), central Oregon lodgepole pine (13), and well-stocked white spruce stands in Alaska (14).

In 1968, David Bruce and Robert W. Cowlin took an overall look at forest mensuration in the Pacific Northwest, in a publication titled, *Timber Measurement Problems in the Douglas-fir Region of Washington and Oregon* (15). The outcome of interviews and conferences with over 120 forest managers and timber producers indicated that a great deal of confusion existed in the field of forest measurement.

The authors found that the Scribner rule, which assigns little volume to small trees or logs, is not well adapted to estimating the value of second-growth stands. In addition, log scaling without taper allowance makes conversions to any other unit of volume inaccurate.

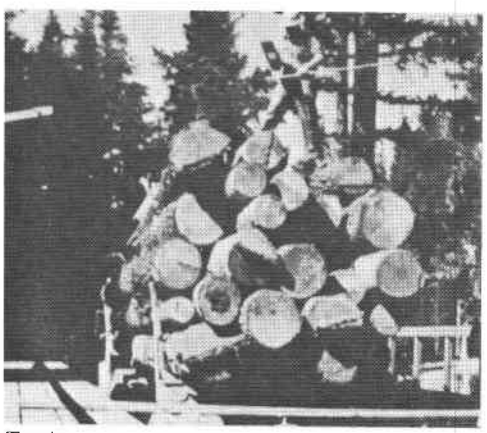
The researchers also found that the estimation of grade and defect is based to a large extent on subjective judgment and that different defects reduce yields of various products to different degrees. Most volume estimates for standing trees depend on volume tables that have an undetermined bias and unspecified errors. To compound this problem, the authors state that "When cruising standing trees, sellers cannot predict accurately the utilization and bucking lengths and, hence, the probable scale."

Each one of these observations contributes to a picture of confusion which could lead to economic loss. In summary, the authors state that the timber industry is faced with the need for a method to accurately determine the value of each log for alternative products. Such a system is still in the process of development.



Rollout or yard

Water



Truck

Log scaling conditions

A Method of Estimation of Gross Yield of Douglas-fir, by Robert O. Curtis (16)

This paper presents a method of estimating gross yield of forest stands and some estimates of gross yield of unmanaged stands of Douglas-fir. It is based on assumptions, techniques, and basic data that differs from those used in previous work.

Possible uses include: (a) comparison of potential yield of alternatives species, (b) indication of yield which may be obtainable with intensive management and nearly complete salvage of mortality, (c) evaluation of effect of variable on the rate of wood production, and (d) comparison of hypothetical management regimes.

The Cubics are Coming: Predicting Product Recovery from Cubic Volume, by Thomas D. Fahey and Richard O. Woodfin, Jr. (17)

If the standard measure for selling timber becomes the cubic foot rather than the board foot, the advantages will far outweigh the inconveniences and a further change to metric units will be facilitated. Much of the published grade-yield and product-recovery information contains cubic volume data that will be very useful in the transition period. The important values are product recovery factor, product recovery ratio, and the relationship of product measure to cubic feet of products recovered. This report defines and shows how to calculate and use these factors.

Forest Survey

The problems of forest mensuration are best observed in the area of forest survey. The data gathered by inventory crews eventually forms the foundation for forest management policy on most levels of ownership. PNW researcher Melvin E. Metcalf said that, "The fundamental objective of the inventory is to provide the information needed to make choices and decisions regarding future policies and programs" (18).

Survey is usually a process of estimation and estimation is subject to error. For this reason, PNW researchers and others are concerned with designing survey methods and mathematical models which will help minimize error (19).

Bob Curtis

THE FOREST AND THE TREES
by Thomas Michael Baugh

Timber covers much of Alaska, from the beautiful offshore islands in the southeast portion of the state through the dense coastal area to the forest of the interior.

Wood from these forests was used by early man for tools, warmth, and dwelling places. It wasn't until the middle part of the present century that industrial consumption began to make significant use of the timber resource.

Early-day forest management has been described as custodial, with an emphasis on forest protection. Little was known about the factors involved in the regeneration and growth of Alaska's forest trees. In 1948, a Forest Research Center was established by the Forest Service at Juneau. Twenty years later the Juneau facility, renamed the Forestry Sciences Laboratory, and the Institute of Northern Forestry at Fairbanks became administrative units of the PNW Station.

In the past 27 years, researchers have made significant progress in understanding the complex worlds of the Alaskan forests. The research picture is by no means complete and perhaps never will be. However, the gaps in a basic understanding of the ecosystem are gradually being filled in.

The key to understanding the forests of Alaska lies in the fact that the coastal forests and the interior forests are two separate worlds. The 13 million forested acres of coastal Alaska are characterized by magnificent stands of Sitka spruce, western and mountain hemlock, western redcedar and Alaska cedar. These forests are extensions of the coastal rain forests of Oregon, Washington, and British Columbia. This is in contrast to the 106 million acres of mixed white and black spruce, paper birch, aspen and balsam poplar found in the interior.

The coastal forests hold about 86 percent of the total commercial sawtimber volume in Alaska, averaging more than 30,000 board feet per acre and ranging anywhere from 8,000 to more than 100,000 board feet. Timber volumes in the interior are lower, with an estimated 22½ billion board feet of commercial sawtimber averaging slightly over 3,000 board feet per acre.

Multiresource Surveys

Traditionally forest survey has dealt with several variables of measurement such as timber volume, growth, etc. The trend today, however, is to the multiresource survey where other forest resources are assessed.

According to PNW researcher John W. Hazard, "The problem then becomes one of how to deal with multipurpose surveys—how to coordinate information needs and how to design the survey to meet these needs efficiently" (20). Hazard proposes a sampling system which will optimize the multiresource inventory and discusses some of the factors which will increase the efficiency and reliability of sampling.

John Hazard

Allocation of Resource Uses

Robert E. Buckman and Roger D. Fight raise a question which is a key to the conflicts which arise when natural resources are allocated through a resource management planning process (21). According to the authors, "The central question around which most major resource conflicts revolve is: Which benefits will be produced? The question of who will receive the benefits and who will pay the costs is seldom raised." The authors feel that this situation develops because "what is produced" largely determines who will benefit. For example, the "production" of wilderness, through the allocation of large tracts of land to the wilderness preservation sysem, will obviously benefit those who use wilderness. According to the authors, resource inventory data must be viewed as just one step in the process of resource decision-making and must be "fully integrated" with other phases of the decision-making process through cooperative efforts with other disciplines.

The debate and concern with the use of inventory data in the management and allocation process will probably continue for some time with each interested party trying to claim a bigger piece of the resource pie. High level resource management decisions, however, will continue to be based, in part, on the data produced in the process of measuring the existing resources.

Research Profile

PNW scientists have completed a wide range of studies in order to provide a better data base for both volume and yield estimates. The publications briefly reviewed below are helping to increase the standardization and reliability of forest mensuration.

Estimating Volume of Douglas-fir Butt Logs, by David Bruce (22)

A new equation to provide a close estimate of the cubic-foot volume of flaring butt logs. This equation takes the guessing out of previous methods by introducing measurements of log length, top diameter inside the bark, and butt diameter inside the bark.

Volume Tables vs. Dendrometers for Forest Surveys, by John W. Hazard and John M. Berger (23)

Volume data measured from trees by using a dendrometer is more reliable than volume data estimated from volume tables which are based on Behre's equation of tree taper.

Considerations and Problems in Determining Volume Growth of Individual Trees, by Donald L. Reukema (24)

This study, based on field research, provides comparisons of the problems encountered with the various measurement systems used to compute tree growth.

Some Transformations of the Behre Equation of Tree Form, by Donald Bruce (25)

Methods of modifying the basic Behre equation for use with various top diameters. A valuable set of formulae for those who have to measure merchantable volumes to top diameters which do not appear in published tables.

Potential Production in Thinned Douglas-fir Plantations, by David Bruce (26)

Each year the number of intensively managed Douglas-fir stands in the Pacific Northwest increases. Intensive management has been practiced in Europe for a much longer period than in North America. This study reviews data gathered from European plantations and demonstrates that major gains in production can be expected from intensive management.

Photo Stratification Improves Northwest Timber Volume Estimates, by Colin D. MacLean (27)

The data from both photo and field plots, when used together, is twice as efficient as simple field sampling in estimating the total timber volume from a forest inventory.

Photo Plot Bias, by Robert B. Pope, Bijan Payandeh, and David P. Paine (28)

In a study of photo intensity (the number of aerial photos per unit of land surface), researchers found that lands that were primarily nonforest had more photos per unit of area that did forest lands. This may cause a serious source of bias in any forest inventory when photo plots with an equal number of plots per photo were used. This problem can be avoided by transferring plot locations from maps to photos.

3P Sample Log Scaling, by Floyd A. Johnson, James B. Lowrie, and Martin Gohlke (29)

The 3P sample selection procedure was originally developed for timber cruising but has now been applied to log scaling. As used, the scaler quickly guesses the small-end diameter and length of each log in the group of logs in which the estimate of total volume is required. The two estimates are then translated to gross log volume using the Scribner Decimal C log scale. The estimated gross volume is compared with a random number from a specially prepared set of random numbers. If the random number is greater than the guessed gross volume or if the random number is zero, the guess is recorded and the log is passed by. If the random number is less than or equal to the guess, but not zero, the log is carefully scaled for both gross and net volume.

This method looks promising for some scaling situations and may prove less expensive than sample log scaling methods now in use.

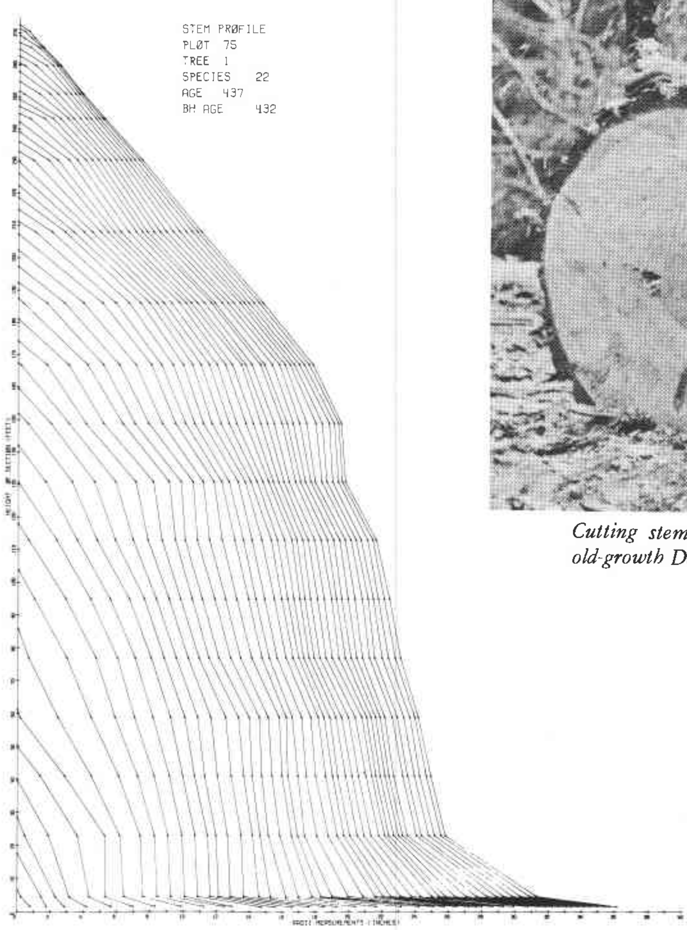
Effect on Diameter Estimates of Rounding Rules in Scaling, by David Bruce and Donald J. DeMars (30)

West of the Cascades, the scaling practice is to drop fractional inches and use the next lower full inch of diameter. East of the Cascades, diameters are scaled to the nearest inch. The difference in the two scaling procedures obviously contributes to a difference in recorded volume. This paper suggests two ways to eliminate the biases introduced by the two systems presently in use.

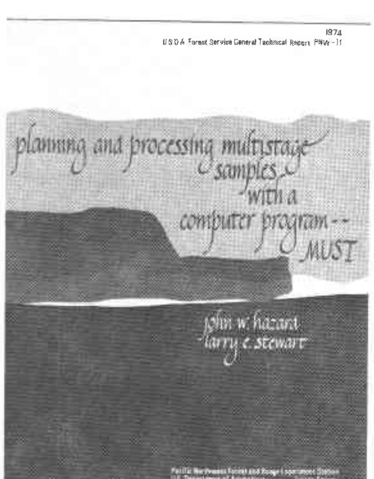
Field and Computer Techniques for Stem Analysis of Coniferous Forest Trees, by Francis R. Herman, Donald J. DeMars, and Robert F. Woollard (31)

A comprehensive publication which describes both field and computer methods of stem analysis. Field instructions include a step-by-step explanation of tree cutting, sectioning, ring count, and measurement techniques. The last half of the publication presents a computer program which calculates the height, age, site, and index, gives instructions for punching this information on cards, and plotting height, age, and stem profile graphs.

Cutting stem section disk from old-growth Douglas-fir.



Computer-produced stem profile chart for noble fir with a breast-height age of 432 years.



Planning and Processing Multistage Samples with a Computer Program —MUST, By John W. Hazard and Larry E. Stewart (32)

Here's a computer program which handles multistage samples up to three stages. The program is based on MUST (multistaged sampling) and provides three different options for the computation of different levels of data.

Part of the reason for this difference lies in the average age of timber stands in the interior and along the coast. The coastal forests are composed of a large volume of old-growth, while the interior forests are much younger, due to frequent summer wildfire. The major difference in sawtimber volume is related to the productivity of the land and this is based on differences in climate and soil.

In general, reforestation in the coastal forests of southeastern Alaska occurs naturally. The process of stand regeneration is well understood. Conifer seedlings which escape logging and seed from nearby trees combine to produce the new stand. The removal of shade from the logged overstory increases ground temperatures, light, and biological soil activity. Researchers have found that the open conditions created by clearcutting favor the growth of Sitka spruce. For this reason, the percentage of spruce seedlings is higher in clearcut areas than in old-growth forests.

Initial growth is relatively slow and it may take up to 10 years for a clearcut to green up. In one experimental area, dominant hemlock averaged 24 feet in height and dominate spruce 15 feet in height within 15 years following logging. Crown closure begins to occur sometime between 15 and 20 years. This is about the time the spruce and hemlock stands begin to reach their maximum growth rate. The volume of wood produced by a normally stocked stand 30 years old is expected to average 3,800 cubic feet of wood per acre. The same stand at age 50 has almost doubled its wood volume to 7,275 cubic feet.

Most researchers agree that for hemlock-spruce stands, clearcutting is the preferred harvest system both from the point of view of silviculture and economic necessity in the high-cost Alaskan economy. Al Harris of the Forestry Sciences Laboratory in Juneau feels that clearcutting will remain the most important silvicultural system in the future but that shelterwood and selection systems will increase in importance in managed stands.

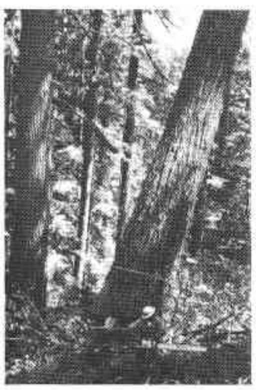
Regeneration is only one of several silvicultural programs currently underway in southeast Alaska. Other studies focus on stand density, wind-throw, and the relationship of logging systems to anadromous fish production and rearing.

New Trends

Timber cruisers, working for the Bureau of Land Management, are using the fall, buck, and scale (FBS) system to estimate timber volume. This system is explained and analyzed in the September 1972 issue of the *Journal of Forestry* (33).

Under FBS cruising, sample trees are felled and bucked by either contract or hired loggers. The cruisers are under certain restrictions which vary depending on local industry requirements, but otherwise buck to optimize tree value. BLM scalers then tally gross length and diameter for each log along with log grade and defect deductions in terms of length and character.

The FBS system reduces the inaccuracy of timber data caused by cruising standing timber which is subject to breakage and hidden defect.



Falling

Bucking

Scaling

Predicting Wood Volumes for Ponderosa Pine from Outside Bark Measurements, by P.H. Cochran (34)

Since the STX-FORTRAN computer program is widely used, investigators involved in measurements of bark thickness should be aware that perhaps other equations may more accurately describe variations in ratios of the diameter inside of the bark to the diameter outside of the bark along the boles of trees. The author analyzes assumptions and equations in common use and suggests a new approach to enhance accuracy.

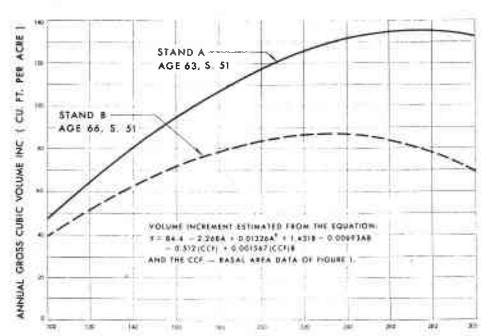
The author states that assumption of a constant diameter inside bark to diameter outside bark ratio along the bole of ponderosa pine results in an underestimate of wood volume determined from optical dendrometer measurements in the STX program. This ratio generally increased up the stem to a given diameter outside bark to diameter breast high outside bark ratio that varies with tree size and then decreases to the tip. Equations describing this change in bark thickness can be incorporated into the STX program. Resulting estimates of diameters inside bark, volume segments, and whole tree volumes are closer to true values than estimates derived by the constant ratio assumption.

Preliminary Site Index Curves for Noble Fir From Stem Analysis Data, by Donald J. DeMars, Francis R. Herman, and John F. Bell (35)

Stem analysis studies are available as background information for managing the upper-slope forest complex. The studies include data for old-growth noble fir as well as other species associated with noble fir. The polymorphic site index curves presented in this report provide reliable estimates of site index for noble fir found between McKenzie Pass in Oregon and the White River drainage of Mount Rainier in Washington.

Relationship of Lodgepole Pine Volume Increment to Crown Competition Factor, Basal Area, and Site Index, by Walter G. Dahms (36)

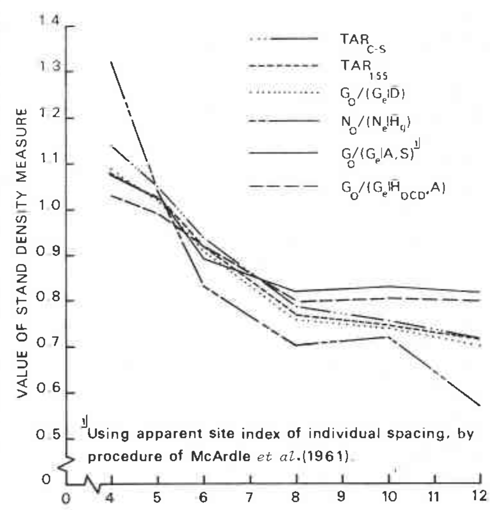
Stand density control may be the forester's most important tool for attaining specific management objectives. In this paper the author discusses the relationship of crown competition factor with the gross cubic foot volume increment for lodgepole pine. This relationship is developed first with site index and then with basal area as the measures of site quality.



Relation of gross cubic volume increment to crown competition factor (CCF) for two stands.

A Tree Area Power Function and Related Stand Density Measures for Douglas-fir, by Robert O. Curtis (37)

How do different measures of stand density compare? PNW Principal Mensurationist Bob Curtis compared numerical values of alternative measures of stand density for three sets of Douglas-fir data. He found that a simple sum of diameters to a suitable power, without reference to other stand characteristics, provided the simplest diameter based measure of stand density.



Comparison of stand density measures for data of the Wind River plantation spacing test, age 42.

Stand Density Measures: An Interpretation, by Robert O. Curtis (38)

Most common measures of stand density are closely equivalent. In general, stand density measures are considered as expressions of the average area available to the trees of a stand. Differences in stand density measures usually occur through the introduction of factors such as stand diameter, height, and volume.

Height Growth and Site Index for Douglas-fir in High Elevation Forests of the Oregon-Washington Cascades, by Robert O. Curtis, Francis R. Herman, and Donald J. DeMars (39)

Height and site index curves for Douglas-fir at high elevations differ from the patterns shown by this same species at lower elevations in the Oregon-Washington Cascades.

According to this report, site index estimation procedures and growth information derived from lowland Douglas-fir are not applicable to high-elevation forests.

This report presents a series of new curves which are applicable to Douglas-fir at high elevations.

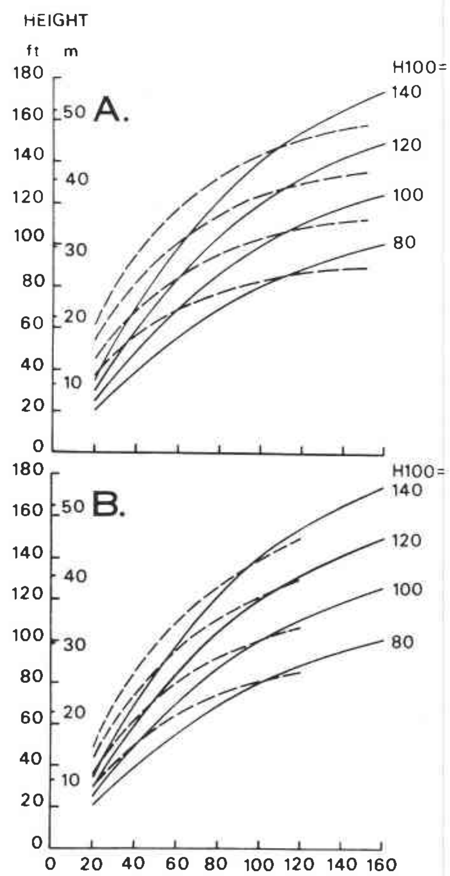
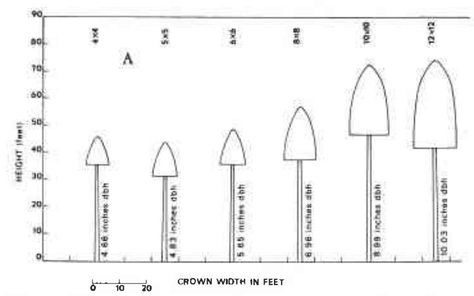


FIGURE 6. *Comparison of shape of new height growth curves for Douglas-fir in high-elevation forests (solid lines) with that of earlier curves for lowland Douglas-fir stands (dashed lines): A, Comparison with curves of McArdle et al. (1961); B, comparison with King (1966).*

Colin MacLean

Crown Development and Site Estimates in a Douglas-fir Plantation Spacing Test, by Robert O. Curtis and Donald L. Reukema (40)

Relationships between stem and crown dimensions of Douglas-fir were examined 43 years after planting. The study took place on Site IV land where initial spacings were from 4x4 through 12x12 feet. The results of the study indicated that average dbh, height, and crown dimensions of the largest trees of comparable crown classes all increased consistently with an increase in initial spacing. In addition, the researchers found that high initial density in low-site stands can lead to serious underestimates of potential productivity.



Comparisons of height and crown dimensions of average trees (quadratic mean dbh) of specified stand components, by spacings, 1965-67 data. (A) all trees 1.5 inches and larger dbh.

Estimating Dunning's Site Index From Plant Indicators, by Colin D. MacLean and Charles L. Bolsinger (41)

It is difficult to measure site index on sites where selective cutting has previously removed all or most trees. For areas such as these in California an alternative method of arriving at site index has been proposed using the occurrence of indicator plants and physical variables.

According to the authors, the system uses four simple equations and requires the ability to identify about a dozen shrubs, herbs, and grasses.

Which Dependent Variable in Site Index-Height-Age Regressions? by Robert O. Curtis, Donald J. DeMars, and Francis R. Herman (42)

Here is a paper which discusses the basic concepts and objectives of site index curves. A survey of the literature indicates that two possible systems of curves exist. The first is based on height growth curves corresponding to the regression of height on age and site index. The second system relates site index estimation curves to the regression of site index on height and age. However, the authors point out that these are not the only possible site index concepts and that the optimum method of curve construction depends on the concept adopted and the intended application.

At present, there is a developing timber industry in the interior. Several mills are now in operation, producing lumber for home use and cants for export to overseas markets. This infant industry may be the harbinger of things to come.

It is difficult to separate silviculture from fire when discussing interior Alaska. Fire is the single most important factor in maintaining the vegetational mosaic found throughout much of the interior. The occurrence of wildfire and the immense areas burned contribute to both the frequency and geographical distribution of many tree species.

White spruce is presently the most important commercial species, although the hardwoods show a strong potential for future development. John Zasada, of the Institute of Northern Forestry, has found that the soil requirements for white spruce regeneration include a mineral soil seed bed. The amount of regeneration is greater when scarification is used for site preparation. Zasada has found that clearcutting and shelterwood are equally effective in producing regeneration. However, clearcutting allows more light and heat to reach the soil and may produce more rapid initial seedling growth and establishment. Zasada feels that his research has demonstrated that natural regeneration is generally sufficient to reforest logged stands at present levels of use.

Hardwood research is in its initial stages in interior Alaska. Research plots have been established to investigate the regeneration of birch, poplar, and aspen. Zasada feels that the life cycle of these species in the interior will be similar to that found throughout the rest of their Northern Hemisphere range. Research concerning the hardwoods will become increasingly important as these species enter the developing commercial markets for interior timber.

Alaska is entering a period of growth and expansion. The anticipated division of lands between native corporations and local, state, and federal jurisdictions points to the need for expanded research programs. The research already underway is just a small part of that necessary to insure the wise use of Alaska's forest and related resources.

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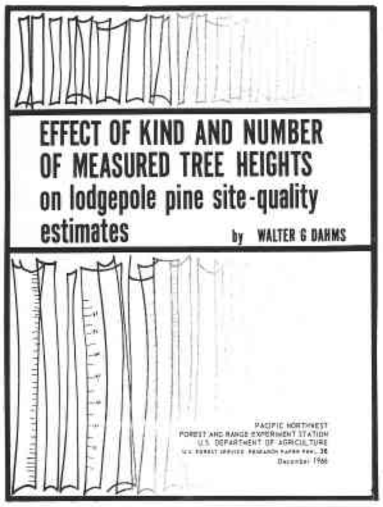


Effect of Kind and Number of Measured Tree Heights on Lodgepole Pine Site-Quality Estimates, by Walter G. Dahms (43)

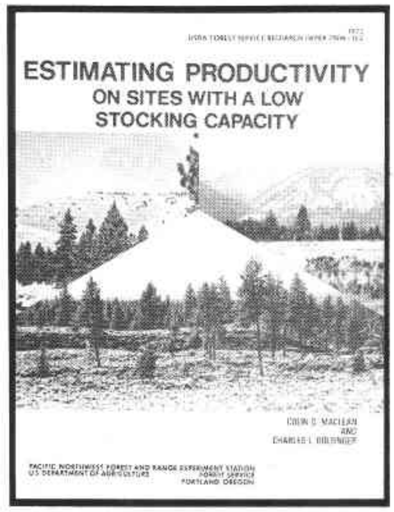
Site index based on tree height and age has become the most widely used method of estimating forest site quality. This paper discussess the relationship between kind and number of tree heights used and the reliability of the resulting site-quality estimates for lodgepole pine.

Productivity Indices for Lodgepole Pine on Pumice Soils, by C.T. Youngberg and W.G. Dahms (44)

In central Oregon, an area characterized by immature or weakly developed soils, productivity for lodgepole pine could not be delineated by soil series alone. Researchers have found that stratifying stands on the basis of understory plant communities provides a better indication of productivity than does stratification on the basis of soil characteristics.

Correction for a Possible Bias in Developing Site Index Curves from Sectioned Tree Data, by Walter G. Dahms (45)

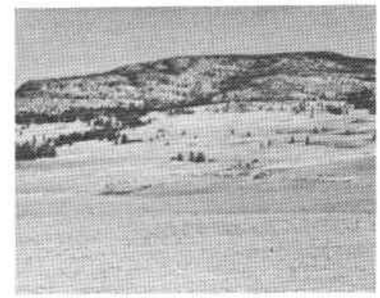
The most serious objection to constructing site index curves with stem analysis methods is that height growth of individual trees does not necessarily represent height growth of stands. Individual trees usually do not retain the same relative height in a stand throughout life. In this paper, researcher Walter Dahms has developed a method of stem analysis for deriving stand height growth from individual tree height growth that is free from the error caused by changes in relative height of trees.



Estimating Productivity On Sites With A Low Stocking Capacity, by Colin D. MacLean and Charles L. Bolsinger (46)

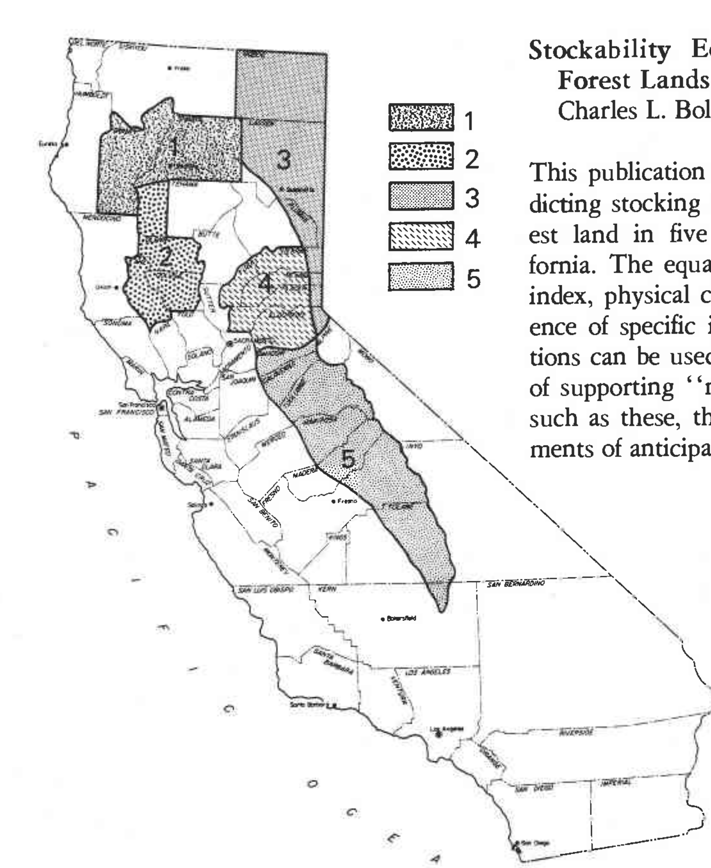
In most areas, normal yield tables are the only tools available for estimating timber productivity and establishing stocking standards. However, the stocking capacity of naturally sparse stands in the arid West is often lower than was found in stands sampled by the makers of normal yield tables. Normal yield table estimates, therefore, may indicate high productivity and understocking for stands that are really well stocked but not very productive.

Several methods are available for estimating productivity on sites of this nature. The first method is to develop factors to discount the normal yield tables in habitat types where a stocking limitation exists. The second method, for areas where habitat types have not been classified, is to predict stocking capacity from multiple regression equations based on site index, elevation, and the presence of indicator plants.



Ponderosa pine on the Colville Indian Reservation growing near the lower limits of occurrence. Stands such as this are naturally sparse.

Jeffrey pine growing on serpentine (peridotite soil) north of Grants Pass, Oregon.



The five geographic areas in California sampled for this study.

Stockability Equations for California Forest Lands, by Colin D. MacLean and Charles L. Bolsinger (47)

This publication presents equations for predicting stocking capacity of commercial forest land in five geographic areas in California. The equations are derived from site index, physical characteristics and the presence of specific indicator plants. The equations can be used to identify areas incapable of supporting "normal" stocking. In areas such as these, the equations provide adjustments of anticipated timber yields.

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resource evaluation

See also:
Mensuration
Alaska

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Forest Survey

The forest survey is one of the oldest research projects in the Forest Service, having been authorized by the McSweeney-McNary Act of 1928. In fact, the forest survey began in 1930 in the Douglas-fir region west of the Cascade Range in Oregon and Washington.

Every year since then, field crews have taken to the woods during the summer to sample and measure the trees. Today, the responsibility of the forest survey has been expanded to include the assessment of other forest resources as well as timber. Under the Forest and Rangeland Renewable Resources Planning Act of 1974, the Secretary of Agriculture is directed to collect, analyze, and report information about all the renewable resources.

The PNW Experiment Station has responsibility for resources evaluation in five states: Washington, Oregon, California, Alaska, and Hawaii. Forest survey information for Alaska will be found in that section. Survey data for Hawaii is published through the Pacific Southwest Forest and Range Experiment Station. Write the Director, PSW Station, P.O. Box 245, Berkeley, California 94701.

Survey data are currently being published by survey units rather than by counties. Survey units for the state of Washington have not yet been determined as the inventory design for that area is currently (1977) being developed. Units for which reports will be published include the following:

California

North Coast: Del Norte, Humboldt, Mendocino, and Sonoma Counties

Central Coast: Contra Costa, and Monterey and Santa Cruz Counties

Northern Interior: Lassen, Modoc, Shasta, Siskiyou, and Trinity Counties

Sacramento: Butte, El Dorado, Nevada and Placer, Plumas and Sierra, Tehama, Yuba, and Glenn, Lake, and Sacramento Counties

San Joaquin: Fresno, Madera and Mariposa, Tulare and Kern, Tuolumne, and Amador, Calaveras, and San Joaquin Counties.

Oregon

Northwest Oregon: Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties

West-Central Oregon: Benton, Lane, Lincoln, and Linn Counties

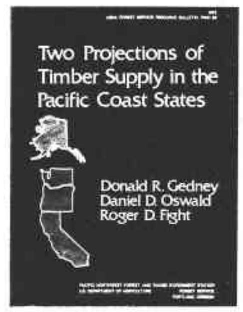
Southwest Oregon: Coos, Curry, Douglas, Jackson, and Josephine Counties

Central Oregon: Crook, Deschutes, Gilliam, Jefferson, Klamath, Lake, Sherman, Wasco, and Wheeler Counties

Blue Mountain: Baker, Grant, Harney, Malheur, Morrow, Umatilla, Union, and Wallowa Counties

Over the years, dozens of reports have been produced by the survey group. As a result, many are outdated or have been superseded by later publications. Only the most current are reviewed here. A list of other major reports that should still be available is found in the bibliography at the end of this section.

timber supply



Two Projections of Timber Supply in the Pacific Coast States, by Donald R. Gedney, Daniel D. Oswald, and Roger D. Fight (1)

If the recent level of forest management continues, softwood timber supply will decrease in the Pacific Coast states from the 1970 level of 24.9 billion board feet to 20.8 billion by the year 2000. The projected decrease for fiber is less, from 3.8 billion cubic feet in 1970 to 3.4 billion by 2000.

These trends are not shared equally by each state. In coastal Alaska, a substantial increase is projected. In eastern Oregon and eastern Washington, there is an immediate decrease in supply, then a continuous recovery. In California, western Oregon, and western Washington, the trend is downward.

The second projection takes into account the fact that forest management could be intensified to help increase timber yields. More intensive management, with an investment of $469 million on 6.7 million acres would increase total harvest by 201 billion board feet over a six-decade period. However, only nominal increases would be available this century; 86 percent of the increase would occur between 2000 and 2030.

Changes in Commercial Forest Area in Oregon and Washington, 1945-70, by Charles L. Bolsinger (2)

Between 1945 and 1970, nearly 1 million acres of commercial forest land in Oregon and Washington were taken out of timber production and converted to other uses. Road construction was the leading cause, with urban and industrial expansion second. Other contributing causes were agricultural and powerline clearing, and construction of reservoirs.

An additional 362,000 acres of commercial forest were set aside in reserved areas for parks, wilderness, natural and botanical areas, and other reservations.

Changes in land ownership are also reported. During this time, there was an increase in national forest and forest industry land and a decrease in Indian and farmer-owned land.

Urban expansion is rapidly changing the character of the Puget Sound area in western Washington.

Hardwood Timber Resources of the Douglas-fir Subregion, by Melvin E. Metcalf (3)

Three species dominate the commercial hardwood scene in the Douglas-fir region. Red alder is the most important commercially and makes up nearly 58 percent of the board foot volume of all commercial hardwoods. Bigleaf maple and black cottonwood are next in importance. Other hardwoods that are used commercially include Pacific madrone, tanoak, and white oak.

Statistics are given for acreage by timber type, volume of growing stock, sawtimber, and landowner class.

The Land Base for Management of Young-growth Forests in the Douglas-fir Region, by Roger D. Fight and Donald R. Gedney (4)

The quality and quantity of young-growth stands that exist today will in large part determine future timber supply. This paper reports on the age, stocking, and site productivity of the existing forests in the Douglas-fir region. The data are essential for identifying treatment opportunities such as commercial and precommercial thinning, fertilization, and stand conversion. When combined with response data, assumed management regimes, and harvesting strategies, the data can also be used to project future forest inventories.

California's Forest Industries—Prospects for the Future, by Daniel D. Oswald (5)

California's timberlands and forest products industries have played an important part in the growth of the state's economy. Growth of early communities was dependent on the success of the mills and the demand for lumber.

Forest products industries are still a major factor in many local and some regional economies within the state. But a continually growing and diversified economy has meant less total dependence on timber resources. California's economy will continue to grow and with that growth will come increasing demand for wood products. But self-sufficiency in wood resources is no longer possible. The large areas of old-growth timber have declined and a further decline in log production—to 80 percent levels—is anticipated by the year 2000. Wood products from out of state will become increasingly important in meeting the anticipated growth in demand.

The history of the use of forest resource in California is discussed, trends are given in the forest products industry, and timber supply and employment are projected to the year 2020.

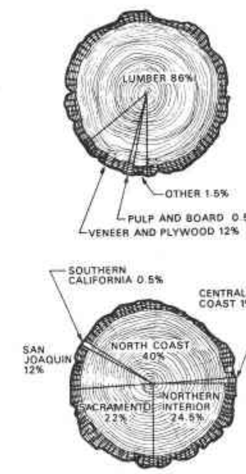
California Forest Industry Wood Consumption and Characteristics, 1972, by James O. Howard (6)

California is a major producer of many wood products. In 1972, California produced 5.6 billion board feet of lumber, 15 percent of the Nation's total. About 18 percent of the Nation's softwood lumber comes from California.

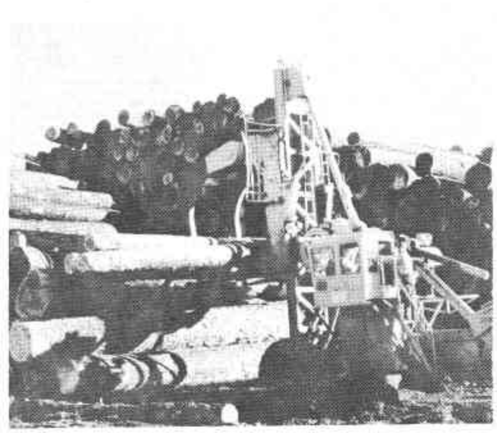
Dramatic changes have taken place in the forest industry in the post-World War II period. Prior to that time, the industry consisted almost entirely of sawmills, with redwood and pines the principal raw materials.

As a result of the post-war building boom and population growth, the sawmill industry increased rapidly—from 450 to almost 1,000 mills during 1945-48.

After 1947, the plywood industry increased rapidly from 20 million square feet production to a peak of 1,305 million in 1964. Up to 1964, Douglas-fir was the primary raw material for these mills. Other wood products industries—including pulp production and hardboard plants—have grown steadily. Today the trend is toward fewer but larger sawmills, increased production in the board industry, and more complex processing operations. Although the industry is still dominated by the sawmill sector, diversification is much greater than before World War II.



Distribution of roundwood consumption by industry and area, 1972.



Oregon Forest Industries, 1972, Wood Consumption and Mill Characteristics, by John P. Schuldt and James O. Howard (7)

This report presents the results of a survey of the primary wood processing industry in Oregon for 1972, and depicts mill characteristics, raw material inputs and residue production and disposition. Data in the survey are broken down for lumber plywood and veneer, pulp and board, shake and shingle, pole and piling, and export industries. This survey provides information on wood flows to industry from various sources, species, harvest areas, the volume of residue utilized, and the raw material requirements of the forest products industries in Oregon.

Reports on the Oregon forest industry are published every 4 years. In 1968, a similar survey was produced by the State Department of Forestry and the Pacific Northwest Forest and Range Experiment Station.

Oregon and Washington Timber Harvest Reports, by J.D. Lloyd, Jr.

