# Hardwood Silviculture Cooperative

## Annual Report 1991-1992

**Staff**

David E. Hibbs

Assistant Professor

Program Leader

Glenn R. Ahrens

Research Assistant

Peter A. Giordano

Research Assistant

Department of Forest Science

Peavy Hall 154

Oregon State University

Corvallis, OR 97331-5705

(503) 737-2244

## Highlights of 1991-1992

- Effort was concentrated on Alder Stand Management Study installations. Six new Type 2 installations were planted. The first set of permanent growth and yield plots was installed on a Type 2 installation site. .

- A report titled "Lumber grade recovery from red alder logs: effects of stand characteristics and individual tree growth rates" was prepared, summarizing results of our cooperative effort with the PNW Station Timber Quality Research Group.

- Dave Hibbs spent the year in France working with a series of alder provenance trials that are now eight years old. Dave, along with Dean DeBell, has also been busy with review and editing of chapters for the new red alder book which will be produced in conjunction a symposium on the "Biology and Management of Alder" (November 1992).

- Two chapters for the "Biology and Management of Alder" book were prepared by the HSC: "Alder seedling production and nursery practices" and "Synthesis".

- In conjuction with a meeting of the Technical Committee, a field tour was conducted on alder plantation and thinning study plots established by Weyerhaeuser Co. on their Twin Harbors tree farm.

## Contents

## Introduction

This report summarizes the activities of the Hardwood Silviculture Cooperative (HSC) during its fifth year of existence. Red alder is still the species of primary interest to the Cooperative, with emphasis on timber production and on the use of alder as an alternative species in areas infected by Phellinus root rot.

The Red Alder Stand Management Study continues as the HSC highest priority research project. Our efforts are focused on establishment and maintenance of Type 2 (new plantation) installations. We also spent substantial effort working with Cooperators and consulting with technical advisors to reassess our minimum database goals and ensure the capability of the Cooperative to meet these goals.

The effects of management on Alder Wood Quality and Stem Form is the HSC's second priority topic for research. We have summarized the results of our first effort on this topic: " Effects of stand characteristics and tree growth rate on lumber grade recovery in red alder". We are planning further study in managed stands to examine effects of spacing on crown characteristics and branch mortality.

The following report provides a more detailed review of our progress in these two major research areas. Related research by HSC Staff on alder and other hardwoods is also reviewed. In addition, the activities of our Policy and Technical Committees are summarized.

## Organizational Activities

### Policy Committee meeting - June 1991

At our June meeting (Peavy Hall, OSU College of Forestry, Corvallis), the Policy Committee reviewed progress reports on the Stand Management Study and the Stem Form and Wood Quality Study. Glenn Ahrens gave a summary of future direction and expected products in each area of study. For the Stand Management Study, we were to concentrate on: 1) installation establishment and maintenance, 2) publication and technology transfer of guidelines for successful regeneration and nursery practices, and 3) synthesis of information from existing alder spacing studies. For the Wood Quality Study: proceed with reporting on the lumber recovery study and refine plans to study crown characteristics and branch mortality in managed stands.

After some discussion the Committee also recommended that HSC Staff:
1) Reassess minimum database goals, determine our maximum capability for plot establishment, and clarify each Cooperator's long term interest in alder silviculture.
2) Develop a protocol for smaller (partial) Type 2 installations,
3) Estimate sampling needs and costs for soil analysis to address questions about the effect of successive alder crops on site productivity for alder.

The meeting concluded with review and approval of the annual budget.

### Technical Committee meeting - November 1991

The Technical Committee met on November 18 at the PNW Research Station in Olympia, Washington. Minimum goals for the alder plot database were

set at 30 Type 2 installations which is within the range of our capability. Smaller (partial) Type 2 installations will be considered supplemental to our goal of 30 full installations.

The Committee agreed that we need a protocol for monitoring and documentation of other vegetation developing in test plantations. We will formalize a protocol employing ocular estimates of cover by species/layer, along with some photography to document early site conditions.

