forest engineering

See also:
Economics
Watershed
Timber Quality

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Contents Page

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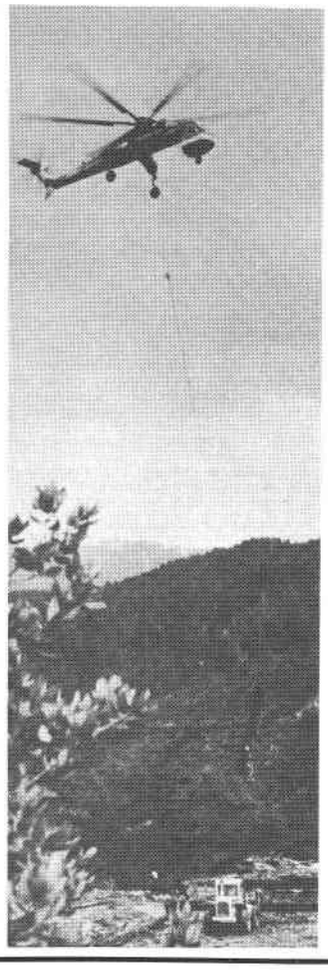
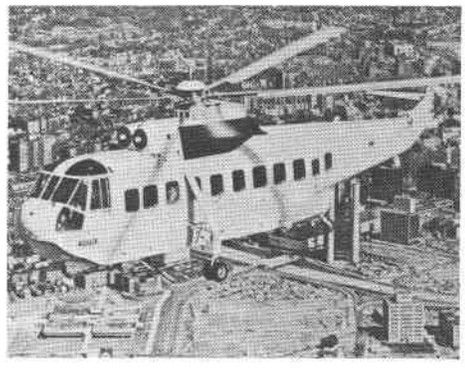
Helicopter Logging: Advantages and Disadvantages Must Be Weighed, by Doyle Burke (1)

Helicopter logging may have advantages where road access is restricted or the use of conventional logging systems is prohibited. Disadvantages related to cost, slash disposal, cull material handling, and post-harvest land management may outweigh the advantages, however. Helicopter logging is especially expensive and therefore may be restricted to the removal of scattered trees or pockets of high-value timber.



Helicopters for Logging—Characteristics, Operation, and Safety Considerations, by P.M. Stevens and Edward H. Clarke (2)

This report presents an overview of factors relevant to the productive and safe use of helicopters for timber harvesting. The load characteristics of approximately fifty helicopters are discussed along with factors such as operating costs, productivity, and safety considerations.



An Analysis of Production and Costs in High-Lead Yarding, by M.E. Tennas, R.H. Ruth, and C.M. Berntsen (3)

Factors influencing production and costs on a high-lead yarding operation in a 100-year-old stand on the Cascade Head Experimental Forest were isolated and analyzed. Industrial engineering techniques and statistical analyses were used to estimate how crew size, haul-in distance, volume per turn, slope, length of yarding road, and number of logs per acre affected production and costs. The influence of these variables is illustrated by a series of curves which demonstrate, for example, that choker-set time increases with increasing distance from the spar tree.

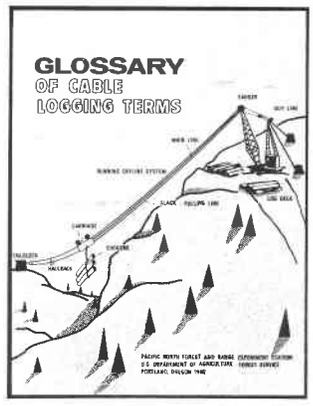
Skyline Tension and Deflection Handbook, by Hilton H. Lysons and Charles N. Mann (4)

The need for additional information on the capabilities of multispan skylines led to this study of skyline tensions. The report begins with a discussion of the general characteristics of skyline logging systems. It then progresses to a detailed investigation of both single-span and multi-span skylines. Problems, such as the rigging of a 1-5/8-inch-diameter skyline on a convex slope, are posed and then solved by the authors.

Graphs related to load factors and tensions under varying conditions are presented in a general manner to allow the solution of all practical problems.

Soil Surface Conditions Following Skyline Logging, by C.T. Dyrness (5)

The results of a study to compare soil disturbance caused by tractor, high-lead, and skyline logging are reported. Both soil surface disturbance and slash density were recorded at about 1,750 different points on one watershed. The most surprising result of the study is that soil disturbance caused by high-lead and skyline logging were about the same.



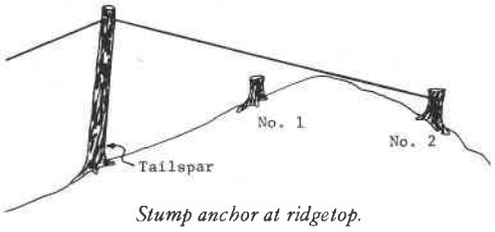
Glossary of Cable Logging Terms, by Pacific Northwest Forest and Range Experiment Station (6)

Did you know that a ''top guy'' is one of several lines tied to the top of a spar tree, or that a ''triple drum'' is found on a three-drum yarder? If you had a copy of the *Glossary of Cable Logging Terms* you would have a comprehensive source of dozens of terms used throughout the logging industry.

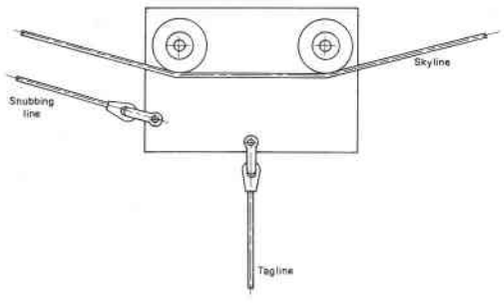
Mechanics of Skyline Anchoring, by Charles O. Campbell (7)

Good anchoring cannot be overemphasized in planning a skyline operation. In the past, there have been many instances when carriages and other equipment have been damaged or destroyed because of anchor failures. Stumps are the most common anchor, and although there are no definite methods of predicting the load-bearing capacity of stumps, a few general observations hold true. The holding power of a stump tends to increase with soil depth and density. Holding power also increases with the square of the stump diameter. A 48-inch stump will hold approximately four times as much as a 24-inch stump.

Methods of rigging stump anchors and calculating load are presented in this paper.



Stump anchor at ridgetop.



Schematic of snubbed carriage.

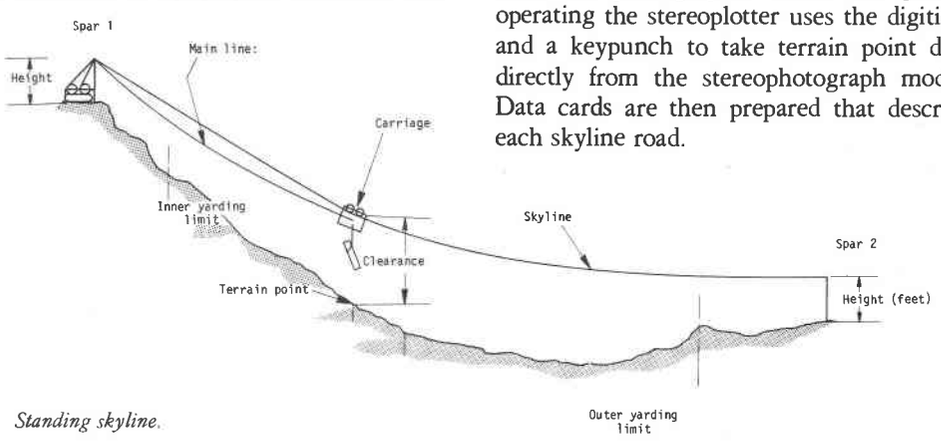
A Technique for the Solution of Skyline Catenary Equations, by Ward W. Carson and Charles N. Mann (8)

The designer of a skyline logging operation must determine the load-carrying capability of his system in order to establish mechanical and economic feasibility. Because of the complexity of the mathematical equations which describe these cable systems, this can be a computationally difficult task. This report proposes an efficient method of computing load-carrying capabilities.

Digitizing Topographic Data for Skyline Design Programs, by W.W. Carson, D.D. Studier, and W.M. Thomas (9)

This research note discusses a procedure for the collection of topographic data from stereophotographs through the use of a Kelsh-type stereoplotter and a digital scaler or digitizer.

First, the skyline designer prepares equipment information and specific road descriptions on photographs. Then the person operating the stereoplotter uses the digitizer and a keypunch to take terrain point data directly from the stereophotograph model. Data cards are then prepared that describe each skyline road.



Standing skyline.

An Analysis of Running Skyline Load Path, by Ward W. Carson and Charles N. Mann (10)

This paper is intended for those who wish to prepare an algorithm to determine the load path of a running skyline. The mathematics of a running skyline design problem are presented. The approach employs assumptions which reduce the complexity of the problem to the point where it can be solved on desk-top computers of limited capacities.

Ward Carson

TAMING THE TUSSOCK MOTH
by Thomas Michael Baugh

June 9, 1974, dawned clear in the mountains of eastern Washington and Oregon. As the light of the new day spilled into the dark canyons, the quiet was broken by the pulsing whir of helicopters.

The ungainly airships, carrying long pipes slung from their undercarriages, were part of the largest all-helicopter insect control project ever to take place in the forests of the Pacific Northwest. When their work was finished, a month and a half later, they had sprayed DDT over 426,000 acres of tussock moth-infested forest land.

The control project was the culminating act in a debate and drama which had involved much of the preceding 2 years. The controversy over the use of DDT had raged throughout the United States. Final approval had been given by the Environmental Protection Agency in an attempt to save as much forest as possible from the moth.

At the same time that the helicopters were spreading their loads of insecticide, planning was taking place in the offices of the United States Department of Agriculture in Washington, D.C. Concerned public officials and natural resource managers were in the process of structuring a major scientific effort to investigate the ecological factors related to tussock moth outbreaks and to find their control methods. Companion investigations were also planned for two other forest insects; the gypsy moth in the Northeast and the southern pine beetle in the South.

As is true of all native insect pests, the tussock moth is "endemic," meaning always present, but in very low numbers. Occasionally, however, the tussock moth population gets out of balance with its environment and a population explosion occurs. The result can be severe defoliation and death of many trees over thousands of acres. Tussock moth outbreaks occur in the West on the average of about every 7-10 years, although not usually in the same location. For example, another serious outbreak may not occur until about 1980, but not necessarily in the Blue Mountains of Oregon where defoliation was severe in 1972-74.

Running Skyline Design With a Desk-Top Computer/Plotter, by W.W. Carson, D. Studier, and H.H. Lysons (11)

The running skyline system is being used by an increasing number of timber operators for thinning and clearcutting. It is a system of two or more suspended moving lines, generally referred to as main and haulback, that when properly tensioned will provide lift and travel to a suspended load. The desk-top computer approach presented in this paper allows the planner to determine deflection and load path for a specified load. The authors show how to apply the formulas developed in the previous paper (*Running Skyline Design With a Desk-Top Computer*).

Calculator, printer, and plotter combination.

Determination of Skyline Load Capability with a Programable Pocket Calculator, by W.W. Carson (12)

For planning purposes, logging engineers need tools and methods to determine the load-carrying capability of skyline cable systems. Both computerized and hand computation methods are available for these determinations; however, no approach has been reported that could be programed onto the pocket-size computers available. This paper presents a method that will determine the load capability of a running or standing skyline on a programable pocket-size calculator.

Skyline Logging: An Economical Means of Reducing Environmental Impact of Logging, by Hilton H. Lysons and Roger H. Twito (13)

Present-day skyline logging systems offer many opportunities for substantially reducing environmental impact. These systems can reduce road density and landing area as well as soil and water disturbance. In partial cut situations, skyline systems have performed with little damage to the residual stand and in an economical manner.

A Computer Program for Determining the Load-Carrying Capability of the Running Skyline, by Ward W. Carson and Donald D. Studier (14)

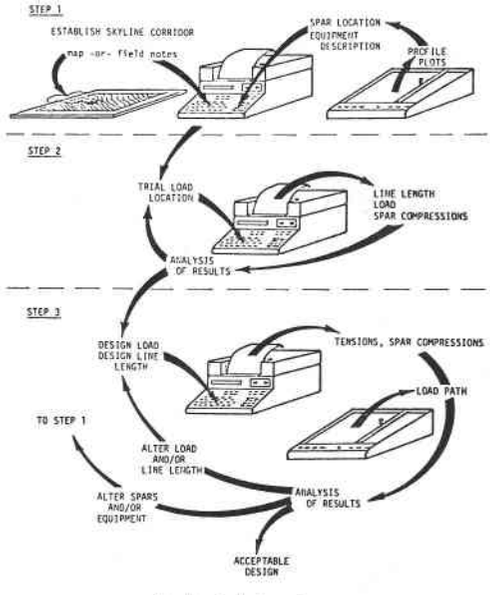
A logging system designer must know what payload a logging system can carry over a given ground profile. A computer program has been designed for this purpose. This program can be used by the timber resource planner for determining the feasibility of a running skyline system. The program was written in standard Fortran IV language for the CDC-6400 machine. It has also been prepared to operate on the CDC-3100.

Skyline Logging Profiles From a Digital Terrain Model, by Doyle Burke (15)

A digital terrain model based on input from improved topographic and orthophoto maps can help to accurately evaluate alternatives for skyline logging operations. A digital terrain model program is available to transcribe data from maps into profile plots. The program has been written in BASIC language for use on the Hewlett-Packard 9800 system. This system includes a digitizer, plotter, cassette memory, and printer.

Skyline Mechanics Simplified, by Ward W. Carson (16)

The introduction of desk-top computer systems has simplified the design of skyline shows. Desk-top systems, with capabilities previously available only with large computers, offer a readily available tool for understanding skyline mechanics. The present generation of desk-top computer systems offers three advantages not available as recently as 5 years ago. These include algebraic, problem-oriented program language, increased memory capacity, and a wider range of support equipment such as digitizers, plotters, and printers.



Desk-top design process.

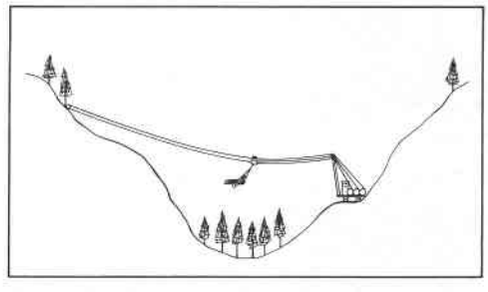
Running Skylines Reduce Access Road Needs, Minimize Harvest Site Impact, by Doyle Burke (17)

A well-planned running skyline system can substantially reduce access road mileage while providing almost unlimited flexibility in meeting timber harvest requirements. The running skyline, one of the most versatile yarding systems ever developed, is designed around the three-line interlocked yarder with tracked or wheeled undercarriage.

Running skylines can be matched to almost any timber harvest situation. They provide for extended yarding up to 2,000 feet. Road spacing can be increased to almost twice that of systems with uphill yarding capability only. Running skylines allow lateral yarding up to 150 feet, reduce average yarding distance, and can be rapidly set up and moved.

New Tools Allow Examination of Skyline Alternatives Speedily, by Doyle Burke (18)

In a summation of the application of desk-top computers to running skylines, logging engineer Doyle Burke says that desk-top calculator systems with digitizers and plotters provide the logging engineer with the means to examine numerous alternatives with speed and accuracy. They allow the engineer to find the best solution rather than just an acceptable solution.



This profile depicts yarding on both sides of a stream, while leaving stream buffer.

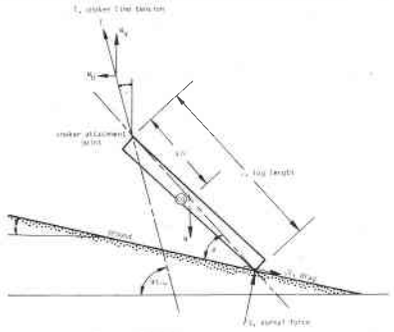
Harvesting Commercial Thinnings on Steep Slopes, by H.H. Lysons (19)

The problem of developing a viable cable system for harvesting commercial thinnings is particularly challenging. This is due to the need to develop a low-cost machine to be economically acceptable, and yet be of the most advanced design to permit thinning of selected trees at a suitable rate with little impact on the residual stand or the environment.

Technology is rapidly approaching the point where major advancements in commercial thinning via cable systems can be anticipated.

Analysis of Running Skyline With Drag, by Ward W. Carson (20)

Most computations for determining the load-carrying capabilities of running skyline systems are based on the assumption that the log load is suspended in the air or is in frictionless contact with the ground. This is rarely the case. This paper presents a mathematical procedure which successfully models the forces and displacements that exist in a running skyline configuration with a dragging log load. The procedure has been programed for desk-top computers and should provide the logging engineer with more realistic estimates of the conditions existing in a running skyline system.



Log skidding geometry.

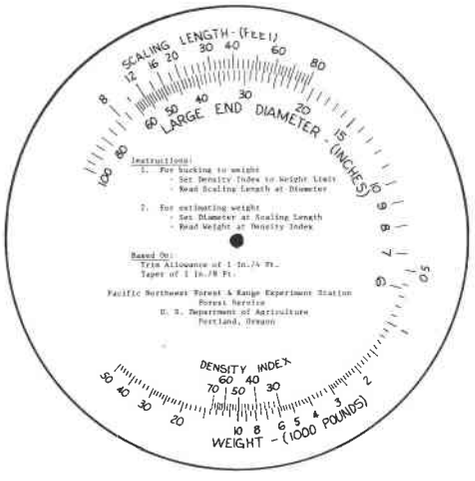
Programs for Skyline Planning, by Ward W. Carson (21)

This publication presents four computer programs with specific application to skyline harvest unit layout. One program prepares terrain profiles from maps. The other three express characteristics of load-carrying skylines.

A Method of Estimating Log Weights, by Charles N. Mann and Hilton H. Lysons (22)

The forest industry has long recognized the need for a practical method of estimating the weight of logs before they are yarded. The need for this type of information has increased with the development of aerial logging systems which have critical weight requirements and limitations.

A method of estimating pre-yarded log weights is now available. The method uses a factor called a density index. Before log weights are estimated, the local density index for a specific species of log is found by measuring and weighing truckloads of these logs. The density index is then used to estimate the weight of remaining logs of the same species before they are yarded. Graphs and tables for estimating log weight are given.



Slide rule for estimating log weights.

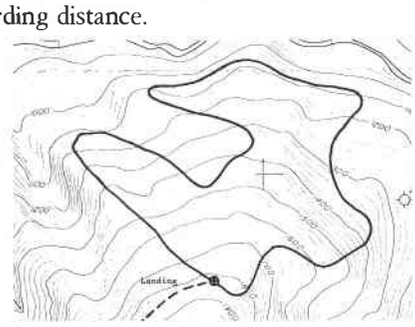
Correction of Average Yarding Distance Factor for Circular Settings, by Hilton H. Lysons and Charles N. Mann (23)

Given the external distance of geometrically-shaped settings a factor is commonly used, in logging cost analysis, to determine the average yarding distance. For circular settings, or segments thereof, the average yarding distance is 2/3 or 0.667 of the external distance. A factor of 0.707 had been used prior to this determination.

Average Yarding Distance on Irregular-Shaped Timber Harvest Settings, by Penn A. Peters and J. Doyle Burke (24)

The trend to natural-shaped cutting units poses new problems in rapidly and accurately determining area and average yarding distance. Easy methods for determining the average yarding distance and area are available for simple shapes such as right triangles, rectangles, and circular arcs. The average yarding distance and area of irregular shapes can be determined by a method known as numerical integration. Unfortunately this involves a time consuming manual computation which makes it impractical for most uses.

A simple and accurate technique for determining the area and average yarding distance of a setting of any shape is now possible through the use of a programmable calculator coupled with a peripheral digitizer. The digitizer transfers the necessary information from a map to the calculator which is programed to compare area and average yarding distance.



Large, irregular-shaped cutting unit.

Just as the interval between outbreaks is somewhat predictable, so is their length. Entomologists have noted striking similarities in the outbreaks which have occurred in the West since 1935. Outbreaks usually follow a distinct 3-year pattern, with the outbreak peaking dramatically during the second year and declining at the end of 3 years. It seems that nature cannot support a population that is out of balance; an equilibrium is eventually sought and reached.

With a native pest such as the tussock moth, there are many natural enemies—including insect parasites, predators, and diseases—which help keep it in check. Exhaustion of the insects' food supply and other environmental factors may also be partly responsible for the decline of outbreaks.

The program expects to develop the capability to detect, evaluate, and suppress outbreaks of the tussock moth by the fall of 1977. This capability will rely heavily on a newly developed chemical sex attractant to detect and evaluate potential tussock moth outbreaks. Several effective, short-residual, chemical pesticides and one or more biological materials are expected to be registered by 1977. In addition, the major effects of these materials on the environment should be known.

Early detection of tussock moth outbreaks is important because of the rapidity with which outbreaks can develop. Through the Tussock Moth Program, an accelerated effort is being made to field test and further develop the sex attractant of the tussock moth so it can be used for prediction as well as detection of outbreaks. Forest land managers could then pinpoint areas where tussock moth populations are building up and apply control measures while infestations are still small.

Two very promising biological control materials are a virus of the tussock moth which often helps bring outbreaks to a halt naturally and Bacillus thuringiensis, *a bacterium which is commercially available and used against the tussock moth in field experiments, are environmentally safe and can be applied as aerial sprays. Development of new, environmentally safe chemical insecticides is a short-term goal of the program. Some of the most promising are Orthene, Dimilin, and Carbaryl.*

Estimating Production of a Skyline Yarding System, by Penn A. Peters (25)

Estimating production of a yarding system is complicated by the effects of yarding distance, harvest unit layout, volume per acre, crew efficiency, terrain, brush, log size, and machine capability. Most current estimation methods depend in part on data obtained from field studies. This is often a time consuming and costly process.

A method of handling this problem has been developed using the concept of a load curve with built-in delay factors. Road changing time is included as a major component and downtime is accounted for by percentage correction.

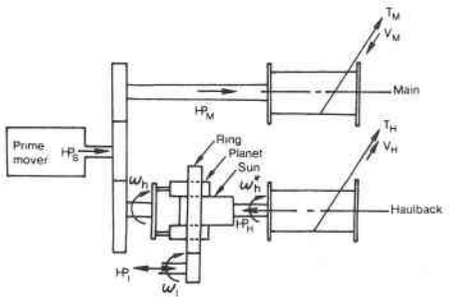
Typical skyline road.

A New Approach to Yarding Cost Analysis, by Penn A. Peters (28)

An important part of logging planning is the preparation of yarding cost estimates. Large companies and public agencies often employ time studies and regression analyses to develop mathematical models to estimate logging costs. A new method has been developed to arrive at estimates of logging costs. This method allows the log size frequency to be estimated in advance of yarding. It also provides a load curve applicable to a wide range of terrain and timber conditions.

Understanding Interlock Yarders, by Ward W. Carson and Jens E. Jorgensen (26)

To appreciate the need for interlock devices on a cable logging yarder, one must understand the principle of the interlocking drums. This publication describes the function of the interlocking mechanism focusing on the slipping clutch, planetary interlock, and direct drive interlock systems.



Planetary gear interlock.

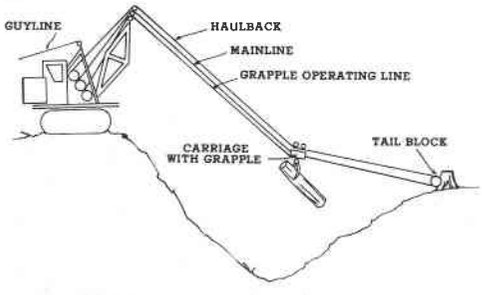
Yarding System Capabilities, by Hilton H. Lysons (29)

Increasing constraints on logging practices makes it important to understand the capabilities of the variety of yarding systems available for logging purposes. Tractors, high lead, standing skylines, running skylines, balloons and helicopters all play a role in the logging picture. Each of these systems, however, can be applied best in specific logging situations. The best yarding system for a particular job is the one that meets performance requirements, in terms of the physical and environmental criteria, at the least cost.

Road and Landing Criteria for Mobile-Crane Yarding Systems, by J. Doyle Burke (27)

Rising logging costs and increased environmental concern have been instrumental in bringing about the trend to mobile-crane, grapple yarding. This system is designed around the three-line running skyline and is characterized by low manpower requirements, increased safety of personnel, reduced average yarding distance, separate loading operation, and decreased soil disturbance. Log size is the most important variable affecting costs.

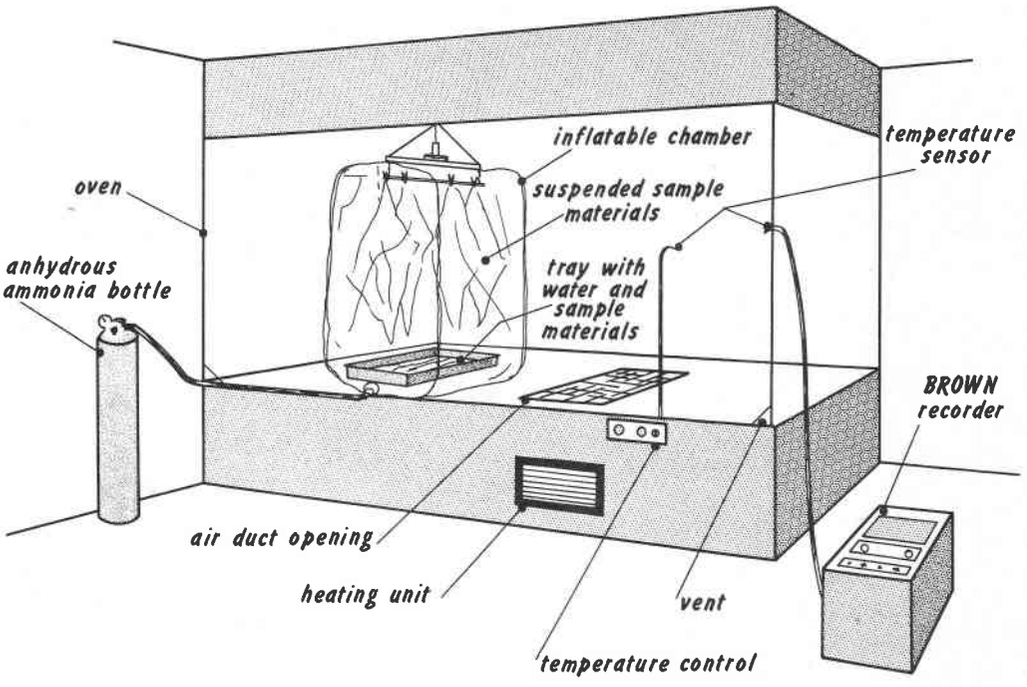
Roads should be located to take advantage of the yarder's mobility to reduce average yarder distance. They must have adequate width for yarder operation independent of the loader, and should provide for uphill and downhill yarding. Landing areas should be such that logs will not roll or slide and the combined road and landing should provide sufficient room for the loading and trucking operations.



Mobile-crane grapple-yarding system.

Compatibility of Balloon Fabrics With Ammonia, by Hilton H. Lysons (30)

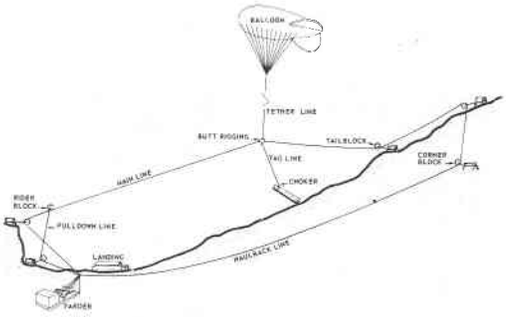
Ammonia was tested as a possible inflation gas on 18 different balloon materials. Nylon was the only fabric which showed favorable life test characteristics. Neoprene-coated nylon fabric showed no deterioration in either NH_3 gas or NH_4OH after eight weeks of exposure.



Setup for testing compatibility of balloon fabrics with ammonia.

Logging Test of a Single-Hull Balloon, by H.H. Lysons, V.W. Binkley, and C.N. Mann (31)

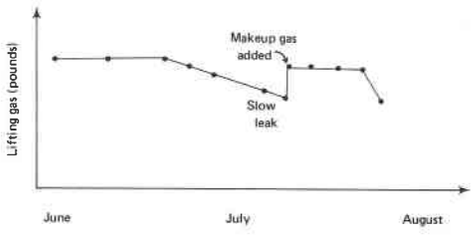
In 1965, researchers at the Forest Engineering Laboratory in Seattle, Washington, tested a single-hull balloon in a logging situation. As a result, they recommended that balloons be used for downhill yarding where logs can be pulled away from facing slopes and where the long yarding distances available with these systems could substantially reduce roadbuilding costs.



Arrangement of operational equipment for single-hull balloon test.

Gross Static Lifting Capacity of Logging Balloons, by Ward W. Carson and Penn A. Peters (32)

Logging balloons are operated in a variety of atmospheric conditions. The influence of these conditions on the gross static lifting capacity of the balloon can be computed from the fundamental principles of aerostatics and thermodynamics. This research paper discusses factors such as humidity, atmospheric pressure, and temperature as they affect the lift capacity of balloons. Nomographs (charts) are supplied which make the calculation of lift capacity a relatively painless process.



Record of lifting gas stored in balloon.

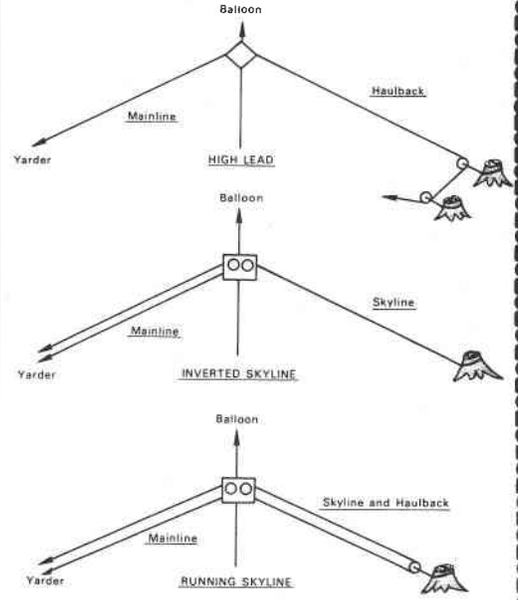
Soil Surface Conditions Following Balloon Logging, by C.T. Dyrness (33)

This is one of a series of studies dealing with soil surface conditions following various forms of logging. Researchers have found that balloon logging caused substantially less soil disturbance than previous studies had shown for tractor, high-lead, and skyline logging methods. In one area, deeply disturbed and compacted soil areas occupied 4.3 percent of the total area, and 15.8 percent of the area was classed as slightly disturbed.

Hilton Lysons

Balloon Logging: A Look At Current Operating Systems, by Penn A. Peters (34)

Balloons are practical for some logging situations. They make it possible to fly logs clear of the ground, and to log convex slopes. Balloons reach up to 5,000 feet and yield a better stumpage return than other aerial methods. On the minus side, failure of balloon fabric and the subsequent loss of expensive helium bother most operators. The greatest environmental and operational hazards are high winds and snow.



Balloon logging rigging systems

Aerodynamic Coefficients of Four Balloon Shapes at High Attack Angles, by P.A. Peters and H.H. Lysons (35)

Since first introduced in the summer of 1963, tethered balloons have been used to yard logs in the Pacific Northwest. Balloons provide a means of harvesting difficult terrain with little impact on the forest environment from access roads or soil disturbance. Knowledge of the aerodynamic characteristics of tethered balloons, as presented in this paper, is necessary for the safe, efficient operation of balloon logging systems.

Extensive field testing is continuing to establish the effectiveness of these materials. Research and development is also required to develop the best aerial application techniques, the minimum dosages needed, the best spray droplet sizes, and to determine environmental effects.

Concurrently, the program is supporting research to develop an understanding of the causes of periodic tussock moth outbreaks. To reduce the need for an extensive detection system, it is important to identify the types of forests most susceptible to outbreaks, and to assemble cost-benefit information to determine what management techniques are most appropriate to prevent outbreaks. The work is essential for development of a pest management system which may reduce the need for chemical pesticides.

The natural factors which promote or inhibit outbreaks are also under investigation. These include factors as diverse as local weather conditions, topography, timber type, and natural enemies of the moth including parasites, predators, and disease organisms.

Many other specialized phases of research and development supplement these studies: for example, research in computer modeling to simulate forests damaged by tussock moth outbreaks; new techniques to sample forests for tussock moths; sociological studies that monitor effects of the outbreaks on recreation and the local economy and health of residents; and determination of impact on wildlife habitat and other non-timber resources.

What of the moth itself? How long will it be around? The Douglas-fir tussock moth is probably as old as the forests. The chances are good that sometime within the next several years moth populations will expand again somewhere in the western United States. After all, the tussock moth has been following its 7- to 10-year cycle of expansion and decline throughout recorded history. The next time this occurs, however, new environmentally sound methods of pest suppression will be available.

end

next "insight" page 109

The Mass Diagram in Timber Access Road Analysis, by Doyle Burke (36)

Mounting pressures on government and private timber managers to reduce the detrimental impact of roads have resulted in a number of modified construction practices. Most notable among these is the end hauling requirement which eliminates indiscriminate sidecasting of surplus excavated materials. These materials often find their way into streams. They also contribute to embankment failures and other forms of mass soil movement.

The use of the mass diagram (a plotted curve which provides sums of earthwork quantities) can help evaluate the impact of end hauling and provides an indication of total volumes of excavation and embankment along roadways. The diagram also indicates accumulative volumes and their locations along a roadway.

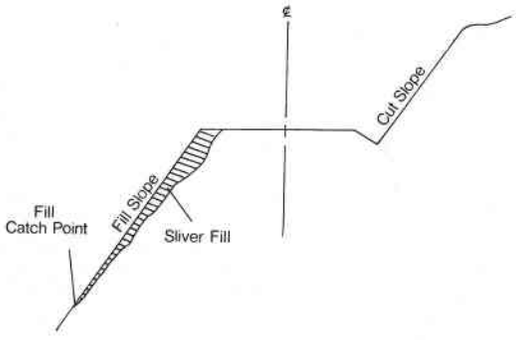


Diagram of road section with sliver fill.

Topometrics: A System for Evaluating Route Alternatives, by Doyle Burke (37)

Topometrics via desk-top computers offers a low-cost, readily available route evaluation system to engineering planners. The system is simple to use, provides for interactive design, and produces graphic and printed results.

The engineering appeal of the system is enhanced because it relies on a proven engineering design process. The designer with professional skills and knowledge is the key, not the computer system. The role of the computer is simple: rapid data manipulation and formatted output. Responsibility for evaluation and decision making rests with the engineer.

A thorough planning effort is possible because the cyclic design process rapidly converges on the best alternative and simultaneously documents results. Costs, safety, and esthetic factors can be more easily evaluated because of the quantitative nature of the results.

Desk-top calculator system with digitizer, plotter, printer, and card reader.

Automated Analysis of Timber Access Road Alternatives, by Doyle Burke (38)

Timber harvest planning and design begins with a thorough analysis of the maps and aerial photographs covering the proposed harvest area. This aspect of the design process can, if properly done, reveal much about the planning area and increase the efficiency of the layout crews in the field. Alternative roads, landings, and settings can be evaluated on paper, and the most suitable combination of these scheduled for field examination.

An analytic system for evaluating timber access road alternatives, using topographic maps and a desk-top calculator, digitizer, and plotter, is now available. The procedure is simple, fast, accurate, and allows maximum interaction and engineering judgment on the part of the designer. This information should be useful to resource managers and of particular interest in planning logging and transportation systems.

Planning Mountain Logging on the North American West Coast, by H.H. Lysons and G.V. Wellburn (39)

Road costs and environmental damage can be minimized by careful planning to reduce road and landing density and minimal earthwork. Lower yarding costs can be achieved by using mechanically efficient systems that have minimal impact on the environment.

The net result of good planning is achievement of desired land management objectives and minimization of total logging costs.

More on Skyline Logging

A lot more information on skyline logging is available as a result of a symposium held in December 1976. Several Experiment Station people gave talks at that meeting. The following papers are available by writing to Publications Distribution (see address on page 131):

"Where and How Skylines Work Best," by Ward W. Carson

Skylines work where and when they have landings, anchors, and payload capability. The physical variables influencing these requirements most strongly are topography, timber size, road location, and yarding equipment. The relationship between these requirements and variables, which must be considered by the logging systems planner, is discussed.

"Why Log With Skylines," by Hilton H. Lysons

The relative costs of roading and yarding are reversing the trend of 30 years ago. Road costs are now rising faster than yarding costs. This is prompting land managers to look to advanced skyline systems to reduce logging costs and environmental impact.

"Automated Yarding Cost Estimation," by Doyle Burke

Yarding cost estimation is of prime importance in logging planning, but is extremely difficult to accomplish manually when several yarding alternatives are being considered, especially within reasonable time limits. A method of automated yarding cost estimation has been implemented on a desk-top computer system using a deterministic approach.

"Why Running Skylines and Interlock Yarders?", by Charles N. Mann

Running skyline systems are receiving increasing acceptance as a method to satisfy current logging needs. These systems are operated most effectively by interlock yarders. This paper presents: the basic running skyline system; an example of power required by various methods of line tensioning to explain the need for interlock; and the suitability of this system to satisfy current logging needs.

Copies of the 196-page *Proceedings, Skyline Logging Symposium* are available for $6.00 each from Centre for Continuing Education, University of British Columbia, Vancouver, B.C. V6T 1W5.

forest engineering - bibliography

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insect and disease

See also:
Silviculture
Watershed
Timber Quality
Alaska

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Contents — Page

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forest insects

insect pests

Forest Pest Leaflets

General information about forest insects is available in a series called *Forest Pest Leaflets,* published by the Forest Service, USDA. These short articles are full of basic and useful information. Generally, they give a description of the biology and ecology of the insect and discuss the range of the insect pest, its host trees, life history, and biological, silvicultural, and chemical control methods.

Following is a partial list of *Forest Pest Leaflets* (1), including some of the more important forest pests. Order from the Experiment Station or from U.S. Forest Service, Region 6, Insect and Disease Control, P.O. Box 3623, Portland, Oregon 97208.

The Heart Rots of Redwood, #25
Heart Rots of Incense-Cedar, #30
Pine Root Collar Weevil, #39
Elytroderma Disease of Ponderosa Pine, #42
Sitka-Spruce Weevil, #47
Laminated Root Rot of Douglas-fir, #48
Western Spruce Budworm, #53
Dwarfmistletoe of Douglas-fir, #54
European Pine Shoot Moth, #59
Silver Fir Beetles, #60
Comandra Blister Rust of Hard Pines, #62
California Oakworm, #72
Heart Rots of Douglas-fir, #73
Douglas-fir Tussock Moth, #86
The Pandora Moth, #114
Fir Tree Borer, #115
Balsam Woolly Aphid, #118
Western Tent Caterpillar, #119
Pine Engraver, *Ips pini,* in the Western States, #122
The Spruce Beetle, #127
Phytophthora Root Rot of Port-Orford-Cedar, #131
Hemlock Dwarf Mistletoe, #135
The Large Aspen Tortrix, #139


FOREST PEST LEAFLET 135

Hemlock Dwarf Mistletoe

U.S. DEPARTMENT OF AGRICULTURE
Forest Service
October 1972

balsam woolly aphid

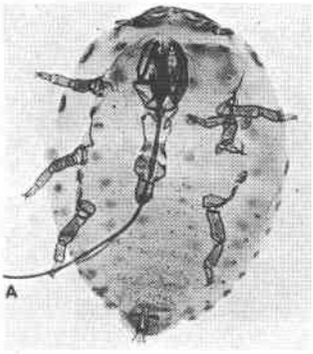
Infestation Characteristics of the Balsam Wooly Aphid in the Pacific Northwest, by Russel G. Mitchell (2)

The balsam woolly aphid is one of the most inconspicuous insect pests in the woods. Because the aphid itself is so tiny and the damage accumulates over a period of years, the insect's presence often goes unnoticed. However, the aphid's size and method of attack is not a measure of its importance. In the Pacific Northwest, the aphid has demonstrated considerable ability to kill and damage three species of our native true firs.

Between 1950 and 1957, more than a billion and a half board feet of commercial-sized sawtimber was killed or seriously weakened in a 400,000-acre area in southwestern Washington. Additional unmeasured damage has occurred since.

Early recognition of damage caused by the balsam woolly aphid can result in considerable savings of timber. Stands suffering the greatest damage should be scheduled for early logging. This paper will aid the forester and landowner by describing (a) some distinguishing characteristics of the aphid and its damage and (b) the nature of balsam woolly aphid infestations as related to its three principal hosts in Oregon and Washington—Pacific silver fir, subalpine fir, and grand fir. Information is also presented on the susceptibility of 15 other species of firs —exotic and native—growing in the Pacific Northwest.

Gouting by balsam woolly aphids settling only around the buds and annual nodes. Typical on trees with smooth internodal bark such as grand fir.



Greatly enlarged ventral view of an adult balsam woolly aphid. The threadlike mouthparts (A), through which food is taken and toxin injected into the host, are about twice as long as shown here.

Foreign Predator Introductions for Control of the Balsam Woolly Aphid in the Pacific Northwest, by R.G. Mitchell and K.H. Wright (3)

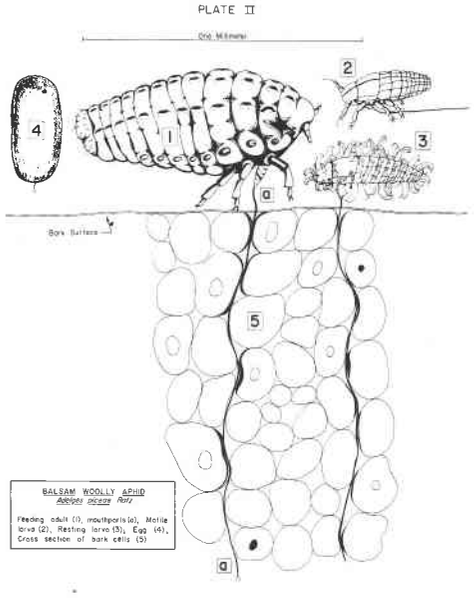
The balsam woolly aphid causes major damage to true fir forests in North America. A program was begun (now discontinued) in 1957 to control the pest in Oregon and Washington by introducing insect predators.

Twenty-three species have been introduced from seven countries throughout the world. They include 15 species of beetles, 4 of flies, 3 of lacewings, and 1 bug. Three species of flies and two species of beetles are successfully established. They prey on the aphid but so far have not sufficiently reduced populations to prevent tree killing. The aphid problem is expected to decrease as the present virgin old forests are converted, under management, to less susceptible young forests. Aphid predators may become relatively more effective under such forest conditions.

The Balsam Woolly Aphid Problem in Oregon and Washington, by Norman E. Johnson and Kenneth H. Wright (4)

This is a report (1957) on an outbreak of balsam woolly aphid in true firs of Oregon and Washington. A 1956 aerial survey showed slightly more than 200,000 acres infested in southern Washington. In Oregon, approximately 150,000 acres were attacked.

The paper describes: 1) the seriousness of the problem, 2) what is being done and what should be done about it, and 3) the insect and its habits.

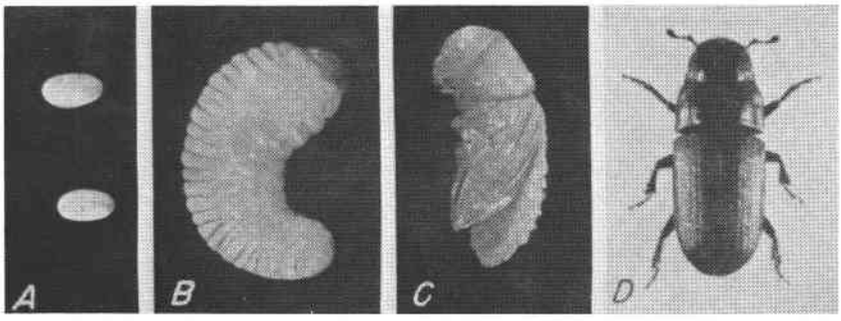


bark beetles in pine trees

The Western Pine Beetle, A Serious Enemy of Ponderosa Pine, by John M. Whiteside (5)

In a format similar to the forest pest leaflets, this report discusses the western pine beetle: the beetle itself, its importance, work and habits, and control methods. The western pine beetle is the most destructive insect enemy of ponderosa pine in the virgin pine forests of California, Oregon, Washington, Idaho, western Montana, and British Columbia. In the United States during the period 1921-45, this beetle, no larger than a grain of rice, killed approximately 2 million trees, or 1 billion board feet of timber, every year. This destruction represents a gross loss of nearly 25 billion board feet of timber, worth 100 million dollars on the stump.

Beetle-killed trees deteriorate rapidly and soon become a total loss to the lumberman. Most of these trees are left in the forest as snags where they fall or rot on the forest floor. Trees thus damaged are also an ever present fire hazard in pine-growing regions.



The four stages of the western pine beetle: A, eggs; B, larvae; C, pupa; D, adult.

BURNING WITH RESPECT

by Dorothy Bergstrom

"There hasn't been a fire that we know of in this stand since 1902. But sooner or later another fire will start in the accumulated dead wood and duff. We want to burn now so we can control what happens."

Frank Lehto, a Forest Service fire specialist, was briefing 53 trainees in a workshop on prescribed burning on their final field exercise, an operational burn in a ponderosa pine forest.

After 3 days of training, the students had a far better understanding of the interrelationship of the various elements of an ecosystem. They understood that fire prescribed for any single purpose has complex effects on all parts of the ecosystem. Those effects last a long time and are not reversible. Mistakes can be serious.

With the trainees were two men who had organized and conducted the workshop: John Dell is a fuels management specialist with the Forest Service's Pacific Northwest Region in Portland, Oregon. Robert Martin is a project leader for Silviculture of Interior Forest Types, a research unit of the PNW Station at Bend, Oregon. Martin was formerly an instructor in fire science at the University of Washington. Dell had recently taken a four-week training course in prescribed burning in Region 8 which included operational burns in the South.

Dell and Martin had enlisted a faculty of specialists in botany, ecology, wildlife, meteorology, and prescribed burning, who had been with the students for three days, giving talks, conducting field exercises, demonstrating, explaining, even exhorting. Ecologist Fred Hall had been emphatic: "When someone asks about the effects of burning, you have to ask where and in what plant community. It is vital to consult the local experts in range, wildlife, plants, and soils to find out ahead of time what will happen if a particular site is burned."

This first workshop in the Pacific Northwest to include field experience in prescribed burning under a timber canopy, brought together employees of several agencies: the Forest Service, the Bureau of Indian Affairs, State Forestry Departments, the National Parks, and a Canadian forestry organization. Most of the students had been trained previously to put out fires. Now they were learning how to use fire safely to achieve specific management objectives.

bark beetles in douglas-fir

Biology and Control of the Western Pine Beetle, by J.M. Miller and F.P. Keen (6)

A 381-page book that is a summary of the first 50 years of research on biology and control of the western pine beetle. Published by USDA in 1960, the text is a reference for research workers and for fieldmen concerned with surveys, the appraisal of infestations, and control.

Investigations of the biology and control of the beetle began in 1900. The insect has been the subject of more intensive study during the past 50 years (1910-60) than any other western forest insect.

The pine beetle, of course, was not a problem before the advent of the lumber industry: ''Then, as the realization developed that the supply of virgin pine stumpage was limited and that the beetle was hastening exhaustion of the old stands, the western pine beetle became a problem of great importance. The beetle upset logging programs and shortened the life of sawmill communities because it often became active in the woods before loggers reached the timber. It killed the very trees that the lumberman preferred to cut and mill into high quality lumber. Its work earned it the epithet 'The Pine Beetle Logging Company.'''

Degrees of risk in ponderosa pine.

Mountain Pine Beetle in Ponderosa Pine, by Charles Sartwell and Robert E. Stevens (7)

Mountain pine beetle is the major insect enemy of second-growth ponderosa pine in many interior areas of the western United States. Severe tree killing occurs predominantly in dense stands where competition has substantially slowed growth of even the dominant trees. Experiments were begun in the 1960's to determine if beetle outbreaks can be prevented by silvicultural thinning. Early results indicate that thinning of dense stands deserves major emphasis in efforts to minimize this pest problem.

See also a paper on *Thinning Ponderosa Pine to Prevent Outbreaks of Mountain Pine Beetle,* by Charles Sartwell (8), and a report by Keen and Salman, *Progress in Pine Beetle Control Through Tree Selection* (9).

Table 1. Cumulative mortality and net growth 5 years after thinning.

Thinning treatment	Stand density 1967	1972	Mortality M.p.b.[1]	Ips[2]	Other	Total	Net growth
	Stem basal area, sq. ft./acre						
Unthinned	173.2	152.5	11.8	4.0	5.2	21.0	−20.7
12×12 ft	116.8	113.5	3.2	2.3	0.5	6.0	−3.3
15×15 ft	85.8	89.0	0.2	0.0	0.3	0.5	3.2
18×18 ft	61.8	64.8	0.0	0.5	0.3	0.8	3.0
21×21 ft	35.0	37.2	0.0	0.0	0.8	0.8	2.2

[1]*Mountain pine beetle.*
[2]*Pine engraver* (Ips pini *(Say)).*

Silvicultural and Direct Control of Mountain Pine Beetle in Second-Growth Ponderosa Pine, by Charles Sartwell and Robert E. Dolph, Jr. (10)

In the Northwest, the mountain pine beetle, *Dendroctonus ponderosae,* is a major pest of second-growth ponderosa pine. Beetle-killed trees characteristically have grown very slowly for more than 10 years prior to being attacked, indicating that low tree vigor, due to intensive between-tree competition, underlies the occurrence of beetle outbreaks. This suggests that silvicultural thinning may be appropriate in prevention of such beetle infestations. This paper describes results obtained after instituting silvicultural thinning of an area located in the Sumpter Valley, about 15 miles southwest of Baker, Oregon.

In the first 5 years after treatment, thinning reduced killing of ponderosa pole-timber by the mountain pine beetle by more than 90 percent and led to positive net stand growth. The felling and burning of infested trees also substantially reduced tree mortality caused by the beetle, but the treated stand declined in the post-treatment period due to damage by other agents. It was found that the practical effect of direct control, in combination with thinning, was no greater than that obtained by thinning alone.

Charles Sartwell

Douglas-fir Beetle, *Dendroctonus pseudotsugae* **Hopk.,** by K.H. Wright and R.R. Lejeune (11)

The Douglas-fir beetle is the most destructive insect enemy of sawtimber-size Douglas-fir; severe tree-killing has been recorded throughout the range of the host tree. Some 3 billion board feet of sawtimber were killed in western Oregon and Washington from 1951 to 1954 and more than 400 million feet in the northern Rocky Mountains of the United States in 1952.

Outbreaks in the inland regions differ from those in coastal areas. Those in the interior often last many years and may not decline until essentially all trees of susceptible size (usually over 10 inches in diameter) in the stand or drainage are killed. In some areas, however, the outbreaks tend to subside after a few years. Outbreaks appear to be closely related to stand conditions such as overmaturity and overstocking, and to climatic conditions such as drought.

In the coastal areas, outbreaks usually are of short duration. Here, beetle populations typically build up following major stand disturbances such as blowdown and firekill, spread to green trees, kill large volumes of timber, and then decline rapidly, apparently because of the natural resistance of the host.

This paper, really a chapter in a book, is much like the *Forest Pest Leaflet* series. It discusses distribution, hosts and damage, life history, control measures, and gives selected references.

Fire and Insects in the Douglas-fir Region, by R.L. Furniss (12)

An older paper (1941) that discusses the use of prescribed fire as a control for the Douglas-fir bark beetle in the Pacific Northwest.

It was once widely thought that understory trees and brush were a harboring ground for insects that occasionally would reach epidemic proportions and spread out to kill forest trees! With his usual wit and clarity, Furniss describes the problem:

''Some, considering the understory trees and other vegetation that have developed since concerted efforts have been made to keep fire out of the woods, have concluded that in such cover is a likely place for pest of all kinds to thrive. It is evident to anyone who will observe that there are all kinds of leaping and crawling insects everywhere upon the forest floor. What then would be

more logical than that this multitude of insects should periodically come forth and find the forest trees to their liking? If that is what takes place, solution seems simple and direct. Burn the brush!''

Furniss goes on to describe the habits of the Douglas-fir beetle and to pooh pooh the whole idea of prescribed fire as a cure for the bark beetle problem. Rather, he says, fire prevention is the solution:

''In conclusion, it can be stated that Douglas-fir in western Oregon is normally resistant to insect attacks. Occasionally as a result of unusual circumstances, an outbreak of the Douglas-fir beetle may develop and for a year or two cause extensive damage. The best way to prevent a large part of these outbreaks is to prevent the large forest fires that provide much of the breeding material necessary for the beetles to attain sufficient numbers to attack and kill green trees.''

Ken Wright

The Deterioration of Beetle-Killed Douglas-fir in Western Oregon and Washington, by K.H. Wright and G.M. Harvey (13)

The Douglas-fir beetle sporadically kills large volumes of Douglas-fir sawtimber in western Oregon and Washington. Salvage of dead timber before it deteriorates is often a major problem for forest-land owners and managers. A study was started in 1952 to determine how fast beetle-killed trees deteriorate, the factors influencing the rate of deterioration, and the causal agents. Highlights of the results are:

• Volume of wood deteriorated increases steadily with time.

• Wood deterioration the first year following death is minor, but stain and pinhole borers reduce quality for some uses. After 3 years, the high-value sapwood is extensively deteriorated. By 5 years, there is significant decay penetration of the heartwood. Deterioration is slower in the heartwood, but by 9 years the typical beetle-killed tree is a broken snag with only a sound core remaining in the lower half of the bole. After 11 years, deterioration is usually complete except for the butt-log of the largest trees.

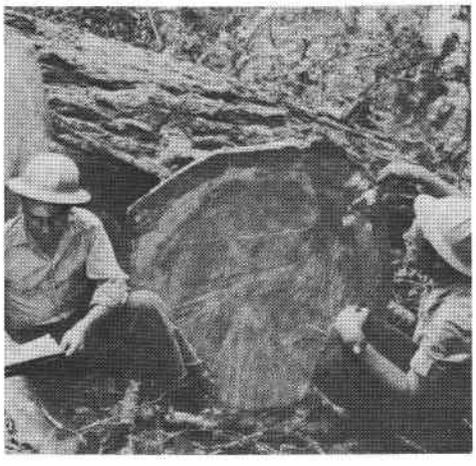
• Rate of deterioration is strongly related to age and size of tree and, to a lesser degree, to locality.

• Timber cruisers can use external tree characteristics to estimate time since death and the attendant amount of deterioration.

• The red belt fungus (*Fomes pinicola*) is by far the most imporant agent causing deterioration.

• Felling breakage is related to time since death and size of tree—when expressed in terms of total number of breaks or height of the first break.

• When established logging priorities are for beetle-killed timber, maximum value will be recovered if consideration is given to: age and size of the timber, locality differences in deterioration rate, accessibility of the timber, topography as it affects felling breakage, products to be manufactured, and changing utilization standards.



Field procedures for obtaining deterioration data.

Lehto talked about the tracts the students were about to burn on his district—the Crescent Ranger District of the Deschutes National Forest in Oregon. ''Besides reducing the accumulated fuel, we want to discourage pine reproduction. The overstory stand is dense enough and still growing. We'd also like to stimulate the growth of snowbrush and bitterbrush to bring in more wildlife. We decided on burning instead of machine piling and burning to avoid damage to the pumice soil. As you know, burning in piles creates intense heat, and vehicles compact the soil.''

Setting objectives for the stand and deciding how to achieve them were steps the trainees themselves would take in the future. Today they were conducting a burn to achieve the objectives of the District and at the same time gaining practical experience. The trainees had been divided into four teams, each led by an instructor trained in prescribed burning. The day before, they had practiced on 2- and 3-acre burns. Today they were to plan and conduct burns of 34 to 68 acres.

The District had made most of the preparations. Vehicles and equipment were in place. Men were standing by to control flare-ups and mop up afterward. Firelanes had been plowed around the plots to be burned. Snags to be saved for wildlife had been marked and sprayed with fire retardant. Local residents had been notified the burn was to take place, an important step because most people in central Oregon still expect the Forest Service to put out fires, not start them.

Since this was an operational burn on his District, Lehto gave instructions about equipment and safety. Cars would be parked facing downhill with keys in them. Cars moving would have lights on. Passengers were to get out and walk through thick smoke. All tools were to be returned to the road.

Part of the students' experience was to identify the vegetation and predict its response to fire. Len Volland, range ecologist, explained, ''There are five plant communities here, and you will find the four plots to be burned are not all the same. There is a strong relationship to slope. As you climb up you will see more manzanita.''

A 10-Year Study of Mortality in a Douglas-fir Sawtimber Stand in Coos and Douglas Counties, Oregon, by K.H. Wright and P.G. Lauterbach (14)

In 1945, a growth and inventory cruise of the Millicoma Forest in Coos and Douglas Counties, Oregon, disclosed that mortality was approximately equal to growth. Follow-up studies were made from 1946 through 1955 to determine causes, amounts, and trends of the mortality. The more important findings of these studies are reported in this publication.

Insects, particularly the Douglas-fir beetle, were the most important cause of tree-killing during the 10 years, accounting for 59 percent of the total mortality. Windthrow and windbreak were next in importance, amounting to 38 percent. Disease, particularly root rot, was also an important factor. Other less important causes of mortality were suppression, mechanical injury, lightning, and "unknown."

Recommendations to forest-land managers, based on findings of the Millicoma and related studies, include the following: (a) Strong efforts should be made to salvage killed trees, (b) recently developed survey methods of detection and evaluation should be used to expedite salvage, (c) logging plans should be adjusted for maximum recovery of dead material, (d) more timber access roads should be built to allow prompt pickup of killed trees, (e) small-scale logging equipment should be developed to handle salvage, and (f) cutting budgets should be stepped up when mortality of catastrophic proportions occurs.

Estimating Beetle-Killed Douglas-fir by Aerial Photo and Field Plots, by J.F. Wear, R.B. Pope, and P.G. Lauterbach (15)

Color panchromatic aerial photographs are a reliable method for estimating epidemic tree killing by the Douglas-fir beetle. Color photographs are better than black and white. Sequential color photography taken annually may be used to record the course of an epidemic. By regression sampling, taking a large number of inexpensive photo plots, and ground checking a small number of expensive field plots, a survey of equal accuracy is obtained at less cost than by field survey only. A procedure is outlined for conducting aerial photographic surveys of Douglas-fir beetle epidemics.

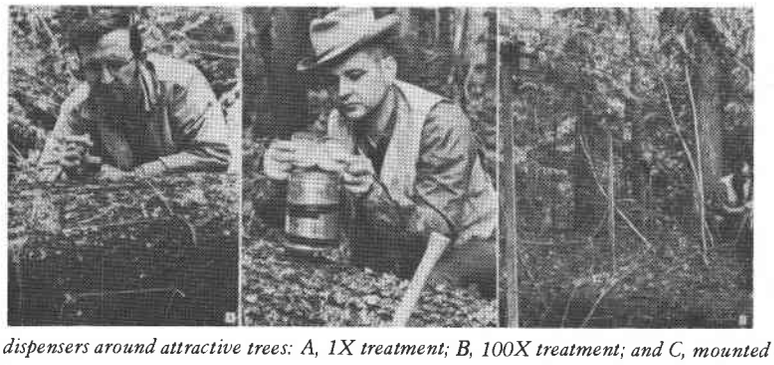
Sex Attractants of Bark Beetles

The Douglas-fir beetle infests Douglas-fir throughout much of that tree's range in western United States and British Columbia. It characteristically breeds to epidemic numbers in windthrown or otherwise damaged trees. The resulting progeny sometimes kill vast numbers of live trees. Thinning, harvesting, and removal of susceptible trees are the most effective and economical means of preventing a build-up of damaging populations. However, where susceptible trees are inaccessible or esthetic or other values preclude such management actions, other means of preventing damage or of suppressing beetle populations may be needed. The natural pheromones of the species are being tested to determine whether or not they can fill this need.

In this study, the pheromone MCH (chemically, 3-methyl-2-cyclohexen-1-one) was deployed at three rates and tree spacings around attractive felled trees. The chemical was very effective as an attractant and reduced beetle attacks by 96 percent at one level and 91 percent at the other. But researchers indicate that the attractant is still only a potential control strategy, and that more practical and effective formulations must be developed.

See *Effectiveness of the Douglas-fir Beetle Antiaggregative Pheromone Methylcyclohexenone at Three Concentrations and Spacings Around Felled Host Trees,* by Furniss, Daterman, Kline, McGregor, Trostle, Pettinger, and Rudinsky (16).

Several other reports have been published on bark beetles and sex attractants. See also those lised under (17) in the bibliography.



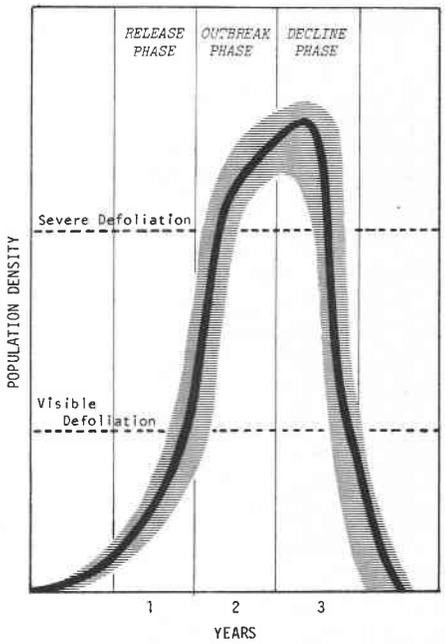
Pheromone dispensers around attractive trees: A, 1X treatment; B, 100X treatment; and C, mounted on stakes 10 feet apart.

douglas-fir tussock moth

Major Outbreaks of the Douglas-fir Tussock Moth in Oregon and California, by Boyd E. Wickman, Richard R. Mason and C.G. Thompson (18)

Case histories of five tussock moth outbreaks that occurred in California and Oregon between 1935 and 1965 are discussed. Information is given on the size and duration of the outbreaks, the presence of natural control agents and the damage caused. Most of the outbreaks were eventually treated with DDT. However, enough information was available from untreated portions to show the probable trend of natural events in the absence of direct control.

All infestations followed a 3-year cycle with inconspicuous to minimal defoliation the first year, severe foliage loss the second year, and ultimate collapse of the population by the end of the third year. The most severe tree damage occurred in the second year. Additional loss of foliage before population collapse in the third year was usually of minor importance in terms of total impact. Although other natural factors were involved, a virus disease appeared to be the principal cause of insect mortality during collapse.



Hypothetical model of an outbreak cycle of the Douglas-fir tussock moth.

Boyd Wickman

Decay in White Fir Top-Killed by Douglas-fir Tussock Moth, by Boyd E. Wickman and Robert F. Scharpf (19)

One of the earliest recorded and studied outbreaks of Douglas-fir tussock moth on white fir occurred at Mammoth Lakes, California, from 1934 to 1938. In 1937, a 5-acre plot was established there to study the immediate effects of defoliation.

New studies were begun in 1970 when a timber sale, which included the study plot, offered an opportunity to determine if heart rots were a significant cause of defect in white fir trees 33 years after top-killing. This was done by dissecting the tops of trees felled during logging. Results were compared with white fir in a nearby logged area where defoliation had not occurred.

Investigations found old top damage and a condition known as wetwood in the insect-damaged area. Few decay organisms were found, however. The researchers conclude that in east-side Sierra Nevada white fir stands, the threat of defect is not serious in large trees that will be logged within 35-40 years after an insect outbreak.

Forked tops resulting from Douglas-fir tussock moth defoliation contained buried leaders.

Collapse of an Outbreak Population of the Douglas-fir Tussock Moth, by Richard R. Mason and C.G. Thompson (20)

Three factors may have combined to cause the collapse of an outbreak of the Douglas-fir tussock moth in northern California white fir stands in 1966. A major cause of the collapse was probably a natural virus disease in the larval population. However, a late spring frost which destroyed much of the preferred food of the larvae may also have contributed. The number of larvae in a given locale may also have influenced the decline, with the collapse being more rapid in areas where insect populations were highest.

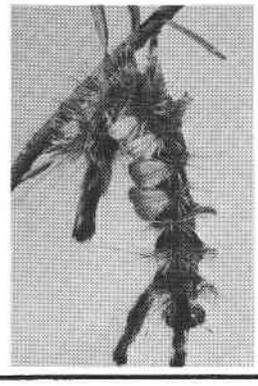
Evaluating Damage Caused to a Campground by Douglas-fir Tussock Moth, by Boyd E. Wickman and Donald A. Renton (21)

In 1964-65, the tussock moth caused heavy damage to white fir in a campground on the Modoc National Forest in California. Researchers sought to determine the impact of the outbreak on the recreation resource. As a result, tree mortality and topkill were tallied and evaluated in a small campground in 1970. Cleanup costs involving hazardous trees and dead tree tops amounted to $23.75 per camp unit. When esthetic values were assigned to the trees, the insect damage costs increased to $126.88 per camp unit.

Flight, Attraction, and Mating Behavior of the Douglas-fir Tussock Moth in Oregon, by B.E. Wickman, R.R. Mason, and H.G. Paul (22)

Knowledge of the reproductive biology of the Douglas-fir tussock moth is important for developing a sex pheromone sampling technique and timing egg mass collections. Adult activity rhythms have been studied in the laboratory, but they have never been determined in the field. This study describes intensive observations and measurements made over a 31-hour period in the Blue Mountains of northeastern Oregon in 1972.

Continuous observations and measurements were made of adult flight, mating, and oviposition. Male flight started at 1000 (P.S.T.), gradually increased to a peak period ca. 1700, and concluded at 1930. This coincided with peak mating activity with the wingless females. Oviposition occurred immediately after mating. Virgin females attached to sticky traps were very effective for attracting and capturing male moths. The female sex pheromone offers a possible technique for early detection of Douglas-fir tussock moth populations.



Armed with vegetation manuals and workbooks, the group scrambled to check the vegetation on their hillside plots. They decided that a light burn would accomplish the District's objectives. It would consume the dead vegetation and part of the duff. The young pines would be killed. The snowbrush and bitterbrush would sprout in response to heat. The thick bark of the large pines would not be damaged by a low intensity fire, but flame height had to be kept low to prevent crown scorching.