The volume of timber harvested in Oregon and Washington is reviewed each year in a special 1-page bulletin from the Experiment Station. Order by year and state. For example, the latest reports are:

1974 Oregon Timber Harvest, Resource Bulletin PNW-63 (Revised), by J.D. Lloyd, Jr. (8) and

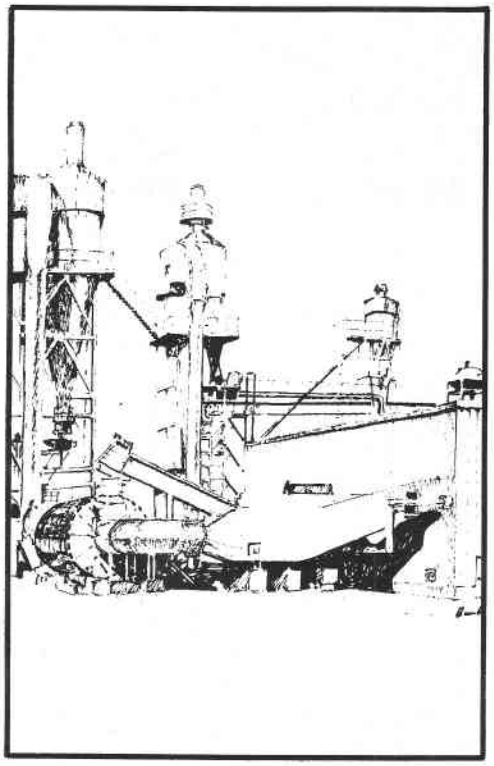
1973 Washington Timber Harvest, Resource Bulletin PNW-61, by J.D. Lloyd, Jr. (9)

Harvest data is given in board feet and compared to the previous year's figures. Statistics are also given for eastern and western portions of the states and by county for various ownerships: private, state, and federal.

Statistics are given for characteristics of the industry, log consumption, and disposition of mill residues. A descriptive analysis of current conditions and past trends is given. Reports on the California forest industry are published every 4 years.

Washington Forest Industry

Information about the forest industry in Washington state is available through the Department of Natural Resources in Olympia. Forest Service researchers have often been cooperators and co-authors of these reports, which are done every 2 years, but they have been published by the state.



forest survey reports

oregon

Timber Resource Statistics for Oregon, January 1, 1973, by Patricia M. Bassett and Grover A. Choate (10)

For an area as large as Oregon, a complete field inventory of the timber resources is not possible within a single year. Nor is it feasible to reinventory every year to maintain current statistics. But it is possible to make fairly accurate projections of the current timber situation using older data, and updating with computer models.

For this report, timber resource data from forest surveys since 1962 were updated to 1973 using a stand projection model, TRAS (Timber Resource Analysis System), used nationwide by the Forest Survey. Information is given for the national forests and Bureau of Land Management as well as three other ownership classes: other public, forest industry, and farmer and miscellaneous private.

GOLD LAKE BOG— AN OUTDOOR LABORATORY

by Thomas Michael Baugh

Gold Lake Bog is a strikingly beautiful place. It lies in a natural basin at the 5,000-foot elevation of the central Cascades in Oregon. Springs from the surrounding slopes drain into the basin creating moist conditions suitable for the perpetuation of a subalpine bog. Spruce, Douglas-fir, hemlock, and several species of pine and true fir surround the grassy meadows. Marsh plants grow in profusion along the banks of the bog and nearby Salt and Skyline Creeks.

Tons of volcanic ash and pumice were deposited in the basin over 6,000 years ago when Mt. Mazama erupted. Throughout the centuries, this ash has been converted into the soil which today nourishes the bog.

Beaver have dammed the streams and cut channels in the meadow grass. Bobcat, marten, fisher, fox, and other predators stalk their prey in the marshy bottoms. Flying squirrels leap from the surrounding trees while small mammals scurry in the brush and grasses below.

The climate of Gold Lake Bog is normally cool and wet. Summer temperatures are mild with highs in the mid-seventies occurring in July. In winter deep snows cover the land. The tracks of small animals wander along the streambanks in testimony to their passage through the hours of winter darkness. During the spring months the striking pink flowers of bog laurel splash the surrounding slopes with color.

Dr. James Kezer, professor of biology at the University of Oregon, was one of the first scientists to take note of the bog. He discovered the site while hiking in the area about 15 years ago and was impressed by the beauty of the location and the fascinating plants and animals. During that initial visit, Dr. Kezer recorded the presence of several specise of carnivorous plants and noted both the western spotted frog and the Cascade frog.

The interest of Dr. Kezer and others led to a movement to establish a special protectorate for the area. Mrs. Ruth Onthank, a citizen active in environmental causes, led the effort to preserve and protect the bog. She was supported by the Regional Forester for Region 6 of the Forest Service, and the Director of the Pacific Northwest Forest and Range Experiment Station. The effort was successful and in 1965 the Chief of the Forest Service formally established Gold Lake Bog as a Research Natural Area.

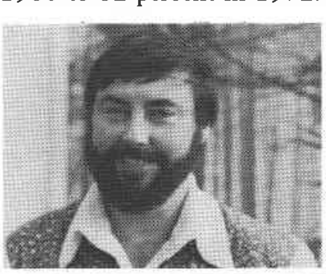
The Timber Resources of the Blue Mountain Area, Oregon, by Charles L. Bolsinger and John M. Berger (11)

This report summarizes the findings of the third inventory of the forest in Baker, Grant, Harney, Malheur, Morrow, Umatilla, Union, and Wallowa Counties in eastern Oregon. Fieldwork on lands outside the national forests was completed during the summer of 1969. The Wallowa-Whitman National Forest was inventoried in 1966 and 1967, the Malheur National Forest in 1967 and 1968, and the Umatilla National Forest in 1968 and 1969. Inventory of the Snow Mountain Ranger District of the Ochoco National Forest in Grant and Harney Counties was completed in 1967, and that of the Crooked River Working Circle in Grant County was completed in 1962.

The inventory indicates that there are about 47 billion board feet of sawtimber on 4.6 million acres of commercial forest land in the Blue Mountain area. Public agencies administer about 76 percent of the area and hold 89 percent of the sawtimber volume; farmer and miscellaneous private ownerships account for 16 percent of the area but only 6 percent of the sawtimber volume; and forest industries 8 percent of the commercial forest area and 5 percent of the volume. Total volume of timber and area of commercial forest land has declined about 10 percent since the mid-1950's.

Ponderosa pine is the most abundant species, accounting for 44 percent of the sawtimber volume. Douglas-fir accounts for 20 percent of the volume, with true firs and larch occurring in significant amounts.

Most of the available timber volume is in public ownership. Private timberland is largely cut over, with resulting low inventory volumes. Although total timber cut has remained at about the same level, the harvest from public lands has increased from 56 percent in 1960 to 82 percent in 1972.



Chuck Bolsinger

Timber Resource Statistics for Central Oregon, by John M. Berger (12)

Results of the third inventory of timber resources are summarized for the nine counties in central Oregon: Crook, Deschutes, Gilliam, Jefferson, Klamath, Lake, Sherman, Wasco, and Wheeler.

Field data for central Oregon were collected for all lands except the national forests during the summer of 1964. Data for the national forests were collected between 1957 and 1962.

Commercial forest land in the region totals 6,255,000 acres and makes up 35 percent of the land area. Growing stock volume totals 13,849 million cubic feet, with 82 percent of that in four species: ponderosa pine, lodgepole pine, white fir, and Douglas-fir.

Statistics are also given on sawtimber volume, by various forest ownerships, and for net annual growth, mortality, and average annual cut for the 5 previous years.

Timber Resources of Douglas County, Oregon, by C.D. MacLean (13)

Douglas County has 66 billion board feet of sawtimber—75 percent federally owned and 21 percent owned by the forest industry. Sixty percent of the private commercial forest land has been clearcut and an additional 20 percent partially cut. At the current rate of harvest, the private sawtimber inventory will not last 20 years.

Poor conifer stocking prevails on more than half the county's clearcut area. About one-third of the federal clearcut area, over half of the forest industry clearcuts, and over two-thirds of the other private clearcut lands are inadequately stocked with conifers. Many of the poorly stocked acres are on "tough sites" where planting is both expensive and uncertain of success.

About half the commercial forest area in the county is suitable for final or intermediate harvest. Another 20 percent is either nonstocked or partially stocked with conifers and needs planting or stand conversion. Many of the poorly stocked acres are now covered with brush or hardwoods. Four percent of the commercial forest land—all in nonindustrial private ownership—is brushy, nonstocked cutover on low site where treatment is not feasible because of high cost, low return, and the likelihood of failure.

Immature stands of conifer stock 22 percent of the county's commercial forest land. However, over half these stands would grow faster if excess competition were removed, either through cleaning of brush and hardwoods or through precommercial thinning.

washington

Timber Resource Statistics for Washington, January 1, 1973, by Patricia M. Bassett and Grover A. Choate (14)

For an area as large as Washington, a complete field inventory of the timber resources is not possible within a single year. Nor is it feasible to reinventory every year to maintain current statistics. But it is possible to make fairly accurate projections of the current timber situation using older data, and updating with computer models.

For this report, timber inventory data was updated to January 1, 1973, using a stand projection model, TRAS or Timber Resource Analysis System, a method used nationwide by the Forest Survey. In general, most information used in this report was updated from the 1970 estimates for *The Outlook for Timber in the United States* published by the Forest Service in 1973 (15).

The Timber Resources of the Inland Empire Area, Washington, by Hal A. Arbogast (16)

Statistics are given from the latest inventory of the timber resources of the 12 easternmost counties in the Inland Empire area of Washington.

The inventory indicates that there are 24 billion board feet of sawtimber on 3.9 million acres of commercial forest land. Public agencies administer about 56 percent of the area and 70 percent of the sawtimber volume, farmer and miscellaneous private ownerships account for 37 percent of the area but only 22 percent of the sawtimber volume, and industry 8 percent of the total commercial forest area and 8 percent of the volume.

Douglas-fir is the most abundant species, accounting for 30 percent of the sawtimber volume. Ponderosa pine accounts for 29 percent of the volume, with larch and true firs also occurring in significant amounts.

The forests of the Inland Empire are young, although the 12 percent of old growth is the principal source of timber for the area's forest industries. For the area as a whole, growth exceeds cut, with most of the growth on lands in farmer and miscellaneous private ownership. This imbalance could result in increased timber harvesting, depending on industry's willingness to process smaller timber from these types of owners and the individual owner's management objectives.

Forest Industries of Eastern Washington, by Brian R. Wall, Donald R. Gedney, and Robert B. Forster (17)

A sawmill, built in 1872, marked the beginning of the forest industry in eastern Washington—almost half a century after the emergence of the lumber industry in western Washington. Since then, this industry has increased in importance to eastern Washington's economy, now furnishing about one-fifth of the total manufacturing employment and wages paid—in some counties and many communities, it is the major source of employment and wages. In 1962, various forest products firms paid about $43 million in wages to more than 8,000 employees.

The forest industries are not only important to the whole economy of eastern Washington, but the health of these industries determines how intensively the forest resource can and will be managed. In order to inform those interested in the forest resource as well as those interested in the general economy of eastern Washington, the primary forest industries are examined in this paper; these include lumber, pulp, plywood, and a number of relatively smaller forest industries. The basis for this examination is a survey, made during the summers of 1963 and 1964. Each wood manufacturing plant was personally contacted, and information was obtained on log consumption, source of logs, equipment, production, degree of manufacturing, and use of mill residues.

The single most important forest industry in eastern Washington is lumber. To obtain additional background, a study was made of the numbers and stability of sawmills between 1945 and 1963.

Timber Resources and the Timber Economy of Okanogan County, Washington, by Charles L. Bolsinger (18)

In 1972, forest industries in Okanogan County, Washington, accounted for 23 percent of total employment and 29 percent of wages paid. Total forest industrial employment has increased since 1953 but represents a smaller proportion of total employment in the county due to the increase in other industries, mainly construction and trade. Timber harvest has nearly doubled since 1953, from 116 million board feet to 198 million. In 1972, 90 percent of the timber harvest was from public lands compared with 76 percent in 1953.

Timber supplies are projected to decline slightly—about 4 percent—by the year 2020, though the value is expected to increase about threefold. Employment in forest industries is projected to decline about 60 percent by the year 2020, but forest industrial payrolls will decline by only 27 percent.

The Timber Resources of Central Washington, by James O. Howard (19)

The findings of the latest inventory of the timber resources of central Washington indicate there are 50.9 billion board feet of sawtimber on 4,370,000 acres of commercial forest land. Land owned or administered by public agencies accounts for 73 percent of the area and 84 percent of the sawtimber volume; farmer and miscellaneous private ownerships account for 17 percent of the area but only 9 percent of the volume; and the forest industry sector is smallest, with only 10 percent of the area and 7 percent of the volume.

About 280,000 acres are classified as nonstocked. Much of this occurs in the lower fringe of the forest zone and may not be able to support additional stocking.

Douglas-fir is the most abundant species, occurring on 37 percent of the commercial forest land and accounting for 38 percent of the sawtimber volume. Ponderosa pine is found on 27 percent of the area and accounts for 24 percent of the volume. True firs cover only 10 percent of the area but account for 17 percent of the volume.

Poletimber stands cover 809,000 acres, with about 220,000 acres classified as overstocked. These stands present a problem of reduced future yield unless they are thinned. Harvest exceeds growth by almost 200 million board feet, primarily because of a large volume of old-growth timber and the low overall site productivity of the area.

Recreational use of the forests of central Washington has been increasing rapidly. Associated with this increased demand has been pressure to reserve land area exclusively for recreation use. Presently there are almost 800,000 acres in reserved status.

Forest areas of central Washington.

Natural areas, such as Gold Lake Bog, are tracts of land basically undisturbed by the activities of man. For this reason they can provide comparisons with similar types of land which have been heavily used. Scientists can study both the animal and plant life in these outdoor laboratories with reasonable assurance that the complex ecosystems will remain much as nature evolved them.

Five species of carnivorous plants grow in the sphagnum moss of the bog. Two species of sundew and three species of bladderwort share the area with other, more common plants. Although deadly to some forms of small insect life, the carnivorous plants are fascinating to students of nature. This grouping of remarkable plants makes Gold Lake Bog one of the biological treasures of the Cascades.

Scientists feel that the adaptations which allow the plants to feed on insects may have some relation to a lack of soil nutrients. The plants are usually found on damp, acidic soils which are deficient in nitrogen. The root systems are often poorly developed and it is possible that the plants obtain nitrogen from the bodies of the trapped insects.

Each plant has developed its own bizarre adaptations. The red, jewel-like tentacles on the leaves of the sundew plant are tipped with a clear, sticky substance which traps insects. As the insect struggles against this natural glue, the leaves begin to slowly fold. More and more tentacles come in contact with the prey until it is pinned down and enclosed by the leaf. Glands within the plant secrete a digestive enzyme which consumes parts of the insect. When the process is completed, the sundew leaf unfolds exposing the undigested remains. Both the round-leaved (Drosera rotundifolia) *and long-leaved sundew* (Drosera longifolia) *thrive at Gold Lake Bog.*

The bladderwort is less spectacular in appearance than the sundews but has a much more intricate device for capturing small aquatic animals. This rootless plant grows in the wet sphagnum moss of the ponds of the bog. The stalks of the bladderwort support tiny, pear-shaped bladders. The flattened end of each bladder conceals a trapdoor surrounded by hair-like filaments. The filaments guide small animals such as the Daphnia *down to the surface of the trap where they trigger small "pegs" which spring the trap. The trapdoor opens and the inrushing water pulls the prey into the bladder where it is digested.* Utricularia minor, *a relatively rare bladderwort, is included among the three species found in the still waters of the bog.*

Timber Resources of the Puget Sound Area, Washington, by Charles L. Bolsinger (20)

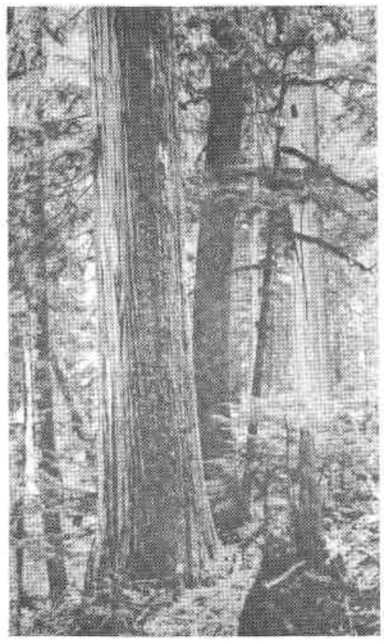
The latest inventory of the forest resources in the Puget Sound area shows a total of 3,300,000 acres of commercial forest land and 74,859 million board feet of sawtimber volume. Since 1953, about 221,000 acres of commercial forest land have been converted to roads, powerlines, reservoirs, agriculture, and urban and industrial developments, and about 65,000 acres have been set aside in parks and other reserved areas. Total sawtimber volume has decreased about 8 percent; softwoods have decreased 11 percent, while hardwoods have increased 71 percent.

About 41 percent of the commercial forest land is in public ownership; 59 percent is private, with forest industries holding 28 percent and farmers and miscellaneous private owners, 31 percent. About 20 percent of the commercial forest land is in old-growth timber, and over half of this is in national forest ownership. Other public owners have 13 percent of the old growth; forest industries, 28 percent; and farmers and miscellaneous private owners, 8 percent.

Douglas-fir is the most extensive forest type but is estimated to cover only half as much area as it covered in the 1800's before settlement of the Puget Sound area. Over 600,000 acres of logged and burned country now stocked with hardwoods, and many agricultural areas, roads, reservoirs, and town and industrial sites were once Douglas-fir forest.

Though Douglas-fir is the most extensive forest type, there is more western hemlock volume—24 billion board feet of hemlock compared with 21 billion Douglas-fir. This is because much more of the Douglas-fir type is young growth with less volume per acre.

Aerial seeding of Douglas-fir.



Western redcedar stands such as this, typical of the coastal cedar belt, cannot be grown on a continuous yield basis.

The Timber Resources of the Olympic Peninsula, Washington, by C.L. Bolsinger (21)

This report summarizes the findings of the fourth inventory of the forests in Clallam, Jefferson, Grays Harbor, Mason, and Thurston Counties in Washington. Fieldwork on lands outside the national forests was completed during the summer of 1965. Fieldwork for the Olympic National Forest was completed in 1963, and for the Snoqualmie National Forest, a small portion of which lies in southeast Thurston County, in 1965.

The fourth inventory shows a total of 3,105,000 acres of commercial forest land and 81,464 million board feet (International 1/4-inch scale) of sawtimber volume. Total timber volume has remained about the same for the past 12 years, and cut and growth currently are nearly in balance.

Compared with the Douglas-fir region as a whole, less of the forest in the Olympic Peninsula is in a poorly-stocked condition, and a greater proportion is in fast-growing young conifer timber. The generally good condition of the forest reflects the high growth potential of the forest land and the relative ease with which lands restock. Most of the present young sawtimber stands originated after logging or burning in the timber boom period of the late 1800's and early 1900's, or as a result of the February 1921 windstorm. Although most of these young-growth stands originated by chance, forest protection the past few decades has been important in their survival and development.

california

Timber Resources of Mendocino and Sonoma Counties, California, by Daniel D. Oswald (22)

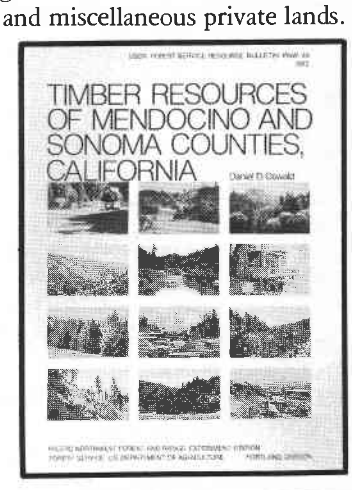
Information from the first complete inventory of timber resources in Mendocino and Sonoma Counties is presented. Data were collected during several field seasons in 1964, 1965, and 1967.

Findings indicate there is 19.1 billion board feet of sawtimber on 1,564,000 acres of unreserved commercial forest land in these two counties. Forest industries own about 34 percent of the commerical forest area and 37 percent of the timber volume; farm and miscellaneous private ownerships account for 53 percent of the area but only 42 percent of the volume; and public ownerships account for 13 percent of the area and 21 percent of the volume.

Almost half the commercial forest area is stocked with low value hardwoods and scattered conifers. This condition has resulted from wild fires, logging, and unsuccessful or abandoned attempts to convert timberland to grazing land. Redwood is the area's most abundant conifer, predominating on 368,000 acres; sawtimber volume in this species is 9.6 billion board feet. Douglas-fir type is found on 281,000 acres; sawtimber volume is 6.5 billion board feet.

The forests in these counties are predominantly young, 79 percent of the area having stands under 100 years old. These young forests are responsible for almost all of Mendocino-Sonoma's 499 million board feet of net annual growth.

In recent years, the forest industries of these counties have been utilizing old-growth timber, more Douglas-fir than redwood, and have been relying heavily on their own holdings. In the next 10 to 15 years, the realities of raw material availability will likely lead industry to greater reliance on young redwood sawtimber, much of it from farm and miscellaneous private lands.



Timber Resources of Northern Interior California, 1970, by C.L. Bolsinger (23)

This report summarizes a timber resource inventory in Lassen, Modoc, Siskiyou, Shasta, and Trinity Counties, California. Included are detailed tables of forest area, timber volume, growth, mortality, removals, and a discussion of the current timber resource and timber industry situation.

The five-county area contains 9.6 million acres of forest land, of which 6.0 million acres are classified as commercial, 3.2 million as unproductive, and 0.4 million as productive reserved in parks and other reservations. About 60 percent of the commercial forest land is in public ownership; 40 percent is in private ownership.

The total standing timber volume is estimated at 86.0 billion board feet—more softwood sawtimber than occurs in the states of Georgia, North Carolina, and South Carolina combined. Since 1953, total timber volume has declined 17 percent on public lands and 45 percent on private lands. The decline was primarily because of logging, but several large fires and forest conversions have also contributed.

Net annual growth on all ownerships is about 1.25 billion board feet, and annual mortality is about 0.2 billion board feet. National forests have the highest per-acre growth rate and the lowest mortality relative to inventory volume. Private lands have lower growth and higher mortality because of the relatively poor condition of many cutover stands. About 75 percent of the land in these ownerships has been cut over. Growth has increased on private lands, and there is reason to expect better performance in the future.

The annual timber harvest has remained stable for the past 20 years at 1.3 to 1.5 billion board feet. The cut gradually shifted from the eastern to the western part of the five-county area and from private lands to national forests. Private lands will continue to provide the smaller proportion of the timber harvest in the foreseeable future. The species harvest has shifted from pines to Douglas-fir and later to white and red firs. In the near future, the pine harvest will continue to decline as Douglas-fir and the white and red firs account for a greater portion of the total cut.

The Timber Resources of Humboldt County, California, by Daniel D. Oswald (24)

This report presents the first complete inventory of Humboldt County's timber resources. Field data were collected during the summer of 1966 and are presented as of January 1, 1967.

Humboldt County has been an important source of raw material for wood products for over 100 years. This county, which has the largest sawtimber inventory and second largest commercial forest area of all California counties, is largely responsible for California's position as a leading state in production of wood products. Since 1920, Humboldt County's forests have yielded over 33 billion board feet of roundwood for manufacture of wood products, 20 billion board feet of it in the last 15 years. In 37 of the last 47 years, Humboldt County has led all other California counties in roundwood harvest and lumber production and has never ranked lower than third during the remaining 10 years.

Humboldt County today leads the state in the production of lumber, softwood veneer and plywood, and woodpulp. It accounts for one-quarter of the state's annual timber harvest, and its sawmills provide more residue for pulping than any other county.

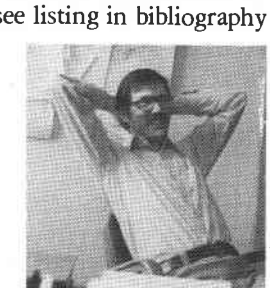
Softwood Tree Volume Equations for Major California Species, by C.D. MacLean and J.M. Berger (25)

New cubic-foot, International 1/4-inch board foot, and Scribner board-foot tree volume equations have been developed for eight species: Douglas-fir, ponderosa pine, Jeffery pine, sugar pine, lodgepole pine, white fir, California red fir, and incense-cedar. Although developed specifically for use in the forest survey of California, they are suitable for general use throughout the state, wherever total height, d.b.h., and volume equations are needed.

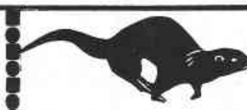
The equations were developed from measurement data from 2,110 felled trees and 957 dendrometer-measured trees from sites extending from the Modoc plateau to the southern Sierra Nevada. Data from the Coast Ranges were unavailable. Both equations and volume tables are presented.

Other Publications

For other publications on this same subject, see listing in bibliography under (26).



Dan Oswald



Two species of frogs are found within the varied wildlife population of Gold Lake Bog. The Cascade frog (Rana cascadae) *can generally be found inhabiting the fringes of the bog, while the western spotted frog* (Rana pretiosa) *prefers the interior. Scientists who have worked in the area have discovered that these two amphibians are genetically compatible and interbreed. Colorful frogs showing the characteristics of both species have been collected.*

There has been very little man-caused disturbance at Gold Lake Bog. In the past, wildlife managers removed beaver dams which were blocking the upstream migration of rainbow trout into nearby Gold Lake. During the fall months, hunters used to camp in the higher, drier portions of the basin. Both of these activities have stopped since Research Natural Area designation and the visits of man are now limited to those who are interested in the bog for scientific and educational purposes.

Gold Lake Bog is just one of over 500 Research Natural Areas located throughout the United States. Human impacts are carefully controlled by the federal agencies responsible for the protection of the areas. Formal permission for visitation is the rule. Scientists are generally limited to nondestructive studies although infrequently small amounts of collected material are removed with prior permission. No activities are allowed which will alter the basic nature of these outdoor laboratories.

Commercial and recreational use of the wildlands continues to grow, chipping away at those places which remain essentially pristine. Scientists Jerry Franklin and James Trappe of the Pacific Northwest Forest and Range Experiment Station recognized this problem when they wrote, "Even the West, long considered a reservoir of lands unaffected by man, will not be so in the forseeable future." These researchers point out that the "opportunities for establishing adequate, representative natural area systems are quickly vanishing."

The concern expressed by Franklin and Trappe is shared by many others. For this reason, the search for these unique, untouched islands in a rapidly developing landscape continues. It is conceivable that areas such as the Gold Lake Bog may someday provide the only links between man and the undisturbed past of this magnificent continent.

end

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resource evaluation - bibliography

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genetics

See also: Silviculture

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Contents

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General

Foresters have known for a long time that some trees grow taller, faster, and bushier than others, and that they vary in their resistance to disease and insects, or survive greater extremes of environment. Although site conditions, climate, and adequate sunlight and nutrients are important to tree growth and survival, it is their inherited traits that determine how they will respond to these conditions.

The goal of forest genetics research is to improve tree growth and other desirable traits without losing the adaptiveness that is already present in the gene pool. Basic laboratory studies and practical work in the forest complement each other in the Forest Service research program. Most of the research has been done on Douglas-fir, the most important timber species in the Pacific Northwest.

The Care and Handling of the Forest Gene Pool, by Roy R. Silen with Ivan Doig (1)

The 22 commercial conifer species of northwestern America constitute a unique pool of genes. They outproduce other temperate species in the droughty climate and ordinary soils of the West. This uniqueness probably reflects the fact that the species survived the ice ages intact, with each locality having selected an exactly adapted race. Alteration of the gene pool, randomly with planting and deliberately with genetics, is now a certainty. The current philosophy, like mining, discards all the gene pool except pure, profitable genotypes. A plea is made for a more cautious approach.

tree development, environmental effects

Frequency of Seedlings from Natural Self-Fertilization in Coastal Douglas-fir, by Frank C. Sorensen (2)

In many plant species, including forest trees, the progeny which result from inbreeding are less vigorous and less competitive than those which come from crossing. Trees, having both male and female reproductive structures, can fertilize themselves (self-fertilization or selfing), an extreme form of inbreeding. The natural regeneration strategy of a species such as Douglas-fir often leads to the formation of ''family groups'' around individual trees or portions of stands. Mating between members of the same family group or between a parent tree and one of its offspring also leads to inbreeding, but less extreme than selfing.

In most species seed and plant quality can be upgraded by avoiding inbreeding. While there is not much foresters can do to prevent inbreeding in the forest, operators of seed orchards should try to minimize inbreeding in seed orchard progeny.

In 1964, geneticist Frank Sorensen began studies of self- and cross-pollination in stands of Douglas-fir in western Oregon. Later studies were begun in ponderosa pine and noble fir.

Some of the effects of inbreeding on fertility and vigor which are reported in these related publications (3) are given below:

• Self-fertility in Douglas-fir is low. Most self-fertilizations end up as empty seeds because the weak self-embryos abort before completing their development. On the average, Douglas-fir produces only about 11 percent as many filled seeds after self-pollination as after cross-pollination. For ponderosa pine it is about 35 percent, for noble fir about 70 percent.

• Weight and germination of filled seeds from self-fertilization are only slightly less than for seeds from cross-pollination. However, survival of self-seedlings is about 10 percent less and seedling nursery height about 25 percent less than for seedlings from cross-pollinations.

• Self-fertilization also reveals trees which carry recessive or ''hidden'' genes for mutant traits such as albinism. These mutants are used to study pollen flight and natural inbreeding. In Douglas-fir it has been found that about 7 percent of the seedlings from wind pollination are self-seedlings, and the inbreeding depression in stem volume is about 5 percent compared to the same family with no inbreeding.

• The frequency of self-seedlings in the wind-pollination progeny of several tested Douglas-fir trees ranged from 0 to 27 percent. An undesirably high frequency for a particular tree results from combining a good pollen crop and high inherent self-fertility, with flower receptivity ahead or behind the average of the stand. This is further magnified if the tree is growing in a cluster of relatives which inter-pollinate, or is in a two-story stand and receives pollen from one or both of its parents.

Operators of tree improvement programs may wish to read specialized reports by Sorensen concerning the response of Douglas-fir to environmental changes (4).

Frank Sorensen

Self-Pollination Effects on Seed and Seedling Traits in Noble Fir, by Frank C. Sorensen, Jerry F. Franklin, and Robert Woollard (5)

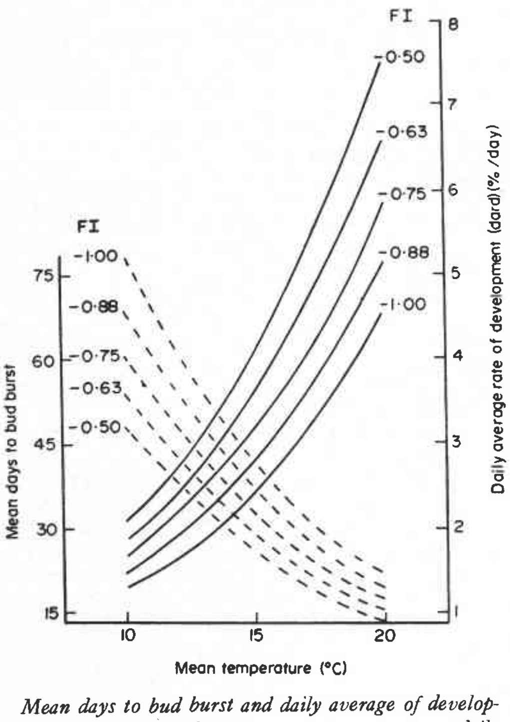
Artificial regeneration in noble fir, an important upper slope conifer in western Oregon and Washington, is complicated by the relatively low germination of seed, a characteristic of the species.

This study tested the idea that poor germination might be the result of self-pollination. Results, however, did not confirm the researchers' suspicions. Some other cause is more likely.

Use of Phenology for Examining Provenance Transfers in Reforestation of Douglas-fir, by Robert Campbell (6)

Foresters learned long ago that local seed is usually best for reforestation purposes, but there are times when local seed is not available. Campbell explores ways to use the timing of bud burst to predict the response of seedlings to geographic transfers. Seed collected at 44 locations in western Washington, Oregon, and northern California was planted and grown at different temperatures in a greenhouse. Buds of seedlings from the 44 locations burst at different times, depending on temperature. This information was used to predict the dates of bud burst for seedlings planted in various locations.

Results indicate that moving seed in east-west directions is more likely to be harmful than moving it north or south an equivalent distance.



Mean days to bud burst and daily average of development towards bud burst as a response to mean daily temperature.

Bob Campbell

Predicting Bud Burst in Douglas-fir

This report covers the same subject as (6) but was written a year later and takes the preceding study further. While the mechanism by which perennial plants adapt to variable seasonal climates is not completely understood, it appears possible to predict some plant behavior, specifically bud flushing in seedling Douglas-firs.

Three growth chamber experiments were used to examine the seedlings' response to combinations of chilling, photoperiod, and temperature during dormant and postdormant phases. On the basis of the results, Campbell proposed a conceptual model for the action of temperature and photoperiod on the time of bud flushing. On the average, bud burst is advanced by 0.4 days per degree C rise in average temperature, but this rate is influenced by length and temperature of chilling. The longer the chilling period that precedes bud development, the greater the rate of bud development at a given temperature. Also, the longer the photoperiod during the flushing period, the greater the rate of bud development. The report is titled, *Phenology of Bud Burst in Douglas-fir Related to Provenance, Photoperiod, Chilling, and Flushing Temperature,* by Robert Campbell and Albert I. Sugano (7).

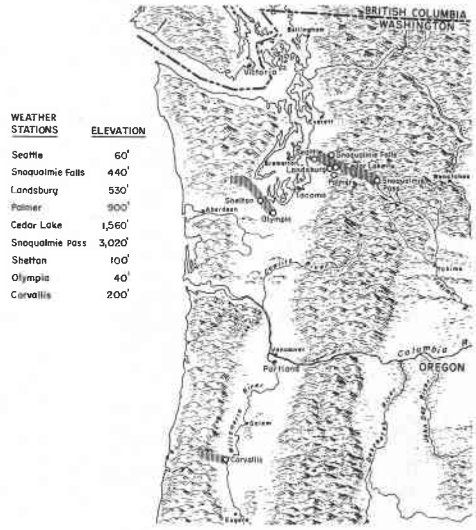
A Study of Genetic Control of Bud Bursting in Douglas-fir, by Roy R. Silen (8)

Silen investigated the degree of genetic control over bud bursting in Douglas-fir by grafting scions from trees with widely different bud bursting dates onto limbs of seven trees of a 17-year-old clone. The experiment included replications of seven scion types on each clone tree, the seventh type being a control graft in which a limb of the clonal tree was cut, then regrafted.

The conclusion was that practically all variation in bud bursting is genetic. Differences in bud burst of the seven scion types were consistent. Results also showed that local environment differences may delay bud bursting of genetically similar material for as much as 2 weeks.

Does Rainy Weather Influence Seed Set of Douglas-fir? by R.R. Silen and K.W. Krueger (9)

Rainy weather during the pollination period has been considered one of the reasons for low yields of seed from Douglas-fir cones. A preliminary study during 1959 indicates that rain during the pollination period could not cause a major reduction in Douglas-fir seed set over a broad elevational zone.



Location of transects and weather stations.

Cold-Acclimation in Seedling Douglas-fir Related to Phenology and Provenance, by Robert K. Campbell and Frank C. Sorensen (10)

One-year-old seedlings from 10 provenances from the Coast Ranges of Washington and Oregon were growing in cold frames at Corvallis, Oregon, when they were damaged by frost in October 1969. The occasion offered an opportunity to study the ability of the seedlings to survive frost damage. Results indicate that the longer the time between bud set and fall frost, the less damage occurred to the seedlings. Since trees from southern sources generally set buds later and are more sensitive to frost than those growing farther north, they were more severely damaged. Those from southern Oregon coastal sources were the most sensitive.

Spacing-Genotype Interaction in Douglas-fir, by Robert K. Campbell and Boyd C. Wilson (11)

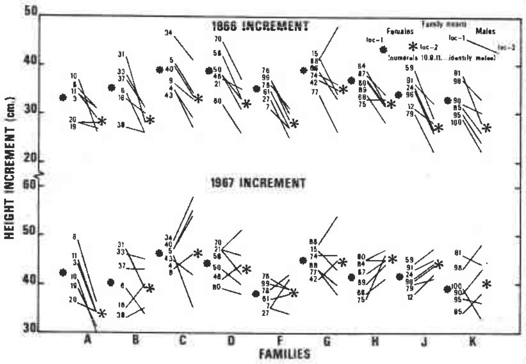
One of the potential problems for tree breeders had been the possibility that the space allowed for each seedling in the plantation might affect the performance of the seedlings and thus the selection of the best tree families for breeding. Results of this study showed that spacing did not affect the growth ranking of seedling families enough to present a problem.

Genetic Variability in Juvenile Height Growth of Douglas-fir, by Robert K. Campbell (12)

Seedlings often must compete with brush species in early life and are also vulnerable to browsing by animals. Various methods have been tried to increase early seedling growth to get them through this vulnerable stage. These include planting in containers or machine planting on terraced slopes, followed by fertilizing, irrigating, or mulching.

Campbell studied the possibility that growth of trees from different families might vary greatly depending on plantation location. Trees that are most productive at one location might be least productive at another, thus hindering selection of best families for breeding.

Results indicate that location affected the ranking of families enough to present a problem.



Mean 1966 & 1967 height-increments for full- and half-sib families grown at two locations.

tree improvement

A Simple, Progressive, Tree Improvement Program for Douglas-fir, by Roy R. Silen (13)

In 1966, after serious technical problems arose in Douglas-fir seed orchards, geneticist Roy R. Silen proposed a simple, low cost tree improvement program that obviated need for orchards. Based upon known performance of tree families in a 50-year-old study, ample gains could be shown using wind-pollinated seed collections from individual parent trees once their ranking was known from a wind-pollinated test of their progeny. The program was originally designed for small landowners.

Silen's proposal was that a large enough number of trees be selected and tested to produce three times the seed needed by the owner. As wind-pollinated seedlings in the test grew in size, the landowner improved his ability to select the genetically better third. The proposal had other features, such as use of a very restricted seed zone, major dependence upon testing, use of existing forestry staffs, and provisions for a long term breeding program to follow.

The program caught on. By 1976, 32 owners of 6.1 million acres of forest land in Oregon and Washington, mostly in tree improvement cooperatives, were using the program.

Douglas-fir Seed Orchard Problems—A Progress Report, by Roy R. Silen and Donald L. Copes (14)

Grafted seed orchards are a major part of several Douglas-fir tree improvement programs in the Pacific Northwest.

This publication reviews progress toward solving three problems common in seed orchards: (a) graft incompatibility, (b) contamination of the seed orchard by pollen from outside the orchard, and (c) the excessive length of time it takes Douglas-fir to produce an abundant cone crop after grafting.

Copes was assigned full time to study graft rejection in 1965. He found that a wounding and rehealing phenomenon was associated with incompatibility and could be detected microscopically. He began making two grafts per parent tree on each root stock. After 1 year he cut off one graft from each root stock and examined it in the laboratory. If the rejection process had begun, abnormal cell types would be seen and the graft eliminated. Once a compatible rootstock was found, additional rootstocks could easily be produced by rooting cuttings from that rootstock.

Silen developed a method (15) to avoid contamination by outside pollen. Solution to the problem of better cone production was being approached by many laboratories through studies of hormonal, nutritional, and daylength requirements.

Don Copes

ANOTHER WAY TO CRUISE TIMBER

by Louise Parker

Over the years, there's been a lot of discussion about which is the best method of selling timber—by lump-sum or scale. Both methods involve cruising, the measuring and grading of trees to determine the volume and the value of the timber in a sale area. In a lump-sum sale, the timber is cruised, a price tag is put on the whole stand, and the timber is sold "lump sum." In a scale sale, cruising is done and a per-thousand-board-foot price is established and applied to the logs that are taken from the woods. Scale sales require special measuring or "scaling" stations.

Both kinds of sales apparently have advantages and disadvantages. For example, scale sales are costly and may encourage operators to leave a lot of residue in the woods, because buyers only pay for what they take out On lump-sum sales, all the merchantable material is paid for, so buyers may be more inclined to take it all. But, lump-sum sales can be inaccurate.

A technique called "fall, buck, and scale (FBS) cruising" offers another option. With it, timber growers can sell lump-sum, without having to measure every tree in the sale area. And, the accuracy of FBS cruising is such that scaling is not required after logging.

There are many other advantages of FBS cruising over older methods. In a traditional cruise, the cruiser uses biltmore sticks, optical measuring devices, and "guestimate" to estimate the volume and value of standing trees. FBS cruising, in contrast, employs a totally new concept. Instead of measuring trees as they stand, sample trees are felled, bucked into standard log lengths, and measured on the ground. The cruiser can measure the diameter and length of the logs as they are cut, and can accurately determine defect, breakage, taper, and other factors which are hard to evaluate on standing trees.

FBS cruising was developed by the Bureau of Land Management in cooperation with researchers at the PNW Station in Portland, Oregon. The original idea for the method can be traced to Leonard Zygar, a cruiser with BLM's Salem District in Oregon. At a training session several years ago, Zygar asked, "Why not cut the sample trees?"

The solution seems so simple that a lot of people wonder why no one thought of it before. One reason is that, until recently,

Cooling a Douglas-fir Seed Orchard to Avoid Pollen Contamination, by Roy R. Silen and Gene Keane (15)

Contamination from outside pollen sources was a major obstacle to developing a successful seed orchard technology for Douglas-fir. Pollen dispersion in the Douglas-fir region is extensive during good years when pollen counts of several thousand per square inch are common.