Individual Cooperators expressed interest in characterization of soil properties on alder test platntations. The Committee agreed that the HSC cannot concentrate research on soil properties. We will monitor research by other agencies and be alert to opportunities to cooperate with scientists interesed in effects of alder on soil properties.

The business meeting was followed by an education session. Glenn Ahrens summarized some 4th-year results from alder spacing studies on 4 sites in the Oregon Coast Range. Glenn also reviewed the history and performance of alder plantations on Phellinus sites in Oregon.

On November 19, Committee members were given a tour of two alder plantations and a set of thinning study plots, all installed by Weyerhaueser Co. researchers.

## Cooperative Research

## Alder Stand Mangement Study

The primary goal of this study is to produce a permanent-plot database for predicting growth and yield in managed stands of red alder. After four year we have a total of 17 permanent plot installation sites in progress (see Tables 1 and 2).

While plot installation is the most urgent priority, it will be many years before growth and yield information is provided by new plots. In the interim, we are learning a great deal about seedling production, regeneration, and site quality evaluation across the diversity of Cooperator environments. Our report titled "Red alder: guidelines for successful regeneration" is available in publication form. A chapter titled "Seedling production and nursery practices" has been prepared for the "Biology and Management of Alder" book/symposium organized by Dave Hibbs and Dean DeBell.

We are working on a report summarizing results from several alder spacing studies that have been established in the Oregon Coast Range. Preliminary results were reported at the Technical Committee Meeting last November. A significant finding was that **maximum** height and diameter growth and optimum stem form occur at intermediate densitiies of 1,000-3,000 trees per hectare (Figure 1). At low densities (<600 tph), stem growth and quality are often reduced by competing vegetation, animal damage, growth allocation to branches, and wind exposure.

Using information from these and other existing studies of alder spacing, we are in the process of testing diameter and height growth predictions using various quantitative model forms. We are exploring both individual-tree and stand level modeling approaches, in consultation with other modeling groups at the OSU College of Forestery (CRAFTS and David Hann's group).

Preliminary results of this modeling work stress the need for better characterization of individual tree crowns in order to predict tree growth. Crown information will also be important for assessing impacts of silviculture on wood quality. Further development of our protocol for measuring crown attributes on permanent installations should be given high priority.

Table 1. Red alder stand management study installations.

**Type 1 installations**

| Installation[1] # | Year | Region[2] | Location | Cooperator |
|---|---|---|---|---|
| **Established installations** | | | | |
| 4101 | 1989 | 4 | Seshelt, B.C. | B.C. Ministry of Forests |
| 2101 | 1990 | 2 | Beaver, OR | Siuslaw National Forest |
| 4102 | 1991 | 4 | Sedro Woolley, WA | Washington DNR |
| **Potential installations** | | | | |
| 2102 | 1993 | 2 | Coos Bay, OR | Diamond Wood Prod. |
| 4103 | 199? | 4 | B.C. Mainland | B.C. Ministry of Forests |

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**Type 2 installations**

| Installation # | Year | Region | Location | Cooperator |
|---|---|---|---|---|
| **Established or planted installations** | | | | |
| 4201 | 1989 | 4 | Sedro Woolley, WA | Goodyear Nelson Hardwood Lumber Co. |
| 4202 | 1990 | 4 | Sedro Woolley, WA | Goodyear Nelson Hardwood Lumber Co. |
| 3201 | 1990 | 3 | Philomath, OR | Siuslaw National Forest |

Table 1 (cont.) Red alder stand management study installations.