The teams worked out and wrote up their burn plans, mapping the directional exposure of the units, the slope position, and the degree of slope and type of terrain.

The meteorologist from the National Weather Service, in his mobile field unit, supplied essential information to the teams of trainees. He reported wind direction and speed, upper air movement, air temperature, relative humidity, and gave an on-the-spot weather prediction. The air was somewhat moist, the temperature cool, the winds moderate. Conditions were satisfactory.

Each team chose a burning pattern suitable for the plot. Most teams used a combination of patterns: strip head fire, which travels in front of the wind for short distances; backfire, which creeps backward into the wind; or flank fire, which burns across the wind. The torches were lit and burning began.

As smoke from the fires began to block out the blue sky, someone noticed a nuthatch building a nest near the top of a snag. The snag was ringed with retardant and would not burn, but the nuthatch didn't know that. Would she complete her nest or move away? The wildlife consultant wasn't sure. Some questions have not been answered yet, especially in the west where little prescribed burning has been done under tree canopies.

To find some of the answers from the Walker Mountain burn, Len Volland had installed permanent transects the week before. He plans to monitor vegetation response for several years, not only to follow results from the Walker Mountain burn, but to add to general knowledge about prescribed burning in the west.

The main purpose of the Walker Mountain burn was to approximate the effects of a low intensity natural fire by removing debris from the forest floor and turning it into nutrients available for new growth. This was the process by which many pine forests had been created and maintained since long before man began managing them.

Population Change in an Outbreak of the Douglas-fir Tussock Moth in Central Arizona, by Richard R. Mason (23)

A study of population density of early stage tussock moth larvae indicates that an outbreak in Arizona developed mainly from populations that had been there for at least 2 years and was not due to the spread of early instar larvae during the outbreak. What this means is that the area of infestation was populated with tussock moths well before the outbreak was apparent. Early instar larvae were not spread long distances by the wind.

Similar to patterns recognized in other outbreaks, the infestation seemed to progress through three phases: release in 1967, a peak in 1968, and decline in 1969. Defoliation was conspicuous in the summers of 1968 and 1969 but disappeared by 1970. Collapse was attributed largely to natural enemies, including a nucleopolyhedrosis virus often associated with tussock moth populations.

Dick Mason

Development of Sampling Methods for the Douglas-fir Tussock Moth, by Richard R. Mason (24)

Methods were developed to standardize sampling of the Douglas-fir tussock moth. Population density is estimated in terms of the number of eggs or larvae per 1,000 square inches of branch area. Mason indicates that larval sampling is easier than egg sampling because egg masses are clumped in masses and larvae are dispersed over the foliage. This means that fewer samples are required for larval sampling.

See also, *Sequential Sampling of Douglas-fir Tussock Moth Populations,* by Richard R. Mason (25).

Food Preference in a Natural Population of the Douglas-fir Tussock Moth, by Richard R. Mason and Jerrold W. Baxter (26)

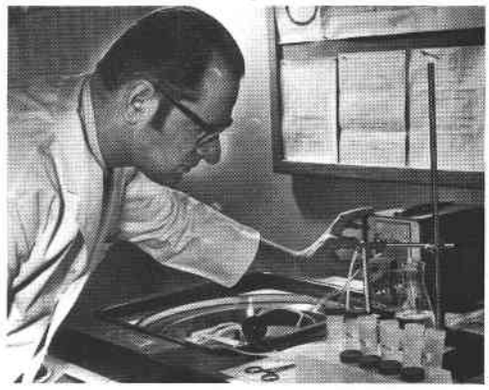
The food preferences of the tussock moth were studied in an outbreak on white fir in northern California. Entomologists found that:

- Caterpillars preferred new foliage to old foliage. Old needles were almost totally unacceptable to early instar larvae, but were eaten by older larvae.

- After a late spring frost killed most of the new growth on white fir, many caterpillars shifted to the new needles of ponderosa pine.

- In the laboratory, larvae favored the new growth of white fir over pine needles.

- When caterpillars were fed only frost-damaged foliage (no new growth), many died, apparently from starvation.



Mauro Martignoni

Life Tables for a Declining Population of the Douglas-fir Tussock Moth in Northeastern Oregon, by Richard R. Mason (27)

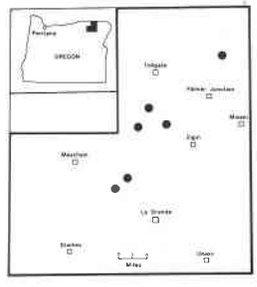
Life tables, a useful technique in the study of population dynamics, provide a format for recording and accounting for all population changes in the life cycle of a species in its natural environment.

The objective of this study was to determine the value of defoliation intensity in the first year that a tussock moth is detected as a predictor of population trend the next year. The evaluation was made by preparing life tables for the generation following detection which show changes in tussock moth population density and the major causes of mortality over a range of stand defoliation conditions.

Rate of decline was variable under different conditions but appeared to be predictable from the level of past defoliation. In general, the decline rate was faster on heavily or moderately defoliated plots than on lightly or previously undefoliated plots.

Population collapse was the result of a multitude of natural factors operating in compensating ways against the high density outbreak. It was characterized by an increase in the effect of numerous mortality factors including virus disease, insect parasites, predators, starvation, and larval dispersion, as well as changes in population quality and structure resulting in lower fecundity, egg quality, and a change in sex ratio.

The largest proportion of mortality occurred early in the larval cycle and was probably due to losses from natural dispersion and predation; however, other factors may have had an equal or greater effect on ultimate collapse of the population although they accounted for less total mortality.



Map shows locations of replicated study areas (•) in northeastern Oregon.

Douglas-fir Tussock Moth: Sex Pheromone Identification and Synthesis, by Ronald G. Smith, Gary E. Daterman, and G. Doyle Daves, Jr. (28)

The sex attractant of the Douglas-fir tussock moth has been isolated and identified chemically as (Z)-6-heneicosen-11-one. The compound has been duplicated artifically in the laboratory and proven highly potent in laboratory and field tests.

For another technical report on the tussock moth sex attractant, see also the publication listed under (29) in the bibliography.

Considerable research has also been done at the Forestry Sciences Laboratory in Corvallis to develop techniques for using a natural virus of the tussock moth as a control method. Some very technical reports on that work are also listed in the bibliography (30).

Influence of Host Foliage on the Douglas-fir Tussock Moth, by R.C. Beckwith (31)

Douglas-fir tussock moth larvae were fed foliage obtained from the top and bottom of the crowns of Douglas-fir, grand fir, and subalpine fir under controlled laboratory conditions. High density field populations were simulated by forcing larvae to feed upon old-growth foliage creating a stress factor that was detrimental to the population. The host plant and crown position had a significant effect on frass production, head-capsule size, and pupal weight. The number of eggs produced was significantly greater from foliage obtained from the top of the crown. The most significant factor was whether larvae were forced to feed upon old-growth foliage. This "stress" resulted in increased development time, frass production, number of instars in decreased head-capsule size, and egg production.

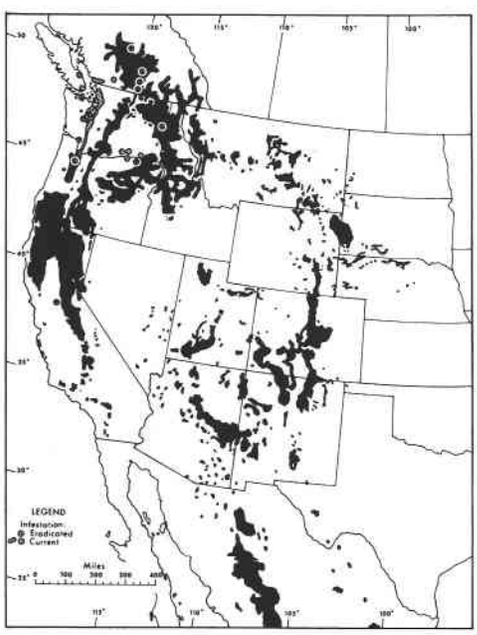
european pine shoot moth

Hazard of European Pine Shoot Moth to Western Pine Forests, by V.M. Carolin, Jr., and G.E. Daterman (32)

Much of the western pine region will be safe from European pine shoot moth damage, principally because of low winter temperatures accompanied by light snow cover. A potential for damage exists in certain areas, however, and the hazard could be particularly high in southern and southwestern Oregon and in northern and central California, where climatic conditions favor shoot moth survival. In some northerly parts of the pine region, local climatic conditions may permit the shoot moth to become an occasional pest.

There are extensive pine stands in the southern Rocky Mountains and in the southern part of the Sierra Nevada in California. There are no records of shoot moth infestations south of 40° N. latitude, but conditions could be suitable for insect survival at higher elevations in that area.

Plantations are especially vulnerable to the shoot moth. Land managers should be particularly alert to shoot moth infestations in young, even-aged stands of ponderosa or lodgepole pine, especially where weather conditions are favorable.



Distribution of European pine shoot moth on ornamental pines in relation to the range of ponderosa pine.

Eradicating Pine Shoot Moth

A series of three reports was prepared in the early 1960's discussing ways to control the shoot moth in forest nurseries and on ornamental pines in residential areas. The following reports are still available:

Eradicating European Pine Shoot Moth on Ornamental Pines With Methyl Bromide, by V.M. Carolin, W.H. Klein, and R.M. Thompson (33)

The introduction of the European pine shoot moth into this region, discovered in 1959, was a potential threat to natural pine stands. To combat this threat, quarantines were invoked and eradication programs undertaken. Destruction of infested areas was initially used as an eradication technique. In the meantime, fumigation with methyl bromide was tested to ascertain its usefulness in eradicating the insect on ornamental pines. Results of this study show that 100-percent control of the shoot moth can be obtained over a wide range of seasonal conditions.

Procedures and Equipment for Fumigating European Pine Shoot Moth on Ornamental Pines, by W.H. Klein and R.M. Thompson (34)

The second in this series reports on procedures and equipment devised for control of European pine shoot moth on single pines and on rows of pines in residential areas and nurseries. Portable chambers of different sizes and shapes were developed, precise application devices were fabricated, and devices for safe evacuation of the gas from the chambers were devised. Methods of controlling the gas concentration and proper use of equipment are also described.

Eradicating European Pine Shoot Moth in Commercial Nurseries With Methyl Bromide, by V.M. Carolin and W.K. Coulter (35)

The third publication in this series reports on the feasibility of eradicating European pine shoot moth in a commercial nursery. Fumigation methods devised earlier were modified for the treatment of groups of trees and rows of trees.

Results indicate that fumigation of an entire commercial nursery is feasible under conditions existing in the Puget Sound area of Washington during late fall and winter. Temperature ranges in chambers of 40° to 65° are acceptable. When tarps were used under the fumigation chambers, treatment resulted in 100 percent control of the shoot moth. Wet soil alone was less successful. Tree damage from fumigation was minor and most apparent on lodgepole pine and western white pine.

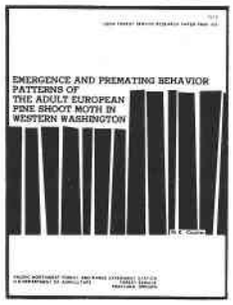
Even man's management has included planned burning. The Indians did it. So did the early stockmen. Farmers still burn. But, since the early 1900's, the efforts of most public agencies have been to prevent and suppress the large destructive wildfires that damage thousands of acres of forest and range. The benefits of fire were ignored. As dead vegetation piled up in the forests, becoming fuel for the devastating fires the agencies were trying to prevent, land managers became concerned and began to consider the possible benefits of controlled fire.

Prescribed burning was first used in the South in the 1930's, and its acceptance has gradually spread to other parts of the country. In addition to reducing the hazard of dead vegetation, burning is now also used to accomplish silvicultural objectives—preparing sites for seeding and planting, controlling insects and disease, and manipulating species —and to improve cattle forage, wildlife habitat and browse, and accessibility within stands.

Many foresters who have had experience with prescribed burning feel it is environmentally sound and is bound to become more important in the future. It is a dramatic and powerful tool—potentially effective if used with respect by trained people, but dangerous if abused.

Acceptance by foresters of prescribed burning in the west made the workshop both possible and necessary. There were more applicants than could be accepted, and annual sessions for the next several years are planned. Like the one held in 1976, future workshops will include field work. John Dell, one of the workshop organizers, feels this was an important feature. "The students had an opportunity to work on an operational burn—to get a feel for the whole process from the first steps in planning to completion. They now have a foundation on which to build," he said. Two of the instructors, fire scientists Jack Dieterich and Steve Sackett of the Rocky Mountain Station, felt that the Region-wide basis of the workshop reflected recognition of the importance of fuel management problems.

One of the students, Paul Haertel, of the Lava Beds National Monument in northern California, said he was reassured by the interest of other agencies in burning. For the past three years the Monument staff has been involved in a fire ecology research project with the University of Washington.



Emergence and Premating Behavior Patterns of the Adult European Pine Shoot Moth in Western Washington, by W.K. Coulter (36)

The European pine shoot moth was discovered in 1959 infesting ornamental pine in Bellevue, Washington. Quarantines were invoked, techniques developed for pest control by tree fumigation, and in 1964 a research program was begun to investigate procedures for eradication by the sterile-male release technique.

One phase of the research program was to record the biological characteristics of the adult shoot moth which were pertinent to the release and dispersion of sterilized males. This paper discusses emergence and premating behavior and deals mainly with observations of adult activity on the twig or tree from which the adult emerged.

Patterns of diurnal activity provide a guide for liberating sterile males at a time of day so that they can compete with wild males for the attention of wild females.

Survival of European Pine Shoot Moth Under Caged Conditions in a Ponderosa Pine Forest, by G.E. Daterman and V.M. Carolin, Jr. (37)

For this study, forest entomologists lived dangerously and took specimens of the European pine shoot moth, an introduced pest, and put them on forest trees that had been caged to keep the insects in. Purpose of the experiment was to evaluate the potential threat of the shoot moth to native forests.

Results indicate the geographic areas where shoot moth might become established. Most likely locations are southern Oregon and California north of 40° N. latitude. The least likely locations are in interior British Columbia, Alberta, some locations in northern Washington and northeastern Oregon, Idaho, Montana, Wyoming, Nebraska, and the Dakotas.

A limiting factor appears to be low winter temperatures that kill overwintering larvae.

For other information about the environmental factors that might influence survival of shoot moth in the forests, see also a very technical paper by Daterman on the effects of temperature and vapor pressure on egg production and survival (38).

Parasites of Shoot Moth Released

Itoplectis quadricingulatus is the Latin name for a parasite of the European pine shoot moth, otherwise known as *Rhyacionia buoliana*! These parasites are native to this country and were found to attack the shoot moth when it moved into the West. So research entomologists decided to try releasing them in an ornamental pine planting in western Washington to see if they had any potential in an integrated control program.

A total of 5,365 female parasites were released on a 40-acre site over a 7-week period when pupae of the pine shoot moth were known to be present. Parasitization of the shoot moth increased by 30 percent.

For details, see the technical report, *Test Release of* Itoplectis quadricingulatus *Against European Pine Shoot Moth in an Isolated Infestation,* by Roger B. Ryan and Richard D. Medley (39).

Sex Pheromone of the European Pine Shoot Moth: Chemical Identification and Field Tests, by Ronald G. Smith and others (40)

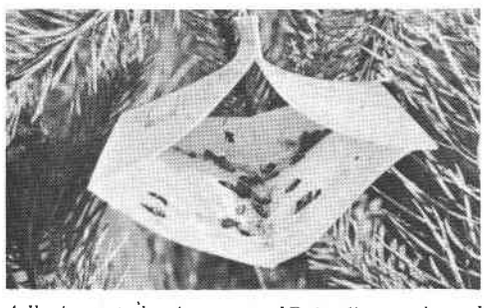
The sex attractant of the European pine shoot moth has been isolated and identified chemically as (E)-9-dodecenyl acetate. As a result, the synthetic version of the attractant has been prepared in the laboratory and later tested in the field. Results were good, with the synthetic material consistently attracting more moths than traps with female moths! The effectiveness of this material indicates a high potential for detection and perhaps suppression of shoot moth infestations.

Synthetic Sex Pheromone for Detection Survey of European Pine Shoot Moth, by Gary E. Daterman (41)

The sex attractant or pheromone of the European pine shoot moth is a chemical compound emitted by receptive females to "call" males for purposes of reproduction. This "come-hither" scent is now available in synthetic form and can be utilized in a very sensitive trapping device to indicate the presence or absence of the insect in a particular area.

Methods are outlined for using the attractant in a detection survey program. The report discusses suitable trapping devices, pheromone doses, trap placement, and the importance of trapping when male moths are in flight.

For other highly technical reports on the sex attractant of the pine shoot moth, see also items listed under (42) in the bibliography.



Adhesive trap showing captured R. buoliana *males and pheromone-plastic bait suspended on pin (arrow).*

lodgepole needle miner

Forest-Site Relationships Within an Outbreak of Lodgepole Needle Miner in Central Oregon, by Richard R. Mason and Timothy C. Tigner (43)

Entomologists studied the relationship between forest site and stand conditions to outbreaks of the lodgepole needle miner in central Oregon.

Results clearly show that site influenced the distribution of needle miner outbreaks. High insect populations occurred only in pure stands in broad basins where lodgepole is considered the climax species. The probable risk of sites to needle miner infestation are as follows:

Pinus contorta/Purshia tridentata community—High risk.

Pinus contorta/Arctostaphylos uva-ursi community—Low risk.

Pinus contorta/Purshia tridentata-Arctostaphylos patula community—or—*Pinus ponderosa/Purshia tridentata-Arctostaphylos patula* association—Low risk.

Resistance to a Needle Miner in Lodgepole Pine Varies With Foliage Source, by T.C. Tigner and R.R. Mason (44)

The ability of lodgepole pine to resist defoliation by the needle miner is related to forest-site characteristics, tree age, and location of foliage in the crown of the tree. In fact, the major cause of differences in defoliation is probably the varying quality of the foliage. There is evidence to indicate that some tree foliage contains a compound that makes it resistant to munching by the needle miner.

Gary Daterman

larch casebearer

Photoperiod Effects on Development of the Larch Casebearer, by R.B. Ryan (45)

The larch casebearer is an introduced pest that is currently causing serious defoliation to some stands of larch in the West. Insect parasites are being introduced in an effort to bring this pest under biological control.

In order to raise parasites for the control program, it is also necessary to raise its host —the larch casebearer. In spite of several comprehensive studies on the biology of the larch casebearer, no one has previously studied the effects of photoperiod or published methods for rearing these insects through several generations in the laboratory.

In this paper, Ryan discusses the effects of photoperiod on insect development. Pupation is controlled by specific long-day and short-day sequences.

Attainment of the Overwintering Instar and the Casebearing Habit by Larch Casebearer Larvae at Different Elevations in the Blue Mountains, by Roger B. Ryan (46)

In order to know exactly when to release parasites to control the larch casebearer, entomologists must know more about the development of the insect through its several larval instars.

Ideally, parasites attacking the casebearer stage should be released in the fall when the larvae has reached the third, or over-wintering instar, but not before. At this time, the larvae wears a protective shell from which it gets its name, the larch casebearer.

Ryan found that larvae at 4,000-feet elevation advanced more rapidly than larvae at either higher or lower elevations. Based on this data, parasite releases should be delayed until mid-September, after which parasites would find some suitable hosts at all elevations.

See also a technical note describing the length of time it takes for casebearer larvae to become active again after over-wintering (47).

Roger Ryan

Parasites of the Larch Casebearer

A total of 240 *Chrysocharis laricinellae* and 513 *Dicladocerus westwoodii* (Hymenoptera: Eulophidae) from Austria and England were released in Washington and Idaho in 1972. This is the first attempted establishment of these parasites in western North America for biological control of the larch casebearer.

This information is found in *Initial Releases of* Chrysocharis laricinellae *and* Dicladocerus westwoodii *for Biological Control of the Larch Casebearer in the Western United States,* by R.B. Ryan and R.E. Denton (48).

For other technical reports on parasites of the casebearer, see publications listed under (49) in the bibliography.

western spruce budworm

Comparison of Western Spruce Budworm Populations and Damage on Grand Fir and Douglas-fir Trees, by V.M. Carolin and W.K. Coulter (50)

The increasing abundance of grand fir in mixed conifer forests of eastern Oregon and Washington may increase the danger of damage from the spruce budworm. This study shows that grand fir is more heavily damaged by the budworm than Douglas-fir. The percent of new growth in grand fir that is defoliated is an indicator of the degree of damage, but bud-killing and top-killing are more meaningful when damage is heavy.

Attractants for Spruce Budworm

Research indicates that a sex attractant of the male spruce budworm of the species *Choristoneura fumiferana* and *C. occidentalis*, is also attractive to the male green budworm, *C. biennis.* A slightly modified chemical attractant is also attractive to the male green budworm, *C. viridis.*

See the paper *Sex Attractants for Two Species of Western Spruce Budworm,* Choristoneura biennis *and* C. viridis *(Lepidoptera: Tortricidae),* by C.J. Sanders, G.E. Daterman, and others (51).

They hope to work into a burning program to duplicate the natural cycle of fires in the area, burning every 7 to 10 years.

Bob Martin, who helped organize this workshop and has also been involved with the experimental burning at Lava Beds Monument, said he especially wanted the students to have field experience in addition to classroom work: "They found out it's not the same as slash burning. You can't hurry burning under a stand and stick to your objectives for flame and scorch height."

And what happened at Walker Mountain? Good fuel reduction was achieved. The younger pines were killed. However, some of the larger lodgepole were also killed in an area that got a little hotter than planned. Conditions for wildlife were improved. Three months after the burn, Volland found deer at Walker Mountain, attracted by their favorite browse—sprouts from the root crowns of ceanothus. "It's like ice cream to them," he said.

end

TRUFFLES BELIEVED VITAL TO FOREST ECOSYSTEM
by Bob Mowrey

Our ideas about truffles, rodents, and trees usually carry old and familiar connotations. Truffles: savory condiment for the wealthy gourmet. Rodents: pests and consumers of the conifer seeds intended for reforestation. Trees: timber, efficiently competitive and towering over all the plants of the forest. However, there is actually a very delicate and balanced interrelationship between many species of fungi, mammals, and plants that is important for the forester to keep in mind.

New insight on how Northwest forest ecosystems function is being gained through integration of information from studies of fungal taxonomy, food habits of small mammals, the nutrient uptake of trees, and the inoculation of conifer seedlings with fungi in nursery experiments. At the Corvallis Forestry Sciences Laboratory of the PNW Station, Dr. James Trappe of the Forest Service and colleague Dr. Edward Trione of the Agricultural Research Service are conducting research on species of fungi which interact with rootlets of plants in a mutually beneficial fashion, called a symbiotic relationship.

Sampling Populations of Western Spruce Budworm and Predicting Defoliation on Douglas-fir in Eastern Oregon, by V.M. Carolin and W.K. Coulter (52)

The western spruce budworm is a serious forest pest in Western United States. Predictions of damage a year in advance are needed, to make realistic plans for direct control. In the Pacific Northwest, the principal hosts—those on which greatest economic damage occurs—are Douglas-fir and grand fir. Emphasis was placed on predictions for Douglas-fir.

Studies were initiated in 1950 to develop methods for sampling the life stages of the insect and estimating defoliation that will occur. Costs were considered, as well as variance of sample estimates, so that efficiency could be used as a basis for recommending surveys at specific life stages. The study area was in the Blue Mountains of eastern Oregon which contained epidemic infestations of the budworm from 1946 to 1959.

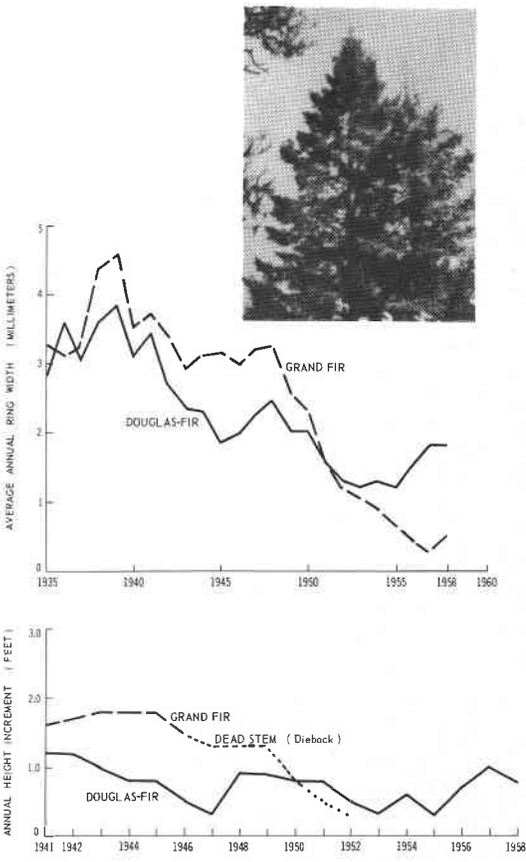
Researchers found that it is possible to predict defoliation with some accuracy. Tables were developed to show egg mass density, corresponding density of larvae in the buds, and the degree of defoliation that will occur. Requirements for surveys during both the egg stage and the bud-mining period are presented, with options as to sampling error survey people are willing to accept.

Differential Effects of the 1944-56 Spruce Budworm Outbreak in Eastern Oregon, by Carroll B. Williams, Jr. (54)

There are differences in the way various trees respond to damage by defoliating insects. The most noticeable differences are usually associated with tree species. For example, the spruce budworm causes most damage to true firs, Douglas-fir, and Engelmann spruce.

The general trend of large larval populations is forest damage by: severe defoliation, reduction of the normal vegetative bud complement, top-killing, reduction of annual growth, and finally, tree mortality.

This study was conducted to determine the differences among grand fir, Douglas-fir, and Engelmann spruce in susceptibility to damage. The study was conducted in 1958-59 in four forest stands in the Wallowa-Whitman National Forest in Oregon. Four case histories are given. The general conclusion is that damage is most severe and most variable on grand fir, intermediate on Engelmann spruce, and least on Douglas-fir and ponderosa pine. Budworm populations may tend to be greater on grand fir than on other species and/or similar populations may do more damage to grand fir.



Annual increment comparisons and a photograph of a heavily damaged grand fir and an adjacent, lightly damaged Douglas-fir which appeared to be competing with each other. The grand fir had the higher growth rate and was rapidly overtaking the Douglas-fir until feedings by spruce budworm killed its top and reduced its growth rate more than that of the Douglas-fir.

Effects of DDT Spraying

What are the effects of DDT on populations of the western spruce budworm? Entomologists studied long-term population trends from 1951 to 1959 at several locations sprayed either in 1949 or 1950 in the course of a large-scale control project. Also, in 1957-60 at other locations they compared densities of associated defoliators and spruce budworm before and after spraying. A special part of their study was to evaluate the effects on parasites of the budworm.

Results indicate that the DDT spraying resulted in effective suppression of the spruce budworm, with only minor and temporary effects on its complex of parasites. Less than 1 percent of the treated area was resprayed and development of DDT resistance seems unlikely. The DDT spray program neither shortened nor extended the duration of the outbreak, but it saved much valuable timber for future use by reducing population levels.

Details are found in *Trends of Western Spruce Budworm and Associated Insects in Pacific Northwest Forests Sprayed with DDT,* by V.M. Carolin and W.K. Coulter (53).

western hemlock looper

Sampling Egg Populations of Western Hemlock Looper in Coastal Forests, by V.M. Carolin, N.E. Johnson, P.E. Buffam, and D. McComb (55)

The western hemlock looper periodically causes severe damage in coastal forests of Oregon, Washington, and British Columbia. Improved survey methods are needed to detect infestations before damage occurs and to express hazard by estimates of egg populations. Cooperative sampling studies by the Forest Service and Weyerhaeuser Co. were conducted in the winter of 1962-63 to improve existing survey techniques.

Results show that the best sampling units for detecting looper infestations are mossy log surfaces and bole sections. Most eggs are laid on moss on roughened bark and flat lichens on smooth bark. The best method for estimating egg populations is to fell the tree and sample the bole at midcrown; this verifies a finding based on studies in British Columbia.

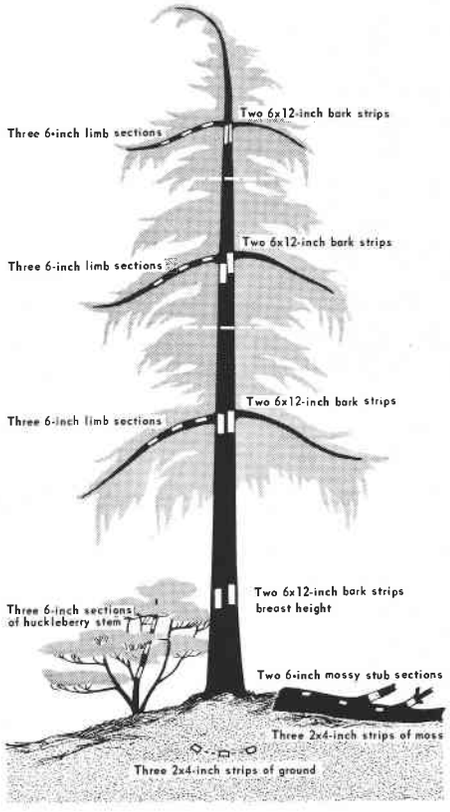
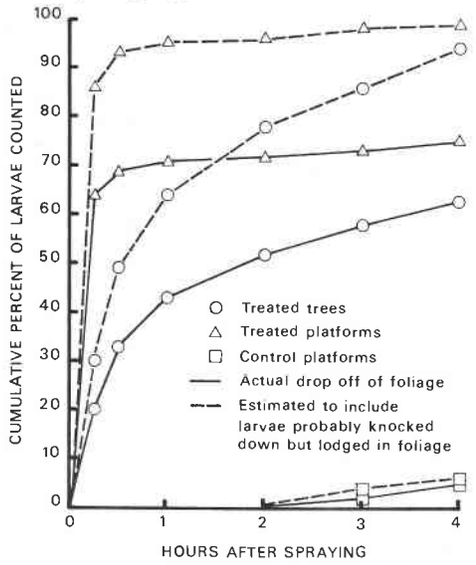


Diagram of sample tree and its understory area, showing location of subsamples.

Controlled Field Test of Stabilized Pyrethrins Against the Western Hemlock Looper, by Richard R. Mason (56)

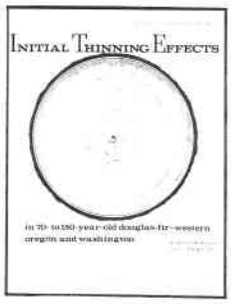
Pyrethrins are natural insecticidal compounds usually extracted from flowers of the pyrethrum plant. They are highly toxic to many lepidopterous defoliators including the western hemlock looper. Moreover, they have a low level of toxicity to mammals and are generally regarded as among the safest of insecticides. However, because of their rapid deterioration in sunlight, previous formulations of pyrethrins have been of little value in controlling forest defoliators.

Recently, a stabilized formulation of pyrethrins has been developed that shows promise of maintaining toxicity in direct sunlight for a relatively long time. It was field tested against larvae of the western hemlock looper by spraying from a helicopter. Larvae were placed in foliage on platforms where they were fully exposed to the spray and on small trees where they were partially screened from direct spray contact. Ninety-nine percent and 94 percent of the larvae on the platforms and on the trees, respectively, were paralyzed or killed by the insecticide. Most of the larvae fully exposed on the platforms were knocked down within a few minutes after spraying, whereas knockdown of larvae in the trees occurred over a considerably longer period of time.



Drop off from foliage and estimated knockdown of hemlock looper larvae in relation to time after spraying.

effects of forest management



Initial Thinning Effects in 70- to 150-Year-Old Douglas-fir—Western Oregon and Washington, by Richard L. Williamson and Frank E. Price (57)

The Douglas-fir beetle rarely attacks trees less than 60 years old. In older trees, mortality may be reduced 60 percent by thinning. This conclusion comes from study of nine areas in western Washington and Oregon. These study areas have been observed for an average of 13 years each. In addition to redistributing growth to fewer, higher quality trees and providing an earlier income, thinning appears to have improved health and vigor of residual trees. This effect is believed to be primarily responsible for the observed reduction of bark-beetle mortality.

The experience of these plots through the 1952, 1959, and 1968 bark beetle epidemics indicates a major advantage of thinning over sanitation-salvage cutting. Thinning can evidently curtail such epidemics in mature young growth and, perhaps more important, drastically reduce normal, endemic, bark-beetle mortality.

Effects of Fertilization

Douglas-fir usually responds to nitrogen fertilization with increased growth and a detectable improvement in foliage color. Forest insect populations can also be affected. For example, nitrogen has been shown to reduce the number of some species of defoliators, bark beetles, and weevils but sometimes stimulates populations of sucking insects.

In Douglas-fir, the Cooley spruce gall aphid is a common and important sucking insect pest of Christmas tree plantations. In this study, entomologists set out to learn what effect fertilization would have on this pest. What they found was mixed—fertilization increased egg laying and winter survival, but aphid establishment was reduced. Two years after fertilization, the population levels were essentially the same on fertilized and unfertilized trees.

See *Field Fertilization of Douglas-fir and Its Effect on* Adelges cooleyi *Populations,* by R.G. Mitchell and H.G. Paul (58).

Russ Mitchell

Nine additional researchers at Corvallis, four scientists and five graduate students, are collaborating with Trappe and Trione in specialized areas of concern with regard to mycorrhizal fungi. Microbiologist Dr. K.C. Lu is studying the kinds of bacteria that surround mycorrhizae in the soil. Plant pathologist Iwan Ho is investigating the enzymes of mycorrhizal fungi and other physiological traits. Botanist Randy Molina is working on the selection and nursery inoculation of mycorrhizal fungi. Microtechnician Darr Duff assists in aspects of analysis and in preparation of fungi for microscopic examination. The graduate students have each designed their own research projects and are further studying the complex characteristics of mycorrhizal fungi.

When the mycelium of a beneficial fungus and the rootlet of a plant combine, they form what the scientists term a mycorrhizal association. Almost all plants, whether grass, forb, shrub, or tree, depend on such an interaction with fungi to survive and develop normally under natural conditions. In fact, in reforestation work most Douglas-fir seedlings die soon after planting if there are no mycorrhizal fungi present in the soil.

At the Corvallis laboratory research is presently underway in cooperation with the Weyerhaeuser Company on inoculation of conifer nursery seedlings with selected mycorrhizal fungi. The goal is to discover which fungi can potentially and dramatically improve the survival and growth of seedlings after outplanting. At the laboratory several thousand seedlings were grown from the seeds of Douglas-fir, ponderosa pine, and western hemlock. The seedlings were grown for about 6 months in containers of vermiculite and peat moss inoculated with mycorrhizal fungi common to the three conifer species. Pure laboratory cultures of four species of fungi were used in the inoculations. Each is widely distributed in western forests.

In the spring of 1976 these seedlings were planted on Weyerhaeuser tree farms near Mount St. Helens, Washington, and Klamath Falls, Oregon. When measurements of seedling survival and growth are completed in 1978, the researchers will be able to better advise foresters which of the four species of fungi show most promise for aiding seedling establishment on comparable sites in the Pacific Northwest. The program on mycorrhizae research is continuing as the researchers seek to discover the most suitable fungi to use in improving reforestation success.

Insects in the Young Stand of Douglas-fir and Hemlock, by R.G. Mitchell (59)

Entomologist Mitchell discusses the situation with regard to insects in young-growth stands—"We're not exactly sure where we're going, but we're getting there awfully fast. We have little experience in dealing with problems in young stands; indications are that the problems of the future will be quite different from those experienced in the past. And intensively managed stands will be particularly vexatious." A quick summary:

Disappearing Problems: Douglas-fir and other bark beetles; ambrosia beetles, flatheads, roundheads, horntails, and other insects that cause degrade in lumber.

Continuing Problems: Insects that feed on needles including spruce budworm, hemlock looper, black-headed budworm.

New Problems: Ants, woolly aphids, needle-mining midges, weevils; cone and seed insects; grubs; mites, cutworms; defoliators; and twig miners.

Disease and Insect Activity in Relation to Intensive Culture of Forests, by Keith R. Shea (60)

Intensive cultural practices influence susceptibility to destructive forest insects and diseases. New forests are being created throughout the world, often with a single native species or an exotic one. Old and new management techniques are being applied with increasing intensity: artificial regeneration of contiguous areas with trees selected for rapid growth or other genetic advantages, fertilization, frequent intermediate cuttings, continuous cropping, and a high degree of mechanization. The effects of these practices upon insect and disease incidence are often unknown or, at best, poorly understood.

In the new, intensively managed forests, insects and diseases will have greater significance. Potentially damaging insects include those affecting twigs, terminal shoots and buds, sucking insects, defoliators, and those feeding in the inner bark and cambial regions. Root rots (including diseases of fine roots), foliage diseases, and stem cankers also are likely to increase in importance as will physiogenic disorders and diseases due to obscure or complex causes. In some cases, seemingly innocuous diseases and insect vectors jointly will create particularly vexing problems.

Broadly based research programs need to accompany development of intensive cultural practices.

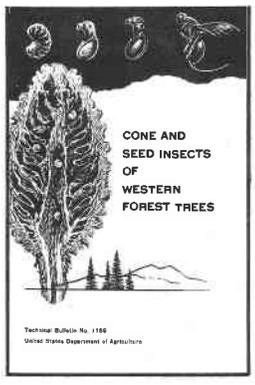
A multidisciplinary research approach is indicated.

The Silvicultural Importance of the Sitka Spruce Weevil in Coastal Oregon and Washington, by K.H. Wright and D.H. Baisinger (61)

The Sitka spruce weevil is a pest of young Sitka spruce in coastal Oregon, Washington, and British Columbia. The weevil attacks the terminals of trees, reducing height growth and deforming the tree. By 1951, the damage had become so severe that a study was undertaken in Clatsop County, Oregon, to evaluate the problem and develop control measures.

Results of the study indicate that hemlock will eventually dominate Sitka spruce in the area studied. The weevil is a major causative factor.

No chemical control measures have been developed for the Sitka spruce weevil. Before such measures can be developed, more information regarding the biology and habits of the insect is needed.



Cone and Seed Insects of Western Forest Trees, by F.P. Keen (62)

Published in 1957, this 168-page book is still an authoritative source of information on cone and seed insects even though more recent work has been published.

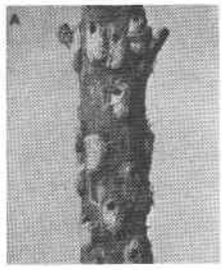
Insects that destroy the seeds of forest trees have an important bearing on reforestation. If a high percentage of a seed crop is destroyed in any year, seed collecting may be unprofitable, and nursery establishment and planting will be greatly hampered. Also the loss of seed may seriously threaten the natural reestablishment of commercially valuable tree species on burned or cutover lands, where timing of seeding may be highly critical.

The book has two main topics: (1) a discussion of the western forest trees and a listing of the cone and seed insects which attack each, and (2) a review of the biology and habits of the cone and seed insects and their insect enemies. Additional information is given on control of the insects and needs for further study.

Susceptibility of 10 Spruce Species and Hybrids to the White Pine Weevil (Sitka Spruce Weevil) in the Pacific Northwest, by R.G. Mitchell, N.E. Johnson, and K.H. Wright (63)

Ten different species and hybrids of spruce were studies on 3 plots for some 16 years to determine their growth rate and susceptibility to the white pine weevil in coastal Oregon and Washington.

The conclusion is that both Norway spruce and Lutz spruce (a natural hybrid of white and Sitka spruce) grow well in the coastal environment. However, because of its low susceptibility to weevil attack, Lutz spruce is a more promising replacement for the heavily weeviled Sitka spruce. Norway spruce was very susceptible to the weevil. Lesser damage was also observed on black spruce, white spruce, and Engelmann spruce.



Damage to Sitka spruce by Pissodes strobi. *A. Weevil larvae mine down the terminal shortly after bud burst and, in midsummer, form pupal cells under the bark at the end of the mines.*

B. New growth arising from attacked terminal dies and starts to droop when the mining larvae grow large enough to sever conductive tissue.

C. Multiple tops often develop when laterals below the killed terminal assume dominance.

D. Killed terminals overgrown by laterals-turned-to-leaders result in poor stem form and decreased wood quality.

control, aerial application techniques

Aerial Photographic Techniques for Estimating Damage by Insects in Western Forests, by J.F. Wear, R.B. Pope, and P.W. Orr (64)

A manager, responsible for administering forest lands, needs to keep a constant check on the status of the forest resource and the changes that have taken place, or are likely to take place. Among the kinds of information he needs is that on the damage caused by forest insects. Such knowledge may affect his decisions on the amount of allowable cut, his plans for the orderly harvest of timber, the salvage of dead or damaged material, and the control of insect outbreaks.

Keeping track of this damage is usually a difficult and expensive task because the mortality is typically scattered in erratic fashion over vast and often inaccessible areas. Often, excessively high costs can be avoided by using aerial photography, which covers ground more quickly and cheaply than fieldwork, yet provides a permanent in-place record of certain kinds of damage. This manual summarizes the present state of knowledge in this field and presents step-by-step procedures for the best known applications of aerial photography to forest insect surveys in the West.

Users should try to get an original copy of this report, as there are several color plates that black and white will not do justice to.

Aerial Applications of Insecticides on Forests in the United States, by Charles Sartwell and David Alligood (65)

Part of a study on pest control for the National Research Council, this report gives information on the forest areas sprayed for various pests from 1945-1974, the acreages sprayed, the chemicals used, and the target species.

Bohdan Maksymiuk

Kinetics and Physics of Pesticidal Aerial Sprays, by Bohdan Maksymiuk (66)

Fundamental knowledge of the kinetics and physics of sprays is essential for improving aerial application of pesticides. Spray kinetics deals with production of spray drops, while spray physics deals with spray behavior, pattern of dispersal, and deposition. Effectiveness and safety of aerial application of pesticides depends on maximum target coverage with minimum dose and spray volume, and reduction of drift hazards.

Factors affecting target coverage and spray deposit assessment are discussed. Improved aerial application technology will result in more efficient distribution of insecticide on the plant, which in turn, will mean a more favorable cost-benefit ratio for the pest control programs.

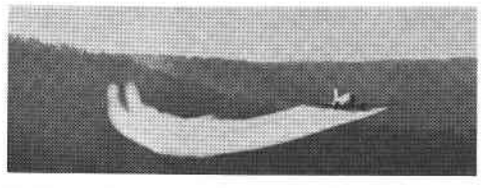
Zectran for Spruce Budworm Control

Mexacarbate, or Zectran[R], has been recommended by the U.S. Forest Service as a replacement for DDT for control of the western spruce budworm, the spruce budworm, and jack pine budworm. (Unfortunately Zectran is no longer available as it is not being produced commercially.) Mexacarbate is considered environmentally safe, but past field trials often produced results too erratic for operational use against the western spruce budworm.

In tests with mexacarbate, the erratic and occasionally low spruce budworm mortalities have been hypothesized to be the result of variable and insufficient target coverage. To test this hypothesis, we conducted a detailed investigation, under typical field conditions during a large-scale pilot-control study, using mexacarbate against the western spruce budworm in northern Idaho.

This paper reports droplet size spectra of deposits at the forest floor level, deposit coverage of the forest canopy, quantity and variation of deposit distribution reaching the forest floor, and correlation of spray deposit on tree foliage with the larval mortality.

See the very technical report *Distribution of Aerially Applied Mexacarbate in a Coniferous Forest and Correlation With Mortality of* Choristoneura occidentalis *(Lepid., Tortricidae),* by Maksymiuk, Neisess, Waite, and Orchard (67).



C-47 applying mexacarbate in study area showing spray cloud.

In the mycorrhizal association, the fungus aids the tree in absorbing nutrients and water, protects it from harmful fungi, and produces growth regulators that foster increased growth while prolonging the life of the rootlets. The fungus forms a protective mantle around the rootlets and in return gains carbohydrates and other photosynthetic products from the tree.

In the Northwest there are more than 2,000 species of fungi which form mycorrhizae with Douglas-fir alone. The fruiting bodies of most of these fungi are the common fleshy mushrooms found on the surface of the ground under host trees. However, several hundred species bear fruiting bodies which develop entirely underground; these are the truffles and false truffles.

While mushrooms normally reproduce by sending out their spores on the wind, truffles depend on small mammals to eat them and transport their spores to new locations. Deer will also eat truffles, but primarily it is the small rodents that consume them in the Northwest. When mature with spores, truffles take on a distinctive odor which enables the animals to locate them.

Truffles come in many colors: delicate shades of white, yellow, brown, blue, green or red. They are from 1 to 4 inches in diameter, or may be even smaller, and look like little wrinkled potatoes.

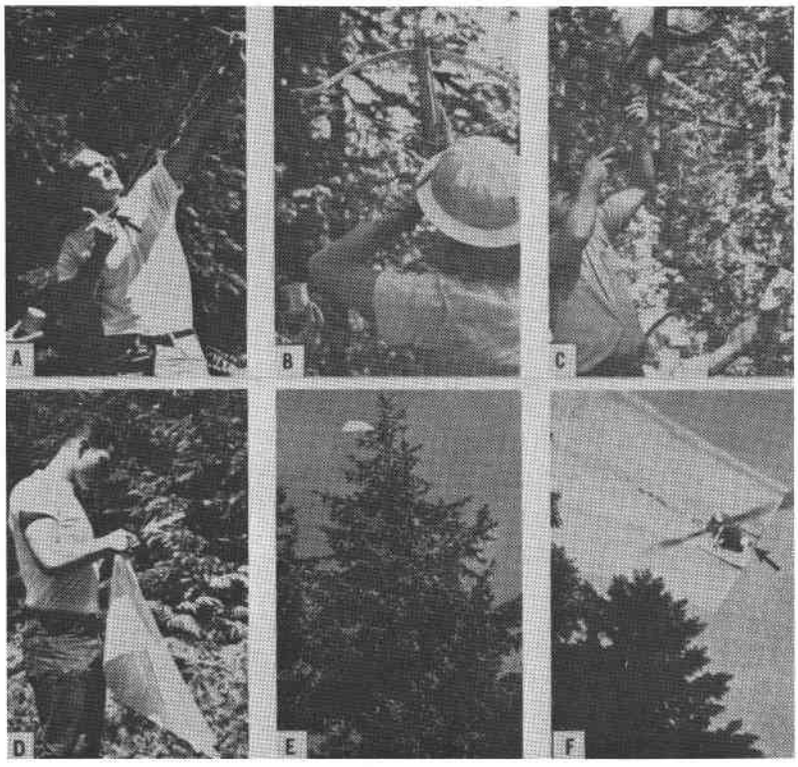
For years, Northwest foresters have looked upon small rodents as highly detrimental because most of them eat the seeds of conifers, which hampers reforestation attempts. However, Trappe's research provides us with a different perspective. Working in collaboration with BLM biologist Chris Maser, Trappe examined the stomach contents of over 500 small rodents of 25 different species and found that fully 80 percent of them took some fungi in their diets. Some of the squirrels, chipmunks, mice, and voles, in fact, feed extensively on truffles. Trappe contends that this interaction between truffle and animal is actually an extremely important ecological relationship.

The ecosystem benefits from the fungus-animal interaction. When eaten, the truffle is digested except for the spores. After passing through the animal's digestive tract, the spores are still viable when deposited in the fecal pellets. As the animals move about

Marking Methods for Improving Aerial Application of Forest Pesticides, by Bohdan Maksymiuk (68)

Markers that are readily visible to the pilot are essential for proper identification of the boundaries of treatment areas and spacing of application swaths. They increase accuracy, efficiency, and safety of aerial application of pesticides and other materials.

Methods for placing marking panels in the treetops are described. The slingshot and crossbow methods are satisfactory for marking trees under 100 feet in height. The line-throwing gun can be used for marking trees up to about 150 feet tall and possibly taller, depending mainly on the load of power charges, ballistics of missile, weight of line, and firing angle. Helium-inflated balloons, protruding above the forest canopy, also are useful navigational aids. Other marking methods are also described and reviewed.



Marking trees from the ground: Projectiles (sinker, bolt, missile) attached to the monofilament line are catapulted over the treetop with the slingshot (A); crossbow (B), and line-throwing gun (C); projectile is removed and the line attached to the marking panel (D); hoisted panel is shown in treetop (E); a pair of captive helium-inflated balloons (F) can be seen above the treetops (in shadow of the helicopter).

How to Minimize Drift of Pesticidal Sprays, by Bohdan Maksymiuk (69)

Drift from herbicides and insecticides poses a potentail hazard to non-target organisms and increases residue problems in plants, animals, air, and water. In general, the potential drift hazard is greater from aerial application of herbicides (such as 2,4-D, 2,4,5-T, and amitrole) than from insecticides because of the chemical nature of herbicides and their patterns of use.

The quantity and extent of drift can be reduced by a combination of several interrelated factors such as spray formulation, equipment, and atomization, meteorological factors, and spraying method. Research for developing effective and safe technology for aerial application of herbicides in forestry is lagging behind that for aerial application of insecticides.

Bell Helicopter Evaluated

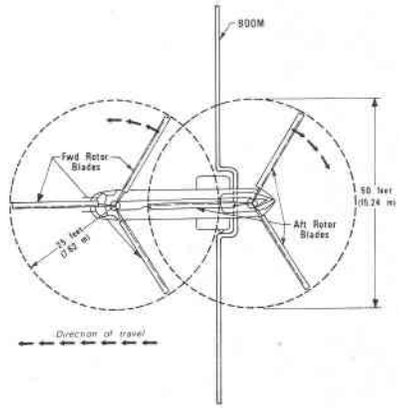
The atomization and distribution of insecticide sprays produced from a Bell 205A-1 turbojet helicopter and spray system were evaluated. The degree of atomization was within the same range as that produced by the smaller helicopters, and the acceptable swath width was wider. In some flights there were two very high deposit peaks similar to that produced by a fixed-wing aircraft spraying at a low height above the ground. By visual observation, the main rotor vortexes appeared stronger and more pronounced than those of smaller helicopters. On a large forest spray program, the Bell 205A-1 sprayed an average of 877 acres per hour at an application rate of 1 gallon per acre for a cost of $1.78 per acre.

This information is found in a research note, *Evaluation of the Bell 205A-1 Turbojet Helicopter and Spray System for Forest Application of Insecticide,* by Richard D. Orchard and others (70).

Boeing Helicopter Evaluated

The distribution of insecticide sprays produced from a Boeing-Vertol 107 helicopter and spray system was evaluated. The Vertol produced a spray pattern similar to that of other helicopters and was found suitable for forest spraying. The swath width varied with the nozzle arrangement on the boom. The outboard nozzle arrangement resulted in the widest acceptable swath width, the lowest deposit across the swath, and the lowest spray recovery. The inboard nozzle arrangement resulted in a moderate swath width, the highest deposit across the swath, and the highest percent spray recovery.

For details, see the report: *Evaluation of the Boeing-Vertol 107 Helicopter and Spray System for Forest Application of Insecticide,* by Richard D. Orchard and George P. Markin (71).



Schematic showing the horizontal position of the forward and aft rotors relative to the boom.

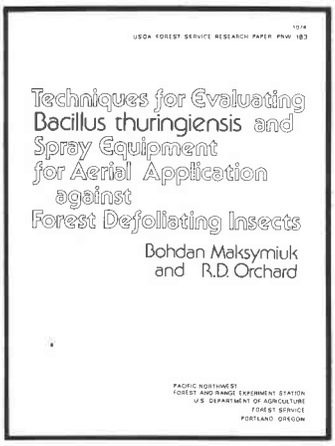
Virus Developed for Insect Control

In 1976, a naturally occurring virus was registered by the Environmental Protection Agency as a potential control method for the Douglas-fir tussock moth. Registration followed some 12 years of work at the Forest Service's Forestry Science Laboratory in Corvallis.

There, scientists conducted extensive basic studies that meant first, developing techniques to raise tussock moths in the laboratory, and identifying the natural microbial enemies (viruses and bacteria) which attack the tussock moth at various stages of its development. Scientists also established procedures for mass production and purification of the virus and demonstrated its safety to nontarget organisms.

Experiments have also been conducted to test aerial sprays of the virus, and to learn more about the natural effects of the virus on tussock moth populations in the woods.

A general article on the virus work is available (72). Additional technical notes are listed in the bibliography (73).

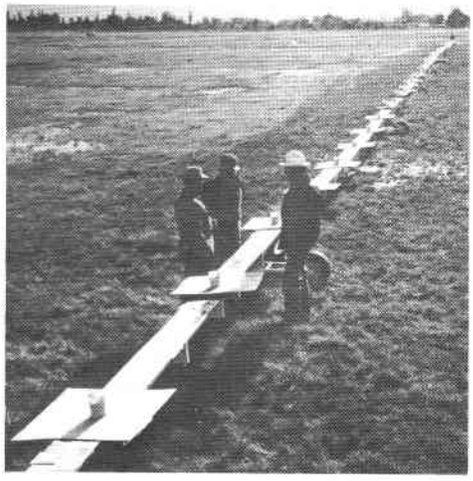


Techniques for Evaluating *Bacillus thuringiensis* and Spray Equipment for Aerial Application Against Forest Defoliating Insects, by Bohdan Maksymiuk and R.D. Orchard (74)

The U.S. Forest Service has recently become interested in the possible use of the microbial insecticide *Bacillus thuringiensis* (*B.t.*) as a replacement for DDT against two major western defoliators, the Douglas-fir tussock moth and the western spruce budworm.

This paper describes techniques and presents results of a study conducted in 1972 to evaluate the performance of Dipel and Thuricide spray formulations and spray equipment for increasing the effectiveness of aerial applications to control forest defoliating insects. The Douglas-fir tussock moth and the western spruce budworm were used as test insects.

The selected formulations and spray equipment performed satisfactorily. A 100-foot swath width is recommended for field use for a small, fixed-wing aircraft equipped with a conventional spray boom and nozzles. Results indicate that *B.t.* has a high potential for control of the Douglas-fir tussock moth and the western spruce budworm.

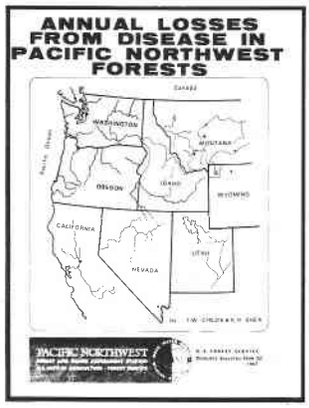


Rotating platform for sampling aerial sprays.

For other, quite technical, publications on insect research, see reports listed in the bibliography (75).

tree diseases

impacts



Annual Losses from Disease in Pacific Northwest Forests, by T.W. Childs and K.R. Shea (76)

Diseases rank with insects and fire as a major cause of damage to western forests. Annual loss from disease in Oregon and Washington was estimated at 3,133 million board feet or 403 million cubic feet in 1967.

A majority of the damage occurs west of the Cascades (234 million cubic feet), with most of the loss from heart rots. East of the Cascades, dwarf mistletoes account for more than half of the estimated annual loss of 169 million cubic feet.

The greatest damage occurs in Douglas-fir, western hemlock, true firs, and ponderosa pine. Most damaging diseases are dwarf mistletoes, root rots, and heart rots.

Researchers have found that losses are about equally divided between young and old growth. But as young stands replace old ones, the damage from heart rots will decrease, and growth-reducing diseases, such as dwarf mistletoe and root rots, will be more of a problem.

For more up-to-date information on both insect and disease pests in the Pacific Northwest, see the *Forest Pest Condition* reports published by the Pacific Northwest Region of the Forest Service. These are published every year and indicate the status of both insect and disease pests, and other damaging factors such as weather or air pollution.

Copies may be obtained by writing to:

Deputy Regional Forester
State and Private Forestry
U.S. Forest Service
P.O. Box 3623
Portland, Oregon 97208

within their ranges, they enter new clearcuts, burned-over areas, and other disturbed sites in their explorations for food, water, cover, and new areas for territorial occupation. In this way, they serve to inoculate new ground with spores of mycorrhizal fungi, thus preparing the way for seeds that fall later—either naturally or when the forester casts the seeds over the land.

Rain washes the spores into the soil where they germinate and form mycorrhizae with the rootlets of a seedling, ensuring the survival of both. Often, the seed falls on a spot where some plant is growing already, and so the seedling is at a competitive disadvantage from the start. However, if spores of a mycorrhizal fungi are there, the seedling gains a significant advantage in its competition for survival.

Dr. Trappe is project leader for the Tree Root Symbiosis Program at the Corvallis laboratory and is considered to be an international expert on truffles. In his taxonomic work he has classified and named many new species. Trappe and Trione are on joint appointments to Oregon State University through the U.S. Forest Service and have extended their research efforts into several interesting aspects of truffles. They are studying the effects of truffle fungi on tree growth, working to isolate different truffle species, and investigating the feasibility of producing them commercially as a new forest product.

end

ENTOMOLOGISTS IN ALASKA
by Thomas Michael Baugh

Two men, working more than a thousand miles apart, are involved in some of the most exciting forestry research in Alaska. Richard "Skeeter" Werner, a staff member at the Institute of Northern Forestry in Fairbanks, and John Hard, of the Forestry Sciences Laboratory in Juneau, are Forest Service entomologists. Their work involves millions of acres of forests, populated with all of the unknowns that a researcher could want.

In many ways the world of the Alaskan forests remains an enigma. For example, Werner points out that in 1975, thousands of acres of larch were defoliated in Alaska's interior region, south of Fairbanks. The insect which caused the defoliation has not been identified. This is just one of many unknowns facing researchers.

dwarf mistletoes

Getting the Jump on Dwarf Mistletoes

Dwarf mistletoes, just like the kissing kind, are parasites which get their nutrients from the tree on which they grow. In contrast to the kissing mistletoes, however, they grow on softwood trees (conifers) instead of hardwoods.

Mistletoes occur on branches or stems of their host trees. They are attached by a modified root or absorbing system inside the host tissues. Serious infections of mistletoe can result in loss of growth or deform and kill a tree.

Mistletoes are known for their unique seed dispersal system. On ripening, the berries develop an internal pressure, which cause them to explode and eject the seed upward and outward. The seeds are literally "shot" from the plant. Seeds may be propelled 30 feet or more!

Most of the Station's research on dwarf mistletoes has been on biology and ecology. New papers (not listed here) deal with biology and biological controls including discussion of the infection process and the effect of urea on infected ponderosa pine.

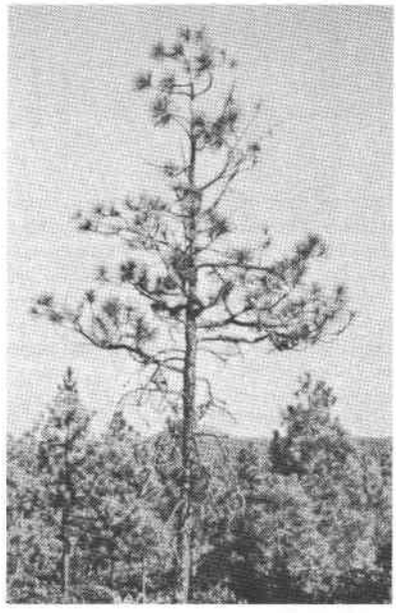
Occurrence of Dwarf Misteltoe in Sanitized Ponderosa Pine in South-Central Oregon, by Keith R. Shea and David K. Lewis (78)

Pruning from the bottom to control dwarf mistletoe did not work very well in a 10-year study begun in 1957 in south-central Oregon.

The study was conducted in a dog-hair thicket of ponderosa pine which was very suppressed and heavily infected with dwarf mistletoe. (There were about 5,000 trees to the acre.) The reason pruning didn't work very well is that there were just too many latent infections. You can trim off all the infected branches and still have infections in the early stages of development.

Scientists also noted that:

- The incidence of latent infections was correlated with the amount of mistletoe in the stand. Only 46 percent of the trees that looked disease-free were actually free of mistletoe infections. This was in very dense stands. In less dense stands, more trees would be disease-free.
- Most latent infections appeared within 5 years. A second thinning at that time would reduce stand infection to insignificant levels.
- Chemical eradicators might be used to stifle growth of competing trees and enable the larger ones (usually the most heavily infected) to grow faster.
- In this study, researchers pruned from the bottom. A better system might be pruning from the top. See next discussion.

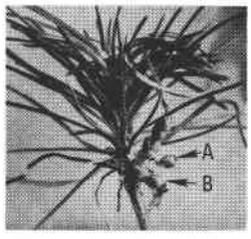


Ten years after thinning without dwarf mistletoe control, infection has increased to damaging proportions.

Dwarf Mistletoe Reduces Root Growth of Ponderosa Pine Seedlings, by Donald M. Knutson and W. Jay Toevs (77)

Dwarf mistletoes damage forest stands by causing mortality and reducing growth. This paper sheds light on one aspect of that —the effect of mistletoes on the roots of ponderosa pine seedlings.

Earlier studies (1916) had indicated that roots of heavily infected Douglas-fir, western larch, and ponderosa pine were weakened and badly decayed. But what is the effect at the seedling stage? To find out, scientists inoculated ponderosa pine seedlings with a single seed of dwarf mistletoe. At the end of 2 years, the roots of the trees were significantly shorter and lighter in weight, and fewer in number than the roots of normal seedlings. Results indicate that infected seedlings in natural stands are at a competitive disadvantage for soil moisture and nutrients and will be snuffed out at an early age.



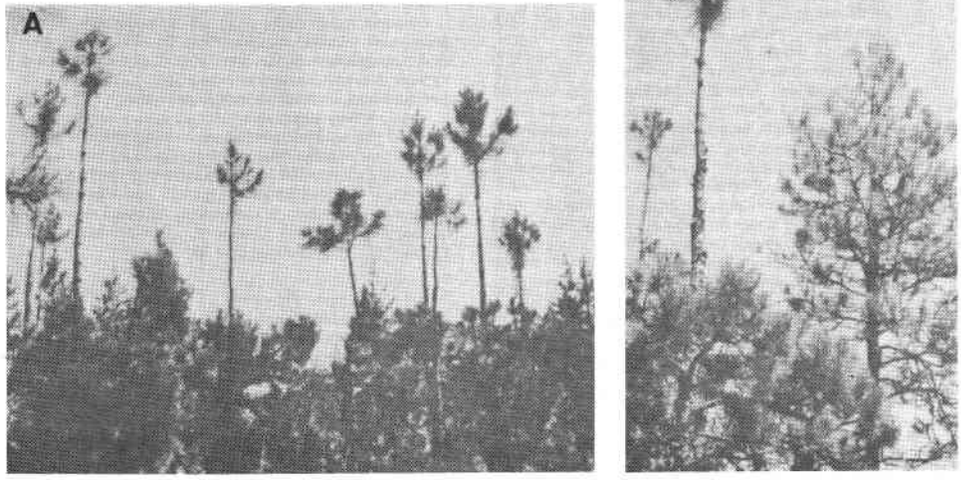
The dwarf mistletoe seed (A) and the resulting aerial shoots (B) are visible.

Dwarf Mistletoe-Infected Ponderosa Pines Survive Top-Pruning, by Donald M. Knutson (79)

Another approach to pruning for mistletoe control in ponderosa pine was dreamed up by Walt Knapp, a forester formerly with the Ochoco National Forest. Knapp and Don Knutson teamed up to test the following method—which worked:

1. Prune all the branches from the top of the tree.
2. Allow the leader to grow and reestablish new branches.
3. Then prune off the lower branches to rid the tree of all its mistletoe.

Top pruning is an additional stress on the tree, and the dryness of the site will probably affect survival. This study was done on a typical ponderosa pine site in Oregon, where precipitation is about 22 inches a year.



(A, left) Top-pruned ponderosa pines 3 years after treatment, showing new top growth and skirt foliage. (B, right) Contrast of foliage of top-pruned tree (left) and infected, unpruned tree (right).

Dwarfmistletoe Effects on Ponderosa Pine Growth and Trunk Form, by T.W. Childs and J.W. Edgren (80)

Dwarf mistletoe reduces the height growth of a tree even more than it reduces diameter growth. As a result, foresters have probably used the poor growth of the tree as an indicator of poor site quality. Actual site quality may be higher than previously thought.

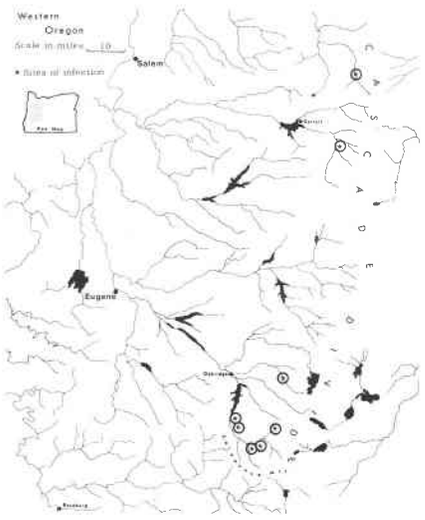
Don Knutson

Douglas-fir Dwarf Mistletoe is West of the Cascade Divide, by Robert O. Tinnin and Donald M. Knutson (81)

The potential exists for an outbreak of dwarf mistletoe in Douglas-fir on the west side of the Cascades. Until this paper, dwarf mistletoe had been reported only twice on Douglas-fir on the west side. Authors Tinnin and Knutson located an additional seven sites scattered along the west slope. The mistletoes were actively producing seed and young Douglas-fir were being infected.

Three factors are important in spread of the disease: stand density, stand composition, and fire. These appeared to be important at the infection sites on the west slope of the Cascades. The stands are relatively open and Douglas-fir is the major canopy species. Mistletoe thrives under such conditions. In addition, fire has been important at some of the west-side sites.

The researchers predict that dwarf mistletoe will become more of a problem in Douglas-fir on the west side as more and more forest stands are ''opened-up'' by roads, recreation areas, and other forest management activities.



Sites of infection.