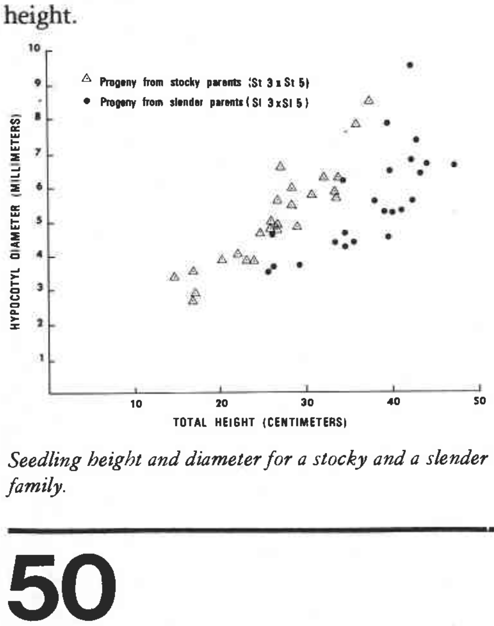
A 1968 study carried out at the Forest Service Heather Seed Orchard near Oakridge, Oregon, showed that floral development could be slowed by irrigating the trees with cold water. Female buds, cooled by a water spray for a month prior to local pollen release, remained in their scales long enough to reduce pollen contamination to a tolerable level. Seed developed normally after 6 weeks of spraying, and pollen produced in the sprayed plots appeared normal in germination tests.

Several commercial trials of irrigation have since been successful and the principle has been widely applied to control phenology of fruit crops.

Inheritance of Stockiness in Ponderosa Pine Families, by Roy R. Silen and Kenneth E. Rowe (16)

Because stockiness in trees means more wood volume, tree breeders would find it helpful to know whether this trait is inherited and should be considered in selecting parent trees for a tree improvement program.

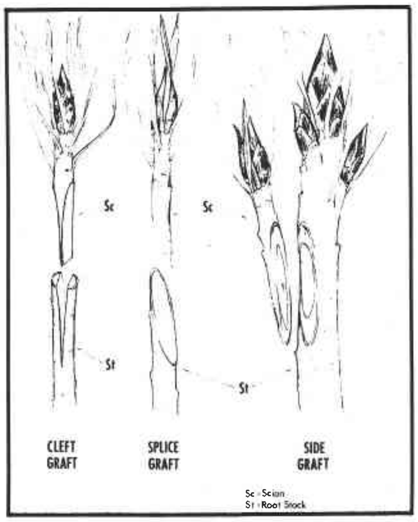
In this study, seed was collected from selected pairs of stocky and slender mature ponderosa pine and planted. Measurements taken after 3 years' growth of the seedling crosses tentatively verified stockiness as an inherited trait. Long-term observation is needed to see whether the early findings persist. So far, results suggest that tree breeders can improve volume growth by selecting parents for stockiness as well as height.



Seedling height and diameter for a stocky and a slender family.

Effect of Graft Type on 6-month Scion Survival of Field Grown Douglas-fir Grafts, by Donald Copes (17)

Thousands of grafts are made each year to establish and maintain Douglas-fir seed orchards. Each orchardist soon adopts the graft type he thinks is best, easiest, or quickest to make. Copes evaluated three types of graft (top—cleft, splice, and side) for improving first-year survival. He found that the type of graft did not significantly influence survival, provided 80 mm or more of cambial contact connected the stock and the material being grafted.



Stock and scions prepared for the top-cleft, splice, and side graft types.

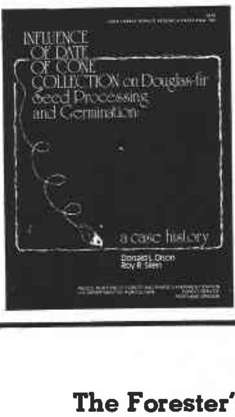
Effect of Date of Grafting on Survival in Douglas-fir, by Donald L. Copes (18)

Seed orchard operators try to anticipate the best time of year for grafting. A field study of 1,300 grafts in western Oregon indicated that survival of 90 percent or better was obtained when Douglas-fir was grafted between early spring and mid-May. Grafting in September and October was especially unfavorable.

Influence of Date of Cone Collection on Douglas-fir Seed Processing and Germination: A Case History, by Donald L. Olson and Roy R. Silen (19)

Because of limited manpower, cone gathering to provide seed for tree nurseries is often begun as soon as cones appear ready. But if cones aren't sufficiently ripe, the seed is likely to be immature. Olson and Silen report some of the problems and costs of using immature seed: fewer seeds per cone, susceptibility to mold, more time spent by nursery workers, and poor germination in laboratory and nursery.

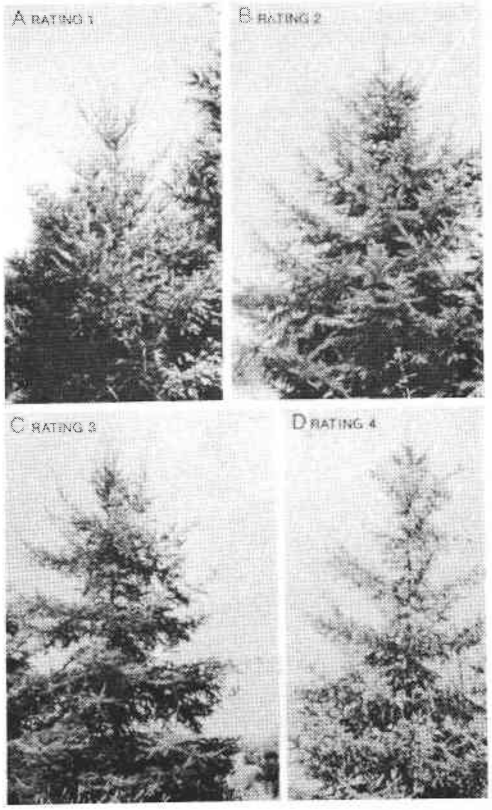
Low seed weight is a clue that the seed is immature. The authors recommend that seed lots suspected of immaturity be discarded, saved for use only when supplies of better seed are exhausted, or artifically ripened. The better way, of course, is to collect only mature cones.



Effect of Annual Leader Pruning on Cone Production and Crown Development of Grafted Douglas-fir, by Donald L. Copes (20)

When grafted Douglas-fir trees grow 2 to 4 feet in height each year, the tops of the trees are soon difficult to reach for insect and disease control or pollination. Tall trees also make the operation of overhead irrigation systems difficult in seed orchards. A study begun in 1965 showed that pruning leaders every other year (after seed trees are 14 to 20 feet tall) is the best way to cope with the height problem without severely reducing cone production.

Several additional reports on grafting Douglas-fir in seed orchards, some of them quite technical, are listed in the bibliography (21).

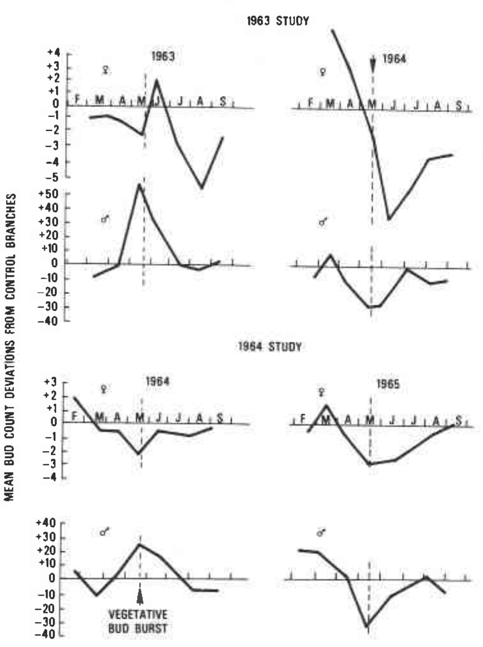


Crown density values employed in rating pruned and unpruned trees are illustrated: A, very dense; B, dense; C, moderately dense; D, low density.

Roy Silen

First- and Second-season Effect on Douglas-fir Cone Initiation from a Single Shade Period, by Roy R. Silen (22)

In a very technical report, Silen discusses the relationship of weather changes (for example, shade) in producing a good cone crop. He wanted to find out if parts of the growing season—between February and September—were more important than others. What he found is that no single part of the season is crucial, but that shading applied for short intervals over a 27-month period can modify cone productivity. Certain portions of the period were more important than others.



Male and female bud count deviations over two seasons from branches shaded 1 month in two separate studies. Perpendicular lines indicate the time of vegetative bud burst.

Artificial Ripening of Douglas-fir Cones, by R.R. Silen (23)

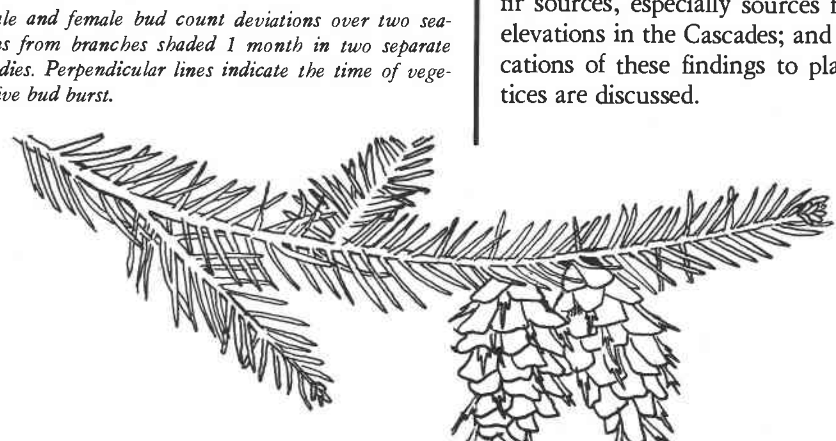
Since Douglas-fir seed is seldom fully ripened on the tree before late August in the Pacific Northwest, the cone collecting period is often short. Lengthening of this period is a worthwhile goal, for it would permit better organization of cone collection and allow skilled personnel to collect more of the crop. Of three storage methods tried, cones stored at about 63° F. in damp peat moss gave full germination for collections made on August 1 and later.

The artificial ripening of seed in immature cones by some commercial method of damp storage appears possible for Douglas-fir. This may greatly lengthen the period of cone collection for this species, or provide a method of handling cones inadvertently picked before they are fully ripe.

Adaptational Requirements of Planting Stock, by Robert K. Campbell (24)

A note from a proceedings of the Western Forestry and Conservation Association meeting in 1975 discusses the adaptation of trees to given sites as the chief genetic requirement of planting stock. In the past, a zone classification system has been used to determine adaptation. All seedlings from within the zone are considered to be adapted, and all from without are nonadapted.

The author discusses a more realistic concept of adaptation and shows how adaptational requirements can influence decisions made by foresters before reforestation. The topic is discussed in four steps: (a) observations are given from the 60-year-old Douglas-fir heredity study to show what happens to a plantation that includes both "adapted" and "nonadapted" provenances; (b) adaptation is related to many facets of artificial regeneration, i.e., spacing, initial plantation success, etc.; (c) some differences are looked at in adaptation among Douglas-fir sources, especially sources from different elevations in the Cascades; and (d) the implications of these findings to plantation practices are discussed.



the available sampling systems required so many sample trees for acceptable accuracy that the idea of cutting them all down was unthinkable. Now, with a statistical sampling method called 3-P, a few sample trees are entirely adequate. For any given sale in which FBS cruising is used, anywhere from 50 to 200 sample trees are selected by 3-P sampling. The 3-P system was developed by Lew Grosenbaugh at the Forest Service's Pacific Southwest Forest and Range Experiment Station about 10 years ago. Under the system, the probability that a tree will be included in the sample is proportional to a quickly predicted ocular volume. Thus 3-P.

BLM adopted the 3-P technique as soon as it became available in 1964. At first they measured the sample trees standing. It wasn't until 1968 that they started falling them. George Hartman, a forester with BLM in Portland, says they saw FBS cruising as a way to get highly accurate estimates without having to measure all the trees in a sale.

"The big benefit of FBS cruising is improved accuracy," according to Floyd Johnson, statistician (retired) at the PNW Station. Johnson, who worked with the Bureau of Land Management and the Forest Service to help get the system tested and put into use, finds FBS cruising intriguing. He says that FBS cruising is "a very practical idea," and that when accuracy is a major consideration, "FBS cruising has a lot of potential for doing the job better and cheaper than other cruising methods."

Johnson says that FBS cruising makes a lot of sense, particularly in defective old-growth timber in the West where there is a good chance of making a bad estimate. According to Johnson, FBS cruising gets rid of the cruiser's bias, so that only sampling error is left.

Johnson believes FBS cruising might also be especially useful for selective cutting in the pine region. With 3-P sampling, at least at present, the forester must visit every tree in the sale area and make a rough, "eyeball" estimate of volume. Only a few trees are actually measured. Because the forester must mark all trees to be cut in a selective harvest anyway, there's very little extra work involved in measuring the sample trees.

end
next "insight" page 55

genetics - bibliography

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silviculture

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Watershed
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Fire
Alaska
Gadgets

Contents

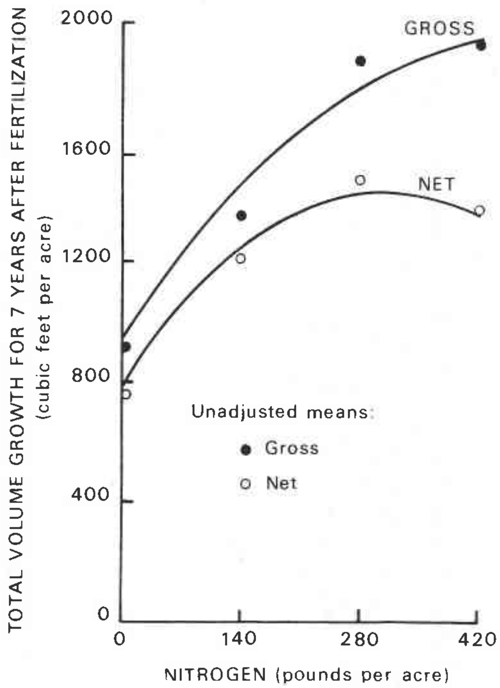
general

Intensive Management of Coastal Douglas-fir, by Curtis, Reukema, Silen, Fight, and Romancier (1)

West of the Cascades, the Pacific Northwest contains the most productive natural coniferous forests on earth. Since the first settlement, the most important tree has been Douglas-fir, a species remarkable for long life, rapid growth, relative freedom from insect and disease attack, and utility of its wood.

We are now in transition from the wild forests of the past to the managed forests of the future. Despite a very large growing stock, annual production rates in the wild forests were relatively low. Our new forests are capable of much higher production.

Intensive culture is really agronomic forestry. First, we must be able to get prompt and adequate regeneration of desired species. Second, we must protect the crop from insects, animals, and disease. Third, we can harvest the crop at ages which take advantage of the naturally high growth rates



Effect of nitrogen fertilizer on cubic-volume growth.

of young stands. Given these, we can further increase production over that of the wild forest by (a) control of spacing and competition, (b) soil fertility improvement, and (c) genetic improvement.

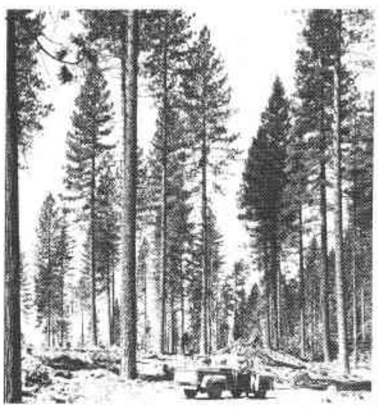
silvicultural systems

Silvicultural Systems for the Major Forest Types of the United States, Agriculture Handbook No. 445 (2)

The current trend toward the establishment and care of forests for a wide combination of uses requires flexibility in forest culture and a knowledge of the silvicultural choices available to the resource manager. This publication summarizes, for each of 37 major forest types in the United States, the silvicultural systems that appear biologically feasible on the basis of present knowledge. Supporting information is given on the occurrence of the 37 forest types, the cultural requirements of the component species, and the biological factors that control the choice of silvicultural options. The text is arranged in regional sections suitable for reprinting.

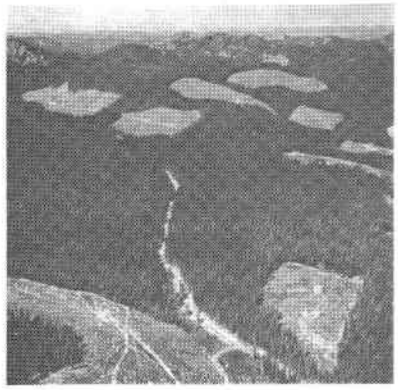
Pacific Northwest forest types discussed here include the following: western hemlock, Sitka spruce, coastal Douglas-fir, mixed conifers of southwestern Oregon, true fir, mountain hemlock, mixed pine-fir of eastern Oregon and Washington, northwestern ponderosa pine, interior Alaska white spruce, and interior Alaska hardwoods.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price is 80 cents domestic postpaid or 55 cents at the GPO Bookstore.

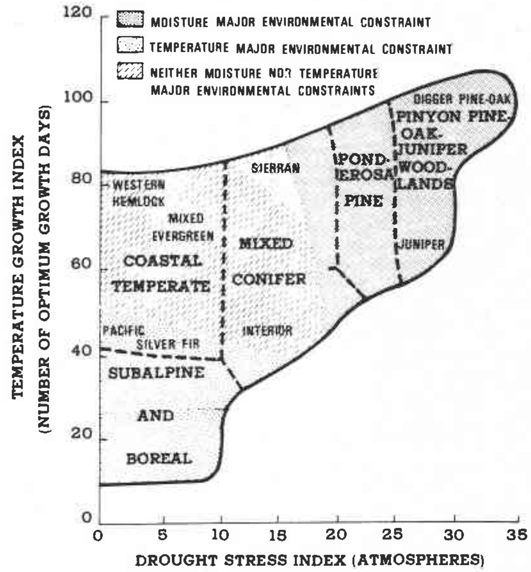


Effects of Various Harvesting Methods on Forest Regeneration, by Jerry F. Franklin and Dean S. DeBell (3)

For most forest types and species on most sites, foresters have wide latitude in choosing regeneration cutting methods insofar as ecological requirements of tree species are concerned. Few species or sites require uneven-age management under a selection system. Likewise, there is no ecological necessity for large patch or continuous clearcuttings to regenerate most types, species and sites including Douglas-fir; shelterwood or strip clearcut systems appear equally suitable for regeneration of most species on most sites. Selection systems can be used successfully for some major species, including certain southern pines. They also could be used for many others, provided that a change in species composition is acceptable. Ecological constraints do limit use of clearcuts on more severe sites, that is, those where moisture and temperature are major problems. With these exceptions, economic and social rather than ecological considerations appear to be the most important factors controlling selection of cutting systems.



Staggered-setting system of clearcut patches.

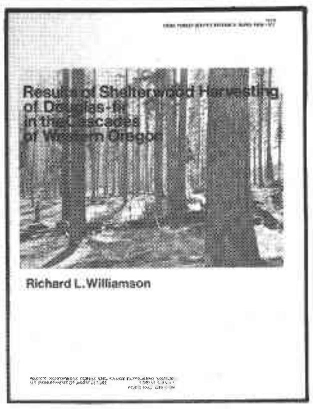


Place of Partial Cutting in Old-Growth Stands of the Douglas-fir Region, by Leo A. Isaac (4)

The partial-cutting system as studied and reported in this paper has not proven to be a successful method of harvesting Douglas-fir and converting virgin forests to new or thrifty stands on the average or better sites in the region. Even under conditions where it appears to offer promise, it is always associated with the danger of an unfavorable species change or loss from windfall, insects, or a combination of causes. Therefore, any plan for partial cut or selection cut in the Douglas-fir type should include a careful study of stand conditions in advance and provision for salvage in the event of severe loss or catastrophe.

See also a 1960 research note titled, *Behavior of Ground Vegetation Under a Partially Cut Stand of Douglas-fir,* by Kenneth W. Krueger (5).

Widely scattered Douglas-fir in a dense stand of hemlock and silver fir just under commerical size. Large trees should not be cut until understory trees reach commercial size and injured trees can be salvaged.


Results of Shelterwood Harvesting of Douglas-fir in the Cascades of Western Oregon

Richard L. Williamson

Results of Shelterwood Harvesting of Douglas-fir in the Cascades of Western Oregon, by Richard L. Williamson (6)

Clearcutting Douglas-fir in the Pacific Northwest does not always result in successful regeneration, either natural or artificial. Where regeneration has failed, this has been due to such causes as temperature extremes and drought. Failures, primarily at higher elevations in the Oregon Cascades, led the Forest Service to try shelterwood harvesting, beginning in 1962, as a possible alternative to clearcutting. R.L. Williamson surveyed these shelterwood stands in the summer of 1970 with two main objectives:

1. To determine how successful shelterwood harvests were in securing natural regeneration.

2. To determine survival and condition of the shelterwood overstories during the regeneration period.

A total of 21 shelterwood cutting units were examined. All were at high elevations (3,000-5,200 feet) in the Cascades of western Oregon.

Results indicate that, in most cases, regeneration stocking is at least adequate by U.S. Forest Service Region 6 standards. These standards require a minimum of 250 uniformly distributed 4-year-old trees per acre, or greater numbers of younger trees. Satisfactory stocking in two shelterwood units was particularly gratifying to Williamson because he had personally made stocking surveys in the mid-1950's in some nearby older clearcuts which had experienced repeated plantation failures. These repeated failures indicated particularly severe local environmental conditions, which shelterwood harvesting apparently mitigated.

Results of Shelterwood Cutting in Western Hemlock, by Richard L. Williamson and Robert H. Ruth (7)

As a result of a shelterwood study in western hemlock, scientists conclude that shelterwood harvest is a viable alternative to clearcutting in that species.

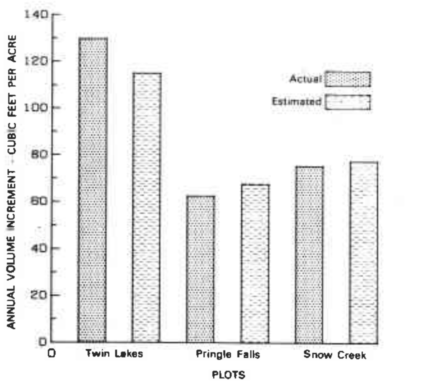
For the study, 12 shelterwood densities, ranging from 38 to 235 square feet of basal area per acre, were created in a 60-year-old stand. Eleven years after the first cut there were ample young seedlings at all cutting levels. In fact, the areas were overstocked. Other factors noted by the researchers included the following: (a) brush was adequately controlled by overstory densities of at least 90 square feet of basal area, (b) volume growth of the overstory trees was approximately proportional to the number of trees left, and (c) based on clearcutting experience in hemlock, shelterwood harvest was probably not essential for successful regeneration at this site.

Lodgepole Pine Symposium Summarized

Proceedings of a symposium on "Management of Lodgepole Pine Ecosystems" give valuable information on how to manage lodgepole pine in Oregon. The proceedings were edited by David M. Baumgartner and published in 1975 by Washington State University Cooperative Extension Service, Pullman, Washington 99163. Requests for the proceedings should be sent to that address.

We do have, however, copies of three reprints of papers given by PNW Experiment Station scientists. They include the following:

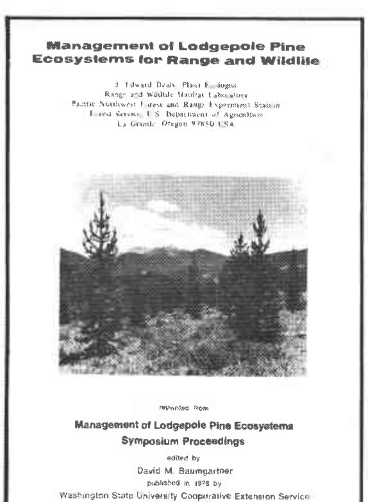
Gross Yield of Central Oregon Lodgepole Pine, by Walter G. Dahms (8). The paper includes yield estimates, site index estimating curves, and height-growth curves.



Comparison of actual and estimated gross volume increment from three sets of permanent sample plots. From Dahms (8).

Water Relations and Photosynthesis in Lodgepole Pine, by W. Lopushinsky (9). Presents available data on water relations and photosynthesis.

Management of Lodgepole Pine Ecosystems for Range and Wildlife, by J. Edward Dealy (10). Discusses the effect of lodgepole pine management on wildlife habitat (particularly mule deer and Rocky Mountain elk) and range for cattle.



Management of Lodgepole Pine Ecosystems for Range and Wildlife

Reprinted from

Management of Lodgepole Pine Ecosystems Symposium Proceedings

edited by

David M. Baumgartner

published in 1975 by

Washington State University Cooperative Extension Service

Logging to Save Ponderosa Pine Regeneration: A Case Study, by Barrett, Tornbom, and Sassaman (11)

Sapling-sized ponderosa pine trees can be saved from destruction during logging by marking the trees with paint. Marking the trees also aided in the systematic disposal of logging slash. After logging and slash disposal, at least 180 crop trees per acre were left on 75 percent of an area in the Pringle Falls Experimental Forest.

There are several million acres of ponderosa pine land in the Pacific Northwest where the incentive to save the understory is great. Trees that are from 1 to 8 inches in diameter and 6 to 30 feet in height might be equivalent to 10- to 30-year-old planted trees. If enough trees could be saved to adequately stock the area, the job of site preparation and planting could be eliminated, and the trees would be further along toward maturity. Furthermore, the area would be stocked with well-established trees highly adapted to the site through many generations of natural selection. Also, the land could be kept green, and the objectionable denuded appearance that results from clearcutting and planting avoided.

PACIFIC NORTH WEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

LOGGING TO SAVE PONDEROSA PINE REGENERATION: A CASE STUDY

ABSTRACT

FOREST SERVICE - U.S. DEPARTMENT OF AGRICULTURE - PORTLAND, OREGON

reforestation

Publications on Reforestation

A bibliography of selected publications on reforestation has been published by the Western Forestry and Conservation Association since 1964. References include: (a) all publications on reforestation in the western United States and Canada; (b) selections from worldwide literature that contain information about western species; and (c) other publications of general interest, timeliness, or broad applicability. Ask for the *Listing of Selected Publications on Reforestation,* by year (12).

SMALL STREAMS AND FISH HABITAT
by Louise Parker

Phyllis Weber is an enthusiastic student of nature. A resident of Seattle, Washington, the perky 26-year-old University of Washington graduate student spent the summer of 1975 in Alaska studying the effect of logging on small streams. Her work was done as partial requirement for a master's degree in forestry at the University of Washington.

The study area is at Corner Bay, southwest of Juneau in the Tongass National Forest. Trees there are mature coastal Sitka spruce and hemlock, around 400 years old. Streams are small and typical of the watercourses that punctuate many mountainous regions in coastal Alaska. They have the added importance of being rearing areas for young Dolly Varden and coho salmon. Information gained from studying the environment of those small streams will help forest managers improve logging practices, especially as they relate to fish habitat.

Study plots are located in both undisturbed forest and in areas that have recently been clearcut. Data are being gathered on many environmental factors, including air and water temperature, aquatic insects, and plant communities.

From her work so far, Phyllis offers several observations about good logging practices. As far as fish habitat is concerned, the best logging practice insures that:

- *Debris is kept from streams, even the smallest tributaries. Nearly all provide some habitat for fish.*
- *Culverts are properly placed to enable passage of fish even during the lowest streamflow. Sometimes culverts are placed properly in the beginning, but end up being ineffective because of settling of the fill material.*
- *Clearcuts are designed to minimize the amount of stream that is exposed. Shrubs and other plants left along streambanks also help shade the stream and maintain proper water temperature.*

When steep slopes must be logged, Phyllis believes that the best system is skyline logging. She bases this observation on her previous Forest Service experience with PNW's logging engineering research unit, which is developing improved logging systems.

natural

Reproductive Habits of Douglas-fir, by Leo A. Isaac (13)

Every forester in the Douglas-fir region should either read or be familiar with the contents of Leo Isaac's early (1943) paper on regeneration of Douglas-fir. As Thornton Munger, the first director of the Experiment Station, once said, Isaac "was an exceedingly sharp observer. He could see little 1-year-old seedlings when the ordinary person would pass them by. . . ."

Isaac summarizes his many years of observations in this 107-page report published by the Charles Lathrop Pack Forestry Foundation. The report is now extremely rare, but good libraries should be able to get a copy. Those who have access to the PACFORNET resource library may want to have copies made. Copies are NOT available from the Experiment Station.

In the report, Isaac discusses everything from seed supply, seedling establishment, and the effect of soils, climate, vegetation cover, to a variety of environmental factors on regeneration of Douglas-fir. Silvicultural treatments, including the single seed tree method, seeding from the side, and partial cutting are also discussed.

The summary paragraph of the paper is still a good rule to follow: "Conditions within the Douglas-fir type are so varied that simple, specific rules cannot be set forth for securing regeneration over large areas, either in the management of young stands or the harvesting of over-mature virgin forests. However, careful study of all local factors coupled with an earnest application of the findings set forth in this publication will produce far more satisfactory regeneration than has been obtained in the Douglas-fir region in the past."

As has been said often, a number of errors in forest management in the Douglas-fir region could have been avoided if foresters involved had only been thoroughly familiar with the work of Leo Isaac. This paper and the following summary are two good ones.

Factors Affecting Establishment of Douglas-fir Seedlings, by Leo A. Isaac (14)

The plant association in the Douglas-fir region, when destroyed by fire, goes through four distinct stages of succession before it reaches the climax type, unless again interrupted by fire or logging. These stages are the "moss-liverwort," "weed-brush," "intolerant even-aged Douglas-fir," and the "tolerant all-aged hemlock-balsam fir;" the last named, so far as is known, will persist. The weed-brush stage is most subject to fire, and successive fires do prolong and can perpetuate this stage.

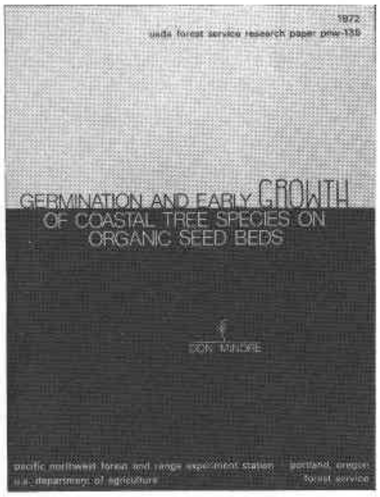
Colonies of exotic species are upsetting natural succession in some localities because they are unpalatable and more vigorous than native species. Grazing tends to eliminate palatable species and favors others like the exotics, bracken, and brush; however, many grasses have been introduced that have become naturalized and have improved grazing.

The underground parts of some virgin forest ground-cover species survive fires and form a minor part of the weed-brush stage; the remainder is made up of invading species, the most important of which are bracken, fireweed, blackberry, and snowbrush. Some species run their course and disappear, while others persist until they are crowded out by more vigorous brush cover and the oncoming forest.

Light cover is beneficial to coniferous seedlings but heavy cover is detrimental, and the weed-brush stage often develops a density that practically prohibits forest regeneration.

Successive fires impoverish the soil, favor the herbaceous species, retard the brush species, and eliminate from the succession the coniferous seedlings that would go to make up the new forest.

This report, too, is extremely rare. In fact, we couldn't find a copy locally to review. But the article was summarized by Isaac in a 1940 *Journal of Forestry* article which should be easy to find: 1940, Vegetative succession following logging in the Douglas-fir region with special reference to fire. Jour. of For. 38:716-721.



Germination and Early Growth of Coastal Tree Species on Organic Seed Beds, by Don Minore (15)

Shelterwood cutting is increasing in coastal forests of the Pacific Northwest, primarily because of scenic values. This means that foresters need to know more about the effects of shade and seed beds on establishment and growth of various tree species in that region—Douglas-fir, Sitka spruce, western hemlock, western redcedar, lodgepole pine, Pacific silver fir, and red alder.

Results of three studies indicate that shade is an important factor in determining where young seedlings will become established and how well they grow once established. For example, in heavy and moderate shade, most coastal conifer seedlings will become established on rotten logs, rather than on the duff-covered forest floor. In light shade, both materials are excellent seed beds. But under full sunlight, neither organic seed bed is very good.

Not only are more seedlings established under heavy shade on rotten logs but they also grow better there—even though more nutrients are available in duff than in rotten wood. The apparent paradox is explained by the fact that more duff accumulates on tops of rotten logs than on the forest floor.

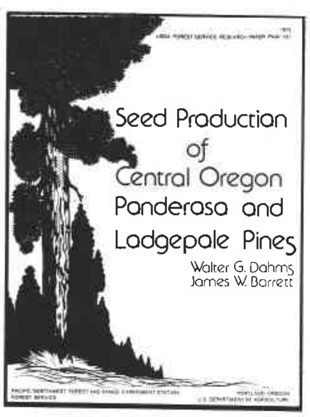
Where light shelterwood will result in a shaded seed bed, rotten wood and duff should be preserved. This will benefit all conifer species by providing extra nutrients for the short-rooted seedlings produced under low-light conditions.

Uprooted hemlock seedling with roots embedded in buried rotten wood.

Dispersal of Lodgepole Pine Seed Into Clear-cut Patches, by Walter G. Dahms (16)

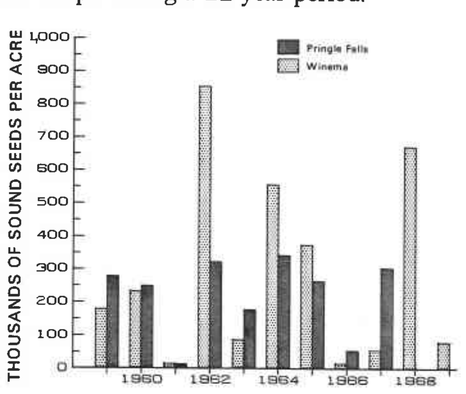
In south-central Oregon, lodgepole pine produces good seed crops in most years. But unlike lodgepole pine in the Rocky Mountain region, the cones in Oregon tend to release their seed fairly promptly following ripening. In the Rockies, lodgepole pine cones are "serotinous," meaning they hold their seed for several years or until opened by fire. As a result, natural regeneration of clearcuttings depends largely on seeds that come from surrounding timber.

The number of seeds dispersed into clearcuttings falls off very rapidly from the timber's edge and reaches a very low level at distances beyond 200 feet. Consequently, foresters should restrict the width of clearcut strips or blocks to about 400 feet, allowing trees on either side to seed into the center of the clearcut.

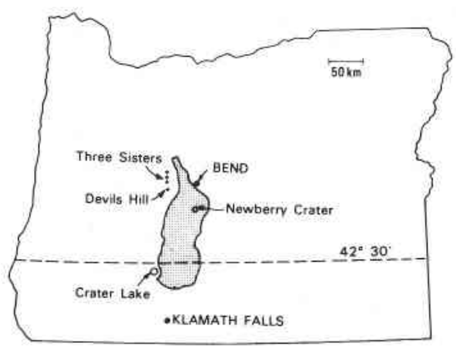


Seed Production of Central Oregon Ponderosa and Lodgepole Pines, by Walter G. Dahms and James W. Barrett (17)

From studies begun in 1953, researchers have learned much about the natural seed production of two central Oregon trees—ponderosa and lodgepole pine. Their observations indicate that lodgepole is a more prolific seeder than ponderosa pine. Lodgepole produced enough sound seed to get a satisfactory crop of seedlings 3 years out of 4. Ponderosa pine produced only five good seed crops during a 22-year period.



Number of sound lodgepole pine seeds per acre on the Winema and Pringle Falls area.



Approximate boundary of the pumice-mantled plateau in Oregon.

Soil Temperatures and Natural Forest Regeneration in South-Central Oregon, by P.H. Cochran (18)

Part of south-central Oregon, that area west of Bend and south to Crater Lake, is covered by a mantle of pumice that resulted from the eruption of Mount Mazama and other mountains thousands of years ago.

This region supports extensive forests of ponderosa and lodgepole pine. Usually lodgepole occurs in pure stands on flats and in basins, while ponderosa or a mixture of the two species dominates the higher ground. This distribution apparently results because lodgepole seedlings are more tolerant to low night temperatures so they grow better in "frost pockets."

Also within this area are many "pumice deserts" which are poorly stocked or nonstocked. Since mismanagement of forest stands could sharply increase this desert area, proper cutting methods and reforestation procedures are essential. Researchers note that natural regeneration is most successful when an ideal sequence of events occurs: a good seed year, followed by a warm, moist spring; a cool, wet summer; and an early snowfall.

Since the ideal can't always be counted on, natural regeneration can be promoted by clearcutting timber in strips less than two tree heights wide, leaving trees in a shelterwood cut no more than one-half tree height apart, and leaving some untreated slash as ground cover. Another alternative is to depend more on a planting program.

For an early report on the same subject, see also Research Note PNW-204, *Natural Regeneration of Lodgepole Pine in South-Central Oregon,* by P.H. Cochran (19).

Pat Cochran

In her field work, Phyllis works closely with Art Bloom, a fisheries biologist at the Juneau Lab. "The problem in Alaska is recognizing the importance of small streams as fish producers," Bloom says. "Most people understand the role that larger streams play in salmon spawning. But few know that the fish, especially coho salmon, use the very tiny feeder streams as rearing areas."

Research in the 1950's, on Prince of Wales Island, indicated that clearcutting did not adversely affect the salmon spawning habitat—at least with the techniques used, no damage was detected. There was a moderate increase in stream temperature in the fall following logging. Streamflow and sedimentation also increased following logging, but no one knew what effect that may have had on fish habitat.

Researchers, including Bloom, now believe that very minor changes in environment do affect the fish and that the early research methods were not accurate enough to detect the small changes in temperature or sediment that might have affected eggs or young fish.

Bloom has some studies underway in the tributaries of the Kadashan River a few miles west of Corner Bay. This is one of the best salmon-producing streams in southeast Alaska. He is studying fish rearing habitat, looking at factors such as physical characteristics of streams, streamside vegetation, and food available for the fish. Bloom is now preparing reports on this work. The research results will help provide management prescriptions for protecting fish habitat during and after logging.

"Logging does not have to be detrimental to the fishery resource," Bloom says. "It's a matter of how it's done."

During some stages of development (particularly the "eyed" stage or until about 2 weeks after fertilization) the fish are especially vulnerable to environmental changes. Very small changes in stream temperature or sediment can cause mortality.

Stream temperature is affected by the amount of vegetation along the streambanks. When an area is clearcut down to the edge of a stream, water temperature can go up as much as 10 to 20 degrees or more. This is important because an increase in temperature can affect spawning behavior, egg survival, and the survival and growth of fry. For one thing, fish eggs hatch according

Lodgepole Pine Cold Resistant

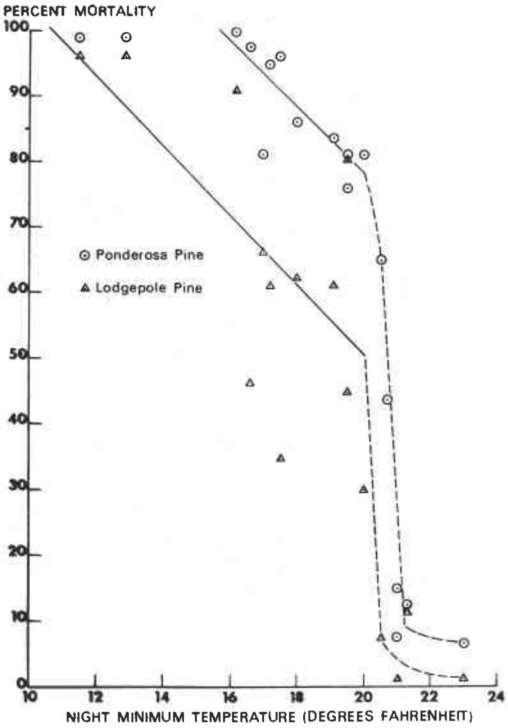
In trying to learn more about why lodgepole pine and ponderosa pine tend to segregate themselves in the pumice soil region of south-central Oregon, researchers conducted some studies to test the cold resistance of each.

What they found was interesting. In growth chamber studies, 36-day-old seedlings were exposed to night minimum temperatures of less than 23° F. As a result, more of the ponderosa pines died. The lodgepole was more frost-hardy.

Interesting to note that younger seedlings (22 days old) were more tolerant of low night temperatures than older seedlings. Prior exposure of seedlings to near-freezing levels also helped reduce the damage. Also, by the time seedlings were 2 months old, the difference between temperature tolerance of the species had disappeared.

Results support the hypothesis that the "frost pocket" distribution of lodgepole pine in a mosaic with ponderosa pine is partly due to the differing ability of the seedlings to withstand low night temperatures.