| | | | | |
|---|---|---|---|---|
| 3202 | 1990 | 3 | Longview, WA | Weyerhaeuser Company |
| 2201 | 1990 | 2 | Aberdeen, WA | Weyerhaeuser Company |
| 5201 | 1990 | 5 | Packwood, WA | Gifford Pinchot Natl. Forest |
| 1201 | 1991 | 1 | Forks, WA | Washington DNR |
| 2202 | 1991 | 2 | Hebo, OR | Siuslaw National Forest |
| 2203 | 1992 | 2 | Toledo, OR | Diamond Wood Products |
| 3203 | 1992 | 3 | Sitkum, OR | Diamond Wood Products |
| 3204 | 1992 | 3 | Yachats, OR | Siuslaw National Forest |
| 3205 | 1992 | 3 | Apiary, OR | Oregon Dept. of Forestry |
| 5202 | 1992 | 5 | Randle, WA | Gifford Pinchot Natl. Forest |
| 5203 | 1992 | 5 | Sandy, OR | Bureau of Land Mangement |

**Potential installations**

| | | | | |
|---|---|---|---|---|
| 4203 | 1993 | 4 | B.C. Vancouver Is. | B.C. Ministry of Forests |
| 4204 | 1993 | 4 | B.C. Vancouver Is. | B.C. Ministry of Forests |
| 3206 | 1993 | 3 | Yamhill, OR | Bureau of Land Management |
| 2204 | 1993 | 2 | Florence, OR | Siuslaw National Forest |
| 3207 | 1994 | 3 | Coos Bay, OR | Bureau of Land Management |
| 6201 | 1994 | 6 | Olympia, WA | Washington DNR |
| 4205 | 1994 | 4 | Sedro Woolley, WA | Goodyear Nelson |

[1] Installation # 1st digit=Region, 2nd digit=installation Type

3rd and 4th digit = number of installation, chronological order of establishment within Region and Type

[2] Physiographic regions of the Pacific Northwest:

1 - Sitka spruce zone north of the Olympic Penninsula

2 - Sitka spruce zone south of the Olympic Penninsula

3 - Coast Ranges, Oregon and Washington

4 - North Cascade foothills and B.C. Coast Ranges

5 - South Cascade foothills

6 - Puget Sound glacial trough

## Alder Wood Quality and Stem Form

We have two goals for our Alder Wood Quality and Stem Form project: 1) to provide immediate information about the effects of stand management on wood quality; and 2) to guide our future work on this topic on permanent plot installations in the Stand Management Study. These goals have been pursued in two separate studies.

**Lumber recovery study** - We supplemented the work of the PNW Timber Quality Project on their study of lumber volume and grade recovery from natural stands of alder in northwest Washington. The PNW project's primary objective was to characterize lumber recovery as a function of log diameter; repeating a similar study conducted in northwest Oregon. Our effort was to assist in stand and tree selection and sampling in order to 1) evaluate effects of tree and stand characteristicss on volume and grade recovery; 2) examine effects of individual tree growth rate on lumber quality recovery; and 3) examine relationships between juvenile growth attributes and characteristics of merchantable sized trees. A report of the results has been distributed to Cooperative members; a brief summary is given below.

Both the Oregon and Washington studies showed an increase in wood quality as a function of log diameter . However, further analysis of the Washington data shows that differences in wood quality between logs were explained more by the position of the log in the tree (Figure 1). Lumber from butt

logs was more valuable than that from other logs. After accounting for the effect of log position, log diameter explained only 4% of the variation in lumber value ($/MBF lumber) in butt logs. For logs above the butt log, diameter explained 12% of the variation in value.

By sampling similar diameter classes in stands of various ages, we succeeded in providing a wide range of tree growth rates within a given diameter class. Table 2 shows regression equations expressing relationships between wood quality variables, diameter, and juvenile growth rates. For butt logs, juvenile growth rate accounted for 7 to 10% of the variation in wood quality in addition to the variation explained by diameter. Decreases in lumber value and recovery of higher grades were associated with more rapid growth from age 15 to 25. We would expect this result since faster growth should be related to larger crowns and branches. However, faster growth after age 25 was associated with increases in wood value. Wood quality in logs above the butt was not related to juvenile growth rate.