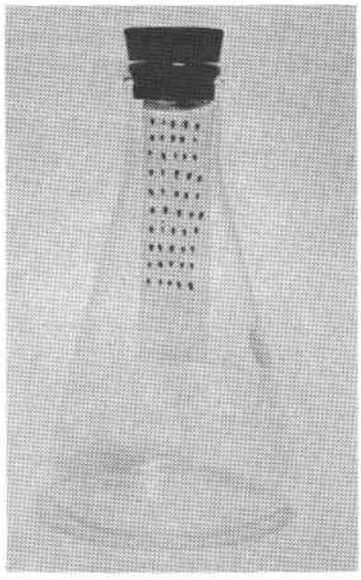
Dwarf Mistletoe Infection from Residual Western Hemlock on Cutover Stands, by J.L. Stewart (82)

Dwarf mistletoe thrives where infected trees protrude above the surrounding forest canopy. Early removal of the infected ''whips'' is important to dwarf mistletoe control. In this study, researchers noted that a high percentage of young western hemlock (trees 15 years old) were infected within 30 feet of the whips. If the stand is less than 10 years old, however, infection should be less than 10 percent.

It makes good sense to destroy all whips when infected stands are clearcut.

Dwarf Mistletoe Seed Storage Best at Low Temperature and High Relative Humidity, by Donald M. Knutson (83)

Most foresters would like to get rid of mistletoe, but for research purposes, it is necessary to grow it in order to study it. Researchers working with dwarf mistletoe in the laboratory need to inoculate conifer hosts (small trees or branches) with mistletoe in order to conduct lengthy laboratory procedures.



Method of storing dwarf mistletoe seed at constant relative humidities.

Previously, this couldn't be done because there was no good way to store the seed year-long. It was just too short-lived. The seed can now be kept viable year-long using a technique which combines optimum temperature and humidity. The best germination occurred when seeds had been stored at 1° C., with 75 percent humidity. Germination was 94 percent at 5 months, 80 percent at 10 months, and 58 percent at 15 months.

For a similar discussion, see also: *Infection Techniques and Seedling Response to Dwarf Mistletoe,* by Donald M. Knutson (84).

Werner and his coworkers at the Institute of Northern Forestry are in a unique position to make significant contributions to knowledge of the forest ecosystem of interior Alaska. They are currently working on a series of studies about epidemics of the spear-marked black moth. During the past 2 years, this moth has raged throughout the interior, defoliating millions of acres of birch. The damage has been so extensive that the brown and golden colors of the hard-hit trees make it appear that fall exists year round.

Werner points out that there have been periodic outbreaks of defoliators for as long as records have been kept and that these insects usually hit millions of acres because of the homogeneous nature of interior timber stands.

Research on the spear-marked black moth is progressing. So far, life history studies have identified four larval stages. The pupae develop in the forest duff and emerge as adults during June. A virus, two fungi, and a bacterium have been found to kill 80 to 90 percent of the third and fourth instar larval stages, and parasites have killed up to 95 percent of the pupae. The identification of these agents holds promise for natural control methods. Werner and his colleagues at the Institute of Northern Forestry assume that hardwoods will become economically important in the future in interior Alaska, and for this reason they are accelerating their research on the insects that attack hardwood trees.

Werner emphasizes the important natural role insects play in the maintenance of the forest. Insects, for instance, add to nutrient cycles. Leaf parts and waste drop to the forest floor by the ton, contributing to the slowly decomposing mass of the forest duff and the nutrient cycle. In addition, birds, yellow jackets, and hornets feed on the moths and act as natural controls.

Until recently, the spruce bark beetle had received the most study in interior Alaska. Entomologists now feel that proper management of forests will help counteract the destructive effects of this forest pest. They have found that the beetle populations expand in areas where untreated slash remains on the ground. Treatments of slash and other residues will significantly reduce the beetle problem.

white pine blister rust

Spread of White Pine Blister Rust from *Ribes* to Sugar Pine in California and Oregon, by James W. Kimmey and Willis W. Wagener (85)

This 71-page pamphlet was published by USDA in 1961, but it is still an excellent summary of the blister rust problem and reasons for its spread.

Blister rust is a severe disease of white pines the world over. It is caused by the fungus *Cronartium ribicola* which spreads in pine forests by way of an alternate host—the wild gooseberry or *Ribes* bush. It attacks all five needle pines, and is especially damaging to sugar pine. In fact, foresters have all but given up on sugar pine as a species for commercial timber production because of the disease.

Blister rust was once controlled by eradicating the gooseberry bushes. Eventually this was judged to be ineffective, or at least too costly, and is no longer being done.

Field tests were conducted between 1935 and 1950 at two locations in southern Oregon and four in California to determine just how blister rust spreads. A total of 56 tests were made on 21 plots. Spread of infections from these sites was erratic. Researchers found that blister rust spreads only under conditions that are favorable to survival of the fungus—generally with adequate moisture being the most important condition. Forests are especially vulnerable to attack and spread of the fungus when weather conditions are humid, where dewfall is heavy at night, or near places of higher than average soil moisture—as along meadows, stream bottoms, or other wet places.

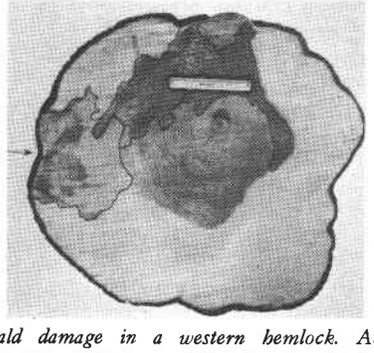
Decay Following Logging Injury to Western Hemlock, Sitka Spruce, and True Firs, by Ernest Wright and Leo A. Isaac (87)

Have you ever run an autopsy (treetopsy?) on a forest tree? That's what two former PNW researchers did to learn more about the diseases that sometimes occur when trees are injured during logging.

The scientists studied the frequency and amount of decay associated with logging injury on western hemlock, Sitka spruce, and the true firs—grand fir and Pacific silver fir. What they found was—in scientific terms—about as complicated as the physicians' names for a liver ailment or heart conditions—diseases like *Fomes annosus, F. pinicola, Armillaria mellea, Ganoderma oregonese,* and some they couldn't identify.

Most important (by common name) were *Fomes* root and butt rot, stereum rots, and brown crumbly rot. All in all 20 different fungi-causing rot in western hemlock were identified, 11 in Sitka spruce, and 8 in the true firs. Trees were also subject to sunscald, windfall, and breakage.

The publication provides information on the probability of occurrence of decay and its rate of spread after logging injury. Data can be used to estimate how much logging damage can be tolerated in a timber stand and to decide what cutting practices will keep injury within allowable limits.



Sunscald damage in a western hemlock. At left (arrow), the cambium was killed by sunscald. Logging scar (above ruler) was invaded by Fomes annosus.

Eliminating Blister Rust Cankers From Sugar Pine by Pruning, by G.L. Hayes and William I. Stein (86)

This publication results from a study conducted about 1952 in the South Umpqua Experimental Forest. The study was a special effort to see if blister rust infections could be removed from understory sugar pine in a two-story forest—one with well-stocked patches of vigorous young sugar pine coming up beneath deteriorating old-growth. Unfortunately, the sugar pine was infected with blister rust! Researchers wanted to save the advance growth rather than cut and replant. So they tried pruning the young trees to get rid of the blister rust.

In this case it worked. Ninety-five percent or more of the visible blister rust cankers were removed. Costs were reasonable. It would probably work again under similar conditions.

Additional publications on blister rust may be obtained from the Intermountain Forest and Range Experiment Station: 507 25th Street, Ogden, Utah 84401.

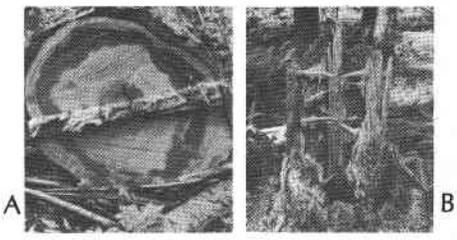
phellinus (poria) weiri

Laminated Root Rot of Douglas-fir in Western Oregon and Washington, by T.W. Childs (88)

Laminated root rot, caused by the fungus *Poria weirii,* damages many conifers in the Pacific Northwest, especially Douglas-fir west of the Cascade Range in Washington and Oregon. It attacks trees of all ages but is most destructive in stands from about 25 to 125 years old.

Poria not only damages trees, it kills them. The disease spreads through the roots of the trees, often moving from roots of infected older trees to roots of young trees. Young trees that are infected seldom live long enough to have their growth reduced. In old-growth stands, where trees are killed more slowly, the disease is less common and decay usually extends only a few feet into butt logs.

It is not yet possible to control laminated root rot, but its economic impact can be reduced by the management practices recommended. This paper summarizes results of research during the past twenty years (published in 1970).



A, Cross section of Douglas-fir base showing incipient and typical decay caused by Poria weirii*; B, base of tree killed many years ago, showing persistent branch bases.*

Invasion of Freshly Cut Douglas-fir Stumps by *Poria Weirii,* by Earl E. Nelson (89)

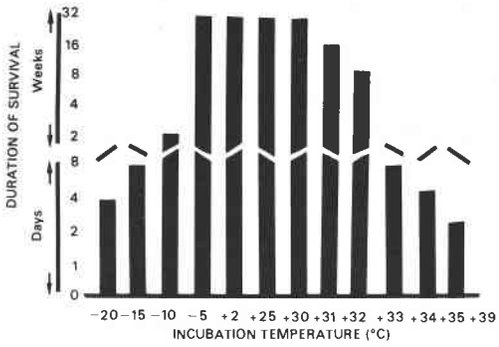
Research has already shown that *Poria* can infect trunk wounds of conifers. If this could happen on stumps, it could greatly accelerate spread of the disease in thinned Douglas-fir plantations. A study was begun in 1967 to learn more about this possibility.

From results of this study, it looks as though spores of the fungus may not penetrate freshly-cut stumps. But the researchers were able to consistently produce the disease by placing the mycelia (vegetative growth) of the fungus on stump surfaces. Under these conditions, the mycelia of *P. weirii* can grow downward at least 12 inches a year—fast enough to enter main roots of thinned tree stumps in a year's time.

Thermal Tolerance of *Poria weirii*, by E.E. Nelson and H. Fay (90)

Soil temperature is probably not a direct factor in determining the survival of *Poria weirii.* In laboratory studies, *P. weirii* survived 32 weeks at temperatures between −5 and +30° C. Although extreme hot or cold can be lethal to the *Poria,* these temperatures are not common deep in the soil where the fungus thrives.

Future research will concentrate on the effects of temperature on *P. weirii*-soil microbiological relationships rather than on effects on the fungus itself.



Survival of Poria weirii in alder sections.

Earl Nelson

Observations on the Formation of Zone Lines in Wood by *Poria Weirii*, by E.E. Nelson (91)

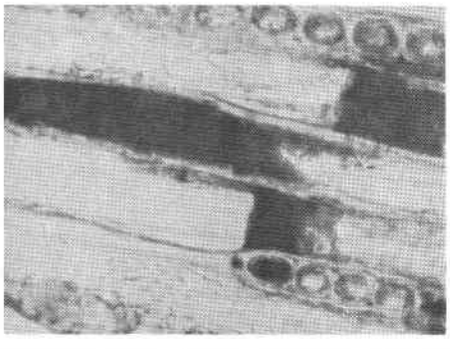
A fairly technical, but fascinating, paper that describes the formation of zone lines in wood infected by *P. weirii.* Under the microscope, zone lines appear as dark lines in cross sections of wood. Although they look like lines, they actually envelop the active fungal colony. They apparently protect the fungus from drought and serve as a barrier to keep antagonistic microorganisms from crossing the lines.

Research may help eventually in developing biological controls for the disease. So far, Nelson has found the following:

1. Zone lines can be formed in 30 days or less under temperature conditions normal in forest soils during most of the year.

2. The protective zone lines will not form in buried wood at temperatures above 15° C.

3. Where microbial competition is absent and other factors are favorable for *P. weirii,* it does not form zone lines.



Microscopic section showing composition of P. weirii zone line.

Estimating Spread of *Poria weirii* in a High-Elevation, Mixed Conifer Stand, by E.E. Nelson and T. Hartman (92)

Aerial photographs can be used to measure the rate of spread of *Poria weirii* in high-elevation forests. Aerial photographs used for this study were taken in 1946 and 1972 in the vicinity of Waldo Lake in the Willamette National Forest. The forest is dominated by an overstory of mountain hemlock, a species very susceptible to *P. weirii.*

The infection centers show up on aerial photographs as irregular rings that are lighter in color than the surrounding forest, and are easy to measure.

During the 26 years between the two sets of photographs, the disease spread at the rate of about 13½ inches per year (radius of the infection).

Examination of aerial photographs can help in making management decisions where *Poria* is a problem. For example, planners would want to avoid putting campgrounds near *Poria* centers because of the increased danger of falling trees.

Survial of *Poria weirii* in Wood Buried in Urea-Amended Forest Soil, by E.E. Nelson (93)

Studies indicate that urea may affect survival of *Poria weirii. Poria* infections failed to survive in wood cubes that had been buried in soil mixed with urea.

What happened (see also item 90) apparently was that the urea stimulated antagonistic microflora which invaded the *Poria*-colonized cubes before zone lines (adequate defenses) could be formed. The fungus did not survive in cubes without zone lines.

A common forest fertilizer, urea is high in Nitrogen (46 percent). Earlier work had shown that both NO_3 and NH_4 forms of nitrogen are effective in reducing *P. weirii* under laboratory conditions.

The situation is different in southeast Alaska. There, the research emphasis is on the black-headed budworm and the hemlock sawfly. Between 1950 and 1955, the budworm was responsible for the defoliation of 9 to 10 million acres of spruce forest in southeast Alaska.

John Hard, entomologist with the Forestry Sciences Laboratory in Juneau, says that the focus of the budworm and sawfly research has been the biology and population ecology of the two species. The most significant effect of both defoliators is reduction in the growth of affected trees and some top kill. In several cases, all parts of the tree were killed.

Hard points to several factors that help control these forest pests. For example, the sawfly and budworm in southeast Alaska are living near the northern limit of their range where conditions are less than ideal. Hard feels there may be a relationship between weather and insect outbreaks. He and Bill Farr, a research forester, are analyzing weather data from 50 to 60 stations in coastal Alaska. The weather data will be used to establish climatic zones to see how these zones compare with the areas where the risk of insect attack is high.

The main research effort involves identification of natural controls and their interaction. Hard says that parasites and fungi, acting together with the cool, moist climate of southeast Alaska, usually control outbreaks naturally before damage becomes extensive in virgin stands.

Most Alaskan timber is harvested from the hemlock and Sitka spruce forests of the southeastern panhandle. The rate of timber harvest has increased since the 1950's. Any time an environment is modified, the risk of problems, such as insect outbreaks, is increased. Hard feels it is highly probable that chemical control will become more necessary as young, managed forests replace the old growth. Environmentally safe chemicals such as Orthene, Dylox, and Lannate, have been tested and look promising.

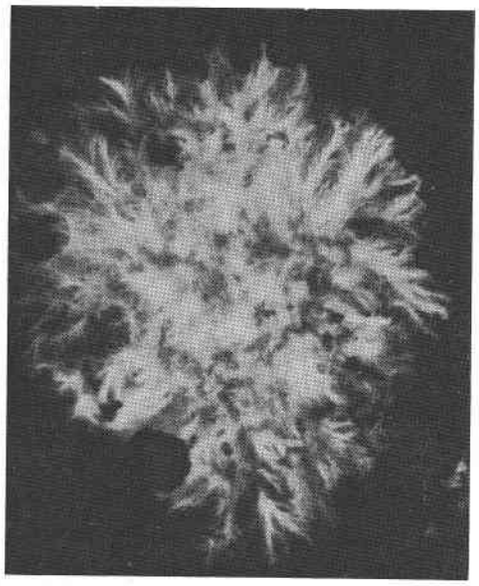
The work of Werner, Hard, and other entomologists is filling in the gaps in man's knowledge of the forest ecosystems of Alaska. These research results are helping to insure productive resource management for the land of the midnight sun.

end

next "insight" page 133

Effect of Urea on *Poria weirii* and Soil Microbes in an Artificial System, by Earl E. Nelson (94)

The ability of *Poria weirii* to survive for many years in decaying root systems makes this destructive root pathogen extremely difficult to control in Pacific Northwest coniferous forests. Competing soil microorganisims replace this root-infecting fungus in decaying root systems but generally not before new disease centers develop in the regenerating forest. Centers thus formed enlarge with root to root spread as a stand develops. Opportunities for control of this disease appear best at final harvest when heavy equipment is present, mobility on the site is least restricted, harvest and reforestation options are available, and soil treatments such as organic amendments or chemicals can be applied.



Colony of P. weirii growing on surface of soil.

Application of N fertilizer seems to be a promising control measure. Nelson found that application of urea at the rate of 674kgNha^{-1} resulted in a dramatic reduction in survival of *P. weirii* in buried wood. This study relates rate of application of urea to microbial activity and consequent suppression of *P. weirii* in buried wood.

Urea added to soil in containers indirectly reduced survivial of *P. weirii* in buried stem sections by regulating populations of soil microorganisms. After 8 weeks a noted antagonistic competitor, *Trichoderma,* began to increase. At the same time survival of *P. weirii* was reduced. After 32 weeks, *P. weirii* survived only where urea was not added. *Trichoderma* was found in stem sections no longer containing living *P. weirii.*

The possibility of this disease control system working under natural conditions is now being tested.

Epiphytology of a Needle Cast Fungus, *Lophodermella morbida,* in Ponderosa Pine Plantations in Western Oregon, by George M. Harvey (95)

Lophodermella morbida, a recently described needle cast fungus, is epiphytotic in plantations of ponderosa pine in the Douglas-fir forest type above 2,500 ft. on the western slope of the Cascade Range in southwestern Oregon. Mature ascospores are discharged during periods of rain from early June through mid-July. Only foliage recently emerged from the fascicle sheath becomes infected. Infected foliage drops from the tree by late summer of the next year. Growth of repeatedly infected trees is reduced; however, mortality appears to be slight.

Probably *L. morbida* is a native fungus catapulted to prominence on a susceptible host planted on unfavorable sites under climatic conditions favoring the disease. Ponderosa pine should no longer be planted on these sites. Such sites especially include ridgetops and natural basins where clouds tend to linger after a general storm. The risk to ponderosa pine stands east of the Cascade crest appears minimal because of limited early summer moisture and cold winter temperatures.

insect and disease-bibliography

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Contents Page

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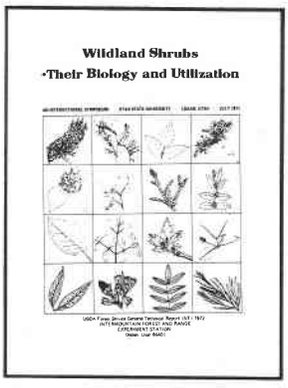


Wildland Shrubs—Their Biology and Utilization, Proceedings of a Symposium, July 1971 (1)

A collection of 48 papers on various aspects of wildland shrubs—from genetics to uses, distribution, physiology, nutrition, regeneration, and the future of shrubs in arid lands. (Available from the Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, Utah 84401.)

Seasonal Trends in Plant Nutrients Studied

Livestock and game managers are increasingly aware of the nutritional aspects of range management. An adequate diet for range animals is essential for the efficient production of animal products.

Deficiencies in protein, phosphorus, and carotene (vitamin A) are common on western ranges and have led to studies on nutritional values of forage plants. Such information can be used to estimate the seasonal adequacy of animal diets and is needed in order to adopt sound management practices.

A limited number of such studies have been undertaken in Oregon by scientists of the Pacific Northwest Forest and Range Experiment Station and Oregon State University.

The Silver Lake sagebrush-grass range, 80 miles south of Bend, is important from the standpoint of big game use and livestock production. Extensive research in livestock and big game management has been conducted there. Studies have included effects of big sagebrush (*Artemisia tridentata*) in deer diets and determination of crude protein levels in native grass and shrub species during winter and early spring. This study was developed to:

1. Define seasonal trends for the crude protein, fiber, and fat (ether extract), moisture, ash (total mineral matter), calcium, phosphorus, and apparent digestibility in selected forage species; and
2. Determine if these trends vary between ecologically different vegetation types.

For details, see *Seasonal Trends in the Nutritive Content of Important Range Forage Species Near Silver Lake, Oregon,* by O. Eugene Hickman (4).

One chapter in the book is by a PNW Experiment Station scientist, George A. Garrison, who discusses "Carbohydrate reserves and response to use." Carbohydrates are important to plants because that is their major source of energy and "raw" material. According to Garrison, "These basic organic substances are the available or nonstructural carbohydrates such as sugars, fructosans, dextrins, and starch which are mobilizable and available within the plant for its nutrition and development."

Seasonal levels of carbohydrate reserves in a key forage species provide primary implications of best dates and systems of grazing to avoid degradation of that species' capacity to sustain itself.

For another report on carbohydrates in range plants, see a paper by B.R. McConnell and G.A. Garrison on *Seasonal Variations of Available Carbohydrates in Bitterbrush* (2). Also see a plant food reserve study by Garrison on elk sedge and wheatgrass titled, *A Preliminary Study of Response of Plant Reserves to Systems and Intensities of Grazing on Mountain Rangeland in Northwest USA* (3).

Ecology of Curlleaf Mountain-Mahogany in Eastern Oregon and Adjacent Areas, by John Edward Dealy (5)

Curlleaf mountain-mahogany, a small, hardwood evergreen tree, was studied to provide information on germination and initial seedling growth characteristics, and the tree's relationship to its environment and associated vegetation.

This is a Ph.D. thesis available in microfilm or Xerography from Xerox University Microfilms, Dissertation Copies, P.O. Box 1764, Ann Arbor, Michigan 48106. Charge is: $7.50 academic, $10.00 other.

Ed Dealy

Relationship of Root Length to Stem Diameter in Curlleaf Mountain-Mahogany, by Pamela S. Talley and J. Edward Dealy (6)

Measurements were made of root lengths and stem diameters on 24 curlleaf mountain-mahogany seedlings 112 days after germination. Plants with the longest root systems had the largest stem diameters, indicating general plant vigor. Selection of seedlings with larger stem diameters for use in outplanting or research may increase rate of survival.

Some Autecological Characteristics of Elk Sedge, by G.O. Klock (7)

Elk sedge, a grasslike plant with extensive fibrous roots and high drought tolerance, may be one of the most important native, herbaceous forage species on national forest lands of Oregon and Washington. Quick establishment of this plant on depleted grazing lands would be desirable for erosion control.

However, there are no techniques available now for artificial regeneration of this species. Preliminary work indicates that ''cores'' taken from clones of the plant can be transplanted successfully. Elk sedge also showed positive response to nitrogen and potassium fertilization.

Soil Properties and Nutrient Availability in Tarweed Communities of Central Washington, by Arthur R. Tiedemann (8)

High elevation grasslands on basalt-capped plateaus dominated by Columbia needlegrass are important summer range for livestock and wildlife in north central Washington. These plateaus are also vital sources of water.

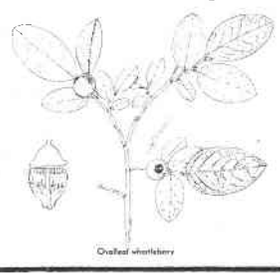
But a prevalent problem on these grasslands is a series of abrupt breaks in the grassland vegetation. These areas tend to be dominated by cluster tarweed, a species not palatable to wildlife or livestock.

This study explores the reasons for the change in vegetation, focusing on the soil nutrient levels, nutrient availability in the soil, and soil physical properties. Results indicate a lower nutrient capital and availability of nitrogen and sulphur, and lower capital of exchangeable manganese in the tarweed communities, and suggest the need for adding these nutrients to the soil.

How much browsing on shrubs by big game and livestock constitutes proper use? This question was not formulated or studied as early as questions about proper use on grasses. Also, the existing knowledge of livestock and big game preferences for different shrubs was not always the high-interest item that it is today.

Research on the level of tolerance that shrubs have to twig removal was performed for several Northwest shrubs and was reported by Garrison in an article entitled, *Effects of Clipping on Some Range Shrubs* (9). The information in this article and a companion item on *Annual Fluctuation in Production of Some Eastern Oregon and Washington Shrubs* (10) will prevent some bad generalizing that all shrubs on all sites can withstand 50 percent use in any year.

A summary of information as to which animals prefer which shrubs for browsing is tucked away in the back of a very easy to use shrub identifier by Hayes and Garrison, *Key to Important Woody Plants of Eastern Oregon and Eastern Washington* (11). You should be able to find this popular little book in either your municipal or college library.



Ovalleaf whortleberry

Range Ecosystem Research, The Challenge of Change, a brochure, September 1970 (12)

One characteristic of our times is change, and change brings with it challenges, opportunities, and problems. As we have looked forward to the 1970's, we have taken a new look at the nation's rangelands and their importance to all segments of society. Half of the United States is rangeland, and as population, industrialization, and urbanization increase, rangeland's role expands. The economy of many localities and regions depends on range resources.

In meeting the challenge of the 1970's and adapting to changes in society's needs, what is the best way to proceed with research on the problems of managing, conserving, and using rangelands?

This publication outlines the direction the Forest Service has taken with rangeland research and explains the underlying philosophy. That direction is based on the findings of a committee appointed in 1968 by the Chief of the Forest Service to: (1) make a critical review of range research; (2) consider society's changing needs for range resources; and (3) develop a comprehensive basis for research programs to meet those needs.

FISHERIES BIOLOGIST IN ALASKA
by Louise Parker

''Look, those are Dollies,'' Art Bloom said as he stepped off the trail to scan the adjacent stream. A swarm of Dolly Varden char wove dark shadows in the cold, clear water.

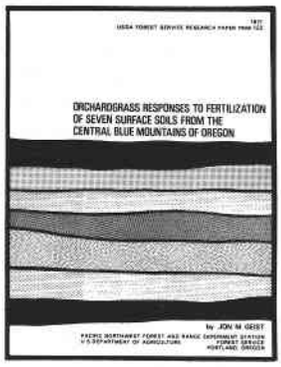
''These fish will spend several years here, growing to around 8 inches in length before they head for the sea,'' Art explained. The stream along which he walked is a very small tributary of the Kadashan River, which flows through a beautiful, remote part of Chichagof Island in southeast Alaska's Tongass National Forest. In the summer, the river is filled with salmon coming upstream to spawn. In 1973, close to 150,000 pinks (humpback) and chums (dog) salmon were counted upstream in the weirs.

The Kadashan and its tributaries are typical of much of the habitat of salmon and trout in southeast Alaska. This makes it an ideal study area for Art, a fisheries biologist with the U.S. Forest Service's Forestry Sciences Laboratory in Juneau.

Art and his wife, Joy, have spent several years at Kadashan Bay where Art is conducting research for the Forest Service. His job is to evaluate the habitat requirements of the fish which spawn in fresh water tributaries to the Kadashan River. This includes coho (silver) salmon, Dolly Varden, and rainbow and cutthroat trout. Six of the smaller tributaries to the Kadashan have been selected as study areas.

''There—under the bank. Those are coho,'' Art said, as he picked his way through the

orchard grass



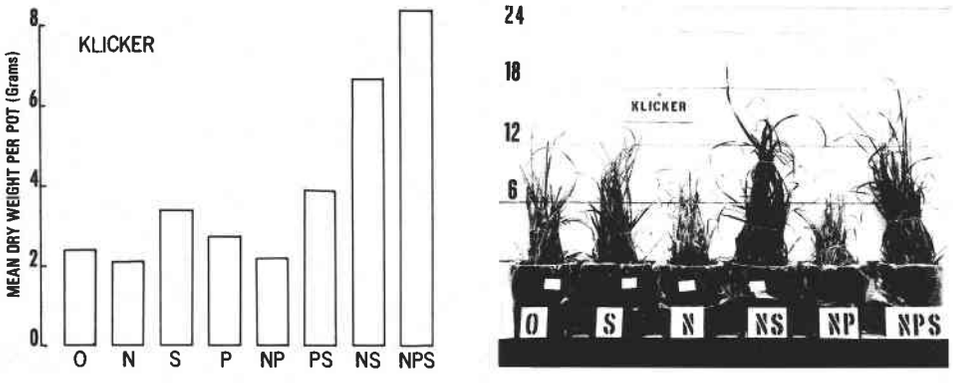
Orchardgrass Responses to Fertilization of Seven Surface Soils From the Central Blue Mountains of Oregon, by Jon M. Geist (13)

This study was conducted to determine the major nutrient deficiencies in seven soils in the Blue Mountains of Oregon. Chemical analysis indicated that there were large differences among the soils in both chemical and physical properties.

Greenhouse tests in which orchardgrass was grown in the soils with various fertilizers added indicated other results:

- In most soils, both nitrogen and sulfur were necessary in order to get maximum growth increases from either element.
- For two soils (both grassland soils), the maximum benefit from fertilizer was possible only by adding phosphorus with nitrogen and sulfur.
- Volcanic-ash-derived soils had the highest response to fertilization and should give the greatest economic return if site and climatic factors are not otherwise limiting.

For another paper on response of orchardgrass to fertilization, see also, *Response of Orchardgrass to Sulphur-Coated Urea,* by G.O. Klock, J.M. Geist, and A.R. Tiedemann (14).



Mean dry matter produced by each fertilizer treatment combination on the Klicker soil. The photograph illustrates plant growth with certain treatments.

pocket gopher

The Dalles Pocket Gopher and Its Influence on Forage Production of Oregon Mountain Meadows, by A.W. Moore and E.H. Reid (15)

Pocket gophers are not something you keep in your pocket. In fact, range managers would probably just as soon not keep them at all. Yet they are found in many places throughout western range lands and are especially common on meadows in the mountainous areas of the West. As a result, some meadows are seriously depleted, with grazing capacities as low as 0.1 or less animal-unit month per acre.

This paper (1951) is the result of a cooperative study by the Fish and Wildlife Service and the Forest Service from 1931 through 1948. The life history of the pocket gopher was studied, as well as its effect on the composition, density, and value of mountain meadow vegetation.

Results of the study indicate that gopher control is necessary to get satisfactory improvement of infested mountain meadows that are in poor condition. If ranges are in fair condition, however, control may not be necessary. In that case, the main value of control would be to make the additional forage available to livestock or to permit more rapid restoration of the range.

Gophers and Range Grass

It is no secret that gophers can destroy rangeland cover in a big way. Apparently they prefer to eat those plants with underground bulbs or fleshy roots. But they will also munch on the root crown of an occasional clump of grass, or new tender shoots of grass.

When unprotected from gophers, new stands of tall oatgrass with bulb-like stem bases were the first to be damaged and suffered most. Wheatgrass was less attractive.

Researchers also found that gophers were less likely to damage bunchgrass seedings if the drill rows were at a narrow spacing (12'') rather than a wide spacing (36''). The latter permitted an invasion of fleshy rooted weeds and encouraged gopher tunneling as the animals searched for tap-rooted herbs. This information should discourage the practice of wide drill-row spacing. In the old system, bunchgrass was seeded at wide intervals, with the range manager attempting to depend on natural reseeding to fill in the stand between drill rows.

Thorough seedbed preparation for new grass seedings aids distruction of fleshy rooted weeds and makes new grass planting sites less attractive to gophers than weedy sites.

Results are reported in *Relation of The Dalles Pocket Gopher to Establishment and Maintenance of Range Grass Plantings,* by George A. Garrison and A.W. Moore (16).

bitterbrush

Some Effects of Grazing Intensity on Bitterbrush Dispersion, by Burt R. McConnell and Justin G. Smith (17)

Three fence-line comparisons were made to determine the effect of grazing intensity on the density and dispersion of bitterbrush in a uniform habitat. Bitterbrush density was reduced by heavy grazing but was not affected by moderate use.

The large increases in mean area per plant that occurred under heavy grazing did not alter the overall form of random dispersion found under all grazing treatments.

Influence of Grazing and Age on Crown Characteristics in Bitterbrush, by Burt R. McConnell and Justin G. Smith (18)

Changes in average crown diameter and percentage of dead crown were related to bitterbrush age on moderately and heavily grazed ranges. There was a significant difference in average crown diameter under the two levels of grazing intensity, but the difference between percentages of dead crown area was not significant.

Effect of Logging on Bitterbrush

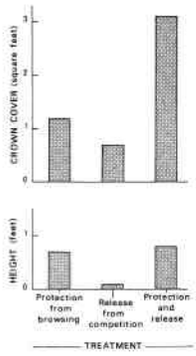
The effect of logging and slash disposal on the bitterbrush understory in a lodgepole pine forest has been studied in central Oregon. Soils were moderately to heavily disturbed on 75 percent of the area, and bitterbrush crown cover was reduced by 71 percent. Most of the damage resulted from slash disposal.

Despite extensive damage, shrubs quickly responded to more favorable growing conditions in the postlogging environment. Twig growth doubled and large numbers of seedlings were established on disturbed soils.

Results are from, *Initial Response of Bitterbrush to Disturbance by Logging and Slash Disposal in a Lodgepole Pine Forest,* by Paul J. Edgerton, Burt R. McConnell, and Justin G. Smith (19).

Survival and Growth of Bitterbrush on the Silver Lake Deer Winter Range in Central Oregon, by J. Edward Dealy (20)

This report (1970) presents results of the first 2 years of a study on survival of planted bitterbrush and its response to browsing protection and release from competing vegetation in central Oregon. After 2 years, researchers found that bitterbrush responded better to protection from browsing than from elimination of plant competition. Also, the additional growth tended to be in crown size rather than in plant height.



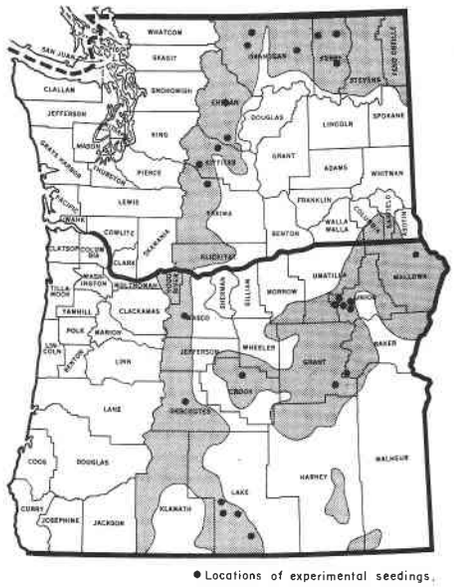
Average response per plant of an established antelope bitterbrush planting after 2 years of protection from deer browsing, vegetation competition, and the two combined.

range rehabilitation

Seeding Summer Ranges in Eastern Oregon and Washington, by Robert S. Rummell and Clark E. Holscher (21)

Range seeding, as an adjunct to good range management, is needed to increase the productivity of eastern Oregon and eastern Washington summer ranges. On about 600,000 acres, now yielding only a small percentage of their potential forage production, seeding is the only practicable way to reestablish a stable vegetative cover and increase the forage supply within a reasonable length of time.

To find successful ways for seeding summer ranges, the Forest Service has tested approximately 150 forage species and strains on many experimental areas under numerous conditions and methods of planting. In addition, many other seedings made by ranchers and federal land administrators have been studied, and information from the Soil Conservation Service and state agricultural experiment stations has been drawn on where pertinent. The results are the basis of recommendations reported in this bulletin.



Summer range areas in eastern Oregon and eastern Washington.

Sagebrush Control on Rangelands, by Joseph F. Pechanec, A. Perry Plummer, Joseph H. Robertson, and A.C. Hull, Jr. (22)

According to the authors, sagebrush is not the most desirable range plant on western range lands. Where range grazing is the preferred use, they advocate getting rid of the sagebrush and restoring forage plants through natural or artificial seeding.

"Innumerable examples have demonstrated that sagebrush eradication can more than repay its cost on many ranges in the West; double to 25 times greater grazing capacities have been obtained."

The authors discuss where and when to control sagebrush, and give some practical guidelines about how: by burning or use of herbicides, plowing or disking, anchor chaining, harrowing, cutting, beating, shredding, and some other methods.

brush along the creek. Coho prefer slow-moving water and often hide in pools where the bank has been undercut. In the cold streams of Alaska coho remain in fresh water for 2 to 3 years before moving to the ocean as smolts. Dolly Varden, on the other hand, are bottom feeders and prefer riffles and fast-moving water where insects abound. Art grabbed a mosquito from his jacket and tossed it into the water. It was quickly gobbled up by a young coho.

For a long time, Dolly Varden were considered undesirable because the adults feed on salmon eggs, and salmon are one of Alaska's principal commercial fish. Dollies were occasionally poisoned, and there was even a bounty for a while. But biologists now know that Dollies feed mostly on loose eggs which wash away in the current during spawning. They present little threat to the salmon. Too, fisheries is an important part of the tourist trade. Each year more and more people vacation in Alaska. By 1980, some 325,000 visitors are expected each year. Many come solely for hunting and fishing. In Alaska, the sport and commercial fishing industry is a multimillion dollar business. And Dolly Varden are a "good eating," popular sport fish.

Along the trail Art pointed to evidence of timber cutting in the flat land at the upper end of the estuary. A portion of the forest was logged in the early 1950's. Mostly it was high graded, rather than clearcut as is the practice today. The timber company took just the biggest and best hemlock and spruce, and left the rest. In southeast Alaska, good timber regions like this may have been "high graded" several times. At Kadashan Bay, the logs were skidded out by tractor, a practice foresters today believe causes the most disturbance, especially to stream channels.

Twenty years after logging, the land is green once again. Only a few stumps, skidroads, and patches of alder show where logging occurred. But very few hemlock and spruce have come back. Mostly it's pole-sized alder along old skidroads. It takes a long time for the conifers to come back naturally in this bottom-land country.

One of the skidroads at Kadashan indicates the poor logging practices of the past. It becomes a watercourse when the stream is in flood stage. Water in this channel disappears in the summer, leaving young coho and trout trapped in small ponds. They die when the water dries up.

Standley Range, a brochure, July 1976 (23)

A brochure describes the Standley Range in the Wallowa Mountains of eastern Oregon and its place in the history of research and management of national forest rangelands in the western United States. It was in these subalpine grasslands in the early 1900's that Dr. Arthur W. Sampson conducted early range studies and developed ecologically sound principles of livestock management on mountain rangelands.

Sampson's plant and range ecology studies, conducted between 1907 and 1911, contributed greatly to the infant science of range management. Thanks in part to his work, the subalpine grasslands of the Wallowas have been restored and are now able to support small herds of sheep in the summer.

forested range

Management of Conifer Woodland Grazing Resources for Cattle, Deer, and Elk, by Jon M. Skovlin and Robert W. Harris (24)

Deferred-rotation grazing in the open forest was the only management treatment which resulted in significant improvement in herbage production. There was no real difference between levels and systems on grassy openings. In the forest, however, herbage production was definitely improved by reducing cattle pressure and employing a deferred-rotation system.

A close relation exists between cattle management and use by deer and elk on these woodland ranges. Elk are especially sensitive to grazing pressure by cattle, perhaps owing to the presence or absence of ungrazed forage. Although deer and elk accounted for about one-fourth of the forage used, they did not make much use of forage important to cattle.

The low rate of stocking provided gains in elk sedge production, and least interference with food and habitat preferences of deer and elk. Deferred-rotation grazing provided for maintenance and improvement of elk sedge, the most abundant forage species for both elk and cattle.

Some Effects of Livestock Grazing on Ponderosa Pine Forest and Range in Central Washington, by Robert S. Rummel (25)

A study of ungrazed Meeks Table and grazed Devils Table in central Washington provided evidence that parts of the virgin ponderosa pine forest contained dense mats of herbaceous understory vegetation and sparse stands of tree reproduction. Pinegrass dominated and elk sedge was a minor part of the understory virgin flora.

Densities of herbaceous understory vegetation on ungrazed Meeks Table were 183 percent to 254 percent of the densities on grazed Devils Table. Herbage yields of pinegrass were strikingly different between the two tables. Pinegrass beneath open ponderosa pine produced 850 pounds of air-dry herbage per acre on Meeks Table compared to only 240 pounds on Devils Table. While the timber overstories on the two tables were similar, Meeks Table had only a very few small trees but Devils Table had 3,291 small trees per acre.

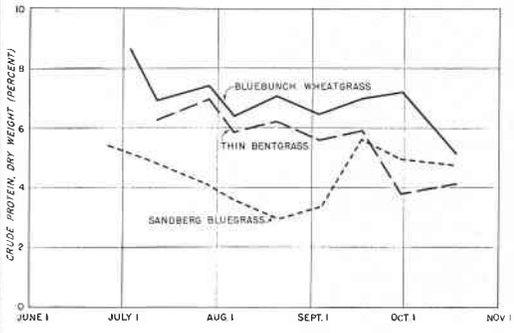
The high density of herbaceous understory vegetation on Meeks Table contributed substantially to the deficiency of advance tree reproduction. Heavy grazing of the herbaceous understory vegetation, rather than exclusion of fire, appeared to be the prime factor in explaining the dense advance tree reproduction on Devils Table.

Forage Utilization on Summer Cattle Ranges in Eastern Oregon, by G.D. Pickford (27)

This USDA circular (1948) presents the results of a 2-year study at the Starkey Experimental Range in eastern Oregon. The study was designed to learn more about the best grazing regimes for various forage plant and range types in the summer ranges of eastern Oregon. Results apply to the open mixed-conifer type of the Pacific Northwest, but many of the principles can be used in the management of mountainous range lands throughout the West.

The values of various summer-range types are discussed:

bunchgrass
dry meadows
pine-bunchgrass
pine-grass-elk sedge.



Crude-protein content of important grasses of the untimbered-range type, 1941.

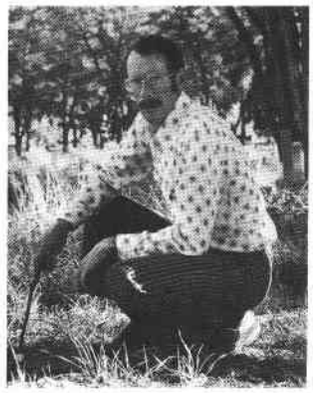
Improving Cattle Distribution on Western Mountain Rangelands, by Jon M. Skovlin (26)

Many ranchers lose valuable forage from uneven cattle distribution. Left to their natural inclinations, cattle tend to graze the easy acres while forage is underused on less accessible range. Unless these habits can be overcome, forage yield from high-producing areas will continue to diminish while usable forage on the less accessible range is wasted.

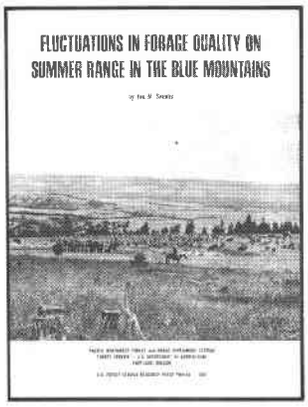
Distribution problems are aggravated for a cattleman who depends on mountain range of intermingled forest, brush and grassland. This range can be properly stocked as a whole, yet be severely overutilized in some places and unused in others.

Improving distribution enlarges the area of properly grazed range. More forage is taken from unused and lightly used range, and grazing pressure is reduced on habitually overused range.

Benefits to the rancher from better distribution are more complete utilization of available forage and faster recovery of depleted range. Heavier cattle, more calves, and more effective use of salt, water, and supplemental feed can result.



Jon Skovlin



Fluctuations in Forage Quality on Summer Range in the Blue Mountains, by Jon M. Skovlin (28)

Rangelands in the Blue Mountains of eastern Oregon and Washington provide 4 to 5 months of grazing for about 100,000 cattle. They also furnish 3 to 4 months of forage for nearly as many sheep. Big-game census and harvest figures indicate these same ranges carry an estimated 200,000 mule deer and about 65,000 elk for 6 to 8 months. The importance of this forage resource is apparent.

Although these native ranges have been grazed by livestock for over 100 years, little is known about their seasonal forage quality. Information on range plant values is needed to aid managers in getting full benefit from the forage supply through improved systems and seasons of grazing. This knowledge will also help ranchers in deciding when to change grazing practices or to market animals. To the big-game manager, the level of late-season forage quality suggests the condition of deer and elk for winter.

This paper combines unpublished research with several reported studies in an attempt to assess overall range forage value in the Blue Mountains. Much of the work has been done on the Starkey Experimental Forest and Range. It has been a field proving ground for grazing research on forest and related ranges for over 25 years.

Effects of Cattle Grazing Methods on Ponderosa Pine-Bunchgrass Range in the Pacific Northwest, by J.M. Skovlin, R.W. Harris, G.S. Strickler, and G.A. Garrison (29)

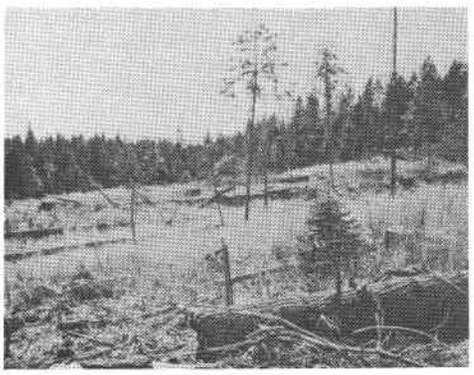
Reports results of an 11-year study of plant and animal responses to grazing in the pine-bunchgrass range of eastern Oregon (Starkey Experimental Forest and Range). Results are applicable to the Blue Mountains of Oregon and Washington.

The study showed that forested range is improved by deferred rotation. There was little change, however, on intermingled grassland openings. As more cattle were put into the ranges, big game used the areas less. *Carex geyeri,* the most valuable forage plant, was favored by light deferred rotation.

The Effect of Cattle and Big Game Grazing on a Ponderosa Pine Plantation, by Paul J. Edgerton (30)

Mixed conifer stands that have been clearcut, planted with trees, and seeded to grass are a potential source of summer forage for livestock and wildlife. The height of trees that had been planted in portions of a clearcut that had been ungrazed, grazed only by deer and elk, and by deer, elk, and cattle were compared. After five growing seasons, grazing had neither greatly harmed nor benefited growth and survival of the trees in the plantation.

A portion of the clearcut grazed by deer, elk, and cattle.



A portion of the clearcut grazed only by deer and elk. Note the abundance of ungrazed timothy. (This area adjoins the area shown at left.)

Art and his boss, Don Schmiege, who heads research at the Forestry Sciences Laboratory in Juneau, are particularily concerned about the effect of logging on fish habitat. It is impossible, they say, to know what effect logging at Kadashan had on the fisheries resources there. The fishing is good now. But no one knows how the fishing was before the timber was cut.

''We know logging can be disruptive,'' Schmiege says. ''Certain practices are detrimental to spawning areas and to the habitat of young fish. What we need to do is define their needs at the crucial time of spawning and rearing so foresters and others can make better decisions about how to harvest timber and manage other forest resources.''

Forest managers, too, are concerned about the effect of logging on the fisheries resource. Art's study area is part of the Tongass National Forest, and his work is conducted in cooperation with Region 10, the land management unit of the Forest Service in Alaska. Altogether, the national forests cover 21 million acres, with 16 million acres in the Tongass National Forest. Although the Research branch of the Forest Service and the National Forest System are administered separately, they work hand in hand. And their objectives are the same—to improve forestry practices in Alaska and elsewhere. Information gained from the research will be incorporated into management prescriptions and directives for national forest and other land managers.

''Logging doesn't have to be detrimental to the fishery resource,'' Art says. ''It's a matter of how it's done.''

How covers a lot of territory especially in Alaska where there has been plenty of room to err in the past. Years ago, hardly anyone but foresters and loggers ever saw logged-over areas. But that's changed now. More of Alaska is becoming visible every day.

Art has worked in cooperation with the Alaska Department of Fish and Game on a study to test the effectiveness of minnow traps (wire baskets) to measure the local fish population. In the course of this work, he made many observations about the fish and their habitat requirements. He has also concentrated on studying smaller sections of streams to identify the types of habitat each fish species prefers at different stages of development. He's looking at factors such as streamside vegetation, water velocity,

Response of Understory Vegetation to Ponderosa Pine Thinning in Eastern Washington, by Burt R. McConnell and Justin G. Smith (31)

Pine thinnning caused highly significant increases in understory vegetation. After eight growing seasons, total understory yield increments ranged from 75 lb/acre on the unthinned plots to 417 lb under 26-foot pine spacing. The increase comprised 51 percent grasses, 37 percent forbs, and 12 percent shrubs. When pine canopy exceeded about 45 percent, forbs produced more than grasses; below 45 percent, grasses were superior producers. Shrubs were the least productive at all levels.

Logging on Forest Range

First-year effects are reported from a study of logging on Pacific Northwest ponderosa pine ranges. It was found that tractor logging disturbed herbaceous and shrubby vegetation on an average of 21 percent of the ground, and covered 5 percent more with slash. Included within these data was a category of deep soil disturbance to 15 percent of the area. This denudation had a potential of long-term significance of forage and watershed values. Logging with a cable from a jammer was less damaging, and horse logging resulted in the least disturbance.

See a 1951 report, *First-Year Effects of Logging on Ponderosa Pine Forest Range Lands of Oregon and Washington,* by George A. Garrison and Robert S. Rummel (32).

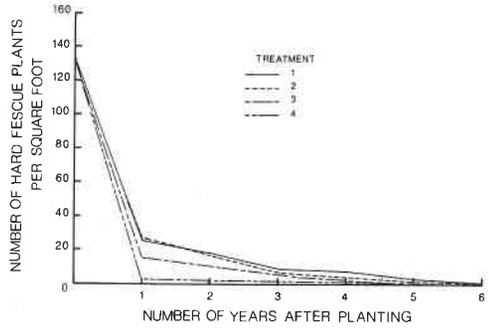
Subsequent publications displayed the slow vegetation recovery that followed the first year assessment of disturbance. Results also pointed out the need for improved logging methods and that reseeding denuded areas will hasten restoration of ground cover and forage. See two items by G.A. Garrison: *Recovery of Ponderosa Pine Range in Eastern Oregon and Eastern Washington by Seventh Year After Logging* (33), and *Changing Conditions in Northwest Forests and Their Relation to Range Use* (34).

George Garrison

Effect of Ponderosa Pine Needle Litter on Grass Seedling Survival, by Burt R. McConnell and Justin G. Smith (35)

Needle litter under stands of ponderosa pine can have an effect on the understory of shrubs and herbaceous vegetation. This may in turn have an effect on use of the areas by cattle.

In the study, researchers found that needle litter had a significant effect on initial survival of fescue seedlings. Subsequent losses probably resulted from several factors.



Number of living hard fescue plants per square foot from seed planting through the 6-year period under four levels of ponderosa pine needle accumulation.

Economics of Forest Range

This paper deals with economic returns from planting forage in a shelterwood management regime, with stocking densities typical of those in ponderosa pine-grass areas of eastern Washington. See *Economic Returns from Planting Forage in National Forests,* by Robert W. Sassaman (36).

Idaho Fescue Preference, by J. Edward Dealy (37)

The author discusses the untalked about problem of cattle grazing on Idaho fescue under ponderosa pine—and offers some valuable ideas for ranchers and land managers. Each problem, Dealy indicates, will likely require its own solution. But there are several possible approaches: 1) flash burning grass litter, 2) a year of heavy early grazing to force litter use, and 3) a rotation of forced use and moderate use, being careful not to let pine needles and litter get back on top with too long a wait between ''forced use'' years.

wildlife habitat

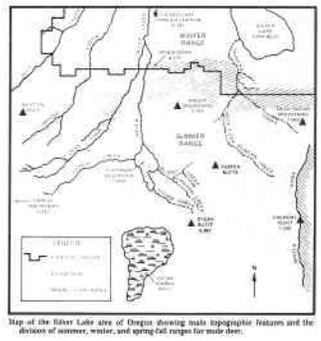
big game

Habitat Characteristics of the Silver Lake Mule Deer Range, by J. Edward Dealy (38)

Mule deer in central Oregon are migratory. They roam a vast mountainous summer range and crowd into a relatively small winter range. Most of the deer ranges in central Oregon are grazed by livestock, either cattle or sheep or both together. Excessive populations of animals compete for food. Prolonged competition can produce changes in diet, nutrition, fecundity, and range conditions. To prevent or reduce this competition, a wide variety of facts must be gathered concerning the animals and their environment.

This paper presents an analysis of 21 habitats present on the Silver Lake deer range in northern Lake County, Oregon. Treatment includes analysis of site, vegetation, and soils on both the summer and transition (summer-winter range boundary) ranges and discussion of vegetation types for suitability as mule deer habitat. This descriptive work is one of the first steps in developing realistic management plans for maximum sustained and compatible mule deer-livestock production.

Information presented here is directly applicable to the Silver Lake deer herd range. Data can be used as guides for management of deer herd ranges in central and south central Oregon and elsewhere in the western United States under similar conditions.



Map of the Silver Lake area of Oregon showing main topographic features and the division of summer, winter, and spring-fall ranges for mule deer.

Forage Use by Deer and Elk

A knowledge of the food and cover preferences of wildlife is necessary in order to effectively manage the animals and their habitat. This is particularly important to managers of public lands who need to balance wildlife use with other important resources.

This paper presents results of a 3-year study of seasonal forage use by deer and elk on part of the Starkey Experimental Forest and Range in the Blue Mountains of eastern Oregon. Three major habitats were sampled: open forest, dense forest, and grassland. Open forest land rated highest as a food and shelter in spring, summer, and fall. This habitat had a season-long abundance of forage, particularly elk sedge, a highly preferred grasslike plant. Grassland rated second in the spring when succulent forbs were abundant but dropped to third during the summer and fall when grassland plants were dry and not very palatable. Deer and elk then sought food as well as cover in the forest.

Details may be found in, *Seasonal Forage Use by Deer and Elk on the Starkey Experimental Forest and Range, Oregon,* by Paul J. Edgerton and Justin G. Smith (39).

Open forest

Dense forest

Grassland

Big Game Use and Habitat Changes in a Recently Logged Mixed Conifer Forest in Northeastern Oregon, by Paul J. Edgerton (40)

Logging is dramatically changing the character of big game summer ranges in the mixed conifer forests of northeastern Oregon and southeastern Washington. Animal use and habitat changes were documented in recently logged clearcuts, adjoining uncut and nearby partial-cut forest stands. Elk use was highest in the clearcuts, lowest in the partial-cut areas. Deer showed essentially the same order of preference, but differences between habitats were much smaller. Forage was the obvious attraction in the clearcuts. Adjoining uncut stands provided excellent cover. The partial-cut stands lacked both the volume and variety of forage in the clearcuts and hiding cover found in the uncut areas.

The Old 1-2-3, by Burt R. McConnell, Jerry A. Davis, and Paul D. Dalke (41)

Deer management is largely a matter of taking a sufficient harvest to protect food supplies during the winter months. Reduction for the winter stress period is what game managers are usually after when they recommend heavier hunting on certain herds. They know that in a healthy herd spring fawning will restore numbers to a high level. Normally, under this kind of management, losses are low, reproductive rates are high, and hunters are using the full annual increment of the herd.

This is what managers had in mind for the Cassia deer herd after a cooperative interagency study group took stock of things in the early 1940's. This herd ranges in part of the Sawtooth National Forest, and adjacent Bureau of Land Management lands, southeast of Twin Falls. Over the years it has been one of Idaho's top-ranked mule deer producers.

During the early 1940's, extensive deer population studies and range surveys were conducted which indicated a winter range carrying capacity of about 10,000 deer and a population of 13,000-14,000 deer. These studies also showed that too many livestock were using the area, so plans were drawn up for a coordinated program aimed at reducing both deer and livestock to proper stocking levels. Sheep allotments were generally in poorer condition than cattle allotments, so they were targeted for the heaviest reductions. When this overall program was initiated in 1943, no one figured it would take nearly 20 years to complete.

The authors discuss this program, and outline a basic 1-2-3 approach to deer and livestock management:

1) balance deer and livestock with carrying capacity,
2) as a result, forage conditions improve, and
3) fawn production increases on Idaho's Cassia Division deer range.

volume, water depth and width of the stream, natural cover, bottom type, and the type of food available for the young fish.

Art hopes to develop enough information to write management prescriptions for protecting fish habitat during and after logging.

From his studies, Art believes that almost all streams, regardless of how small they are, provide rearing habitat for fish. This means more attention should be paid to protecting very small streams during logging. "Coho may not spawn in these streams, but they are vitally important for rearing the young fish," he says.

Currently, good management practice calls for foresters to carefully evaluate the natural vegetation along major streams in order to insure productive salmon spawning habitat. But small streams, which have rearing or resident populations may or may not support spawning populations, were ignored up until a few years ago. And there has been little or no research on the role of these smaller streams—the type Art is studying now. Most studies have been conducted on habitat for pink and chum salmon, the most valuable of the commercial fish in Alaska. These two species have a short freshwater life and spend most of their life cycle in the open sea. But other species are becoming more valuable. These include coho, king, and sockeye salmon, rainbow and cutthroat trout, and Dolly Varden. All these species have a freshwater rearing stage and some have populations that remain in fresh water throughout most of their life cycle. Dolly Varden and trout are most typical of these.

In the main Kadashan River and the larger tributaries, coho may go 10 to 12 miles upstream to spawn. Pinks and chums go almost that far, but concentrate more in the lower reaches. After the young coho hatch, they move into backwaters and eddies, or into smaller tributaries.

These are some of the most productive fisheries waters in the world. But they will stay that way only if the vital habitat of the fish is protected. The potential conflicts between logging or other land use activities and fisheries are obvious. But experts such as Art Bloom believe we can have both. The answer certinly lies in a more thorough understanding of the needs of the fish throughout their life cycle.

end

next "insight" page 145

Yukky to Yummy—With Fertilizers, by J. Michael Geist, Paul J. Edgerton, and Gerald S. Strickler (42)

Webster's unabridged does not define "yukky," but we think it means not tasty. In this study, the authors describe how fertilization of timothy grasses on summer ranges in eastern Oregon helped make them more attractive to wildlife, especially elk.

Researchers suggest a unique use of this information. For example, people enjoy viewing wild animals; fertilizers might be used to attract elk to locations where they could be seen readily.

Timothy grass

Forage Quality as a Tool in Wildlife Management, by W.O. Hanson and Justin G. Smith (43)

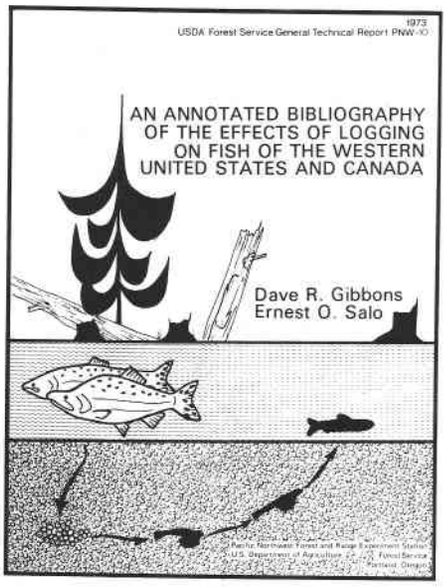
This is not a research paper, but a thoughtful discussion of forage quality as a tool in wildlife management. Three major topics are discussed: 1) the effect of forage quality on animal production, 2) improvement of forage quality through management practices, and 3) research needs. Management techniques considered include: timber cutting, mechanical treatment of brushland, herbicide treatment, prescribed burning, fertilizing, and plantings as attractants to wildlife.

Immobilization of Rocky Mountain Elk Using Powdered Succinycholine Chloride, by Richard J. Pedersen and Jack Ward Thomas (44)

If you want to immobilize an elk for any reason, you may want to read more about this study. Researchers used darts filled with a neuromuscular blocking agent called succinylcholine chloride to quiet the animals after they had been trapped. On the average, it took a dose of about 26 mg to do the job, an average of about 7 minutes to achieve the immobile state, a condition which lasted an average of 24.5 minutes. Timing is important! Some animals recover quicker than others.

For another publication in this category, see item in the bibliography under (45).

other



An Annotated Bibliography of the Effects of Logging on Fish of the Western United States and Canada, by Dave R. Gibbons and Ernest O. Salo (46)

This bibliography is an annotation of the scientific and nonscientific literature published on the effects of logging on fish and aquatic habitat of the Western United States and Canada. It includes 278 annotations and 317 total references. Subject areas include erosion and sedimentation, water quality, related influences upon salmonids, multiple logging effects, alteration of streamflow, stream protection, multiple-use management, streamside vegetation, stream improvement, and descriptions of studies on effects of logging. A review of the literature, a narrative on the state of the art, and a list of research needs determined by questionnaires are included.

Silvicultural Options and Habitat Values in Coniferous Forests, by Thomas, Crouch, Bumstead, and Bryant (47)

The coniferous forest moves through successional stages from bare ground to old-growth stands. Each stage in succession is more or less favorable to each bird group in terms of habitat requirements, and therefore, there is a successional pattern in the avifauna reflecting changes in the forest vegetation.

Silvicultural treatments have the general effect of modifying successional patterns to achieve some timber-related objective to speed up succession, to select for certain plant species, to concentrate growth on selected stems, or to harvest valuable commodities. The effects of such silvicultural options are predictable and controllable.

Equal Time for Non-Game Species, by Jack Ward Thomas (48)

There is an old saying, "Variety is the spice of life." Variety (diversity) is also the spice that provides the requirements of myriad wildlife and a fail-safe principle for comprehensive land use planning.

Thomas discusses various principles of wildlife management and how they relate to land use planning. First, he says, most wildlife biologists are trained to know the most about game animals and pest species. But most wildlife fit neither of these categories. Planning suitable habitats for each of those species would be an impossible task. But when planning is done to ensure that important "habitats" are not destroyed, then the individual wildlife species will be assured their important ecological niche.

Further, he says, a valuable habitat for wildlife is one that is also desirable for people. Consider some urban environments where sparrows, starlings, pigeons, and rats are the only kind of wildlife. Compare this with an environment that has catbirds, robins, orioles, and squirrels. In the first place, there is little diversity; buildings are crowded and vegetation is sparse. In the second, there are trees, shrubs, and grass in diversity.

Germination of Cascara Seed, by M.A. Radwan (49)

Cascara seeds are dormant when the fruit is mature and the seed is dispersed. This dormancy can be broken by artificial stratification for 4 months or by soaking in potassium gibberellate prior to spring sowing. Cascara trees provide protection for watersheds and food and cover for wildlife.

Birds are a natural part of the coniferous forest biome. They evolve with it and influence the system as well as being influenced by it. The effects of birds in the population dynamics of forest insects is one role that we have discussed.

Applied fire management is just coming into its own. Fire can be used for several purposes—but primarily results in alteration of ground cover or successional patterns.

Opportunities for wildlife biologists to attain their forest management goals were never better. Many, if not most foresters are now receptive to reasonable proposals to enhance bird habitats or at least to minimize adverse impacts of silvicultural practices on the habitats. However, biologists must provide factual, professional, and realistic leadership in planning and implementing land management policies and programs if habitat diversity is to be maintained.

range and wildlife – bibliography

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recreation

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Contents

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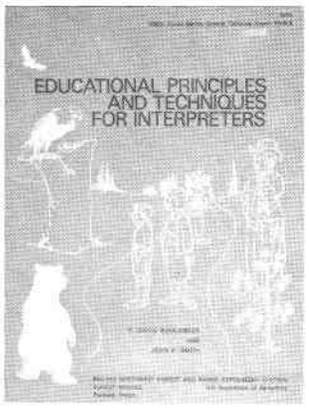
interpreting the environment



Educational Principles and Techniques for Interpreters, by F. David Boulanger and John P. Smith (1)

To make the insights of educators available to interpreters, principles and techniques for effective talks and discussions have been summarized. Coverage includes objectives, selecting and organizing visitor experiences, motivation and attention-holding techniques, use of questions, and use of examples, analogies, and metaphors. A checklist is included along with a bibliography for readers wanting additional information.

Evaluating Visitor Response to Exhibit Content, by Randel F. Washburne and J. Alan Wagar (2)

The effectiveness of various exhibit characteristics was studied in four visitor centers: two in Mount Rainier National Park, one in Olympic National Park, and one in the Siuslaw National Forest in Oregon.

Results indicate a preference for dynamic presentations such as movies, audio sequences, and exhibits with changing lighting. People also preferred three-dimensional presentations, themes of violence and destruction, mammals and birds, ecological relationships, and holistic presentations of cause and effect relationships or parts making a story.

Because visitors tended to prefer the more expensive exhibits, future studies should consider not only effectiveness but cost-effectiveness.

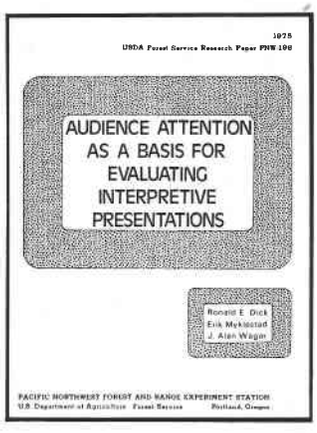
Visitor Groups and Interpretation in Parks and Other Outdoor Leisure Settings, by Donald R. Field and J. Alan Wagar (3)

To inform visitors and enhance their experiences, resource managers responsible for interpretation must understand both human behavior and resources. Five principles for effective interpretation are suggested: (a) visitors are diverse, (b) visitors anticipate a relaxed and enjoyable atmosphere, (c) interpretive information must be rewarding, (d) interpretive information must be understood, and (e) the effectiveness of interpretation must continually be evaluated.

This report was published in the *J. Environmental Educ.* 5(1):12-17, and reprinted in *Guideline* 4(2):13-24, 1974. It was also published as "People and Interpretation," Chapter 3 (p. 43-56) in *Interpreting the Environment,* Grant W. Sharpe (ed.). 1976. John Wiley & Sons. New York. 556 p.

Objectives and Evaluation in Interpretive Planning, by Allen D. Putney and J. Alan Wagar (4)

Effectiveness cannot be evaluated unless objectives have been specified in terms suited to measurement. To gain the advantages of broad planning goals as well as specific and measurable behavioral objectives, a hierarchy having three or more levels of objectives is suggested. Each broad policy goal at the top is supported by more specific objectives that are consistent with that goal. Each of these objectives is in turn supported by even more specific objectives that are consistent with the objective and goal above it. Measured achievement of the most specific objectives then permits us to infer that the policy goals are also being achieved.