See *Tolerance of Lodgepole and Ponderosa Pine Seedlings to Low Night Temperatures,* by P.H. Cochran and Carl M. Berntsen (20).



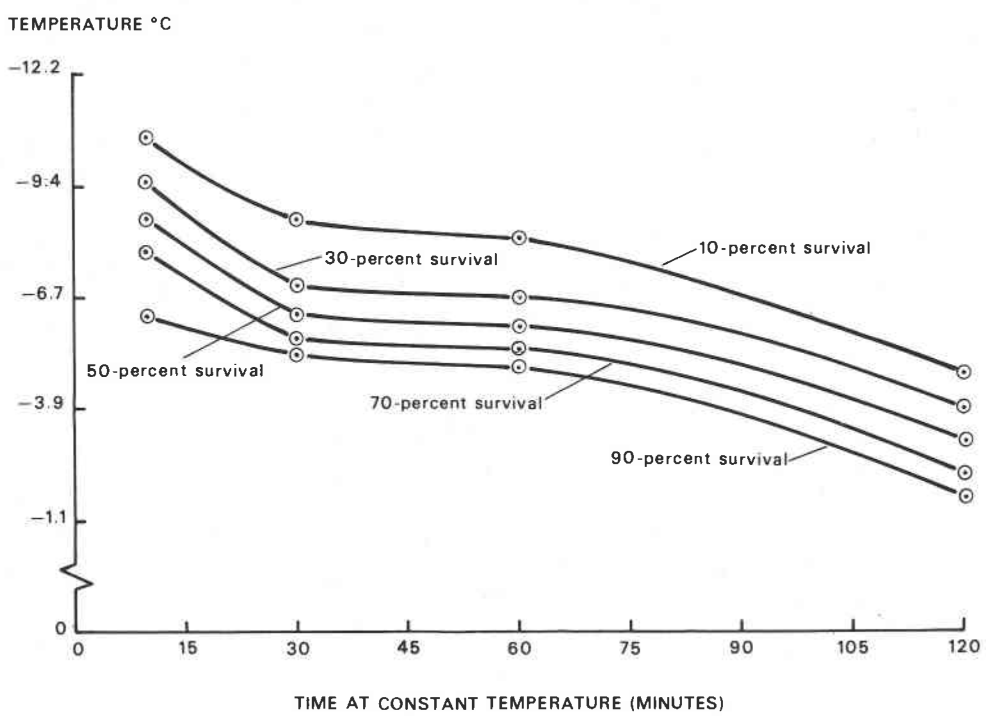
Mortality of ponderosa and lodgepole pine as related to night minimum temperature.

Freezing Kills Grand Fir

Temperatures lower than −5° C. can result in considerable mortality of newly germinated grand fir seedlings—if they are exposed longer than 10 minutes. Since temperatures this low are common in the spring in central Oregon, this can be a significant factor in causing grand fir mortality.

Low night temperatures are not likely to be a problem in the fall, however, because by then seedlings are more frost resistant. Also, in the fall temperatures do not generally drop below −18° C. or, if they do, not for very long.

Freezing Resistance of Hardened and Unhardened Grand Fir Seedlings, by K.W. Seidel (21).



"Isosurvival curves" of 10, 30, 50, 70 and 90 percent for 1-week-old grand fir seedlings.

Frost Tolerance of Ponderosa and Lodgepole Pine, by Frank C. Sorensen and Richard S. Miles (22)

The cones and pollen catkins of lodgepole pine were much less damaged by a late spring frost than those of ponderosa pine at the same stage of development. Previous studies had reported that lodgepole is more tolerant of low temperatures as the seedlings emerge, and this species is found in frost pockets of central Oregon where ponderosa is not.

Soil Moisture and the Distribution of Lodgepole and Ponderosa Pine, by Robert F. Tarrant (23)

This report is a review of the literature on soil moisture and the distribution of lodgepole and ponderosa pine. Lodgepole pine had generally been thought of as a "weed" species. At times there had been proposals to get rid of the lodgepole and replace it with the economically superior ponderosa pine. These proposals were based on the assumption that lodgepole stands are the direct result of fire and represent encroachment onto ponderosa pine sites. A roundup of the pertinent literature helps eliminate some of these misconceptions.

seeding and planting

Ten-Year History of an Oregon Coastal Plantation, by Robert H. Ruth (24)

In 1941, the federal government acquired the Blodgett tract between Waldport and Yachats on the central Oregon coast. Although the region is highly productive timber land, it was not in good shape. The entire area was clearcut between 1919 and 1936, removing a stand of huge old-growth Douglas-fir, Sitka spruce, and western hemlock. Then the area burned over several times, eventually killing most of the seed trees. Tree planting was begun almost immediately after the tract was acquired by the government and continued until late 1944. By then, brush and alder had developed over the remainder of the area to a point where planting was impractical.

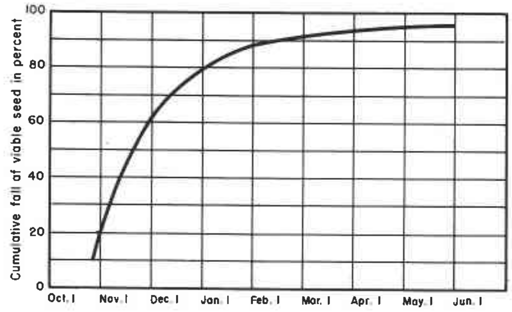
In 1943, a study area was established on the ridge near the center of the tract to test various species for planting on the site, survival of fresh and stored planting stock, effects of various planting techniques, and the influence of aspect.

The report describes what happened to trees in the study area during a 10-year period. Stocking averaged 581 trees per acre.

A 4-Year Record of Sitka Spruce and Western Hemlock Seed Fall, by Robert H. Ruth and Carl M. Berntsen (25)

Four years' measurement of seed fall in the spruce-hemlock type on the Cascade Head Experimental Forest indicates that an ample supply of seed is distributed over clearcut areas under staggered-setting cutting. The largest tract sampled was 81 acres; in spite of a seed crop failure in 1950, it received an average of 243,000 viable spruce and hemlock seeds per acre yearly on a high ridge near the center of the area. In the spruce-hemlock type it is apparently practical to clearcut fairly large openings and still depend upon adjacent stands for an adequate distribution of seed.

Spruce and hemlock seed fall consistently started during the last 10 days in October, usually when the first dry east wind occurred. Viability of seed averaged 55.5 percent.



Season of seed fall for Sitka spruce and western hemlock on the Cascade Head Experimental Forest.

Sugar Pine Successful in Southwest Oregon

An older, but still useful research paper, describing the first pilot-scale direct seeding of sugar pine in southwestern Oregon. The project was carried out in an area that had been logged in the Umpqua National Forest near Tiller, Oregon, in 1951. Elevations in the 67-acre clearcut ranged from about 2,900 to 3,300 feet, with all aspects represented.

Control of seed-eating rodents was accomplished by three separate applications of baits before seeding. Seed was placed in the ground in November in spots spaced 4 x 8 feet apart.

A good stand of sugar pine resulted. At the end of the second year, a survey showed 72 percent stocking and 455 seedlings per acre. Germination and survival were generally better on exposed mineral soil.

A Successful Direct Seeding of Sugar Pine, by William I. Stein (26).

A view of the seeded area looking southeast from the north boundary.

Pumice Soils Limit Root Growth

In the pumice soil region of central Oregon, the physical characteristics of some soils—notably the C1 horizon of the Lapine soil—limit seedling development. Apparently several factors are involved—bridging of individual soil particles, the high percentage of air-filled pore space in the soil, the non-plasticity of the pumice material. They combine to create a soil condition that limits root proliferation and penetration.

The study results suggest that some comparisons should be made between machine and auger planting in this region. Auger planting might result in more rapid penetration of roots through the unweathered surface layers into the buried soil profile.

Pumice Particle Bridging and Nutrient Levels Affect Lodgepole and Ponderosa Pine Seedling Development, by P.H. Cochran (27).

Peroxide Not Recommended

Use of strong hydrogen peroxide as a seed treatment to speed germination is not recommended. Researchers used a 30-percent solution of hydrogen peroxide and compared its effect on seed with normal cold stratification. Subsequent growth of potted seedlings was measured after 7 weeks and after 1 year. Average size of the peroxide treated larch was significantly less than for the trees from stratified seed. In most cases, Douglas-fir and ponderosa pines also tended to be smaller when the seed was treated with strong peroxide.

See *Growth of Douglas-fir, Ponderosa Pine, and Western Larch Seedlings Following Seed Treatment with 30 Percent Hydrogen Peroxide,* by James W. Edgren and James M. Trappe (28).

to the amount of heat they have accumulated. If the temperature is higher than normal, the eggs hatch sooner. They might even hatch before there are enough natural foods available for them.

Too much sediment in the streambed can also cause mortality. One of the research problems has been to develop devices that are sensitive enough to detect small changes in bedload sediment. Since salmon eggs are laid in gravel on stream bottoms, a suitable gravel sampling device is necessary.

Unhappy with the devices available, Bloom's research technician, Bill Walkotten, invented an improved "gravel freeze sampler" using carbon dioxide to freeze a core of the streambed. The method is now being used by other researchers around the state.

The Walkotten sampler enables a biologist to remove a plug of frozen gravel from the streambed. To take a sample, a hollow copper probe is inserted in the streambed. The liquid carbon dioxide is then pumped into the probe. When the probe is pulled out again, a frozen section of streambed comes with it. A device to measure waterflow in the gravels is also being developed.

Geographic features and weather conditions make it difficult to conduct research in Alaska. For example, all of the study areas are at considerable distances from the Lab's Juneau headquarters. Kadashan Bay is 50 air miles away, as is Corner Bay. Young Bay, another study area, is somewhat closer, but is often less accessible by boat or airplane. Maybeso Creek valley, where early watershed studies were conducted, is 240 miles.

The effective working season, in this rainy, cold part of southeast Alaska, is from the end of May to mid or late September. Access is by helicopter, airplane, or boat. There are no roads or trails. For long-term studies, you really need to live where you work.

A few years ago, the researchers needed to move a truck and backhoe to Young Bay. It took four men 5 days with a tug and a barge to get the equipment moved. The cost of moving the equipment alone was $1,200.

In such an environment, with a small staff, research results come slowly. But the work is important, and the lessons learned so far have been of help to foresters planning timber harvest programs in the Tongass

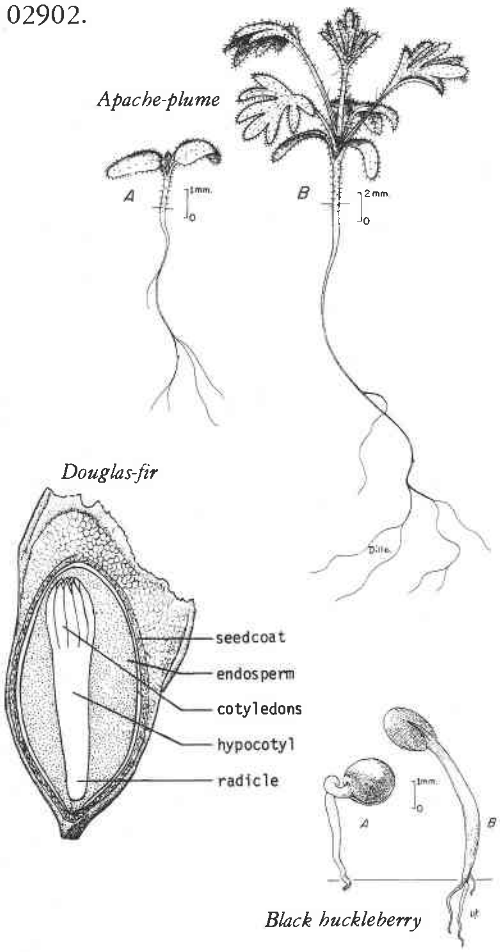
Seeds of Woody Plants in the United States, USDA Agriculture Handbook No. 450 (29)

An updated handbook that serves as a basic and necessary reference for anyone working with seeds of forest trees or other woody plants in the United States. Part I of the book covers principles and general methods of producing and handling seeds in 8 chapters:

I. Seed Biology
II. Principles of Genetic Improvement of Seed
III. Production of Genetically Improved Seed
IV. Pollen Handling
V. Harvesting, Processing, and Storage of Fruits and Seeds
VI. Presowing Treatment of Seed to Speed Germination
VII. Seed Testing
VIII. Tree-Seed Marketing Controls

Part II is a compilation of data on 188 genera of woody plants including flowering and fruiting dates, seed processing methods, storage conditions, seed yields and weights, methods of breaking seed dormancy, germination tests, and a large collection of fruit and seed photographs.

The book is for sale from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at a cost of $13.60. Order Stock Number 0100-02902.



An Increase in Conifer Seedling Survival and Vigor on an East Cascade Slope With a Soil Fumigant, by G.O. Klock (30)

Biotic factors may be restricting conifer seedling development in some soils east of the Cascades. Study results at one planting site indicate that soil fumigation can improve seedling survival. Survival of 2-year-old Douglas-fir seedlings was 45 percent on nonfumigated plots; 92 percent on plots fumigated with methyl bromide.

Fumigation is not necessarily recommended, but this researcher believes more research should be done to determine **why** fumigation resulted in the positive response.

Food Reserves and Seasonal Growth of Douglas-fir Seedlings, by Kenneth W. Krueger and James M. Trappe (31)

Stage of seedling growth and development should govern the timing of many nursery operations. In this study, seasonal relationships were determined between food reserves and growth of Douglas-fir seedlings.

Rapid root growth both preceded and followed the period of rapid top growth. Concentrations of certain sugars also followed seasonal patterns and, in some instances, were correlated with increased root activity. Concentrations of fat and protein changed little with season.

These results provide physiological evidence on the need to lift seedlings in the nursery at the right time. Late fall lifting allows sufficient time for buildup of food reserves. Spring-lifted stock should be dug prior to the surge of root activity. Adequacy of other nursery practices can also be analyzed by information provided by this type of fundamental study of seedling processes.

Relationship of Shoot-Root Ratio to Survival and Growth of Outplanted Douglas-fir and Ponderosa Pine Seedlings, by W. Lopushinsky and T. Beebe (32)

What effect do the amount of roots and height of top have on survival and growth of conifer seedlings? The answer comes from a study carried out in north-central Washington.

Two-year-old Douglas-fir and ponderosa pine seedlings with three top heights, and with either large or small roots, were planted in a burned-over area. The first-year survival of fir seedlings with large roots was 22 to 26 percent higher than survival of seedlings with small roots. Pine survival was increased 5 to 15 percent. Shoot growth (increase in shoot mass) of large-rooted fir and pine seedlings was as much as 2.1 and 4.8 times, respectively, that of small-rooted seedlings. Height growth of both fir and pine seedlings with large roots was 1.2 to 1.7 times that of seedlings with small roots. Weather during the year was cooler and moister than most years, apparently accounting for the relatively high survival of most seedlings.

nursery practices

Nursery Fertilization of Douglas-fir Seedlings With Different Forms of Nitrogen, by Radwan, Crouch, and Ward (33)

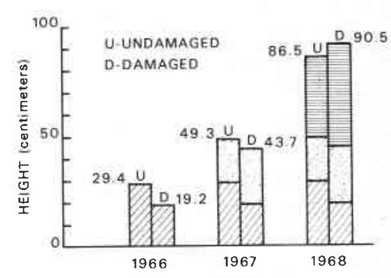
Three commercial fertilizers—ammonium sulfate, calcium nitrate, and urea—were tested to determine the relative values of ammonium, nitrate, and urea as nitrogen sources for Douglas-fir seedlings. The seedlings were grown at a forest tree nursery in western Washington, and the fertilizers were broadcast at 50 pounds nitrogen per acre in May and again in September. Seedling growth in the nursery and outplanting performance of the trees fertilized with nitrate and urea were essentially the same and superior to the ammonium treatment.

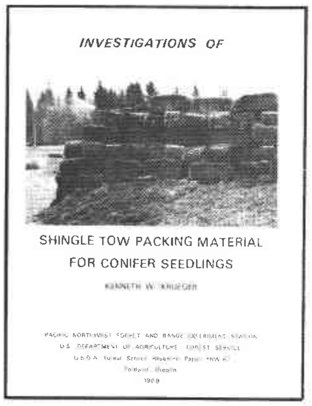
Growth of Frost-Damaged Douglas-fir Seedlings, by James W. Edgren (34)

Douglas-fir seedlings recently damaged by frost in the nursery should not be culled too heavily or seedlings with excellent juvenile growth potential will be discarded.

In a study at the Wind River Nursery, seedlings that had been hit by a hard frost in September 1965 were planted the same fall and next spring. Both seedlings that appeared damaged and those that did not were planted. Height growth of these seedlings over the next three seasons indicated that:

1. Some damage to Douglas-fir seedlings is hidden and can't be identified visually for many months,
2. Even when obvious, damage may not handicap future seedling growth,
3. Subsequent growth seems affected most when seedlings are lifted soon after being frosted, and
4. Multiple tops resulting from frost damage may be relatively unimportant.





Investigations of Shingle Tow Packing Material for Conifer Seedlings, by Kenneth W. Krueger (35)

Shingle tow, the stringy by-product from the manufacture of western redcedar shingles, has been used since about 1915 to keep seedling roots moist during shipment. For decades, it was the most commonly used material for packing trees for shipment from Pacific Northwest forest nurseries.

Shingle tow has not been without its critics, though. Unexplained seedling mortality during the first season after outplanting has been frequent in the Pacific Northwest. While there are many possible causes for such mortality, shingle tow has sometimes been suspect. In fact, some of the chemicals that leach from shingle tow are know to be toxic to Douglas-fir seedlings.

But are they toxic enough to cause large-scale mortality under the conditions of use? Unlikely, according to this report. But the concerns will probably persist, especially when plantation failures occur.

Sizing Seed Reduces Variability in Sowing Ponderosa Pine, by James W. Edgren and Charles A. Bigelow (36)

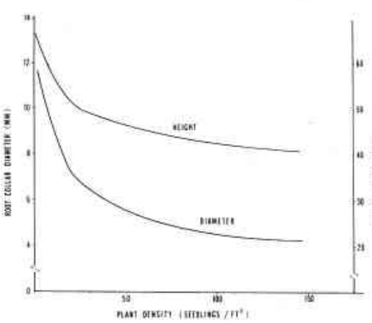
What effect does sorting seed by size have on the uniformity of sowing in the nursery? The answer to that question comes from a study at the Bend Forest Nursery.

Results indicate that sorting seed into size classes will improve seeder performance. Sowing rates for small seeds were more variable than for medium and large seeds. However, even medium and large seeds were not sown uniformly enough. Because seedling size is influenced by seed size, seedling density and distribution, the authors recommend that: (a) the actual contribution of small seed to the reforestation program be investigated, and (b) a seeder should be designed which ensures more uniform sowing.

Seedbed Density Influences Height, Diameter, and Dry Weight of 3-0 Douglas-fir, by Boyd C. Wilson and Robert K. Campbell (37)

Fairly large seedlings are needed in order to reforest many planting sites. These trees are usually produced by growing trees 2 years in a nursery seedbed and 1 year in a transplant bed, thus 2-1 stock. It might be cheaper, however, to grow the seedlings 3 years in the seedbed and thereby avoid transplanting.

Past observation has suggested that the growth of seedlings is greatly influenced by seedbed density. So a study was conducted at different spacings in the nursery, with the following conclusions: (a) spacing affects both height and diameter of seedlings; (b) Douglas-fir 3-0 seedlings do not have the same characteristics as 2-1 or 1-2 transplants; (c) Douglas-fir 3-0 seedlings use more bed space than transplants but are cheaper; (d) height and diameter of the seedlings can be used to predict dry weight of roots and tops; (e) with 3-0 planting stock, the top/root ratio is not likely to fall below 2.6; and (f) growing Douglas-fir 3-0 seedlings at 8-10 seedlings per square foot is suggested in order to produce optimum planting stock.



Relationship of seedbed density to seedling height and diameter of 3-0 Douglas-fir.

Douglas-fir 2+0 Nursery Stock Size and First-Year Field Height Growth in Relation to Seed Bed Density, by James W. Edgren (38)

A preliminary account of the effects of seedbed density on seedling size and survival, this report points out the striking effect of bed density on diameter of the seedlings in the nursery and eventually on height growth in the forest.

Although additional studies must be made, it now appears that seedlings are too dense in the nursery at 40 per square foot.

Jim Edgren

National Forest. The fisheries work is conducted in cooperation with the Alaska Region of the Forest Service.

Don Schmiege, who heads the research program in Juneau, points out that the whole coast of southeast Alaska is important for fisheries. There are literally thousands of salmon-producing streams that run through forested watersheds. Land management practices in coastal Alaska can have a significant effect on the fisheries resource.

"It's the fresh-water habitat here we're interested in," Schmiege says. Other agencies, such as the Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service, have responsibility for keeping accurate fish counts and for research on saltwater habitat.

No one knows for sure just what effect logging has on salmon production. Salmon catches have fallen off dramatically since about 1945. Many people believe the real problem is overfishing—not just of salmon, but also fish the salmon eat, such as herring. But the responsibility of land management agencies is to keep the habitat as productive as possible.

Habitat improvement research is also possible in the future. "There are many things that might be done to improve the fish habitat," Schmiege says. This might include removal of log jams, installation of fish ladders around natural barriers, and "riffle sifting" to rid the gravels of excessive sediment.

end

DESIGNING WITH DESK-TOP CALCULATORS

by Louise Parker

The PNW Experiment Station's Forest Engineering Laboratory in Seattle, Washington, has achieved a major advancement in logging engineering technology by using desk-top calculators. The compact Hewlett-Packard 9830 calculator, together with a high-speed printer, electronic digitizer, and plotter, can now be programmed for road planning and harvest unit design.

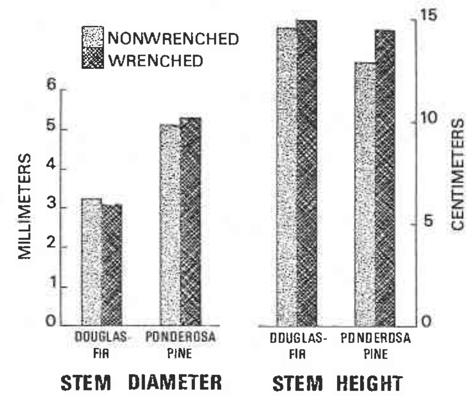
The basic cost of the system runs about \$20,000. But even in today's inflated economy, that buys a lot of analytic and design

Wrenching—Recent Developments in an Old Technique, by James W. Edgren (39)

If seedlings raised in forest nurseries develop efficient root systems, they are hardier and survive better when planted in the forest. Undercutting and wrenching—techniques to encourage fibrous rooting, prevent deep rooting, and limit height growth—have been used for many years. New combinations of these techniques are now under study in the Pacific Northwest.

Seedlings are first conditioned by undercutting, a procedure in which the tap roots are cut off by passing a sharp blade under the seedbed. This is followed by passing a thicker, broader, tilted blade beneath the seedbed (wrenching) one or more times to sever replacement tap roots and aerate the root zone.

Though pioneered in New Zealand nurseries with Monterey pine, similar techniques should prove useful in the Pacific Northwest on native species when the proper treatment interval is discovered. A preliminary test involving ponderosa pine and Douglas-fir is discussed.



Coating Materials Protect Douglas-fir and Noble Fir Seedlings Against Drying Conditions, by Peyton W. Owston and William I. Stein (40)

The roots of tree seedlings should not be allowed to dry out excessively between lifting in the nursery and planting. Several coating treatments have been used successfully to prevent drying out. Clay slurry, xanthan gum, and sodium alginate protected roots of freshly lifted Douglas-fir and noble fir seedlings during 40 minutes' exposure. Xanthan gum was best for Douglas-fir and clay slurry best for noble fir.

The treatments are not recommended for trees destined for storage. Treated seedlings stored for 8 weeks were under much higher moisture stress one month after planting than seedlings stored with sphagnum moss packing material.

Field Survival Poor for Stored and Heeled-In Ponderosa Pine Seedlings, by James W. Edgren (41)

From a bad experience, the result of a premature lifting of several thousand ponderosa pine seedlings from the nursery in mid-November of 1968, has come some good advice—don't do it again.

The 3-0 seedlings were accidentally lifted, then put into cold storage or stored and later heeled-in until they could be planted in the spring. Storage and storage plus heeling-in had adverse effects on the seedlings. A year after planting, survival was best (57 percent) in the control group of trees planted immediately after lifting in the spring, poorest (18 percent) in the group stored longest, and intermediate (24 to 32 percent) in the trees stored and later heeled in.

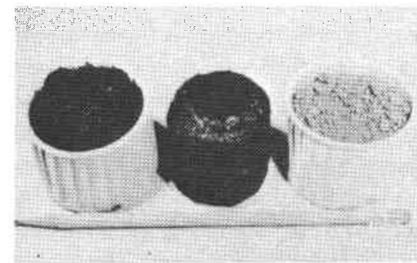
The trees were planted in southwest Oregon, where sites are normally hot, dry, and difficult. But length of storage is also important for seedling survival in other parts of the West.

Peat Proves Superior Medium for Douglas-fir Seedling Growth, by James W. Edgren (42)

In one test, Douglas-fir seedlings grew considerably better in expanded Jiffy-7 peat pellets and crumbled peat than in nursery soil.

Lateral root length differences between seedlings growing in peat and soil were startling. Total length of lateral roots in soil was one-twentieth that in Jiffy-7 pellets and one-nineteenth that of crumbled peat.

Study results suggest that a high percentage of peat would be advantageous for producing Douglas-fir in containers.



Douglas-fir seedlings were grown in, left to right, crumbled peat, expanded Jiffy-7 pellets, and soil.

container seedlings

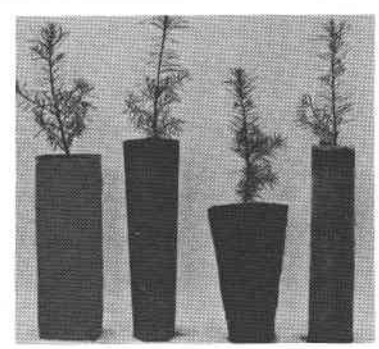
First-Year Performance of Douglas-fir and Noble Fir Outplanted in Large Containers, by Peyton W. Owston and William I. Stein (43)

First-year survival of Douglas-fir and noble fir seedlings can be improved substantially by outplanting in large containers in which the seedlings have previously grown. Growth of 2-year-old nursery-grown Douglas-fir and noble fir was compared with trees grown and planted in four types of containers: milk carton, cardboard tube, peat pot, and plastic-mesh tube.

First-season survival of containerized Douglas-fir averaged 95 percent compared with 83 percent for bare-root stock. Comparable figures for noble fir were 88 percent for containerized trees and 78 percent for bare-root stock.

Height growth was also substantially better for containerized seedlings. Douglas-fir growth averaged 8.1 cm compared to 2.8 cm for bare-root stock.

For further discussion of this work, see also *Field Performance of Containerized Seedlings in the Western United States,* by Peyton W. Owston (49).



Douglas-firs 2 months after potting in; left to right, milk carton, Weyerhaeuser tube, Fertil pot, and Conwed tube.

Cultural Techniques for Growing Containerized Seedlings, by Peyton W. Owston (44)

Containerized seedlings may never fully replace conventional bare-root stock in the West, but they can be used to solve special reforestation problems:

1. To provide stock at optimum times for high-elevation sites
2. To regenerate western hemlock
3. To quickly reforest areas unexpectedly denuded
4. To provide uniformly treated, high quality seedlings for genetic and reforestation tests.

Owston discusses several factors related to growing containerized seedlings, including environmental controls, containers, potting mixture, sowing, watering, fertilizing, and hardening-off.

A Suggested Method for Comparing Containerized and Bare-Root Seedling Performance on Forest Lands, by Peyton W. Owston and William I. Stein (45)

Containerized seedlings are being produced and planted by the millions on forest lands in the Pacific Northwest. Approximately 23 million were grown in Oregon and Washington greenhouses and nurseries in 1973. With more and more forest acres being planted with containerized stock, it is necessary to evaluate the success of containerized seedlings and develop guidelines for their use.

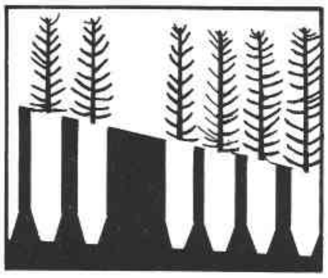
In this report, Owston and Stein describe procedures for making field comparisons of containerized and bare-root stock. Common use of the suggested methods will facilitate pooling of data and analyses. In addition, they seek to cooperate with organizations interested in evaluating containerized seedling performance.

Outlook for Container-Grown Seedling Use in Reforestation, by William I. Stein, Jerry L. Edwards, and Richard W. Tinus (46)

The reforestation methods of yesterday can no longer handle some of the challenges posed by modern forestry. The profession is turning increasingly to containerized seedlings. In 1973, the United States produced 963,105,000 trees for forest and windbarrier purposes. Of these, 3 percent (26 million) were grown in containers. Each year the number of container-grown seedlings increases.

In August 1974, about 350 people attended the North American Containerized Forest Tree Seedling Symposium at Denver, Colorado. In this synopsis, published in the *Journal of Forestry,* three Forest Service people describe the current containerized situation. The authors give some of the reasons for the move to container-grown nursery stock, expose some of the drawbacks, and point to important research needs.

Also available from that symposium are papers presented by Stein and by Owston (47 & 48).



Field Performance of Containerized Seedlings in the Western United States, by Peyton W. Owston (49)

The use of containerized stock is increasing dramatically in the western United States. As a result, field performance of these trees needs to be thoroughly evaluated. Operational flexibility gained by use of container trees is of questionable value if their survival and growth does not match or exceed performance of conventional bare-root stock.

Owston summarizes information from early trials where performance of bare-root and container stock is being compared. Small containerized Douglas-firs performed acceptably on sites that were not climatically harsh but did not match bare-root stock performance on hot, dry, south slopes. Large containerized stock may be suitable for a variety of uses but more needs to be known about cost and performance.

Bill Stein *Pete Owston*

Why Use Container-Grown Seedlings? by William I. Stein and Peyton W. Owston (50)

Since 1970, use of container-grown conifer seedlings has increased dramatically in the western United States and Canada. For example, container seedling production in Oregon and Washington increased from less than 1 million to 43 million in just 5 years. During the same period, production of bare-root stock also increased substantially.

There are important contrasts between container and bare-root seedlings. Container seedlings are generally younger and smaller, have a complete root system, are physically better protected, and do not lose contact with soil as do bare-root seedlings when moved from the nursery to the field. About twice as many container seedlings can be produced in the same amount of space in about half the time. Lot identification and seedling growth can be more closely controlled than for bare-root seedlings.

Field comparisons indicate that container-grown seedlings often equal or exceed the survival of bare-root seedlings. The choice of stock to use hinges on relative cost, flexibility, management objectives, and individual circumstances. Container production and planting systems add a new dimension to the attainment of reforestation goals.

capability. According to Hilton Lysons, project leader at Seattle, the H-P 9830 system can significantly aid the logging engineer in expanding his design capability.

The Engineering Laboratory acquired their first desk-top calculator, an H-P 9100, in 1969 to use in skyline logging design. But they could see then that this approach had other applications in forestry—perhaps in road design, timber sale appraisal, and forest surveying. Since then, the group has developed seven computer programs for skyline engineering and five for road planning and design.

"Technology has a long history of advancing to meet the needs of the times," Lysons says. "Today's environmental constraints, plus the energy crisis, are forcing us to look at new ways to get our job done. The calculator lets the user properly consider the total systems requirements in developing the best logging and road plan."

Ward Carson, an engineer at the Laboratory, has used the calculator package to improve the design of skyline logging systems. He says recent skyline developments have promoted new interest in this method of logging.

Skyline systems are complex. The logging designer who opts for a skyline system is faced with a multitude of engineering problems, including anchors, allowable deflections, tensions, loads, topography, and the overall capability of the system under consideration. The chances for failure are almost legion and the hazards costly in terms of shutdowns, equipment failures, and hazards to life and property.

But skylines also have some distinct advantages. They can be used to log country that is steep and rugged without causing excessive environmental damage to the slope. Energy requirements are low, especially when compared to the heavy energy demands of helicopter logging, an alternate system for logging steep slopes.

In order to work with skylines, Carson says the logging designer must understand them thoroughly. In the past this was only achieved after long practice and experience in the field. "Now," says Carson, "that experience can be obtained by studying the system through the computer." He claims that any skyline design can now be handled on desk-top computers.

spacing and thinning

Considerable research has been done at the PNW Station on thinning and fertilization, and on their benefits when combined. Papers on thinning include articles that deal with the following species: lodgepole pine, western larch, ponderosa pine, and Douglas-fir.

douglas-fir

Guidelines for Precommercial Thinning of Douglas-fir, by Donald L. Reukema (51)

Production of merchantable wood in even-aged Douglas-fir stands can be increased substantially by precommercial thinning. Considerations are discussed and procedures are recommended here. Guidelines for precommercial thinning depend on the size of tree that is wanted at the first commercial cut. In general, the larger the tree desired: (a) the fewer trees should be left after precommercial thinning, (b) the greater the age or tree size at which precommercial thinning is practical, and (c) the greater the gain in usable wood from precommercial thinning.

Also, generally, the longer the time required for a stand to reach commercial size without thinning, the greater the gains from precommercial thinning.

Fire Hazard from Precommercial Thinning of Ponderosa Pine, by George R. Fahnestock (52)

Precommercial thinning has become a major feature in management of ponderosa pine on the national forests of Oregon and Washington. Nearly 47,000 acres were thinned in 1966, up from 9,196 in 1959; and the upward trend appears certain to continue.

Thinning persumably increases wood production, but what effect does it have on fire hazard? The conclusion outlined is that thinning increases fire hazard for at least 5 years after cutting, but that the long-term result is reduced fire hazard.

Unthinned young ponderosa pine stands.

Dick Williamson

Cooperative Levels-of-Growing Stock Study in Douglas-fir, Report No. 1, by Richard L. Williamson and George R. Staebler (53)

Public and private agencies are cooperating in a study of eight thinning regimes in young Douglas-fir stands. The study is being carried out in western Oregon and Washington and on Vancouver Island in Canada. The regimes differ in the amount of basal area allowed to accrue in growing stock at each successive thinning. All regimes start with a common level-of-growing stock. Site quality of the areas varies from I through IV. Climatic and soil characteristics for each area and data for the stand after the initial thinning are described.

See also, Report No. 2 on the same study by John F. Bell and Alan B. Berg (53). Data from the first seven years shows that growth changes in the thinned stands were greater than expected.

See also Report No. 3 from trials in British Columbia, Canada. It's called *Levels of Growing Stock Cooperative Study in Douglas Fir in British Columbia,* by P.K. Diggle, BC-X-66, 1972, available from the Pacific Forest Research Centre, Canadian Forestry Service, Victoria, British Columbia.

Report No. 4 by Richard L. Williamson (54) described the status of three of the nine study areas maintained by the U.S. Forest Service.

In those areas, growth in all thinned stands was considerably below that in unthinned stands. The two older stands—27 and 32 years old—responded similarly to the calibration thinning. Growth percent of thinned stands was about 25 percent better than that of unthinned stands, however. The youngest stand, 19 years old at thinning, was so young that all trees were essentially free growing and little growth stimulation resulted. Thinning, however, enabled the trees to continue their free-growing condition as control stands began to show signs of competition.

So far, (this report was published in 1976) smaller trees (codominants) in thinned stands seem to be growing better than larger trees, but more time is needed to substantiate this finding.

Some Observations on Yield and Early Thinning in a Douglas-fir Plantation, by Norman P. Worthington (55)

A May 1961 article in the *Journal of Forestry* discusses the advantages of proper spacing in Douglas-fir.

At 31 years of age, measurements showed that yield in the plantation was markedly higher than if the trees had not been planted at exact spacings. Merchantable volume yields of 4,583 cubic feet and 17,614 board feet were obtained on a 150-foot site index —increases of 64 and 55 percent over yields from natural stands.

The greater growth of the planted trees is attributed to more exact spacing, which permits a rapid, less inhibited development of individual trees. As a result, plantation trees have larger and more numerous limbs than trees in natural stands, but it is believed their effect on lumber quality will be small. However, pruning would be practical if clear wood is desired.

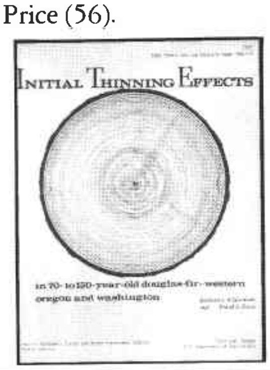
Initial Thinning Effects in Douglas-fir

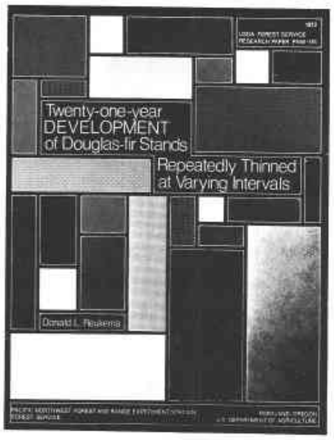
Management guides are given for maximum production in vigorous, mature, essentially even-aged stands of Douglas-fir. The guides are primarily for stands 70 to 150 years old, but they may also be applied to older stands that are still vigorous.

The areas studied to obtain these guidelines are in western Oregon and Washington. In these studies, thinning resulted in the transfer of growth to fewer and better trees, and a more vigorous stand with less risk of mortality from bark beetles.

Recoverable cubic-volume growth, averaging 81 percent of normal gross growth, was recorded for up to 38 years with single thinnings and for 18 years with two thinnings. This percentage increases with stand age. In addition, there was a dramatic 61 percent reduction in loss caused by bark beetles and substantial reductions in losses from windthrow, breakage, and suppression.

Initial Thinning Effects in 70- to 150-year-old Douglas-fir—Western Oregon and Washington, by Richard L. Williamson and Frank E. Price (56).

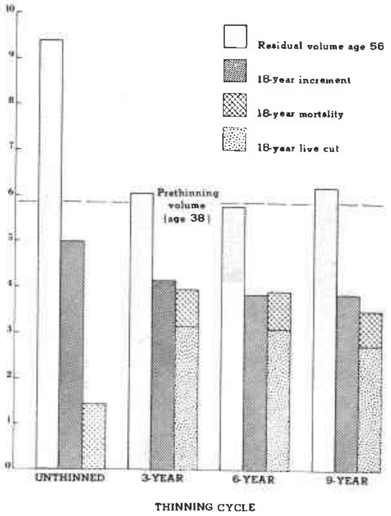




Twenty-One-Year Development of Douglas-fir Stands Repeatedly Thinned at Varying Intervals, by Donald L. Reukema (57)

Douglas-fir stands first thinned at about age 38 have been studied for 21 years. Four treatments were compared: no thinning, light thinning at 3-year intervals, moderate thinning at 6-year intervals, and heavy thinning at 9-year intervals.

Eighteen years after initial thinning, all the stands had about 65 percent of the volume they would have had without thinning. Gross growth in all thinned stands was about 20 percent less than in unthinned stands. There was less mortality in thinned stands, however, and that was enough to offset the growth loss. The primary benefit was an earlier harvest of products, not a substantial increase in total usable wood fiber.



Eighteen-year growth and yield, by treatment.

Don Reukema

Forty-Year Development of Douglas-fir Stands Planted at Various Spacings, by Donald L. Reukema (58)

As the need for intensive forest management becomes more evident, the effect of initial plantation spacing and/or early thinning on stand development is of increasing interest and importance to the land manager. Douglas-fir stands planted in 1925 at Wind River, near Carson, Washington, have been observed periodically for over 40 years and provide an increasingly valuable record of the benefits derived from fairly wide, uniform spacing.

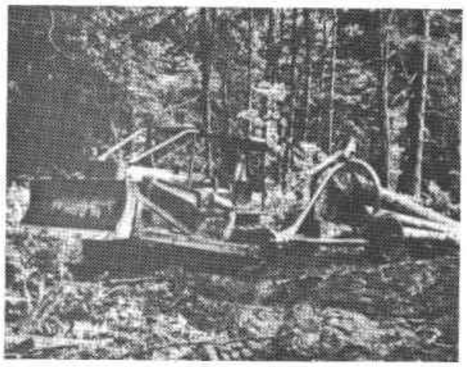
During recent years, diameter and height growth of even the 100 largest trees per acre and total basal area and cubic volume growth per acre have all been substantially greater on the wider spacings. Furthermore, a great share of the total volume produced in the closer spacings in not merchantable.

See also a 1970 report by Robert O. Curtis and Donald L. Reukema (59) that discusses *Crown Development and Site Estimates in a Douglas-fir Plantation Spacing Test.* Striking differences were noted among the various spacings in apparent site indices. These differences are attributed to reduced growth caused by competition rather than real site differences.

The authors caution that high initial density in low-site stands can lead to serious underestimates of potential productivity.