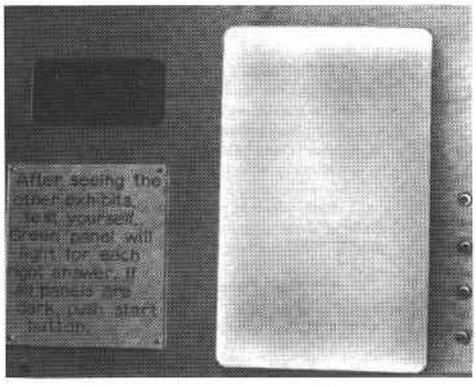
Audience Attention as a Basis for Evaluating Interpretive Presentations, by Ronald E. Dick, Erik Myklestad, and J. Alan Wagar (5)

How can interpreters find out how visitors respond to presentations without having to ask questions? This paper presents a tested technique for recording audience attention at 1- or 2-minute intervals. Where possible, observers watched people's eyes. If that was not practical, watching the orientation of people's heads was a good method. Graphed records of audience attention showed substantial differences both within and between presentations.

The Recording Quizboard: A Device for Evaluating Interpretive Services, by J. Alan Wagar (6)

Describes a device to help interpreters evaluate the effectiveness of presentations. After a visitor has passed through an exhibit, he comes to a sign which says: "Test yourself. Green panel will light for each right answer. If all panels are dark, push start button."

The answers on the panel—both right and wrong—are recorded and tell the interpreter which exhibits are most effective in producing right answers. The interpreter can then change the exhibit and check again to see if people are getting the message.



A Summary and Annotated Bibliography of Communications Principles, by Ronald E. Dick, David T. McKee, and J. Alan Wagar (7)

Principles from communications and related fields are directly pertinent to environmental education and interpretation. However, the people who usually design, present, and administer these programs often lack formal training in communications. As a result, valuable information often has not been readily available to them.

This summary and annotated bibliography have been assembled specifically to provide environmental educators and interpreters with the major principles from communications and related fields. Principles are summarized under headings of Communicator or Source Factors; Communication or Message Factors; and Receiver or Audience Factors.

Interpretation to Increase Benefits for Recreationists, by J. Alan Wagar (8)

To be effective, interpretation must attract and hold attention. For greatest interest, interpretation must be dynamic, rewarding to visitors, easily obtained, tailored to diverse visitors, and meaningfully structured. Evaluation of effectiveness requires feedback from visitors and objectives for which achievement can be measured.

Challenging the Folklore of Environmental Education, by John C. Hendee (9)

Environmental education and related programs now attract more attention than ever before. In many cases, the recent attention and importance of environmental education has led to the approval and financing of long awaited proposals. Environmental educators should rejoice at the new importance and recognition of their field and attempt to capitalize on their current popularity. But at the same time, a critical eye should be directed at the traditional approaches that are likely to capture and direct the increased appropriations for environmental programs.

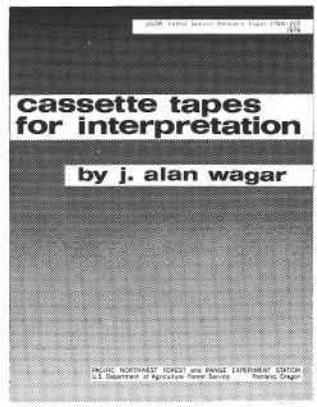
The increased importance of environmental education is well founded. But are the capabilities, accumulated knowledge, and conventional tools of environmental education up to the challenge? Will the imminent investments in environmental education efficiently contribute to the alleviation of environmental problems? Is the growing complexity of environmental problems matched by growth in the sophistication of method, technique, and objectives among environmental educators? These are reasonable questions and might be constructively used in a critical self appraisal by professionals in the field. From my perspective the view is not encouraging. Recent experience and a review of literature and research in the field of environmental education and related topics left me with some unfavorable impressions and triggered some suggestions for improvement.

Research in Interpretation, by J. Alan Wagar (10)

Three kinds of studies useful for increasing the effectiveness with which natural and cultural resources are interpreted are discussed: (a) studies providing interpreters with summaries of knowledge from such disciplines as psychology, sociology, communications, and education; (b) studies to evaluate costs and effectiveness of alternative interpretive procedures; and (c) studies to develop feedback methods that interpreters can use to evaluate audience response to presentations.

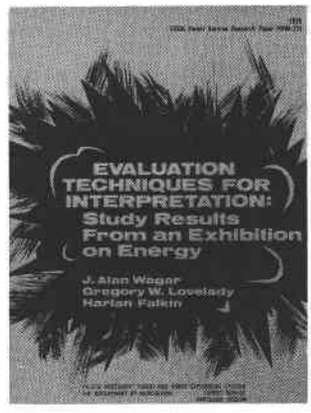
Evaluating the Effectiveness of Interpretation, by J. Alan Wagar (11)

The changes in attitudes or behavior brought about by interpretation are extremely difficult to measure. However, so much interpretation fails on the prosaic matters of gaining attention and understanding that their measurement is useful for evaluating effectiveness. The advantage and disadvantages of 12 evaluation techniques are discussed.



Cassette Tapes for Interpretation, by J. Alan Wagar (12)

Interpretation using portable tape players and cassettes provided greater enjoyment and retention of information on a visitor trail than either trail signs or a trail leaflet. Questions within a tape increased visitor retention of information so emphasized but at the risk of reduced retention for other information. On-the-ground costs were estimated as between 4 and 9 cents per visitor contact.



Evaluation Techniques for Interpretation: Study Results From an Exhibition on Energy, by J. Alan Wagar, Gregory W. Lovelady, and Harlan Falkin (13)

Six techniques for evaluating presentations were studied during an exhibition on man and energy at the Pacific Science Center, Seattle, Washington. A panel of outsiders, suggestion boxes, observed audience attention, and time-lapse photography all proved to be good for evaluating effectiveness.

public involvement

Analyzing Public Input

A system is described that enables forest resource managers to analyze input from public involvement processes. The system is Codinvolve, a method which uses edge-punch card sorting techniques to summarize people's comments on resource management issues. A computer may also be used.

The common denominator of all public input is defined and six broad principles listed. In addition, Codinvolve meets a number of other important criteria. It accurately summarizes the content of public involvement in relation to the decisionmakers' questions. And it can provide other descriptive and qualitative information about the input. It is objective, reliable, has a certain flexibility, and can be uniformly applied among different administrative units. It can handle, store, and retrieve large quantities of input. And the procedures used are visible and traceable so that interested people can review the public involvement process.

The report is *Analyzing Public Input to Resource Decisions: Criteria, Principles and Case Examples of the Codinvolve System,* by Roger N. Clark and George H. Stankey (14).

A companion report which discusses the Codinvolve system in more detail is *An Introduction to Codinvolve: A System for Analyzing, Storing, and Retrieving Public Input to Resource Decisions,* by Roger N. Clark, George H. Stankey, and John C. Hendee (15).

Foresters' Views of Interest Group Positions on Forest Policy, by Gordon L. Bultena and John C. Hendee (16)

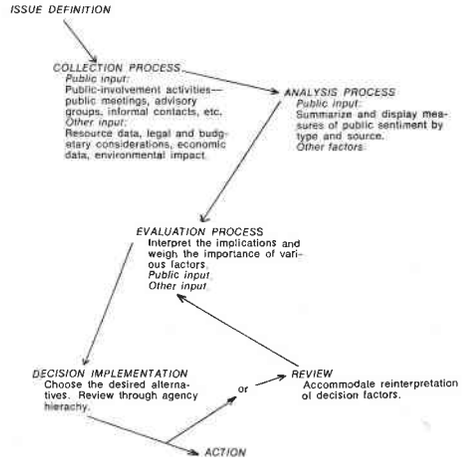
Foresters on five national forests in the Pacific Northwest, when identifying special interest group positions on timber cutting, aligned themselves with commercial vs. recreational-aesthetic interests, viewing the latter as having unjustified expectations. On the issue of opening trails to motor bikes foresters saw a split among recreational interests.

A Framework for Agency Use of Public Input in Resource Decision-Making, by John C. Hendee, Roger N. Clark, and George H. Stankey (17)

A thoughtful discussion of public involvement as an aid to help resource managers in the decision making process. In summary, the authors conclude that failure to solicit public participation aggressively and innovatively—and respond to it—can result in the loss of agency stature, damaging public criticism of agency policies and programs, and continued antagonistic situations between the agency and some of its clientele. Public participation is unlikely to eliminate confrontations with polarized constituents, but it can bring out and focus the conflict well in advance of the deadline for making a decision.

Pressures to secure better public input are, in part, a response to the public's demands for a greater voice in land management. By increasing public participation in decision-making, public agencies should avert disastrous mistakes and diminish *ex post facto* confrontations.

But the issue is a broader one. Public involvement provides a forum in which the public can effectively exert its rightful role as a goal-setting body. On the other hand, with a more accurate assessment of public desires, professional managers can better fulfill their role as achievers of those goals.



Processes for using public input in resource decision-making.

Public Participation in Forest Management Decisions, by J. Alan Wagar and William S. Folkman (18)

Diverse interest groups, often with conflicting goals, are demanding voices in setting land management goals. If they are to reflect informed opinion, compromise and opportunities for mutual advantage, managers and conflicting interest groups must interact sufficiently to identify trade-offs. Small working groups, with sustained interaction among representatives of conflicting interests, offer a solution.

PHEROMONES FOR INSECT CONTROL
by Dorothy Bergstrom

The search continues for better ways to cope with future Douglas-fir tussock moth outbreaks. One of the most promising new control techniques may be the pheromone, or sex attractant, of the tussock moth, produced artifically in the laboratory in 1974. Development of the artificial sex attractant, which duplicates the natural attractant of the moth, may soon make it possible to determine the location and size of local populations. Eventually the attractant may also be developed as a control technique.

The scientific team that identified and synthesized the pheromone is headed by Dr. Gary Daterman, an entomologist at PNW Station's Forestry Sciences Laboratory in Corvallis; and Dr. Doyle Daves and Dr. Ronald Smith, chemists at the Oregon Graduate Center, Beaverton, Oregon. Supporting and assisting them are technicians who perform highly specialized tasks. Dr. Lonne Sower, a recent transfer from the Agricultural Research Service, is an experienced pheromone scientist who has joined this team to assist in development of pheromones of tussock moths and other insects.

In 1973, the same team identified the sex attractant of the pine shoot moth. Using similar laboratory and field procedures, they are now working to identify the attractants of the western tussock moth and the rusty tussock moth. Though these insects are far less destructive to Northwest conifers, scientists are interested in their attractants because these moths are closely related to the Douglas-fir tussock moth. In the woods they may even be attracted by the same pheromone.

In their collaboration, which began in 1970, Daterman, Daves, and Smith have developed their own investigative methods for tuning in on insect communication. It is a process, that requires perseverance and, most of all, cooperation between the chemist and the entomologist.

The first step is to find out whether the insect has an attractant and, if so, which sex produces it. To start with, the entomologist grinds up the abdomens of female insects

camping

Guidelines for Roadless Area Campsite Spacing to Minimize Impact of Human-Related Noises, by T. Dailey and D. Redman (19)

Guidelines for campsite spacing and location in roadless areas are presented which allow insulation from noise between campsites. The guidelines are based on the distance that different human-related noises travel in a variety of outdoor settings. Eleven human-related noises were measured, four of which were: trail bike motor, conversation, gunshot, and chopping wood.

The physical and psychological properties of these noises are described and discussed. The effects of different environmental features—ridges, hills, dense woods, low vegetation, still water—on noise transmission are also described. General management actions are suggested for locating camps to minimize noise from other camping parties.

Recreational Carrying Capacity Reconsidered, by J. Alan Wagar (20)

In designing guidelines for protecting recreational resources, managers have long borrowed the concept of carrying capacity from the fields of range and wildlife management. In many ways, it was a bad choice that has diverted our attention from more promising approaches to effective management of recreation lands.

Because recreation areas produce psychological experiences, acceptable levels of use depend greatly on desired qualities of experience, management patterns, and such off-site factors as alternative opportunities and visitor characteristics.

The "Adequacy" of World Recreation Resources, by J. Alan Wagar (21)

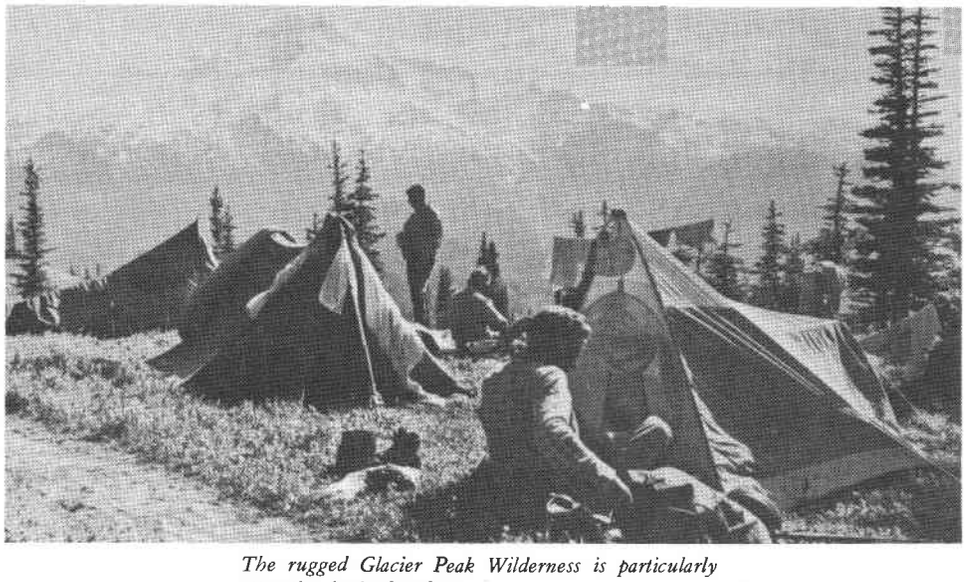
Vast differences in the wealth, value systems, technology, and other characteristics of different nations make American standards inappropriate for defining "adequate" recreation resources on a worldwide basis. Worldwide, people's expectations for recreation will generally be shaped by supply rather than *vice versa.*

wilderness

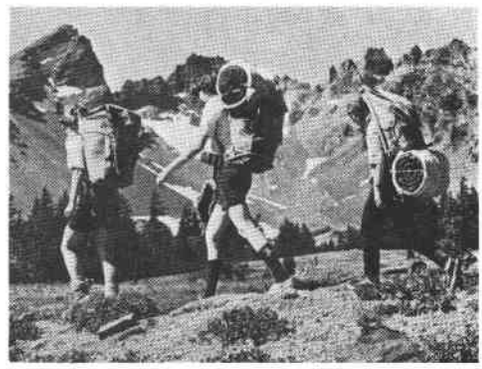
Wilderness Users in the Pacific Northwest—Their Characteristics, Values, and Management Preferences, by J.C. Hendee, et al (22)

Wilderness users were canvassed during the summer of 1965 in the Glacier Peak Wilderness in Washington and the Eagle Cap Wilderness and the Three Sisters Wilderness in Oregon. These areas were chosen because they were the three most heavily used wilderness areas in the Pacific Northwest. Each was dominated in use by a different type of visitor: backpackers in Glacier Peak, horseback riders in Eagle Cap, and 1-day hikers in the Three Sisters.

The authors sought to determine what kinds of persons visit wilderness in the Northwest, what values and codes of behavior they associate with wilderness use, and how they feel about certain policies that might be used in the management of such areas. The study is based on the response of 1,350 persons to an eight-page questionnaire that was sent to a random sample of visitors recorded during 1965.



The rugged Glacier Peak Wilderness is particularly attractive for backpackers.



Motivations of Wilderness Users, by W.R. Catton, Jr. (23)

Wilderness user motivations can be deduced from study of users' characteristics and behavior. Motivations for wilderness use are learned, and increasing numbers of people will learn them from each other, from contact with wilderness environments, and from conservation organizations and resource management agencies.

Motivation toward a wilderness goal, such as mountain climbing, tends to be highest if the goal outcome is uncertain. If it is a certainty that the summit will be reached, or that it is impossible, then motivation is less. Motivation toward a less demanding goal, such as hiking and camping, may be governed more by the mystery that the endeavor holds for the user.

Camping may be motivated greatly by the desire to participate in a way of life that is thought to be free from crime such as theft. Even when users have some valuable items stolen, they tend to be reluctant to redefine the campground as anything but a crime-free environment. This attitude may be indicative of a major motivation for camping —the desire to live in a morally and socially dependable world for a time.

Apparently, another motivation for camping is the desire to escape the usual necessity for considering the consequences of one's actions. Also, the social side of camping may be an important part of the camper's motivation.

Wilderness use results from positive attractions by the natural environment as well as from mere repulsion by urban environments. Campers seek opportunities for social contact with chosen companions, but are also motivated by a quest for privacy which can be gained either from geographic remoteness in back country areas or from adherence to a norm of non-involvement in intensively used campgrounds. Educated, professional, urban-bred users of wilderness tend to prefer the natural environment and be advocates of preservation and wilderness. These attitudes may be expected to become even more prevalent.

A Scientist's Views on Some Current Wilderness Management Issues, by J.C. Hendee (24)

The author expresses opinions on issues concerning the professional's role in allocation and management of wilderness, the need for a comprehensive public-land policy to preserve that wilderness, the need for a pure approach to wilderness management, mandatory wilderness permits, and rationing wilderness use.

Resource professionals play a vital role in developing strategies for managing wilderness in ways that assure its preservation.

Wilderness is vulnerable to impacts which occur outside its borders. Comprehensive land management is critical to protect it from erosion.

Two opposing philosophies compete for the allegiance of wilderness managers. The anthropocentric approach centers on enhancing man's use of the natural environment. By contrast the biocentric (or ''pure'') approach emphasizes the natural integrity of wilderness ecosystems because the values of wilderness ultimately depend on the natural processes of environmental change operating independent of man's interference. The author endorses the biocentric or pure approach on both philosophical and practical grounds.

Mandatory Wilderness Permits: A Necessary Management Tool, by J.C. Hendee and R.C. Lucas (25)

A mandatory wilderness permit system is suggested for providing essential management information on use, provide a means of influencing visitor behavior, and control overuse when necessary.

The authors explore some costs and benefits of mandatory permits, basing their judgement on relevant research findings, experience with wilderness registration and permit systems, and on an assessment of the need for such control.

Wilderness permits offer valuable information to help resource managers preserve the integrity of wilderness experience without resorting to rationing use. This should be the last alternative to which we turn after exhausting all other means to control the impact of use. A major challenge to resource managers and researchers is the development of wilderness management techniques capable of controlling or redistributing the impact of use within acceptable limits.

Biocentricity in Wilderness Management, by J.C. Hendee and G.H. Stankey (26)

Two contrasting philosophies on wilderness management are identified and evaluated: anthropocentric versus biocentric. The ''anthropocentric'' philosophy emphasizes man's use of wilderness as the primary objective, while the ''biocentric'' philosophy emphasizes the importance of maintaining the natural integrity of wilderness ecosystems at the expense of recreational and other human use, if necessary. The authors endorse the biocentric view, summarize arguments for and against this philosophy, and call for further debate on these issues in scientific, professional, and political circles.

vandalism and littering

Values, Behavior, and Conflict in Modern Camping Culture, by Roger N. Clark, John C. Hendee, and Frederick L. Campbell (27)

Research findings suggest that campers and managers subscribe to similar goals associated with camping, but they disagree about the types of activities appropriate to attaining those goals. In addition, there seem to be important differences in the way both groups perceive behavioral problems in campgrounds. Campers express less concern than managers about problems such as vandalism, theft, and nuisance behaviors. These differences are thought to be attributed to the social goals and urban behavior patterns of campers compared to the more traditional, natural environment-oriented expectations for camping behavior held by recreation managers. Certain changes in recreation user populations and in the organization of public campgrounds are discussed in relation to behavior problems. A strategy is recommended to avert problems inherent in continued change in the camping scene.

Roger Clark

and mixes them in a solution. This is filtered and tested on male moths in cages. If the males respond, the solution contains an attractant. In addition to the mysterious attractant, it also contains hundreds of miscellaneous compounds that are unrelated to the pheromone. Before the pheromone can be identified, it must be isolated from these other chemicals.

The purification process is a sort of laboratory do-si-do in which the entomological and chemical teams take turns performing their specialized procedures. The chemist's job is to eliminate all compounds except the pheremone. The entomologist's job is to test the material on male moths to verify attractiveness of test samples.

The chemists use column and gas chromatography and mass spectrometry to seperate the various compounds and divide the solution into small fractions. The entomologist tests each fraction on male moths in a laboratory cage. The fractions which attract moths are separated further and the resulting fractions again tested on male moths. This process may be repeated dozens of times until only the attractive chemical remains.

Finally, the chemists are able to make a substance identical to the one female moths produce effortlessly and unknowingly. The chemical that attracts the Douglas-fir tussock moth is cis-6-heneicosen-11-one. It is highly attractive to male moths regardless of whether it comes from a female moth or a chemical laboratory. A one-nanogram sample—35 trillionths of an ounce—is enough to attract male moths in laboratory tests.

In 1975, field studies to develop new control methods for the Douglas-fir tussock moth were carried out by Forest Service and cooperating researchers under an accelerated

Controlling Vandalism in Recreation Areas—Fact, Fiction, or Folklore?, by Roger N. Clark (28)

Problems with vandalism in private and public recreation areas are increasing. Vandalism results in serious impacts on management budgets, quality of the environment, and recreationists' experiences. The nature of the literature on vandalism is described, solutions discussed, and research needs outlined.

Depreciative Behavior in Forest Campgrounds: an Exploratory Study, by Roger N. Clark, John C. Hendee, and Frederick L. Campbell (29)

Vandalism, theft, littering, rule violation, and nuisance behaviors were studied in three campgrounds during 1968. Depreciative acts are apparently committed for a variety of reasons; and several approaches seem logical for their control, including better communication of rules, educational programs to increase the campers' awareness of the consequences of certain acts, and stricter enforcement of regulations. The data suggest, contrary to some prevailing opinion, that depreciative behavior is not always the result of ''slobism'' or vandals running wild.

Observations from this study indicate that all campers share responsibility for depreciative behavior. Contrary to popular belief, teenagers did not commit a larger proportion of depreciative acts, but preteenage children did.

Finally, the data indicate that people will cooperate with a ranger if he explains the situation. People need to understand the underlying reasons for rules in campgrounds, or they are likely to ignore them.

Depreciative act[1]	Tent campers (N=32)	Trailer campers (N=46)	Pickup truck campers (N=16)	Day users (N=21)
	Percent[2]			
Nuisance acts	31.3	10.9	12.5	23.8
Vandalism	12.5	17.4	12.5	9.5
Rule violations	56.3	71.7	75.0	66.7
Total depreciative acts[3] [4]	100.1 (26.4)	100.0 (38.0)	100.0 (13.2)	100.0 (17.4)

[1] Only those depreciative acts for which "type of camper" could be determined were included in this table.

[2] Numbers in parentheses are percentages of "total depreciative acts."

[3] Five percent was attributed to "other" types of users not included in this table.

[4] Percentages may not total 100.0 percent due to rounding.

Types of depreciative acts committed by different types of campers.

How to Control Litter in Recreation Areas: the Incentive System, by Roger N. Clark (30)

The smiling children on the cover of this publication have just helped a Forest Service Ranger clean up a campground, and they're pleased as punch. Not only did they do a good job and receive the praise of the ranger and their parents, they got some tangible rewards to keep—Smokey Bear badges, posters, comic books, and other goodies.

The paper describes the ''incentive system'' for litter control and shows resource managers how to use it in a few easy steps. The system is easy to use, costs almost nothing, and can be adapted for use in developed campgrounds, in dispersed roaded areas, and in backcountry and wilderness.

A ''how to'' guide for anyone who wants to deal more effectively with litter in outdoor recreation areas.

The ''how to'' brochure is based on several years of research and practical field tests. This work is reported in three publications listed in the bibliography (31).

Litterbags: an Evaluation of Their Use, by Roger N. Clark, John C. Hendee, and Randel F. Washburne (32)

A study in Mount Rainier National Park indicates that only a very small proportion of the litterbags handed out end up in park trash cans. Most of the remaining litterbags are carried away from the park without being used. Of the two types of litterbags tested, plastic bags were used more often than paper bags.

dispersed recreation

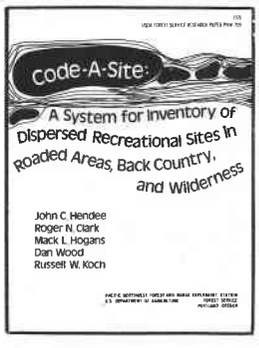
First Results of a Study

Data gathered during the first year of a 3-year study of dispersed recreation along forest roads in Washington and Oregon are described. Dispersed road recreation includes both overnight camping at undeveloped sites and day activities which take place along and adjacent to forest roads.

An inventory indicated that campers had established 622 camp sites along the 333 miles of road in the three study areas. Most of the sites were located near water. Most of the use was on weekends and holidays. In one of the areas, 40 percent of the use was during elk season.

Observations of 1,613 dispersed recreation parties, and conservationists with many of them, indicated that 91 percent had visited the areas previously. Eighty-five percent lived within 100 miles.

The report is *Dispersed Recreation on Three Forest Road Systems in Washington and Oregon: First Year Data,* by John C. Hendee, Mack L. Hogans, and Russell W. Koch (33).



Inventorying Sites

Code-A-Site is a system for inventorying dispersed recreation sites on forest roads, in back country, or wilderness. Dispersed sites in these settings have usually been established by impromptu use of recreationists but are important to management since they are the focal point for considerable recreation activity. Code-A-Site uses edge-punch cards for recording and storing basic information about dispersed sites for subsequent retrieval as needed for planning, management, and research purposes. Use of edge-punch cards and needle-sorting methods, facilitates easy summary and analysis of data at field levels. Code-A-Site is designed for field use but provides opportunity for transfer of data to centralized computer storage and retrieval systems if desired.

See *Code-A-Site: A System for Inventory of Dispersed Recreation Sites in Roaded Areas, Back Country, and Wilderness,* by John C. Hendee, et al (34).

wildlife management

A Multiple-Satisfaction Approach to Game Management, by J.C. Hendee (35)

A new multiple-satisfactory approach to game management is proposed wherein the most significant direct products of management are hunting experiences which produce human satisfactions. This approach is different from traditional game-bagged and days-afield concepts which are now viewed as no longer adequate to measure the results of game management.

Six tenets of this multiple-satisfaction approach are outlined and illustrated with suggestions given for their application.

The multiple-satisfaction concept of recreation resource management.

General Model	General Example	Specific Example
RESOURCE	OUTDOOR RECREATION RESOURCES	GAME AND FISH
↓	↓	↓
MEANS OF UTILIZATION (how the resource is tapped to gain a product)	RECREATIONAL ACTIVITIES AND EXPERIENCES	HUNTING AND FISHING
↓	↓	↓
PRODUCT (what is derived from the resource)	MULTIPLE SATISFACTIONS	EXERCISE, DISPLAYING SKILL, COMPANIONSHIP, SUCCESS, ETC
↓	↓	↓
GOALS (ultimate objectives of management)	HUMAN BENEFITS	PHYSICAL BENEFITS (such as health), PSYCHOLOGICAL BENEFITS (such as self-esteem), PERSONAL BENEFITS (such as social relationships), ECONOMIC BENEFITS (such as food)

Hunting Satisfaction: Game, Guns or Nature?, by D.R. Potter, J.C. Hendee, and R.N. Clark (36)

Hunting satisfaction is complex and consists of many elements or aspects of the hunting experience. Different hunters gain varying degrees of satisfaction from the different elements. A questionnaire was sent to hunters and a multiple-satisfaction model developed from the responses. The model indicates that the capacity to provide hunters with the satisfactions they seek may decline before either the amount of game or sheer physical space becomes a limiting factor.

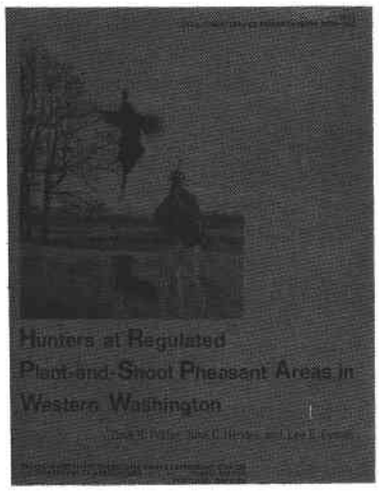
The growth of hunting, coupled with relatively little potential for change in the amount of game and land available, indicates that the numbers of hunters will have to be managed carefully—perhaps limited to maintain opportunities for quality hunting of whatever kind.

Generic and specific satisfactions from hunting.

Generic satisfactions (Important to all kinds of hunting, but form and intensity may vary)	*Specific Satisfactions* (Importance as well as form and intensity varies with kind of hunting)
Nature	Skill
Escapism	Vicariousness
Companionship	Trophy-Display
Shooting	Equipment
Harvest	
Outgroup verbal	
Outgroup visual	

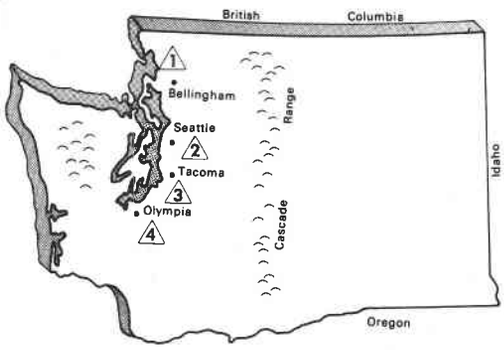
Social Science, Social Scientists, and Wildlife Management, by R.N. Clark (37)

Integrating social science perspectives and methods into wildlife programs is urged by the author. He further suggests that long-term, continuous interaction between social scientists and wildlife managers, at many levels of expertise, is necessary to facilitate the sharing of knowledge and viewpoints. Specific problems associated with the relationship between social and wildlife sciences are discussed, and recommendations outlined.



Hunters at Regulated Plant-and-Shoot Pheasant Areas in Western Washington, by D.R. Potter, J.C. Hendee, and L.E. Evison (38)

Hunters visiting four public plant-and-shoot pheasant-hunting areas in Washington's Puget Sound basin were studied by use of a mail questionnaire. Findings suggest positive values from a popular program, the need to reduce crowding, a need to more equitably distribute hunting success, and a revenue potential from a user charge. Hunter's sex, age, education, occupation, income, residence, organization membership, and hunting-related reading habits, motives, complaints, and success are described. Management recommendations are developed from the study findings.



Location of the four regulated plant-and-shoot pheasant-hunting areas studied in Washington: (1) Lake Terrell, (2) Stillwater, (3) Fort Lewis, (4) Scatter Creek.

research program of the U.S. Department of Agriculture. Nine western states and British Columbia were involved. All cooperators reported captures of moths in areas where they could not be detected by other methods. In addition to Douglas-fir tussock moth, three other species were attracted by the chemical. Methods have been worked out to distinguish the different species captured in the cages.

With pheromone studies the primary effort is to develop an effective trapping procedure. Researchers tested trap design, trap placement, the number of traps needed in an area, and the attractant dosages needed. The goal is to determine the relationship between the number of moths trapped to the total number in a given area. When applied over a wide area, a trapping system could pinpoint areas where populations are increasing and require intensive surveillance. This information would help land managers forecast potential epidemics and make decisions about the need, timing, and methods for control.

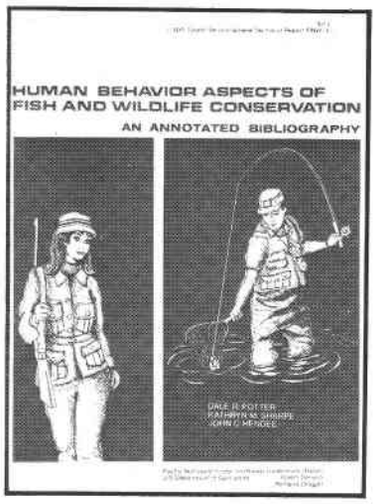
New information about the geographic range of the Douglas-fir tussock moth was also gathered by placing hundreds of traps in Oregon, Washington, Idaho, Montana, California, Colorado, New Mexico, Arizona, Utah, and British Columbia. This information will also help identify areas where other insects (such as related tussock moths) are attracted.

The possibility that the sex attractant may be used for direct control is also under study. One way to do this may be to disrupt the reproductive behavior of the moth by permeating the atmosphere with the attractant so male moths cannot find the females. This approach has already been used successfully in field experiments against the gypsy moth and some agricultural pests.

Like most insects, the Douglas-fir tussock moth operates by instinct and reacts to behavioral stimuli. Once a stimulus such as the pheromone has been duplicated it can be used to mainpulate or disrupt the normal life processes of an insect. The use of pheromones is particularly promising since only small quantities are needed, and there appears to be no hazard to other parts of the environment.

end

next "insight" page 155



Human Behavior Aspects of Fish and Wildlife Conservation, by D.R. Potter, K.M. Sharpe, and J.C. Hendee (39)

This annotated bibliography was compiled to aid students, teachers, researchers, conservationists, and managers seeking literature on nonbiological or human behavior aspects of fish and wildlife conservation, including sportsman characteristics, safety, law enforcement, professional and sportsman education, nonconsumptive uses, economics, and history. There are 995 references from 218 different sources. Also included are a list of reference sources used, an author index, and keywords, along with a keyword index.

other

Skiing—"And on Grass Base," by G.O. Klock and W.A. Hampton (40)

Field tests in revegetating ski slopes on Mission Ridge near Wenatchee, Washington, demonstrate that the method of planting is perhaps as important as the choice of seed mixture. It is important to use a starter fertilizer with a fall planting and cover the seed and fertilizer with a thin layer of soil. This practice would also likely be successful on spring plantings, but the inaccessibility of these areas due to snowbanks and wet soil conditions make such plantings impractical.

Mission Ridge—A Case History of Soil Disturbance and Revegetation of a Winter Sports Area Development, by G. Klock (41)

Soil disturbance areas caused by construction of Mission Ridge, a winter sports area, are identified and a review is made of the operator's use of forest research findings to reduce the effects of these disturbances. Soil disturbances were caused by construction of buildings, parking facilities, roads, trails, and summer slope grooming.

A reasonable land use plan by the U.S. Forest Service and the Mission Ridge management provided an excellent recreation area with a minimum impact on the soil resource. The best test for those concerned about the development's effect on the environment would be its effect on the domestic water supply in the lower valley. No change in water quality has been measured, although the county access road poses a potential threat of sedimentation.

The Demand Survey Dilemma: Assessing the Credibility of State Outdoor Recreation Plans, by R. Burdge and J. Hendee (42)

The authors reviewed twelve demand surveys conducted in support of state recreation plans. Recreation use surveys have been conducted for several years in compliance with Land and Water Conservation Act requirements for matching funds. In most states, the second generation of surveys will soon begin. It is not clear that the multimillion dollar investment in recreation surveys has provided accurate information on recreation trends and facilitated more efficient investment in acquisition and development of facilities.

The authors examine the problems encountered in using demand surveys and recommend that future recreation demand surveys be based on random, stratified samples of the general population. *In lieu* of desirable but expensive personal interviews, telephones can be utilized with supplemental personal interviews to include persons with no phones. Carefully prepared interview schedules must be developed with adequate pretesting of both the data collection and analytic procedures. In addition to social and demographic variables, a broad range of outdoor recreation and other leisure activities must be covered including data on where and when it occurs.

Land-Use Planning: A View from Holland, by J. Alan Wagar (43)

Participation in a Dutch planning study suggested that public resource decisions require input from at least five groups: diverse specialists, interest groups, analysts, plan builders, and decision-makers. Integrating these inputs requires emphasizing meanings rather than details, careful distinction between facts and values, and a defensible hierarchy of values. A computer mapping technique for identifying and defining alternatives is described.

Forestry's Response to Increased Demand for Commodity and Amenity Values, by J.C. Hendee (44)

Future demands on forest resources will require more intensive management, emphasizing multiple use. The political support necessary to finance more intensive management will depend on better consensus among various forest clients. Preference for roaded versus unroaded areas obscures the broader range of values desired from each. Three trends with long-range implications include the energy crisis, increasing popularity of commodity activities, and the value of forests as a medium for employment, education, and rehabilitation of people.

Many of the recreational uses of roaded forest land now accrue as an incidental by-product of roads built to harvest timber—but more by accident than by design.

Recreation Insights from Europe, by J.A. Wagar (45)

After a year (1973-1974) spent in The Netherlands, with side trips into England, Switzerland, Germany, France, Belgium, and Liechtenstein, the author describes some important insights gained on European landscape management, interpretation, recreation management, and land-use planning.

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watershed

See also: Research Facilities
Ecosystems, Classification
Silviculture
Forest Engineering
Fire
Alaska
Gadgets

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Contents

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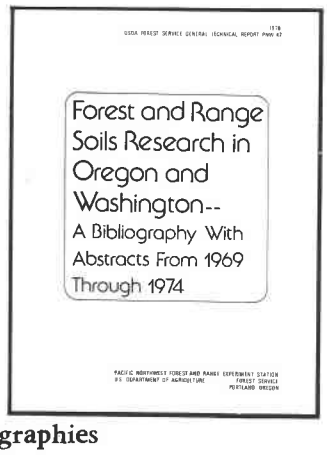
soils, nutrient cycling



Bibliographies

Three bibliographies have been published on soils research under the main title, *Forest and Range Soils Research in Oregon and Washington—A Bibliography With Abstracts.* Reports are available for the following years:

From 1969 Through 1974, compiled by Glen O. Klock (1),

From 1964 Through 1968, compiled by Glen O. Klock (2), and

A Bibliography With Abstracts Through 1964, compiled by Robert F. Tarrant (3).

Note: Terminology used in papers on soils is based on a standard system of soil classification. The reference on that is the 754-page book, *Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys,* Agriculture Handbook No. 436, Soil Conservation Service, U.S. Department of Agriculture, December 1975, for sale by the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Price is $17.50; order stock number 001-000-02597-0.

Chemical and Physical Properties of Forest Litter Layers in Central Washington, by David D. Wooldridge (4)

Forest floor layers and their associated microflora and fauna are probably the most dynamic phase of the forest ecosystem and are of great importance in forest land management.

Annual contributions of litter on the forest floor represent a revolving fund of plant nutrients, particularly nitrogen, phosphorus, and sulfur. Forest floors are a food supply and habitat for many soil organisms. These organisms are important in litter decomposition and maintenance of soil physical properties as well as being the active agent in the dynamics of nutrient cycling in forest ecosystems.

This study reports information developed about the physical and chemical properties of forest L, F, and H layers on the east slopes of the Cascades in central Washington.

Evaluating Soil Samples

Soil studies in central Washington indicate that care should be taken in evaluating data from soil samples where the samples are taken at different times. In this study, basalt soils sampled during 1968-69 showed significant periodic variation in cation exchange capacity, pH and Na and K contents. In sandstone soils, cation exchange capacity and Ca, Na, and K content varied significantly among sampling dates.

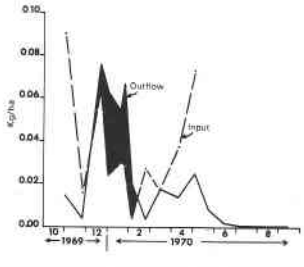
See *Periodic Variation in Physical and Chemical Properties of Two Central Washington Soils,* by Tom D. Anderson and Arthur R. Tiedemann (5).

Nutrient Budget of a Douglas-fir Forest on an Experimental Watershed in Western Oregon, by R.L. Fredriksen (6)

The purpose of this study was to measure the inputs, losses, and retention of plant nutrients on two small watersheds in the H.J. Andrews Experimental Forest. Initial results from one watershed are reported.

Annual loss of nitrogen, phosphorus, silica, and the cations sodium, potassium, calcium, and magnesium followed the same pattern as annual runoff which is heavily dominated by winter rainstorms arising from the Pacific Ocean. Even though a lot of water passed through this ecosystem in the 2 years of the study, the system very effectively conserved nitrogen. In fact, there was a small gain in nitrogen. There were small annual losses of phosphorus and potassium. Calcium, sodium, and magnesium losses were very large with the quantity decreasing in the order given. Silica loss was very high.

Although sediment loss was low during the study period, the loss of nutrients through soil erosion may be of major importance over the long term due to catastrophic erosion events that are few and far between.



Input in precipitation and loss in runoff of dissolved organic nitrogen for each sampling period, 1969-70.

Soils in Northeastern Oregon

A two-part series describes the chemical characteristics of forest and grassland soils on the Starkey Experimental Forest in the Blue Mountains of northeastern Oregon.

I. *Chemical Characteristics of Some Forest and Grassland Soils of Northeastern Oregon. I. Results From Reference Profile Sampling on the Starkey Experimental Forest and Range,* by Jon M. Geist and Gerald S. Strickler (7)

This paper describes results of chemical analyses of six soil series. Among the forest soils, available phosphorus was consistently much higher in the Tolo profiles. Organic matter and total nitrogen values were comparatively low. Couse and Klicker soils had higher levels of total exchangeable cations than did the Tolo soils. Only minor differences were noted among grassland soils. However, the Rock Creek soil was quite low in available P.

II. *Chemical Characteristics of Some Forest and Grassland Soils of Northeastern Oregon. II. Progress in Defining Variability in Tolo and Klicker Soils,* by J. Michael Geist (8)

These data establish a firmer data base for virgin soils of the Tolo and Klicker series. The results will be useful in assessing land management impacts on the soil resource.

Comparisons are made of several characteristics of both Tolo and Klicker soils. Results indicate that Tolo soils are generally less fertile. Topsoil conservation practices should be stressed in heavy equipment use on both Tolo and Klicker soils. The data indicate that precautions are necessary in soil sampling, particularly if fertilization guides are to be useful in determining effects of forest management on soil chemical systems.

Soil Moisture Trends Under Three Different Conditions, by H.G. Herring (11)

A 3-year study of summer soil moisture trends was conducted on the Mission Creek drainage of the Wenatchee National Forest. Soil moisture trends were collected on a grassy opening, a second-growth ponderosa pine stand, and a clearcut plot in the pine stand.

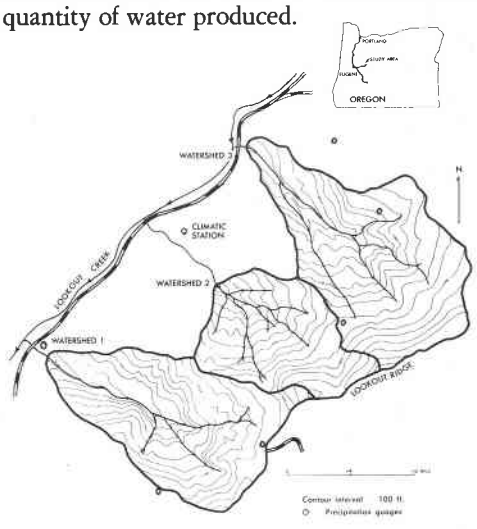
The grassy openings and ponderosa pine stand showed very similar soil moisture regimes except during years of abnormally low winter precipitation and for soils deeper than average for the ponderosa pine zone of north-central Washington. Removing ponderosa pine results in a higher soil moisture content at the end of the growing season.

effects of logging

water quality

Hydrologic and Related Characteristics of Three Small Watersheds in the Oregon Cascades, by J. Rothacher, C.T. Dyrness, and R.L. Fredriksen (12)

Three small study watersheds were established in the H.J. Andrews Experimental Forest in 1952 for study of the quality and quantity of water produced.



In this report, the authors summarize information about geology, soils, vegetation, climate, streamflow, sediment yield, nutrient content, and temperature of streams. Concepts developed serve as benchmarks for watersheds within the Douglas-fir forests on the western slopes of the Oregon Cascade Range. The data collected from these undisturbed watersheds will provide the basis for determining changes that occur as the result of planned timber harvesting.

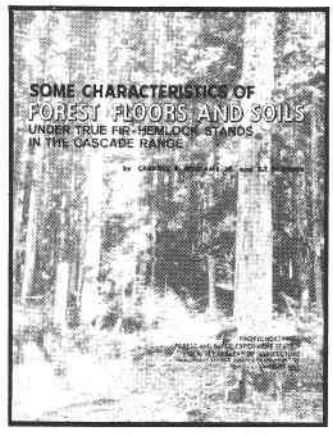
Transpiration of Conifer Seedlings in Relation to Soil Water Potential, by W. Lopushinsky and G.O. Klock (9)

A major factor affecting transpiration is the availability of soil water. This paper compares the transpiration response of five species of conifers, native to the Pacific Northwest, to decreasing soil water potential. The experiments were conducted with 4-year-old seedlings of ponderosa pine, lodgepole pine, Douglas-fir, grand fir, and Englemann spruce.

The results showed that the transpiration rate of ponderosa pine was reduced to a greater degree at intermediate and low levels of soil water potential than that of Douglas-fir. The demonstrated ability of the pines to reduce their rate of water loss to a greater degree than the firs helps to explain the survival of ponderosa and lodgepole pine on relatively dry sites and the presence of the firs on relatively more mesic sites.

Demonstration of differences in transpiration behavior of these species also has significant implication for watershed management: a species which shows a large decrease in rate of water loss when subjected to moderate soil drying should be a more economical user of water than a species in which water loss is less affected by soil drying.

Bill Lopushinsky



Some Characteristics of Forest Floors and Soils Under True Fir-Hemlock Stands in the Cascade Range, by Carroll B. Williams, Jr., and C.T. Dyrness (10)

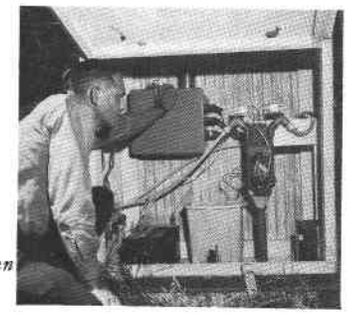
An exploratory study in which soils were sampled in 46 undisturbed, old-growth true fir-hemlock stands along the Cascade Range from Diamond Lake in southern Oregon to Mt. Baker in northern Washington. The 46 plots provide a cross section of sites occupied by true fir-hemlock forests.

Results indicate that forest floors under true fir-hemlock stands in Oregon and Washington generally attain only moderate thickness. Nutrient content varied greatly from plot to plot, and there was little apparent correlation between nutrient content and ecological province. Available phosphorus content appeared considerably higher under Pacific silver fir stands, and noble fir forest floors contained more calcium. Otherwise, nutrient content was virtually uniform among forest types. Nutrient levels appear to be adequate for good tree growth, with the possible exception of phosphorus.

Timber Production and Water Quality —Progress in Planning for the Bull Run, Portland, Oregon's Municipal Watershed, by R.L. Fredriksen and Richard N. Ross (13)

The Bull Run Municipal Watershed constitutes a cooperative land use planning effort between the City of Portland and the Mt. Hood National Forest. Using this watershed as an example, the authors review information on resource inventories, consider research about land processes, and describe the planning process used to coordinate land capabilities to land use. They conclude by illustrating the land use planning process by presentation of two examples: (a) The Fox Creek Experimental Watershed Study, and (b) the North Fork of the Bull Run River.

The planning process described is new and evolving and must be viewed as continuing. It is being tested along with other approaches in use throughout the country, and evaluation and refinement of the plan must be done. Research will continue to provide better information for developing management prescriptions. Nutrient enrichment, bacteriological quality, and the effect of reservoirs as a source or a sink in planning are areas needing further study.



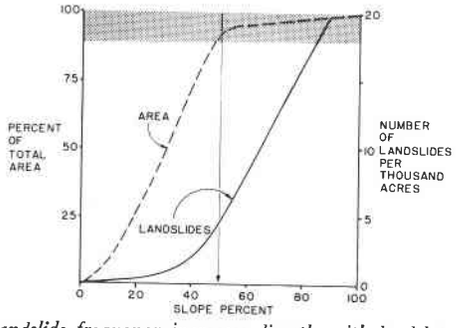
Dick Fredriksen

Impact of Forest Management on Stream Water Quality in Western Oregon, by R.L. Fredriksen (14)

Aspects of water quality and forest management considered by the author include sedimentation, forest fertilization, loss of naturally occurring nutrients, and water temperature. Discussion is presented on how erosion processes deliver soil to streams, how logging increases loss of soil, and how erosion of forests and sedimentation of rivers can be minimized.

Relevant questions about nutrient chemicals in streams are selected and discussed: (a) Do nutrient concentrations in forest streams increase after logging or fertilization? (b) Are the concentrations raised to levels that are toxic to living organisms? (c) Do increased concentrations of nutrients lead to noxious overproduction of aquatic plants?

The author concludes with discussion of the principal impact of elevated stream temperatures and their effects upon resident trout and anadromous fish.

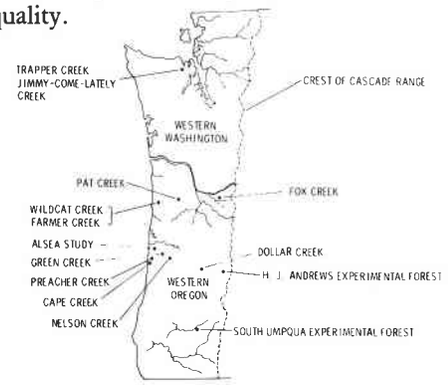


Landslide frequency increases directly with landslopes greater than 50 percent. These steep, actively eroding lands occupy less than 10 percent (shaded area) of the H.J. Andrews Experimental Forest, Oregon.

The Impact of Timber Harvest, Fertilization, and Herbicide Treatment on Stream Water Quality in Western Oregon and Washington, by R.L. Fredriksen, D.G. Moore, and L.A. Norris (15)

This comprehensive review, presented at the Fourth North American Forest Soils Conference in Quebec in 1973, presents concepts about the processes of soil erosion and stream sedimentation, the outflow of native nutrients, fertilizers and herbicides in streams, and illustrates concepts with research findings from experimental watersheds in western Oregon and Washington.

The authors concluded that: (a) Sedimentation of forest streams after timber harvest increases with increasing angle of slope. Roads that cross steeply inclined stream channels cause much greater levels of sedimentation than roads on ridge tops; (b) nutrient loss following clearcutting decreases rapidly with revegetation; (c) nitrogen in streams from forest fertilization does not exceed published standards and the total loss of applied nutrients is relatively small; (d) long-term consequences of repeated forest fertilization must be determined; and (e) drift or direct application of spray materials to surface waters is the principal route of herbicide entry to streams. Overland flow and leaching are relatively unimportant in forest stream pollution. Carefully controlled herbicide applications are not expected to have a significant impact on forest stream quality.



Locations of experimental watersheds in western Oregon and Washington.

AN UNDERGROUND BOOST FOR SEEDLINGS

by Dorothy Bergstrom

Several thousand tree seedlings recently planted by Weyerhaeuser Company in Washington and Oregon are fighting for survival on forest sites where regeneration has been extremely difficult. Researchers are watching them closely to see whether they will establish the new roots they need to survive and grow.

The seedlings, planted in the spring of 1976, are Douglas-fir, ponderosa pine, and western hemlock. Because of research, they may have a chance to become established where others have failed. Before being planted on Weyerhaeuser tree farms, they were given a boost with a specially selected mycorrhizal fungus. The seedlings started life in the laboratories and greenhouses of the PNW Station in Corvallis, Oregon. They grew from seeds planted in containers of vermiculite and peat moss, to which a mycorrhizal fungus had been added.

Mycorrhiza literally means "fungus root." Fungi capable of forming a symbiotic or mutually beneficial relationship with trees are known as mycorrhizal fungi. These fungi form mantles around the roots of plants and assist them in three important ways: (1) they help the roots absorb nutrients and water, (2) they protect the trees from harmful fungi, and (3) they produce growth regulators that foster increased growth and prolong the life of rootlets.

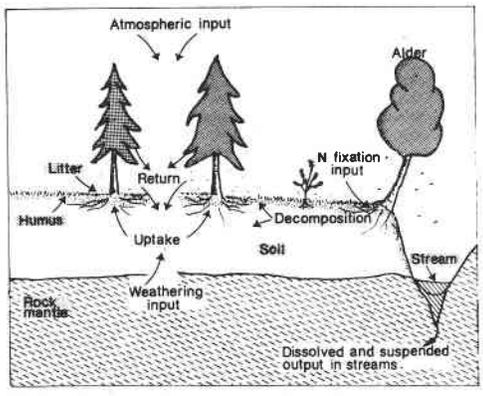
In 1974, Weyerhaeuser and the Pacific Northwest Station began a cooperative study to find out whether reforestation success on hard-to-regenerate sites could be significantly improved by inoculating container-grown seedlings with mycorrhizal fungi. The Weyerhaeuser study was designed by Bratislav Zak, PNW plant pathologist, recently retired. He worked closely with Donald H. Marx, project leader for research on soil-borne organisms at the Southeastern Station, in planning the study. Southeastern Station researchers had successfully introduced mycorrhizal fungi into nursery beds, but no one had tried inoculating seedlings for planting in the Douglas-fir region.

The initial phase of the Northwest study established inoculation methods, growing medium, and fertilizer levels. Then the seeds of ponderosa pine, western hemlock, and Douglas-fir were planted in individual

Comparative Chemical Water Quality —Natural and Disturbed Streams following Logging and Slash Burning, by Richard L. Fredriksen (16)

A comparison of studies on differences in water quality in natural streams and streams disturbed by logging and slash burning showed that loss of nutrient cations increased 1.6 to 3.0 times, following timber harvest and slash burning, when compared with an undisturbed watershed.

A surge of nutrients that followed broadcast burning contained concentrations of ammonia and manganese that exceeded federal water quality standards for a period of 12 days. Annual nitrogen loss following burning averaged 4.6 pounds per acre; 53 percent of this was organic nitrogen contained in sediment. Inorganic nitrogen, dissolved in the stream, made up the remaining part. Annual loss of nitrogen from the undisturbed forest was very small—.16 pound per acre. A review of literature pertinent to the coast Douglas-fir region was included.



Major elements and processes in a forest ecosystem.

Managing Forest Land for Water Quality, by Jack Rothacher (17)

Water quality management relates to problems of ultimate social importance. Technology is available to control large-scale changes in sediment, temperature, and chemical and bacteriological quality of water from forest land. In many cases, water quality considerations are also economic in terms of maintaining site quality, minimizing road mileage and maintenance, and reducing treatment costs.

In general, managing forest lands for water quality involves a society-oriented attitude on the part of the forest manager in contrast with the traditional economic resource-oriented attitude.

Man-Caused Fluctuations in Quality of Water From Forested Watersheds, by R.F. Tarrant (18)

Forest land managers are beginning to realize the urgent need for water quality standards to measure their success in maintaining a water supply of sufficiently high quality for the great variety of uses to which it may be put downstream. These include domestic water, recreation and esthetics, support of fish and other aquatic life, wildlife, and agricultural and industrial uses.

Man's actions may directly or indirectly cause changes in water quality by altering energy patterns, chemical or physical properties, or abundance of organisms therein. When such changes adversely affect man, we call the phenomenon water pollution.

It is apparent that the changes in energy patterns, chemical or physical constitution, or abundance of organisms in forest waters that do constitute pollution are most often the result of man's activity. Results of research throughout the world indicate also that it is possible for man to enjoy the economic and aesthetic values afforded by forested areas and yet maintain an unpolluted supply of water. The key to producing multiple benefits from the forest, including high quality water, is the amount of care that the forest watershed manager can and will exert in all his activities.

logging roads and erosion

Small Watersheds Studied

In studies on stream sedimentation rates after road construction, timber harvest, and debris burning on the H.J. Andrews Experimental Forest, it was found that minimal deterioration in water quality from sedimentation may be achieved when disturbance from road construction is minimized by reduction of midslope road mileage through use of specially designed yarding systems. Where midslope roads must be constructed across steep sideslope or headwall areas, all knowledge available to the engineer should be used to stabilize roads. In the logging operation, every effort should be made to minimize disturbance to the streambed by keeping slash and debris out of streams.

See *Erosion and Sedimentation Following Road Construction and Timber Harvest on Unstable Soils in Three Small Western Oregon Watersheds,* by R.L. Fredriksen (19).

Impact of Clearcutting and Road Construction

To compare the impacts of clearcutting and road construction on soil erosion by landslides, the H.J. Andrews Experimental Forest was divided into two zones of approximately equal area. The zones, one stable and one unstable, had strikingly different susceptibilities to erosion by rapid soil movements.

Since logging and road cutting began in 1950, only two small road-related slides have taken place in the stable zone. In contrast, the unstable zone has been the site of 139 slides during the same period.

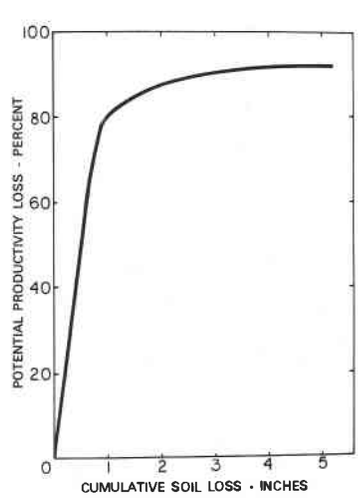
When road impact is assessed at a level of development comparable to timber cutting, roads contribute about half of the total management impact. The combined impact of roads and clearcut logging has constituted a five-fold increase in landslide erosion relative to undisturbed forested areas.

See *Impact of Clear-Cutting and Road Construction on Soil Erosion by Landslides in the Western Cascade Range, Oregon,* by F.J. Swanson and C.T. Dyrness (20).

Estimating Two Indirect Logging Costs Caused by Accelerated Erosion, by G.O. Klock (21)

Indirect costs of onsite and downstream damages due to logging operations were analyzed for their potential use in hypothetical erosion assessment models.

By using the soil erosion potential for several yarding systems to determine the erosion assessments, total relative logging costs for each system may be evaluated. This evaluation method may show that environmentally acceptable advanced systems of yarding could cost less than traditional yarding systems at some locations.



Potential productivity loss as a function of cumulative surface soil loss.

Factors Affecting Mass Movement of Four Soils in the Western Cascades of Oregon, by R.C. Paeth, M.E. Harward, E.G. Knox, and C.T. Dyrness (22)

Four soils derived from tuffaceous rock in the western Cascades were studied to determine relationships to slope stability. The study was undertaken to determine physical, chemical, and mineralogical properties of the four soils in order to understand why soils formed on greenish tuff and breccia were more prone to mass soil movements than soils formed on yellowish and reddish tuff and breccia.

Soils prone to slope failure were characterized by high amounts of smectite clay, absence of kaolin, and moderate amounts of free iron oxide. The more stable soils contained kaolin, more chlorite and chloritic intergrades, less smectite, and higher amounts of free iron oxide.

While all four soils contained appreciable amounts of clay, there was no consistent relationship between clay content by mechanical analysis and stability of the soils on slopes. Soil and rock colors, however, seem to provide a local field guide for prediction of clay mineralogy and relative landscape stability.

Judging Impact and Damage of Timber Harvesting to Forest Soils in Mountainous Regions of Western North America, by Douglas N. Swanston (23)

Slope disturbance produced by forest operations in mountainous regions has been clearly identified as a major contributor to accelerated soil mass movements. Roadbuilding is the most damaging operation, but timber cutting and slash burning have also been shown to be significant initiators of mass erosion activity.

Since timber harvesting is a major economic activity in mountainous areas and is rapidly advancing onto increasingly unstable terrain, it is essential that the land manager be able to recognize potential problem zones and identify major factors contributing to instability.

There are two main options available to the land manager. He can: (a) identify problem areas and avoid operations on unstable terrain, or (b) identify and attempt to control operational effects. In highly unstable areas or areas of questionable economic value, avoidance of all operations is probably the best and least expensive solution. Controlling operational effects is a much more difficult approach which at best will probably be only partially successful. It is applicable in high value areas of questionable soil stability or where other considerations override a desire for stability maintenance.

Map of aerial extent and severity of landslide problems in the United States.

Principal Soil Movement Processes Influenced by Road-Building, Logging and Fire, by Douglas N. Swanston (24)

Studies on watersheds of the Intermountain and Pacific Coast States indicate that there are four dominant natural soil mass movement processes active (listed in order of decreasing importance and regional frequency of occurrence): (a) debris avalanches, debris flows and debris torrents; (b) slumps and earth flows; (c) deep-seated soil creep; and (d) dry creep and sliding. Roadbuilding, logging and fire play an important part in initiation and acceleration of the four kinds of soil mass movements.

Roadbuilding stands out at the present time as the most damaging activity, with soil failures resulting largely from slope loading, back-slope cutting, and inadequate slope drainage. Logging and fire affect stability primarily through destruction of natural mechanical support for the soils, removal of surface cover, and obstruction of main drainage channels by debris.

logging and streamflow

Does Harvest in West Slope Douglas-fir Increase Peak Flow in Small Forest Streams? by Jack Rothacher (25)

Studies on the H.J. Andrews Experimental Forest indicate that timber harvest by overhead cable (in situations where logging roads occupy no more than 6 percent of the drainage) has only a minor effect on major peak streamflows which occur when soils are thoroughly wet. Exceptions are the early fall storms following the dry summers characteristic of the west coast climate. At this time, peak streamflow from unlogged areas may be less than in the harvested area because the soil in the unlogged area is drier and has greater moisture storage capacity than in the harvested area. These early fall storms rarely result in major peak streamflows.

containers of vermiculite and peat moss inoculated with a pure culture of one of four species of mycorrhizal fungi. The fungi, isolated in the laboratory from fresh mushrooms, were selected because they are widely distributed in western forests and can be grown in laboratory cultures. One of the species is prominent in Douglas-fir forests; the other three are commonly found under ponderosa pine and western hemlock as well as Douglas-fir.

The seedlings grew in their containers in the Corvallis lathhouses for about 6 months before they were planted on Weyerhaeuser tree farms near Mount St. Helens, Washington, and Klamath Falls, Oregon.

Before the study is completed, several thousand more seedlings will be inoculated with other fungi before being planted. When measurements of seedling survival and growth on the tree farms are completed in 1978, researchers will be able to tell foresters which of the mycorrhizal fungi tested best aid seedling establishment on hard-to-regenerate sites in Northwest forests.

Although the concept of mycorrhizae was advanced as early as 1842, Mycologist Jim Trappe, project leader for research in tree root symbiosis and current director of the Weyerhaeuser study, has found that it is not generally well understood by foresters and others who are responsible for reforestation programs.

Researchers have known for some time that all economically important forest trees and most forage plants need mycorrhizae for survival and satisfactory growth.

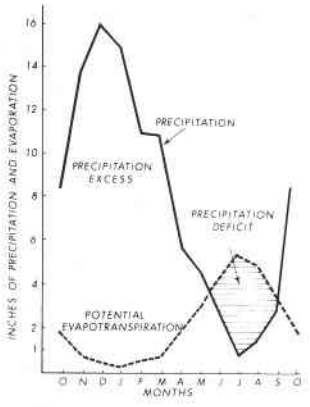
The importance of mycorrhizae has been demonstrated by the failure of exotic trees to flourish when planted in distant parts of the world. However, when suitable mycorrhizal fungi have been added to nurseries or planting sites, the survival and growth of these trees have improved dramatically. Similarly, on mining spoils, areas never forested, or those where trees have been absent for a long time, naturally seeded plants usually die unless spores of mycorrhizal fungi carried by air or animals are washed into the soil.

In the forest, mycorrhizae develop when the growing roots of a seedling encounter spores or mycelium of mycorrhizal fungi. The spores germinate and the growing fungi surround the roots. However, if this process is

Regimes of Streamflow and Their Modification by Logging, by Jack Rothacher (26)

In the H.J. Andrews Experimental Forest, measurements of changes in streamflow from clearcutting and partial cutting on old-growth Douglas-fir forests were compared with data on precipitation, evapotranspiration, soil moisture, and seasonal streamflows to determine if stream regimes and their fish resources are significantly altered by logging.

It was concluded that although timber harvest may influence the stream environment in a number of ways, evidence to date suggests that any modification in streamflow regime is probably generally beneficial to the fishery, at least on the west slope. More water flows in the streams all year long; major flood flows are apparently not markedly increased; minimum streamflow during dry summers is materially increased. In the majority of cases, changes in streamflow resulting from vegetation manipulation will probably be much less than the normal climatic variation.



Mean monthly precipitation and evapotranspiration.

High Yield From the Bull Run Watershed, by L.V. Luchin (27)

Measurements on the Bull Run watershed were made to determine whether water production is higher or lower than should be expected when comparing actual discharge with computed yields.

It was found that other than by removing vegetation to decrease interception and transpiration, no means of substantially increasing water yields from Bull Run watershed appear to be feasible. Furthermore, it is important to note that the feasibility of increasing water yields through removal of vegetative cover has been considered purely from a physical standpoint. The removal of vegetative cover from areas of the watershed will affect other resources such as wildlife, soils, water quality, and esthetics. Before attempting large-scale increases in water yields, watershed managers must determine the effect of the proposed actions upon other watershed resources.

Forest Land Use and Streamflow in Central Oregon, by H.W. Berndt and G.W. Swank (28)

In this case study of Ochoco Creek, the hydrologic performance of a 295-square mile drainage in central Oregon was compared with the land use history for the period 1921-65. Two distinct changes in streamflow regimen were identified. The first, beginning about water year 1942, was an increase of 2.21 inches in average annual yield. The timing of this increase is approximately coincident with the onset of timber harvesting activity in the basin. The second change was a decrease of 1.18 inches in average water yield beginning about 1958. This change could possibly be related to the full stocking of cutover lands by dense, second-growth stands and a general reduction of timber harvest activity.

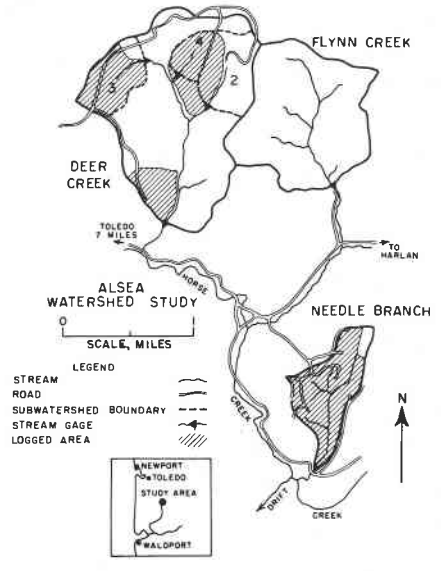
Though more sensitive, refined tests of the influence of timber harvest on water yield are needed for stands east of the Cascade Range, the analyses in this report show that accepted management practices for vegetative types found on Ochoco Creek have favored water yields.

Changes in Storm Hydrographs After Road Building and Clear-Cutting in the Oregon Coast Range, by R.D. Harr, W.C. Harper, J.T. Krygier, and F.S. Hsieh (29)

Six small watersheds in the Oregon Coast Range were studied and data gathered on changes in storm hydrographs after road building, clearcutting, and burning. It was found that peak flows increased significantly after road building, but only when roads occupied at least 12 percent of the watershed.

Roads had no detectable effect on volumes of storm hydrographs. By reducing transpiration and interception, partial clearcutting increased peak flow, quick flow, delayed flow, and total storm hydrograph volume of some streams. Most increases were largest in the fall when maximum differences in soil water content existed between cut and uncut watersheds.

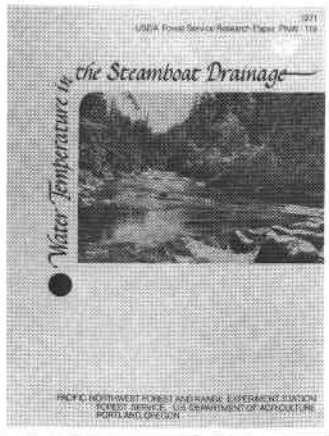
The effect of roads on peak flows has significance for design of culverts and bridges in headwater areas, but probably does not influence downstream flooding. Increases in streamflow after clearcutting should have no appreciable effect on either damage to bridges and culverts in headwater areas or downstream flooding. Caution must be used in extending results of this study to storm runoff events of low frequency and large magnitude.

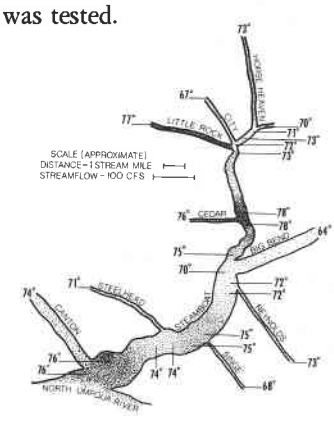


Watersheds in the Alsea watershed study.

Water Temperature in the Steamboat Drainage, by George W. Brown, Gerald W. Swank, and Jack Rothacher (30)

Stream temperatures were studied in the Steamboat drainage in the North Fork of the Umpqua in Oregon. Logging operations in this area are typical of much of the commercial forests on the west slopes of the Cascade Range. Changes in water temperature of tributary streams influenced by various degrees of exposure from logging were measured, and a simplified prediction equation was tested.





Maximum water temperatures (degrees F.) on Steamboat Creek and tributaries, July 27, 1969.

slope stability problems

Stability of Steep Land, by D.N. Swanston and C.T. Dyrness (31)

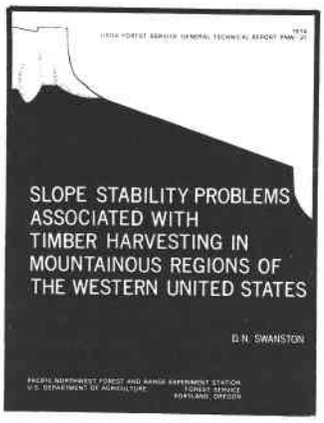
One of the most important factors affecting stability of steeply sloping terrain is disturbance. As a general rule, with increasing disturbance comes increasing erosion. The actual erosion processes include both surface erosion and mass soil movement.

On-site erosion reduces site productivity by removing soil material and lowering nutrient capital available for plant growth. The resulting soil and debris causes damage to roads and other improvements, ranging from roadblocks by landslide debris to houses buried by mudslides.

Continuing instability may cause difficulty in reestablishing protective vegetation and tree seedlings.

Downstream effects include lowering of water quality by increased sediment and dissolved chemical content; shortened life span of reservoirs due to excessive siltation; and degradation of fish habitat through increased sediment in spawning gravels and blockage of fish passage by landslides.

Reduction in landslide incidence is best approached through improved road design and construction and planting vegetation to stabilize disturbed areas. Some effective road design and construction techniques are already available to the engineer and land manager; it is their successful application which will determine the final impact.



Slope Stability Problems Associated With Timber Harvesting in Mountainous Regions of the Western United States, by D.N. Swanston (32)

As forest operations shift to steeper slopes, they play an increasing role in initiation and acceleration of soil mass movements. Logging operations create major problems through (a) destruction of roots, the natural mechanical support of slope soils, (b) disruption of surface vegetation cover which alters soil water distribution, and (c) obstruction of main drainage channels by logging debris. Road building stands out at the present time as the most damaging operation with soil failures resulting largely from slope loading (from road fill and sidecasting), oversteepened back cuts, and inadequate provision for slope and road drainage.

At the present time, attempts at prevention and control are limited to identification and avoidance of highly unstable areas and development and implementation of timber harvesting techniques least damaging to natural slope stability.

Debris torrent developed in an intermittent stream channel along the South Fork of the Salmon River in Idaho. Initial failure occurred in road fill near the ridgetop.

Soil Moisture Tension Variation on Cutovers in Southwestern Oregon, by William E. Hallin (33)

Three study areas, Calf Creek, South Umpqua, and Dead Indian, in southwestern Oregon were examined for purposes of collecting data on soil moisture tensions. From these data, the author reports on characteristics of soil moisture retention for several southwestern Oregon forest soils; describes variation in soil retention in relation to parent material, aspect, depth, clay content; and compares soils moisture tension on cutovers with and without vegetation during the driest part of the growing season. Soil texture is also discussed to characterize the study soils.

Doug Swanston

delayed, a seedling's roots may be invaded by harmful fungi. If the seedling survives, it may be stunted. Some seedlings will grow without mycorrhizae in the nursery, provided they are given sufficient nutrients and pathogens are controlled. But, when seedlings are planted in the forest, the mycorrhizae are essential.

Researchers have also found that mycorrhizal fungi vary in their environmental requirements. Some tolerate a wide range of conditions; others do not. Mycorrhizal fungi may unite with roots of seedlings growing in nursery beds, but if these fungi are not adapted to the sites where the seedlings are planted, they may not function or may even die. If that happens, the seedlings also will die unless they contact mycorrhizal fungi native to the planting site soil.

The ways mycorrhizal fungi reproduce are significant for forest management. Although most mycorrhizal fungi live in the upper few inches of soil, some surface to reproduce. Miniature mushrooms and toadstools are formed underground. At the proper stage of development, they suddenly take on water and push their way through the soil surface to expand and discharge their spores. The spores are carried by the wind and washed back into the soil by rain. Other species, such as truffles, reproduce underground. Small animals, attracted by the odor of the truffles, eat the fruiting bodies, but, the spores are not digested and are excreted in their fecal pellets. Squirrels, mice, and voles traveling from forested areas to newly planted clearcuts distribute spores of fungi to the benefit of new seedlings.

Several forest management practices deplete mycorrhizal fungi in the soil, Trappe says. The most important are elimination of host plants and drastic soil disturbance. Heavy timber cutting and slash burning can reduce fungi populations. Some pesticides may also destroy them. Eliminating truffle-eating small animals from newly planted areas is likely to reduce the number of fungal spores available for forming mycorrhizae.

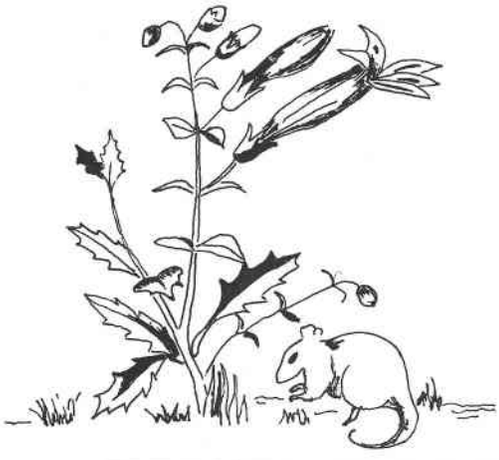
Until the ecology of mycorrhizae is better understood, researchers will not be able to recommend changes in forest management practices. However, if seedlings can be supplied with suitable fungi before they are planted, the depletion of local fungi by management practices will not be of critical importance. Much remains to be learned about mycorrhizae, especially in forestry.

roadside stabilization

Response of *Penstemon fruticosus* to Fertilization, by G.O. Klock (34)

Bush penstemon is an attractive native ground cover frequently found on recently logged areas and new roadbank cuts on the east slopes of the Cascade Range in Washington. It is easily identified by its brilliant blue-lavender to light purplish flowers in the early spring.

This plant is apparently able to survive under conditions of low fertility and drought. It reproduces by seed and spreads across open ground by prolific layering. Rate of spread appears to be fairly slow, and since it is most frequently found growing on poor soils such as roadbanks, it might be that fertilization could hasten growth. A greenhouse fertilization study indicates that bush penstemon does respond to nitrogen and phosphorus fertilization. With adequate soil moisture, 50- to 100-ppm nitrogen is sufficient for nearly maximum growth.



Stabilization of Newly Constructed Road Backslopes by Mulch and Grass-Legume Treatments, by C.T. Dyrness (35)

Six different treatments to control erosion along roadsides were studied. Both grasses and legumes were tested, with all treatments showing beneficial results.

Considerable evidence has accumulated to indicate the desirability of treating newly constructed roadside slopes in the early fall before heavy rains. Most important is that the loose, unprotected soil is most vulnerable to erosion during this period. In addition, mulching of backslopes may be necessary to keep soil loss to a minimum during the first few critical months following road construction.

Ted Dyrness

Grass-Legume Mixtures for Erosion Control Along Forest Roads in Western Oregon, by C.T. Dyrness (36)

Continued study of roadside seeding to control erosion in the mountains of western Oregon provides the following information:

- Legumes are unable to compete with grasses and tend to disappear from most roadside stands after 1 year.

- Erosion can be halted by using grass-legume seed, fertilizer, and straw mulch.

- Erosion is greater on recently disturbed slopes than from backslopes that have been bare for several years.

- Mulches should be used, along with seeding, to minimize erosion during the first rainy season following road construction.

- Infertile subsoils failed to maintain a viable vegetative cover and required refertilization 7 years after the plots were initially seeded and fertilized.

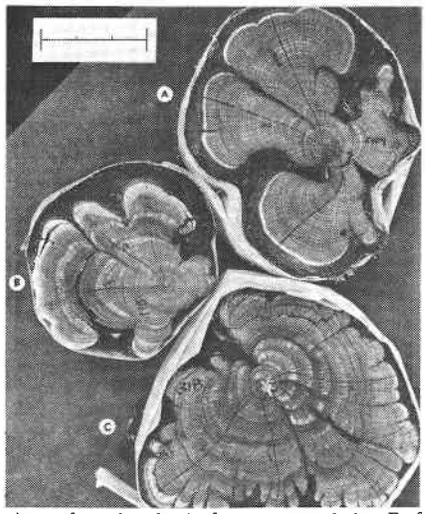
- Bare, unprotected roadside slopes continued to erode at a rather constant rate, or at about .2 inches of soil per year, during the course of the study.

For additional information on this subject, see also older publications listed in the bibliography (37).

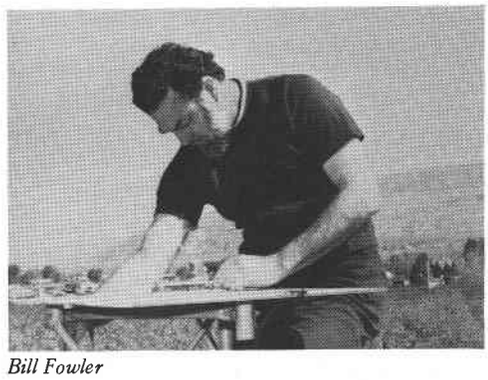
effects of irrigation

Effect of Large-Scale Irrigation on Climate in the Columbia Basin, by W.B. Fowler and J.D. Helvey (38)

Charles K. Stidd claimed in 1967 that evaporation of irrigation water from the Columbia Basin caused a significant increase in precipitation over the basin and surrounding area. Forest Service scientists, however, do not agree. Information for this report, which appeared in *Science* magazine in 1974, was gathered by studying weather records and by examining cross sections of sagebrush, a desert shrub which is very sensitive to moisture changes in the environment.



Sections of sagebrush: A, from a control site; B, from an irrigated site; and C, from an irrigated site. Scale bar, 3 cm.



Bill Fowler

Irrigation Increases Rainfall? by Charles K. Stidd, William B. Fowler, and J.D. Helvey (39)

The article listed above by Fowler and Helvey added fuel to the scientific arguments over the climatic effects of irrigation. This later article (also in *Science*), by Stidd, Fowler, and Helvey, debates the subject further.

Stidd tested data available for 7 years since 1966, and found that his original claim—that irrigation does affect precipitation—was strengthened. Fowler and Helvey respond with technical arguments in a rejoinder which, they claim, confirms their earlier contention that irrigation does not increase rainfall in the Basin. They point out that a period selected by Stidd as "normal" was actually a period of widespread drought, especially in the Columbia Basin.

Fowler and Helvey feel it is important to resolve the issue. If continuing irrigation increases precipitation over the irrigated area, it would have far-reaching implications for land-use and water resources planning. They expect to compare results from the Columbia Basin with those from other large irrigated areas. More will undoubtedly be heard on this subject.

entiat experimental forest

Operation Phoenix, Forest Hydrology Laboratory, Wenatchee, Washington (40)

This pamphlet briefly traces the history of major research studies conducted on the Entiat Experimental Forest near Wenatchee by scientists from the Forest Hydrology Laboratory.

From 1959 to 1970, studies in the three watersheds of the experimental forest were mainly directed at ways of improving water quality and yield from eastern Cascade forests. In August of 1970, wildfire destroyed the experimental forest and thousands of surrounding acres. The fire halted or seriously impaired studies in progress and necessitated that the scientists define new directions for research. "Operation Phoenix," named for the mythical bird which was reborn from its own ashes, is this new research program.

The new program is designed to study the effects of fire on watersheds and to evaluate ways of rehabilitating them. Research includes studies of the environmental effects of logging systems devoted to salvage wherein nutrient and soil loss, degree of damage to successional plants, soil disturbance, and stream sedimentation are monitored for each system.

The three watersheds on the Entiat Experimental Forest, Fox, McCree, and Burns Creeks, were divided into three separate research zones, each receiving a different type of experimental treatment. A fourth, and adjacent watershed, Brennegan Creek, was also included within the study area.

Fox Creek, the original control watershed before the fire, was left untouched. No seed or fertilizer has been applied here and no roads have been built. The scientists use this watershed to study the ways in which nature, uninfluenced by man, reacts to wildfire. In this watershed they have found that snowbrush ceanothus sprouts one month after the fire, provides natural ground cover and fixes atmospheric nitrogen, helping to restore nutrients to the soil.

The McCree Creek watershed was treated with a high nitrogen urea fertilizer. Burns Creek received ammonium sulfate, and Brennegan Creek was left unfertilized. McCree, Burns, and Brennegan watersheds were then seeded with orchardgrass, hard fescue, Drummond timothy, perennial ryegrass, and yellow sweet clover.

In general, the scientists found that the locations treated with both fertilizer and seed had higher plant productivity, less erosion, and higher stream nutrient levels. 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 hard fescue produced the best results.

Perhaps the most dramatic effects noted on the Entiat were changes in water yield. Flows from denuded slopes almost doubled during the first year after the fire and heavy precipitation in the second year caused an increase in water yield four to five times above normal. The greatest erosion noted was caused by massive debris flows coupled with high precipitation.

Studies on Entiat watersheds should continue to provide answers about the long-term impacts of fire on forest ecosystems east of the Cascade Mountains.

Climate and Hydrology of the Entiat Experimental Forest Watersheds Under Virgin Forest Cover, by J.D. Helvey, W.B. Fowler, G.O. Klock, and A.R. Tiedemann (41)

This publication presents detail on conditions existing in the three watersheds of the Entiat Experimental Forest before the wildfire of August 1970. Described are watershed conditions with respect to location, topography, soils, vegetation, precipitation, and the patterns, temperature, and chemistry of streamflow. These data are a useful addition to hydrologic information collected from small, undisturbed watersheds throughout the United States. The paper also serves as a reference, and detailed information presented need not be repeated in future reports which describe postfire conditions.

The part of the forest ecosystem that exists above ground has been studied in great detail. Much less is known about the underground organisms (roots, animals, and microorganisms), even though their biomass is as great as that above ground and as important. For example, most plants have been adequately classified, but many mycorrhizal fungi have not and cannot even be identified. Trappe believes that classification is vital to research and is now devoting part of his time to this essential task.

The Pacific Northwest Station is one of several public agencies in Corvallis now engaged in mycorrhizae research. Others include the Ornamentals Laboratory of the Agricultural Research Service and the Departments of Botany and Plant Pathology, Horticulture, Soils, and Forestry at Oregon State University. In May 1976, the university, in collaboration with the Pacific Northwest Station, received a grant of $146,000 from the National Science Foundation for a 2-year study of the role of mycorrhizal fungi in nutrient capture and cycling in Douglas-fir ecosystems.

At present, probably more people are involved in mycorrhizae research in Corvallis than anywhere in the world. "It is important that a sizable portion of forestry research be devoted to figuring out how a forest works," Trappe says, "because such knowledge will lead to better forest management practices."

end

STUDYING FIRE IN THE INTERIOR
by Louise Parker

A June storm rolls in over the mountains, dropping lightning bolts into the dry forest. A tiny stream of smoke curls up and in minutes several trees are ablaze. Soon, a whole hillside is covered with smoke.

With luck, the fire has been spotted within a few minutes of its start, and reported. A Bureau of Land Management crew, dispatched from the nearest smokejumper center, is quickly on the way.

It is a scene repeated many times in the Western United States during the summer months. But this time the scene is interior Alaska.

Early Effects of Forest Fire on Streamflow Characteristics, by H.W. Berndt (42)

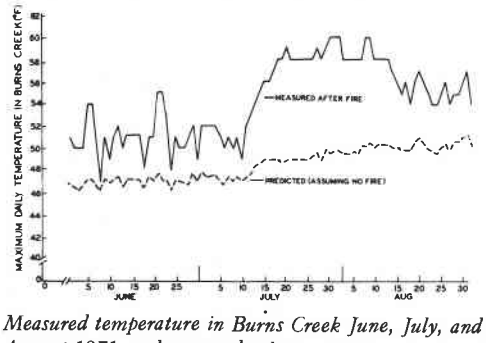
Comparison of streamflow records from three small mountain streams before, during, and after the August 1970 wildfire showed three immediate effects of destructive burning on the Entiat Experimental Forest.

First, flow rate was greatly reduced while the fire was actively burning. Second, destruction of vegetation in the riparian zone reduced the daily variation of flow rates. And third, flow rates increased to levels above extended normal depletion curves, but to varying degrees between watersheds. No drastic immediate change in stream temperatures was noted during the studies.

Dave Helvey

First-Year Effects of Wildfire on Water Yield and Stream Temperature in North-Central Washington, by J.D. Helvey (43)

Records of flows from the three Entiat watersheds had been kept for 9 years before the 1970 fire. These were used as control data to determine the first-year effects of the fire on water yield and stream temperatures in the experimental forest. Water yield increases (averaging 3.5 inches) due to the effects of the fire, apparently came during spring snowmelt and the summer months. During late summer when streams were exposed to direct sunlight, maximum daily stream temperature increased by as much as 10° F. The study is continuing so that the transition back to forest vegetation can be related to changes in water yield, stream temperature, and other hydrologic factors.



Measured temperature in Burns Creek June, July, and August 1971, and expected values, assuming the forest had not been destroyed by fire.

Art Tiedemann

First-Year Vegetation After Fire, Reseeding, and Fertilization on the Entiat Experimental Forest, by A.R. Tiedemann and G.O. Klock (44)

Regrowth and successional patterns of native plant species were evaluated after fire, reseeding and fertilization, using two different sources of nitrogen and one of sulfur.

Comparisons between seeded watersheds and the unseeded, unfertilized control indicate that erosion-control seeding improved first-year vegetative cover by up to one-third. Of the seeded species, orchard grass, hard fescue, and timothy provided most of the first-year cover. Perennial rye and yellow sweetclover showed poor development.

Effectiveness of fertilizer was questionable the first year since total cover on the seeded-only watershed was nearly as great as on the watershed seeded and fertilized with ammonium sulfate and greater than on the watershed seeded and fertilized with urea. However, observations in the early summer of 1972 indicate that vegetal cover on the fertilized watersheds is substantially higher than on the control or seeded-only watershed. Also, vigor of seeded species appears to be much better on the fertilized watersheds.

Streamflow Nitrogen Loss Following Forest Erosion Control Fertilization, by G.O. Klock (45)

Nitrogen monitoring studies on streams of the three watersheds of the Entiat were made after initiation of an erosion control reseeding program designed to offset the effects of the wildfire of 1970. In the reseeding program, two of the watersheds were fertilized, one with urea and the other with ammonium sulfate. The third watershed was retained as an unrehabilitated control.

For a 60-day period during and following fertilization, 1.37 kilograms of urea-N and 2.90 kilograms of nitrate-N were estimated to have been carried by streamflow from the watershed fertilized with 27.5 metric tons of elemental nitrogen as urea. On the watershed fertilized with 33.16 metric tons of elemental nitrogen as ammonium sulfate, 1.45 kilograms of nitrate-N were estimated to have been transported from the watershed by streamflow.

Stream Chemistry Following a Forest Fire and Urea Fertilization in North-Central Washington, by A.R. Tiedemann (46)

The stream chemistry of Grade, Camas, and Falls Creeks on the slopes north of Lake Chelan was monitored to determine the impact of urea fertilizer on water flowing from an area that was burned by wildfire in July of 1970.

After the fire, the area had been seeded with grasses and legumes and fertilized with urea to help prevent soil erosion and restore soil-plant nutrient cycles. Since the creeks draining the area are a source of municipal water, the U.S. Forest Service, administrator of these lands, was concerned that nitrate-N and ammonia-N, which are derived from urea fertilizer, might exceed permissible limits.

It was found that the quality of water for municipal use from watersheds involved in the fire does not appear to be threatened by either burning or urea fertilization during the first and second year after these treatments. Even though urea fertilization after fire at 78 kg./ha. apparently caused immediate and protracted increases in nitrate-N levels, the maximum observed level of 0.31 p.p.m. poses no hazard. This value is 30 times less than the proposed permissible level.

It is not likely that losses of nitrate-N in streamflow are substantial enough to affect future productivity of these ecosystems.

Impact of Five Postfire Salvage Logging Systems on Soils and Vegetation, by Glen O. Klock (47)

Impacts of five traditional and advanced logging systems were compared under postfire salvage conditions on the east slope of the Cascades.

Traditional systems included tractor skidding over bare ground and cable skidding. Advanced systems included skyline, helicopter, and tractor skidding over snow. It was found that traditional logging systems caused more severe soil surface disturbance and consequent erosion than advanced systems.

System	*Total Logged Area (%)*	*Number of Sample Plots*
Helicopter	48.8	1,336
Tractor skidding on snow	24.2	534
Tractor skidding on bare ground	4.0	279
Cable skidding	20.1	497
Skyline	2.9	255

Percent of study area harvested by each yarding system and number of sample plots within each individual area.

Wildfire Effects on Nutrient Distribution and Leaching in a Coniferous Ecosystem, by Charles C. Grier (48)

Results of experiments indicate that the Entiat fire had a substantial effect on the nutrient status of this forest ecosystem. These effects included large nutrient losses during the fire, rapid leaching of mineralized cations into the soil after the fire, and retention of large amounts of these cations by the soil. The study was designed to (a) estimate nutrient losses during the fire; (b) determine the average chemical composition and amount of surface ash; (c) directly measure quantities of certain nutrients leached from ash during the first year after the fire; and (d) examine patterns of nutrient retention by the soil.

Erosion Control Fertilization—From Pot Study to Field Testing, by G.O. Klock, J.M. Geist, and A.R. Tiedemann (49)

In the Entiat Experimental Forest, a study was conducted to determine why reseeding with orchardgrass met with limited success when nitrogen was used as an initial fertilizer in the rehabilitation program.

The study was designed to test the hypothesis that sulphur deficiency may be limiting vegetative establishment when nitrogen fertilizers are used. Results suggest that sulphur fertilization is also important and that further research is needed to compare nitrogen-sulphur fertilization with nitrogen fertilization alone.

Seeding Recommendations for Disturbed Mountain Slopes in North Central Washington, by G.O. Klock, A.R. Tiedemann, and W. Lopushinsky (50)

Firelines constructed in 1970 to control wildfire in the Wenatchee and Okanogan National Forests were reseeded in 1971 in four study locations.

Forty plant species were seeded on plots in the firelines and fertilizer applied as a secondary treatment. The four study locations were Dinkelman Ridge, Sugarloaf Corral, Handy Springs, and Silver Creek.

Results of the study show that firelines with severely disturbed soil can be successfully revegetated by artificial seeding on east Cascade upper slopes of north central Washington. Later orchardgrass, Drummond timothy, perennial ryegrass, Manchar smooth brome, and tall fescue proved to be the best adapted species for this purpose.

Limited success with mixtures of species, whether perennial or perennial-annual, indicates that the best ground cover will probably be achieved with one or two of the above selected species. A starter fertilizer treatment is imperative. Covering the seed by methods such as with a seed drill or harrowing and using mulches, particularly at higher elevations, can be expected to increase the level of success.

Glen Klock

Watershed Behavior After Forest Fire in Washington, by J.D. Helvey (51)

Research results are summarized for the first postfire year after the Entiat burn of 1970. Presented are recent findings on water yield and information on soil movement and channel cutting since the fire.

Hydrologic behavior in 1972 was in sharp contrast to prefire conditions but was confounded by several factors, and the effects of a single factor could not be determined. For example, the effect on runoff of reduced evapotranspiration caused by destruction of the vegetation by fire was confounded by abnormally high precipitation. Other factors include logging road construction, logging over snow, and intense summer rainstorms.

The total effect of road building and logging on the occurrence or severity of these debris torrents could not be determined. However, massive torrents occurred on Fox watershed which was burned but remains unroaded and unlogged. Lake Creek watershed which joins the western boundary of Fox watershed was not burned or logged, and it remains stable. An allauvial fan at the mouth of almost every tributary of Entiat River testifies to the occurrence of these events over past centuries, long before man began harvesting timber. If road building and logging on the experimental watersheds had an effect, it was probably minor compared with the effects of fire and subsequent record precipitation amounts.

The fact that debris torrents and the associated channel cutting occurred on Fox and McCree Creeks but not so much on Burns may indicate that the rehabilitation program applied to Burns watershed was more successful. Although such a conclusion is plausible, it is too early to know for sure. Future studies may reveal a relationship between hydrologic behavior differences of these watersheds and differences in their geology, geomorphology, or both. Meanwhile studies are underway to monitor trends of vegetation development on all three drainages and to relate vegetation density to soil movement and water yield.

Alaska's great interior is a very special environment. A land of great mountain ranges, snow, ice, and glaciers, it is also a land of great river systems—the Yukon, Copper, Susitna, Kobuk, and Kuskokwim. There are also lowlands, rolling hills, and wide expanses of forest.

Fire is an ever-present part of the environment of the interior. It has been a part of the ecosystem for the past several thousand years. As a result, the vegetation is a subtle mosaic that includes mixtures of birch, poplar, and cottonwood trees, black and white spruce, and recently burned areas that are just beginning to recover from fire.

The Bureau of Land Management manages most of the interior stretching from the Alaska Range north to Prudhoe Bay, an area of about 172 million acres. The BLM's Alaska Fire Control Service was established in 1946, with the charter to extinguish all fires. More recently, a new management policy for BLM in Alaska requires initial attack on all fires. Then, if a particularly hot fire eludes control, a top-level management team evaluates the situation. Today, in some cases, a decision may be made to let the fire burn itself out naturally. Although this policy is still controversial in other parts of the United States, it makes sense in Alaska's interior, in stands of low-volume black spruce and in areas where fire is important in maintaining browse for some kinds of wildlife.

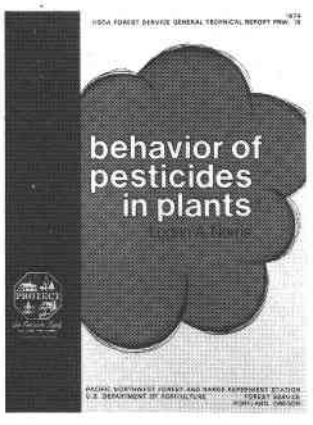
The BLM reports an average of more than 400 fires a year, with about 800,000 acres burned annually. Some years that total runs as high as 5 million acres. Although about two-thirds of the fires are man-caused, lightning fires do more extensive damage because they often start in inaccessible places.

In this environment, fire research is especially important. The Forest Service is currently reviewing its fire research program at the Institute of Northern Forestry at Fairbanks. The Institute is a field unit of the PNW Station. Since 1971, the research has concentrated on fire effects, emphasizing the ecological role of fire in the environment, and learning more about how fire affects succession in various forest types. Resource managers from the BLM and other groups are using this information.

What scientists have learned about fire in the northern environment is impressive. Their reports detail the role of fire in creating a vegetation mosaic that is unique to

chemicals in the environment

general



Behavior of Pesticides in Plants, by Logan A. Norris (52)

The behavior of a pesticide determines its fate in all parts of the environment including plants. Pesticides in plants may be absorbed, stored, metabolized, and/or released to the environment. These processes determine both the pesticide's impact on the plant and its residue characteristics.

The behavior of a chemical results from the interaction between the properties of the compound and the environment. The environment has many components, and a chemical may interact with any or all of them. The chemical behavior we observe in the field is a result of many single interactions.

Scientists can accurately measure both the chemical properties and the environmental factors which interact to produce behavior. The results of some simple interactions can be predicted. However, the field of chemodynamics has not yet attained the sophistication necessary to quantify the multiple interactions which may occur between chemicals and their environment.

It will be difficult to develop a single predictive equation which includes the important primary and secondary interactions which produce chemical behavior, but such an equation is needed. A better understanding of the behavior of chemicals in organisms would result in greater pesticide effectiveness and fewer hazards in use. Pesticides will remain available to man only if he can learn to use them with greatest effectiveness on target organisms and minimum impact on the remainder of the environment.

The Entry and Fate of Forest Chemicals in Streams, by Logan A. Norris and Duane G. Moore (53)

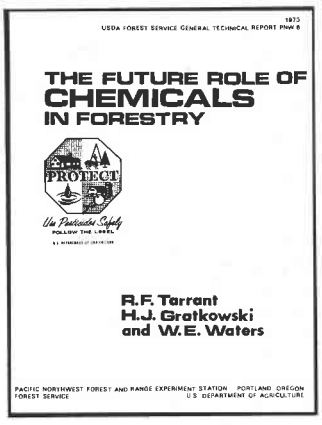
An interesting discussion of the distribution and fate of herbicides, insecticides, and fertilizer applied from the air to forest environments. Research findings and a long history of use indicate that most forest chemicals have minimum potential for pollution of the aquatic environment when they are properly used.

The authors discuss the distribution of aerially applied pesticides, including spray drift and atmospheric dispersion, dispersion in forest vegetation and soil, and the movement of pesticides to streams. The impact of fertilization and the behavior of various chemicals in the aquatic environment are also covered.

This is a general discussion, but specific enough to be highly informative. The paper was given at a symposium on Forest Land Uses and Stream Environment, in October 1970. Copies of the complete proceedings can be purchased for $6.25 each from Forestry Extension, Oregon State University, Corvallis, Oregon 97331, or by writing Continuing Education Publications, Waldo 100, Corvallis, Oregon 97331.

Pesticide Residue Dynamics in a Forest Ecosystem: A Compartment Model, by Warren L. Webb, Henry J. Schroeder, Jr., and Logan A. Norris (54)

This paper presents a computer model of the movement of pesticide residues, especially herbicides. This is important in determining the potential direct effects on target and nontarget organisms. The very long-term consequences of restructuring the vegetation in an ecosystem are not discussed. Simulations using the model trace the movement of two herbicides (2,4,5-T and picloram) through two different environments, one typical of an Oregon forest and the other typical of southern California chaparral. The model is written in DYNAMO.



The Future Role of Chemicals in Forestry, by R.F. Tarrant, H.J. Gratkowski, and W.E. Waters (57)

Chemicals are useful, necessary tools for helping to meet needs for food, wood fiber, and water, while man readjusts his numbers and modes of life to the rapidly dwindling resources of the earth. The more selective, less persistent chemicals will continue to play an important role in forest resource management, probably for several decades. However, chemical use must eventually be minimized, for it is simply a system of treating symptoms of unhealthy ecological conditions created by nature or man in the past.

Technological, environmental, and socio-economic factors will add new dimensions to chemical use, placing greater demands on the research and development process.

Our pressing need, aside from solutions to problems of population pressures and extravagance in natural resource use, is rapid development of the ecological knowledge necessary to manage and maintain a healthy biosphere with minimum use of chemical tools.

Pesticides and Their Safe Use

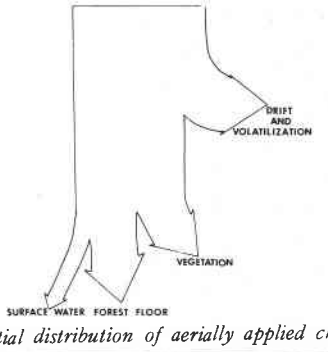
In 1971, a short course for pesticide applicators was conducted by OSU, the U.S. Forest Service, and the Division of Continuing Education. Two reprints from that session are available from the Experiment Station. They are:

The Behavior of Chemicals in the Forest, by Logan Norris (55), and

Principles of Monitoring, by Duane G. Moore (56).

Proceedings of the entire short course are still available. Cost for the proceedings is $6.50 plus postage (prepaid or included in the billing). *Pesticide Short Course* may be ordered from:

Continuing Education Publications
1633 Southwest Park Avenue
P.O. Box 1491
Portland, Oregon 97207



The initial distribution of aerially applied chemicals.

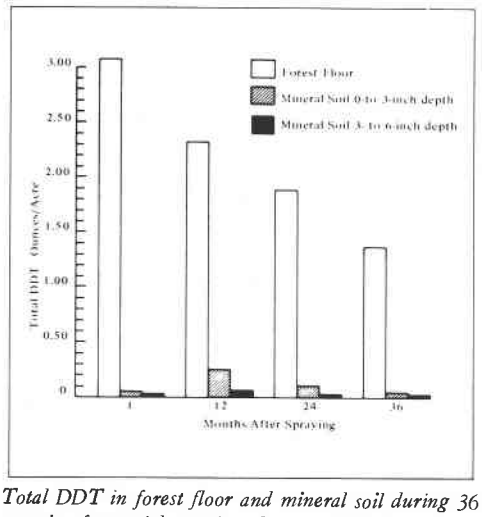
insecticides; DDT and others

DDT Residues in Forest Floor and Soil After Spraying, Oregon—1965-68, by R.F. Tarrant, D.G. Moore, W.B. Bollen, and B.R. Loper (58)

A report on the persistence of DDT in forest soils after aerial spraying in eastern Oregon. One month after the application of DDT at the rate of 12 ounces per acre, 3 ounces were found in the forest floor. Three years later, the DDT content had decreased by more than 50 percent, and had not leached into the surface mineral soil.

What little DDT got into streams rapidly decreased to undetectable levels. No effect of the spray was noted on soil microbial populations, nitrification rate, or amount of nitrate nitrogen in the soil.

About 26 percent of the DDT spray reached the ground initially. Through the action of litterfall, eventually one-third of the chemical got to the forest floor. The need for more efficient aerial methods of chemical application is evident.



Total DDT in forest floor and mineral soil during 36 months after aerial spraying, Oregon 1965-68.

DDT Residue Accumulation and Decline in Kidney Fat of Lambs Grazing Sprayed Forest Range, by Gerald S. Strickler (59)

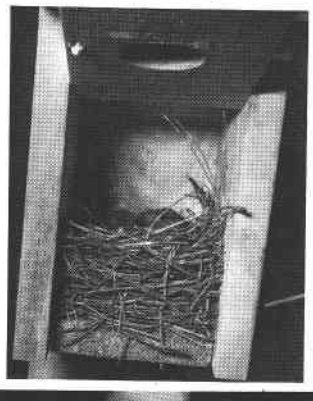
DDT residues in fat of young lambs grazing in forest sprayed with DDT for Douglas-fir tussock moth control increased rapidly up to 2 weeks, then decreased. Following removal of lambs to unsprayed feed for 14 to 22 weeks, fat residue levels declined, but only those in the shortest treatments (1 and 2 weeks of grazing) fell significantly below the 5-p/m tolerance level.

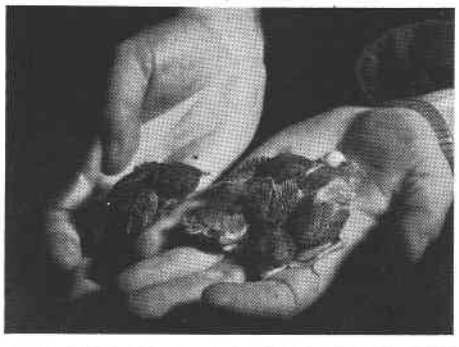
DDT, Bluebirds and House Wrens

In an eastern Oregon study, there was no harmful effect on mountain bluebirds and house wrens when DDT was sprayed at the rate of 3/4 lb. per acre to control the Douglas-fir tussock moth. Scientists compared the number of eggs laid, eggs hatched, and nestling mortality for both sprayed and unsprayed plots. Most nests were in nest boxes which had been put up to attract birds for the study.

For details, see *Effects of Aerial Application of DDT for Tussock Moth Control on Nestling Survival of Mountain Bluebirds and House Wrens,* by Jack Ward Thomas and D. Calvin McCluskey (60).

Jack Thomas examining nest box.





Effect of Zectran on Microbial Activity in a Forest Soil, by W.B. Bollen, K.C. Lu, and R.F. Tarrant (61)

When Zectran or No. 2 fuel oil was applied to soil in concentrations far greater than those that could result from current operational application rates, neither material adversely affected soil microbial activity. We conclude from these data that low-volume applications of Zectran as an insecticide for forest use poses no hazard to soil microbes.

the far north and beneficial to the wildlife and plant communities involved. In short, it is distinctly a "fire environment," in which the plants and animals that live there have adapted to the periodic burning of the forests.

There are several vegetation types in the interior. All are susceptible to fire, but each reacts somewhat differently. Biologist Joan Foote of the Institute of Northern Forestry has been conducting studies to learn more about those responses. She has been at the laboratory since 1964, and in 1971 began work on fire effects. A map in her office shows all the fires in northern Alaska in the past 10 years. Her goal is to study fires in order to pin down the successional patterns that have occurred in each of the various forest types.

So far, 130 burned stands have been studied. Most of the research plots are within 60 miles of Fairbanks (it makes travel easier). Plots have been set up at all of the areas that can be reached by road. Many plots, however, must be visited by helicopter, float plane, or boat.

Black spruce grows primarily on the poorer sites, in cooler places that may be boggy and are usually underlain by permafrost. It is the spindly black spruce forests for which the taiga is named. Taiga is a Russian word meaning "land of little sticks."

In the black spruce forest, six separate community types have been identified. In the white spruce community, four types have been identified.

In a typical black spruce type, the mature forest might be about 50 years old, and the trees 2 to 5 inches in diameter. In boggy areas, trees grow on sphagnum moss, sometimes underlain by peat that is over 25 feet deep. On better-drained sites, feathermosses are more typical and cover the ground in layers about 12 inches thick. There are also a few herbs and shrubs.

When the forest burns, there is very little left. The trees are dead, the moss is blackened, and the shrubs are killed. Gradually, the shrubs begin to regrow from the roots and rhizomes. Aspen regrow from root suckers, and birch from stem suckers. At the end of a year, some very small black spruce seedlings appear. The hotter the fire, the longer it takes for the green to come back. Within 5 years, trees may be 3 inches to 2 feet tall, the shrubs are coming back, and the willow trees are taller than a man's head. Blueberry shrubs have regrown and are producing berries again.

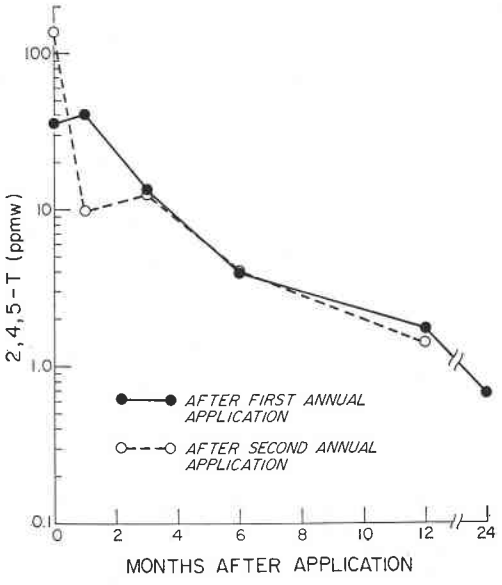
use of herbicides

general

Behavior and Impact of Some Herbicides in the Forest, by Logan A. Norris (62)

Foresters are making management decisions about the use of herbicides to accomplish a variety of management purposes. Sound decisions require a good understanding of the concepts involved, as well as an adequate data base. This paper considers the environmental consequences of herbicide use in the terrestrial part of the forest environment. It provides foresters with concepts and a partial data base for assessing the hazards associated with the use of four herbicides: 2,4-D, 2,4,5-T, amitrole and picloram.

The paper is based on a talk reprinted from *Herbicides in Forestry,* 1975 Proceedings of John S. Wright Forestry Conference, Purdue University, West Lafayette, Indiana.

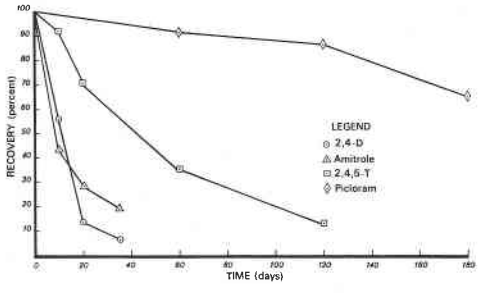


Residues of herbicide in forest floor after two annual applications of 2,4,5-T at 2 lbs./acre by helicopter in April.

Degradation of Herbicides in the Forest Floor, by Logan A. Norris (63)

The herbicides 2,4-D, 2,4,5-T, amitrole, and picloram are degraded in forest litter but at markedly different rates. The degradation of 2,4-D differs slightly in litter from different vegetation types, but these differences are not important in the field. 2,4-D is degraded rather rapidly, but 2,4,5-T is somewhat more persistent—about 90 percent will be gone after 4 months. Picloram is considerably more resistant to degradation than the other herbicides studied, but it is biodegradable. Amitrole is rapidly degraded.

Various constituents of spray formulations may retard the degradation of 2,4-D but the addition of picloram, 2,4,5-T, and diesel oil do not. Scientists have also found that some chemicals can be applied in the forest a month prior to spraying of herbicide with no effect on degradation of 2,4-D. These chemicals include DDT, phosphamidon, or carbaryl. However, degradation of 2,4-D is stimulated when 2,4-D and DDT are applied together.



Recovery of 2,4-D, 2,4,5-T, amitrole, and picloram from red alder forest floor material.

Chemical Brush Control and Herbicide Residues in the Forest Environment, by L.A. Norris (64)

This paper reports research from a 5-year U.S. Public Health Service grant to determine the dangers associated with the use of herbicides in the forest. Data on stream pollution are emphasized.

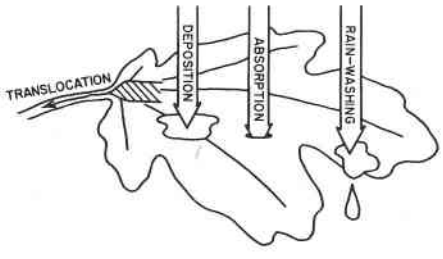
The land manager concerned with the planning and use of herbicides should remember the three most important things learned from these research efforts:

1. The direct application of herbicide to the water surface is the most important cause of stream contamination.

2. Avoid treating areas with a high water table.

3. When operating in areas which are particularly sensitive from a biological or public relations standpoint, stream contamination can be held to an absolute minimum by recognizing and avoiding those situations which lead to direct application to streams or surface water.

4. Herbicides can be used safely in the forest in most instances.



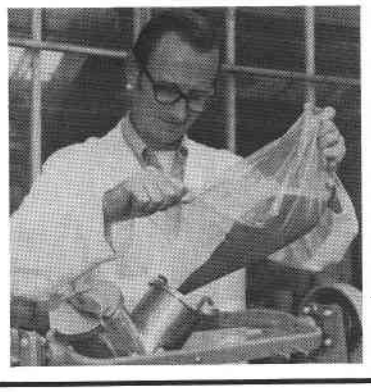
The fate of chemicals intercepted by foliage.

Chemical Brush Control: Assessing the Hazard, by Logan A. Norris (65)

An adequate evaluation of the hazard associated with the use of any chemical agent requires consideration of both the toxicity of the material and the potential for exposure of non-target organisms. The hazard can be high only if both the toxicity of the chemical and the potential for exposure to a significant dose are high.

This paper includes specific data on toxicology and organism exposure for four herbicides. These data can be used to evaluate the hazards.

The relatively large doses of 2,4-D, amitrole, 2,4,5-T, and picloram required to produce acutely toxic responses in most nontarget organisms are not likely to occur from normal chemical brush control operations on forest lands. The short persistence, lack of biomagnification in food chains, and the rapid excretion of these herbicides by animals preclude chronic exposure and, therefore, chronic toxicity. A long history of field use and research shows our common brush control chemicals can be used with minimum hazard to the quality of our environment.



Logan Norris

Field Application of Herbicides—Avoiding Danger to Fish, by Erland T. Juntunen and Logan A. Norris (66)

Chemical weed and brush control with herbicides is an important land management practice in modern agriculture and forestry. In some cases, herbicides are applied directly to bodies of water for aquatic weed control. More commonly, herbicides are applied to lands adjacent to waterways for general weed and brush control.

The responsible applicator will avoid damage to fishery resources by being fully aware of a particular herbicide's potential hazard to fish. Herbicide applications should be considered hazardous to fish when there is the probability fish will be exposed to herbicide concentrations which are harmful. This bulletin groups commercial herbicide formulations by toxicity to aid in selecting the particular formulation of least hazard to fish.

2, 4-D; 2, 4,5-T; and others

A Preliminary Evaluation of the Hazards of 2,4,5-T in the Forest Environment, by Marvin L. Montgomery and Logan A. Norris (67)

Increasing concern about the quality of man's environment has resulted in careful scrutiny of the use of 2,4,5-T for vegetation management. Aerial applications of 2,4,5-T to forest lands result in an initial low-level, short-term stream contamination which does not represent a significant hazard to fish or animals. The extensive adsorption and degradation of 2,4,5-T in the forest floor prevent subsequent movement from treated areas to surface and ground waters. The primary exposure of animals to 2,4,5-T will be by ingestion of treated vegetation. Rainfall, growth dilution, and degradation markedly reduce herbicide residues in vegetation within a few weeks after application.

Effects on Wildlife

The effects of the herbicides 2,4-D and 2,4,5-T on the forest environment have been extensively studied. Conclusions from three papers are included here:

Toxicity of Various Formulations of 2,4-D to Salmonids in Southeast Alaska, by William R. Meehan, Logan A. Norris, and Howard S. Sears (68)

A very technical study that reports results of laboratory tests to determine the toxicity of 2,4-D to young salmon, Dolly Varden char, and rainbow trout in southeast Alaska. Various doses of several different commercial grades of 2,4-D were tested.

Objectives of the study were to compare the toxicity to juvenile salmonids of various formulations of 2,4-D and to compare the toxicity of a given chemical under identical laboratory conditions to the same species of fish (coho salmon) in Oregon and in Alaska. The latter objective was to evaluate extrapolation of results over a wide geographic range. The isooctyl ester of 2,4-D was the least toxic of the esters tested. Oregon and Alaska coho salmon responded the same to various concentrations of the chemical.

The Kinetics of Adsorption and Desorption of 2,4-D and 2,4,5-T, Picloram, and Amitrole on Forest Floor Material, by Logan A. Norris (69)

A very technical paper that discusses the interaction of herbicides with material on the forest floor. Results indicate that the speed and degree of adsorption of 2,4-D, 2,4,5-T, picloram, and amitrole on forest floor material varies with the herbicide.

Short-Term Effects of 2,4-D on Aquatic Organisms in the Nakwasina River Watershed, Southeastern Alaska, by Howard S. Sears and William R. Meehan (70)

Approximately 400 acres of cutover land on the Nakwasina River watershed in southeastern Alaska were treated with 2,4-D to inhibit the growth of broad-leaved plants. No immediate mortality to salmonid fishes or aquatic invertebrates was attributable to the spray. Samples of water and fish had concentrations of 2,4-D well below the level generally considered to be lethal to aquatic organisms. The results were considered inconclusive because of the lack of information on the pretreatment condition of the test animals. Further research is required to assess the immediate and long-term effects of these spray operations in Alaska.

A Discussion on Herbicides, by Luke Popovich, Michael Newton, and Logan A. Norris, and

Statement on 2,4,5-T and TCDD, by Frank Dost, James Witt, Michael Newton, and Logan A. Norris (71)

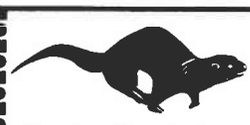
The July 1975 issue of the *Journal of Forestry* carries an excellent discussion and summary of the use of herbicides, especially with regard to 2,4,5-T and its toxic contaminant TCDD or dioxin. A panel of experts is consulted. The following discussion is of special interest:

No human health problems or effects on other animals of any sort had been associated with widespread uses of 2,4,5-T over a 22-year period in American forests. However, in 1969, a research laboratory which was developing a very sensitive test method for cancer and birth defects found a significant induction of fetal deformities by 2,4,5-T under these special test methods.

Examination of the 2,4,5-T used in the tests revealed an impurity called dioxin or TCDD present at the unusually high level of 27 parts per million. It was determined over the course of many more studies that it was this impurity which caused these deformities, not the 2,4,5-T. TCDD is formed as a by-product of one of the steps in the manufacture of 2,4,5-T.

In recent years, improved manufacturing processes have reduced levels of TCDD in the herbicide. The experts consulted here conclude that the registered uses of 2,4,5-T in the forest do not constitute an unacceptable hazard to humans, animals, or the general quality of the environment.

Other highly technical articles that discuss the possible cancer producing hazards of 2,4,5-T and its contaminant TCDD are included in the bibliography under (72).



Eventually the burned spruce forest is replaced. Along the way, many species appear which provide good habitat for wildlife. For example, most of the large populations of moose in Alaska can be traced to a large fire or series of fires in the past that have increased the supply of shrubs, willows and other hardwoods. Snowshoe rabbits also love the willow. They nibble the lower branches, leaving the upper branches to the moose.

Beneath the surface other things are going on. Much of the taiga is underlain by permafrost. Around Fairbanks, about 50 to 75 percent of the area is permafrost. The frozen soil extends from a foot or so beneath the surface down to 400 to 500 feet or more. Fire has a profound effect on the permafrost layer. The removal of the understory and the forest canopy allows sunlight to reach and warm the soil.

Ecologist Les Viereck of the Institute of Northern Forestry is an expert on both tundra and taiga vegetation, and has studied the effects of fire on the taiga environment. "Following fire," he says, "surface temperatures go up, warming the underlying permafrost, and causing melt. Thawing continues at a high level for 15 to 20 years. After about 25 to 30 years, the thawing rate recedes to where it was before the fire." Ecological information such as this is needed to develop policies for the management and protection of these northern forests from fire. It is important to know when and where fires should be controlled and where they should be left to go out naturally.

In developing a new program of fire research in the interior, researchers are also looking at the need for fire control studies. The environment is significantly different from other forest environments in the United States. Special techniques may be needed to manage the taiga.

It is very important to develop a fire management policy for the interior, one that will recognize the very special nature of the taiga ecosystem. If the natural mosaic of vegetation is to be maintained, then some fires must be allowed to burn. Otherwise, the tendency will be to move toward a climax spruce forest everywhere.

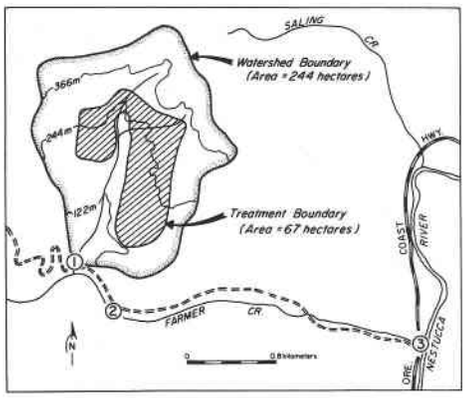
A fire management policy is also needed for maintaining caribou habitat. It is generally agreed that fire destroys the lichen-rich winter range of the caribou. Some have estimated that it may take as long as 100 years for the range to return to its pre-burn condition.

end of "insights"

Dicamba Residues in Streams After Forest Spraying, by Logan A. Norris and Marvin L. Montgomery (73)

Concern about the possible hazards of the herbicide 2,4,5-T has led to study of possible alternative chemicals for brush control. Dicamba, an auxin-type herbicide, is one possibility. It is both soil and foliage active and has a relatively low toxicity.

This paper reports results of a study to learn more about its residues in streams. From their observations, the researchers conclude that dicamba can be used for brush control on forest lands with little or no impact on aquatic environments—if direct application to surface waters is minimized by using appropriate spray application techniques. Residues posed no acute hazard to aquatic organisms or to downstream water users. The short persistence of the herbicide in water precludes chronic exposure.



Farmer Creek tributary watershed, treatment area, and sampling points one, two, and three.

rodenticides

Influence of Endrin on Soil Microbial Populations and Their Activity, by W.B. Bollen and C.M. Tu (79)

Endrin applied to soil at rates of more than three times the maximum that might be expected from application of endrin-treated tree seed exerted no appreciable effect on numbers of soil microbes or on ammonification, nitrification, or sulfur oxidation. The decomposition of soil organic matter, as indicated by the production of CO_2, was increased significantly in the presence of endrin.

Results of our study agree substantially with other studies, indicating that a very high rate of endrin in soil would be necessary to alter microbial properties. We conclude that the relatively insignificant amount of endrin formulation applied to forest soil from coated tree seed is unlikely to damage soil microbes and their activities.

Arasan in Endrin Treatments to Protect Douglas-fir Seed From Deer Mice, by G.L. Crouch and M.A. Radwan (80)

The use of arasan, along with endrin, to protect forest tree seeds from rodents is not a good idea. The compound did not lower seed consumption when used alone. In addition, the chemical also caused significant reductions in seed germination.

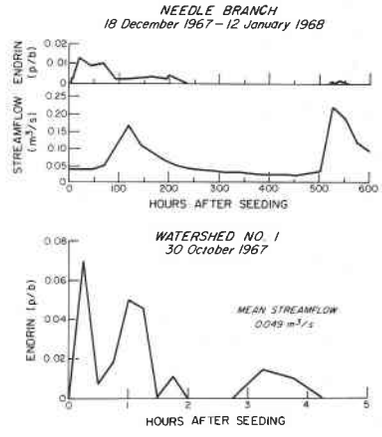
Endrin in Streams

Endrin, a chlorinated hydrocarbon insecticide, has been extensively used in the Pacific Northwest for many years to protect directly sown Douglas-fir seed from seed-eating rodents. The amount of endrin thus introduced into the forest environment is exceedingly small. However, endrin-treated seed may enter small streams flowing through seeded areas. Since endrin is one of the most toxic pesticides to fish, there is concern about the potential hazard.

In this study, scientists sought to determine how much endrin might get in streams and how persistent it might be. Detectable residues were found in a stream with steep gradient for no more than 5 hours after seeding. In a slower flowing stream, endrin could be detected for 11 days. Endrin was again detected in the low gradient stream during the high flow of a winter storm 23 days after seeding. Maximum concentrations, however, were well below the 96-hour median tolerance limits for important fish species.

The report is *Endrin in Forest Streams After Aerial Seeding With Endrin-Coated Douglas-fir Seed,* by Duane G. Moore, James D. Hall, and Wayne L. Hug (81).

Other highly technical publications are listed in the bibliography under (82). One deals with the systemic properties of tetramine, an extremely toxic chemical once considered for use as a seed protectant in reforestation. The other report is on the effects of organotin compounds on microbial activity in the soil. Organotin compounds have fungicidal, batericidal, and rodent repellent properties as well as potential for use in insect control.



Concentration of endrin in streamflow after aerial seeding with endrin-coated Douglas-fir seed: Needle Branch Watershed—seed treated with 1.0 percent endrin and sown at 0.84 kilograms per hectare; Watershed No. 1—seed treated at 0.5 percent endrin and sown at 0.56 kilograms per hectare.

A few other, rather highly specialized reports are included in the bibliography for this section (83).

arsenic compounds

Studies of the Safety of Organic Arsenical Herbicides as Precommercial Thinning Agents: A Progress Report, by Logan A. Norris (74)

In early 1970, the Forest Service invited interested scientists and forest land managers in the Pacific Northwest to meet to determine gaps in knowledge about the hazards associated with forest use of the organic arsenical herbicides, MSMA and cacodylic acid. As a result of these meetings, a cooperative effort coordinated by the PNW Station was initiated to determine the behavior and impact of organic arsenical herbicides in the forest. Specifically, these studies are to:

1. Measure the initial distribution of organic arsenical herbicides among components of the forest environment.

2. Determine their persistence, movement, and fate in the forest.

3. Characterize the acute and chronic toxicity of these chemicals to large and small animals.

Results of these studies will be used to determine the degree of risk involved in current chemical thinning practices and to make recommendations which will minimize the risk of future practices. This report covers the research approach of each cooperative study and summarizes and interprets results to date.

Other reports in this section describe results of the study of the effect of arsenic compounds on forest workers (75), rabbits (76), cattle (77), and soils (78).

So far, the conclusion seems to be that arsenic compounds are fairly safe, when applied correctly and with appropriate safety precautions. Forest workers using silvicides for thinning projects do absorb arsenic into the skin or in other ways. But the chemical appears to be excreted in a short time and there is no evidence that arsenic levels continue to increase. Workers, and their supervisors, should exercise proper safety precautions.

SOILS, NUTRIENT CYCLING

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2. Klock, Glen O. 1969. Forest and range soils research in Oregon and Washington; a bibliography with abstracts from 1964 through 1968. USDA For. Serv. Res. Pap. PNW-90, 28 p.

3. Tarrant, Robert F. 1964. Forest soils research in Oregon and Washington. (A bibliography with abstracts through 1963.) USDA For. Serv. Res. Pap. PNW-15, 29 p.

4. Wooldridge, David D. 1968. Chemical and physical properties of forest litter layers in central Washington. Tree Growth and Forest Soils. Third North American Forest Soils Conf. Proc., North Carolina State Univ. at Raleigh, p. 327-337.

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timber quality and utilization

See also:
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Mensuration
Resource Evaluation
Silviculture
Insect and Disease
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Gadgets

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Contents

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wood utilization

Status of Timber Utilization on the Pacific Coast, by John B. Grantham (1)

A 42-page report outlining the opportunities to improve timber utilization by reducing logging residue in the Pacific Coast region. There, some 14 million tons of residue accumulate each year and some 3 million tons of unused bark create a disposal problem at the mill.

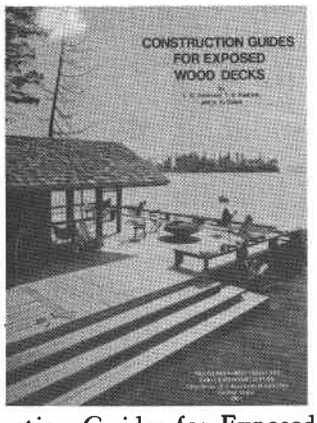
Grantham discusses: (a) the quantities and characteristics of wood residue available, (b) wood residue use now, (c) progress that is being made toward more complete utilization, and (d) administrative changes for fuller timber utilization.

Utilization Estimates for Western Softwoods—Trees, Logs, and Residue, by Donald R. Gedney and John W. Henley (2)

How much of the wood fiber in trees is actually used and becomes part of an end product? Answers to that question were published in 1971 and based on then-recent information on wood utilization.

At that time, wood utilization looked like this:

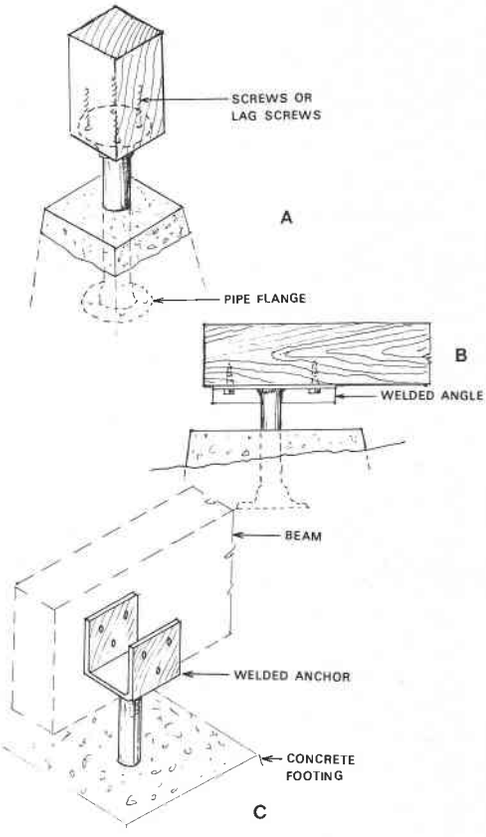
1. Of the tree harvested, 85-95 percent of the total cubic foot content reached a processing plant.
2. Of the log processed, 44-50 percent is used for primary products.
3. Of the mill residue generated, 81 percent is used.
4. Of the total sound volume of the tree, 76-86 percent of the cubic foot content is used.



Construction Guides for Exposed Wood Decks, by L.O. Anderson, T.B. Heebink, and A.E. Oviatt (3)

The all-time "best seller" publication from this Experiment Station gives guides for the design, finishing, and treatment of outdoor wood decks. Both good and poor construction details are illustrated for the benefit of architects, builders, and homeowners.

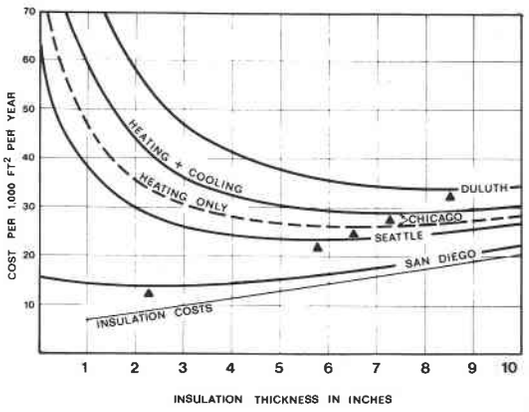
Copies are no longer available from the Experiment Station, but may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order as Agriculture Handbook 432, stock number 0100-2577. The last time we checked the price was $.75.



Pipe and flange anchor. A-pipe flange; B-welded angle (low decks); C-saddle anchor for low decks.

Optimum Insulation Thickness in Wood-Framed Homes, by A.E. Oviatt (4)

New design methods must be developed to reduce energy waste in buildings. This study examines an economic approach to the design of thermal insulation in the home and demonstrates graphically that an optimum point of insulation thickness occurs where total costs of insulation and energy over the useful life of a building are a minimum. The optimum thickness thus determined exceeds that recommended by older design criteria and significantly reduces energy requirements for heating and cooling.



Optimum roof-ceiling insulation thickness.

Moisture Content of Glulam Timbers in Use in the Pacific Northwest, by Alfred E. Oviatt, Jr. (5)

Preliminary results of this study in western Washington and Oregon generally confirm current industry standards and recommendations for the design of glulam structural members. However, indications are that existing classifications of exposure do not fully cover all possible use conditions, and that the application of present standards frequently must depend on engineering judgments in areas where field data are lacking.

The Influence of Design on Exposed Wood in Buildings of the Puget Sound Area, by Edward W. Schein (6)

This report summarized a field survey of the performance of exposed structural wood members.

The study included a survey of 175 buildings in the Puget Sound area of the State of Washington. Building designers, owners, and custodians were consulted for details of construction and maintenance. Though the primary concern was with contemporary structures, the influence of design was also observed in some older examples. Twenty-seven representative buildings were selected for analysis from the original survey list, and sketches of these are contained in an appendix. Illustrations accompanying the text are keyed to these by suffix number.

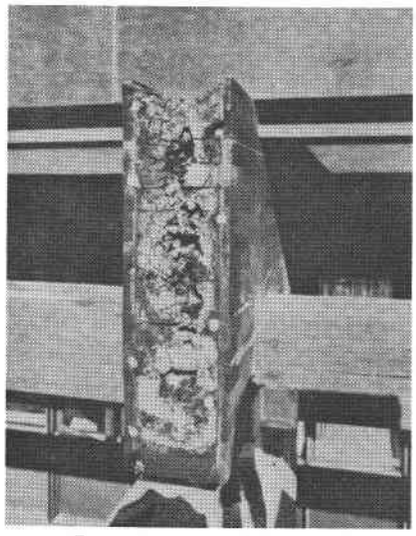
The objective of the study was to identify the best existing design solutions to exposure hazards.

A good metal flashing cap design. This cap channels water runoff away from the sides of the beam.

Protecting Exposed Ends of Timber Beams in the Puget Sound Area, by A.E. Oviatt (7)

When heavy timber members are fully exposed to the weather, changes in moisture content caused by the action of sun and rain are appreciable. This exposure is most severe on end-grain surfaces which absorb moisture rapidly. Stresses in beams of large sections usually cause checking, staining, and degradation of finishes. In the rainy climate of the Puget Sound area, moisture contents in the wood readily reach levels at which decay occurs, and even pressure-treated timbers may decay if deep checks allow water to penetrate to untreated material in the interior.

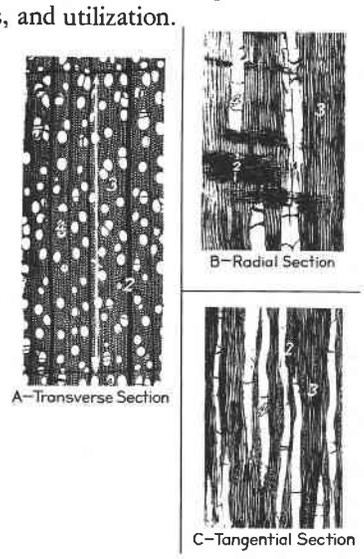
Finishes, flashing, and protective covers may be used to reduce these effects; and experimental evaluations of many potential protective methods are needed to identify systems which provide satisfactory durability and minimize maintenance. This report describes weather exposure tests of 12 protective methods, with observations of moisture content and appearance over a 3-year period. One finishing system and two types of protective covers appear to provide adequate protection.