Commercial Thinning of Douglas-fir in The Pacific Northwest, by Norman P. Worthington and George R. Staebler (60)

This 124-page handbook may be a little old now (1961) but it is still the best summary on commercial thinning in Douglas-fir. Authors Worthington and Staebler discuss theory of thinning, its effects on forest management, how to carry out a thinning operation, the products produced, and costs and returns from commercial thinning. It's good background reading and a necessary first step for anyone considering thinning in Douglas-fir.



Small tractors are commonly used for skidding thinning products larger than can be handled economically by horses.

''A properly designed computer program puts the designer right into the act,'' Lysons says. ''It enables him to quickly analyze the data, look at all alternatives, and then select the best possible design. That's the only way to meet the environmental constraints in an economical manner. Before the computer, the process of checking out all possible alternatives took so long that by the time you got one design thoroughly analyzed, you said the hell with it and let it go at that.

''The calculator provides the option of checking alternative systems quickly and of determining which system really fits the terrain. With the 9830, it takes about the same time to check all possible alternatives that it used to take to do one design by hand.''

Doyle Burke, a logging engineer with the Seattle group, says that planning of timber access roads has always been one of the weak links in logging engineering. ''The location and quality of commercial timber and elevation can be determined from aerial photos and topographic maps,'' Burke says. ''Road planning and design information such as horizontal and vertical curvature and earthwork volumes are not readily apparent from maps but can be developed with the interactive 9830 calculator system and the road design program package. Road design alternatives can be evaluated at up to 1,000 feet of road per minute.''

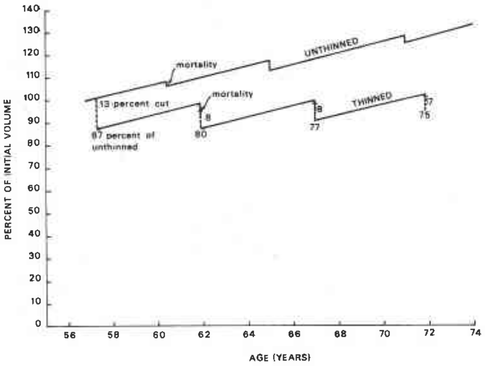
George Goddard, forest engineer on the Willamette National Forest in Eugene, Oregon, is impressed with the applications of the 9830 in stump-to-mill total systems planning. The Forest presently has units at Oakridge, McKenzie Bridge, and Sweet Home.

Personnel on the Willamette spent nearly a year debating the pros and cons of the various software systems presently on the market. Goddard talked with representatives from Hewlett-Packard and discussed the function and capabilities of various systems with the Seattle engineers. The result was a decision to go with the 9830.

According to Goddard, the system is a real benefit in putting sales on the Forest's 5-year action plan. ''We can see if we have a go or no go situation, and we know right now whether we can put the sale in our plan or not. Later on, we can refine the system for specific sales that we decide to include. The 9830 enables us to examine a lot of alternatives in a very short time.

Yields With and Without Repeated Commercial Thinnings in a High-Site Quality Douglas-fir Stand, by Donald L. Reukema and Leon V. Pienaar (61)

A high-site-quality Douglas-fir stand was first thinned when about 57 years old and at 5-year intervals thereafter through approximately age 72. The thinnings evidently caused about a 10-percent reduction in gross growth per acre. On the other hand, 15-year diameter growth of surviving trees was 29 percent greater in thinned than in unthinned stands. The reduction in gross growth was more than offset by forestalling and salvaging mortality. As a result, if the final harvest is made 10 years after the last thinning, at about age 82, thinnings will have brought about an estimated 5-percent increase in total usable production. Removal of volume in these thinnings will have resulted in about a 20-percent reduction in volume to be cut at that final harvest.



Relative cubic volume growth and yield in thinned and unthinned stands.

Individual Trees Respond To Thinning

As more young Douglas-fir stands in the Pacific Northwest come under intensive management, it becomes increasingly important to develop better thinning techniques based on sound scientific principles. Two experiments were set up to measure the effect of different degrees of release on the growth of dominant, codominant, and intermediate trees. The initial test was in a 41-year-old natural Douglas-fir stand. A second test in a nearby 30-year-old plantation permits a comparison of early results.

In the 41-year-old stand, remeasurement at the end of four growing seasons showed that dominants respond more quickly and positively to the removal of competing trees than codominants or intermediates. A second remeasurement at the end of seven growing seasons substantiated this trend.

Three-year results in the 30-year-old plantation showed no significant effect of release on tree growth.

See *Response of Individual Douglas-fir Trees to Release,* by Donald L. Reukema (63) and *Diameter Growth of Plantation-Grown Douglas-fir Trees Under Varying Degrees of Release,* by Kenneth W. Krueger (64).

Litter Fall in a Young Douglas-fir Stand As Influenced by Thinning, by Donald L. Reukema (65)

Litter falling to the forest floor plays a fundamental role in soil formation and fertility and has a basic influence on forest productivity. A study conducted in the Voight Creek Experimental Forest in western Washington has helped scientists learn more about the amount and timing of litter fall and how these factors are influenced by thinning. Research results are of considerable scientific interest and provide background data for studies of nutrient cycling in forest stands.

Average litter fall in the unthinned Douglas-fir stand was 1,974 pounds per acre per year. On the average, litter fall remained nearly proportional to basal area over the 13-year period of the study. Thus, thinning reduced the amount of litter fall.

Crown Expansion and Stem Radial Growth of Douglas-fir as Influenced by Release, by Donald L. Reukema (66)

A study in a 50-year-old Douglas-fir stand in western Washington indicated that release by thinning tends to reduce rather than accelerate crown expansion during the first few growing seasons following thinning. This effect was most pronounced in the upper part of the crown. Moreover, when released and unreleased sides of a given tree were compared, no differences in branch elongation were apparent. Stem radial growth was increased by release, progressively improving lower on the stem. Thus, apparently, crown buildup was not a major contributing factor in the stem-growth response of released trees.

Production Rates in Commercial Thinning of Young-Growth Douglas-fir, by Thomas C. Adams (62)

This study has identified the variable factors that affect production rates of commercial thinning and provides a basis for estimating logging costs over a wide range of situations. Time studies were made of the individual steps in commercial thinning operations: felling, bucking, skidding, and loading. Equations were then developed that express time study results in terms of (a) log and tree volume in cubic and board feet, (b) several stand variables, and (c) alternative types of logging equipment.

Specific findings of the study were:

1. After the first thinning, some cost savings can be expected in subsequent thinnings.
2. Low volumes per turn or per log tend to give sharply increased unit costs.
3. Under favorable conditions, logs as small as 2.5 cubic feet or 10 board feet can be carried along with larger logs at no additional costs.
4. All logs other than bonus logs must bear the direct costs for the full amount of their handling from woods to mill.

Although the report was published in 1967, the basic data is still being used by the Bureau of Land Management (a cooperator in the study) to plan thinning operations. BLM has revised the logging cost estimates, but other data is still usable.

A 65-hp. tractor decks saw logs at edge of the landing.

Seed Production of Douglas-fir Increased by Thinning, by Donald L. Reukema (67)

In planning thinnings and final harvest cuttings for stands of young-growth Douglas-fir, foresters need reliable information on the capacity of young-growth stands to bear seed, on the periodicity of seed crops, and on the effects of thinning and other forest practices on seed production. One of the first studies designed to help provide this information was begun in 1950.

A 1961 research note from this study provides the following conclusions: (a) in a good seed year, thinned stands of young Douglas-fir produce much more than unthinned stands, (b) thinning does not affect the proportion of sound seed produced, and (c) thinning does not stimulate seed production in poor seed years.

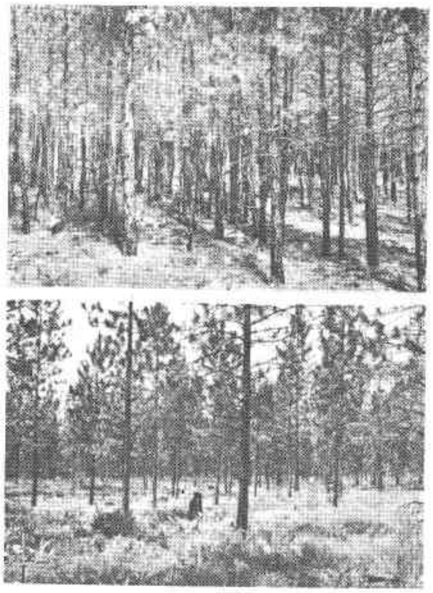
ponderosa pine

Effects on Understory Vegetation

With better management practices, production from overstocked ponderosa pine stands in the Pacific Northwest can be significantly increased. Large-scale thinning programs are currently underway, primarily to increase timber production. But other benefits seem likely, for example, to increase grass forage for cattle or wildlife.

In this study in north-central Washington, pine thinning caused significant increases in understory vegetation. After eight growing seasons, total understory yield ranged from 75 pounds per acre on the unthinned plots to 417 pounds under 26-foot pine spacing. The increase comprised 51 percent grasses, 37 percent forbs, and 12 percent shrubs.

Details are found in *Response of Understory Vegetation to Ponderosa Pine Thinning in Eastern Washington,* by Burt R. McConnell and Justin G. Smith (68).

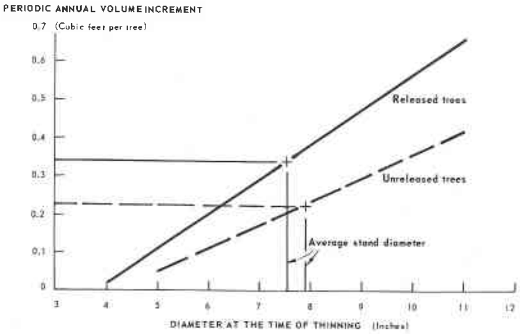


Only an occasional shrub and a few scattered grasses and forbs made up the understory before thinning (upper). Seven years after thinning to 18.7-foot spacing, 550 pounds of understory vegetation were being produced, including many desirable forage species (lower).

Dominant Ponderosa Pines Do Respond to Thinning, by James W. Barrett (69)

Over the years, considerable work has been done on thinning in ponderosa pine at the Pringle Falls Experimental Forest in central Oregon. An early study, begun in 1953, was designed to find out if dominant pole-sized ponderosa pine would respond to thinning. The answer, after 6 years of study, was a resounding "yes."

In this study, the leave trees responded by adding considerable girth—but no height. Researchers also noted that lower limbs on released trees did not die as much as in unreleased stands. Because dead limbs persist for many years on ponderosa pine, unreleased trees would have more loose knots than trees in the thinned stand. This could cause significant lumber degrade.

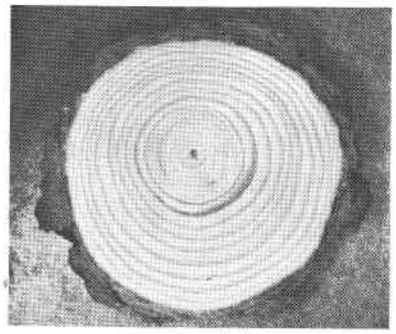


Average annual cubic-foot volume increment per dominant tree in relation to initial diameter.

Ponderosa Pine Saplings Respond to Control of Spacing and Understory Vegetation, by James W. Barrett (70)

Forest inventories indicate that about 5 million acres of commercial ponderosa pine forest land east of the Cascade Range in Washington and Oregon have a dense understory of suppressed trees. On many additional acres, the overstory has been removed, leaving dense thickets of 40- to 80-year-old, sapling-sized trees. Some managers have chosen to thin these residual stands while others, still hesitant about the investment in thinning, have elected to let the understory develop naturally. Most agree, however, that if these stands are to make reasonable progress toward producing a merchantable product, they must be thinned.

This paper presents 8-year-growth results from a spacing study in the Pringle Falls Experimental Forest, south of Bend, Oregon. This study was designed to give the manager a wide range of alternatives from which to choose an initial spacing.



A 6-inch section cut from a ponderosa pine released to a wide spacing (1959). Center "core" is 1.5 inches in diameter.

"The instant feedback of the 9830 approach has made our job of long-range planning an easier one. And, our road and logging designers are planning together in closer association than in the past. It's obvious that the design capabilities of systems such as the H-P 9830 will expand beyond the confines of skyline logging and road design."

end

OPERATION PHOENIX
by Thomas Michael Baugh

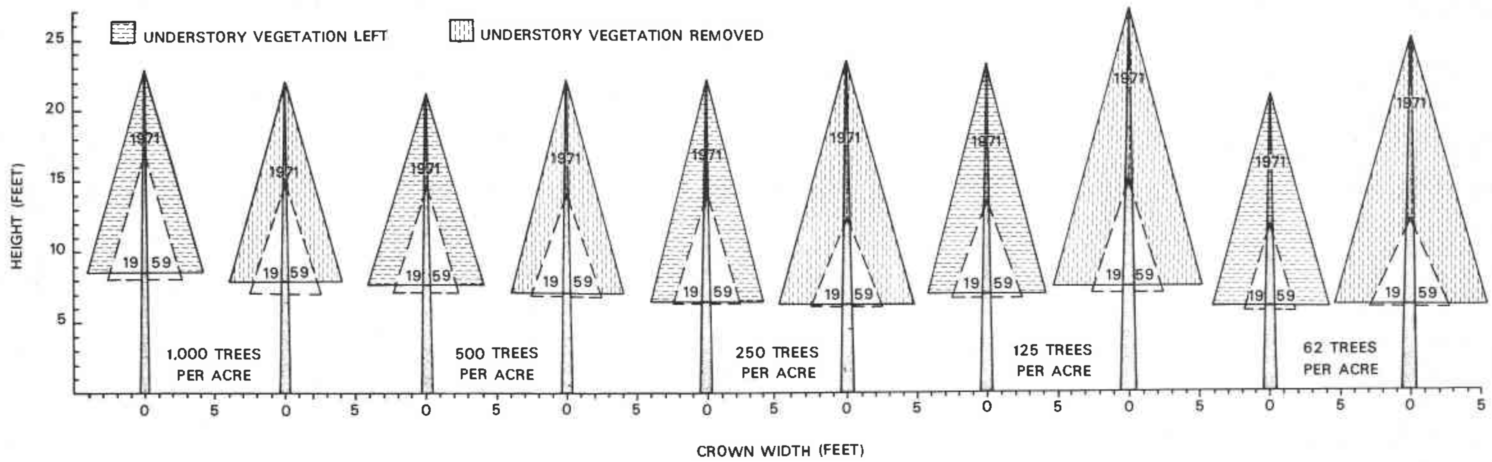
August 24, 1970, was hot and dry in north-central Washington. On the Entiat Experimental Forest, near Wenatchee, U.S. Forest Service scientists scanned the skies with concern as the early morning light revealed a threatening buildup of thunderheads. Lightning bolts were soon lancing into the tinder-dry forest. Columns of smoke rose to meet the clouds as fire after fire began to rage across the bone-dry lands. By 8:00 p.m. of the same evening, it was all over for the Entiat Experimental Forest . . . or was it?

Scientists from the Forest Hydrology Laboratory in Wenatchee began studies in the Experimental Forest in 1959. They were investigating ways to improve water yield and water quality from the forest on the east side of the Cascades. Ten years of research had been invested when fire destroyed the Experimental Forest and thousands of surrounding acres.

The scientists were successful in saving much of their equipment as fire began to envelop the forest. Men with master's degrees and Ph.D.'s in soil science, hydrology, meteorology, and ecology became fire-fighters, joining hundreds of other men and women in an attempt to halt the massive blaze. The struggle was in vain, and as darkness fell it became apparent that the battle to save the Entiat had been lost.

The men who watched their outdoor laboratory disappear in grimy clouds of smoke were dedicated scientists. They could have thrown up their hands and walked away from what, at first, appeared to be the end of many years of research. But they didn't.

While dense smoke continued to blanket the community of Wenatchee, Project Leader Wally Berndt called his scientists together. Dr. Art Tiedemann, an ecologist, recalls Berndt's words. "We're going to be back in business on the Entiat," he said. "We're not going to abandon the Entiat."



Average crown dimensions of the 62 largest diameter trees per acre in 1959 and 12 growing seasons later. Crown widths for 1959 were estimated from 1971 regressions of crown width on diameter.

Thinning Increases Growth Rate

Thirty years of study of a natural ponderosa pine stand in the Pringle Falls Experimental Forest, south of Bend, Oregon, has taught foresters much about the desirability of thinning. At the time the study was begun, trees in the area were 40-70 years old and averaged an inch in diameter and 8.2 feet in height.

Researchers now believe that clearcutting and planting is not the best way to get this forest growing again. They recommend logging the old growth ponderosa pine carefully, thinning the understory saplings, and controlling the brushy understory. As much as 10 years of stand growth may be saved by controlling the brush, and additional time is saved by using the understory trees instead of planting.

In this study, saplings thinned 8 years earlier to 125 trees per acre grew three times the cubic wood volume that was being produced by the old growth before harvest. The sapling stand is now growing rapidly and may soon produce five to six times the wood of the overstory.

For details, see *Latest Results from the Pringle Falls Ponderosa Pine Spacing Study,* by James W. Barrett (71).

High Yields From 100-Year-Old Ponderosa Pine, by James W. Barrett and Richard P. Newman (72)

A 100-year-old stand of ponderosa pine on a good site responded with faster growth to a thinning from above which removed 20 percent of the volume. Growth in both thinned and unthinned stands of this age were impressive. But, because of attack by the mountain pine beetle, similar stands should be thinned lightly and frequently from below. In the last several years, mortality increased to about 77 percent more in the unthinned plots and was consistently lower in the thinned plots during the 30 years of observation.

Thinning Controls Pine Beetle

Dense stands of ponderosa pine are particularly vulnerable to attack by the mountain pine beetle. Research over the past 15 years indicates that thinning is probably the best prevention. But how much to thin and when? There is some question yet about that, but entomologists believe that thinning to the density required for normal silvicultural purposes will also prevent beetle attacks. Researchers figure, for example, that a stand density over 150 square feet per acre is hazardous for ponderosa pine at age 90.

Mountain Pine Beetle in Ponderosa Pine, by Charles Sartwell and Robert E. Stevens (73)

Jim Barrett

Thinning and Soil Moisture

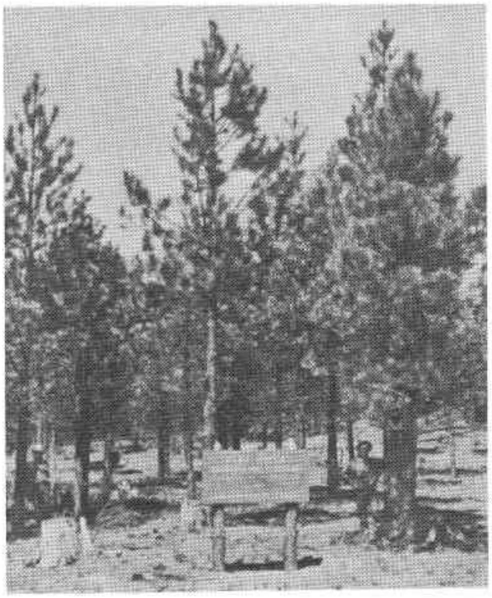
Clues are provided here to the effects on moisture depletion and growth response after thinning in ponderosa pine. Age of the trees at time of thinning was about 50 years, with growth averaging only about .05 inch per year.

The response to thinning was good, with accelerated growth on trees that were left, and an additional bonus—reductions in moisture depletion in summer months. Since thinned stands in this region are widely scattered, there will not likely be increased water production in streams. But extra water is obviously available for growth of grasses and forbs.

For details, see *Soil Moisture Depletion and Growth Rates After Thinning Ponderosa Pine,* by J.D. Helvey (74).

Large-Crowned Planted Ponderosa Pine Respond Well to Thinning, by James W. Barrett (75).

A 30-year-old planted stand of ponderosa pine responded well to thinning in central Oregon studies. A variety of levels of spacing produced similar increases in wood volume for the stand. Stands thinned to the widest spacing (17.6 feet) grew in diameter at an average rate of 2.7 inches per decade. Those at the narrowest spacing (8.8 feet) grew less than 1 inch per decade.



Most trees left after thinning were full-crowned and capable of responding to the additional growing space provided by thinning.

Growth and Soil Moisture in Thinned Lodgepole Pine, by Walter G. Dahms (76)

The rewards from thinning lodgepole pine may be greater than for thinning most other species. Most natural stands are very dense and produce few merchantable trees. As a result, a major part of the total wood produced in these stands ends up as residue following logging.

The study was conducted in the Twin Lakes area of the Deschutes National Forest in Oregon. At the time of this report, three thinnings had been made: the initial one in 1959, and additional cuts in 1964 and 1969. Results indicate that foresters can capture most of the total wood production on usable-sized trees by controlling stand density. Furthermore, the density that is best for timber production also took less water from the soil.

See also another paper by Dahms on the same study, *Growth Response in Lodgepole Pine Following Precommercial Thinning* (77).

Fifty-Five-Year-Old Lodgepole Pine Responds to Thinning, by Walter G. Dahms (78)

A 55-year-old stand of lodgepole pine, after thinning in 1934, has shown considerable increase in wood volume. Barrett (1961) reported a good response of individual tree growth during the first 22 years. At the end of 32 years, net annual per acre volume increment on two thinned plots averaged 300 board feet. But the overall gain from the thinning was modest. The main problem is that the stand was heavily infected with rust diseases. An unpublished office report when the study began indicates that:

"During the establishment of these plots it was difficult to pick out the healthiest trees because of the presence of fungus diseases throughout the stand. . . . Almost all dead trees and those lacking in vigor were infected by one or both of these diseases. Although the healthiest trees were left, 67 percent of these were attacked."

At the end of 32 years, rust-caused mortality was still high, accounting for about three-fourths of the total volume loss. Although the amount of rust in this stand is higher than normally found in lodgepole pine, the wide distribution of cankers in this species indicates there would usually be losses.

Delay Thinning—Waste Wood

Putting off thinning until a stand of lodgepole pine was 47 years old meant considerable waste of site productivity. That conclusion comes from a study at Snow Creek in the Deschutes National Forest south of Bend, Oregon. Because of the delay, a large volume of wood was grown on trees that had almost no chance to reach usable size. As a result, there was very little response to thinning during the first 5 years after cutting. Researchers expect the trees will eventually resume their normal growth rate.

One reason to thin a stand of this age, however, would be to increase streamflow from the area. Soil moisture withdrawal was definitely less after thinning.

Tree Growth and Water Use Response to Thinning in a 47-Year-Old Lodgepole Pine Stand, by Walter G. Dahms (79).

Low Stand Density Speeds Lodgepole Pine Tree Growth, by Walter G. Dahms (80)

For the silviculturist, judicious control of tree density throughout the life of a forest stand is one of the best ways to optimize returns from timber growing. Tree density is especially critical in lodgepole pine because stagnation from overcrowding is probably more pronounced in this species than in any other western conifer.

The first of a series of experiments, designed to provide foresters with better basic information on growth-growing stock relationships in lodgepole pine (*Pinus contorta*), was started in a 22-year-old stand in central Oregon in 1959. This note reports findings from the first 5-year growth period.

"Operation Phoenix," named for the mythical bird which arose from its own ashes, was born during that meeting. Berndt asked each of his scientists to suggest ways of turning the disaster into a plus for forestry research. "We realized then that we had an unprecedented opportunity to study the effects of fire on the watershed," Tiedemann says.

Within several days the scientific staff at Wenatchee had redesigned their entire research program. Working closely with land managers from the Wenatchee National Forest, the scientists moved out into the still-smoldering stumps. They began to study the effects of wildfire and to evaluate ways of rehabilitating the watersheds.

Prior to the fire, the steep, rugged slopes of the Experimental Forest were covered with stands of Douglas-fir and other species of timber. The scientists had planned to harvest this timber in several different ways and to study the effects of logging on the watershed. Although the once green forests were gone, some blackened timber with salvage value remained. The research program was changed to include an intesive study of the environmental effects of salvage logging systems.

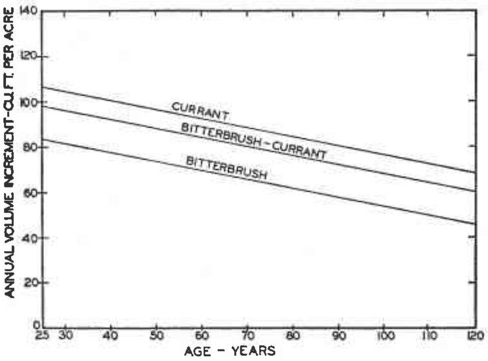
Large tractors began to haul scorched logs across the ash-covered slopes. In other areas, thick steel cables pulled salvageable timber down the hills to yarding areas. The effects of tractor logging on steep slopes were carefully monitored while log-carrying helicopters roared overhead removing dead trees. Scientists investigated a host of environmental factors during the timber salvage operations. The amount of stream sediment caused by each type of logging system was noted. The degree of damage to the slowly returning plant life and the disturbance to the soil were measured. The information concerning soil disturbance, stream sedimentation, and other factors is already being put to use by forest land managers who are responsible for similar fire-destroyed areas.

Throughout history, foresters have faced the problem of stabilizing land which has been burned by fire. Trees, plants, and grasses hold soil in place and allow water to seep into the earth at naturally controlled rates. Scientists worked with foresters from the Wenatchee National Forest to see what they could do to hold the thin soil on the mountain slopes. The four watersheds on the Entiat Experimental Forest were divided into four separate research zones. Each zone received a different type of experimental treatment.

Productivity Indices for Lodgepole Pine on Pumice Soils, by C.T. Youngberg and W.G. Dahms (81)

In central Oregon, productivity of lodgepole pine cannot be determined by soil series only. Categorizing stands on the basis of the understory plant communities present is a better indicator of productivity.

Although the information given is for lodgepole pine, it may also apply to ponderosa pine when growth is not restricted by poor drainage or low temperature.



Regression of lodgepole pine volume increment on age by plant community.

western larch

Larch Grows Faster After Thinning

Western larch at 33 years of age responds well to thinning, a 5-year study indicates. Using the information presented, foresters can estimate the number and size of trees to leave in order to get desired future growth.

For example, in order to have all trees reach a diameter of 10 inches 20 years after the first thinning, the average stand diameter would have to be about 12 inches. In the example given, this would require leaving about 120 trees per acre at an average spacing of about 19 feet. This is based on the following assumptions:

1. The first thinning is a precommercial thinning designed to get enough growth on remaining stems that a commercial thinning can follow.
2. The second thinning is made 20 years later and removes only merchantable trees.
3. Basal area increment will continue at about the present rate during the 20-year period.
4. Little mortality will occur during the 20 years.

See *Growth of Young Even-Aged Western Larch Stands After Thinning in Eastern Oregon,* by K.W. Seidel (82).

Ken Seidel

More on Western Larch

Thinning larch at age 33 may get the desired results, but don't count on it at age 55. By then, the trees are past the sapling and pole stage and cannot adjust to the new space available to them. Recommendations from this source are to thin when the trees are much younger.

Of course, if you're stuck with a 55-year-old stand and can't go back to 33, thinning from below may be worthwhile. For details, see *Response of Western Larch to Changes in Stand Density and Structure,* by K.W. Seidel (83).

fertilization

Douglas-fir Growth Can Be Increased Report From Pacific Northwest Shows, by Robert F. Strand and Richard E. Miller (84)

A nice summary, in not too technical terms, of what is currently known about forest fertilization in the Pacific Northwest:

1. Nitrogen fertilizer can increase growth of Douglas-fir on a wide range of stand age, stocking levels, and site quality.
2. Other elements have not been adequately tested to evaluate their importance.
3. In general, cubic-volume responses by Douglas-fir to nitrogen range from 0 to over 100 percent and probably average about 30 percent during a 5- to 7-year period.
4. Optimum rates of N appear to lie between 150 and 300 pounds per acre for a response duration of 5-7 years.
5. Existing fertilizer trials are potential sources of information about growth and yield in managed stands. They are local examples to help managers select stands for treatment.

Forest Fertilization: Foliar Application of Nitrogen Solutions Proves Efficient, by Richard E. Miller and Donald C. Young (85)

This article briefly discusses forest fertilization in the Pacific Northwest and southeastern United States and summarizes experiments comparing foliar applications of concentrated nitrogen solutions to Douglas-fir trees with conventional applications of urea prill to the soil. The purpose of foliar applications is direct entry of the fertilizer into the plant and avoiding the inevitable losses and fixations that occur when fertilizer is applied to the soil. The authors compare the costs of and growth response from these two methods of fertilization and conclude that with careful formulation and application to control the degree of foliar damage, foliar application of concentrated nitrogen solutions can be an efficient alternative to urea prill.

Nutrient Cycling in the Douglas-fir Type—Silvicultural Implications, by Richard E. Miller, Denis P. Lavender, and Charles C. Grier (86)

The authors describe nutrient cycling in Douglas-fir and show how various silvicultural treatments can affect stand nutrition by removing or adding nutrients or by altering the rate of a critical process in the nutrient cycle, such as organic matter decomposition. Adequate cycling of nitrogen is important to the growth of Northwest forests because N is normally the critical nutrient limiting growth. Through silvicultural practices, the land manager can affect forest nutrition and growth.

Dick Miller

growth responses

Fertilizing 75-Year-Old Trees

Seventy-five-year-old Douglas-fir trees responded well to fertilization, with increased growth during the 5 years after treatment with nitrogen in six different forms.

Basal area growth increased from 17 to 53 percent over unfertilized trees, but only ammonium nitrate at 300-N dosage increased growth enough to be statistically significant.

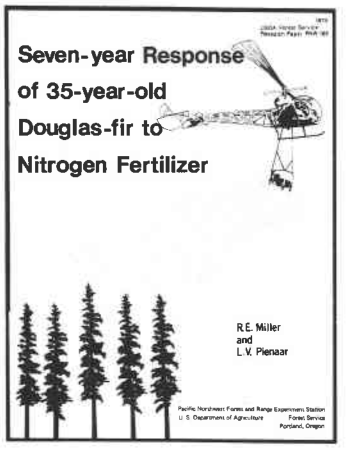
See *Seventy-Five-Year-Old Douglas-fir on High-Quality Site Respond to Nitrogen Fertilizer,* by Richard E. Miller and Donald L. Reukema (87).

Fertilizing and Thinning in Southwest Oregon

Growth of 30-year-old Douglas-fir trees on Site IV in southwest Oregon was increased by both thinning and fertilization. Four years after treatment, fertilization increased diameter growth of dominant trees by 57 percent on a clay loam and 28 percent on sandy loam soil. By fertilizing and thinning together, growth was increased by 94 and 132 percent respectively on the two soils. Height growth was not affected.

Researchers emphasized that only 4 years of observation had been summarized when these results were reported. It is likely that benefits will continue from both treatments.

Details are found in *Dominant Douglas-fir Respond to Fertilizing and Thinning in Southwest Oregon,* by Richard E. Miller and Richard L. Williamson (88).



Seven-Year Response of 35-Year-Old Douglas-fir to Nitrogen Fertilizer, by R.E. Miller and L.V. Pienaar (89)

This paper describes the results of 7 years of observations following fertilization in a 35-year-old Douglas-fir plantation in the Wind River Experimental Forest in southwestern Washington. In an initial report, Reukema reported substantial increases in height, diameter, and basal area growth during the first 4 years after fertilization. These growth increases were sustained after 7 years and will likely continue in the future.

Ammonium nitrate was applied at rates of 140, 280, and 420 pounds N per acre. As a result, volume growth increased by 55, 92, and 109 percent, respectively. The increase at 140 pounds per acre was equivalent to temporarily raising the site quality by one class. With nitrogen at 280 and 420 pounds per acre, winter breakage of trees was increased, but not enough to outweigh the benefits from fertilization. So far, net gain in total cubic volume was as much as 83 percent, with the maximum gain from the 280-pound treatment.

Fertilize Western Hemlock—Yes or No? by Dean S. DeBell (90)

Growth response of hemlock to urea fertilizer has been highly inconsistent, varying from −20 percent (apparent growth depression) to +47 percent of annual basal area growth. Chances for obtaining a good response increase with latitude along the coastal belt and are better in the Cascades than on the coast. Stands that have been thinned or are naturally less dense respond better than dense, unthinned stands. Forest managers may get a profitable response to fertilization of hemlock in the Cascades and in British Columbia with present methods. However, successful fertilization of coastal hemlock must await the completion of research suggested in this paper.

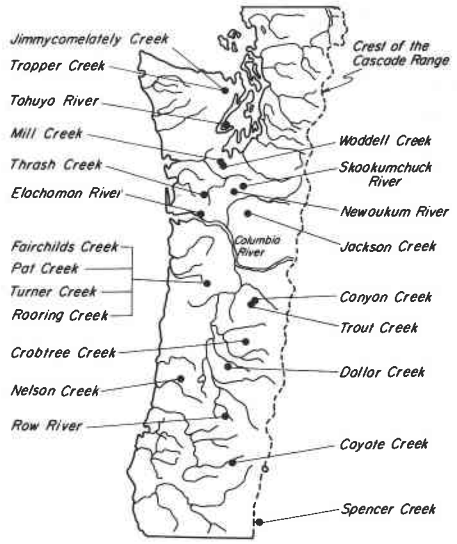
Fertilization and Water Quality

The effects of forest fertilization on water quality is being studied at 22 sites in western Oregon and Washington. In addition, other studies have been conducted in western Washington, Idaho, and southeast Alaska.

Following fertilization, increased levels of nitrogen have been detected in streams, not enough to have a measurable impact on eutrophication in downstream impoundments. Concentrations of the compounds have not approached levels considered unacceptable in public water supplies.

The amount of nitrogen entering streams can be kept at a minimum by leaving adequate buffer strips along main streams and larger tributaries. Also, fertilizer should not be applied when the streams are swollen by spring snowmelt or heavy storm activity.

See the technical report, *Impact of Forest Fertilization on Water Quality in the Douglas-fir Region—A Summary of Monitoring Studies,* by Duane G. Moore (91).



Location of forest fertilization-water quality monitoring studies in western Oregon and Washington.

The eastern-most watershed was left untouched, no seed or fertilizer was applied, and no roads were built. The scientists used it to study the ways in which nature, unaided by man, reacted to wildfire. They noticed, among many other things, that snowbrush ceanothus, a natural ground cover, began to reestablish itself within 1 month after the fire. The seeds of this shrub are known to lie dormant for hundreds of years and only germinate after being exposed to fire.

McCree Creek which lies near the center of the Experimental Forest was treated with a urea fertilizer high in nitrogen content. Ammonium sulfate, also high in nitrogen, was applied to adjacent Burns Creek. The fourth watershed, Brennegan Creek to the west, was not fertilized.

Using fixed-wing aircraft and helicopters, the scientists then seeded the McCree, Burns, and Brennegan watersheds with a variety of different plants. Orchardgrass, hard fescue, Drummond timothy, perennial ryegrass, and yellow sweet clover were applied uniformly across these three watersheds.

Soil stability and land stabilization are not the only problems experienced by land managers following a fire. Many of the nutrients found in the plant and litter materials on top of the ground are burned and converted to oxides which are mixed with the ashes. These nutrients are lost when rain water and snowmelt leaches them from the soil into the streams. The loss of nutrients can make the land less productive and pollute the water in the streams.

Immediately following the fire the scientists began to measure and record the nutrient and soil loss which was occurring on the untreated watershed. Over the years they have been able to compare this data with the information obtained from the other three areas where various rehabilitation activities took place.

In general they found that the locations treated with both fertilizer and seed had higher plant productivity, less erosion, and higher stream nutrient levels. Erosion was heavy on the untreated watershed, and the stream filled with silt, washing large amounts of nutrients from the soil. The ground cover on Brennegan Creek was similar to that on the seeded and fertilized watersheds, but plant productivity and health was lower. The scientists found that orchardgrass and

Fertilizing Lodgepole Pine

The price of fertilizer has a definite effect on its use for improving the growth of low-producing stands of lodgepole pine. As a result, it is important to be able to quantify the growth increases that might result from fertilization. Initial research results (one study) indicate that heavy doses of nitrogen, phosphorous, and sulphur can greatly increase diameter growth—at least for 4 years, and probably beyond that. In addition, fertilization increased grass production in the understory.

Fertilization was heavy: 600 pounds per acre of nitrogen, 300 pounds of phosphorous, and 90 pounds of sulphur. Read more in *Response of Pole-Size Lodgepole Pine to Fertilization,* by P.H. Cochran (92).


PACIFIC NORTH WEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

October 1973

RESPONSE OF INDIVIDUAL PONDEROSA PINE TREES TO FERTILIZATION

INTRODUCTION

Diameter and height growth of sapling ponderosa pines can be accelerated on certain sites by thinning some trees and removing understory vegetation (Barrett 1970). The increased growth caused by these cultural treatments is probably a result of increased water and nutrients available to the remaining trees. Therefore, we can speculate that fertilization might increase production of usable wood in ponderosa pine stands.

FOREST SERVICE – U.S. DEPARTMENT OF AGRICULTURE – PORTLAND, OREGON

Fertilizing Ponderosa Pine

Initial studies in four areas indicate promising results with a combined treatment of fertilizing and thinning in ponderosa pine.

This study was carried out in ponderosa pine that was 40 to 65 years old in 1967. The stand was first thinned, then nitrogen fertilizer was applied alone or in combination with P, S, and B to the soil around some of the remaining trees. As a result, diameter growth increased substantially. Height growth also increased, except where research results were confused by insect-caused top damage. Volume growth was significantly increased by fertilization in all but one location—an especially dry site near Fort Rock in central Oregon.

It should be noted that these growth increases were in connection with thinning, a proven tool for producing more usable wood. Considerable research is necessary before guidelines can be recommended for fertilizing only. This work is underway.

For details of the study, see *Response of Individual Ponderosa Pine Trees to Fertilization,* by P.H. Cochran (93).

Forest Fertilization in the Pacific Northwest—A Case Study in Timber Production Under Uncertainty, by Dennis L. Schweitzer (94)

The future of forest fertilization is plagued with uncertainties—lack of knowledge of the physical response to forest fertilization, lack of good ways to determine which stands will benefit most from fertilization, application technology, and the environmental and political climate.

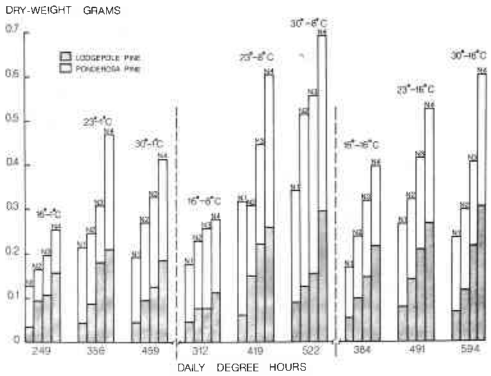
All of these uncertainties result in a lack of complete information for the forest resource manager. For the present, in the Pacific Northwest, fertilization will continue to be justified on the basis of the fragmentary experimental and experience data that are available and by the advantages gained through the allowable cut effect.

Temperature and Soil Fertility Affect Lodgepole and Ponderosa Pine Seedling Growth, by P.H. Cochran (95)

Do species differences exist between ponderosa and lodgepole pine in their response to temperature and soil fertility? A study was undertaken to find the answer to this question, with seeds taken from the Pringle Falls Experimental Forest and planted in growth chambers. There, light intensity and day and night temperatures were carefully controlled, and the soil fertilized with various levels of nitrogen.

Results of the study did not explain the growth differences sometimes found between lodgepole and ponderosa pine in south central Oregon, but an interesting relationship surfaced. It appeared that as more nitrogen was added to the soil, warmer night temperatures were required to produce maximum growth rates. In future studies of the effect of temperature on seedling growth, researchers should pay more attention to the soil fertility.

Studies such as this, carried out under controlled laboratory conditions, are also useful as a first indicator of whether various tree species will benefit from forest fertilization.



Dry weights of lodgepole and ponderosa pine seedlings grown under four increasing levels of soil fertility and nine temperature regimes.

Fertilizing Planted Ponderosa Pine on Pumice Soils, by J.W. Barrett (96)

Foresters should be aware that exciting possibilities exist for stimulating growth of planted ponderosa pine with fertilizers. But research suggests caution until more positive results are obtained.

Author Barrett reports information from several tests using different types of fertilizers. None of the fertilizers used met all the objectives—that is, a fertilizer that will shorten the time to timber harvest, enable the tree to maintain reasonable growth, survive in the midst of competing vegetation, and increase in size quickly and be unattractive to browsing animals.

environmental effects

Monitoring Water Quality

Forest fertilization on a commercial scale began in the Pacific Northwest in 1965. Under pressures of increasing demands for wood fiber, this management practice has grown rapidly. Between 1965 and 1969, approximately 36,400 hectares were fertilized in western Oregon and Washington. By 1974 this figure increased to over 285,000 hectares.