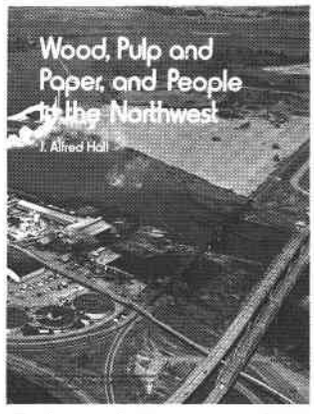
Decay in an exposed beam end.

Utilization of Bigleaf Maple of the Pacific Northwest, by Herman M. Johnson (8)

A rather old (1932) report but a fascinating (and still available) discussion of the importance of bigleaf maple—its range, annual production and consumption, wood properties, and utilization.

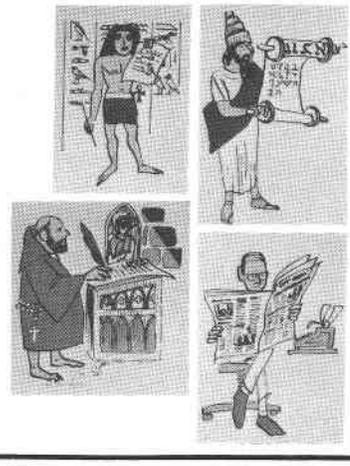


Highly magnified sections of bigleaf maple showing structure.



Wood, Pulp and Paper, and People in the Northwest, by J. Alfred Hall (9)

A fascinating discussion and explanation by a former Station Director of what goes on in the pulp and paper industry, with emphasis on environmental issues, natural resources use, economic history in the Northwest, and pulp and papermaking technology. Designed for use by high school students.



American Wood Series

The Department of Agriculture publishes a series of papers on *American Woods* that give general information on distribution of the species, their growth characteristics, wood properties, and wood uses. Several (10) were written by Experiment Station scientists and are currently available:

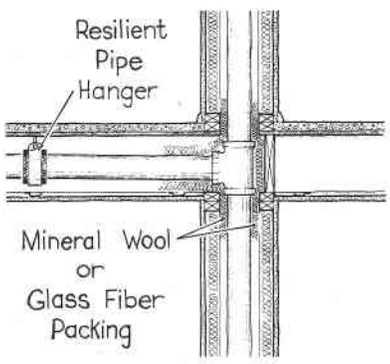
Red Alder, American Woods FS-215, 1971
Alaska-Cedar, American Woods FS-224, 1971
Sitka Spruce, FS-265, 1973
Port-Orford-Cedar, FS-228, 1973.

sound control

Insuring Noise Control in Wood-Framed Buildings, by J.B. Grantham and T.B. Heebink (11)

Lab test values of the sound insulation provided by several wood-framed wall and floor constructions illustrate that one can design for any required resistance to noise transmission between living units. However, designers and builders must follow practices that insure the expected performance when a wall or floor is incorporated in a building. Practices that reduce the expected sound insulating properties of a wall or floor are described and illustrated from field test experience. Losses due to flanking may reduce the sound transmission class (STC) of a wall by 10 points (to half its predicted effectiveness), but the combination of leaks and flanking generally reduces the STC by only 1 to 5 points.

Articles in this category are quite technical and of interest primarily to builders or architects. For a list of publications, see (12) in the bibliography for this section. Another good source of information on this subject is the Western Wood Products Assoc., Yeon Building, Portland, Oregon 97204.



One means of isolating plumbing lines to control airborne and structure borne noise.

product yield potential

Background

In 1970, former PNW Station Director Philip A. Briegleb commented on the estimation of timber quality and the appraisal of timber values. Briegleb said, "Public agencies and the forest industry are much concerned with how timber is appraised for sale. An important and difficult part of the appraisal job is estimating the quality of a tract of timber in terms of the amount of the various grades of lumber or other products that can be produced from it."

The Forest Service in cooperation with other public agencies and the forest industry is conducting research to develop better methods for estimating the potential lumber and veneer grade yield from standing timber (13).

The work performed by PNW scientists in timber quality research is extensive. Basically this research can be divided into studies dealing with the product yield potential of the total resource, methods for estimating the timber quality of various species, and related studies in the field of forest products utilization.

At the present time there are about 30 current publications which deal with these subjects. Some of these are listed in the bibliography for this section.

Standing Dead Timber

What are we going to do with all that dead timber? Questions such as this, referring to the more than 5 billion board feet of dead timber in the West, have accelerated research on the product potential of standing dead timber. When studies are completed, new information will be available for standing dead white pine and for true firs killed by the Douglas-fir tussock moth in eastern Oregon. Results to date show that 2 years after mortality, tussock-moth-killed true fir retained 73 percent of the value of the live tree. Standing white pine in Idaho retained 72 percent of its value 2 years after death. In these studies, a close relationship has been observed between the length of time the timber has been dead and its recovery value.

Preliminary information is available in a paper presented at the 1976 Rocky Mountain Forest Industries Conference. See *Potentials from Salvage Timber,* by Richard O. Woodfin, Jr. (14).

Tom Fahey

Product Yield

Information about product yield potential includes studies for Douglas-fir lumber and veneer recovery (15), true fir lumber and veneer recovery (16), and other species such as old-growth coast Douglas-fir (17), and Black Hills ponderosa pine (18).

Resource and plant managers concerned with estimating timber quality and the product yield of standing timber at the mill site can benefit from the extensive research conducted by PNW scientists. Generally, these studies pinpoint product grade yield, lumber or wood product loss, and cubic recovery relationships. They also report on lumber and wood product cubic recovery.

Improved utilization to reduce degrading, or the loss of lumber in volume and value due to treatment processes, can play a critical role in the economics of a mill operation. It is important to identify the manner and the place in processing at which wood loss occurs. And researchers are concentrating on this problem. For example, in his paper, *Wood Loss in Plywood Production—Four Species* (19), Richard O. Woodfin says that the best point to observe loss in a veneer mill is beyond the clipper, after the veneer has passed the crew or the equipment that pulls the veneer onto carts.

In this paper, Woodfin explores the relationship of dry-end wood loss in coast Douglas-fir, red and white fir, western hemlock and Black Hills ponderosa pine. He provides valuable information which can help the mill manager estimate wood loss and veneer recovery for these species.

The Woodfin paper is just one example of a growing volume of information in the area of product yields and losses. Other studies dealing with degrading include white fir wood properties (20), the distribution of lumber degrade in white fir trees (21), veneer losses in red and white fir (22), and changes in lumber grade during drying (23).

Dick Woodfin

Conversion Factors for the Pacific Northwest Forest Industry: Converting Forest Growth to Forest Products, by David A. Hartman and others (24)

This is a revised and expanded successor to the classic *Conversion Factors for Pacific Northwest Forest Products.* It is an entirely new handbook and reference manual that will meet the demands of many in the forest industry for a quick, convenient one-stop source of conversion and recovery factors.

It features a completely integrated system of conversion and recovery factors currently used in the Pacific Northwest to measure standing timber, logs, poles and piling, cord and pulpwood, lumber, veneer and plywood, pulp and paper, composition board, shake and shingles, and wood residues.

Up-to-date recovery factors have been included along with full metric conversions. There are special sections on wood residues as fuel, log scaling practices and correction factors, and wood weights and shrinkage. Other features are log and tree volume tables, common tables of equivalents (US and metric), forestry factors, and a glossary of terms and units.

The report—a handy 6x9-inch size with 124 pages, durable cover, and wire binding—can be obtained from the University of Washington, Institute of Forest Products, Seattle, Washington 98195, for $5.30.

Lumber Recovery

The reverse side of the coin, the recovery of lumber and wood products, is equally well represented by studies such as *Predicting Product Recovery from Logs and Trees,* (25). This paper provides estimating equations, based on the size of logs and trees, that can be used to predict the amount of lumber, veneer, pulp, or other products that can be produced from trees.

In addition, specific area and species product yield reports are available for red and white fir in central California (26), western white pine in Idaho (27), second-growth Douglas-fir (15), and old-growth coast Douglas-fir (17) and highly defective, low grade coast Douglas-fir (28). Reports which focus on specific milling operations and lumber recovery are available for grand fir and Douglas-fir thinnings at bandmill and chipping canters (16).

Gene Pong

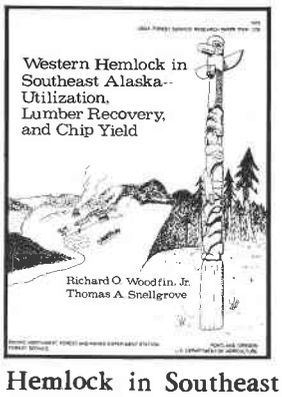
Marlin Plank

Lumber Yields by the New Timber Cruising Log Grades for Old-Growth Coast Douglas-fir, by Marlin E. Plank and John W. Henley (29)

Lumber grade yield information is presented based on a new system of grading old-growth coast Douglas-fir. The report contains recovery on nearly 5,000 logs that were sawn in 10 sawmills in Washington, Oregon, and California.

The logs produced nearly 2.7 million board feet of lumber. About 54 percent of the lumber production was in 2-inch dimension, 10 percent was 1-inch boards, shop was about 12 percent, and other items thicker than 2 inches accounted for 24 percent of the total. Average lumber grade yields are shown in curve and table form.

On the average, about 64 percent of the gross cubic content of the log was manufactured into rough green lumber. About 25 percent of volume was lost as shrinkage and planer shavings, and about 50 percent of the cubic content of the log was shipped as lumber. These relationships are shown in tables and curve form.



Western Hemlock in Southeast Alaska—Utilization, Lumber Recovery, and Chip Yield, by Richard O. Woodfin, Jr., and Thomas A. Snellgrove (30)

This is the first published information on lumber recovery from western hemlock trees in southeast Alaska national forests. Logs for this study were sawn at a southeast Alaska mill that was cutting for the Japan export market.

The total of 1,261 sawn-length logs in the study produced about 335,400 board feet of lumber. Over 88 percent of this volume was in 4-inch-thick items, primarily nominal 4 by 4's. Lumber grade recovery was concentrated in two grades: Standard and Construction.

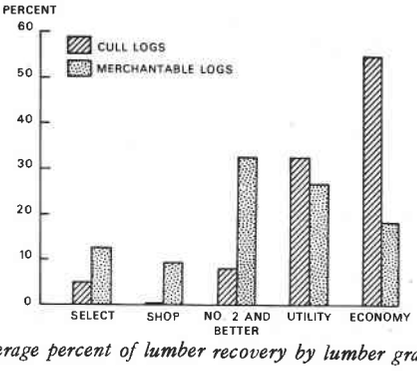
Sawing the 1,165 noncull logs (logs at least one-third sound by Scribner Scale) resulted in a 20-percent overrun from net scale. The cubic lumber recovery was 48 percent of the gross cubic log volume. In contrast, the 96 cull logs yielded only a 26-percent cubic recovery. Average scaled defect for the 1,165 sawn, noncull logs was 19.6 percent. Defect percentages were lowest for the peeler and No. 3 grade logs.

The amount of ovendry chippable wood is discussed and variation by log size illustrated. Examples explain practical application of this information.

Logging residue accounted for 23.3 percent of the total tree volume. Residue types recognized were broken logs, long butts, unused volume to an 8-inch top (includes cull logs left in the woods), and the volume between the used top and total height. These amounted to 3.2 percent, 5.7 percent, 3.6 percent, and 10.8 percent, respectively, of total tree volume.

Lumber Potential for Cull Logs in the Pacific Northwest, by Thomas A. Snellgrove and David R. Darr (31)

Cull log volume left after logging in western Washington and western Oregon amounts to less than 10 percent of the log volume consumed by the lumber industry in the two states. 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. This study indicates that the economic feasibility of using cull logs for lumber manufacture is marginal except when lumber prices are very high.



Average percent of lumber recovery by lumber grade.

Courtesy Fort Collins Coloradoan

Tom Snellgrove

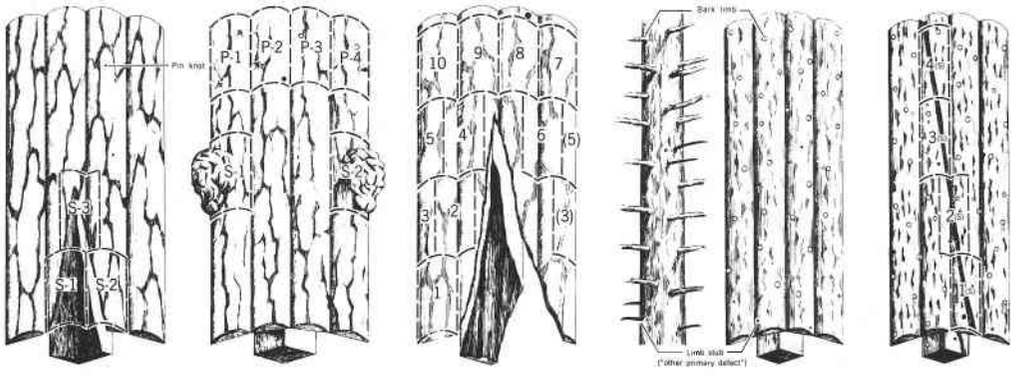
forest residues

general

Log Grading

Resource managers and wood processors are constantly faced with the question of timber value. Two factors, log grades and defects, play a critical role in estimating value. Constant refinements in these systems of classification allow those concerned with estimating timber quality and price to make more reliable judgments about the resource.

At PNW, log grading, or timber quality estimating systems, have been developed or are available for old-growth and second-growth coast Douglas-fir (32), western white pine (33), ponderosa pine and sugar pine (34), and inland Douglas-fir (35). The *Pocket Guide to the Improved Grading System for Ponderosa Pine and Sugar Pine Saw Logs in Trees* (36) allows timber cruisers to independently grade each log by identification of both primary and secondary defects.



Grade 1 *Grade 2* *Grade 3* *Grade 4* *Grade 5*

Defect Estimation

PNW scientists, conducting research on forest diseases, have made a strong effort to extend research results into working tools for resource managers. Research data has been compiled into "how to" brochures which can be taken to the field and used to reliably estimate a variety of defects. At the present time, three of these pocket-sized guides are available.

1. *How to Estimate Defect in Grand Fir in the Blue Mountains of Oregon and Washington* (37)
2. *How to Estimate Defect in White Fir in South-Central Oregon* (38)
3. *How to Estimate Defect in White Fir in Southwest Oregon* (39)

These guides were authored by Paul Aho of the PNW Station and James Hadfield of Forest Service, Region 6. They include photographs of each of the major and minor defects along with written descriptions of each defect and the recommended amount of deduction.

Paul Aho

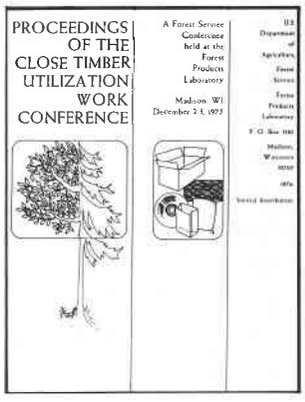
Broken Tops

Basal Injuries

Each guide in this series is a valuable tool for those who cruise timber. The guides are based on extensive field research which also includes a study of decay in Englemann spruce in the Blue Mountains of Oregon and Washington (40) and ponderosa and sugar pine logs (41).

Slide-tape instructional programs have also been developed for defect estimation in grand fir in the Blue Mountains, white fir in south-central Oregon, and white fir in southwest Oregon. Information concerning the rental or purchase of these training aids can be obtained from:

Forestry Instructional Center
c/o Forestry Business Office
School of Forestry
Oregon State University
Corvallis, Oregon 97331
Phone: 503/754-1702 or
FTS: 424-1702.



Proceedings of the Close Timber Utilization Work Conference, Madison, Wisconsin (42)

A 94-page report contains presentations by 16 Forest Service people on the subject of forest residues and how to improve wood utilization. The report is the proceedings of a Forest Service Conference held at the Forest Products Laboratory in Madison, Wisconsin, in December 1975. All aspects of residues are discussed, including volumes, utilization potential, research needs, and timber sale considerations.

Logging Leftovers

A small brochure describes a cooperative study between the Forest Service and Simpson Timber Company. Conducted in the Sustained Yield Unit of the Olympic National Forest near Shelton, the study is examining ways to create less residue during the timber harvesting. It will also explore new ways to use more of the wood that remains after logging in the Douglas-fir region. Cooperators hope to increase wood utilization and improve the looks of recently logged areas.

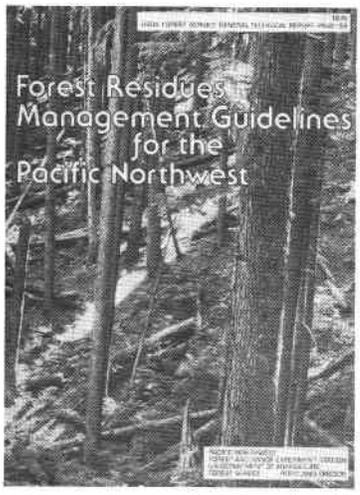
See *Logging Leftovers, A Study of Wood Use* (43).

Environmental Effects of Forest Residues Management in the Pacific Northwest—A State of Knowledge Compendium, edited by Owen P. Cramer (44)

If you want to know about forest residues, this is the place to begin. In this compendium, 27 research scientists summarize the state of knowledge of the effects of forest residues and residue treatments on the components of the forest environment: soil, water, air, fire, esthetics, forest growth, animal habitat, insects, and disease. Researchers question some current management practices and identify areas for research where current knowledge is lacking.

This summary provides a basis for:

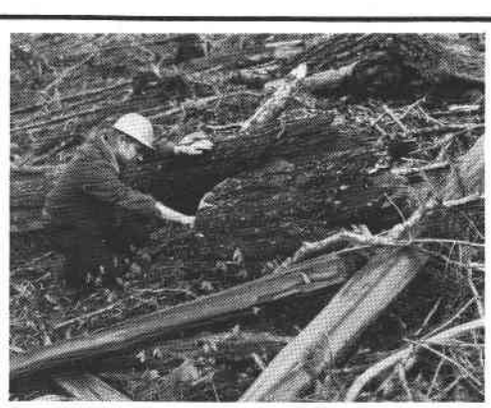
1. Guiding forest resource managers in their selection of residue treatment alternatives.
2. Planning an intensive, broad research and development program on effects of residue and residue treatments.
3. Designing equipment for treating forest residue.



Forest Residues Management Guidelines for the Pacific Northwest, by Pierovich, Clarke, Pickford, and Ward (45)

This 273-page book provides practical guidelines that will help foresters make management decisions about treatment of forest residues. A unique keying system helps guide users to the solution of their particular land management problem.

The guidelines are based on the information gathered for the residues compendium listed earlier. Both publications were prepared with the cooperation of foresters, scientists, and technical specialists representing several agencies and private landowners. Recommended guidelines consider all the resources of the forest and are given for both public and private ownerships.



Choosing Forest Residue Management Alternatives, by John M. Pierovich and Richard C. Smith (46)

Residue management must become part of the overall scheme of forest management. This paper discusses residue management from the standpoints that forest residue is: (a) potentially usable wood fiber, (b) a serious fire hazard, (c) an obstruction to forest use and management, and (d) a solid waste disposal problem that attracts much public attention.

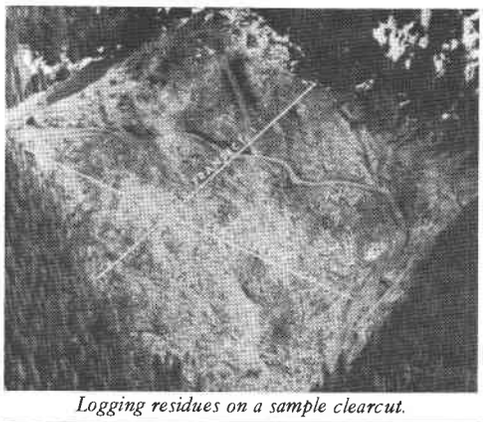
A schematic thought process is suggested whereby land managers may compare alternative residue treatments in terms of their expected costs and benefits.

volume & measurement

Logging Residues on Douglas-fir Region Clearcuts—Weights and Volumes, by John D. Dell and Franklin R. Ward (47)

Logging residue weights and volumes are given for a sample of clearcuts in the Douglas-fir region of western Oregon and Washington. A total of 1,509 acres were sampled in the study.

Results show the large volumes of logging residue being left in the Douglas-fir forests of the Northwest. The mean gross volume of residues on the 30 units sampled was 7,430 cubic feet per acre. Slash fuel weights ranged from 32 to 227 tons per acre.



Logging residues on a sample clearcut.

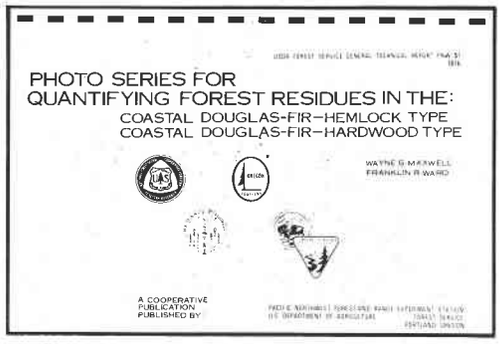


Photo Series for Quantifying Forest Residues in the: Coastal Douglas-fir-Hemlock Type; Coastal Douglas-fir-Hardwood Type, by Wayne G. Maxwell and Franklin R. Ward (48)

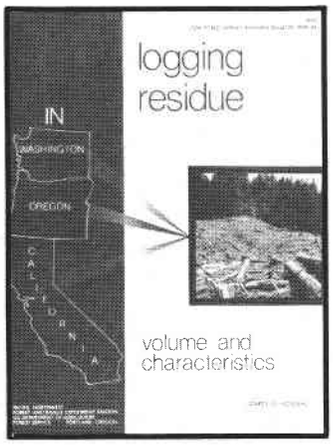
Measurement of forest residues has been costly and time consuming in the past. Photo Series provides a fast, easy, inexpensive way to quantify and describe existing and expected residues—adequate for most management needs.

Photo Series is an array of colored photos showing different residue loading levels generated from like timber types and cutting practices. Each photo is supplemented with data and information such as measured quantities by size classes, stand characteristics, harvest and treatment methods employed, and fuel ratings.

The photo series is a comparative tool and communication aid. Users can:

- Inventory residues by matching characteristics on the ground with like characteristics in a photo and extracting quantities from the accompanying photo series data sheet.
- Predict loadings and appearance of planned cutting or treatment areas by matching planned volume removal and treatment methods with like information on a photo series data sheet, extracting residue quantities from this sheet, and viewing the accompanying photo.
- Determine desired residue levels to meet land management objectives, irrespective of professional specialty, by studying photo series to visualize described quantities, evaluating benefits and impacts of various quantities, and discussing most advantageous quantities with other participants.

A companion publication for predominant pine types in the Pacific Northwest is also available (49).



Logging Residue in Washington, Oregon, and California—Volume and Characteristics, by James O. Howard (50)

This report makes available data on the volume and characteristics of logging residue resulting from 1969 logging operations in Oregon, Washington, and California.

Highest volumes of logging residue are found on clearcuts in the Douglas-fir region of western Oregon and western Washington. Average gross volume of residue in this region ranged from 4,548 cubic feet per acre on national forest land to 1,491 cubic feet per acre on private land.

Total net volume for all owners in this region was estimated to be about 460 million cubic feet for 1969. The lowest volumes were found in the ponderosa pine region of eastern Oregon and eastern Washington. In California, gross volume averaged 1,905 cubic feet per acre for private lands and 1,460 cubic feet per acre for National Forests.

For earlier reports on logging residues, see also items listed in the bibliography (51).

Jim Howard

Measurement of Logging Residue—Alternative Applications of the Line Intersect Method, by James O. Howard and Franklin R. Ward (52)

Alternative designs are outlined for using the line intersect method to measure logging residue. These methods can be used to estimate logging residue volume within ± 15 to 20 percent of the actual volume. Results also indicate that it will be costly to increase the accuracy of estimates beyond that point.

Characteristics of Residues in a Balloon Logged Area of Old-Growth Douglas-fir, by W.Y. Pong and John W. Henley (53)

The residues in a 44-acre old-growth Douglas-fir stand in the Oregon Cascades were examined before and after the area was clearcut and balloon logged.

The amount of residues on the ground increased from more than 5,000 cubic feet per acre before logging to more than 8,000 cubic feet after logging—a 53-percent increase. Not all size classes of residues increased in volume. In fact, there was a noticeable decrease in the larger classes, indicating that some of the material classed as residues had been yarded out.

If we define usable residues as material which can be yarded without breaking up, at least 10 percent sound, 3 inches and greater in diameter, and at least 4 feet long, then more than 80 percent of the prelogging residues and nearly 70 percent of the logging residues could have been used.

treatment

High-Lead Scarification: An Alternative for Site Preparation and Fire-Hazard Reduction, by Franklin R. Ward and James W. Russell (54)

Scarification is evaluated as an alternative to slash burning in preparing for planting (a) a recently logged site, and (b) a previously treated site that had been taken over by a dense stand of brush.

The scarifying tool was a 1½ by 4½-foot steel cylinder, concave on both ends, and filled with concrete. It was connected to a cable system employing a yarder with a 25-foot tower and a specially modified crawler tractor which served as a mobile tailblock. The weighted cylinder was dragged back and forth between the tower and the tractor to scarify, break, or masticate the residue.

Using this system, it took 43 hours to scarify 34 acres of one unit and about 42 hours to scarify 29 acres of the second area. Scarification reduced the slash considerably and resulted in more exposure of mineral soil. Total cost of treating the areas was $244 per acre and $264 per acre, respectively.

Evaluations on Accelerating Wood Decomposition in the Field, by Franklin R. Ward (55)

Douglas-fir logging residues may retard forest regeneration and increase the fire hazard in Pacific Northwest forests. Since decay of Douglas-fir wood is relatively slow, this condition can persist for many years.

The objective of this study was to see if wood decay could be speeded up by treating it with various chemicals: ammonium phosphate, urea, asparagin, 2,4-D and 2,4,5-T, and a plastic spray to keep moisture in.

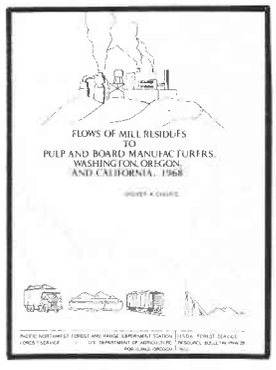
They just didn't work. Researchers do not recommend these materials for residue reduction.

Semipermanent Fire Retardants—Are They Needed? by Hugh R. McLean (56)

A semipermanent fire retardant would be a valuable tool in building lines around a prescribed burn area. A survey of fire management specialists indicated that retardant lines could replace 25 to 500 miles of conventionally constructed control lines annually in each of the National Forest Regions responding.

Forest Service fire laboratories, in cooperation with one or more of the interested fire retardant chemical manufacturing companies, are urged to undertake additional research and development work.

utilization



Flows of Mill Residues to Pulp and Board Manufacturers, Washington, Oregon, and California, 1968, by Grover A. Choate (57)

Twelve million tons of residues were generated by lumber and veneer and plywood mills in the Pacific Northwest in 1968. Of the 10.3 million tons that went to domestic mills, 83 percent went to pulpmills (average distance 82 miles) and 17 percent to board mills (30 miles); 74 percent was shipped by lumber mills (68 miles) and 26 percent by veneer and plywood mills (88 miles). Fifty percent of residues to domestic mills went by truck (37 miles), 35 percent by rail (147 miles), 6 percent by barge (59 miles), and 9 percent by onsite transport (1 mile).

Nine million tons of wood residues from sawmills and veneer and plywood mills were either unused or went for fuel in 1968.

Jack Grantham

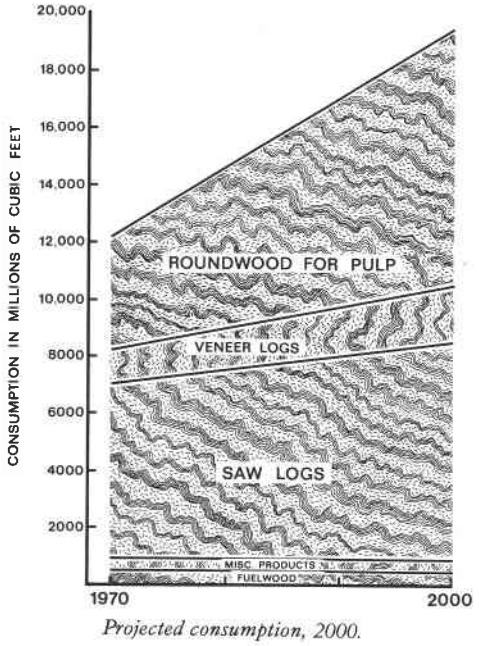
Energy From Wood

The energy of the sun is locked inside every living thing. Trees are an abundant source of this energy, and there is renewed interest in converting wood, especially logging residue, to energy.

What are the possibilities for using wood waste for energy in the Pacific Northwest where both wood and water resources are relatively abundant? A preliminary study indicates that generation of electricity from wood residue is not generally practical here; at least at this time. However, small scale power production may be feasible for individual plants that have a need for both process steam and electric power. The major drawback is the high cost of collecting and transporting wood to the conversion site.

See *Energy and Raw Material Potentials of Wood Residue in the Pacific Coast States—A Summary of a Preliminary Feasibility Investigation,* by John B. Grantham, Eldon M. Estep, John M. Pierovich, Harold Tarkow, and Thomas C. Adams (58).

See also a report titled, *Potentials of Wood for Producing Energy,* by John B. Grantham, and Thomas H. Ellis, a reprint from the *Journal of Forestry* (59).



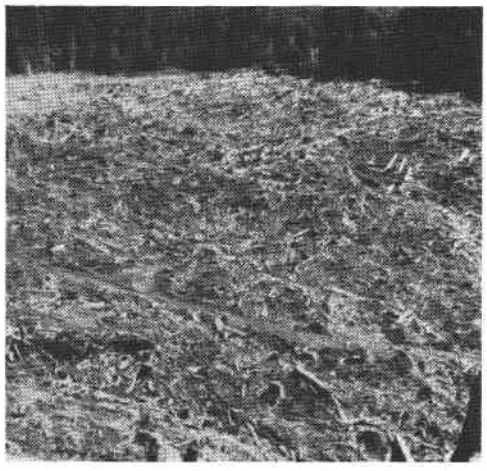
Projected consumption, 2000.

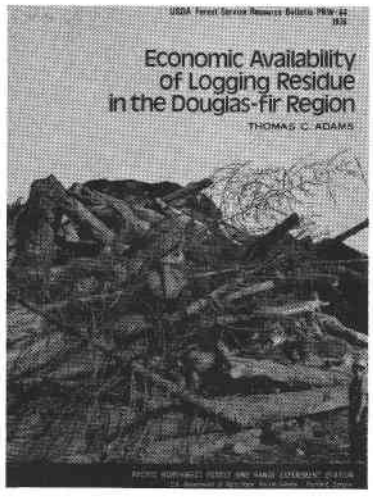
Review of the Logging Residue Problem and Its Reduction Through Marketing Practices, by Thomas C. Adams (60)

Air quality regulations adopted in the last 10 years require reduced burning of logging slash. New ways are being sought to reduce the quantity of logging residues by other means.

A review of potential marketing practices designed to reduce logging residue explored several approaches. These include stronger removal incentives or treatment requirements in the timber sale contract, more efficient harvesting methods, and development of expanded markets for utilization of residue type material.

For example, alternative sale arrangements can include such things as reduced stumpage charges for low quality logs or required yarding of unutilized material to the landing or to some stockpiling or disposal point. Improvements in harvesting methods can be designed and specified to create less breakage. Also, more wood fiber will be made available through more careful bucking, sorting, and grading, and coordination with the diversity of available utilization outlets.

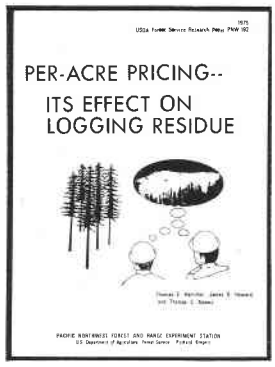




Economic Availability of Logging Residue in the Douglas-fir Region, by Thomas C. Adams (61)

Logging residue from harvest operations in old-growth forests of the Douglas-fir region contains much sound wood fiber. Economic availability of each piece, however, depends on its size, condition, location, existence of a market for that kind of material, and an adequate price to cover costs.

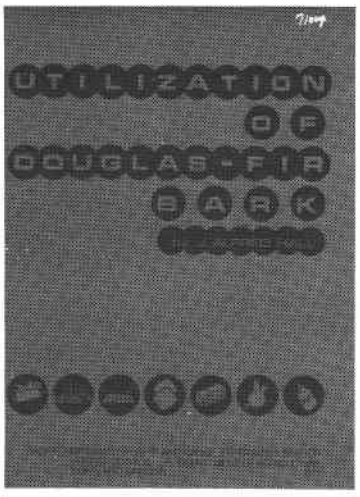
A study of one year's harvest estimated 185 million cubic feet of logging residue in western Washington and western Oregon had a positive conversion value in 1970, if it had been yarded at the time of regular logging, and if there had been no stumpage charge for such material. Lack of utilization, however, is considered to be due to such factors as the operator's lack of suitable equipment for handling small logs or pieces, lack of local markets, general market instability, and problems of setting specifications, scaling, and pricing.



Per-Acre Pricing—Its Effect on Logging Residue, by Thomas E. Hamilton, James O. Howard, and Thomas C. Adams (62)

Do timber sale procedures affect the amount of wood residue left in the forest after logging? This paper compared two methods used by the U.S. Forest Service in Oregon and Washington for selling standing timber. One method (scale sales) applies a set price per thousand board feet, by species, to the log scale or the measured amount of timber removed. The other method (per-acre material or PAM sales) sells all logs below a given net volume for a lump sum per acre with larger logs sold on a scale basis.

The purpose of the PAM method is to encourage the logging operator to remove more of the low value material that might otherwise be left as logging residue. Results of this study showed 14.1 percent less residue for the PAM sales. This was a significant difference at the 10-percent probability level, but not at the 5-percent level; the authors concluded this was not strong statistical evidence that a real difference exists between the two methods.



Utilization of Douglas-fir Bark, by J. Alfred Hall (63)

About 1.5 million tons of bark is produced annually in the Douglas-fir region as a result of timber harvesting operations. Existing outlets are taking substantial quantities of bark, but much more is wasted or used only for fuel. The physical and chemical makeup of old-growth Douglas-fir bark is unique and increased attempts should be made to find uses for it.

Whole bark is used for power fuel, domestic fuel, charcoal manufacture, board and tile manufacture, and for agricultural use. Physically, bark is made up of three principal fractions: cork, fiber, and fines. A survey is given of the many efforts to develop markets for these materials.

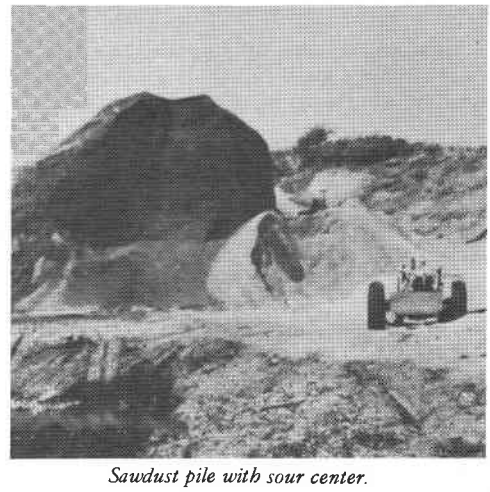
Twenty years experience by the Weyerhaeuser Company in producing and marketing the physical fractions has resulted in a continuing business of modest size. One of the best markets has been for fines in drilling muds. Both the cork fraction and the fiber fraction have also been used extensively. The market for these products, however, has been uneven. Further refining of the chemical properties of bark might produce better results.

For another report on the same subject, see *Bark—Old and New,* a keynote speech by J. Alfred Hall at a conference on Converting Bark into Opportunities, held in 1971 at Oregon State University (64).

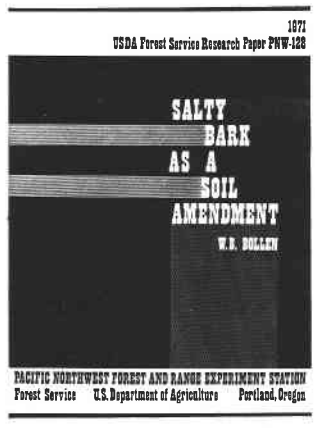
Sour Sawdust and Bark—Its Origin, Properties, and Effect on Plants, by W.B. Bollen and K.C. Lu (65)

Milk sours as it gets old and so does sawdust! Acetic acid and other volatile organic acids accumulate as a result of fermentation of sawdust and bark in large storage piles. Such sawdust should not be used for horticultural purposes without aeration or addition of lime to reduce the volatile acids.

A highly pungent odor means the sawdust should not be used. Usually the nose will guide the user. But a simple pH test kit and a reading below about 3.5 also means trouble.



Sawdust pile with sour center.



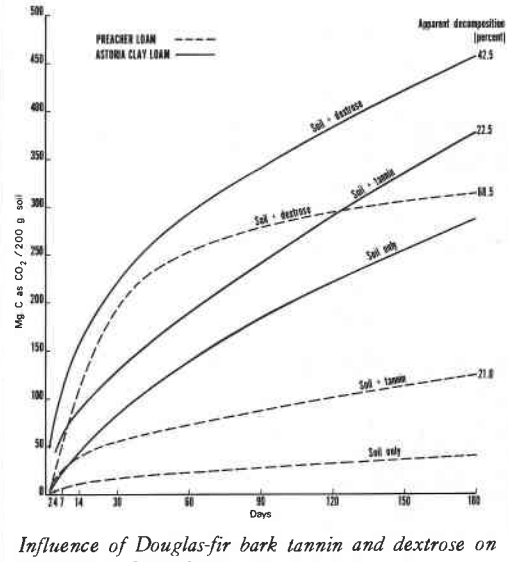
Salty Bark as a Soil Amendment, by W.B. Bollen (66)

Salt is toxic to plants, and bark from logs that have soaked in salt water for a long time may be harmful to plants when applied at the usual rate of about 40 tons per acre. Salt leaching may injure sensitive plants if the salt is concentrated in the upper root zone.

Salty bark that is ground to the nominal ¼ to ½-inch size commonly used for horticultural purposes would be less hazardous as a mulch than if incorporated in the soil.

Douglas-fir Bark Tannin Decomposition in Two Forest Soils, by W.B. Bollen and K.C. Lu (67)

Addition of tannin, from Douglas-fir bark, to two greatly different forest soils produced no evident harmful effects. However, a moderate decrease in nitrification caused by the tannin should be considered when bark is used for agricultural purposes. This feature might even be useful in watershed management because bark on forest soils might lower nitrate production and thus decrease the hazard of nitrates in water supplies fed by forest streams.



Influence of Douglas-fir bark tannin and dextrose on carbon dioxide production.

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fire

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Contents

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Only limited research has been done at the PNW Experiment Station on forest fire problems. Of the studies that have been conducted, most relate either to the effects of fire and prescribed fire on the environment, or to fire weather and fire danger rating.

The Forest Service does have an extensive fire research program, however. That work is conducted at three fire laboratories throughout the country. Information may be obtained from the following:

Northern Forest Fire Lab
University of Montana Campus
Drawer G
Missoula, Montana 59801

Forest Fire Lab
P.O. Box 5007
Riverside, California 92507

Southern Forest Fire Lab
Georgia Forestry Center
P.O. Box 5106
Macon, Georgia 31208

wildfire

fire weather

Effect of Fire Whirlwind Formation on Solid Fuel Burning Rates, by Martin, Pendleton, and Burgess (1)

Fire whirlwinds are one of the most disastrous phenomena associated with forest or urban fires. In addition to their high wind velocities and ability to transport firebrands, fire whirlwinds also cause the burning rates of woody fuels to accelerate from 1.5 to over four times as fast as without the whirlwind.

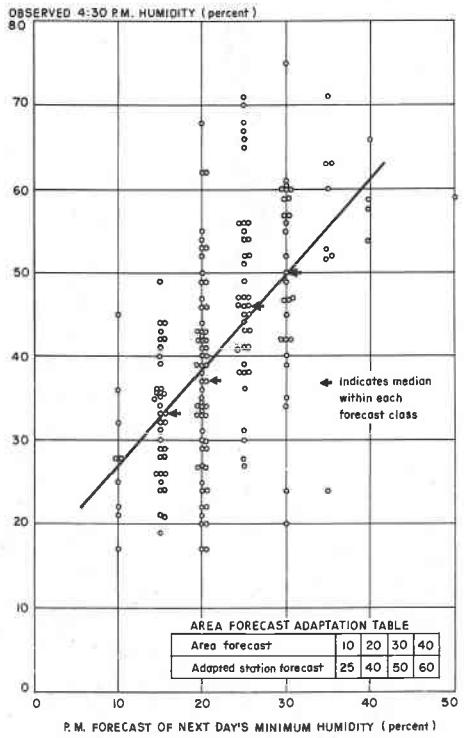
Predicting Burning Index

Considerably more research is needed before fire weather and fire danger can be predicted with enough accuracy to adequately meet the needs for forest fire control.

In this study, researchers explored the praticality of using several tabular and graphical aids to convert area forecasts and local observations of relative humidity and wind speed into predicted values for individual fire-danger stations. Four different aids were tested: (a) aids for adapting area forecasts of wind speed and relative humidity, (b) a procedure for predicting wind speed, (c) aids for predicting fuel moisture, and (d) routine statistical procedures for predicting wind speed, fuel moisture, relative humidity, and burning index class.

Some of the aids showed promise, and some improvements were made during the course of the study. But, more important, the difficulty of the task has emphasized the need for more research on the problem.

See *Using Fire-Weather Forecasts and Local Weather Observations in Predicting Burning Index for Individual Fire-Danger Stations,* by Owen P. Cramer (2).

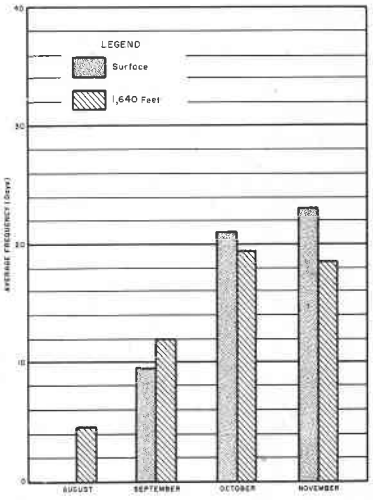


Example of humidity forecast adaptation aid and worksheet.

Frequency of Dry East Winds Over Northwest Oregon and Southwest Washington, by Owen P. Cramer (3)

There is a close relation between occurrences of severe easterly winds and large forest fires in northwest Oregon and southwest Washington. With the east wind comes the dreaded combination of low humidity and high wind that in the past has whipped small fires into conflagrations such as the Tillamook fire of 1933 and the fire that burned Bandon in 1936. These easterly winds are of the **foehn** type, typically dry because they are downslope winds.

Cramer discusses the situations that produce dry east winds, and gives data on the frequency of major and extreme east winds in three elevation zones.



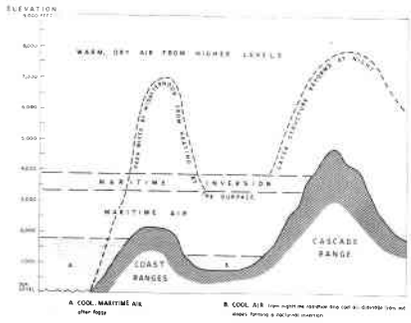
Comparison of frequencies of major easterly winds at 1,640 feet over Portland with major surface winds in northwest Oregon and southwest Washington during 1934-41 and 1948.

Relation of Number and Size of Fires to Fire-Season Weather Indexes in Western Washington and Western Oregon, by Owen P. Cramer (4)

In this study, fire-season weather indexes for western Oregon and western Washington were found to be correlated with actual fire occurrence. Equations given here make it possible to compute the number of man-caused fires and the proportion of all fires in each of three size classes that might reasonably have been expected under actual fire weather conditions.

Adjustment of Relative Humidity and Temperature for Differences in Elevation, by Owen P. Cramer (5)

Weather patterns in mountainous terrain are so complex that general forecasts are not always useful when used to predict weather in the mountains. But much information about temperature and humidity can be obtained by adjusting available observations or forecasts for any difference in elevation from the forecast or observation point.



Typical strata of air over western Oregon and western Washington on a summer morning.

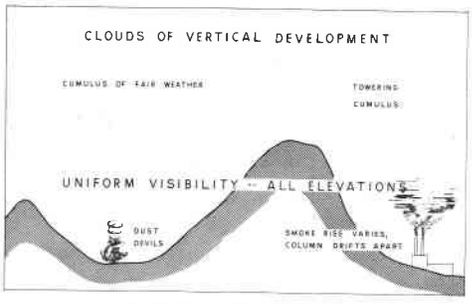
This paper provides charts that make it possible to:

(a) Determine the vertical extent of layers in which mixing is present (unstable layers) and of layers in which there is no mixing (stable layers).

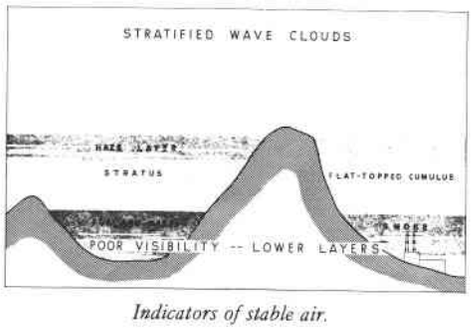
(b) Adjust temperature and humidity between elevations within mixed layers.

(c) Predict afternoon valley temperatures and humidities from morning observations at peak stations.

(d) Estimate humidities at any level within the mixed layer beneath cumulus clouds.



Indicators of unstable air.



Indicators of stable air.

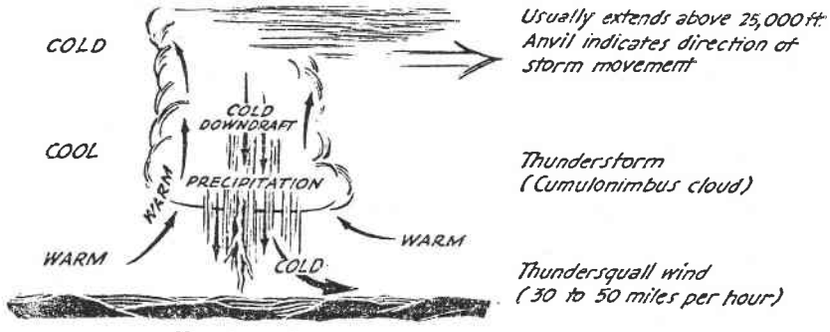
Recognizing Weather Conditions That Affect Forest Fire Behavior, by Owen P. Cramer (6)

A nice discussion of the various conditions that make up fire weather. Emphasis is on discussion of factors that can cause violent or erratic fire behavior and subsequent fire "blow up." The following conditions are described:

stable air	thundersquall
inversion	whirlwind
unstable air	dust whirl
turbulence	fire whirlwind
gustiness	fire storm
convection	

As an example, the following description and diagram is given for a thundersquall:

Thundersquall—The sudden wind that blows outward from beneath a thunderstorm. Such a wind originates in the area of heaviest precipitation in a cumulonimbus cloud, a convective cloud type that occurs in unstable, moist air. Air, cooled by precipitation, descends from the cloud and fans out at the surface. The thundersquall usually occurs with a well developed thunderstorm and hits suddenly with speeds averaging 30 to 50 miles per hour for a period of several minutes. The thundersquall may occur beneath a thunderstorm from which no precipitation reaches the ground, and may extend outward a mile or more ahead of the storm edge. These sudden, strong winds may sweep a fire far beyond its confines before the rainy section of the thunderstorm arrives. If the rain evaporates before reaching the ground, the fire may continue to burn unchecked.



Thundersquall.

occurrence and detection

Forest Fires in Western Oregon and Western Washington, by William G. Morris (7)

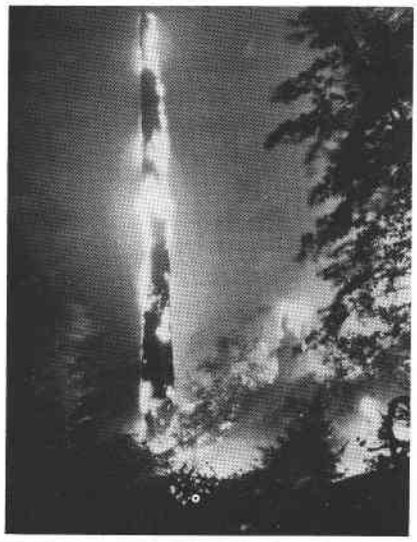
The first anniversary of the great Tillamook fire of 1933 prompted William G. Morris to write this fascinating report on early forest fires for the *Oregon Historical Quarterly.* It's all here. . .the drama and heartbreak that is best summarized here by a few excerpts:

1845: "When the fire came, after several smoky days, the Indians had to leave all their belongings in order to escape down the river."

1846: "Salmon River John, an Indian who was accustomed to weigh his words carefully, bore witness that the fire was so great in the Yaquina Bay region that the flames leaped across the river, that many of the Indians perished and that only those were saved who took refuge in the water."

1864: "Never, since the white man trod the sod of southern Oregon, has there been so much fire in the mountains as during the past few weeks. From north of the canyon to the Siskiyous, the fire has been raging with increased fury. Much of the sickness which prevails among us at present is attributed to the heated state of the atmosphere and the immense volumes of smoke ever created by the vast fires."

1868: "We learn from Captain Cosgrove, of the Mary Woodruff, that the fire is raging extensively in the woods around Bellingham Bay. . .The sawmill took fire and the coal miners all turned out en masse and succeeded after strenuous efforts in saving the mills. . .The coal company has lost some thousands of dollars worth of hewn timber which they had in the woods. . ."



Lightning Storms and Fires on the National Forests of Oregon and Washington, by William G. Morris (8)

This unique and still valid study of thunderstorm occurrence, movement, and lightning production characteristics scrutinizes the summer, forest-fire starting storms common over the forested mountainous areas of Oregon and Washington.

This analysis is based on more than 6,000 reports by U.S. Forest Service lookouts who observed some 1,500 separate thunderstorms in the summers of 1925 to 1931. From these reports, individual storm tracks were reconstructed and the storms' characteristics determined. Morris found that:

- Sixty-six percent of all lightning fires are started on ''general'' storm days.
- There were no preferred ''breeding'' spots and no preferred storm tracks.
- An ''intermediate'' or ''general'' storm day has a 40 percent chance of being followed by another similar day.
- There are definite zones of lightning storm frequency.
- The summer average of 23 to 27 days with thunderstorms far exceeds the frequencies for the more densely populated areas of the two states.
- Ninety percent of the storms developed between 10 a.m. and 10 p.m.
- Most storms had tracks 11-60 miles long, moved at 6-20 mph, and travelled in a northerly direction.

Records and Experience of Discovering Fires from Aircraft, by William G. Morris (9)

An early report documenting the benefits of forest fire detection from aircraft. During the period 1950-56, about 250 fires were discovered by aerial observation on four national forests in the Pacific Northwest. Ninety-three percent were only small spots when discovered.

Personnel kept special records concerning fires discovered and fires missed by aerial patrol, method of using the eyes while looking for fires, and conditions that might affect efficiency of an aerial observer. Records are from four national forests: the Wallowa-Whitman, Okanogan, Mt. Baker, and Siskiyou.

prescribed burning

Use of Fire in Managing Forest Vegetation, by George R. Fahnestock (10)

In using fire, man has sought to emulate nature. He has observed that wildfires produce widely varying effects in response to the many combinations of fuel, weather, and topography in which they burn. Even fires that are remembered for their high intensity and destructiveness almost invariably contain areas of low-intensity burning where little damage or even some benefit results. Consequently, man has learned to use fire in various intensities, according to his purpose. This paper reviews briefly the purposes, techniques, costs, and consequences of man's use of fire to manage forest vegetation.

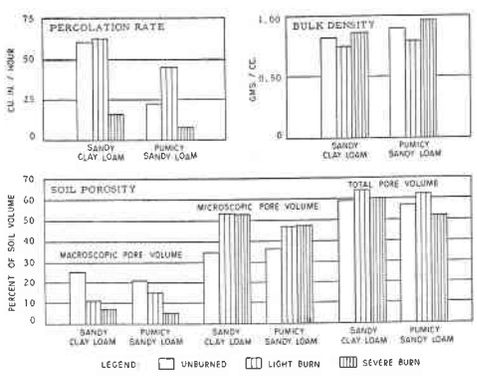
Effects of Slash Burning on Some Soils of the Douglas-fir Region, by Robert F. Tarrant (11)

Effects of slash burning on soils are important in order to maintain productivity of the site. Three classes of surface soil condition following burning are recognized: unburned, light burn, and severe burn. Each class is defined and the effects studied.

Information gained from this study indicates that severe burning does damage the soil, but usually only a small percentage of the area is severely burned. Severe burning is most often associated with heavy concentrations of slash, which will be less common on new clearcut areas in the Douglas-fir region as old-growth harvest is reduced.

An intensive sampling of 10 clearcut and burned areas gave these results:

Surface condition	Percent of total area
Unburned	47.1
Light burn	46.9
Severe burn	2.8
Non-seedbed (rock, etc.)	3.2



Changes in physical soil properties after slash burning.

Some Effects of Logging and Slash Burning on Physical Soil Properties in the Corvallis Watershed, by C.T. Dyrness, C.T. Youngberg, and Robert H. Ruth (12)

The effects of slash burning on forest soils are discussed. This study indicates that light or moderate burning will not cause much change in soil properties. In severely burned portions, however, scientists found a consistent and significant change in the character of the surface soil. Severe burn was found on only about 8 percent of the three units examined, which was probably a higher percent of severe burn than normal in the Douglas-fir region.

Severe burning caused loss of silt and clay and a corresponding increase in sand components in the soil. Organic matter was also reduced, and the percentage of aggregates in the top two inches was lowered.

This paper is really an introduction to slash burning and its effects on soil properties. The authors indicated that results should be applicable over a substantial part of the Douglas-fir region, but that only three soil types were sampled.

Fire Ecology in the Pacific Northwest

The proceedings of the Fifteenth Tall Timbers Fire Ecology Conference held in Portland in October 1974 is a landmark publication on fire ecology in the Pacific Northwest. Papers on many aspects of fire ecology are included. The following are available as reprints from the Experiment Station:

- *Fire in the Pacific Northwest—Perspectives and Problems,* Robert E. Martin, Dan D. Robinson, and Walter H. Schaeffer.
- *Development of Vegetation After Fire, Seeding, and Fertilization on the Entiat Experimental Forest,* Arthur R. Tiedemann and Glen O. Klock.
- *Soil-Water Trends Following Wildfire on the Entiat Experimental Forest,* G.O. Klock and J.D. Helvey.
- *Some Climatic and Hydrologic Effects of Wildfire in Washington State,* J.D. Helvey, A.R. Tiedemann, and W.B. Fowler.
- *An Approach to Predicting Slash Fire Smoke,* D.V. Sandberg and S.G. Pickford.

The entire proceedings is available as a report (13) from the Tall Timbers Research Station, Route 1, Box 160, Tallahassee, Florida 32303.

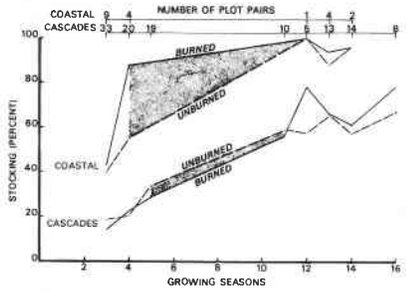
Effects of Slash Burning in Overmature Stands of the Douglas-fir Region, by William G. Morris (14)

The established management system of clearcutting the tall, dense, overmature forests of the Douglas-fir region of western Oregon and Washington usually leaves great quantities of debris after all merchantable wood is removed. In areas where the stands contained much rot and other defect, the slash may total 100 tons or more per acre.

National forests of the Douglas-fir region contain about 3 million acres of stands more than 150 years old. Most logging on national forests for at least the next 50 years will be in these stands. Patches, usually of about 30 to 60 acres, are clearcut. In the past, the slash on most of them has been burned under prescribed conditions to reduce fire hazard, prepare seedbed or planting site, and reduce brush competition with tree reproduction.

Some foresters have doubted the efficacy of slash burning for the stated purposes. Concern with the possible contribution of slash burning to air pollution has further stimulated reviews of the benefits and harm of burning.

In this study, it was found that slash fires consumed nearly all fine fuels, left nearly all logs, and severely burned less than 6 percent of the soil surface. Burning significantly reduced the fire hazard for as much as 12-16 years. In addition, burning changed the species composition of brush and herbage and reduced brush cover for a few years (except where *Ceanothus* invaded), but did not affect total herbaceous cover. Nor did burning affect the number of young seedlings that became established after the slash fires.

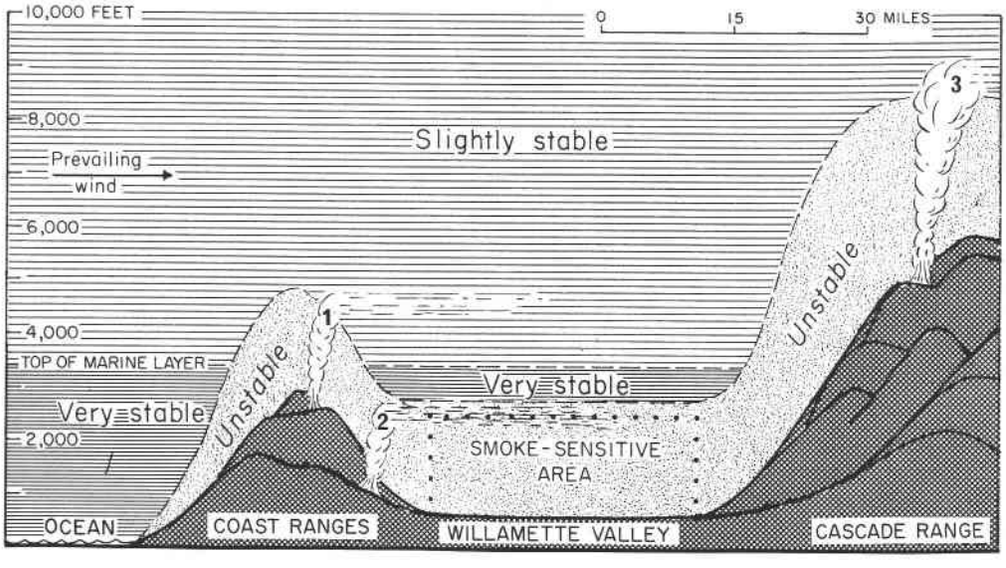


Percent of stocked 4-milacre areas on burned and unburned plots, by growing seasons.

Cooperative Management of Smoke from Slash Fires, by Owen P. Cramer and Howard E. Graham (15)

In Oregon and Washington, a cooperative system has been developed for maintaining reasonable air quality in connection with forest slash burning. Cooperating are the Department of Environmental Quality, the Oregon Forestry Department, Oregon Forest Protection Association, U.S. Bureau of Indian Affairs, U.S. Forest Service (and more recently, the Department of Natural Resources, Washington).

During the first season's operation, the Oregon Department of Forestry reported: "During this period, there were 1,226 prescribed burns involving 51,600 acres (2 million tons) under the smoke management program. It appeared that no major pollution problems were encountered." Slash burning can be done with a minimum of air pollution by controlling the time, location, and quantity of burning.



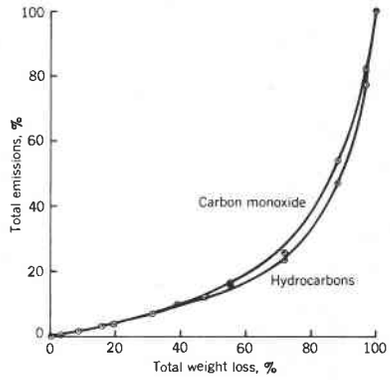
Atmospheric stability conditions over western Oregon on a typical warm-season afternoon.

Emissions from Slash Burning and the Influence of Flame Retardant Chemicals, by D.V. Sandberg, S.G. Pickford, and E.F. Darley (16)

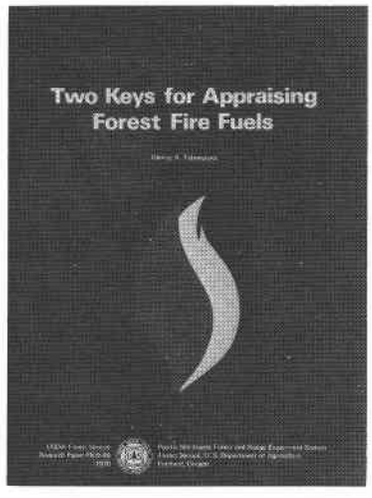
A very technical report concludes that the smoldering phase of combustion is of major importance in producing pollution during slash burning. Most of the fine fuels are burned prior to the smoldering phase, and most objectionable gaseous emissions occur during the latter phase.

The conclusion is that high intensity burning and rapid extinguishment will result in less gaseous pollution.

Researchers also tested the fire retardant DAP to see if it would reduce pollution. Although less fuel actually burned in DAP-treated fuel beds, production of all pollutants went up—including the particulate fraction.



Relation of the proportion of total fuel consumed to the proportion of total pollutant emitted for nine untreated fuel beds.



Two Keys for Appraising Forest Fire Fuels, by George R. Fahnestock (17)

Forest fire fuels are characterized in a new way. Keys are given that enable users to recognize and evaluate fire spread and crown fire potential on the basis of readily observed forest fuel characteristics.

The paper is not a complete fuel appraisal system in itself. But the framework used here can also be used to develop keys for rating ignition probability, fire intensity, and resistance to control.

Slash Fire Atmospheric Pollution, by Fritschen, Bovee, Buettner, Charlson, Monteith, Pickford, Murphy, and Darley (18)

A primary objective of this study was to investigate slash burning in relation to air pollution. Specifically, the researchers sought to determine the effect of fire temperature on pollution (for example, do low temperature fires cause more pollution than hot ones), and to determine if the principal features of a field test can be modeled in the laboratory.

Conclusions are that:

(a) Air pollution can be minimized by a hot fire that creates a strong convection column under conditions favorable for rapid atmospheric dispersion. The fire should be of short duration to consume the smaller fuel only.

(b) Results also suggest that broadcast fires can be modeled in the laboratory with respect to burning characteristics, gaseous and particulate emission from different fuel density, packing, composition, and method of ignition.

Particle Sizes in Slash Fire Smoke, by David V. Sandberg and Robert E. Martin (19)

Burning of forest fuels produces an estimated 23.7 percent of the particulates emitted to the atmosphere each year and 6.9 percent of the hydrocarbons. Increased public awareness of air pollution has focused unfavorable attention on the burning of logging slash. The burning of 6.3 million metric tons of forest residue in Oregon and Washington annually releases 45,000 metric tons of hydrocarbons and 76,000 metric tons of particulate matter into the atmosphere. Wildfires contribute even more, but accurate estimates are difficult to make.

This laboratory study has attempted for the first time to measure the size of particles that are likely to result from forest burning. Studies showed that 82 percent of particulate mass was less than 1 micrometer in diameter. Scanning electron microscopy showed four types of particles.

Forest Fuels, Prescribed Fire, and Air Quality, by J. Alfred Hall (20)

Smoke from forest wildfires or prescribed burns is often considered on a par with other emissions that might affect air quality. But enough is known about smoke from woody fuels to know that the biggest problem is with reduced visibility rather than addition of harmful pollutants to the environment. Visibility can be improved by proper preparation and timing of prescribed burning.

Much of the organic matter in smoke from forest fuels is similar to that which naturally enters the air—from decomposition of vegetation or from vegetative growth processes. Fire compresses these emissions into a shorter time.

The reduction in danger of forest conflagrations more than compensates for the temporary decrease in visibility from prescribed burning.

Predicting Weights of Douglas-fir Slash for Material up to 3 Inches in Diameter, by Woodard, Pickford, and Martin (22)

The weight of Douglas-fir slash can be predicted from tree diameter at breast height. This information can then be used to predict the amount of slash fuel that will be created by logging. The forest manager should find this useful in predicting the amount of treatment needed for brush disposal in laying out timber sales and in evaluating treatment effectiveness.

Slash Fire Behavior Correlates With Fuel Moisture Indicator Stick Readings, by William G. Morris (21)

Good judgment is needed in order to decide when to burn slash west of the Cascades in Oregon and Washington. If conditions are not correctly analyzed, slash may not burn well enough to reduce the hazard; or it may burn too readily and damage soil or adjacent stands.

The following guidelines are given:

- Burn in fall when rain has moistened the bottom of the duff layer in slash area and in adjoining green timber.
- Burn more than 1 day after rain.
- Avoid periods of east wind.
- Burn when fuel moisture indicator sticks read about 14 percent in the slash area and 20 percent in the adjoining green timber.

With less than average fuel, a smaller proportion of fuel with cured needles attached, less slope, or less wind, fuel moisture stick readings should also be lower in the slash area to indicate satisfactory burning. With more than average fuel, slope, and wind, fuel moisture readings should be higher to reduce risk of spot fires.

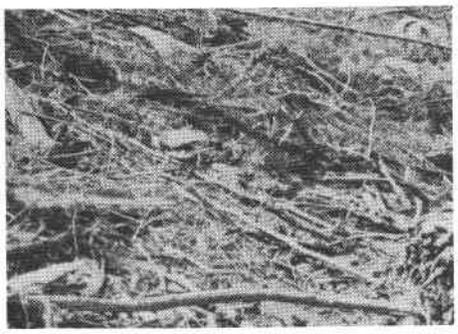
The guiding fuel moistures do not apply to periods within 1 day after rain nor to periods when deep duff is dry. Nor do they apply to burning in spring when deep duff and interior parts of logs and large limbs are more moist than in fall. Additional records are needed to determine guidelines for spring burning.

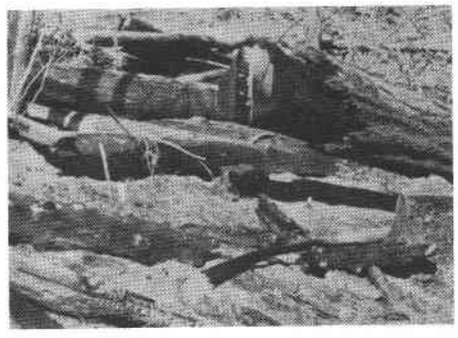
Variation in Vegetation Following Slash Fires Near Oakridge, by Harold K. Steen (23)

Photographic sequences illustrate how vegetation differed following logging and slash burning on two old-growth clearcuts in the Willamette National Forest near Oakridge, Oregon. Burned and unburned plots are shown for each area. Both areas were clearcut in 1949 and the slash burned in October of the same year. The two pairs of plots were selected because of the obvious differences in plant cover in the areas.

The difference in recovery of vegetation is striking. Thirteen years after the slash fire, conifers were well established in one area while heavy brush covered the other.

Readers should try to see an original (not a copy) of this report as the photographs are important to its understanding.





Unburned plots have a little trailing blackberry, starflower, Pacific rhododendron, and vine maple. Two percent of the burned plot had a hard burn (organic material destroyed and some soil coloration).

fire - bibliography

WILDFIRE

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alaska

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Contents

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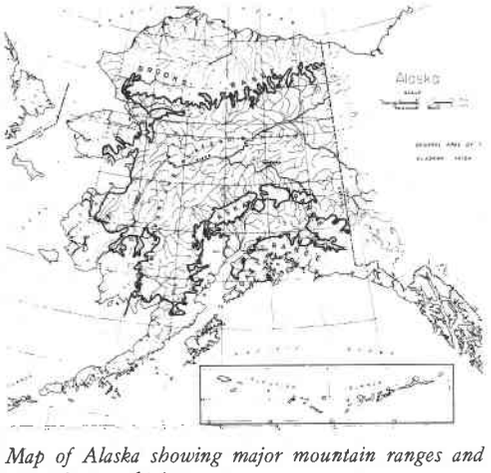


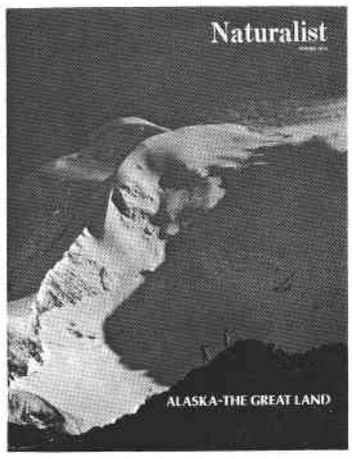
Map of Alaska showing major mountain ranges and general zone of taiga.

general

Sourdough Science

Scientists from the Forestry Sciences Laboratory in Juneau and the Institute of Northern Forestry in Fairbanks are studying 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.

Forestry research in Alaska is linked to two very different forest ecosystems. The taiga, or northern forests of the interior, contrast sharply with the luxuriant coastal forests. This brochure (1) gives a general overview of the research program in Alaska.



Alaska—the Great Land, edited by Clayton G. Rudd (2)

The Naturalist magazine presents its first issue devoted to Alaska—32 pages of articles dealing with natural resource management in the 49th state. Many are by Experiment Station scientists. Les Viereck, a noted northern ecologist, discusses the role of fire in the taiga; Austin Helmers writes on the climate, vegetation, and geology of the interior; and William R. Meehan discusses fish habitat and timber harvest in southeast Alaska.

Other articles are on planning Alaska's future, a trip by boat up the Inside Passage, and a story on the Dusky Canada Goose—a native-born Alaskan that goes south for the winter.

Copies are no longer available from the Experiment Station. Check your local library.

Research Opportunities and Needs in the Taiga of Alaska, by Austin E. Helmers and Charles T. Cushwa (3)

An appraisal of taiga (the northern forests of interior Alaska) environment research opportunities and needs was made based upon accomplishments since Alaskan statehood, current involvement of citizens in resource issues, information needs incident to the National Environmental Policy Act of 1969, and needs of new resource managing agencies and changing ownerships brought about by statehood and the settlement of aboriginal land claims. Research needs can best be met through a multidisciplinary interagency program. The program suggests closer coordination among several departments of the University of Alaska and a number of state and federal agencies now conducting research. The urgency of research implementation is related to rapid change and diminishing opportunity to insure orderly development of Alaska's resources.

Environment information needs in the taiga cover five major problem areas:

- ecology
- fire effects
- water
- culture
- economics.

Scientists in Alaska

Forest Service researchers in Alaska are listed in a brochure published by Region 10 in Juneau. It includes a photo and short biography for all research personnel at the Forestry Sciences Laboratory in Juneau, and the Institute of Northern Forestry in Fairbanks.

Copies may be obtained from the Office of Information, Forest Service, Region 10, P.O. Box 1628, Juneau, Alaska 99802. Ask for *Forestry Research Directory for Alaska* (4).

Publications List, 1963-1974

In 1967 the Northern Forest Experiment Station (NOR) became the Institute of Northern Forestry, which in turn became the Forestry Sciences Laboratory in 1972. Many of the earlier publications are now out of print, but may be requested on a loan basis. As the Forestry Sciences Laboratory became a division of the Pacific Northwest Forest and Range Experiment Station in 1967, all of its publications are now issued there and numbered in the PNW- series.

Order the bibliography from:
Forestry Sciences Lab
P.O. Box 909
Juneau, Alaska 99802

Arland Harris

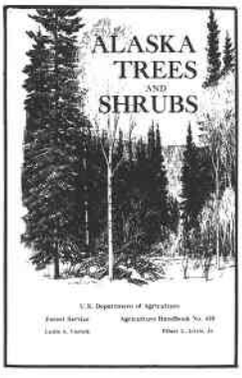
Alaska-Cedar. A Bibliography With Abstracts, by A.S. Harris (9)

This bibliography contains references to North American and European literature containing information about Alaska-cedar. References are listed alphabetically by author, and abstracts are given for many of those considered more significant. A subject matter index is included, as is a list of scientific and common names of tree species.

The compiler would appreciate learning of additional articles on Alaska-cedar not included here.

Cones and foliage of Alaska-cedar.

trees and shrubs



Alaska Trees and Shrubs, by Leslie Viereck and Elbert L. Little, Jr. (5)

$6.00 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; or from some book stores.

It's cold in Alaska (although not as cold as the North Pole where nothing much grows) and for that reason it is a region of relatively few trees and shrubs. At last count there were about 133 species, all included in this publication. Information is presented on identification (pen and ink drawings plus botanical descriptions), distribution, and uses.

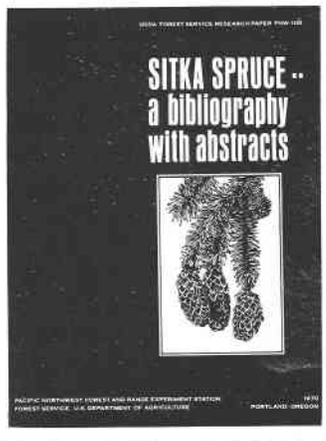
If you're only visiting Alaska and $6.00 is too expensive, you might want to consider buying the shorter guide to trees only. Called *Guide to Alaska Trees,* by the same authors (6), it is 98 pages and includes information about 20 trees and a few shrubs. That one is available for $1.35 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; stock number 0100-03308.

Salmonberry (Rubus spectabilis) *winter twig at right.*

Sitka Spruce—A Bibliography With Abstracts, by A.S. Harris and Robert H. Ruth (10)

This bibliography contains references to world literature on Sitka spruce published through 1967. A subject matter index and a list of scientific and common names of tree and plant species is included. References are listed alphabetically by author. Abstracts are given for many references.

Special effort was made to include the large body of British literature resulting from extensive plantings of Sitka spruce in the British Isles—an important source of information sometimes overlooked by American foresters.



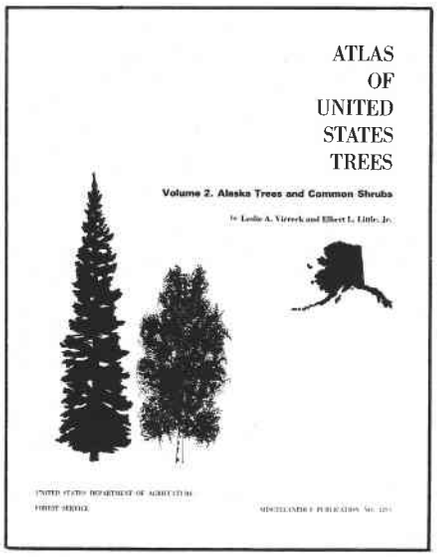
Dawn Redwood in Alaska, by A.S. Harris (7)

Dawn redwood, now native only in China, once flourished in the territory now known as Alaska, but way back in Mesozoic times. In 1948, R.W. Chaney of the "Save the Redwoods League" sent some 165 seedlings to Juneau to see if the species would grow there again.

Results of the experiment indicated that the present Alaskan climate is too harsh for the trees. Most of the seedlings died. By 1955 only five were known to be alive, and today (1973) only one is still alive on Japonski Island near Sitka.

Alaska-Cedar, by A.S. Harris (8)

Alaska-cedar, one of the most durable of American woods, has a fine, even texture, straight grain, and clear yellow color. The principal uses are for specialty products, boats, interior trim, outdoor uses, and heavy construction—wherever durability, acid resistance, stability, smooth-wearing qualities, and workability are needed. Production has been low in the past, largely because the species is scattered and the cost of logging is high. But as logging for other species progresses to poorer sites and higher elevations, production is increasing. Efforts are being made to market lower grades, and domestic use is expanding. Much of the lumber and logs is now exported to Japan.



Atlas of United States Trees, Volume 2. Alaska Trees and Common Shrubs, by Leslie A. Viereck and Elbert L. Little, Jr. (11)

This volume contains large maps showing the natural distribution or range of the native tree species of Alaska. The 82 species maps include 32 trees, 6 shrubs rarely reaching tree size, and 44 more common shrubs.

Twenty-three general maps summarize environmental factors and supply background information on geography, geology, climate, and vegetation. These basic maps indicate the broad conditions under which each species grows wild and may serve as a preliminary forest atlas of the 49th State.

environment, ecology

Alaska Ecosystem Featured

In 1974, the Experiment Station began a 10-part series of General Technical Reports on the forest ecosystem of southeast Alaska. The intent was to provide resource managers and users of southeast Alaska's forest resources with the most complete information available for estimating the consequences of various management alternatives.

The papers summarize published and unpublished reports and data as well as the observations of resource scientists and managers developed over years of experience in southeast Alaska. The reports serve as an aid in planning future research and as background information for land use planning in that region.

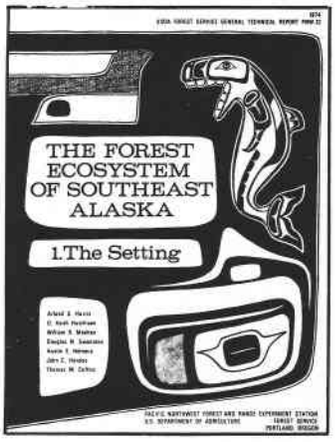
The Forest Ecosystem of Southeast Alaska, 1. The Setting, by Arland S. Harris and Others (12)

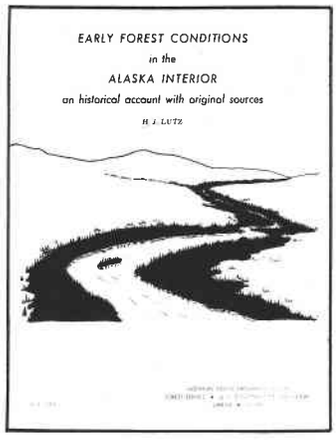
A description of the discovery and exploration of southeast Alaska sets the scene for a discussion of the physical and biological features of this region. Subjects discussed include geography, climate, vegetation types, geology, minerals, forest products, soils, fish, wildlife, water, recreation, and esthetic values.

This is the first of a series of publications summarizing present knowledge of southeast Alaska's forest resources. Publications will follow which discuss in detail the subjects mentioned above and how this information can be helpful in managing the resources.

Other publications in this series include the following:

2. Forest Insects (13)
3. Fish Habitats (14)
4. Wildlife Habitats (15)
5. Soil Mass Movement (16)
6. Forest Diseases (17)
7. Forest Ecology and Timber Management (18)
8. Water (19)
9. Timber Inventory, Harvesting, Marketing, and Trends (20)
10. Recreation (in preparation/1976)





Early Forest Conditions in the Alaska Interior, by H.J. Lutz (21)

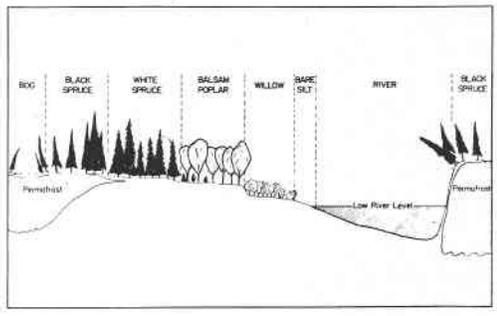
This report is based almost wholly on the journals, records, and publications of early observers of forest conditions in Alaska's interior. These observers generally had no special training in forestry or in matters pertaining to the productivity, growth, and yield of forests or stands of trees. They were explorers, geologists, army and navy officers, and a few natural scientists. Their observations on forest conditions were often incidental to other more central objectives and the care and accuracy used in arriving at their estimates and measurements can only be conjectured. Consequently, caution should be used when comparing present-day forests with those described by the early writers.

The historical record of early forest conditions in the Alaska interior, compiled from the original sources, is presented. The question, "What were the forest conditions in the early days?" has been answered as best it can.

Les Viereck

Forest Succession and Soil Development Adjacent to the Chena River in Interior Alaska, by Leslie A. Viereck (22)

Changes in soil and vegetation were studied in four stands growing on different aged river deposits on the flood plain of the Chena and compared with a climax stand on a higher and older terrace. The stands were a 15-year-old willow stand on a newly formed gravel bar, a 50-year-old balsam poplar stand, a 120-year-old white spruce stand, a 220-year-old white spruce/black spruce stand, and a climax black spruce/sphagnum stand. The vegetation characteristics of each stand are given.



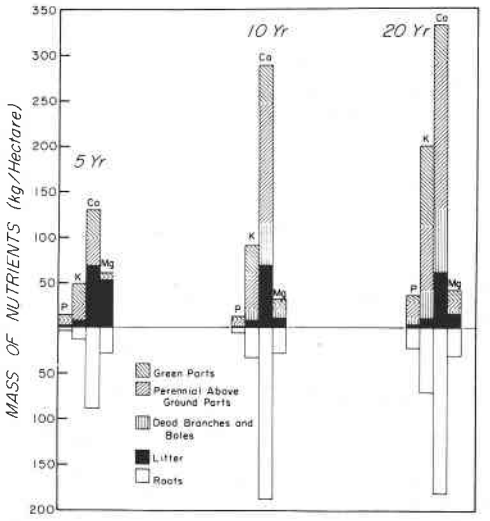
Diagrammatic cross section of typical distribution of vegetation and permafrost across a meander of a river in interior Alaska.

Distribution of Selected Chemical Elements in Even-Aged Alder (*Alnus*) Ecosystems Near Fairbanks, Alaska, by Keith Van Cleve and Leslie A. Viereck (23)

The influence of vegetation with time on the nutrient balance of even-aged alder ecosystems was demonstrated by the researchers. By analysis of selected nutrients (Ca, K, Mg, P, and Mn) in newly formed sand bars and in alder stands of 5, 15, and 20 years, it was found that there were a number of significant changes in the distribution of these elements within the ecosystem. In the soil there was a general decrease in pH in the older stands whereas cation exchange capacity and soil organic matter showed general increases.

These changes showed a close relationship to increases in percentage of organic matter. Exchangeable nutrients were lowest in the time zero soils, showed a marked increase in the 5-year stage, but showed no consistent further increase in the older stands. Their distribution was related to both texture and soil organic matter content.

In the ecosystem vegetation, the mass of nutrient elements was related to plant biomass and increased with ecosystem age. Ca showed the greatest mass at 20 years. Ranking of the nutrient mass was generally Ca > K > Mg > P > Mn. Alder contributed from 69.9 to 91.2 percent of the mass of ash for the 5- and 20-year stands respectively.



Mass of selected nutrient elements in components of alder ecosystems.

Summary of Climatic Data for the Bonanza Creek Experimental Forest, by Richard J. Barney and Erwin R. Berglund (24)

A summary of climatic data during the 1968-71 growing seasons is presented for the subarctic Bonanza Creek Experimental Forest located near Fairbanks, Alaska. Data were obtained from three weather station sites at elevations of 1,650, 1,150, and 550 feet from May until September each year. Data are for relative humidity, rainfall, and maximum, minimum, and mean temperatures. Analyses indicate that Fairbanks mean monthly temperatures were higher than those at Nenana or at the Bonanza Creek Experimental Forest.

Annual Tree-Litter Production by Successional Forest Stands, Juneau, Alaska, by Richard M. Hurd (25)

Litter production from high latitude forests in North America is not well documented, and even less is known about litter production from successional forest stands within a relatively small area receiving essentially uniform radiant energy input at such latitudes. An opportunity exists near Juneau to determine litter production both for relatively high latitude forest and for several successional forest stands following the recession of the Mendenhall Glacier.

The purpose of this study was to determine annual tree-litter production through a range of successional stands from recently established, relatively ephemeral, woody pioneers to older, more permanent forest tree species.

Litter production in four stands for 3 years averaged 2,850 kg/ha. Production varied among stands and years, but no real differences were apparent. Nonwoody litter was about 64 percent of total litter and, although less variable, there were no consistent differences for stands or years.

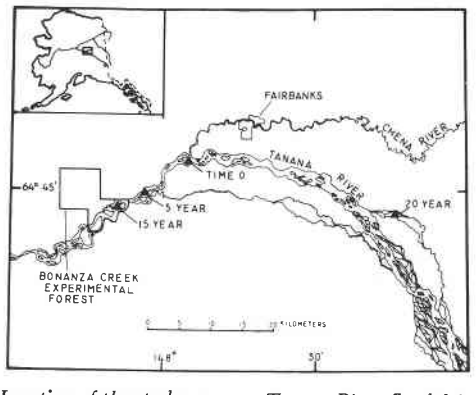
Accumulation of Nitrogen in Alder (*Alnus*) Ecosystems Near Fairbanks, Alaska, by Keith Van Cleve, Leslie A. Viereck, and Robert L. Schlentner (26)

Biomass and nitrogen accumulation was investigated in even-aged alder ecosystems on the Tanana River flood plain near Fairbanks. The distribution of biomass and nitrogen was recorded for foliage, branches, boles, roots, litter, and soil.

After a rapid increase in mean annual biomass increment during the first 5 years of ecosystem development, the increment showed a slower but steady increase from 5 through 20 years. The productivity of these ecosystems occupied an intermediate position compared with the productivity of forest ecosystems in other geographic regions.

The mean annual rate of nitrogen build-up was rapid during the first 5 years of ecosystem development but decreased with ecosystem age to 20 years.

Rates of addition of N in these alder ecosystems were equal to or greater than those reported for alder by other investigators. Periodic additions of N may occur by flooding and these additions are probably small compared with additions of N by symbiotic fixation.



Location of the study areas on Tanana River floodplain.

Rainfall Interception by Mature Coniferous Forests of Southeast Alaska, by J.H. Patric (27)

Rainfall intercepted by the crowns of trees is wasted in the sense that it neither replenishes soil moisture nor streamflow. The author reported that southeast Alaska forests, like other mature coniferous forests of western North America, intercept about 25 percent of annual rainfall.

Scientist Patric points especially to western hemlock as a tree that is "waterproof." If you're ever caught in a southeast Alaska downpour, it would be wise to head for a mature stand of that species. The trunks of hemlock trees remained at least partly dry during weeks of continuous rain. Concentrations of rain shed from central "drip points" in the crowns of western hemlock, but there was little stemflow.

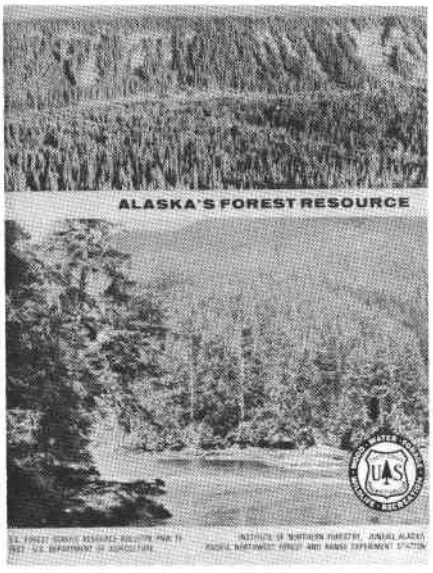
For forest managers, he also makes an observation about the effect of timber harvest on streamflow. Removing or reducing the forest canopy by logging would reduce but not eliminate interception loss and correspondingly increase streamflow. This method of increasing water yield has not yet been tested in southeast Alaska.

More on Subarctic Environments

A number of papers written by hydrologist Charles W. Slaughter before he joined the Forest Service research staff in Fairbanks may be of interest. His work prior to 1976 dealt primarily with snowpack management, the effects of roadbuilding on thaw and erosion, and climate in the subarctic. For information, write to Slaughter at the Institute of Northern Forestry in Fairbanks.

forest survey, volume tables, lumber grade yields

resource statistics

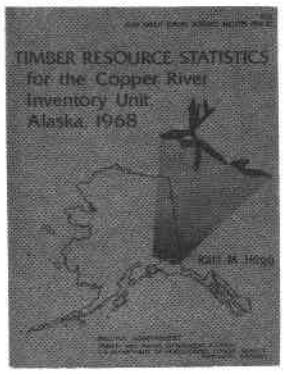


Alaska's Forest Resource, by O. Keith Hutchison (28)

This report presents the results of the first forest inventory of Alaska, made as part of the nationwide Forest Survey. Forest inventory work began in Alaska in 1954. Because of recognized regional economic and forest differences, the inventory was done in two parts—coastal and interior.

Alaska has 16 percent of the forest land in the United States, or 119 million acres. This is as much forest land as is found in the states of Montana, Washington, Oregon, and California combined. But the average quality of forest land in Alaska is below that of the other states mentioned. Only 28.2 million acres is considered commercial; that is, capable of producing a minimum of 20 cubic feet of industrial wood per acre annually. Oregon alone has nearly as many acres of commercial forest land.

Keith Hutchison



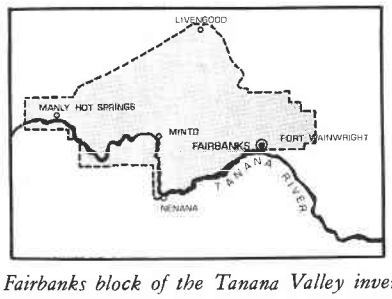
Timber Resource Statistics for the Copper River Inventory Unit, Alaska, 1968, by Karl M. Hegg (29)

This first intensive forest inventory of Alaska's Copper River Valley found a commercial forest area of 287,800 acres with 303.8 million cubic feet of growing stock. In addition, a noncommercial stratum was examined that had substantial standing volume but did not meet the growth criteria for commercial forest land. This stratum contained 152,800 acres with a volume of 157.9 million cubic feet. Because of the distance from population centers and the general low quality of the timber, the Copper River stands probably would be marginal suppliers to the world market.

Karl Hegg

Timber Resource Statistics for the Fairbanks Block, Tanana Inventory Unit, Alaska, 1970, by Karl M. Hegg (30)

This report for the 3-million-acre Fairbanks block is the first of four on the 14-million-acre Tanana Valley inventory unit. Observations are made on forest condition, defect, stand regeneration, fire history, and present use. Data are provided for an operable noncommercial forest land category as well as for standard Forest Survey area and volume statistics. Commercial forest land occupies three-quarters of a million acres and has a net volume of 578 million cubic feet. Growing-stock volume on 51,000 acres of operable noncommercial forest land is 49.6 million cubic feet.



The Fairbanks block of the Tanana Valley inventory unit.

Forest Resources of the Susitna Valley, Alaska, by Karl M. Hegg (31)

This report summarizes the data from the first intensive inventory of the forests in the Susitna Valley, Alaska, conducted during the period 1964-65.

Approximately 5.6 million acres were included in the inventory. Of this, forests cover about 3.2 million acres, with commercial stands making up nearly 1.3 million acres. The principal species are paper birch, which occupies 64 percent of the commercial forest area; spruce, 26 percent; balsam poplar-cottonwood, 9 percent; and aspen, 1 percent. The net volume in growing-stock trees is 1.4 billion cubic feet or 4.1 billion board feet. Growth rates are low—total net annual growth is only 2.2 percent of net volume but averages 25 cubic feet per acre per year.

Grades 1 and 2 cottonwood logs at a small sawmill in the Matanuska Valley.

Forest Statistics for the Upper Koyukuk River, Alaska, 1971, by Karl M. Hegg (32)

Area and volume statistics from the first intensive forest inventory of the upper Koyukuk River drainage, in north-central Alaska, are given. Observations are made on forest location, description, defect, regeneration, growth, and mortality. Commercial forests, although generally restricted to a narrow band along drainages, were found as far as 70 miles (113 kilometers) north of the Arctic Circle. Commercial forests occupy less than 5 percent of the 742,000-acre inventory area but, despite the northerly latitudes, support an average volume in excess of 1,100 cubic feet per acre (80 cubic meters per hectare).

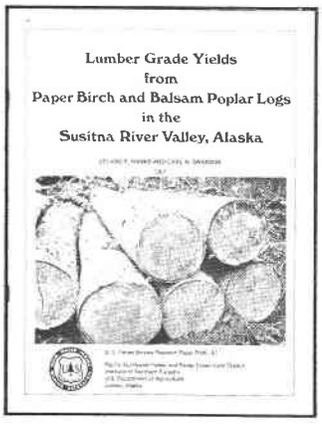
Areas of Nonforest and Noncommercial Forest Lands by Cover Type and by Topographic Site for Interior Alaska, by Karl M. Hegg and Ronald M. Dippold (33)

Previously unreported land-cover data obtained during a 1957-62 forest inventory of 229 million acres of interior Alaska are given. Tables have been prepared for 10 subunit divisions showing area of noncommercial land by topographic site and nonforest land by eight different ecosystems. A brief description is given of methodology and terminology.

growth and yield

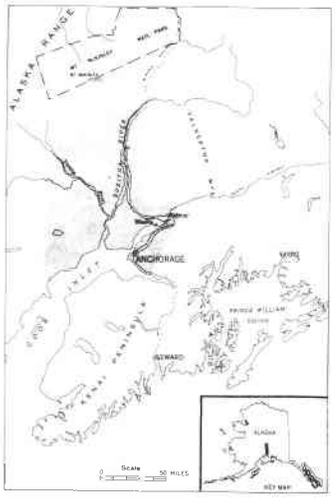
Growth and Yield of Well-Stocked Aspen and Birch Stands in Alaska, by Robert A. Gregory and Paul M. Haack (34)

Presents normal yield tables for well-stocked, even-aged stands of quaking aspen and paper birch in interior Alaska.



Lumber Grade Yields From Paper Birch and Balsam Poplar Logs in the Susitna River Valley, Alaska, by Leland F. Hanks and Carl W. Swanson (35)

A study was conducted at Wasilla, Alaska, in 1964 to determine the lumber grade recovery from paper birch and balsam poplar logs. Actual recoveries are summarized by scaling diameter for each of the three U.S. Forest Service log grades. This information, when coupled with pertinent lumber prices, may be used to estimate the value of lumber to be sawn from birch or poplar logs in Alaska.



The Susitna River Valley.

Lumber Yield From Sitka Spruce in Southeastern Alaska, by Paul H. Lane, Richard O. Woodfin, Jr., John W. Henley, and Marlin E. Plank (36)

About 98 percent of the Sitka spruce lumber sawn in a southeastern Alaska lumber recovery study was in cants 3 to 8 inches in thickness. Thirteen percent of the lumber volume was graded No. 2 and 3 Clear by the Pacific Lumber Inspection Bureau rules and 9 percent Piano under Export rules.

Study cants being graded and tallied on green chain.

Growth and Yield of Well-Stocked White Spruce Stands in Alaska, by Wilbur A. Farr (37)

Site index curves and normal yield tables are presented for even-aged stands of white spruce in interior Alaska. Site is based on height of the four tallest trees per acre at index age 100 years. Yields are related to combinations of the variables, site index and age.

Wilbur Farr

volume tables

Volume tables have been developed for most of the major tree species in Alaska. The following reports are available:

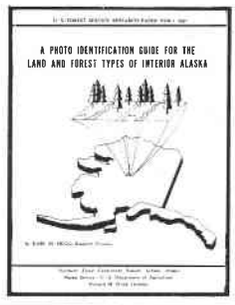
- Western Redcedar and Alaska-cedar in Southeast Alaska (38)
- Western Hemlock and Sitka Spruce in Southeast Alaska (39)
- White Spruce, Balsam Poplar, and Paper Birch of the Kuskokwim River Valley (40)
- White Spruce in Interior Alaska (41)
- Aerial Photo Volume Tables for Interior Alaska Tree Species (42)
- Western Hemlock in Southeast Alaska—Utilization, Lumber Recovery, and Chip Yield (43)

measurement techniques

Using Aerial Photographs

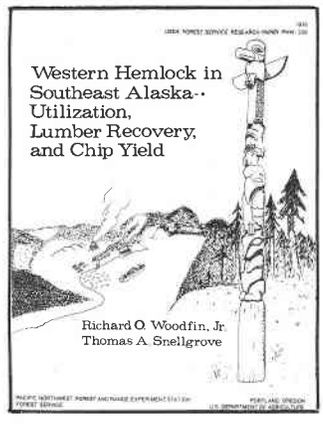
When the initial survey of forest resources of interior Alaska was begun in 1956, it was apparent that the usual inventory technique, using complete photo coverage with a large ground sample, would be too costly. The country was just too vast. The survey area encompassed 229 million acres.

This paper describes a "triple sampling" design that was selected for the inventory. See *A Photo Identification Guide for the Land and Forest Types of Interior Alaska,* by Karl M. Hegg (44)



A Cull Estimation Method for Use in Forest Inventory and Timber Sale Cruises, by Vernon J. LaBau and Thomas H. Laurent (45)

This report summarizes a study of cull in standing trees in the old-growth hemlock-spruce forests of southeast Alaska. Results provide improved techniques for predicting cull in standing Sitka spruce and western hemlock.



Western Hemlock in Southeast Alaska—Utilization, Lumber Recovery, and Chip Yield, by R.O. Woodfin, Jr., and T.A. Snellgrove (43)

This report presents lumber recovery information on a sample of western hemlock trees selected from southeast Alaska national forest land and sawed at a southeast Alaska mill cutting for the Japan export market. Data discussed includes cubic volume yields, cull log lumber recovery, estimates of chippable wood, and logging residue from sample trees.

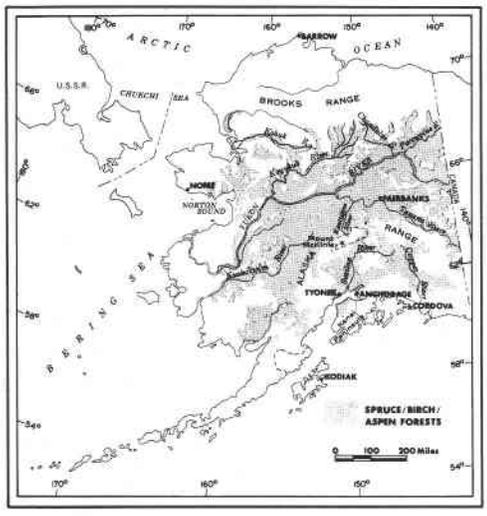
timber management

interior alaska

silviculture

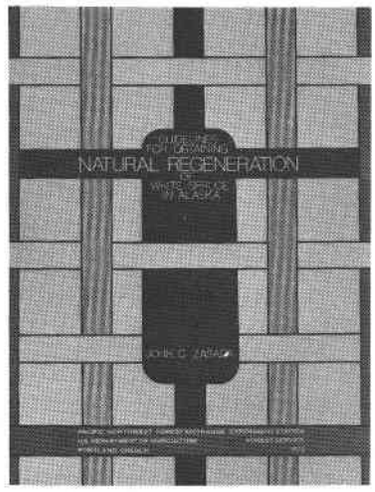
Ecological and Silvicultural Considerations, Alaska's Interior Forests, by John C. Zasada (46)

In climate, physical geography, species composition, and other properties, Alaska's interior forests are similar to those found in the northern United States, Canada, Finland, Norway, and Sweden. Productivity is adequate for forestry to be considered a legitimate land use, and current research indicates that stands can be regenerated. The author suggests that silvicultural practices developed in other northern forests should be evaluated to determine their applicability in the taiga.



Timber Resources and Utilization, Alaska's Interior Forests, by O. Keith Hutchison and David R. Schumann (47)

Interior Alaska has about 105.8 million acres of forest land, of which 22.5 million acres is estimated to have potential commercial value. These 22.5 million acres contain a total growing stock of 14.25 billion cubic feet of white spruce, paper birch, quaking aspen, and balsam poplar. The potential of the interior forests compares favorably with that of the Lake States, where stands in Minnesota average 574 cubic feet per acre as compared to 634 cubic feet per acre in interior Alaska. About 50 small sawmills now operate to supply local markets plus some beginning export of chips and cants.



Guidelines for Obtaining Natural Regeneration of White Spruce in Alaska, by John C. Zasada (48)

These guidelines are based on research conducted in western white spruce forests of Canada and minimal Alaskan observations and research. The author reviews basic requirements for natural regeneration of white spruce and recommends methods for creating conditions which meet these requirements. Survey techniques are summarized for determining adequacy of seedbed preparation and regeneration.

Response of 70-Year-Old White Spruce to Thinning and Fertilization in Interior Alaska, by Keith Van Cleve and John C. Zasada (49)

Forest thinning and fertilization are important management techniques for increasing forest productivity. This paper reports the results of the first 5 years of a study designed to assess the effects of thinning and fertilization on the growth of a 70-year-old white spruce forest in interior Alaska on the Yukon-Tanana uplands 33 km west of Fairbanks.

Basal areas of the trees were measured as to their response to fertilization, thinning, thinning plus fertilization, and compared to a control. A significant increase in basal area increment over the control was produced during each of the five growing seasons in both the thinned and thinned + fertilized treatments. During this period, the thinned + fertilized treatment consistently produced the greatest basal area increment.

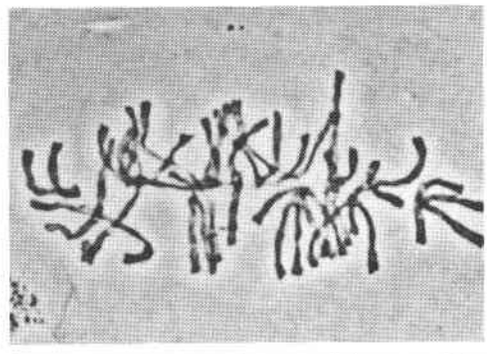
John Zasada

Natural Regeneration of Interior Alaska Forests—Seed, Seedbed, and Vegetative Reproduction Considerations, by John C. Zasada (50)

The forests of interior Alaska are a complex mosaic of stands which are related to their fire history. Following fire, the major interior forest tree species—white spruce, black spruce, paper birch, quaking aspen, and balsam poplar—can regenerate from seed and/or by vegetative means. The author discusses various aspects of seed production (including seedbed considerations) and vegetative reproduction as they may relate to burn reforestation.

Albino Seedlings of White Spruce, by John C. Zasada and Lawson L. Winton (51)

The researchers described their studies on seeds collected from a stand of mature white spruce trees (*Picea glauca* [Moench] Voss) which produced almost 2 percent albino seedlings. None of the albinos lived more than a few weeks, and all had normal chromosome counts of $2n=24$. Chlorophyll deficiency is evidently a recessive character, but observation did not resolve current questions of whether the character is controlled by one or more genes or is linked with an embryonic lethal. The authors feel that the albino seedlings may have resulted from self-fertilization of one or more parent trees.



Somatic metaphase stage in one cell from an albino white spruce seedling, with 2n=24 *chromosomes.*

White Spruce Cone and Seed Production in Interior Alaska, 1957-68, by John C. Zasada and Leslie A. Viereck (52)

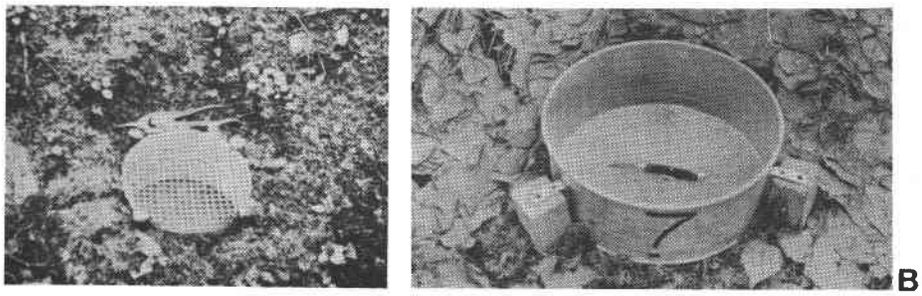
Observations indicate that very good seed years may be separated by at least 10 to 12 years, although during this interval individual stands may produce from one to several fair or good cone crops.

The authors discuss estimates of seedfall per acre, seed dispersal over time, cone production by individual trees, number of seeds per cone and per tree, and cone crop rating from white spruce stands in interior Alaska for the period 1957-68.

Paper Birch Seed Production in the Tanana Valley, Alaska, by John C. Zasada and Robert A. Gregory (53)

The paper birch (*Betula papyrifera*) forest type covers over 5 million acres of Alaska, and many of these stands originated from seed following destruction of the previous stands by fire. Information on seed production characteristics of this species enhances our knowledge of its natural regeneration. The authors report their results of a study of the quantity and quality of paper birch seed crops.

The authors suggest that seed crops adequate for natural regeneration of 100-foot-wide clearcuts occur in at least 1 out of every 4 years in this portion of the taiga.



Seed traps: A, Thimble trap in place (surface area, 0.041 square meter); B, funnel trap in place (surface area, 0.050 square meter).

The Effect of Temperature and Stratification on Germination in Selected Members of the Salicaceae in Interior Alaska, by John C. Zasada and Leslie A. Viereck (54)

In Alaska, seeds of salicaceae can be divided into two general groups, those dispersed in spring and early summer and those dispersed in September and October.

On tests of five species, the seed of four early-seeding species germinated completely at temperatures of 25, 20, 15, 10, and 5° C. The seed of one late-seeding species germinated completely only after stratification and then only at 25, 20, and 15° C.

Effect of Cone Storage Method and Collection Date on Alaskan White Spruce (*Picae glauca*) Seed Quality, by John C. Zasada (55)

White spruce cone storage and time of collection significantly affect germination. The author and colleagues investigated aspects of the effect of various approaches to storage and collection on white spruce seed quality. The effects of collection date and method of cone storage were investigated for Alaskan spruce seeds.

The results on germination tests are considered with respect to specific gravity and percent moisture content changes in the cones and embryo growth.

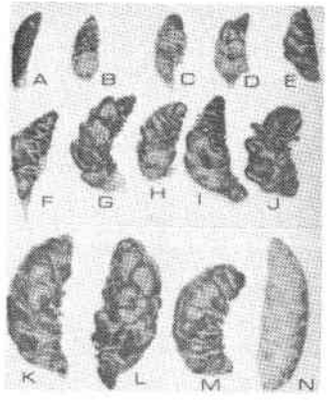
Aspen Root Suckering in Alaska: Effect of Clone, Collection Date, and Temperature, by John C. Zasada and George A. Schier (56)

Many of the aspen (*Populus tremuloides* Michx.) stands in Alaska originated from root suckers after the parent stands were destroyed by fire. Although there has been extensive research in other parts of the species' range on the capacity for aspen to sucker, there has been no research conducted on Alaskan genotypes. To obtain this basic information, the authors examined initial sucker development on excised roots from three Alaskan clones as affected by date of collection, clone, and temperature.

miscellaneous

Frost Damage to White Spruce Cones in Interior Alaska, by John C. Zasada (57)

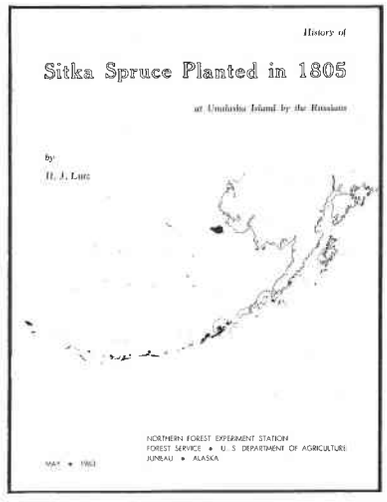
During studies of seed production in 1969 in interior Alaska, an exceptionally warm April and May followed by a relatively mild late-May frost permitted the observation of some effects of freezing temperatures on cone and seed production. Although this subarctic region is characterized by a relatively cold climate, this was the first observation of frost damage to white spruce cone and seed crops.



Variability in frost damage to white spruce cones. A—dead cone; N—apparently undamaged cone; other cones have variable number of damaged scales.

Cambial Activity in Alaskan White Spruce, by Robert A. Gregory (58)

There is now considerable evidence that the rate of growth in diameter of trees is closely associated with circumferential growth of the vascular cambium. The author discusses his work on cambial activity in stems of Alaskan white spruce, *Picea glauca.* The objective of this study was to record natural cytological (cell) events and anatomical features associated with secondary growth of tree stems. This is an essential step preceding a search for mechanisms promoting tree growth.


History of

Sitka Spruce Planted in 1805

at Unalaska Island by the Russians

by

H. J. Lutz

NORTHERN FOREST EXPERIMENT STATION
FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE
JUNEAU • ALASKA

MAY • 1963

History of Sitka Spruce Planted in 1805 at Unalaska Island by the Russians, by H. J. Lutz (59)

Over 150 years ago Sitka spruce trees were planted by the Russians on naturally treeless Unalaska Island. This was perhaps the first attempt at afforestation on the North American continent. All the Aleutian Islands are treeless; the western limit of natural tree growth on the Alaska Peninsula occurs roughly between Naknek Lake and Becharof Lake at the base of the peninsula. The author reviews the history of the spruce on Unalaska Island and summarizes the literature of other writers who have studied the question of why the Aleutian Islands and the westward portion of the Alaska Peninsula are treeless.

Severe winds and unfavorably low temperatures during the growing season are the climatic elements most commonly regarded as limiting factors. Other authors suggest that the absence of trees is to be explained by the newness of the land areas involved and their isolation from sources of tree seed. In other words, sufficient time has not elapsed for trees to reach the westward parts of the Alaska Peninsula and the Aleutian Islands. In support of this view is the fact that trees are now advancing into previously treeless areas on the Alaska Peninsula and on Kodiak Island.

southeast alaska

silviculture

Natural Reforestation on a Mile-Square Clearcut in Southeast Alaska, by A.S. Harris (60)

After clearcutting, the forest cover must be established promptly to restore the landscape's natural beauty, to minimize erosion, and to assure a sustained yield of timber. Natural regeneration requires little or no investment and so is preferable if the resulting stands compare favorably with those originating under artificial methods.

A study of natural regeneration began in 1954 on the Maybeso Experimental Forest near Hollis, Prince of Wales Island, Alaska. One cutting unit, referred to as the "mile-square" unit, was made especially large to determine distance of seed dispersal.

Eight growing seasons after logging began, the mile-square cutting unit, as a whole, was well stocked, as shown by a regeneration survey. However, it was apparent that stocking was far from uniform, with some small areas occupied by dense thickets of spruce and hemlock and others sparsely stocked.

SEED YEAR	AVERAGE SEEDS PER TRAP (6 square feet)	SPECIES COMPOSITION		
		Hemlock	Spruce	Cedar
	Number	*Percent*		
1956-57[1/]	10.8	37	38	25
1957-58	13.8	95	3	2
1958-59	1.9	48	37	15
1959-60	40.8	39	46	15
1960-61	1.8	28	57	15
1961-62	.2	89	11	0

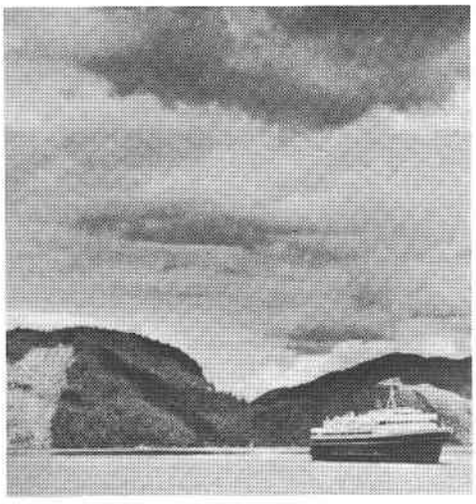
1/ Incomplete data—include counts only until January 20, 1957.

Average annual seed catch since logging; mile-square cutting unit, Maybeso Experimental Forest.

Clearcutting, Reforestation and Stand Development on Alaska's Tongass National Forest, by A.S. Harris (61)

Clearcutting appears to be the most desirable silvicultural system for use on the Tongass to secure good natural stocking and rapid growth of conifer regeneration. Increased soil temperature improves nutrient cycling, and added light encourages Sitka spruce, a relatively shade-intolerant species. It is also a desirable system for use in stands infested with hemlock dwarf mistletoe.

Continued reliance on natural reforestation is anticipated, with increasing use of planting to supplement natural reforestation on difficult sites. Clearcutting is likely to continue as the predominant silvicultural system, but other systems may be useful in situations where clearcutting is incompatible with other resource values.



Alaska State Ferry approaching the dock at Sitka. Old-growth timber in the background was clearcut four years earlier.

What Happens to Nonmerchantable Trees Left After Clearcutting? by Robert S. Embry (62)

This study of western hemlock and Sitka spruce left standing after clearcutting shows a 5-year survival rate of 51 percent. Wind and logging damage caused greatest mortality. Response of diameter growth was good but height growth response was poor. The trees produced cones but the quality of the seed was not determined.

It seems unlikely that residual trees such as those reported upon will form a significant part of a new stand or be detrimental to its establishment. They may, in some cases, serve as a supplementary seed source on cutover areas. The genetic quality of this seed is not known, but so far, the author reasons, there is no reason to suspect that seed produced by these trees is genetically inferior. He concludes that there appears to be no silvicultural reason for eliminating residual trees in this and comparable situations.

Natural Reforestation After Logging on Afognak Island, by A.S. Harris (63)

Sitka spruce is the only conifer on Afognak Island, Alaska. Observations of natural reforestation on a 100-acre cutting unit on the island 25 years after logging showed that some areas were still dominated by grass-herbaceous vegetation and that growth of Sitka spruce seedlings was slow. This competition probably is slowing growth of trees and preventing natural restocking of spruce. If such conditions prove to be typical, measures to control competition will be necessary to insure adequate reforestation after logging on Afognak Island.

Effects of Slash Burning on Conifer Regeneration in Southeast Alaska, by A.S. Harris (64)

A test was made at Kina Cove, Prince of Wales Island, to determine if slash burning would improve seedling distribution by providing a more uniform seedbed, and favor Sitka spruce, a highly desirable species.

It was found that fewer seedlings became established on the burn, but stocking percent was higher, showing that the seedlings present were better distributed. The percentage of spruce was higher on the burn. The reason for the improved response of spruce on burned plots is not known, although it appeared to be related to improved conditions for initial spruce seedling establishment, rather than improved survival under the burned conditions.

Partial Cutting of Western Hemlock and Sitka Spruce in Southeast Alaska, by Wilbur A. Farr and A.S. Harris (65)

This study of response of western hemlock and Sitka spruce to partial cutting over a 17-year period in a 96-year-old stand at Karta Bay, Alaska, showed that crop trees left after partial cutting were able to increase or maintain about the same rate of diameter growth as before thinning, but growth in diameter of trees in an unthinned stand followed the normal pattern of decline.

Opening the stand stimulated epicormic branching, thus reducing quality of trees in the future. Partially cut plots became well stocked with conifer regeneration, mostly western hemlock.

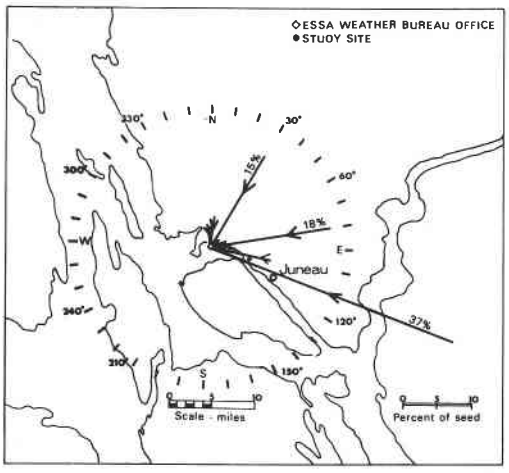
One-half-acre plot thinned to two-thirds of basal area in 1950, as it appeared in 1967.

Many spruce seedlings such as this one at Kazakof Bay are growing slowly. The observer is standing in dense fireweed-grass-salmonberry cover that offers severe competition for Sitka spruce.

Ripening and Dispersal of a Bumper Western Hemlock-Sitka Spruce Seed Crop in Southeast Alaska, by A.S. Harris (66)

Both hemlock and spruce are prolific seed producers. During the heavy seed year of 1966-67, a mature western hemlock-Sitka spruce stand produced an average of 131 pounds of seed per acre, 23 percent of which was sound.

Seed was dispersed over a 1-year period beginning on October 22, with cone scales opening and closing in response to moisture, and seedfall increased by wind. Information on cone condition, seed ripening, and weather conditions associated with seed dispersal is given in the report.



Percentage of seed dispersed on days with prevailing wind direction indicated (length of vector line indicates percentage of seed dispersed). Juneau, Alaska, 1966-67.

Mechanics of Debris Avalanching in Shallow Till Soils of Southeast Alaska, by Douglas N. Swanston (70)

Excessive slope gradient and pore-water stress in glacial till soils of the Karta series have been found to be primary factors in debris avalanche and flow occurrence in recently logged areas of southeast Alaska.

The author reports on the applicability of standard soil mechanics techniques to evaluation of factors affecting debris avalanching in the steep, shallow, permeable till soils. He also quantifies relationships between these factors which, up to now, have only been suggested on the basis of field observations.

environmental effects

Mass Wasting in Coastal Alaska, by Douglas N. Swanston (67)

An understanding of erosion processes involving downslope movement of earth materials is essential to the forest-land manager in Alaska. This had become increasingly clear in recent years with the apparent acceleration of slope erosion following large-scale clearcutting of steep, timbered slopes in southeast Alaska. Erosion occurs primarily as soil mass movements associated with oversteepened slopes and high soil-water levels.

This paper summarizes and interprets the accumulated data and knowledge about slope erosion in southeast Alaska, particularly in relation to recently logged areas, with general suggestions and guidelines for prediction and control.

Landslides on Logged Areas in Southeast Alaska, by Daniel M. Bishop and Mervin E. Stevens (68)

Recent large-scale clearcut logging of timber in southeast Alaska has accelerated debris avalanches and flows on steep slopes during heavy rainfall. The authors present information on the general mechanics of landslides and how they relate to slides in southeast Alaska. They discuss factors influencing shear stress, such as earthquakes, tilting, precipitation, vegetation, and construction. They discuss factors influencing shear strength, such as parent materials, pore water, weight, root deterioration, and construction projects. The authors also present a review of literature on slides in timbered areas through discussion of the work of researchers in New Hampshire, Oregon, Japan, and Italy.

Judging Landslide Potential in Glaciated Valleys of Southeast Alaska, by Douglas N. Swanston (69)

The author presents a very interesting first-person narrative account of a reconnaissance he conducted with colleagues on slide-prone areas of southeast Alaska. They studied and recorded slope stability characteristics of several areas, and developed accurate techniques for stability mapping.

The author concludes from his studies that, in terms of good land management policy, areas within highly unstable zones should be entirely withdrawn from developmental activities. Any disruption of surface cover or disturbance of the soil mantle in such areas is almost certain to cause or accelerate landslide occurrence, with little chance of effective control. Areas in the potentially unstable zone should be examined carefully for evidence of unstable conditions on a local basis, and operation and development criteria should be designed to fit each stability situation encountered.

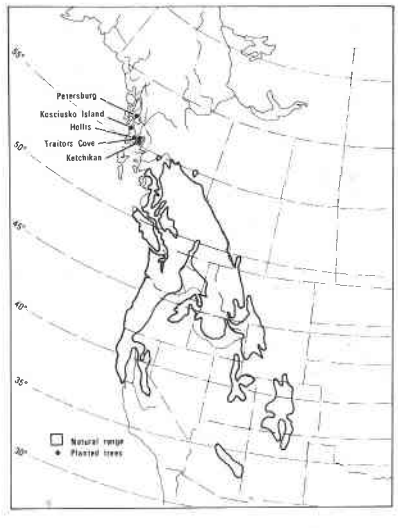
A surface view of a landslide showing some of the important characteristics determining stability. Parent material is a glacially smoothed granite covered with less than 12 inches of soil. Slope at point of failure is approximately 40°.

miscellaneous

Experience With Douglas-fir in Southeast Alaska, by A.S. Harris (71)

Douglas-fir does not occur naturally in Alaska, and there is no known fossil evidence to show that it has occurred in the state since the Pleistocene. However, under present climatic conditions, the species is capable of germinating, becoming established, making excellent growth, and producing viable seed far north of its present northern coastal natural limit. Observations from Alaska are only fragmentary and of short duration, but the excellent growth reported suggests that Douglas-fir may be of future silvicultural value in Alaska.

Studies show that there may be a place for Douglas-fir in forest management in coastal Alaska when more intensive silviculture is practiced. However, widespread planting should be preceded by test plantings of a collection of provenances or progeny of individual parents. Such care will help in avoiding serious mistakes which could be made in the introduction of a new species.



The Economics of Rafting vs. Barging as Means of Transporting Logs in Southeast Alaska Waters, by Kenneth E. Beil (72)

Water transport of logs is the only possible method of transportation in the island geography of southeast Alaska. Logs have customarily been floated in rafts from producing points to water storage areas and to mills. A very limited amount of barging has taken place in Alaska, but a considerable amount takes place in coastal British Columbia.

The author examines two main questions relating to the economics of rafting and barging of logs: (a) Is it more economical for the timber producer to transport logs by barging or rafting in southeast Alaska waters? (b) What costs of barging and rafting are external to the timber producer and are they sufficient to warrant the use of one system or the other?

He concludes that there appears to be no compelling environmental reason to favor land-to-land barging over rafting if careful handling methods are followed, but there are very compelling economic reasons to favor rafting over barging.

Forest Residues in Hemlock-Spruce Forests of the Pacific Northwest and Alaska—A State-of-Knowledge Review With Recommendations for Residue Management, by Robert H. Ruth and A.S. Harris (73)

This report provides a detailed look at residue management throughout the north Pacific coastal fog belt, including Oregon, Washington, British Columbia, and Alaska. The approach is a general look at forest residues as part of the ecosystem, then a closer look at dead and decaying material after logging, considering fire hazard and the silvicultural, physical, chemical, and esthetic effects of this material. Residue treatments are described, evaluated, and recommended. The report is intended to provide an improved scientific framework for management decisions.

Small residues such as bark and wood chips, twigs, and needles damage fish habitat in spawning and rearing stream. Seal Bay, Chichagof Island, Alaska.

Specific Gravity of Western Hemlock and Sitka Spruce in Southeast Alaska, by Wilbur A. Farr (74)

Specific gravity is recognized as a simple, reliable index of wood quality. It is associated with many important strength and working properties of wood and is an indicator of pulp yields and wood weight. Because of its importance, the subject of specific gravity has received considerable attention.

In a recent growth and yield study of even-aged stands of western hemlock and Sitka spruce in southeast Alaska, trees of average basal area were felled and sectioned for stem analysis. The study provided the opportunity to collect specific gravity information with little additional effort. Results of an analysis of this specific gravity data are presented and discussed.

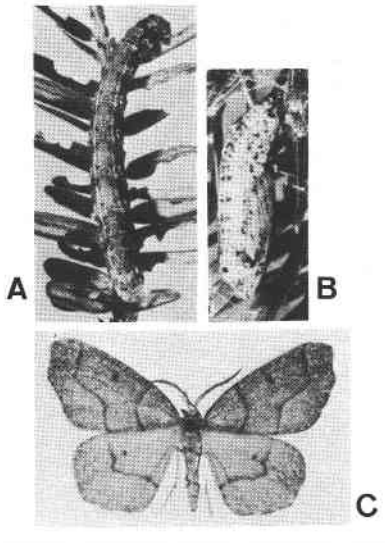
insect pests

general

Identification of Destructive Alaska Forest Insects, by J.S. Hard (75)

A guide to the identification of the principal forest insect enemies of Alaska's forests, including the defoliators and bark and stem borers. Information is given on life history and the type of damage each insect causes, and the importance of the pest. Keys, photographs, and illustrations will help in identifying the pest. Information about pest control is not given.

Identificaton of the offending pest may not always be possible with this guide. When significant damage to forest trees cannot be positively identified, samples of the damage and the insect should be collected and sent to Juneau for identification.



The western hemlock looper, Lambdina fiscellaria lugubrosa; *A. Mature larva, about one and one-fourth inch long; B. Mottled pupa, about five-eights inch long; C. Moth, wingspread about one and three-eighths inches.*

New Parasite-Host Records for North American Ichneumonidae (Hymenoptera) in Alaska, by Torolf R. Torgersen (76)

Twenty new parasite-host records for 16 North American species of Ichneumonidae are given. Hosts were collected in southeastern and interior Alaska.

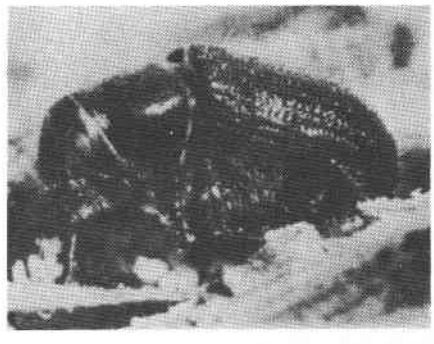
Instructions for the Collection and Identification of Forest Insect Pests of Alaska and Their Parasites and Predators, by Richard A. Werner (77)

These instructions serve as an aid to entomologists in collecting and identifying forest insects of Alaska. It serves as a field guide in collecting insects and as a laboratory guide in rearing, preserving, and identifying insects.

interior alaska

Key to Adult Bark Beetles of White Spruce Stands in Interior Alaska, by Roy C. Beckwith (78)

With this key, entomologists can identify the adult Scolytidae (bark beetles) commonly found in white spruce stands in interior Alaska, including the Kenai Peninsula. Schematic drawings are included.



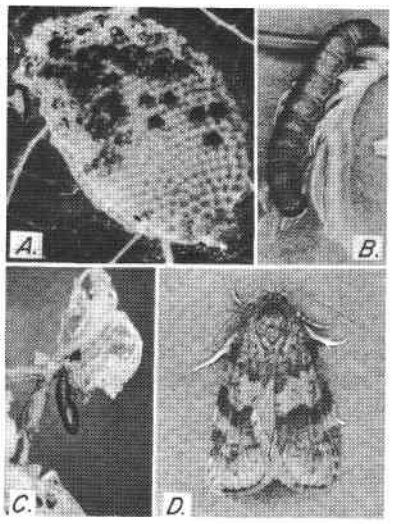
Scolytid Flight in White Spruce Stands in Alaska, by Roy C. Beckwith (79)

In white spruce stands near Fairbanks, Alaska, and on the Kenai Peninsula, Alaska, *Dendroctonus rufipennis, Ips* spp., and *Trypodendron lineatum* disperse in late May and early June. Other scolytids fly in June and July. Flight in interior Alaska is about 2 weeks earlier than on the Kenai Peninsula. Mean daily temperatures during spring and early summer are generally warmer in the interior than in coastal areas. There was a large increase in the total number of beetles in a thinned area, mostly of *Dryocoetes affaber.*

The Large Aspen Tortrix, by Roy C. Beckwith (80)

The large aspen tortrix (*Choristoneura conflictana*) periodically causes extensive defoliation throughout parts of the range of its principal host, the quaking aspen. The tortrix becomes a problem only where quaking aspen is a major part of the forest stand.

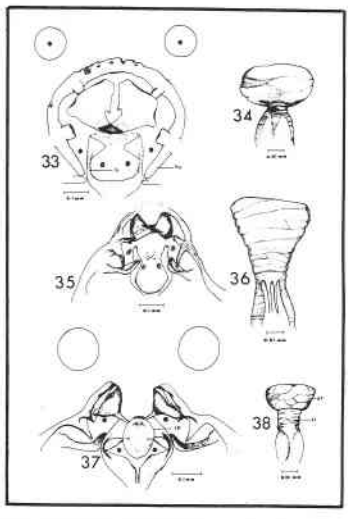
The author reviews current knowledge of the tortrix and presents information on its description, host trees, life history, and natural control factors. Artificial control of this species is not generally recommended except in high-use areas such as campgrounds because populations characteristically collapse in 2 or 3 years. Despite growth loss, aspen trees usually withstand the outbreak with little tree mortality.



Life stages of the large aspen tortrix: A, Egg mass—the black eggs are parasitized by Trichogramma minutum *and the white "eggs" are empty chorions following eclosion; B, mature larva; C, pupa; D, adult.*

Parasitoids Associated With the Large Aspen Tortrix in Interior Alaska, by Torolf R. Torgersen and Roy C. Beckwith (81)

Twenty-four species of parasitoids are associated with the large aspen tortrix in interior Alaska. Keys are supplied for determining adults and, in the absence of adults, the parasitoids based on host stage and on late-instar larval remains. Brief biological and descriptive notes are given for each species.



Final-instar cephalic structures and spiracles of hymenopterous larvae.
33, 34, Coccygomimus pedalis; *35, 36,* Phytodietus vulgaris; *37, 38,* Glypta inversa.

Skeeter Werner

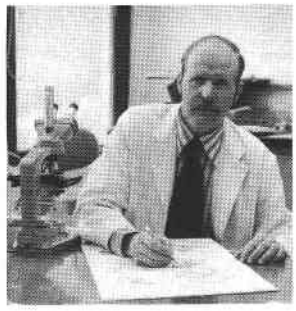
Sex Identification of Adults and Pupae of a Birch Defoliator, *Rheumaptera hastata,* in Interior Alaska, by Richard A. Werner (82)

Populations of the spear-marked black moth, *Rheumaptera hastata* (L.), have reached epidemic levels in birch forests of interior Alaska in 1974 and 1975. Investigation of the life cycle and reproductive behavior could not be accomplished accurately without some method of differentiating the sexes. This paper describes a method for identifying sex in both pupae and adults.

White Spruce Seed Loss Caused by Insects in Interior Alaska, by R.A. Werner (83)

Several species of cone and seed insects were found to damage white spruce cones and seeds in interior Alaska. The insects caused serious damage to cones and seeds during 1 of the 5 years of this study. A new seed and cone insect, *Pegohylemyia* sp., was recorded for the first time from Alaska.

Insects damaged 3-6 percent of the seeds per cone during 4 of the 5 years of the study. In 1962, damage increased to 50 percent and most of it was caused by *Pegohylemyia* sp. Both cone and seed damage was least in 1958 when there was an abundant cone crop and the number of seeds per cone was high. In contrast, the greatest insect damage was in 1962 when few cones were produced but the number of seeds per cone was high. Insect damage to cones varied from 15 to 89 percent during the 5-year period.



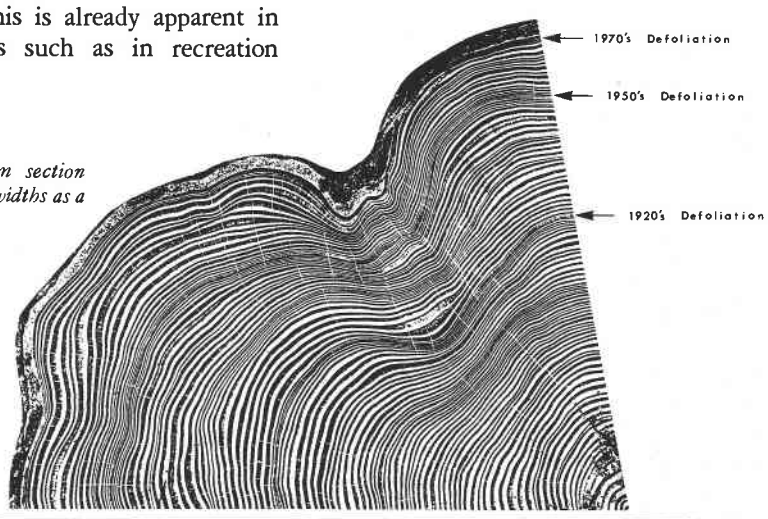
Torgy Torgersen

southeast alaska

Field and Laboratory Techniques for Evaluating Hemlock Sawfly Infestations, by John S. Hard and Torolf R. Torgersen (84)

The hemlock sawfly causes much defoliation of western hemlock in localized areas in southeastern Alaska. As the intensity of forest resource management increases, there will be increasing demands on forest pest management specialists to assess the course of infestations. This is already apparent in high value stands such as in recreation areas, near population centers, and in high-risk, overmature stands.

This paper discusses techniques that will permit pest management personnel to determine trends in sawfly populations. Procedures are given for sampling and handling all stages of the sawfly. Methods are also shown for determining larval instar composition, survival, sex ratio, fecundity, and classes of mortality. Figures, descriptions, and a key are given to help the user diagnose and identify specific sources of mortality.

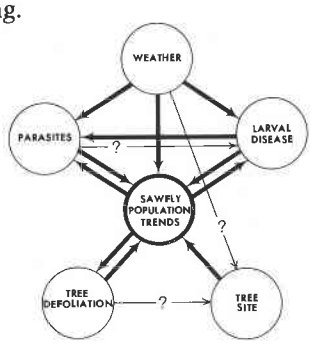


Western hemlock stem section showing reduced ring widths as a result of defoliation.