Although the total acreage fertilized is relatively small and widely scattered, it is important to know how much nitrogen is getting into streams and what its environmental effect will be. Consequently, monitoring studies were established in Oregon, Washington, and Alaska to measure nitrogen in streams under a variety of conditions of soil, climate, and vegetative species.

Results so far indicate that the amount of nitrogen that enters streams from fertilization is relatively small and should not have a measurable impact on eutrophication. Nitrogen levels can be kept at a minimum by providing buffer strips along streams and larger tributaries. In addition, fertilizer should not be applied to watersheds during spring snowmelt or heavy storms.

For an interesting summary, see *Impact of Forest Fertilization on Water Quality in the Douglas-fir Region—A Summary of Monitoring Studies,* by Duane G. Moore (97). See also a paper by Moore titled, *Fertilization and Water Quality,* (98).

Duane Moore

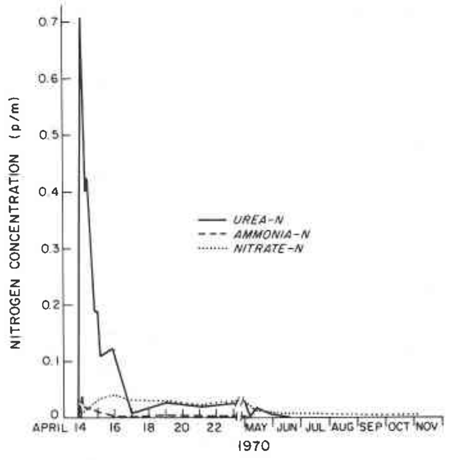
Effects of Forest Fertilization With Urea on Stream Water Quality—Quilcene Ranger District, Washington, by Duane G. Moore (99)

Application of nitrogen fertilizer to two units of the Quilcene Ranger District of the Olympic National Forest in April 1970 provided an opportunity to monitor water quality in small streams adjacent to the treated areas.

Application rate was low—224 kilograms nitrogen per hectare (200 pounds nitrogen per acre). Detectable amounts of nitrogen were found in streams after aerial application, but concentrations were very small.

It seems apparent that the small amounts of nitrogen applied in this area would have little measurable impact on eutrophication.

For other studies on the effects of fertilization on water quality, see results of research in the Entiat Experimental Forest near Wenatchee, Washington. Considerable work has been done there on fertilization of grasses following wildfire. See sections on watershed management and chemicals in the environment.



Concentrations of urea-, ammonia-, and nitrate-nitrogen in streamflow following fertilization of a 49-hectare unit with 224 kilograms urea-N/ha in April 1970—Jimmycomelately Creek, Quilcene Ranger District, Olympic National Forest, Washington.

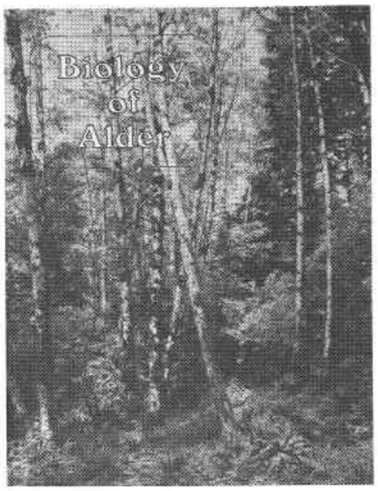
role of red alder

We include a special section here on the role of red alder, a beautiful, but sometimes misunderstood hardwood. Alder grows along streambanks and in cutover areas and along old skid roads. As its lacy lime-green leaves unfold, it is a first welcome sign of spring throughout much of the West.

But during recent decades, forest management has become increasingly intensive in this region. In striving for higher yields of more valuable trees such as Douglas-fir, forest managers have tended to regard alder as a weed species. Research, however, continues to point out its desirable properties.

Scientists, including silviculturists, plant pathologists, and microbiologists have been fascinated by the red alder. For one scientist —Robert F. Tarrant—his research has meant international acclaim. In part for his research to identify the role of red alder in fixing nitrogen in the soil, Tarrant was awarded the USDA Superior Service Award in 1973.

There are no practical guidelines published on how to use red alder to improve the nitrogen balance in forest soils, or to control diseases such as *Phellinus weirii* (*Poria*). But there are strong suggestions that this may be possible in the future. Additional research, or field trials, may provide the answers.



Biology of Alder, edited by J.M. Trappe, J.F. Franklin, R.F. Tarrant, and G.M. Hansen (100)

The beneficial role of red alder in the Douglas-fir forest has long been recognized. Alder is a nitrogen-fixing plant, meaning its roots have nodules that "capture" nitrogen from the air and transform it into nitrogenous compounds that plants can absorb from the soil. The appearance of this leafy hardwood in forest ecosystems following fire, or on old logging roads or disturbed sites, may be especially significant. In this role, alder may help prepare the soil for later growth of conifers such as Douglas-fir.

This publication is a summary of reports given at the 40th annual meeting of the Northwest Scientific Association in Pullman, Washington, April 14-15, 1967. Many are quite technical and of background rather than immediate practical use. But the publication will help foresters appreciate an important tree that was once considered a "weed species."

hard fescue produced the best results of any of the seeds which were tried. As the grasses took hold, the amount of water loss also decreased.

The effects of the urea and ammonium sulfate fertilizers have also been carefully monitored throughout the research effort. Tiedemann points out that it would be of little help to land managers to be able to establish plant cover on steep slopes if the streams were polluted by fertilizer. Small amounts of the fertilizers did find their way into both Burns and McCree Creeks. The tests used showed that the amounts were so small that they had no significant effect on stream life or water quality.

Changes in water yield were perhaps the most dramatic effects noted on the Entiat. Researchers found that the amount of water flowing from the denuded slopes almost doubled during the first year following the fire. Heavy precipitation during the second year caused an increase in water yield four to five times above normal.

The outcome of the research on the Entiat Experimental Forest has helped to provide guidelines for land managers who will continue to be faced with wildfire and other erosion problems. Each year foresters from federal and private companies visit the Forest Hydrology Laboratory and the Experimental Forest. They come to discuss their problems with the scientists and to learn what can be done to rebuild similar burned watersheds in other parts of the country.

end

A VIRUS THAT KILLS THE TUSSOCK MOTH
by Louise Parker

The year 1973 might well be called "The Year of the Tussock Moth." But for Dr. Hank Thompson, concern about the tussock moth began back in 1964, 4 years after he joined the Forestry Sciences Laboratory in Corvallis, Oregon, as a research entomologist with the Forest Service. That was about the time people were becoming concerned about the effects of pesticides and other chemicals on the environment. DDT was going out of favor, and foresters were anxious to find some new control methods —techniques that would be safer for use around fish and other wildlife. Natural biological controls looked promising because most insects have diseases and are subject to attack by parasites and predators. Thompson's assignment was to set up a new research project to explore the use of natural biological controls to halt the spread of forest insect outbreaks.

Range of red alder

Red Alder: Its Management and Utilization, by Norman P. Worthington, Robert H. Ruth, and Elmer E. Matson (101)

Getting a little old now, this 44-page report still contains a lot of useful information about the red alder—its range and distribution, characteristics, wood properties, major uses, etc. The information that's really old (primarily wood production data) has been updated in a new publication, titled simply *Alder,* an American woods leaflet (FS-215) by Marlin E. Plank, November 1971 (102).

Red alder is used today primarily for pulpwood, with lumber for furniture next in importance. Production has gone up dramatically in this century. Production of red alder lumber was first reported in 1907 as 115,000 board feet. That increased rapidly in the late 1920's, and in 1965 production was estimated at 82 million board feet. Use of alder for pulpwood has grown rapidly since the early 1950's.

Stand Development and Soil Fertility in a Douglas-fir Red Alder Plantation, by R.F. Tarrant (103)

The story of research on red alder is one that again demonstrates just how long it takes between the development of new knowledge and its practical application in the forest. Not that that's all bad. In many cases, it takes a long time to verify research findings and develop practical applications.

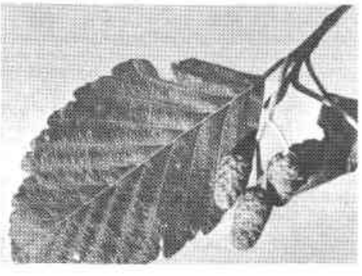
For example, scientists have known since the early 19th century that alder has root nodules. Later studies indicated that the nodules resemble those of legumes in that they are nitrogen-fixing. In 1951, PNW forest scientists learned that red alder foliage contains much greater amounts of nitrogen than other tree species in the Pacific Northwest (104).

Another 10 years passed before an article in *Forest Science* by Robert F. Tarrant thoroughly established this concept in the Pacific Northwest (101). Tarrant studied stands of Douglas-fir and Douglas-fir mixed with alder in experimental plantings in the Wind River Experimental Forest near Carson, Washington. Tarrant found that the addition of red alder to the site enabled a 27-year-old mixed stand of Douglas-fir and red alder to produce more than twice the wood volume of a similar site with Douglas-fir only! Even though there were more Douglas-fir stems in the pure plantation, in the mixed stand there were an average of 443 stems per acre—enough for satisfactory stocking. Moreover, there were an additional 627 red alder trees! Tarrant realized that it was the addition of increased amounts of nitrogen to the soil that enabled this phenomenal wood production.

In addition, the Douglas-firs growing with alder were larger and better formed than those that grew alone. The partnership of Douglas-fir and red alder had proven to be a healthy one.

So, should foresters go out and plant red alder with Douglas-fir to produce greater yields everywhere? Not necessarily, says silviculturist Richard E. Miller. Miller, who did a follow-up study with Tarrant in the same forest stands (105), cautions that the Wind River studies were done under conditions that would show a maximum benefit from red alder. For example, the alder was planted after the Douglas-fir and did not compete with the fir as on many high sites in the Douglas-fir region. There, alder normally suppresses Douglas-fir if it gets a head start.

Scientists at Oregon State University have also done some studies with red alder. Their results suggest that alder might be planted in heavily thinned stands of Douglas-fir to increase production of the fir. Ten years after thinning, the alder understory was deteriorating, and many of the alder trees were dead. In the meantime, however, the alder had contributed hundreds of pounds of nitrogen to the soil and litter on the forest floor. For details of that study, see *Natural Fertilization of a Heavily Thinned Douglas-fir Stand by Understory Red Alder,* School of Forestry, OSU, Forest Research Laboratory, Research Note No. 56, 1975, by Alan Berg and Allan Doerksen.



Accumulation of Organic Matter and Soil Nitrogen Beneath a Plantation of Douglas-fir and Red Alder, by R.F. Tarrant and Richard E. Miller (105)

Another report from the same study describes the actual amount of nitrogen added to the soil by the alder. Tarrant and Miller dug holes in the ground to get soil samples, down to just below root level. They found greater quantities of nitrogen in the mixed stand down to a depth of 36 inches.

Over the 30-year period of growth of the stands, the scientists calculated that total nitrogen in the soils and forest floor averaged about 3,000 pounds per acre in the Douglas-fir forest. In the mixed stand, it was about 4,000 pounds per acre. This meant that about 1,000 pounds of nitrogen had been added to the soil by the red alder trees during the 30 years. On a yearly basis, that figured out to about 36 pounds of nitrogen per acre per year—added because of the alder trees.

Coastal Study Confirms Data

Later research in the Cascade Head Experimental Forest on the central Oregon coast verified the general trend of the findings at Wind River, but indicated a three-fold increase in the amount of nitrogen circulating in the ecosystem from the addition of red alder.

In that study, scientists measured litter fall under three types of stands: (a) red alder only, (b) red alder and conifers mixed, and (c) conifers only (Douglas-fir, western hemlock, and Sitka spruce). The scientists measured only 32 pounds of nitrogen per acre in litter under the conifer stand. But the alder stand contained 100 pounds per acre and the mixed site 104 pounds per acre.

See Tarrant, Lu, Bollen, and Franklin's, *Nitrogen Enrichment of Two Forest Ecosystems by Red Alder* (106).

Nitrogen Addition by Stemflow

In another study at Cascade Head, scientists also investigated the role of rainfall in adding nitrogen to soils in the alder stand. They collected both stemflow (water draining down tree trunks) and rainwater that had dripped through alder foliage. Results indicate that the amount of nitrogen added in this way is minimal. Litter fall is a much more significant source of nitrogen.

See *Nutrient Cycling by Throughfall and Stemflow Precipitation in Three Coastal Oregon Forest Types,* by Tarrant, Lu, Bollen, and Chen (107).

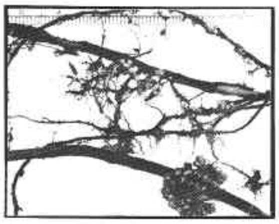
Red Alder and *Poria weirii*

Since first identifying the capacity of red alder to add nitrogen to the soil, scientists have continued to explore several possibilities: (a) increasing forest productivity with red alder, and (b) the possibility that it may be useful in controlling or preventing root diseases of conifers.

Several technical reports have been published. For a nice summary of the possible role of red alder in preventing the root disease *Poria weirii* (now *Phellinus weirii*), see an article by James M. Trappe, *Regulation of Soil Organisms by Red Alder: A Potential Biological System for Control of Poria weirii,* from a symposium at Oregon State University in 1970 (108).

Trappe points out that the addition of nitrogen to forest soils may help reduce the viability of buried *Poria*. Red alder also produces large amounts of other compounds that are known to be *Poria* inhibiting—for example, phenolics and fatty acids. In addition, the microorganisms that form nitrogen-fixing nodules on red alder roots are in an order which includes antibiotic producers. These may be useful in inhibiting *Poria*.

Furthermore, red alder is known to resist attack by *P. weirii.* For these reasons, the long term alteration of sites may be the best hope of controlling the disease in the future. Trappe speculates further that: "Much of the buried *Poria* in clearcuttings (from stumps of infected trees that were cut) likely would be starved out if a rotation of alder were grown for several decades."



Nitrogen-fixing nodules on red alder root.

Other reports on this subject are quite technical. Check the bibliography for a complete listing (109).

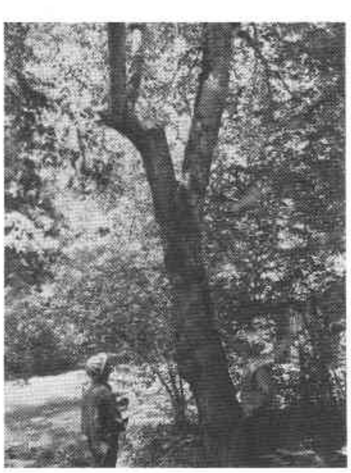
Subsequent research on the role of red alder in inhibiting *Poria weirii* has not yet met with success. Earl Nelson did a study (see 109) where little cubes of wood inoculated with *Poria* were buried for several years in a red alder stand. The *Poria* was not killed.

A later study by Everett Hansen (110) was done to see if *Poria* was inhibited in a Douglas-fir plantation with intermixed red alder. It wasn't, at least not yet, and trees were then about 10-17 years old. But it might work better if alder were established for a couple of years before the Douglas-fir was introduced.

Results of both studies are inconclusive. Long-term research may help answer the question.

The Role of *Alnus* in Improving the Forest Environment, by Tarrant and Trappe (111)

This 13-page article is an excellent summary of what is known about the role of red alder and its beneficial effects on forest environments in the Pacific Northwest.

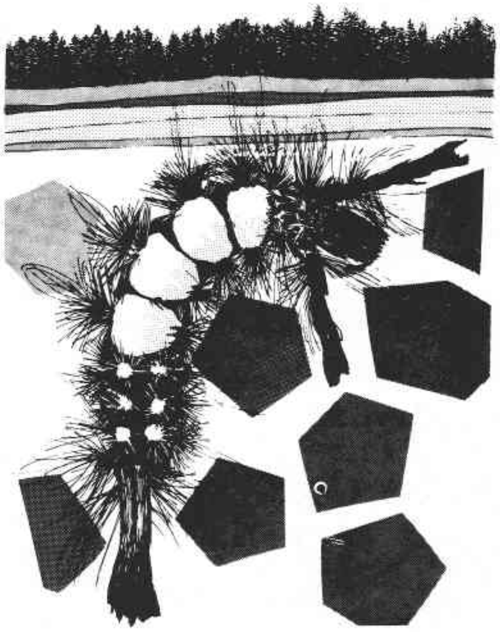


Growth and Development of Red Alder Compared With Conifers in 30-Year-Old Stands, by Carl M. Berntsen (112)

In 1935, a long-term study was begun to learn more about growth and development of red alder compared to conifer stands. Several treatments were made to get stands that were pure alder or conifer, with various combinations of thinned and unthinned.

Results indicate that the conifer stand responded to thinning. In contrast, the pure alder stand showed only negligible accelerated growth. Lack of thinning in the alder-conifer stand, however, resulted in a prolonged struggle between species that reduced yield.

One of Thompson's first concerns was to narrow the problem. "Everyone tries to do too much," he says. "That just dilutes the effort and you can't solve any one problem." Since the mid-1960's, almost all of his work has been on the tussock moth and the viruses and other disease agents which attack it. Most of the research has been on study of a nucleopolyhedrosis virus which helps control the tussock moth outbreaks in nature.



One of the difficulties with entomological research is the cyclic nature of insect outbreaks. "They'll be up for a few years, then down," Thompson says. "When they're down you can't even find a tussock moth in the woods."

In 1964, outbreaks appeared in several parts of the West, giving scientists an opportunity to work on the tussock moth. In the succeeding years, Thompson's research team of four scientists and four technicians has made considerable progress in developing a sound biological control for the tussock moth. They have:

- *Developed techniques to raise tussock moths in the laboratory for experimental purposes. Thousands of moths have been reared on artificial diets and used in the research.*
- *Identified the natural microbial enemies (viruses and bacteria) which attack the tussock moth at various stages of development.*

role of mycorrhizae

Mycorrhiza literally means "fungus-root". It is a structure that combines the plant root and the fungus. Mycorrhizae have fascinated scientists for years, and with good reason. The symbiotic, or mutually beneficial, relationships which bind fungi and plants together, are a biological continuation from earliest times. As plants evolved in primeval waters, both algae and fungi were present. Probably neither could subsist alone on land. But together they could survive, the algae a specialist in producing chlorophyll, and the fungi scavenging mineral nutrients from the soil.

Today, the mycorrhizal fungi and roots still coexist, each doing its own important work. Without these beneficial fungi, most modern plants, including forest trees, could not survive.

Occurrence of Mycorrhizae After Logging and Slash Burning in the Douglas-fir Forest Type, by Ernest Wright and Robert F. Tarrant (113)

There are two principal types of mycorrhizae: endotrophic—with the fungus inside the root cells; and ectotrophic—with an external fungal mantle enveloping the root tips and the fungus between outer root cells, but not in them. Both types are most abundant in the upper part of the soil. The ectotrophic ones are more common on trees of the Douglas-fir region.

To check the effect of slash burning on mycorrhizae of Douglas-fir, researchers examined roots of seedlings 1 and 2 years after logging in the Wind River and H.J. Andrews Experimental Forests.

In study areas, the seedlings had more mycorrhizae after 2 years than after 1 year. Unburned sites had more mycorrhizal seedlings than burned sites. At Wind River, mycorrhizae were more common on lightly burned sites than severely burned sites, but this difference did not show up on the Andrews.

Jim Trappe

Fungus Associates of Ectotrophic Mycorrhizae, by James M. Trappe (114)

Plant pathologist Jim Trappe is especially proud of this publication. It's primarily written for specialists, but has served as a basic reference for much of the subsequent mycorrhiza research.

Here is a listing of all the fungi known up to 1962 to produce ectotrophic mycorrhizae on specific tree hosts (see the last article if you haven't already). Among these, nature lovers and botanists will recognize many of the common forest mushrooms—boletus and the deadly amanita for example.

Trappe says it is extremely important to identify and classify the fungi as a first step in working with them. There is a great physiological diversity in the fungi. Each has a different function in the life of the forest. One may protect roots against disease. Another may help the tree survive on dry sites.

In the past 10 years, dozens of papers have pointed out differences in these fungi. As these become known, scientists will be able to determine which are most helpful in promoting establishment, growth, and health of tree seedlings.

Mycorrhizal Deficiency in a Douglas-fir Region Nursery, by James M. Trappe and Robert F. Strand (115)

Nurserymen should be especially careful when fumigating soils in forest tree nurseries. Fumigation can kill important mycorrhizal fungi as well as disease-producing ones!

Seedlings in a forest nursery in the Willamette Valley in Oregon were severely stunted, sickly, and would not respond to fertilizer. On close examination, plant pathologists found that the trees were nonmycorrhizal. Ectomycorrhizal fungi were apparently sparse in the soil because of soil fumigation during development of the nursery.

The problem is that Douglas-fir needs phosphorous and micronutrients that they can't absorb by themselves. They need the mycorrhizal fungi, which pick up phosphorous from the soil and pass it on to the trees.

Because of research such as this, nurserymen now know that if they fumigate the soil to kill the harmful diseases, the beneficial mycorrhizal fungi must then be replaced.

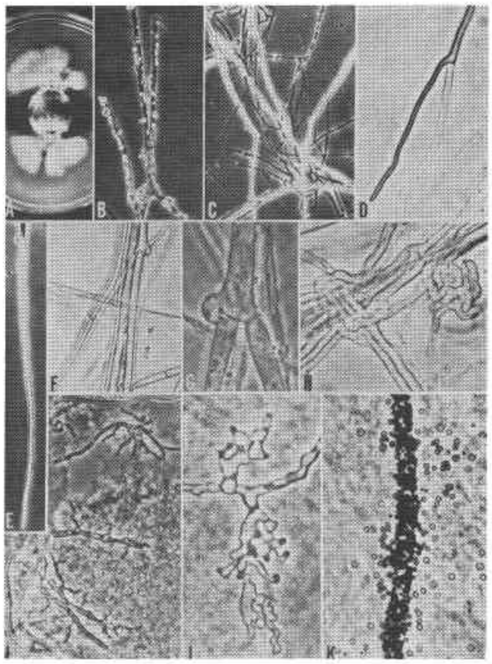
Mycorrhizae and Container Seedlings, by B. Zak (116)

Mycorrhizae were discovered nearly a century ago; trees have been known to depend on mycorrhizal fungi for uptake of nutrients from soil for well over 50 years. Only recently, however, has it become possible to manipulate mycorrhizal fungi to increase survival and growth of planted seedlings. Now fungi can be selected for particular qualities; for example, drought resistance or production of growth regulators to speed root growth of hosts or strong antagonism against root diseases. These fungi can be inoculated on seedlings grown in nursery beds or containers. Containerized seedlings offer particularly good opportunities because the fungal inoculum can be incorporated directly into the container mix just before seeding. The technology of large scale inoculation is now being developed. In a few years, it may well be possible to "tailor" mycorrhizae for the sites for which the seedlings are destined.

Characterization and Classification of Mycorrhizae of Douglas-fir. II. *Pseudotsuga menziesii* + *Rhizopogon vinicolor*, by B. Zak (117)

Hi. Are you still with us? This paper will defy the average reader, but we talked with a plant pathologist to learn just what it's all about.

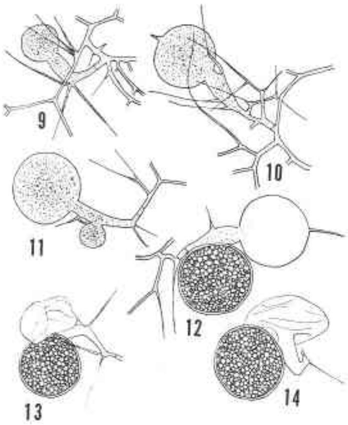
The paper further defines the botanical nature of a "false truffle," a fungus with habits similar to a truffle, but in a different class. A widely distributed mycorrhizal fungus on Douglas-fir roots, the mycorrhiza is of special interest in forestry because it inhibits growth of several root pathogens, including *Poria weirii* and *Fomes annosus.*



Microscopic characteristics of Rhizopogon vinicolor *grown on photo-dextrose agar.*

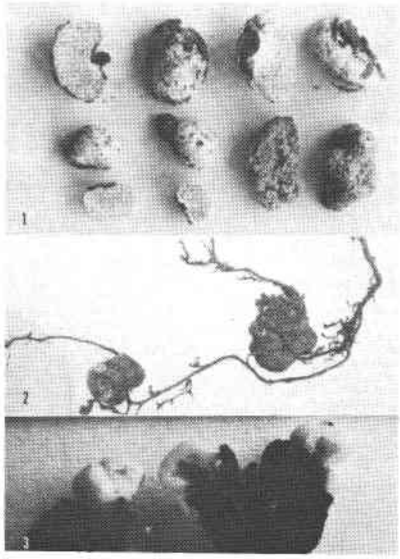
The Endogonaceae in the Pacific Northwest, by J.W. Gerdemann and James M. Trappe (118)

Research on mycorrhizae has been advanced by a report on the mycorrhiza-forming fungi of the family Endogonaceae (pronounced en-doe-go-nay-cee-ee). This work, completed in cooperation with the University of Illinois, will enable researchers to determine which of the 44 known species of Endogonaceae they are working with, or if they are dealing with a new species. These fungi, which form vitally needed mycorrhizae with nearly 95 percent of the world's plant species, could not previously be identified.



Developmental stages in the formation of azygospores of Acaulospora laevis.

The book on Endogonaceae is particularly timely as interest in reforestation and containerized seedlings has grown. Researchers are already at work to develop the methodology for inoculating nursery seedlings with beneficial fungi. This was very difficult before development of soil fumigation technology because the soil must be sterilized first. Otherwise the beneficial fungi would be crowded out by competing resident micro-organisms.



Sporocarps of Endogone.

Germination of Spores of *Glomus macrocarpus* (Endogonaceae) After Passage Through a Rodent Digestive Tract, by J.M. Trappe (119)

Many mycorrhizal fungi, including truffles and false truffles fruit underground. Such species are widespread in Pacific Northwest forests. They have no mechanism to discharge their spores to the air for wind dispersal. Rather, they depend on being dug up and eaten by small mammals such as squirrels, deer, mice, and voles. The mammals digest all of the fruiting bodies except the spores, which are passed out in fecal pellets —small "packages" of viable spores mixed with nitrogenous animal wastes. Rains then wash the spores into the soil, where they can germinate in contact with tree roots to form new mycorrhizae. Many small mammals that have a bad reputation as tree seed eaters thus also help new seedlings become established by dispersing mycorrhizal fungi. For further information on subterranean fungi, see the bibliography (120).

For other reports on mycorrhizae, see the bibliography for this section (121).

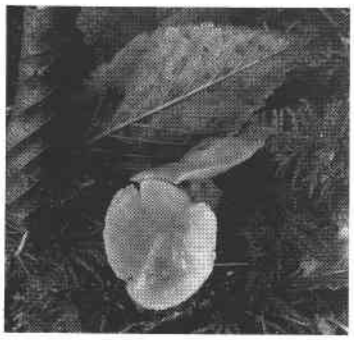
The Higher Fungi of Oregon's Cascade Head Experimental Forest and Vicinity, by Alexander H. Smith and James M. Trappe (122)

In the fall of 1970, two mycologists joined forces to explore the forest fungi of Cascade Head on the central Oregon coast. Both are internationally recognized authorities on taxonomy of mycorrhizal fungi.

Cascade Head is a perfect "garden spot" for fungi because of the varied environments and the wet, moderate year-long climate. The scientists checked up and down the coast, along stream valleys, and made frequent visits to various forest types, sand dunes, pastures, and the many shrub types.

The result was a huge collection of fungi. Smith's collection numbers 1,440 specimens, while Trappe has collected nearly 1,000 from the same area.

This publication lists some of the fungi found, including nine new species or varieties. Many are undoubtedly mycorrhizal.



•Established procedures required for mass production and purification of a naturally occurring virus of the tussock moth and demonstrated its safety to nontarget organisms.
•Conducted experiments to test aerial sprays of the virus and a bacterium for control of tussock moths.
•Studied the natural effects of the virus on tussock moth populations in the woods.

Thompson is most enthusiastic about the virus because it works against the tussock moth in nature. The bacterium (Bacillus thuringiensis, *or* BT) *will kill tussock moths and is commercially available, but it is not a part of their natural ecosystem. Both microorganisms, however, have demonstrated considerable promise as safe, sound tools for pest management.*

The virus is particularly potent, Thompson says. The tussock moth larvae eat the virus while feeding on tree foliage. As the virus mutliplies and spreads through the larva, it causes a degenerative disease which kills the insect. A larva which has been killed by virus dissolves into a messy residue that's highly infectious to other insects.

In nature, the virus contributes to the collapse of tussock moth outbreaks—usually on a 3-year cycle. "We believe the virus plays an important role in the termination of most outbreaks," Thompson says. "We don't always find virus in the early stages of an outbreak. If we do, it's at a very low level. The virus is probably there, but at such low levels that it is hard to locate."

Last year, the third year of the cycle in the original Blue Mountain outbreak, the virus was much more prevalent. It came in too late to prevent severe defoliation, but the principle still holds. "Everything we know about the tussock moth points to a pattern of outbreak and decline—usually on a 3- to 4-year basis. And the virus usually plays an important role."

The virus is not the only natural control factor, but is "one we can readily manipulate," Thompson says. Other factors which contribute to the collapse of tussock moth outbreaks are climatic conditions, parasites and predators, and food supply for the insects.

One of the first questions that comes up about viruses is safety. Could they be harmful to wildlife or to man when sprayed in

Insect Mycophagy: A Preliminary Bibliography, by Robert Fogel (123)

Little is known about the insects that eat fungi. They are important because they are probably responsible or contribute to the spread of many forest diseases, including *Poria weirii.*

Scientists know, for example, that *P. weirii* is just loaded with insects. Some are beetles which could carry spores of the disease to the roots of trees.

This is a bibliography—a beginning point for anyone interested in this highly specialized subject.

Generic Synonyms in the Tuberales, by James M. Trappe (124)

Like other areas of science, fungal taxonomy is a continuing process. Concepts and conclusions often change as more and better data become available. ''New'' species found in different parts of the world often later prove to be one and the same. For example, one species had previously been known by eight **different** names. To bring order out of such confusion, Trappe has examined literally thousands of specimens in herbaria in nine different countries.

This particular paper deals with the taxonomy of important mycorrhizal fungi in the Tuberales—the epicurean delight otherwise known as truffles!

Pure Culture Synthesis of Bearberry Mycorrhizae, by B. Zak (125)

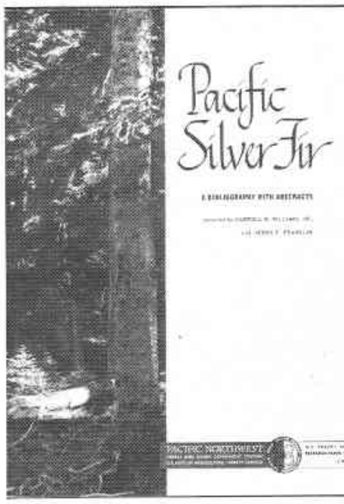
Foresters have noticed that bearberry *(Arctostaphylos uva-ursi)* and Pacific madrone *(Arbutus menziesii)* are often good nurse plants for pine and Douglas-fir reproduction. Careful laboratory experiments provide an explanation for this phenomenon. Several fungi that form mycorrhizae with the conifers also form mycorrhizae with bearberry and madrone. When a tree seed germinates near a bearberry or madrone, the seedling's roots grow down to contact compatible mycorrhizal fungi. Its rootlets can ''plug in'' to the mycorrhizal system of the nurse plant rather than having to compete with the nurse for soil nutrients.

Shrubs such as vine maple form mycorrhizae with fungi that are not compatible with most conifers. The seedling started under vine maple must compete directly with it rather than form a friendly relationship. For an additional source of information on pure culture synthesis, see the bibliograpy (126).

high elevation management

Mountain Hemlock, A Bibliography With Abstracts, by Jerry F. Franklin (127)

A 50-page bibliography that lists references to mountain hemlock from North American and European literature. An attempt has been made to include all references which might provide useful information on this species. Abstracts are provided for those considered most significant.



Pacific Silver Fir, A Bibliography With Abstracts, by Carroll B. Williams, Jr., and Jerry F. Franklin (128)

Researchers found references as far back as 1855 to include in this 84-page bibliography on Pacific silver fir. Titles are included from North American and European literature. An attempt has been made to include all references which might provide useful information on this species. Abstracts are included for those considered most significant. The report includes a subject matter index and a list of common and scientific names of tree species mentioned in the bibliography.

Elevation Affects Timber Growth

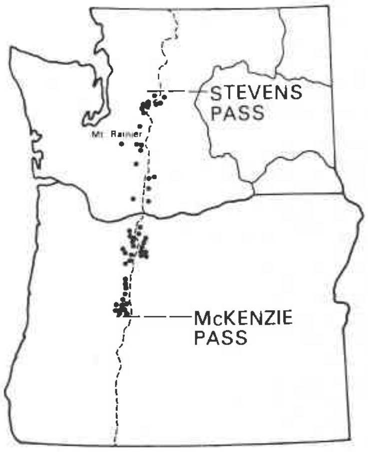
The potential timber productivity of the high-elevation forests of the Cascades can be more accurately estimated because of studies by three PNW mensurationists. As road systems have improved and management has intensified, these forests have become more important for timber production.

The mensurationists have found that height growth patterns of Douglas-fir on the west slope of the Cascades between 2,000 and 5,000 feet differ from growth patterns of the same species at lower elevations. Use of site index curves developed from data from low-elevation stands will tend to overestimate productivity of old stands and underestimate that of young stands. Lower temperatures and a shorter growing season apparently produce slower early growth and more prolonged growth in later life. Noble fir and possibly other associated species show similar patterns.

In two reports in *Forest Science* in 1974, Bob Curtis, Francis Herman, and Don DeMars present a new method of constructing site index curves and new information on height growth of Douglas-fir in these upper-slope forests (129). The reports are *Which Dependent Variable in Site Index-Height-Age Regressions?* and *Height Growth and Site Index for Douglas-fir in High Elevation Forests of the Oregon-Washington Cascades.*

Information presented indicates that the height growth pattern of Douglas-fir at high elevations differs from that for lowland Douglas-fir. Corresponding differences exist in the pattern of volume growth. Researchers indicate that site index curves developed for lowland Douglas-fir should not be used to predict growth rates (and allowable cuts) at higher elevations as they may result in erroneous estimates of growth potential.

The height growth curves presented here can be used to predict growth within the geographic and elevational zone represented by the data—the Oregon and Washington Cascade Range between Stevens Pass and McKenzie Pass at elevations above about 2,500 feet.



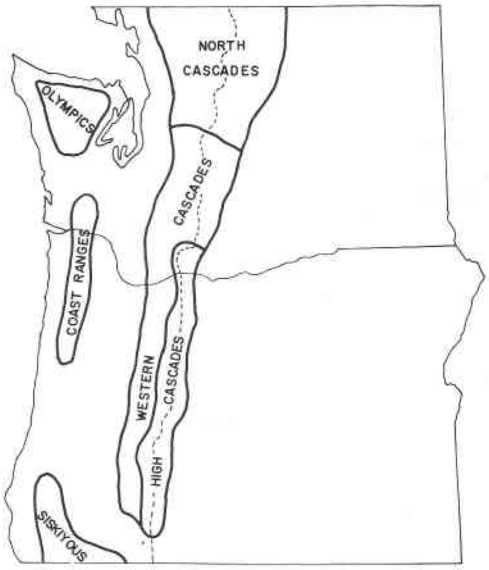
Geographic distribution of Douglas-fir stem analysis study locations in Oregon and Washington.

Ecology and Silviculture of the True Fir-Hemlock Forests of the Pacific Northwest, by Jerry F. Franklin (130)

The "true fir-hemlock forests" occur at middle to high elevation in the Cascade and Coast Ranges of Oregon and Washington. These forests are typified by such species as Pacific silver fir, noble fir, Shasta red fir, subalpine fir, mountain hemlock, and western white pine. The forests cover in excess of 3,000,000 acres in the Pacific Northwest and are one of the region's most important forest resources.

Until recently, this complex of forest types was relegated to relative obscurity by the Douglas-fir forests on western slopes of the Cascade Range. In the past decade, however, this has changed dramatically. Species previously considered "weed" trees now command major attention from practicing foresters.

This report, presented at the 1964 meeting of the Society of American Foresters in Denver, Colorado, is an introduction to the true fir-hemlock forests, the environment they occupy, management systems presently in use, and problems encountered in management and utilization of the resource.



The six major geologic areas in which true fir-hemlock forests occur. Crest of the Cascade Range indicated by a dotted line.

Natural Reproduction of Grand Fir and Mountain Hemlock After Shelterwood Cutting in Central Oregon, by K.W. Seidel and R. Cooley (131)

Although based on a single case history, the information presented here should prove useful as a basis for determining how many trees to leave when using the shelterwood method in upper-slope fir-hemlock stands in the central Oregon Cascades.

It is apparent from the study that grand fir and mountain hemlock seedlings require a considerable amount of overstory protection in order to live through the first 2 years after germination. In order to get satisfactory numbers of grand fir seedlings, residual stand density should be no less than about 80 ft^2 per acre.

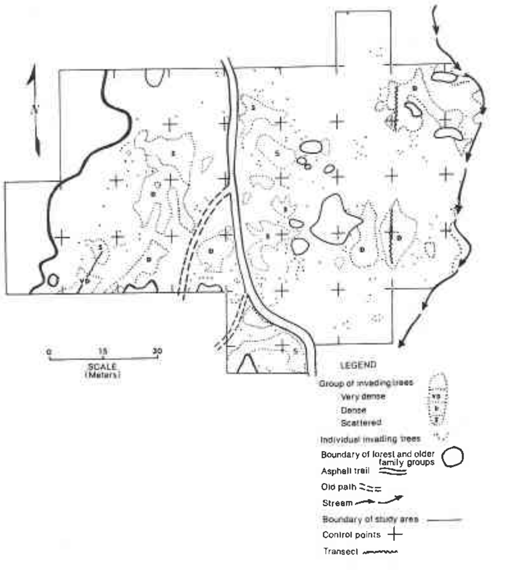
Mountain hemlock is more sensitive to microclimatic extremes than grand fir and more vulnerable to windthrow. As a result, overstory density should be even higher in this species (more than 100 ft^2 per acre) if hemlock makes up a large percentage of the stand. The tallest, large-crowned trees should be kept to minimize loss from windthrow.

Trees Invade Subalpine Meadows

In the past, meadows of the forest-tundra region of the Washington and Oregon Cascades have been invaded by a variety of tree species, most notably subalpine fir and mountain hemlock. The heaviest invasion occurred between 1928 and 1937, with very little since about 1945.

The authors discuss various reasons for the encroachment of forest on meadows, including fire and grazing, but suggest that climatic change is the most probable cause. A relatively dry period occurred late in the nineteenth century and extended into the 1940's. This caused the glaciers to retreat and lengthened the snow-free period in high mountain areas.

For an interesting discussion read, *Invasion of Subapline Meadows by Trees in the Cascade Range, Washington and Oregon,* by Jerry F. Franklin, William H. Moir, George W. Douglas, and Curt Wiberg (132).



Distribution of invading seedlings and saplings and of older family tree groups on the 0.8-ha study tract in Paradise Valley, Mount Rainier National Park, Wash.

the forest? Extensive safety tests are required by the Environmental Protection Agency before a material can be registered for use. Most of this work has already been done. Dr. Mauro Martignoni, a microbiologist on Thompson's staff, has directed preliminary tests on rabbits, rats, mice, deer, quail, fish, and bees—and none were harmed by the virus. The work with rabbits and fish has been done in the Corvallis laboratory. Other work has been contracted or conducted by the U.S. Department of the Interior's Fish and Wildlife Service.

According to Thompson, viruses are "among the more specific pathogens. A good many have only one host." The virus Thompson's team is working with is a nucleopolyhedrosis virus, of which there are several hundred varieties. Most of these viruses cause diseases of the larvae of the tussock moth and other Lepidoptera such as the cabbage looper, cotton bollworm, forest tent caterpillar, and hemlock looper. The specific virus under study is infectious to only a few closely related species of tussock moths.

Working from electron microscope pictures, researchers have identified at least three distinct viruses that kill the tussock moth. One, a bundle virus, was selected for intensive studies, primarily because it seems to cause greater breakdown of the larvae, says Kenneth Hughes, a research entomologist on Thompson's staff.

Hughes, who has studied hundreds of electron microscope pictures of the virus, talks about its structure: the virus comes in bundles with anywhere from 1 to 20 individual virus rods per bundle. The bundles, surrounded by lipo-protein membranes, are grouped into a polyhedron. Because it acts as a protective device, the polyhedron enables the virus to survive in the environment. Without the polyhedron, the virus breaks down quickly and is destroyed in sunlight. Enclosed in the polyhedron, the virus can last for years—perhaps indefinitely—if conditions are ideal.

Ask Hughes if the virus is alive, and he gets a quizzical look on his face. "The polyhedron is a protein crystal," he says. "It grows as a crystal grows. If virus particles are there, they are incorporated in it. They reproduce, but so do other complicated chemicals not generally thought of as living."

"Perhaps we're at the shady margin where it isn't even appropriate to make a distinction," he says.

Seasonal Height Growth of Upper-Slope Conifers, by Carroll B. Williams, Jr. (133)

This paper is the first published information available for seasonal height growth for some of the principal middle- to high-elevation species of the Cascade Range in the Pacific Northwest. Observations are given for subalpine fir, noble fir, Pacific silver fir, Douglas-fir, western white pine, lodgepole pine, western hemlock, mountain hemlock, and western redcedar.

Total height growth seemed to be related to length of current growing season, particularly for the true firs and mountain hemlock. Significant variations were found in the study areas between species and by years for initiation of bud bursting, length of growing season, and stages of growth completion.

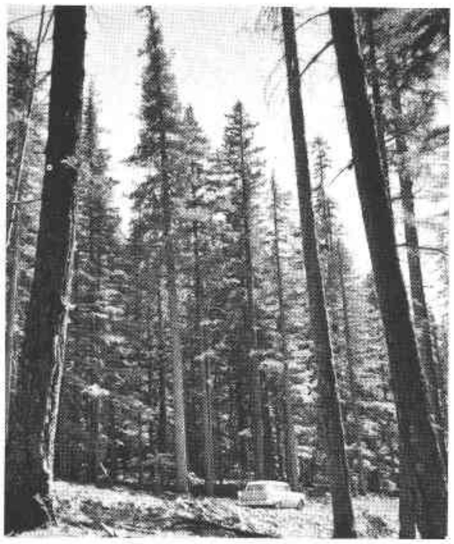
Subalpine fir in foreground.

Seeding Habits of Upper Slope Species

Several papers have been published under the title, *Seeding Habits of Upper-Slope Species.* These include:

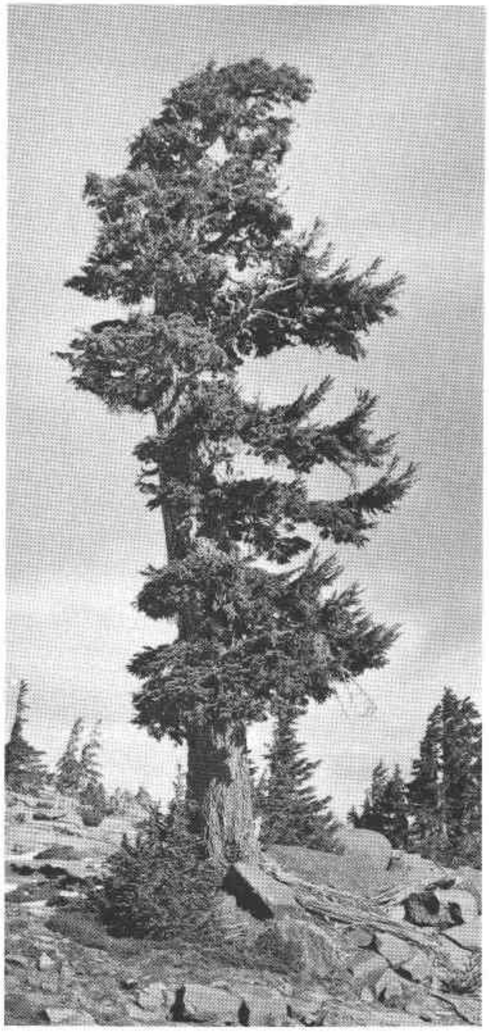
I. *A 12-Year Record of Cone Production* (134), by Jerry F. Franklin, Richard Carkin, and Jack Booth. This is a 12-year study of cone production by noble, Pacific silver, grand, white, subalpine, and Shasta red firs, mountain hemlock, western white pine, and Engelmann spruce. Upper slope species produced medium to heavy cone crops at 2-3 year invervals at most locations.

II. *Dispersal of a Mountain Hemlock Seedcrop of a Clearcut* (135), by Jerry F. Franklin and Clark E. Smith. Mountain hemlock seedfall declined rapidly beyond 125 feet from the stand edge, but central portions of a 30-acre clearcut still received large amounts of seed. Seedling germination or establishment appears to be the major problem in regenerating mountain hemlock on clearcuts.

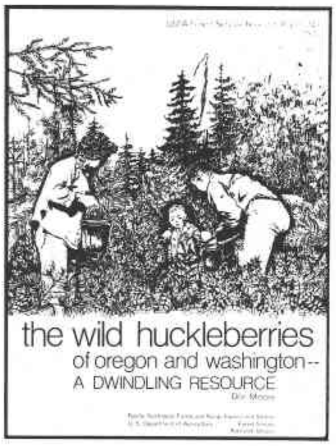


Western white pine in a mixed stand of Douglas-fir, western larch, western white pine and hemlock.

III. *Dispersal of White and Shasta Red Fir Seeds on a Clearcut* (136), by Jerry F. Franklin and Clark E. Smith. Very heavy seed crops occurred in 1968 and 1971 in white and Shasta red fir stands. Southwesterly winds were most important in seed dispersal. As a result, shelterwoods and strip clearcuts should be elongated northwest-southeast to provide the best assurance of adequate seed supply.



Mountain hemlock on Mt. Adams near Bird Creek Meadows.



The Wild Huckleberries of Oregon and Washington, a Dwindling Resource, by Don Minore (137)

An estimated 160,000 acres support huckleberries in Oregon and Washington, but this area is dwindling as trees and shrubs invade the berry fields. Effective vegetation-control methods and huckleberry management techniques have not been developed. However, such techniques are available for the closely related eastern blueberries, and it may be possible to modify these methods for northwestern conditions.

The Twin Buttes huckleberry field is probably the most productive of the 160,000 acres of wild huckleberry land in Oregon and Washington. The 1969 season was unusually favorable near Trout Lake, Washington, producing an estimated berry harvest of 280,000 gallons—or 112 gallons per acre. With these berries valued at $3 per gallon, the economic yield was over $300 per acre for that single year. In addition, recreational benefits also were enjoyed by the berry pickers, who spent 163,000 visitor days on the Twin Buttes huckleberry field during the 1969 season.

Even half of the 1969 huckleberry yield at Twin Buttes would equal or exceed the value of timber produced annually on most high-site forest land, and the Twin Buttes huckleberries grow on a poor site. In fact, most huckleberry fields apparently occupy sites that are only marginal for timber production. The most productive fields seem to occupy the poorest timber-growing lands.

This publication is the first step in a research program aimed at developing management techniques that can be used to conserve and develop the huckleberry resource. It summarizes available information on native northwestern *Vaccinium* species and their management. Management techniques for eastern *Vaccinium* species also are summarized.

Several notes on this research have also been published. See also articles listed under (138).

Tentative Ecological Provinces Within the True Fir-Hemlock Forest Areas of the Pacific Northwest, by Jerry F. Franklin (139)

True fir-hemlock forests occupy extensive areas at middle to high elevations in mountainous regions of Oregon and Washington. These forests are characterized by Pacific silver fir, noble fir, Shasta red fir, subalpine fir, western hemlock, mountain hemlock, and western white pine. True fir-hemlock forests constitute a major forest resource, covering approximately 3 million acres and containing about 100 billion board feet of timber. They occupy the upper reaches of many major drainages, occur within summer ranges of big-game animals, and in many areas receive heavy recreational use. True fir-hemlock forests vary a great deal in species composition and stand characteristics and will require a variety of silvicultural prescriptions for intensive management.

This paper suggests useful geographic divisions of the true fir-hemlock forests within the mountainous regions of western Oregon and Washington. Divisions are based on differences in geology, topography, soil parent materials, climate, and forest composition. Because the regions or provinces are based on a consideration of several factors rather than just a single factor such as physiography or climate, they are considered ecological provinces. The provinces provide a geographic framework which facilitates isolation and solution of management problems and provides an initial stratification for research purposes.

animal damage

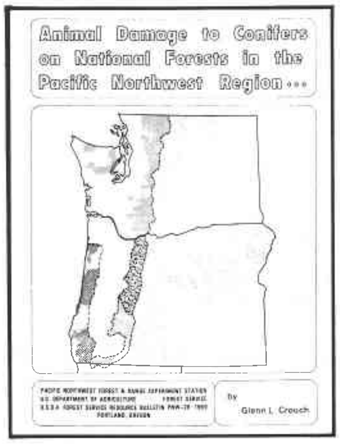
general

A survey of animal damage to forest plantations in Oregon and Washington was begun in 1963, under the direction of the Cooperative Animal Damage Survey Committee. The survey was scheduled to end in 1969. Cooperators installed a series of 112 sampling plots in plantations during 1963-64 and a second series of 82 during 1964-65. Of these plots, 165 are on Douglas-fir plantations, 4 are in mixed Douglas-fir and ponderosa pine, and 25 are in ponderosa pine and Jeffrey pine, or mixtures of the two.

We found a significant amount of mortality, unrelated to animal damage, soon after planting. But, based on differences between survival of caged and uncaged seedlings, animals caused 35 percent of the mortality in Douglas-fir, 51 percent in the pines.

Animals damaged seedlings on all plots. Browsing and clipping of stems were the principal causes of seedling injury. Cutting of roots, budding, barking, trampling, pulling seedlings from the ground, and covering seedlings with soil were also noted. Browsing by deer was the most common source of animal damage on all plots. Animals that injured seedlings, ranked by frequency of damage in 1968, were big game, hares and rabbits, grouse, mountain beavers, pocket gophers, domestic stock, porcupines, microtine rodents, and moles.

Survey of Animal Damage on Forest Plantations in Oregon and Washington, by Hugh C. Black, Edward J. Dimock II, Wendell E. Dodge, and William H. Lawrence (140).



Animal Damage to Conifers on National Forests in the Pacific Northwest Region, by Glenn L. Crouch (141)

This study was conducted to provide an assessment of animal-conifer problems on national forests in the Pacific Northwest. Information was gained through questionnaires mailed to ranger districts. The study reports data on: (a) kinds of damage, (b) species of animals causing damage, (c) locations of problems, and (d) related management factors.

Regionally, browsing of young seedlings by deer, elk, and livestock was the most serious problem. Removal of bark by porcupines, bear, and other animals was second in importance.

PROBLEM ANIMALS[2]

The following animals were reported to be damaging trees:

Deer	*Odocoileus* spp.
Porcupine	*Erethizon dorsatum*
Gophers	*Thomomys* spp.
Snowshoe hare	*Lepus americanus*
Black-tailed jackrabbit	*Lepus californicus*
Rabbits	*Sylvilagus* spp.
Elk	*Cervus canadensis*
Cattle	*Bos* sp.
Domestic sheep	*Ovis* sp.
Domestic goats	*Capra* sp.
Horses	*Equus* sp.
Mountain beaver	*Aplodontia rufa*
Bear	*Euarctos americanus*
Voles	*Microtus* spp.
Beaver	*Castor canadensis*
Chipmunks	*Eutamias* spp.
Ground squirrels	*Citellus* spp.
Western gray squirrel	*Sciurus griseus*
Wood rats	*Neotoma* spp.

The structure of the virus also affects the way it acts inside the tussock moth. In feeding, the tussock moth eats not only the virus, but also the polyhedra which enclose them. When the polyhedra reach the midgut of the insect, they come in contact with an alkaline solution, which dissolves the protein base of the polyhedron and allows the virus to spread through the insect's bloodstream.

Researchers don't really know what happens after that. Hughes would like to know, and perhaps one day the pictures will yield a clue. But right now, the important thing is that the virus does the job. Somehow, the virus is transmitted to various parts of the insect, where it multiplies, breaks down cell tissue, and eventually kills the insect.

end

A RECIPE FOR CLEANER CAMPGROUNDS
by Thomas Michael Baugh

Children in national forest campgrounds throughout the Pacific Northwest have become litter fighters. These young anti-litterbugs are helping to reverse an expensive and highly objectionable trend. Instead of tossing a candy wrapper or empty can on the ground, the new generation picks up discarded trash, places it in a bag provided by the campground attendant, and turns the bag in for a well-earned reward.

Most observers agree that traditional approaches to controlling litter have not worked. The litter continues to build up, and campground workers spend long hours and public dollars cleaning up the debris.

In 1971, researchers in a Seattle unit of the Pacific Northwest Forest and Range Experiment Station began investigations into the control of litter. The PNW scientists, Roger Clark and John Hendee, together with Robert Burgess, a Univeristy of Washington sociologist, not only learned a lot about why people litter, but also developed and tested an incentive system aimed at solving the litter problem.

The initial research took place in two movie theaters in the Seattle area. Clark points out that movie theaters were an ideal starting point, because most movie-goers feel that it is okay to throw empty popcorn bags and boxes on the floor.

Destruction of Conifer Seed and Methods of Protection, by M.A. Radwan (142)

Unlike many deciduous tree species which are easily propagated vegetatively, most conifers are reproduced naturally and artificially from seed. Success of conifer forest regeneration, therefore, depends on production of sufficient quantities of high quality seed. This can be achieved only by thorough knowledge of factors affecting seed production and protection of the seed crop from natural destructive agents.

Presently, the trend in artificial reforestation is toward planting rather than direct seeding. However, seeding will probably remain the more economical and perhaps the only suitable reforestation method in many situations. The overall problem of seed destruction and methods of protection, therefore, are reviewed in this paper to guide present and future reforestation efforts with conifer seed.

Coating and Impregnating with Endrin Protects Field-Sown Douglas-fir Seed, by G.L. Crouch and M.A. Radwan (143)

Artificial seeding is a useful means of reforestation under suitable conditions, but the probability of success is variable and dependent upon a multitude of uncontrollable physical and biological interactions. Regardless of other variables, the writers reaffirm their belief that Douglas-fir seed sown at 1.12 kg or less per hectare must be protected with endrin or another equally effective chemical if seeding is to have a reasonable chance for success.

M.A. Radwan

Natural Resistance of Plants to Mammals, by M.A. Radwan (144)

A report on some of the problems involved in determining the chemistry of resistance to browsing of forest trees by animals. There is much evidence to show that resistance occurs among and within plant species. But determining precisely what chemical factors are responsible for that resistance is very difficult.

For a general discussion of research by PNW scientists at Olympia, Washington, see also an article titled, "What makes Deer Choosy Eaters?" in the February 1975 issue of *Forestry Research: What's New in The West* (145).

Animal Resistant Douglas-fir

When asked about reducing animal damage to planted conifers, research forester Ned Dimock reports that the way is now clear for exploiting genetic resistance in Douglas-fir. Working with forest geneticist Roy Silen and forestry technician Virgil Allen, Dimock showed that both captive black-tailed deer and snowshoe hare would select among Douglas-fir clones while feeding on tree foliage. Preferences for similar appearing but genetically different foliage samples approached a ratio of 5:3 for deer and exceeded 5:2 for hare. In addition, deer and hare showed both parallel and differing preferences for genetically identical material.

Crossing resistant parents produced seedlings that also resisted deer browsing and hare clipping in controlled tests with captive wild animals. Differences between susceptible resistant progenies were on the order of 2:1. Such animal resistance is strongly inherited. Resistance is predictable with a reasonably high degree of accuracy—close enough to minimize the need for progeny tests if parental resistance characteristics are determined.

How effective is resistance in protecting seedlings planted in areas susceptible to heavy animal damage? "Highly so," says Dimock, "if we can base conclusions on our experience with snowshoe hare—a species that can heavily damage small seedlings. In two different field tests, we found that resistant families were only clipped about half as much as susceptible ones during periods of most severe damage. In both cases, we got effective protection for a whole year—and, in one case, natural resistance was effective for 2 years, the longest time we've monitored it."

Rating Douglas-fir parents for damage resistance is easy in theory—but difficult in practice due to the need for special facilities, carefully controlled testing methods, plus sufficient time and money to achieve reliable results. Also, Douglas-fir genotypes resistant to one animal species may not be resistant to another. However, with increasing attention being paid to improving genetic strains of valuable conifer crops, animal resistance should be a trait worth developing. From what we know so far, it is a trait that seems entirely compatible with rapid growth, good stem form, and other characteristics usually sought after in tree breeding.

For further details, consult *Animal Resistant Douglas-fir: How Likely and How Soon?* (146) by Edward J. Dimock, and *Genetic Resistance in Douglas-fir to Damage by Snowshoe Hare and Black-Tailed Deer* (147), by Edward J. Dimock, Roy R. Silen, and Virgil E. Allen.

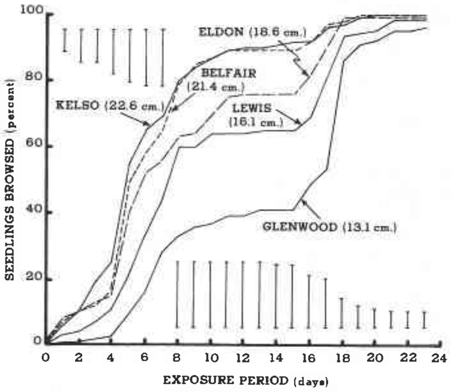
Ned Dimock

deer and elk

Seedling Height and Deer Browsing

In a study near Olympia, Washington, researchers tried to determine if Douglas-fir seedlings from different sources would be browsed differently by deer. Results were interesting. In the preliminary analysis, it looked as though feeding preference differed markedly among the races tested. But more complete results later indicated that feeding preferences were strongly linked to seedling height. Even that conclusion is probably a simplification. In all likelihood, both height and qualitative variations affect browsing preference.

See *Influence of Douglas-fir Seedling Height on Browsing by Black-Tailed Deer,* by Edward J. Dimock II (148).



Browsing preference by black-tailed deer for Douglas-fir seedlings from five western Washington races.

Plant Characteristics Related to Feeding Preference by Black-Tailed Deer, by M.A. Radwan and G.L. Crouch (149)

Like other herbivores, black-tailed deer show definite selectivity in their feeding. Thus, the animals have often been observed to prefer different parts of plants and to have preferences among and within species.

Many investigations have been made of the causes for these differences. Most, however, have dealt with nutritive value as a preference factor, the theory being that wildlife browse species that will be most nutritious.

Not so, says chemist and plant physiologist M.A. Radwan. He thinks that's a lot of nonsense. This publication is an attempt to resolve the literature on that point.

Vegetation and Soils of a 30-year Deer and Elk Exclosure in Central Washington, by A.R. Tiedemann and H.W. Berndt (150)

Study of the soils and vegetation surrounding a 1-acre deer and elk exclosure in eastern Washington has enabled ecologists to learn more about the effect of wildlife on soil and vegetation. The study site was in and around an exclosure established in 1939 near Wenatchee.

The striking contrast in vegetation within and outside the exclosure drew scientists' attention to the site. The area inside the exclosure supports a dense stand of snowbrush ceanothus. Grasses and forbs dominate the understory outside the exclosure.

The researchers discuss the soil and vegetation of areas inside and outside the exclosure. Their results, of course, point out the continued increase in biomass and litter within the exclosure. But they also indicate that heavy use by wildlife was not enough to affect soil nutrient levels or soil stability. Only vegetative composition, plant crown cover, and litter accumulation have been affected.

Terpenes May Also Affect Browsing

Two large groups of chemicals—the phenols and terpenes—appear to affect browsing preference in Douglas-fir. Work on the phenols is summarized in the preceding note. In this study, researchers measured the monoterpene hydrocarbons in foliage vapors from four Douglas-fir clones—two that were resistant to browsing and two that were not. With all methods used, more terpenes were found in foliage that was resistant to browsing. Results are preliminary, but may have application in breeding Douglas-fir resistant to browsing.

See *Clonal Variation in Monoterpene Hydrocarbons of Vapors of Douglas-fir Foliage,* by M.A. Radwan and W.D. Ellis (151).

	Peak height (cm/g)[c]							
	Clone SD-19		Clone SD-10		Clone SD-22		Clone SD-13	
Component[a]	Range	Mean	Range	Mean	Range	Mean	Range	Mean
			A. In presence of air					
α-pinene	123–163	135	42–52	47	130–202	162	219–296	250
Camphene	4–9	7	1–3	2	6–11	8	4–15	8
β-pinene	128–170	150	37–50	42	227–339	275	166–243	198
Sabinene	12–49	33	6–50	33	12–63	42	22–169	114
Δ-3-carene	41–68	51	100–120	109	48–64	57	60–133	98
Myrcene	1–18	6	1–10	4	1–3	2	1–68	27
Limonene	8–12	10	2–4	3	10–18	13	6–15	11
β-phellandrene	2–6	4	2–6	4	4–8	6	5–16	10
γ-terpinene	2–10	5	2–10	6	3–9	6	6–32	20
Terpinolene	4–8	6	6–10	8	6–10	8	16–31	24
Total terpenes	372–484	430	269–303	280	521–720	610	679–974	805
			B. In presence of nitrogen					
α-pinene	114–232	173	43–80	66	152–208	166	206–410	266
Camphene	5–13	8	2–4	3	6–12	9	5–13	8
β-pinene	102–262	173	30–74	55	162–38	269	162–406	222
Sabinene	44–59	53	42–96	74	27–106	56	63–296	153
Δ-3-carene	18–84	54	83–187	142	24–106	79	62–248	131
Myrcene	14–26	19	1–65	26	2–29	12	1–13	6
Limonene	12–20	14	3–7	5	13–24	18	12–20	15
β-phellandrene	4–8	6	4–10	6	5–8	6	11–22	14
γ-terpinene	2–13	6	2–17	6	2–11	6	8–36	23
Terpinolene	6–13	8	12–20	14	7–14	11	21–48	29
Total terpenes	685–1005	800	507–740	671	688–1116	924	874–1780	1126

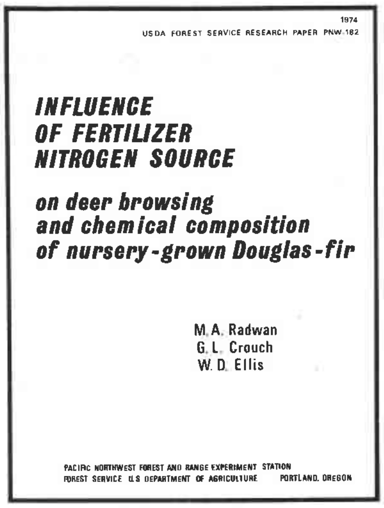
[a] Year-old foliage sampled during winter. SD-19 and SD-10 susceptible to browsing, SD-22 and SD-13 resistant.
[b] Separated on a capillary column. Total terpenes include all unknowns.
[c] Figures, rounded to nearest cm, represent five composite samples.

Monoterpenes of vapors from whole foliage of Douglas-fir.

Chlorogenic Acid Linked to Browse Resistance

A phenolic compound, chlorogenic acid, appears to be involved in deer browsing preference in Douglas-fir. In studies, deer consistently browsed tree foliage that is high in chlorogenic acid. Deer are also known to prefer mature Douglas-fir which is higher in chlorogenic acid than that of young seedlings.

For papers on this topic, see (152) in the bibliography.


1974
USDA FOREST SERVICE RESEARCH PAPER PNW-182

INFLUENCE OF FERTILIZER NITROGEN SOURCE

on deer browsing and chemical composition of nursery-grown Douglas-fir

M.A. Radwan
G.L. Crouch
W.D. Ellis

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE PORTLAND, OREGON

Effects of Fertilizer on Browsing

Results of one study indicate that the type of nitrogen fertilizer has no effect on browsing preference by deer in Douglas-fir. One-year-old Douglas-fir seedlings were fertilized with ammonium sulfate, calcium nitrate, and urea. Seedlings from the different treatments were browsed with equal vigor by penned deer.

Influence of Fertilizer Nitrogen Source on Deer Browsing and Chemical Composition of Nursery-Grown Douglas-fir, by M.A. Radwan, G.L. Crouch, and W.D. Ellis (153).

Interaction of Deer and Forest Succession on Clearcuttings in the Coast Range of Oregon, by Glenn L. Crouch (154)

The author reviews the history of man's interest in deer and forest succession. Deer by themselves can slow the return of Douglas-fir on clearcuts in the Pacific Northwest region, but do not delay succession for long—unless their use is extremely heavy.

Repetitive browsing by deer in combination with hare or mountain beaver, however, can definitely cause regeneration failures. Since tighter hunting regulations are unlikely for those areas, some type of physical or chemical control is necessary if reforestation is desired.

Saturday matinees, with their large audience of children, were selected for the theater phase of research. Over a 14-week period, researchers handed out litter bags, increased the number of trash cans and made them more conspicuous, and showed a short film with a strong anti-litter message. Littering behavior was measured, in order to determine the response of the viewing audience to these traditional anti-litter measures. The results of this early work indicated that these conventional approaches did not work—almost half the litter remained on the floor.

In the next step, investigators implemented a system to reinforce anti-litter behavior. Children were offered several types of incentives for picking up trash and seeing that it was properly disposed of. With one group, the reward was a free ticket to a specially-scheduled matinee; with another test group, the award was one thin dime. The results of the incentive system were impressive. Children in both test groups picked up more than 90 percent of the litter.

The Lake Kachess campground on the Wenatchee National Forest in Washington state was the scene for phase two of the research. Baseline data was again gathered in order to determine the amount and type of litter commonly found in the campground.

The researchers then approached 26 children from seven camping families and asked if they would like to help in a litter pickup program.

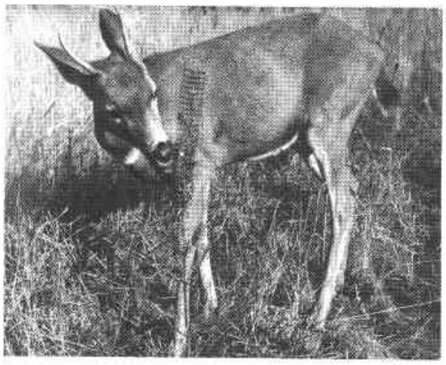
Animal Resistant Douglas-fir: How Likely and How Soon? by Edward J. Dimock II (155)

The author speculates on the future control of deer and hare browsing by genetic changes in Douglas-fir planting stock. Dimock is not optimistic that genetic control can be achieved in the near future. Research on feeding preferences has not shown either the consistency or the degree of variation that seems necessary for close genetic control. In fact, this research effort has now been shifted into other areas at the PNW Experiment Station on the assumption that it is relatively unproductive in both the short and long term.

Deer and Reforestation in the Pacific Northwest, by G.L. Crouch (156)

The author discusses the merits of managing deer and forests concurrently. In interior forests, browsing by mule deer often damages conifer seedlings planted on winter or transitional ranges. In the Douglas-fir region, numbers of black-tailed deer increase dramatically after forests are logged or burned, in response to improved forage supplies. Here, browsing on planted stock in clearcuts lowers forest productivity by reducing growth rates and occasionally contritributes to plantation failures.

Amelioration of damage by black-tailed deer could be achieved through long-range planning for concurrent deer and timber harvests, with hunting pressure directed to areas where logging promotes more deer.



small mammals

TMTD Wild Mammal Repellent: Review and Current Status, by M.A. Radwan (157)

Tetramethylthiuram disulfide, otherwise known as TMTD, is a very useful animal repellent, although further research is needed. This paper discusses its chemical properties, its use as a repellent against browsing and clipping animals, and limitations of the chemical.

Impregnating and Coating With Endrin to Protect Douglas-fir Seed from Rodents, by M.A. Radwan, G.L. Crouch, and W.D. Ellis (158)

Endrin is evaluated as a chemical treatment for protecting tree seed from small mammals during reforestation operations. The chemical was applied to the seed both by coating and by impregnation.

Endrin remains the only chemical recommended for protecting seed from rodents, yet because of its toxicity should be replaced by true repellents as soon as possible. Results from this study also indicate that the endrin treatment now used should be improved. Doubling the endrin concentration would increase the effectiveness of the treatment, but researchers do not recommend that approach. Impregnation, which is more effective than coating, would be more desirable but more costly. Use of additives to increase the effectiveness of coatings should also be considered.

See also, *Factors Affecting Endrin Content of Endrin-Coated Douglas-fir Seed,* by M.A. Radwan and W.D. Ellis (159).

Protecting Forest Trees and Their Seed from Wild Mammals, by M.A. Radwan (160)

A research paper, published in 1963, reviews the literature on control of wild mammal damage to forest trees. Radwan discusses the methods used to control wild mammal damage to forest tree seed, seedlings, and trees. References to mammals causing the damage, their motivation, types of damage, and effect on the forest resource are given.

The review suggests that the damage is increasingly serious and the amount and scope of current research on control methods is still inadequate to overcome the problem.

Coating and Impregnating with Endrin Protects Field-Sown Douglas-fir Seed, by Glenn L. Crouch and Mohamed A. Radwan (161)

Endrin is a useful tool in treating for protecting Douglas-fir seed from deer mice. Observations from this study indicate that seedling production and stocking were much greater when the seed was treated with endrin. No differences were noted, however, when different endrin treatments were tested—for example, coating with endrin, using a combination of endrin and thiram, and by impregnating the seed with endrin.

Storing Endrin-Coated and Endrin-Impregnated Douglas-fir Seed, by M.A. Radwan and H.W. Anderson (162)

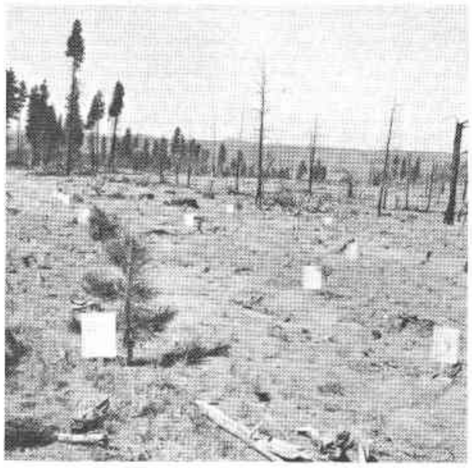
Results are reported on the effect of storing endrin-coated Douglas-fir seed. Application of endrin to Douglas-fir seed by coating at .5 percent or by soaking in endrin-dichloroethane solutions did not inhibit germination or seedling growth.

For other papers on chemicals to protect Douglas-fir seed from small mammals, see publications listed under (163).

Susceptibility of Ponderosa, Jeffrey, and Lodgepole Pines to Pocket Gophers, by Glenn L. Crouch (164)

Pocket gophers can be extremely damaging to young plantations of pines. In this study, the pesky creatures began to attack the pines almost immediately after planting. Within 3 hours, pocket gophers had walked off with several seedlings.

Trees were planted in March 1966. By September 1969, two-thirds of all the trees had been destroyed by gophers. Most of the damage occurred during the winter when the seedlings were presumably under snow.

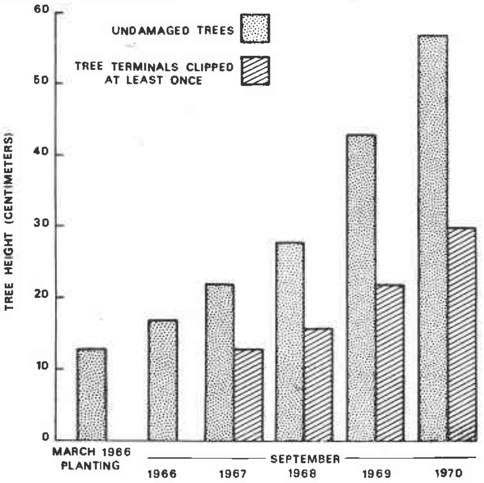


Typical burned area adjacent to the study site, March 1966. Trees marked by cards were planted in 1962, damaged by gophers during the 1965-66 winter, and subsequently died.

Jackrabbits Injure Ponderosa Pine Seedlings, by Glenn L. Crouch (165)

Black-tailed jackrabbits are present in many stands of ponderosa pine in central Oregon, especially where this forest type is interspersed with brush or grassland. In contrast to their sometimes damaging effect on agricultural crop or range lands, forestland jackrabbits appear to have little direct effect on tree crops except during forest regeneration. Then, like their forest-dwelling counterpart, the snowshoe hare, they may damage tree seedlings.

Although apparently not widespread, damage to conifer seedlings by jackrabbits has been reported from Nebraska and central and eastern Oregon, but little quantitative information is available on mortality and height losses cause by these animals. This paper gives an account of injuries by jackrabbits to an experimental planting of ponderosa pine.

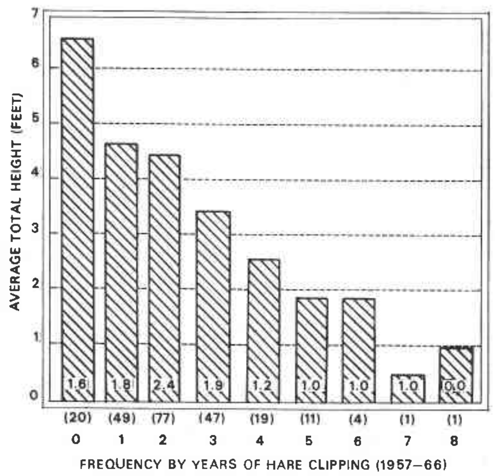


Heights of unclipped and clipped ponderosa pines through five growing seasons after planting. Differences in heights each year are significant at the 1-percent level.

Ten-Year Height Growth of Douglas-fir Damaged by Hare and Deer, by Edward J. Dimock II (166)

A 10-year study of animal damage to Douglas-fir seedlings in Washington's coastal zone yields important information for forest land managers. Researchers suggest that in this area, planting of extra large trees may have dual benefits: (a) it will help get trees established and growing quickly enough to outdistance early browsing by hares, and (b) it should improve tolerance to western bracken.

Although both deer browsing and hare damage were reported, nearly all animal-caused losses were attributed to early damage by hare.



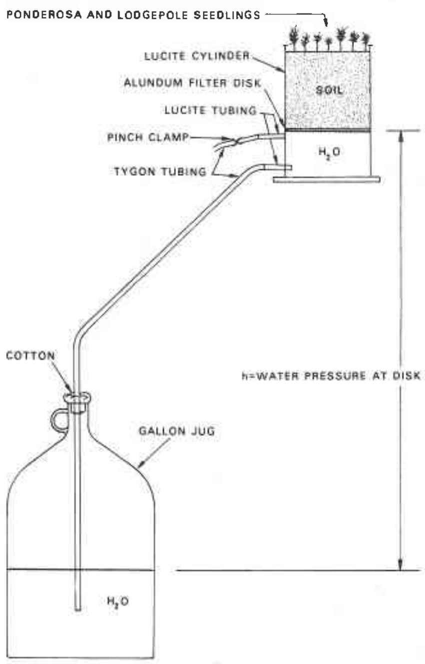
Height in 1966 of planted Douglas-fir seedlings as related to clipping frequency by hare.

effects of environment

Tolerance of Lodgepole and Ponderosa Pine Seeds and Seedlings to High Water Tables, by P.H. Cochran (167)

In south-central Oregon, there is a distinct type line between lodgepole and ponderosa pine. Stands of almost pure lodgepole pine grow on depressions and flat areas with ponderosa pine or a mixture of ponderosa and lodgepole growing on adjacent higher slopes. In this report, researchers analyze the possibility that this might be caused by differing tolerance of the two species to high water tables.

Results indicate that seeds and seedlings of both species have a surprisingly high tolerance to very wet soils and low oxygen diffusion rates. It is very likely that factors other than water table account for the difference in geographic preference of the species.



Apparatus for controlling soil water suction.

The children were told that in exchange for picking up litter they would be able to choose from rewards such as a Smokey the Bear comic book or shoulder patch, a Junior Forest Ranger badge, a small box of gum, a wooden ruler, or a "Keep Washington Green" pin. With litterbags clutched tightly in their small hands, the children worked through the campground. According to Clark, the results of this experiment and the many with followed suggested that litter can be reduced by about 75 percent when using this incentive system.

Campgrounds are obviously only a part of the total litter problem. Dispersed camping areas and hiking trails also accumulate litter. It was to one of these areas that the researchers next turned. Both the design of the study and the results were similar to the previous outdoor experiments. In the dispersed camping area, there was a 75 percent reduction from previous litter levels when the researchers offered incentives to the children of camping families.

Results such as those found by the PNW recreation research unit are of particular interest to land managers who face constantly rising costs and lower operating budgets. The practical applications of this simple incentive system have obvious esthetic and monetary advantages. Clark points out that an evaluation of one of the controlled experiments indicated that the incentive system was far more effective and much less costly than routine litter pickup by campground personnel. In one area, each bag of litter collected by Forest Service maintenance personnel cost about $8.30 in wages. Each bag of litter collected and turned in by one of

Don Minore

Water Tables Affect Tree Growth

Although lodgepole pine and western redcedar may be grown in areas with shallow water tables, they seem to grow best over deeper water tables. Red alder and Sitka spruce, also suitable for shallow water table areas, seem less suited to deep water tables. Douglas-fir is not tolerant of shallow water tables and should not be planted where water tables are near the surface.

Researchers caution that the absolute water tables discussed in this study are not directly comparable to water tables in forest areas. However, the relative tolerence of the species mentioned here should hold in forest regions.

See *Seedling Growth of Eight Northwestern Tree Species Over Three Water Tables,* by Don Minore (168).

More on Water Tables

In this study, plant ecologist Minore studied the effects of shallow water tables (skunk cabbage swamps and stream bottoms on the Olympic Peninsula) on four tree species—red alder, western redcedar, Sitka spruce, and western hemlock. Western hemlock cannot tolerate winter water tables less than 15 cm deep. Sitka spruce tolerates shallower water tables, but only where the water is flowing. Red alder and western redcedar seem little affected by water table, and grow reasonably well even where stagnant water is at or near the surface during the winter.

The absence of Douglas-fir on wet areas, even when surrounded by Douglas-fir trees, indicates that this species cannot tolerate shallow water tables.

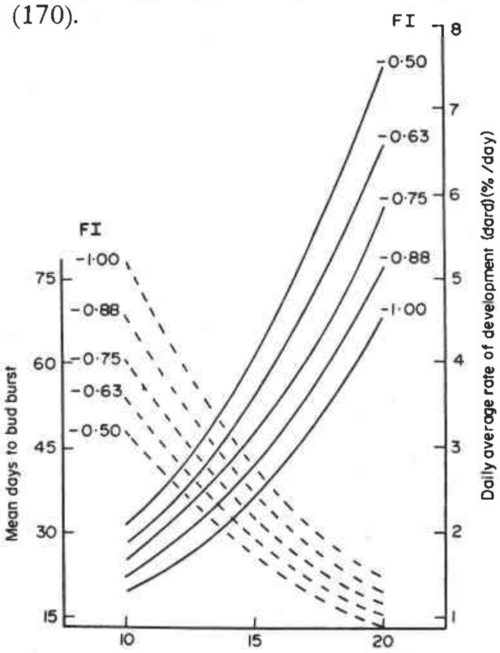
See *Occurrence and Growth of Four Northwestern Tree Species Over Shallow Water Tables,* by Don Minore and Clark E. Smith (169).

Seed Source Important

Transfer guides currently used for seed sources for reforesting Douglas-fir in western Washington and Oregon are rules of thumb taken from Swedish models.

This very technical paper presents a predictive model which uses timing of vegetative bud burst for examining reponses of seedlings to transfer. Results of a hypothetical transfer indicate that moving seed in east-west directions is less desirable than moving seed an equavalent north-south distance.

For details, see *Use of Phenology for Examining Provenance Transfers in Reforestation of Douglas-fir,* by Robert K. Campbell (170).



Mean days to bud burst and daily average rate of development towards bud burst as a response to mean daily temperature.

Shade Benefits Douglas-fir in Southwestern Oregon Cutover Area, by Don Minore (171)

This experiment discusses the benefits of shade in improving the survival of young Douglas-fir trees planted in clearcut areas. On a hot, dry site in southwestern Oregon, shade is necessary for survival. The author discusses the relative merits of "dead" versus "live" shade. Dead shade is provided by nonliving materials such as rocks, piles of dirt, dead stumps, or logs. Live shade is provided by living things such as trees or shrubs. There appeared to be no difference between the benefits provided by each. It is the shade that is important.

Survival and growth of Douglas-fir seedlings, by treatment.

Treatment	Survival 1968	Survival 1969	Average height growth 1968	Average height growth 1969
	Percent	*Percent*	*Inches*	*Inches*
No shade	18.3	10.0	0	1.2
Live shade	56.7	46.7	.2	1.2
Dead shade	86.7	60.0	.3	1.6

Proposed Harvesting Guides Based Upon An Environmental Classification in the South Umpqua Basin of Oregon, by Richard E. Carkin and Don Minore (172)

Success or failure of forest regeneration on clearcuts is significantly related to soil depth and texture, elevation, solar radiation, moisture, and temperature of the preharvest environment. Regression equations are given which express these relationships. They should be useful in comparing potential regeneration difficulty on areas to be harvested.

Direct Solar Radiation on Various Slopes From 0 to 60 Degrees North Latitude, by John Buffo, Leo J. Fritschen, and James L. Murphy (173)

Solar energy is by far the most important climatic factor and is a significant parameter in ecological problems dealing with silviculture, entomology, pathology, and fire control.

In this report, computer programs were modified and written to calculate direct solar radiation on selected slopes and aspects in 10-degree increments from the Equator to 60 degrees north. These results are presented in tabular form and as graphical plots of hourly and daily values.