Natural Control of Hemlock Sawfly in Southeast Alaska, by John S. Hard (85)

Hemlock sawfly infestations occur most commonly in the warm southern half of southeast Alaska. Biotic factors that limit sawfly populations are a fungus which kills large numbers of female larvae, food quality as affected by host site and defoliation, and three ichneumonid parasitoid species which attack prepupal larvae in cocoons. The fungus was the most effective natural control in recent years, especially during wetter than normal summers. Parasites which attack after the fungus has decimated larval populations were most abundant during two dry summers. Parasitization and sawfly emergence were directly related, and both were highly inversely correlated with percentage fungus killed sawflies. Sawflies reared on lightly defoliated trees produced significantly more eggs than those reared on heavily defoliated trees, and fecundity was directly related to cumulative heat units during the summer.

Between 1952 and 1974, most negative sawfly population trends south of Frederick Sound occurred when two wet summers occurred consecutively. Apparent widespread collapse of sawfly populations in 1974 was associated with low temperatures in 1973 which delayed sawfly development and reduced opportunities for successful breeding.



Interaction of natural controls and hemlock sawfly populations in southeast Alaska. Broad arrows represent major relationships. Thin arrows with question marks represent minor suspected but undetermined relationships.

Parasites of the Western Hemlock Looper in Southeast Alaska, by Torolf R. Torgersen (86)

The western hemlock looper was found in Alaska for the first time in 1965. Field collections and laboratory rearings were conducted during 1966 to obtain life history data and to determine parasitization. Shortly after the completion of the 1966 field season, a salvage logging operation was carried out within and adjacent to the looper infestation. This permitted only a single season of fieldwork. Results of the preliminary studies dealing with the biology of the looper were reported by Torgersen and Baker.

This is a key to help entomologists identify parasites of the western hemlock looper. Eight major species of parasites are included in this first examination of the natural enemies of this looper in Alaska.

Budworm in Coastal Alaska, by John S. Hard (87)

Periodic outbreaks of black-headed budworms have been reported in southeast Alaska and on Prince William Sound since 1917. An outbreak in the 1950's caused severe defoliation of mature hemlock. Almost one-third of net volume was lost in some stands. The defoliation trend—ratio of acres defoliated in a given year to acres defoliated the year before—was directly related to regional Temperature Index. Since virgin stands have recovered from past outbreaks, widespread defoliation need not be viewed with alarm.

Sequential Sampling of Hemlock Sawfly Eggs in Southeast Alaska, by J.S. Hard (88)

In another report on the hemlock sawfly, entomologist Hard describes a sequential sampling technique for estimating egg populations. In this technique, branch samples are examined only until a single egg is found, which greatly reduces the amount of field time. A tree is called ''infested'' if the sample yields one or more eggs, and ''uninfested'' if the sample yields none. Percent of ''infested'' trees determines egg population concentration. The upper limit for an endemic to light population is 33.3 percent ''infested'' sample trees. The lower limit for a moderate to heavy population is 50.0 percent ''infested'' sample trees.

Mortality of Overwintering Eggs of the Black-Headed Budworm and Hemlock Sawfly in Southeast Alaska, by D.C. Schmiege (89)

The black-headed budworm and the hemlock sawfly both overwinter as eggs. Budworm eggs are laid singly on the flat surface of needles of western hemlock and Sitka spruce. Sawfly eggs are deposited singly in notches cut into the edge of western hemlock needles. Fall egg surveys are used to predict budworm and sawfly populations for the following season. Egg mortality between deposition and hatching must be known in order to make accurate population predictions. A study of winter egg mortality was begun in 1962 and completed in 1965. Field work was done at Limestone Inlet near Juneau, Alaska.

Parasites of the Black-Headed Budworm *Acleris gloverana* (Lepidoptera: Tortricidae) in Southeast Alaska, by Torolf R. Torgersen (90)

Studies of budworm parasites in Alaska have been underway since 1953. The purpose of these studies has been to identify the parasites attacking the budworm and to assess their role in regulating host populations.

A key for the identification of parasite adults and notes on the bionomics of each species are given. The list of parasites includes 16 species, contrasting sharply with the 48 species reported from coastal British Columbia. Only two species, *Triclistus pallipes* Holmg, and *Meteorus argyrotaeniae* Johansen, appear in the Alaskan complex that do not also appear in the list from British Columbia.

Oviposition Preference of the Black-Headed Budworm and Host Phenology, by D.C. Schmiege and J.S. Hard (91)

Black-headed budworms prefer hemlock foliage for laying their eggs. This probably accounts for the fact that more severe defoliation has occurred on hemlock than adjacent spruce. During prolonged outbreaks, when hemlock is severely defoliated, budworms may be forced to lay eggs on spruce. It is likely that fewer of these budworm larvae survive because the rapidly expanding spruce shoots do not provide the shelter found in hemlock buds.

Don Schmiege

The Relation of Weather to Two Population Declines of the Black-Headed Budworm in Coastal Alaska, by Donald C. Schmiege (92)

Hot, dry weather accompanied the decline of black-headed budworm populations in coastal Alaska in 1955 and 1965. A study of weather records for the period 1945 to 1965 shows that population collapse occurred in years of unusually warm, dry weather during July. No consistent weather pattern was apparent during the years of population increases. The great reduction in budworm numbers occurred during the larval periods in both 1955 and 1965. No evidence of disease was found in either outbreak.

New Insect Identified

They've probably been in Alaska for centuries, but entomologists have only recently found them—a new species of *Spinolochus,* or small wasps (nonstinging) that inhabit forests and parasitize other insects. The newly-discovered species was named *Spinolochus distolatus* Torgersen, by the author who first found this parasitic insect.

See *A New Species of* Spinolochus *from North America,* by Torolf R. Torgersen (93).

The Amount of Foliage Consumed or Destroyed by Laboratory-Reared Larvae of the Black-Headed Budworm, *Acleris variana,* by Richard A. Werner (94)

This study provides data on the number of buds and needles consumed or destroyed by budworm larvae feeding on hemlock and spruce in the laboratory. Since Sitka spruce produces twice as many needles per linear inch of twig as western hemlock, defoliation by the budworm is more severe on hemlock than spruce because of differences in the development of the hosts and in the feeding behavior of first- and second-instar (instar: period of growth between molts) larvae on each of the hosts.

The results of this study can be used to predict the relative amounts of western hemlock and Sitka spruce defoliation expected in areas of known egg populations. Correlations can thus be made by the survey entomologist between expected population levels and expected defoliation.

Development of the Black-Headed Budworm in the Laboratory, by Richard A. Werner (95)

The black-headed budworm, *Acleris variana* (Fernald), is a major defoliating insect in southeast Alaska. The preferred host in Alaska is western hemlock, but defoliation occurs also on Sitka spruce.

In this study, two successive generations of *A. variana* were successfully reared in the laboratory on both western hemlock and Sitka spruce foliage.

There was no difference in development time (egg to adult) between first generation budworms reared at an average temperature of 66° F. (range 58-71°) and second generation budworms reared at 71° F. (range 69-72°). The average development time of budworms (egg to adult) was approximately equal when reared on hemlock and spruce.

Female budworms had a longer life span (88 days) than males (77 days) when reared on either hemlock or spruce. This difference in life span was greatest in the adult stage.

fire and flood

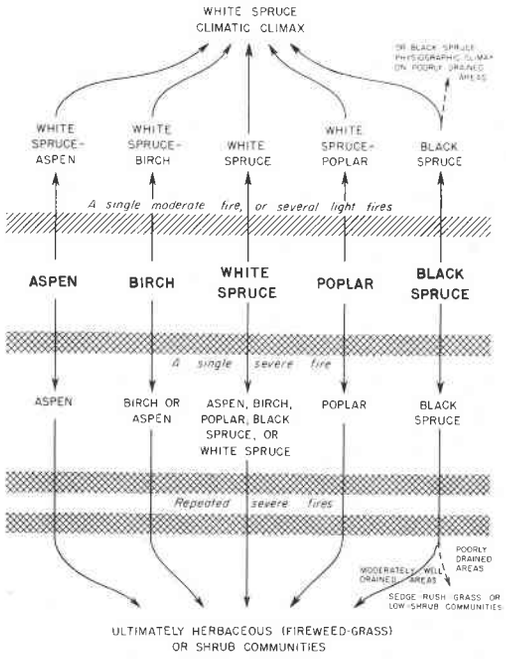
ecology

Ecological Effects of Forest Fires in the Interior of Alaska, by H.J. Lutz (96)

A 121-page bulletin published in 1956 describes the history of forest fires in interior Alaska and the effect of fire on various parts of the ecosystem—forests, soils, watershed characteristics, economic development, and wildlife (fur-bearing animals, moose, and caribou). Information for the study was collected from 103 sample plots.

The forests of interior Alaska are very susceptible to destruction by fire. Low rainfall, long hours of sunshine during the summer, highly flammable ground cover, and coniferous forests, combine to make a high fire hazard.

Most of the fires in the past were caused by man, who, in many parts of the north, tended to live a seminomadic life. Modern man appears to be even less careful with fire. The forests are also subject to fires caused by lightning. Once started, fires may burn for weeks or months, spreading over hundreds of thousands or even millions of acres.



Changes in forest types following fire.

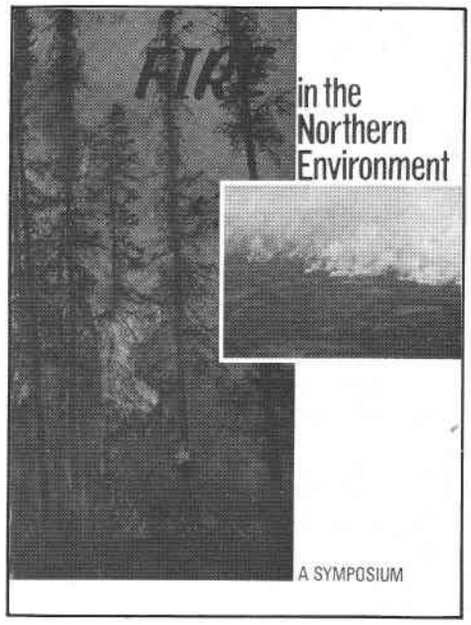
Wildfire in the Taiga of Alaska, by Leslie A. Viereck (97)

The taiga of Alaska consists of a vegetation mosaic resulting primarily from past wildfires. Today (1973), both lightning- and man-caused wildfires burn an average of 400,000 hectares annually, creating vast areas of successional ecosystems. However, although the number of reported fires is increasing, fire control is becoming more effective in limiting the average size of fires and the total area burned.

One of the important influences of fire in the taiga ecosystem is its effect on permafrost and the soil nutrient cycle. Construction of firelines in permafrost areas has a greater effect on soil erosion and situation than does the fire itself.

Some wildlife species, such as moose and snowshoe hare, depend upon fire and its resultant successional plant communities, whereas fire may have deleterious effects on caribou winter range.

Fire has both positive and negative effects on esthetic and recreational values. Fire has always been a part of the Alaska taiga ecosystem; if it is totally excluded from the environment, some major ecological changes will result. Fire-suppression alternatives are discussed and additional research on fire effects suggested.



FIRE in the Northern Environment, Proceedings of a Symposium, edited by C.W. Slaughter, Richard J. Barney, and G.M. Hansen (98)

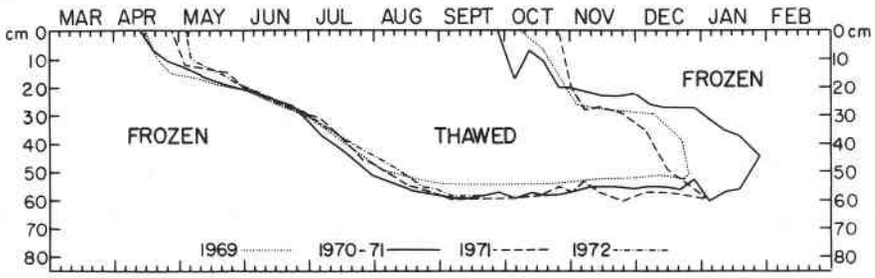
A 275-page summary of all that is known about fire in the northern environment, from a symposium at the University of Alaska in 1971, sponsored by the Alaska Forest Fire Council and the Society of American Foresters. The purpose of the symposium was to explore various aspects of wildfire in the subarctic—its relationship to the natural environment and to man's use of the environment—and fire control.

Ecological Effects of River Flooding and Forest Fires on Permafrost in the Taiga of Alaska, by Leslie A. Viereck (99)

In the taiga of Alaska, permafrost and vegetation are closely related. In areas underlain by permafrost, the nature of the vegetation is important in determining the thickness of the active (melt) layer. In a black spruce/*Ledum*/moss stand, the active layer is normally 30-60 cm thick.

Both flooding and fire can have a profound effect on the permafrost layer. For example, flooding can thaw the permafrost and cause higher soil temperatures in the upper levels. Siltation also results in the compaction and death of the moss layers, and thus increases the active (melt) layer.

Fire has a similar effect on thickening the active layer of permafrost. Although thawing in burned forests the year of the fire may not be significant, by the end of the second summer it may be as much as 160 percent of that in unburned stands. Return to preburn thaw levels takes about 50 years.

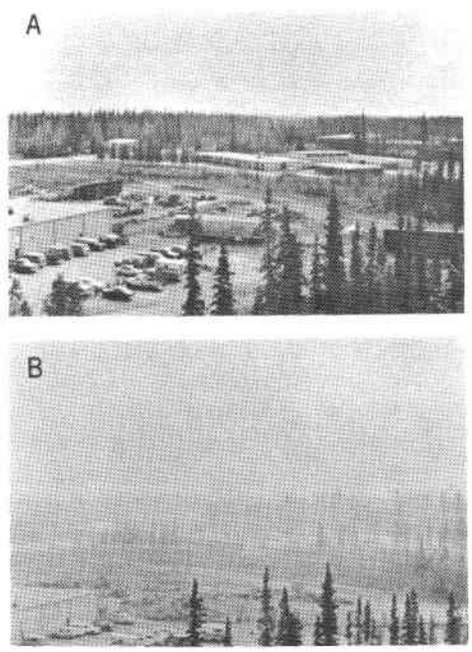


*Four-year record of freeze-thaw cycle in 55-year-old open black spruce/*Ledum*/moss type near Fairbanks.*

Wildfire Smoke Conditions: Interior Alaska, by Richard J. Barney and Erwin R. Berglund (100)

Wildfires are commonplace in Alaska. Aboriginal man, in addition to being careless with fire, started fires to control insects, herd animals, facilitate travel, and dry firewood (Lutz 1956, 1959). Hundreds of wildfires occur each summer—some in excess of 100,000 acres each. In 1969, over 4,000,000 acres were burned. Some of the fires burn for long periods of time, often well into the winter months. Such fire activity under specific meterological conditions results in a smoke pall covering hundreds of square miles and over 5.6 miles thick. From mid-June through mid-July, 1969, an estimated 145,000 cubic miles of smoke persisted in interior Alaska.

In this study, records of 21 stations were analyzed for smoke persistence and visibility. Conditions were better than researchers had previously expected.



A southerly view from the University of Alaska, Fairbanks, overlooking the Tanana River Valley. (A) Clear day; (B) 1969 smoke conditions.

Black Spruce Fuel Weights and Biomass in Two Interior Alaska Stands, by Richard J. Barney and Keith Van Cleve (103)

This study reports the fuel weight and biomass distribution in a 51-year-old lowland and a 55-year-old upland black spruce stand in interior Alaska. Biomass distribution is shown for overstory, standing and down dead tree components, herbaceous understory, and the moss layer.

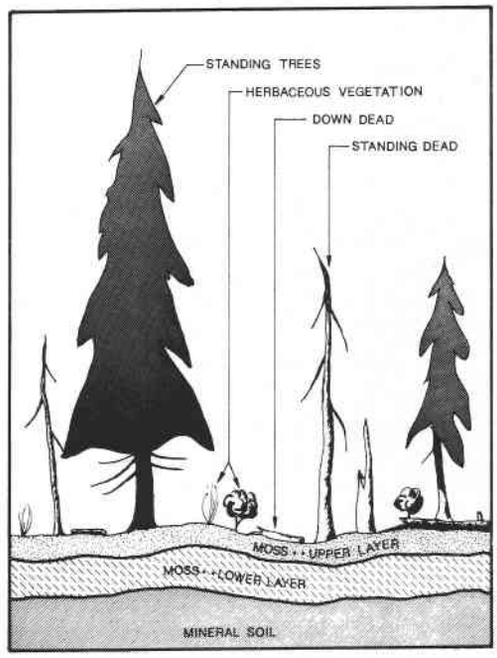


Diagram of stand showing sampling categories.

fire danger rating

Fire Danger and Time-of-Day

Daily cyclic patterns in air temperature, relative humidity, and windspeed cause variations in fire behavior. A relationship between time-of-day and spread index was developed for four interior Alaska stations to predict diurnal fluctuation in fire danger for planning fire control operations.

See *A Relationship Between National Fire Danger Rating System Spread Index and Time-of-Day in Interior Alaska,* by Nonan V. Noste (101).

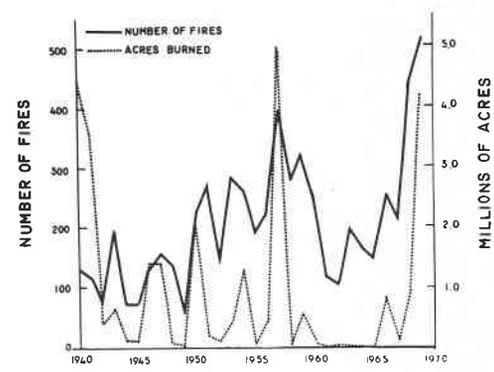
National Fire-Danger Rating System Fine-Fuel Moisture Content Tables—An Alaskan Adaptation, by Richard J. Barney (102)

Fine-fuel moisture content tables have been developed for use with the National Fire-Danger Rating System in Alaska. Comparisons have been made which illustrate differences resulting from danger-rating calculations based on these new fine-fuel moisture tables versus the standard NFDRS tables. New fine-fuel moisture content tables for the cured, transition, and green herbaceous stages of fuel are provided.

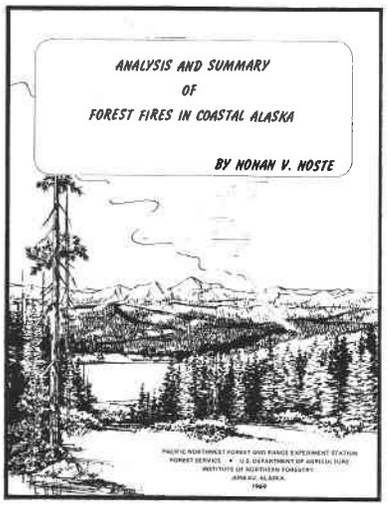
wildfire statistics

Wildfires in Alaska—Some Historical and Projected Effects and Aspects, by Richard J. Barney (104)

This paper discusses some of the historical aspects of wildfires in interior Alaska with particular reference to the period from 1940 to the present. Several speculations are made on the basis of recent records relative to fire impact or effects. The need to obtain quantitative impact information is also discussed.



Number of fires and acres burned by year, interior Alaska, 1940-69.

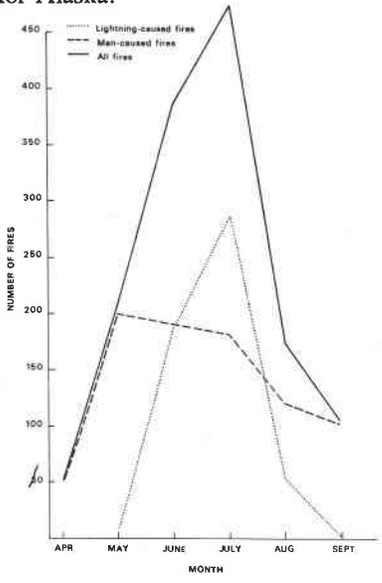


Analysis and Summary of Forest Fires in Coastal Alaska, by Nonan V. Noste (105)

This summary describes the fire problem in coastal Alaska and should be useful in development of both suppression and prevention plans. The future development of a stronger planning base will require a concerted effort at recordkeeping to develop good basic fire data. The author and colleagues identify factors associated with fire occurrence and acreage burned and provide a statistical summary. The information is intended to answer questions concerning who, when, where, and magnitude of the fire problem.

Selected 1966-69 Interior Alaska Wildfire Statistics With Long-Term Comparisons, by Richard J. Barney (106)

Basic historical information is presented on wildfires in the interior of Alaska. The paper presents selected interior Alaska forest and range wildfire statistics for the period 1966-69. Comparisons are made with the decade 1956-65 and the 30-year period 1940-69, which are essentially the total recorded statistical history on wildfires available for Alaska.



Total number of fires by cause and month, interior Alaska, 1966-69.

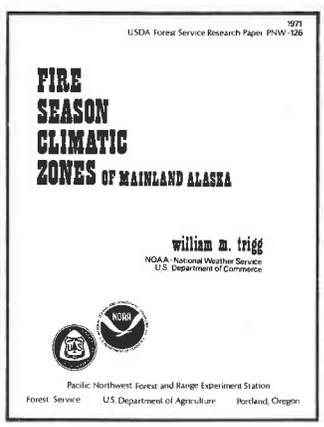
Wildfires and Thunderstorms on Alaska's North Slopes, by Richard J. Barney and Albert L. Comiskey (107)

Although the North Slope is apparently not a fire-dominated ecosystem, wildfire is not unknown to this arctic environment. The authors have gathered information that shows that five wildfires burned more than 1,600 hectares of tundra on Alaska's Arctic Slope. It was found that environmental conditions suitable for lightning, ignition, and burning occur more often than previously recognized at this northern latitude.

The authors conclude that burnable fuel conditions and thunderstorms will occasionally coincide, thereby creating widely spaced potential wildfire conditions over the Arctic Slope. Man and his activities are another potential ignition source. As his access into the area improves, the probability that he will start fires increases.

A Critical Look at Fire Damage Appraisal, by Nonan V. Noste and James B. Davis (108)

Fire-damage appraisal in relation to fire-protection planning shows a need for a standard appraisal system on all federal lands. Fire control costs and damages on an interior Alaska and a northern Minnesota fire are compared: Application of both Bureau of Land Management and Forest Service appraisal criteria to the Minnesota fire produces considerable differences. Control levels cannot be optimized without relating costs to damage.



Fire Season Climatic Zones of Mainland Alaska, by William M. Trigg (109)

This paper describes the maximum and minimum fire danger areas on a seasonal basis in Alaska. It further points out where inadequate data exist as well as the location of extreme or peculiar climatic variations. The author suggests that further work of a more detailed nature is probably desirable, but this depends on the needs and capabilities of both fire weather and fire control personnel.

Helicopters and Helibuckets Used to Control Interior Alaska Wildfires, by Roy M. Percival and Nonan V. Noste (110)

Tactical and logistical problems of controlling remote forest firest in Alaska are tied to the vastness of the country and the limited access to the fires. Aircraft in general and fixed-wing retardant planes specifically have traditionally played an important role in supporting operations. Helicopters and helibuckets are proving to be tools well-adapted to dropping water.

Franklin Log Skidder Adapted for Fireline Use in Alaska, by Robert W. Webber and Richard J. Barney (111)

In order to reduce the impact of fire control activities, the Bureau of Land Management's fire control staff has developed an alternative to cat-built fire lines in Alaska. A Franklin articulated all-terrain log skidder has been adapted for fire-line construction. The skidder has been used not only for direct control activities but also logistical support. The outstanding point of this machine is that there has been no down time in all its use. It can go places that the crawler-type tractor cannot. It does not disturb the surface vegetation to the extent of crawler tractors. In addition to relatively light ground pressure, the machine's ability to turn like a car results in less disturbance to the ground cover than the pivoting action used to turn cats.

Fire control personnel in Alaska feel that this type of machine is well worth considering in other areas of the country as an additional tool in the arsenal of fire control.

Airliner Turns Bomber, by Roy M. Percival and Richard J. Barney (112)

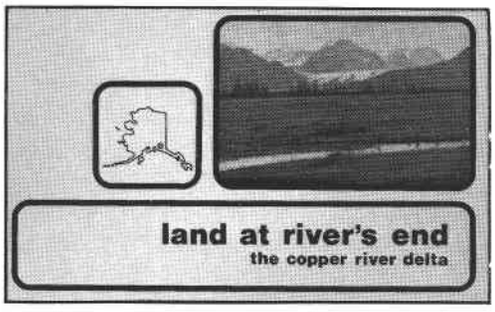
The Bureau of Land Management used a converted DC-6B airliner as a retardant aircraft during the 1971 and 1972 fire seasons. This ship is a significant step toward solving the cost, distance, delivery time, and payload problems encountered in Alaska. Fire control personnel in Alaska generally agree that the DC-6B is a definite advancement in terms of total retardant capabilities and a welcome addition to the aircraft fleet.

Alaska's Extra Ace: Water Dropping, by Nonan V. Noste and Roy M. Percival (113)

A summary of water dropping on interior Alaska wildfire is presented for the 1969 fire season. The study suggests that water dropped from helibuckets can provide a short-term fire control line under certain weather and fuel conditions.

wildlife habitat

interior alaska



Land at River's End, The Copper River Delta, by Thomas Michael Baugh (114)

The natural resources of the Copper River Delta of the Chugach National Forest, southeast of Cordova, Alaska, have been studied and utilized by man since the turn of the century.

This beautiful 10-page pamphlet, liberally illustrated with color and black and white photographs of the wetlands and its wildlife, traces the history of the area and brings the reader up to date on research and development work taking place on the delta.

The first oil well in Alaska was developed in this area in 1901 and continued producing until 1933. Today, six major oil companies are exploring here for more oil.

In 1962, the Forest Service and the Alaska Department of Fish and Game jointly established a 332,000-acre game management area on the delta which provides vital habitat to tens of thousands of waterfowl in the Pacific Flyway.

The devastating 1964 earthquake distrupted the delicate ecology of the area. The quake disturbed nesting habitat for breeding ducks and their populations fell from 70,000 to between 5,000 to 10,000 birds.

Recent efforts to improve the wildlife habitat of the delta have resulted in benefits to waterfowl. About 10,000 pairs of ducks are again visiting the delta; the dusky Canada goose population, which declined following the 1964 quake, appears to have stabilized; trumpeter swan numbers remain stable with 80 pairs nesting and breeding on the delta each year. Work continues on efforts to establish food for waterfowl in ponds on the delta and to identify present and potential duck and goose habitats.

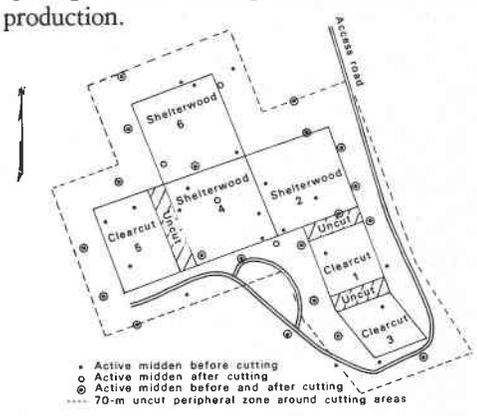
Food Habits of Moose, *Alces alces,* in Alaska: A Preliminary Study Using Rumen Contents Analysis, by Charles T. Cushwa and John Coady (115)

Rumen contents of 166 moose taken in 1971 and 1972 in the Fairbanks and Kenai regions of Alaska were analyzed to determine seasonal food preferences and to understand moose-habitat interactions. The authors compare their findings with data from six studies of other scientists on moose food habits reported for Alaska. Results indicate that there are seasonal and regional variations in habitat utilization by moose.

Browse vegetation favored, when available, was found to primarily twigs of willow, birch, cottonwood, aspen, and alder in winter; willow and birch in spring; willow in summer; and willow and birch in the fall of the year. Depending upon regional availability in these seasons, other items of vegetation less frequently consumed were: fruit, mountain-cranberry, grass, equisetum, lichens, and sedges. Spruce was seldom eaten.

Red Squirrel Response to Clearcut and Shelterwood Systems in Interior Alaska, by Jerry O. Wolff and John C. Zasada (116)

Population response of red squirrels to clearcut and shelterwood silvicultural systems in interior Alaska was determined by comparison of population differences before and after cutting. The conditions imposed by the cutting resulted in the squirrels' vacating clearcuts and in reduction of their numbers in shelterwoods. Populations in adjacent uncut stands remained stable or increased slightly. The long-term suitability of the shelterwood will eventually be determined both by the response of squirrels to the more open stand conditions, especially the spacing of cone-bearing trees, and by cone production.



Map of cutting units.

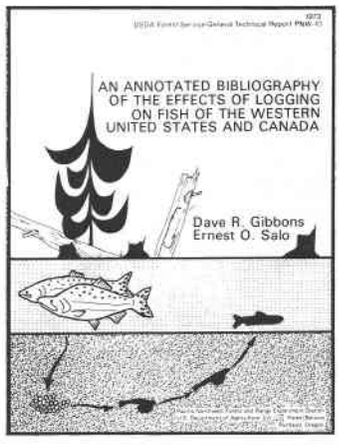
southeast alaska

Effects of Log Dumping and Rafting on the Marine Environment of Southeast Alaska, by Bruce C. Pease (117)

Because of the water-oriented geography and lack of roads on the islands of southeast Alaska, most commercially harvested timber is stored and transported on marine waters.

This report summarizes the extent of water-dependent log handling and storage facilities in southeast Alaska and reviews available literature on the environmental impact of these facilities. Field studies were conducted at 16 sites and correlated with laboratory studies of leaching rates and toxicity of the four major wood species harvested in southeast Alaska. Significant effects on water quality are believed to occur only under unique conditions and were observed at only 2 of the 16 study sites.

Active log dump at Thorne Bay.



An Annotated Bibliography of the Effects of Logging on Fish of the Western United States and Canada, by Dave R. Gibbons and Ernest O. Salo (118)

This bibliography is an annotation of scientific and nonscientific literature published on the effects of logging on fish and aquatic habitat of the Western United States and Canada. It includes 278 annotations and 317 total references. Subject areas include erosion and sedimentation, water quality, related influences upon salmonids, multiple logging effects, alteration of streamflow, stream protection, multiple-use management, streamside vegetation, stream improvement, and descriptions of studies on effects of logging. A review of the literature, a narrative on the state of the art, and a list of research needs determined by questionnaires are included.

Bill Meehan

Toxicity of Various Formulations of 2,4-D to Salmonids in Southeast Alaska, by William R. Meehan, Logan A. Norris, and Howard S. Sears (119)

Because the U.S. Forest Service is using 2,4-D for vegetation control in southeast Alaska, this study was undertaken to test the chemical's toxicity to salmonid fishes using forest streams in that region. Different concentrations were tested for their effects upon pink, chum, coho, and sockeye salmon, Dolly Varden char, and rainbow trout in southeast Alaska. A comparable test was made in Oregon using coho salmon fingerlings.

At less than 50 ppm, 2,4-D acid produced no mortality except in pink salmon fry. The butyl ester was most toxic causing nearly complete mortality in all species at concentrations > 1.0 ppm and the isooctyl ester was found to be the least toxic of the ester formulations. Alaskan and Oregon coho fingerlings were similar in their responses to 2,4-D acid, butyl, and isooctyl esters. The toxicities of three different formulations of isooctyl ester, a PGBE ester, and butyl ester to Alaskan coho fingerlings were also determined. There were few or no differences in toxicity among isooctyl ester formulations. The butyl and PGBE esters were similar in toxicity.

Residues in Fish, Wildlife, and Estuaries, by Howard S. Sears and William R. Meehan (120)

About 400 acres of cutover land on the Nakwasina River watershed in southeastern Alaska were sprayed with 2,4-D to inhibit growth of broad-leaved plants. It was found that samples of water and fish had concentrations of 2,4-D well below the level considered lethal to aquatic organisms. No immediate mortality to salmonid fishes or aquatic invertebrates was attributable to the spray.

The results were considered inconclusive because of the lack of information on the pretreatment condition of the test animals. Further research is required to assess the immediate and long-term effects of these spray operations in Alaska.

Effects of Forest Fertilization on Two Southeast Alaska Streams, by William R. Meehan, Frederick B. Lotspeich, and Ernst W. Mueller (121)

Basic productivity and water quality were studied to determine the effects of forest fertilization with urea.

An initial, short-term increase in ammonia-nitrogen was observed in the treated streams, and nitrate-nitrogen levels increased and remained high compared to control stream levels during the year following treatment. Concentrations did not approach those considered toxic to aquatic life or unsafe for human consumption. Changes in biomass of periphyton and benthic fauna as a result of fertilization were not detected.

Some Effects of Shade Cover on Stream Temperature in Southeast Alaska, by William R. Meehan (122)

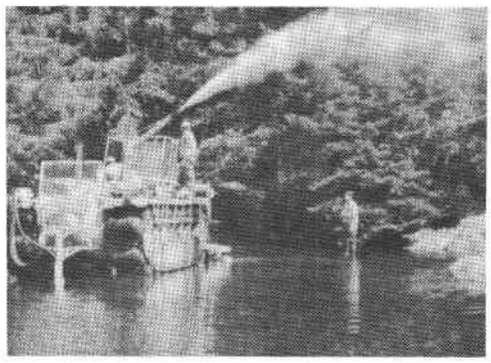
Probably the most important effect of streamside vegetation on water temperature is the biological significance of increased temperatures.

Water temperatures were recorded in several southeast Alaska streams with a portable thermometer accurate to 0.01° C. Measurements were made at 20-yard intervals in shaded and unshaded reaches and on cloudy and clear days. Results indicate that the effects of streamside cover on stream temperatures can be evaluated by this technique, and that shade-producing streamside cover is important in maintaining cool water, especially during warm, clear weather. The results further indicate that temperature increases after clearcutting in this region do not usually approach lethal limits for fish populations.

Effects of Gravel Cleaning on Bottom Organisms in Three Southeast Alaska Streams, by William R. Meehan (123)

In efforts to improve salmon spawning habitat in streams of Alaska's national forests, the Forest Service has been instrumental in development and use of a machine for "cleaning" streambed gravels. The "riffle sifter," as it is called, is a self-powered amphibious vehicle that stirs up the streambed gravel and then sucks up the fine materials and sprays them out onto the streambanks. This report presents an evaluation of some of the effects of the riffle sifter on populations of bottom fauna in some typical salmon streams in southeastern Alaska.

Measurements of the numbers of insects, annelids (worms), and amphipods (crustaceans) were made before cleaning the gravels, then immediately after cleaning, 3 months later, and finally 12 months later. The cleaning initially reduced the bottom fauna populations in each of the streams, but within 1 year these populations apparently returned to the pretreatment levels.



The riffle sifter in operation.

stream sampling

Comparative Effectiveness of the Standard Surber Sampler and a Hydraulic Modification for Estimating Bottom Fauna Populations, by William R. Meehan and Steven T. Elliott (124)

For more than 30 years, aquatic biologists have been using the Surber square-foot bottom sampler to obtain measurements of stream bottom fauna. This sampler consists of two brass frames, each 1 foot square, hinged together so that they form a right angle when extended. One frame then fits over the square foot of streambed to be sampled, and the other is provided with a net into which organisms drift as they are dislodged from the streambed. In practice, the biologist hand stirs the bottom material within the square-foot area to a depth of a few inches. The dislodged organisms then drift into the collecting net.

The Surber sampler was modified for use with a hydraulic unit to dislodge the bottom organisms in the stream. Comparative tests were conducted to determine the relative effectiveness of each.

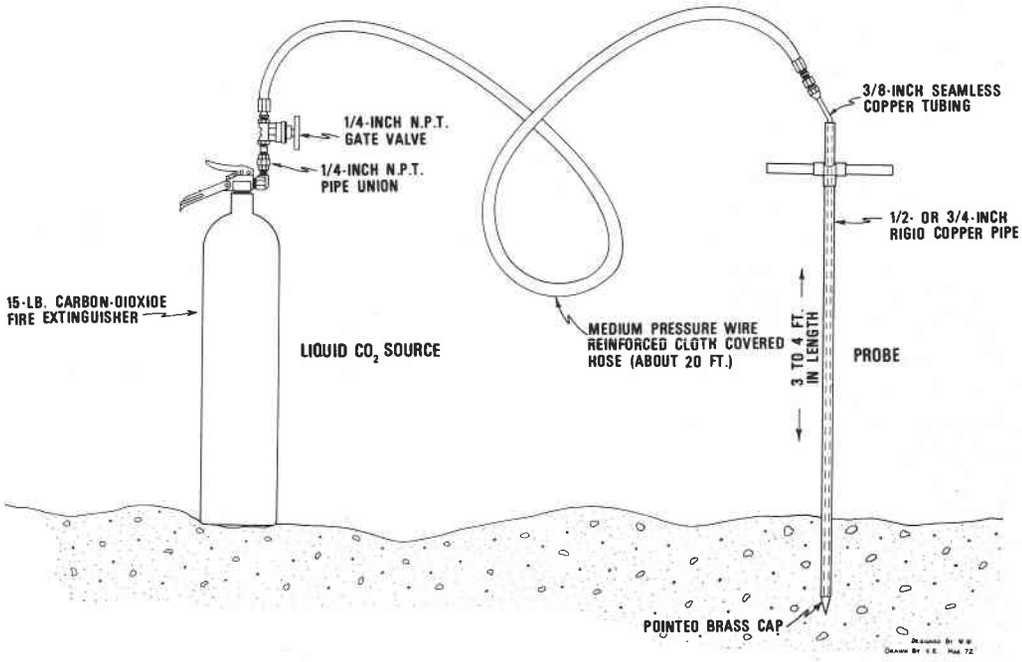
Both techniques are best suited for sampling streambeds composed of fine to coarse gravels and small stones, with water velocities sufficient to pass organisms downstream into the collecting net. Each of the two methods has advantages and disadvantages. The Surber technique is more portable for sampling in areas not readily accessible. It is a better method in areas where water currents are slow, and where streambeds contain considerable silt, sand, or fine organic materials. The hydraulic unit does a more thorough job of stirring up the substrate and is faster and handier for obtaining many samples from a small area. It is more effective for sampling organisms in deeper lying sediments.

A Freezing Technique for Sampling Streambed Gravel, by William J. Walkotten (125)

The need to sample gravel and sediment in rocky, salmon-producing streams of southeast Alaska has led to the development of a freezing technique based on the author's method of using liquid carbon dioxide fed into a copper tube inserted into the gravel.

The liquid CO_2 vaporizes at atmospheric pressure and absorbs heat from the streambed, freezing the intergravel water. Once frozen, the sample is not easily damaged by removal from the sampling site. The technique provides a sample varying in size with the type of streambed material at the sampling location.

The method provides a nearly undisturbed, stratified sample containing stream gravel, intergravel water, and organic material. It should provide valuable information on gravel resedimentation after cleaning and can be used to remove samples from less compact soil types.



Equipment for freeze-sampling streambed gravel.

alaska - bibliography

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gadgets

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Contents Page

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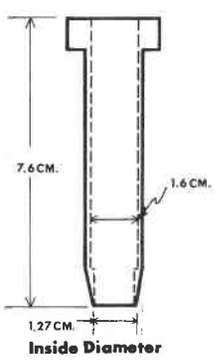
Nothing grabs people quite as much as gadgets. Many PNW researchers are working near the outer limits of scientific knowledge. They are delving into areas of the natural sciences so basic that often they must design and build their own scientific instrumentation and develop new research methods.

This instrumentation ranges from tools as simple as a specialized ratchet wrench to fully automated weather recording stations. Advances in methodology include a variety of sampling techniques, the adaptation of visual equipment for specialized tasks, the use of drugs to immobilize large animals, and many other ways of getting the research job done.

Although instrumentation and methodology are complex subjects, the word often encountered in PNW reports on the subject is "simple." Researchers want to develop easier ways to do their jobs. This benefits both those who use research results and those who adopt the tools and methods for other purposes.

Sampling Yeast and Bacteria

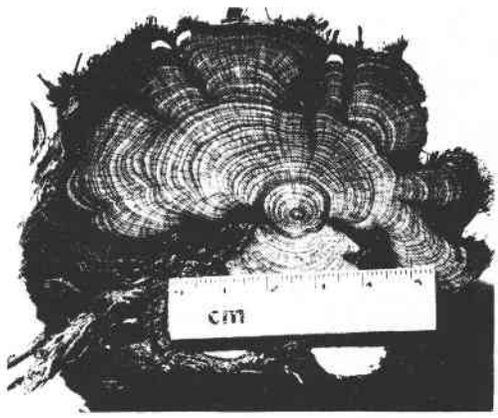
Plant Pathologist Don Knutson has devised a way of sampling yeasts and bacteria in sound wood. Don uses a hollow steel chisel (see diagram) to extract a core sample of wood. This allows him to quantify the relative numbers of microbes in a tree. In his paper (1) Don also describes a system for analyzing the yeast and bacteria content of the wood sample once it is taken.



Inside Diameter

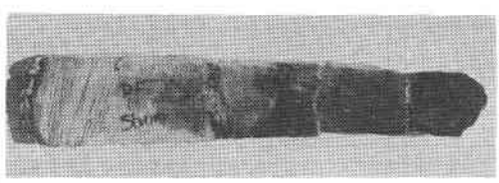
A Sagebrush Weather Station

W.B. Fowler and J.D. Helvey of the Forest Hydrology Laboratory in Wenatchee, Washington, tell us that big sagebrush *(Artemisia tridentata)* can provide important clues about weather patterns in Washington's Columbia Basin. In a December 1974 article in the magazine *Pacific Search* (2) the authors explain how the width of rings on sagebrush can be used to determine past precipitation.



It's Cold Outside

If rotted wood tends to squish and crumble while making a ring count, use a technique developed by PNW researchers Francis R. Herman and Clark E. Smith. Herman and Smith use a system of freezing wood samples for tree stem analysis. Transverse sections of rotten wood are first submersed in water for several hours and then frozen.



Partially decayed Douglas-fir radial section, frozen to provide accurate ring measurement data.

There's an interesting story behind the "discovery" of this method. A large, 400-year-old Douglas-fir with brown cubical butt rot had been felled for stem analysis. "Using conventional techniques in a rainstorm, we attempted to count the rings and measure sequential radial growth in the rotten heartwood," the authors indicate. "The decayed wood tissue crumbled easily and, even though the thinnest, sharpest razor blade available was used, ring measurements and counts could not be made."

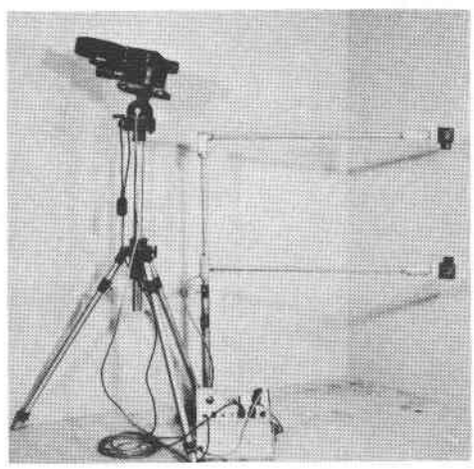
Giving it up for the evening, the two researchers retired to the warmth of their fire. It was cold that night and. . . . "The following morning the rotten stump and breast-high-cut sections were frozen. Sequential radial ring-growth measurements and counts were made with ease" (3).

Photographic Data Recorder For Lumber

W.Y. Pong and G.A. McLaughlin have combined a camera control circuit with a cine pulse Traid Corporation Automax Model G-3 camera and added a built-in strobe light contact and a footage counter to produce a photographic data recorder for use in recording information about individual pieces of lumber as they are produced in a sawmill.

A schematic of the system along with the information necessary to put it together was first reported in the *Forest Products Journal* in 1975 (4).

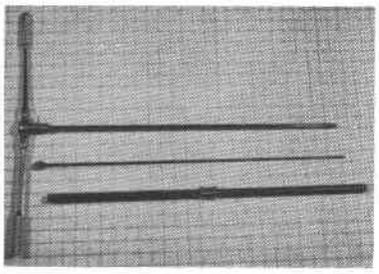
The researchers report that the system was successfully used over 160,000 times in eight recovery studies. The use of the control unit is obviously not restricted to lumber recovery studies but can be applied to almost any conveyor belt type of operation.



Francis Herman

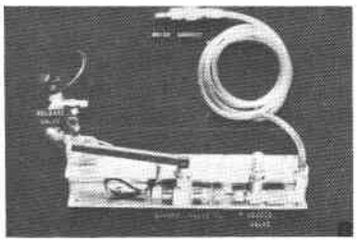
The Ratchet Racket

Mensurationist Francis R. Herman has developed a ratchet wrench and cleaning equipment for increment borers (5) and followed that up with an improved adaptor for an increment borer ratchet assembly (6). If core samples are your thing, you'll be interested in both of these papers.



Measuring Stomatal Aperatures

If a portable apparatus for estimating stomatal aperatures in conifers sounds like something that takes place in your local hospital, then you are in the wrong section of this almanac. Stomata are the small openings in the epidermis of leaves or needles. William Lopushinsky has developed a way to measure these openings. The beauty of this device is its portability. A handful of equipment, a squeeze bottle of alcohol, and a few minutes work result in an accurate measure of stomatal opening in hard-to-measure conifers (7).



Assembled needle chamber, bottom view.

Estimating the Weight of Brush

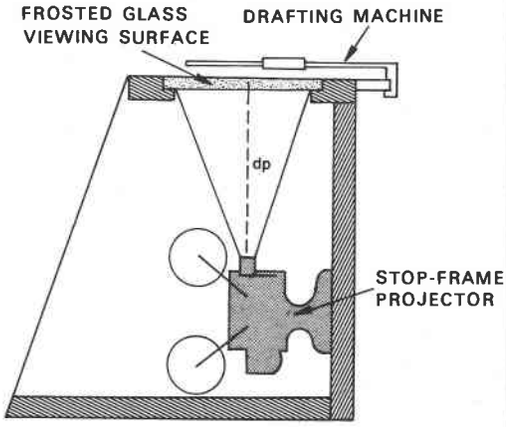
Shrubby vegetation, important as fuel for forest fires and browse for game animals, is extremely difficult to measure. George R. Fahnestock and William K. Key have developed a photo method for estimating the weight and other characteristics of shrubby vegetation for a fraction of the cost involved in actual physical sampling.

The method involves photographing a standard thickness of vegetation, projecting the photographs onto a dot grid, and determining the weight by counting dots and applying a ratio from actual measurements (8).

Fire Photography

Photography has also been used by Research Forester Stewart G. Pickford to collect data on prescribed burning experiments.

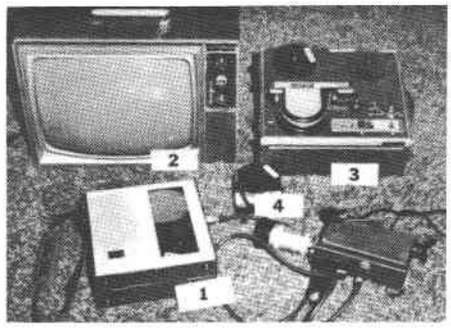
Pickford uses two 16mm moving film cameras, located at separate spots to record fire events. The premeasured, triangulated films are then projected simultaneously on the frosted glass viewing surface with stop frame projectors. Smoke plume velocities and the volume of flow rates of gases have been estimated with this photo technique (9).



A Little More Fire Photography

Gathering information about an in-progress wildfire can be difficult. John D. Dell and Raymond T. Steiger suggest that a portable TV camera-video tape system provides an excellent tool for expanding fire information. This system was used during the project fires which occurred in north-central Washington in 1970.

Viedo-tape films of the fires were used to brief overhead teams with data gathered sometimes only minutes before the briefing session was held. The video tapes provided information concerning fuels, topography, and expected fire behavior as well as additional key information (10).

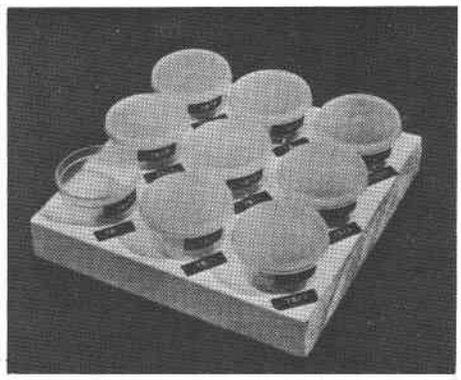


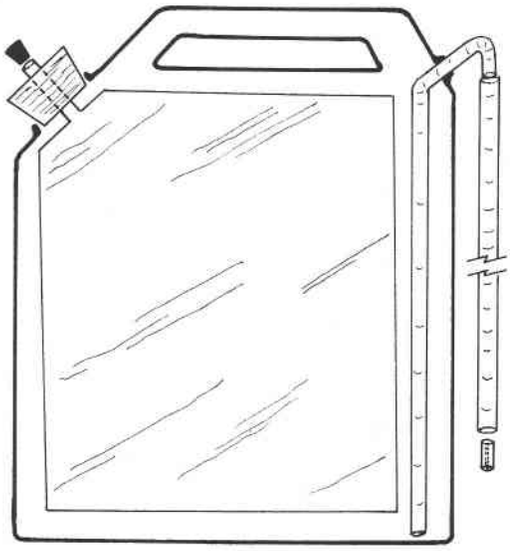
The equipment: (1) portable videocorder and video camera with microphone hookup; (2) 18-inch TV monitor-receiver; (3) playback unit; and (4) ½-inch magnetic video tape.

In The Cups

A quick and economic method has been developed to measure ground distribution patterns of water and fire-retarding liquids dropped from a helicopter in the field.

The equipment is basically simple and includes plastic cups and wooden block cup holders which are placed on a grid marked on the drop site. The entire system is described in *A Field Method For Measuring Patterns of Water Dropped From Helicopters,* by Nonan V. Noste (11).





Waterpowered Air Sampler

Most air quality studies are made in urban areas where electricity can be used to power air samplers. PNW researchers have gone one better and developed a portable water-powered air sampler.

This is a simple, easily constructed device using polyethylene tubing, several rubber stoppers, a 2½-gallon plastic jug containing a Mylar bag and a ¼-inch Tygon head tube (see diagram).

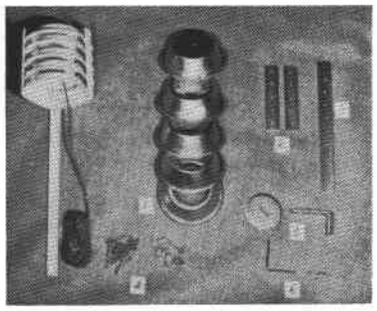
The pumping action is provided by water siphoned from a plastic container at a known flow rate. The water removed is replaced by air drawn into a Mylar sample bag in the plastic jug. The samples are then analyzed in an infrared gas analyzer (12).

Manmade Impacts

The increase in land use planning activity has led to a growing concern for methods of measuring the impacts of human activity. Michimasa Kojima and J. Alan Wagar have evaluated four methods to measure and evaluate these activities in roadway environments. The two researchers have used ground surveillance, ground photography, and large and small scale aerial photography and have compared the effectiveness of the four techniques (13).

Keeping The Sun Out

Richard J. Barney has come up with an inexpensive meteorological radiation shield for thermistors and thermocouples which blocks the effects of solar radiation. He put small aluminum pans or anodized aluminum ashtrays in a special stacking arrangement to shield the heat measuring devices. He found that between 0° and 50°F. the aluminum shelters gave 1° higher readings than the standard Cotton Region shelter and 2° higher between 51° and 100°F. (16).



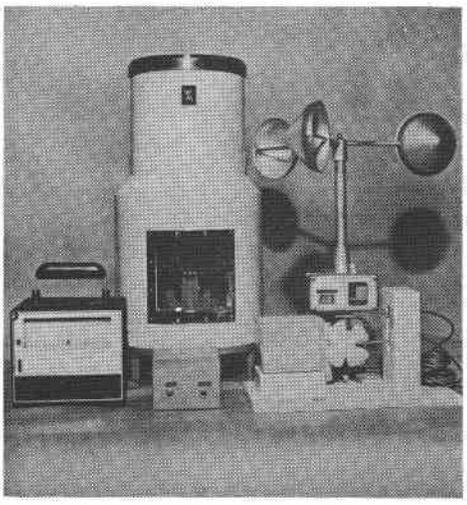
At left, an assembled model with thermistor attached. (1) pie pans, (2) braces, (3) main support, (4) "pop rivets" and washers, (5) bottom radiation shield and mounting bracket, (6) thermistor.

Automated Weather Station

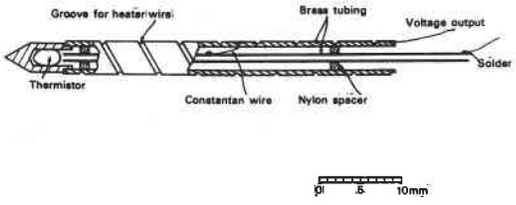
A 31-day battery operated recording weather station has been developed to monitor meteorological information in accessible and remote sites. The station records both wet and dry bulb temperatures, wind speed, and rainfall.

Most of the components are off-the-shelf items. The only fabrications necessary are a battery saver, a psychrometer and a fan assembly. The battery saver is designed to eliminate excessive battery drain when the contracting transducers remain in the "on" or closed position for long periods.

The appeal of this system is its basic simplicity and the fact that some long, hard walks may be avoided due to the 31-day unattended operating period (14).



Front row, left to right: recorder, "battery saver," psychrometer. Back row: tipping bucket rain gauge, anemometer.



Measuring Snow Density

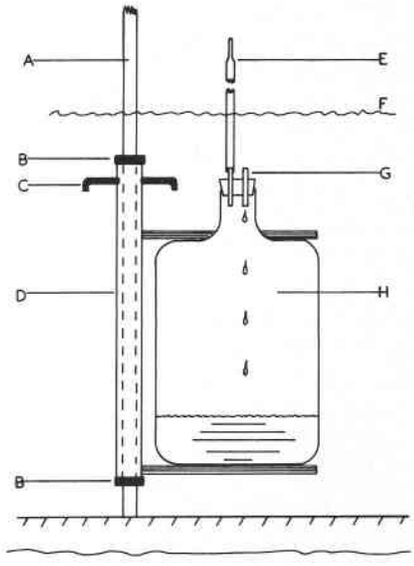
W.B. Fowler at the Forest Hydrology Laboratory in Wenatchee, Washington, has proposed using thermal conductivity to measure snow density. The method uses a special probe and is based on the fact that thermal conductivity is related to the density of the medium being measured, in this case snow (17).

Powerless Stream Sampler

A stream sampler with no exterior energy requirements or moving parts has been designed and tested by PNW scientists. For about $10 you can build the basic unit using simple equipment such as stand pipes, rubber stoppers and a jug known as a carboy. The support equipment adds a little to the cost.

This is one of those items that makes you shake your head wondering why somebody didn't come up with it before. Here's how it works.

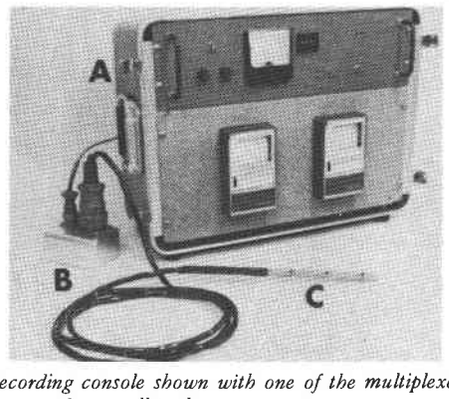
The carboy is submerged to the desired depth. Water enters the carboy through a 3-millimeter inside diameter tube. In order for the water to enter, an equal amount of air is released from the exhaust tube. The sampling rate is dictated by a small diameter capillary inserted at the end of the exhaust tube. Increasing the waterhead on the intake tube increases the carboy air pressure, consequently increasing the air outflow and water inflow. Beautiful! (18).



A—stand pipe; B—position hold collars; C—position control handlers; D—sampler support carriage; E—air pressure control capillary; F—stream surface; G—sample inlet; H—carboy.

Wind Analyzer

Hardware combined with C-MOS computer technology has led to the development of a versatile wind analyzer for long, unattended runs. The instrument uses the time required for wind to travel 1/12-mile past the station as its basic measurement. Low power requirements enable bimonthly data collection (15).



Recording console shown with one of the multiplexer boxes and one well probe.

Measuring Many Wells

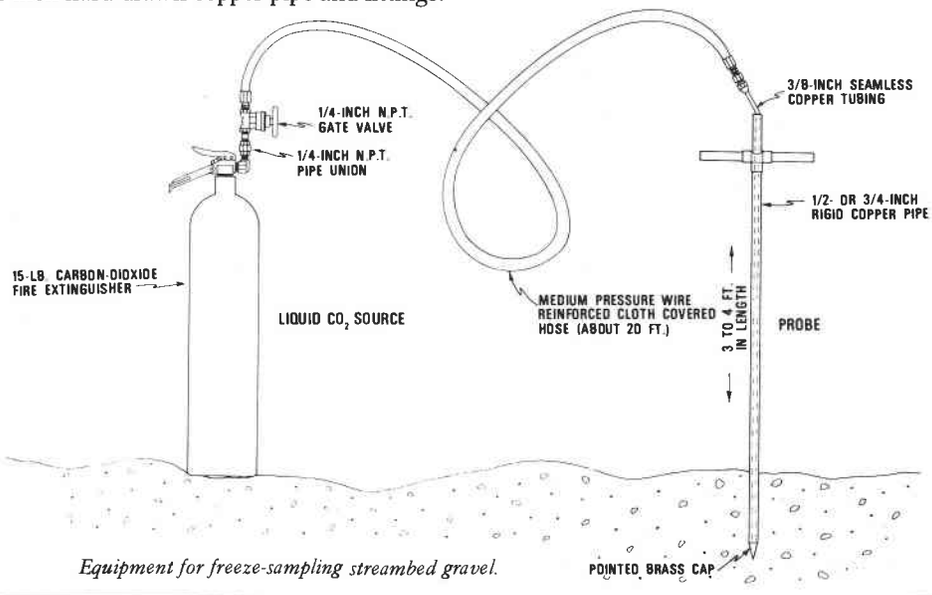
An automated data system has been developed for metering fairly rapid changes in the level of the free water surface in shallow wells. The system is applicable to multiple-well measurements involving the use of 16 well probes and multiplexer boxes coupled to gated-event pen drivers and channel recorders with some rather sophisticated circuitry (19).

Freeze the Creek

The Walkotten gravel freeze sampler enables a biologist to remove a plug of frozen gravel from a streambed. To take a sample, a hollow copper probe is inserted in the streambed. Liquid carbon dioxide is then pumped into the probe. When the probe is pulled out, the frozen core sample comes out with it.

The equipment needed for this device is inexpensive and easy to obtain and assemble. The sampling probe is built from 1/2- or 3/4-inch hard-drawn copper pipe and fittings. To begin, solder a four-way cross pipe to about 3 feet of pipe. Six- to eight-inch lengths of pipe are then soldered to the remaining openings on the four-way cross to finish the handle.

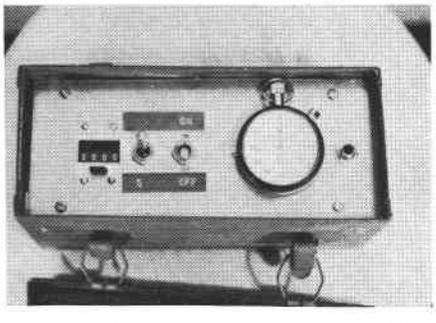
A watertight joint is soldered to the far end of the probe. To complete the assembly, cut a length of 3/8-inch soft-drawn copper tubing long enough to reach the bottom of the probe and connect the tubing to a flared fitting on the upper end of the probe. Add a wire reinforced CO_2 delivery hose, and you're in business (20).



Equipment for freeze-sampling streambed gravel.

Cheap at Twice the Price

Meteorologist W.B. Fowler has designed a low-cost (under $35) counter assembly that will replace earphones for current measurements in streams. According to Fowler, the system is more accurate than audio counts and significantly less expensive than some equipment presently available (21).



Exterior view of completed counter assembly.

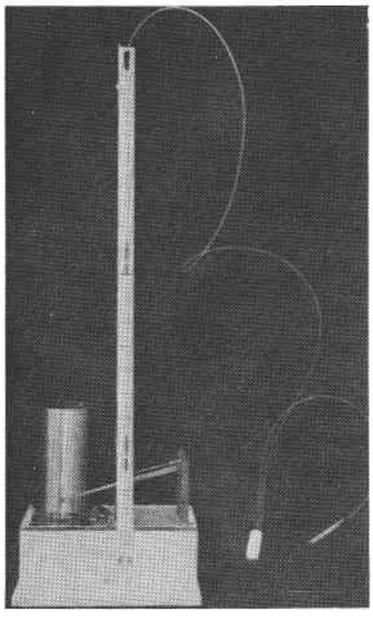
Toothpick Sampling

Searching for inhibitory fungi? If so, check a 1969 paper by PNW microbiologists and mycologists (22). The paper describes a simple, quantitative method of assaying soils for fungi. The system uses birch toothpick probes to transfer the isolates to a double-layered agar plate containing the pathogen mycelium which is sandwiched between the agar layers.

Walkotten Does It Again

William J. Walkotten has done it again with a recording soil moisture tensiometer which provides a continuous record of soil moisture tension for periods of up to 31 days. The instrument detects small moisture changes and diurnal fluctuations.

Walkotten says this instrument can be built for less than $150. If you need one that may be cheap! (23).



Rocks That Glow in the Light

Tracing movement and dispersion of soil-sized fluorescent particles is a promising method for detecting and describing soil erosion. Actively eroding and stable sites are easily identified along with particle size and possible causes. The equipment is simple and consists of natural ore containing fluorescent willemite which responds to ultraviolet light generated by inexpensive mineral-prospecting lamps (24).

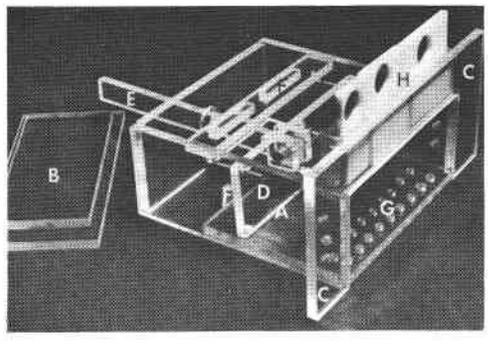
Shooting Elk

Looking for a method to immobilize elk? If so, try dry powder charges of succinylcholine chloride. Wildlife biologists Richard J. Pedersen and Jack Ward Thomas applied this method to 78 Rocky Mountain elk (*Cervus canadensis nelsoni*). The average dosage was 26.4 mg. It took an average of 7.1 minutes before the drug took effect and the drug lasted an average of 24.5 minutes (25).

Photographing Fish

Estimating the dry weight of live, unanesthetized fish can be done photographically. Photographic recording reduces the amount of stress suffered by the fish and makes it unnecessary to use anesthetics.

Fish are slippery creatures and it's generally difficult to get a good side view. To accomplish this task, PNW researcher Clifford L. Hawkes has built an adjustable plexiglass holding device which fits on the inside of an aquarium. Electronic flash at 1/1000 of a second is used to eliminate any movement problems not handled by the holding device.



From this point on, the process becomes a little complicated and it would be best to get a copy of Hawkes' paper which includes a discussion of film and processing techniques and the equations used to establish the weight values.

This technique of photographically measuring fish, constructing regression equations and subsequently measuring live, experimental fish is valuable for stress studies on fish growth where handling must be reduced to a minimum (26).

Double Agent HSUSX

In 1972, Franklin Ward and John D. Dell adapted a hydraulic seeder for use with fire retardants. They tested a Finn Super 1000 Hydroseeder Model HSUSX and found it useful for the general application of retardants as well as for the treatment of areas on steep cutbanks located above roads (27).

A Handy-Dandy Seed Cleaner

Robert F. Woollard and Roy R. Silen have developed an all-pneumatic laboratory seed cleaner using simple equipment such as plexiglass tubing, a vacuum cleaner regulated by a laboratory rheostat and a 1-quart seed container.

This device was developed because of the need for a convenient, compact, gentle seed cleaning apparatus for small seed lots of various species.

The two-staged aspirator used for seed cleaning is constructed from large diameter plexiglass tubing. A blower is mounted on top of the aspirator and a vacuum cleaner is connected at the bottom.

Prior to cleaning, all large debris is removed for the seed sample by screening through a ½-inch wire screen. Seed wings are removed by hand and the seeds are then placed in the aspirator. The entire process for a quart-sized lot of seeds requires from 1-3 minutes (28).

A Seed Extractor

Researchers in Alaska needed a compact seed extractor that could be stowed away when not in use. Finding none on the market, they designed and built one. It has a capacity of one-half bushel of dry cones, is simple, sturdy, and can be built in a few hours.

The extractor consists of a plywood box cut in two and hinged to provide a deep lid and fitted with a revolving drum and a removable drawer. It is powered by a ¼-horsepower electric motor, belted through two pairs of pulleys and an idler shaft to provide a drum speed of 60 r.p.m. At greater speeds, centrifugal force prevents cones from tumbling properly.

A list of materials is included. Cost of the materials was about $75. See *A Compact Laboratory Seed Extractor,* by A.S. Harris (29).

Symbolic Plants

Look no further for an easy, failsafe method of representing plants by symbols. In 1967, the PNW Station printed the third edition of *Northwest Range Plant Symbols* (30). This book-sized publication has been so popular that a fourth edition has been printed.

Northwest Range Plant Symbols uses a fairly easy system for the identification of plants occurring in Washington, Oregon, and Idaho. The first two letters of the Latin genus and species name are combined to form a symbol. Thus, fairway crested wheatgrass, also known as *Agropyron cristatum,* becomes AGCR.

The alpha-numerical code takes no more than six spaces. This simplifies the transfer of data from field sheets to punch cards. The system was originally devised before the widescale use of alpha codes. For this reason each plant is also listed with a numerical code.

The system is widely used throughout the three state area and has been adapted for other areas. As a spin-off, George Garrison, who led the effort to develop the symbol system, says that the publication is one of the best things to happen to the biological secretary. Miss, Ms., or sometimes Mr. Jones can now translate *Epilobium alpimum gracillium* into alpine willow herb.

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