Columbus Day Windstorm Analyzed

The violent windstorm that occurred in the Pacific Northwest on October 12, 1962, was no lady. She caused more destruction in this region than any other windstorm in recorded history. In addition to lost lives and property damage, considerable damage was done to the area's forests. Blowdown of timber in the western parts of Oregon and Washington amounted to more than 11 billion board feet.

But what were the unique weather patterns that contributed to the big blow? Meterologists answer that question in a report: *Detailed Analysis of the 1962 Columbus Day Windstorm in Oregon and Washington,* by Robert E. Lynott and Owen P. Cramer (174).

competing vegetation

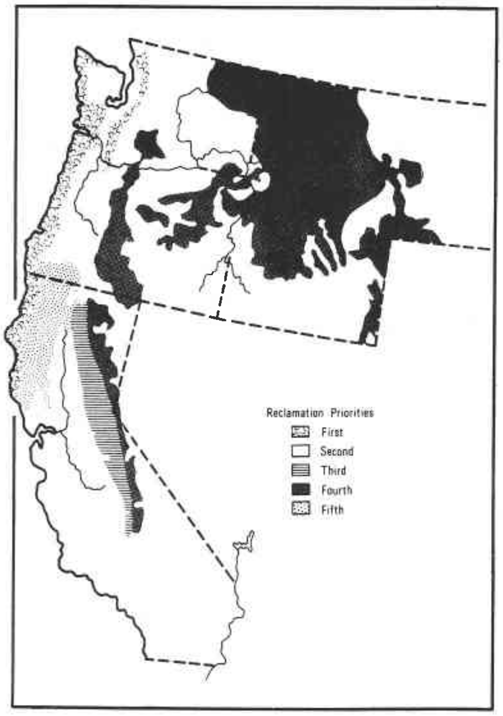
Rehabilitation of Forest Land. The Pacific Coast and Northern Rocky Mountain Region, by H. Gratkowski, D. Hopkins, and P. Lauterbach (175)

There are about 96.7 million acres of commercial forest land in the Pacific Coast and northern Rocky Mountain region. Of this, at least 9 million acres are dominated by brush species and trees commonly considered "weed species" by foresters.

Brush seems to be a problem throughout the region. For example, in the foothills of the Cascades in Washington and in the Oregon-Washington Coast Ranges the usual troublemakers are red alder, bigleaf maple, and shrubs such as salmonberry, thimbleberry, and vine maple. In southwest Oregon and northern California tough evergreen shrubs and weed trees predominate.

On the western slope of the Cascade Range in Oregon, evergreen species such as snowbrush, varnishleaf, and mountain whitethorn ceanothus, golden chinkapin, and greenleaf manzanita are common. In Washington, comparable slopes are occupied by red alder, bigleaf maple, vine maple, elderberries, and willows.

On the west slope of the Sierra Nevada, foresters deal with evergreen shrubs such as greenleaf manzanita, snowbrush, and mountain whitethorn ceanothus, other manzanitas, Sierra evergreen-chinkapin and mountain-mahoganies, bitter cherry, black oak and bearmat.



Location of brush areas and suggested priorities for reclamation based upon average productivity of commercial forest land.

On the east side of the Sierra Nevada and Cascade Ranges and in the northern Rocky Mountains, brush is commonly evergreen in California and Oregon, but deciduous in Washington and the Rocky Mountains. In northern Rocky Mountain forests, the most troublesome plants are smooth menziesia, snowbrush ceanothus, Rocky Mountain maple, mallow ninebark, creambrush rockspirea, and willows.

This paper provides a good introduction to the problem of brush, methods of control, and research needs.

Ecological Considerations in Brush Control, by H. Gratkowski (176)

A fascinating discussion of the environmental factors which should be considered when making decisions about using herbicides to control brush: solar radiation, competition for moisture and nutrients, fire, and wildlife.

Take the case of varnishleaf ceanothus. In southwestern Oregon, studies indicate that varnishleaf (along with Pacific madrone) may act as a nurse crop for young Douglas-firs. The shrub provides shade and reduces surface soil temperatures during the early critical stages of tree growth. In addition, many species of ceanothus are reported to fix nitrogen in nodules on the roots and add to the available supply of nitrogen in the soil —thereby preparing the way for Douglas-fir to grow.

But, interactions in an ecosystem are never simple. And, in this case, the favorable effect of varnishleaf ceanothus on Douglas-fir appears to be counterbalanced by unfavorable effects as well. Douglas-fir trees shaded by varnishleaf are characteristically slender-stemmed and fragile, with narrow open crowns and small amounts of foliage. These stems are deformed as they try to grow upward through the shrubs. Many are broken under snow-laden shrubs in the winter. Height growth is also retarded.

All studies indicate that it would be well to release young Douglas-firs from varnishleaf as soon as the trees are well established on a site. For other brush species and other sites, the story may be very different.

the young volunteers costs about $0.50 in prizes. The time involved in contacting the families, lining up the children, and handing out the rewards is minimal. Both the money and manpower saved can be used for other important duties.

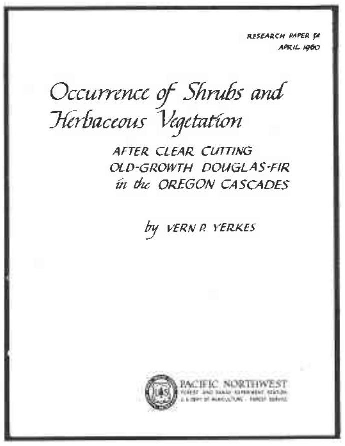
The litter incentive program has some other, not so obvious, benefits. Children who take part in the program leave their camping experience with at least the beginnings of a new environmental awareness. The small, inexpensive rewards, which are readily available at most ranger stations, are a reminder of why they were earned. Some of this awareness also rubs off on both Mom and Pop, who are also part of the litter program.

The use of the litter incentive program has lead to the development of some simple guidelines. According to Clark, the first contact should be with parents. Once the anti-litter campaign is explained, there is no problem in getting children to volunteer. The program seems to work best when the children are shown their incentives before beginning the litter pickup. Young children have been successfully teamed with older ones. These and other points are discussed and demonstrated in "The Incentive System for Litter Control," a 25-minute slide-tape program.

The slide-tape program (including the slides, cassette tape, and script) is available for sale from:

Forestry Media Center
c/o Forestry Business Office
School of Forestry
Oregon State University
Corvallis, Oregon 97331
Phone 503/754-4702
FTS 425-4160

Cost per copy is $45.00. Order by check or purchase order and refer to item No. 747. Make checks payable to: School of Forestry, OSU. Copies may be rented for 3 days for $12.00. National forests in Oregon and Washington can borrow a copy from the Division of State and Private Forestry, Region 6, Portland.



Occurrence of Shrubs and Herbaceous Vegetation After Clear Cutting Old-Growth Douglas-fir in the Oregon Cascades, by Vern P. Yerkes (177)

What kinds of plants are likely to invade clearcut areas in the Douglas-fir region following logging? A 1960 study in the H.J. Andrews Experimental Forest (Oregon) documents the plants that came in first and describes the succession pattern that might likely occur throughout much of the western Cascades.

The scientist noted the presence of 104 species and species groups during the 5 years of the study. Of these, 101 were found on north slopes and 65 on south slopes.

Woody species that "survived" the logging and remained in the clearcut areas included salal, rhododendron, modest whipplea, twinflower, vine maple, Cascades mahonia, and grapeleaf California dewberry. Woody plants that invaded the site later included willow, blueberry elder, and western thimbleberry.

All of the herbaceous species were classified as invaders and included both annuals (annual epilobiums and Woodland groundsel) and perennials: Western hawkweed, pearly everlasting, western bracken, slender cudweed, thistle, and fireweed.

Allelopathic Potential of Western Bracken, by R.E. Stewart (178)

An allelopathic plant is one that releases organic chemicals which inhibit the growth of other plants. Such is the case with western bracken fern. Allelopathic interactions may explain the relative absence of woody shrubs such as thimbleberry and salmonberry from sites that are dominated by western bracken.

In laboratory studies, water soluble extracts from western bracken reduced germination of thimbleberry and delayed germination of salmonberry. No effect was noted on Douglas-fir.

Brush Problems in Southwestern Oregon, by H. Gratkowski (179)

An excellent summary of the brush problems in southwest Oregon. Gratkowski discusses the geography, history of brushfields and their importance, growth conditions, evaluates the problems associated with brushfields, and suggests a research program. This 1960 paper has long been out of print, but a good forestry library should be able to get copies for loan.

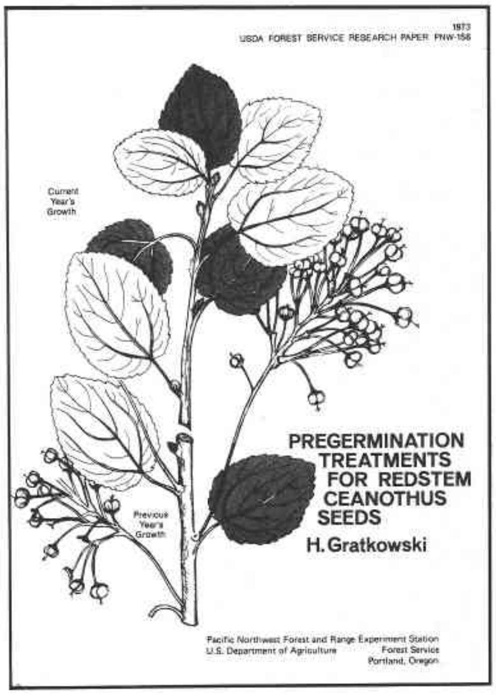
There is general agreement that large brushfields in southwestern Oregon resulted from forest fires. Many have existed for 100 years or more. Once brush has occupied the site, intense competition often excludes forest reproduction. Some brushfields restock naturally, but the process is very slow. Many brush areas remain unstocked for a long time and the site produces only a fraction of its potential timber volume.

Forest survey figures for southwestern Oregon (1951) indicate that there are 315,000 acres of nonstocked burns and old cutovers in this area. Another 865,000 acres are listed as understocked stands of poletimber. Brush probably covers 400,000 acres. An additional 1 million acres have understocked stands of sawtimber, usually with a dense brush understory. Thus, brush control and brushfield reclamation are important land management problems on about one-fourth of the commercial forest land in southwestern Oregon.

New forest survey information for southwest Oregon counties may indicate an even more severe problem at the present time.

In the Umpqua Valley, burning is commonly practiced on cutover forest lands to maintain open pasture.

Hank Gratkowski



Pregermination Treatments for Redstem Ceanothus Seeds, by H. Gratkowski (180)

Forest land managers don't always want to get rid of brush. What hampers the growth of trees in one place can be food for wildlife and cattle in another.

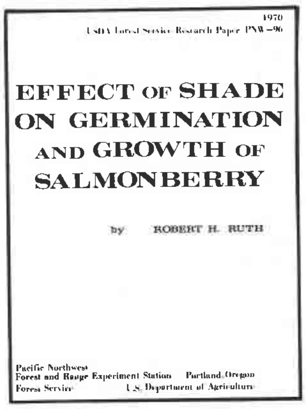
Foresters and wildlife biologists have long been interested in improving winter range for big game. Redstem ceanothus is a good plant for this purpose. Its leaves and twigs are browsed by big game and by cattle and sheep.

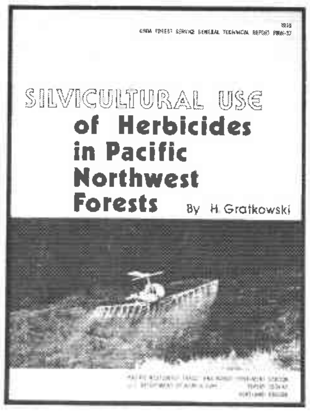
In nature, seeds of this plant are induced to germination by wildfires or logging slash fires. For revegetation projects, seeds should be preheated for 10 minutes at 85°C., and then sown during the late fall rainy season. The seeds stratify naturally in the cold, wet soil during winter and germinate in spring.

Happy ceanothus seeding!

Also see:

Origin of Mountain Whitethorn Brushfields on Burns and Cuttings in Pacific Northwest Forests, by H. Gratkowski (181), and *Effect of Shade on Germination and Growth of Salmonberry,* by Robert H. Ruth (182).





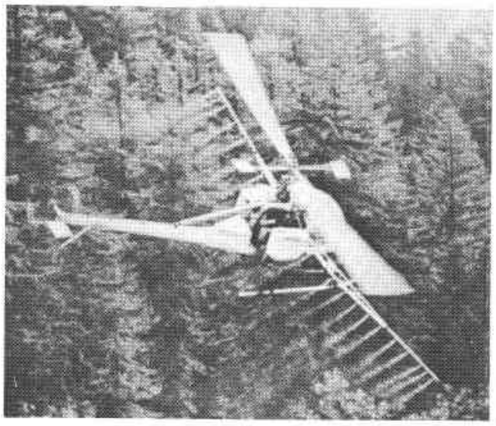
Use of Herbicides

Use of herbicides as a silvicultural control technique is increasing throughout the Pacific Northwest. Chemicals such as 2,4-D, 2,4,5-T, and picloram are being applied to control woody plants.

H. Gratkowski surveys ten common herbicides and discusses five factors basic to their use. The factors include: the selection of the best herbicide or herbicides for a specific job, determining the amount of herbicide per acre, the use of carriers, the volume of spray to be applied per acre, and the seasons for the application of aerial sprays.

This publication also provides a glossary of common agricultural chemical terms and specific recommendations of herbicidal treatments for many silvicultural brush and weed tree problems.

Silvicultural Use of Herbicides in Pacific Northwest Forests (183). See also *Use of Herbicides on Forest Lands in Southwest Oregon*, also by Gratkowski (184).



Helicopter applying 5 gallons of herbicidal spray per acre; the second 5 gallons per acre will be applied at right angles to the initial lines of flight.

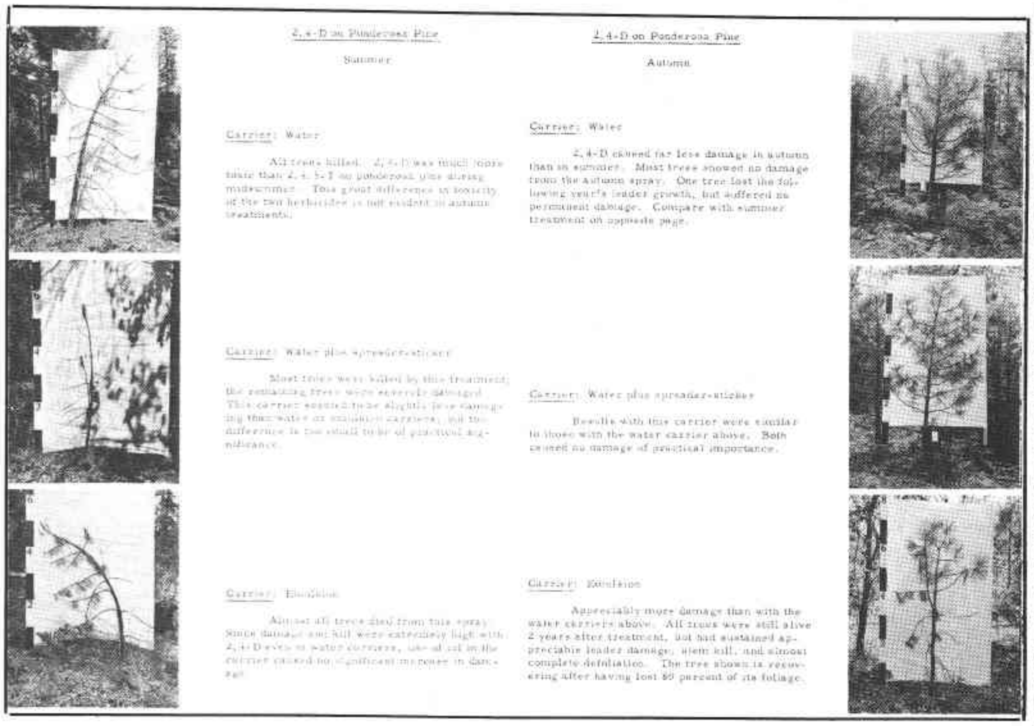
Toxicity of Herbicides on Three Northwestern Conifers, by H. Gratkowski (185)

An early study of the effects of herbicides on three forest tree species common in southwest Oregon—Douglas-fir, ponderosa pine, and sugar pine.

Results indicate that chemical release of Douglas-fir reproduction from brush competition is possible. But release of ponderosa pine and sugar pine is a much bigger problem. Both of these species were damaged more than Douglas-fir by 2,4-D and 2,4,5-T sprays.

Researchers also found that early autumn sprays are far less damaging than midsummer sprays on conifers. And water sprays cause less damage than diesel oil emulsions.

A clever series of photographs in this publication enables the reader to make visual comparisons of the effect each treatment is likely to have on the three species.



Since initial research in 1971, Clark and his colleagues have been working with land managers from a variety of agencies to implement the program. The feedback from both the managers and the public has been very favorable and it appears that the incentive system is well on its way to becoming an established program.

The recipe for success in controlling campground litter is simple. Take the energy and interest of youth, mix it evenly with paper and cans, add a dash of incentive, and top the resulting mixture with a very small portion of your own time and budget.

end

FIRE AND ICE
by Thomas Michael Baugh

Mention the word ''taiga'' to an Alaskan and he immediately thinks of the extensive forests and abundant big game of interior Alaska. The word also brings to mind raging wildfires and hundreds and thousands of acres of ash-covered, smoke-shrouded land.

Each year fires in Alaska burn an average of one million acres. During severe wildfire years, such as 1969, the total may climb as high as four million acres. Long before the advent of man, wildfire was roaring across the taiga, changing the face of the land.

The vegetative landscape viewed by early native people was formed in part by fire. These primitive hunters also introduced the first man-caused fires. The arrival of European colonizers added significantly to the yearly fire score.

Try as he might, however, man can't surpass the fury of nature. Although over 70 percent of the fires in Alaska are now caused by man, they only account for 22 percent of the total acreage burned. The ligntning storms which sweep the state each summer are, by far, the most destructive factor in the Alaska fire picture.

Les Viereck, a scientist at the Institute of Northern Forestry in Fairbanks, says that within the past 200 to 250 years ''. . . a vast majority of interior Alaska has probably burned.'' This means that over 220 million acres have been blackened by fire in a little over two centuries. In the twentieth century alone over 50 million acres have been burned.

Effects of Herbicides on Some Important Brush Species in Southwestern Oregon, by H. Gratkowski (186)

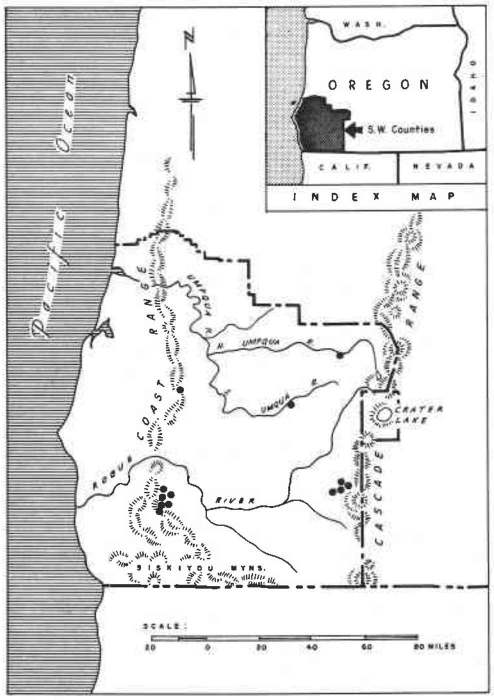
Gratkowski reports results of initial screening tests to determine the effect of six herbicides on the 13 species of brush that are most common in southwest Oregon.

Brush species are divided into three categories:

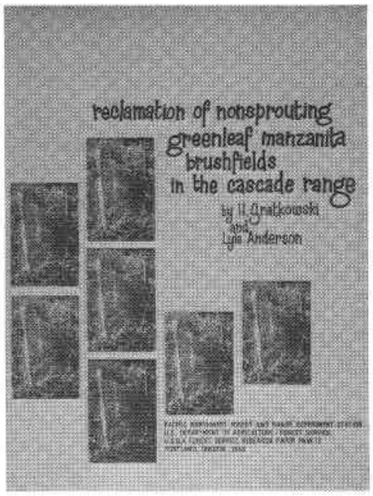
Highly susceptible: hairy manzanita, hoary manzanita, Howell manzanita, and deerbrush ceanothus.

Moderately susceptible: greenleaf manzanita, snowbrush ceanothus, varnishleaf ceanothus, and mountain whitethorn.

Resistant: golden chinkapin, golden evergreenchinkapin, scrub tanoak, saskatoon serviceberry, and canyon live oak.



Location of herbicide test areas in southwestern Oregon.



Reclamation of Nonsprouting Greenleaf Manzanita Brushfields in the Cascade Range, by H. Gratkowski and Lyle Anderson (187)

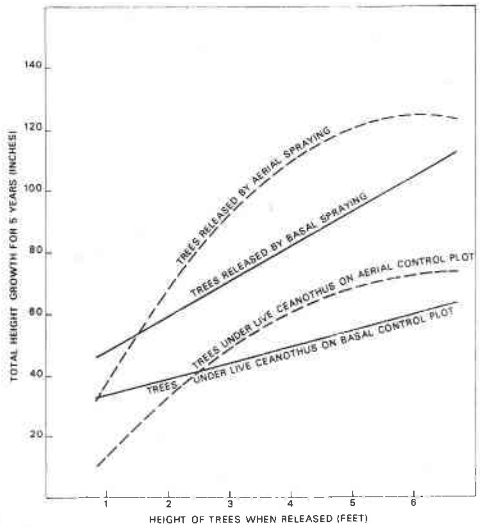
A nonsprouting form of greenleaf manzanita is of special concern to foresters in southwest Oregon. Dense, relatively pure stands occupy extensive areas of commercial forest land in the southern half of the Cascade Range.

Luckily, this nonsprouting variety can be killed with herbicides at far less cost than the sprouting greenleaf form that is common in the Siskiyou Mountains. So, before you spray, look to see if what you have is the nonsprouting form. Then try the following: 3 pounds of 2,4,-D per acre in a diesel oil-in-water emulsion at a rate of 7 to 8 gallons per acre. For best results, the spray should be applied during the growing season in spring or early summer.

Releasing Douglas-firs from Varnishleaf Ceanothus, by H. Gratkowski and P. Lauterbach (188)

Researchers recommend spraying to release young Douglas-fir trees growing under heavy stands of varnishleaf ceanothus. The trees should be released just as soon as they are well established on the site. According to the western Oregon studies, varnishleaf ceanothus drastically reduces height growth of young Douglas-firs in the understory.

Control of ceanothus is recommended using an aerial application of 2 pounds acid equivalent of low volatile esters of 2,4,5-T per acre in an oil-in-water emulsion to make a spray volume of 8 to 10 gallons per acre. Treatment should be in early spring, just before Douglas-fir buds burst and growth begins.



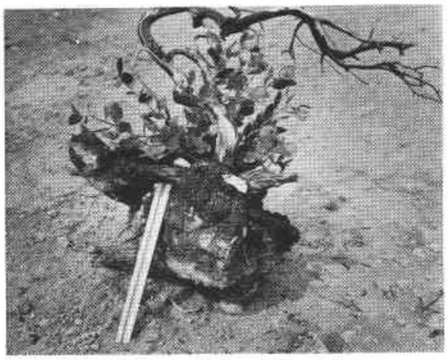
Repeated Aerial Spraying and Burning to Control Sclerophyllous Brush, by H.J. Gratkowski and J.R. Philbrick (189)

Southwest Oregon brush species must be some of the toughest plants alive. They can resist repeated spraying with herbicides, fire, nibbling by wildlife, and sometimes the best efforts of man to get rid of them.

But with persistence and the right combination of treatments, even the most stubborn chinkapin and live oak can be eliminated.

One application of herbicide is seldom enough to control woody plants such as manzanita, canyon live oak, mountain whitethorn ceanothus, and other sclerophyllous brush species. In fact, it may take an initial application of herbicide, burning, and two more sprayings with herbicides to kill sprouts from the burned shrubs!

In the studies reported here, the cumulative effect of spraying, burning, and respraying was estimated to have reduced the number of live shrubs by half. A second respray further improved the situation so that by 1960—5 years after the study was begun—enough of the brush was killed to allow reforestation.



Greenleaf manzanita sprouted from burls at the soil surface after aerial sprays killed the stems.

Repeated Spraying to Control Southwest Oregon Brush Species, by H. Gratkowski (190)

Most brushfields on forest land in the Pacific Northwest include species that are somewhat resistant to herbicides. Where these species are abundant, repeated treatments will be needed in order to kill a high percentage of the shrubs. Research results indicate that respray treatments on such sites are effective, advisable, and worthwhile. Respray treatments were effective in killing resprouting shrubs, even in species that were somewhat resistant to foliage sprays on healthy, full-crowned, mature shrubs.

Results of studies with 13 brush species are given. The best treatments—including the herbicide and number of sprayings needed—are indicated.

Midsummer Foliage Sprays on Salmonberry and Thimbleberry, by H. Gratkowski (191)

Salmonberry and thimbleberry are major components of most brushfields in the Coast Ranges of Oregon and Washington. They quickly occupy sites after logging or wildfires and combine to make life miserable for foresters who want to get trees growing again.

Amitrole-T is generally considered better than 2,4,5-T for controlling salmonberry during the growing season. But, by midsummer, when the tests reported here were done, better control was achieved with 2,4,5-T. 2,4,5-T worked better on thimbleberry, too, and is less expensive to apply.

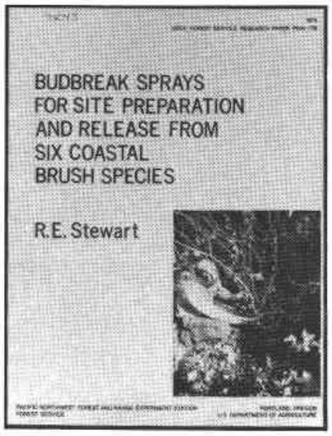
Foliage Sprays for Site Preparation and Release from Six Coastal Brush Species, by R.E. Stewart (192)

Herbicidal treatments are recommended for the following brush species common to the Oregon and Washington coasts:

- red alder
- salmonberry
- western thimbleberry
- vine maple
- California hazel
- salal

In general, picloram produced the best control of all six species, and herbicides were more effective when applied in late spring rather than midsummer. Salal gave researchers the most trouble; not even picloram gave adequate control. But the intrepid scientists didn't give up. See the next item for further tests on salal.

Basal sprouts on live salmonberry shrubs were limited in number and size 24 months after spraying with 2,4,5-T.



Budbreak Sprays for Site Preparation and Release from Six Coastal Brush Species, by R.E. Stewart (193)

Budbreak sprays, or herbicides applied when the buds of the shrubs are just leafing out, can be used to control many coastal brush species. They are often preferred in Douglas-fir stands because the conifers are resistant.

Researchers recommend budbreak sprays of 2,4,5-T in diesel oil to control red alder, vine maple, and California hazel.

Budbreak sprays are not recommended for salmonberry and western thimbleberry, but luckily foliage sprays of 2,4,5-T will do the job.

Salal is still a problem. Silvex produced the best results and may work well enough. But researchers still won't recommend a treatment. All they will say at this point is that "sprays containing 2,4,5 -T are promising for control of salal, but additional tests are necessary." That's just another way of saying, "it doesn't work very well."

Repeated Spraying to Control Four Coastal Brush Species, by R.E. Stewart (194)

Four of the major species which compete with timber for growing space in the Coast Ranges of Oregon and Washington can be effectively controlled by using two applications of herbicides.

In a 1970-73 study, researchers tested selected formulations of four herbicides on six of the most common brush species. Resprouting shrubs of salmonberry, western thimbleberry, vine maple, and California hazel were controlled with two sprays of 2,4,5-T. Control was adequate to release conifers or prepare the site for tree planting. A respray of two other chemicals—Amitrole-T and Picloram—did not produce better results. Red alder was killed with one application of herbicide, and salal was resistant to all herbicides tested. Maybe now they'll give up!

Scientists at the Institute of Northern Forestry are taking a long, hard look at the natural role of fire in the taiga. Their research points to the fact that much of the ecosystem of interior Alaska is the product of fire. They are questioning the need for the control of all the fires which burn in uninhabited areas and they are suggesting that some wildfires be allowed to burn.

Viereck says that "wildfire has always played an important role in determining the natural vegetation patterns in the Alaska taiga." Modern fire control efforts have caused a "downward trend in the acreage burned in Alaska."

What are the effects of fire on the vegetation and soil of the taiga? Soils throughout much of the interior of the state are permanently frozen. Average temperatures below the freezing point help maintain the condition called "permafrost." During the warmer months the soil thaws to a depth of about 1 to 3 feet. Trees, grasses, and other plants provide an insulating layer which, when combined with a stratum of decomposing plant material, helps keep the permafrost from thawing. In this frozen condition nutrients are locked in the icy soil preventing their use by plants.

This situation changes when the protective layer is removed by wildfire. Viereck and other researchers have found that the heat produced by fire has very little immediate effect on the permafrost. In general, fire moves too rapidly through the trees and plants to cause much thawing of the permafrost. The major cause of thawing is the removal of the insulating layer of plant material.

Without the protective plant canopy, sunlight is able to penetrate to ground level where the soil begins to warm. The dark ash left by the fire absorbs a greater amount of heat which slowly penetrates into the permafrost. It is at this point, following a fire, that the balance of the taiga ecosystem becomes apparent.

As thawing continues deeper into the permafrost, important nutrients are released, nourishing the seeds left undamaged by the blaze. Grasses and other forms of vegetation begin to germinate and grow. Over the years the insulating layer of plant and tree life is replaced, and the permafrost level moves closer to the surface and nearer its prefire levels.

Survival of Ponderosa Pine Seedlings Following Control of Competing Grasses, by R.E. Stewart and T. Beebe (195)

Sometimes foresters want to grow grass along with their trees—as in eastern Oregon or Washington where cattle grazing and timber crops may be compatible.

Other times they may want to get rid of the grass because it competes with trees for water and nutrients. When control is desired, herbicides may be enlisted, as in this study in the Wenatchee National Forest in central Washington.

Researchers were able to increase the survival of ponderosa pine trees by 150 and 700 percent (depending on the soil type) by spraying the grasses with atrazine and dalapon. Grasses were timothy, hard fescue, pinegrass, and orchardgrass. Scalping, pronamide, and terbacil were less effective in controlling the grasses.

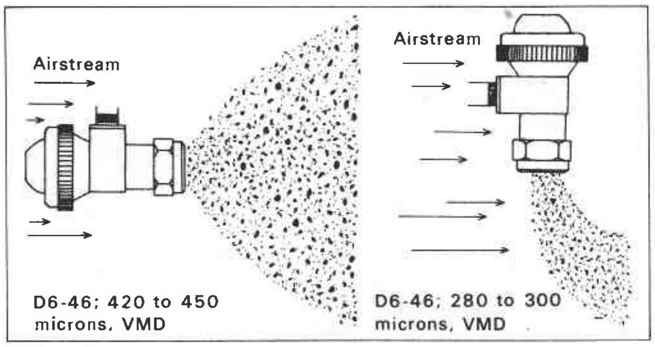
Treatment	Soil type	First year grass control	Second year cover: Grass	Second year cover: Forb	Second year ponderosa pine survival
		Percent			
none	Residual	–	68	17	3
	Pumice	–	75	13	39
Scalp	Residual	–	74	12	13
	Pumice	–	71	7	40
Pronamide	Residual	0	70	19	16
	Pumice	0	69	9	23
Terbacil	Residual	28	46	20	21
	Pumice	90	13	16	31
Atrazine	Residual	2	52	13	20
	Pumice	64	27	4	62
Dalapon	Residual	78	24	34	21
	Pumice	73	26	17	58

Initial grass control, present grass cover, and ponderosa pine seedling survival on residual and pumice soils.

Herbicidal Drift Control: Aerial Spray Equipment, Formulations, and Supervision, by H. Gratkowski (196)

Controlling drift of herbicides when spraying on rough, mountainous terrain is necessary in order to reduce environmental contamination and keep the spray within the desired boundaries.

To a great extent, spray drift depends on droplet size. Large drops fall faster and drift less than smaller ones. Other factors that affect drift include the height of the plane or helicopter, flying speed, the characteristics of nozzles and other spray equipment, and the physical properties of the material being sprayed.



Variation in droplet size resulting from change in nozzle orientation on the spray boom.

Aerial Spray Adjuvants for Herbicidal Drift Control, by H. Gratkowski and R. Stewart (197)

Preventing drift of herbicides during aerial spray operations is the subject of this 18-page report. One way to control drift is to change the physical properties of the material being sprayed. This can be done by adding adjuvants—chemicals that change the consistency of the material being sprayed.

A number of compounds are now available to reduce drift. These include four types of materials:

a. Invert emulsions
b. Spray thickeners
c. Particulating agents
d. Foaming agents

The advantages and disadvantages of each are discussed.

Ron Stewart

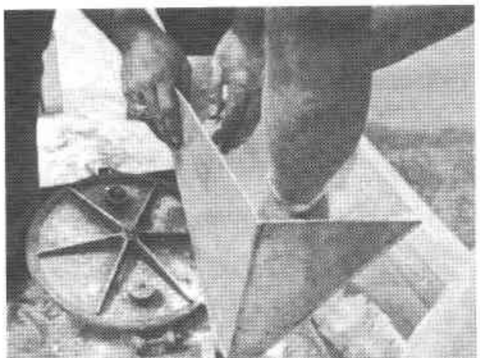
More on Drift Control

Aerial spray tests in western Oregon showed that spray additives in water or oil-in-water emulsion carriers will reduce herbicide drift. Foaming agents and water-soluble polyvinyl polymers were effective additives. However, drift control also reduced swath width and spray coverage which decreased brush and weed tree control with low volatile esters of 2,4,-D and 2,4,5-T.

Foaming agents should be added to water carriers at a rate of 2qt./100 gal. of spray mixture; oil-in-water emulsions require 3 qt./100 gal. Special air-induction nozzles must be used when applying foamed sprays. Use only the nozzles recommended by the manufacturer of the foaming agent.

Spray volumes should be increased to 15 or even 20 gal./A to insure adequate coverage when using drift control additives. Drift control is obtained by applying spray droplets that are larger in diameter, greater in volume, and fewer in number per gallons of spray. With the usual 10 gal./A spray volume, unsprayed areas and strips are almost inevitable even when areas are cross flown or double flown.

See *Aerial Spray Tests of Drift Control Additives for Herbicides in Oil or Oil-in-Water Emulsion Carriers,* by H. Gratkowski and R. Stewart (198).



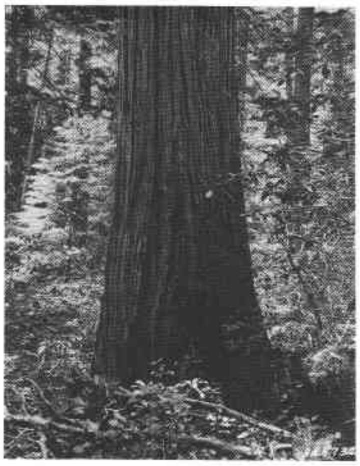
A funnel for adding and dispersing Vistik.

other

Port-Orford-Cedar—A Poor Risk for Reforestation, by John Hunt and Edward J. Dimock II (199)

The natural range of Port-Orford-cedar is restricted to a rather limited area in Coos, Douglas, Curry, and Josephine Counties in southwestern Oregon and in Del Norte, Humboldt, and Siskiyou Counties in northwestern California.

Because of its susceptibility to cold injury and a very destructive root disease, the species should not be used for reforestation outside of its natural range.

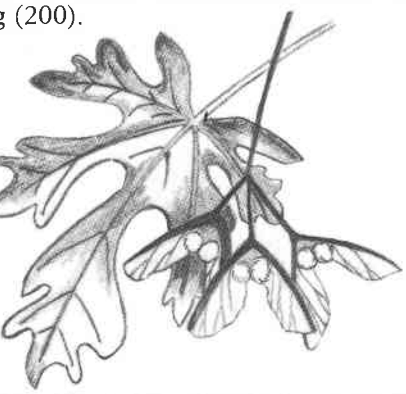


Maple Sirup From Bigleaf Maple

What, sirup from the bigleaf maple? Yes, say forest scientists who produced some of the sweet, sticky stuff by tapping trees in the Pacific Northwest.

After doing comparative taste tests, researchers declared the sirup flavorful—but not as strong in typical maple flavor as that made from the eastern sugar maple. Sirup production appears feasible as a hobby and perhaps as a commercial venture.

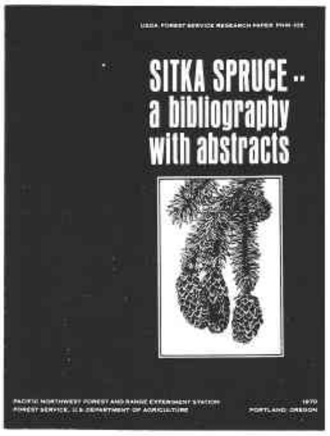
Maple Sirup Production From Bigleaf Maple, by Ruth, Underwood, Smith, and Yang (200).



Investigating Dominance in Douglas-fir Stands, by Kenneth W. Krueger (201)

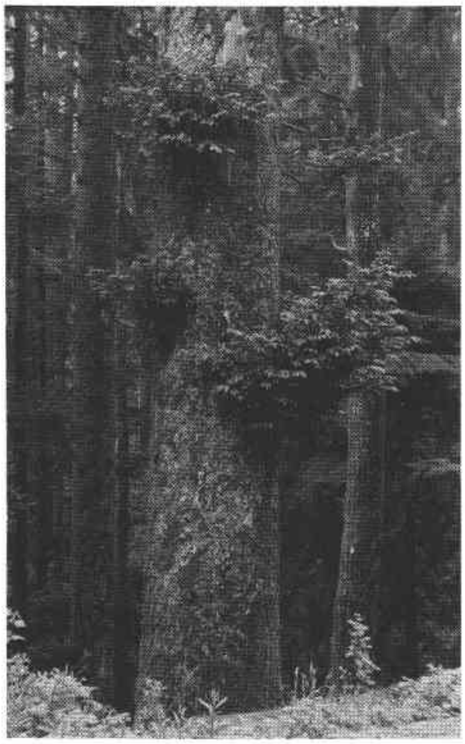
Why are some trees larger than their neighbors? Are they older? Inherently faster growing? Located on a better microsite? Or do they receive less competition from nearby trees? These possibilities come to mind when observing trees of unequal size in young, even-aged stands of Douglas-fir.

The relative size of individual trees—their "dominance"—was investigated in three young Douglas-fir stands in 1958-59. Findings are reported here.



Sitka Spruce—A Bibliography With Abstracts, by A.S. Harris and Robert H. Ruth (202)

This 251-page bibliography contains references to world literature on Sitka spruce from 1903 to 1967. The report has a list of scientific and common names of tree and plant species that are mentioned. Index is by subject matter and abstracts are given for many references.



Fire has a direct effect on both wildlife numbers and their distribution. For instance, scientists have found that fire improves moose habitat. When the forest cover is burned off, deciduous woody plants such as willow, aspen, and birch, begin to rapidly grow. Moose move into the burned areas in order to browse these plants. Viereck reports that "most of the large concentrations of moose in Alaska, such as those on the Kenai Peninsula, can usually be traced to a large fire, or series of fires in the past."

Efforts at large scale fire control in Alaska began in 1938. Since that time fire control organizations have grown throughout the state, and the modern tools of fire management such as aircraft and dozer tractors have been used.

The Swanson River fire is a good example of man's struggle against fire in interior Alaska. The fire began on August 3, 1969, and by the time it was finally controlled it had consumed 86,000 acres. Over 4,000 firefighters were employed to combat the blaze. They were assisted by 30 helicopters, 79 pumper trucks, and 100 dozer tractors.

It is obvious that all of this manpower and mechanized equipment has a direct affect on the delicate natural systems of the taiga. As an example, researchers point to the fact that erosion and melting of the underlying permafrost is greater along firelines than at any other place in a burned area.

Viereck warns that prolonged periods of fire control will lead to significant changes in the patterns of vegetation in interior Alaska. The mosaic of open, burned areas and stands of trees will be replaced by a more uniform forest with less open areas. This will decrease moose habitat and modify many other wildlife distribution patterns.

Alaska is currently in a period of rapid growth. In the last quarter of this century, the use of Alaska's abundant natural resources, such as timber, may well increase. For this reason fires will continue to be controlled in many areas throughout the interior. Other areas of the taiga, however, will be left open to fire management practices which incorporate the "natural" use of fire. It is logical to assume that future land use planning in Alaska will recognize the pattern of fire and ice which is as ancient as the land itself.

end
next "insight" page 101

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