Though log diameter and growth rate had significant effects on wood quality, a relatively large amount of variation was not explained by any tree or stand characteristics. For instance, many trees with fast juvenile growth had high lumber values. Thus under some conditions, management for faster growth rates may not greatly impact wood quality. This stresses the importance of more detailed and controlled studies of the mechanisms determining wood quality (eg. crown development and self-pruning), particularly at managed-stand spacings.

Table 2. Regression equations for lumber value and percent recovery of high grade lumber from butt logs as a function of log diameter and juvenile growth rates.

| Equation | $R^2$ |
|---|---|
| VALMBF = 677-1,217*(1/DIA)-.406*(BAGR1525)+.341*(BAGR25) | .146 |
| partial $R^2$ (.045) (.030) (.071) | |
| PCT1BET = 92-323*(1/DIA)-0.55*(BAGR1525)+.038*(BAGR25) | .193 |
| partial $R^2$ (.126) (.031) (.036) | |

VALMBF = Value of lumber in $ per 1,000 board feet of lumber sawn
PCT1BET = Percent recovery of lumber grade 1 or better

BAGR1525 = Basal area growth at top of first log (22 feet) in sq.cm.; growth from age 15 to 25.
BAGR25 = Basal area growth at top of first log (22 feet) in sq.cm.; growth from age 25 to 30.

**Tree growth and self-pruning as a function of spacing -** Our plan is to sample trees on existing spacing studies to examine relationships between spacing and tree growth, growth allocation, crown dynamics, and stem form. We are organizing a collective effort (HSC, PNW Station) to destructively sample trees from an old spacing study on the Pilchuck Tree Farm in northwest Washington. The primary objectives for this work are to 1) reconstruct and quantify wood quality related characteristics of trees grown at different spacings; and 2) test stem analysis and crown reconstruction methods to help estimate feasibility of further destructive and/or non-destructive sampling on other long-term spacing study

plots.

Progress on our plans for more intensive study of replicated plots is dependent on additional funding. There is a high probability of acquiring additional funding for this topic as part of the PNW Station's "Hardwood utilization research and demnstration project" currently funded for 1992.

# Other Applied Research

## Alder Provenance Trials in France

In 1987, Alan Ager at the University of Washington completed a PhD thesis on the genetics of red alder. He had collected seed along the elevation gradient of 4 Pacific Northwest river systems. He established two provenance trials with this seed in Washington and reported on the phenotypic and genotypic characteristics of these trials after 3 years of growth. The French Institut de la Recherche Agronomique used the same sampling design to collect red alder seed in the PNW and used the seed to establish four provenance trials in France. At the end of the 1991 growing season, two trials were 7 years old, two were 8 years old. David Hibbs has been in France since July of 1991, collecting and analyzing the last year's growth data. While the analysis is not yet complete (mid March, 1992), the following is a qualitative report of the trends so far observed. Ultimately, a synthesis of the results of these two studies with the several other studies of alder genetics will provide a sound basis for genetic decisions on seed sources and seed

movement between seed zones.

**Growth**

At the time of plantation establishment, several fungal diseases were found on the seedlings and caused high levels of mortality at some sites before plantations could be treated with fungicides. Septoria was the most common problem. The records do not show if sun scald was a problem at the time of plantation establishment, but it was apparent in 1991 at all sites. It is most common where patches of mortality had opened holes in the stand canopy. It was also common on 33 foot tall trees in one plantation that was thinned at age 7. Problems with Frankia have been identified at some sites. France does not generally have an endemic population of the right kind of Frankia for red alder. Thus, in France even more so than the PNW, nursery inoculation is important. Growth on the best provenances and in France was comparable to good growth in the PNW (SI20 of about 65 feet). The better provenances on the better site averaged 0.5 inches of diameter growth a year for 8 years at a density of 1200 tpa. The three sites with a high clay content showed less growth than the sandy site. Soil and climate factors were quite different from the PNW. Soils at all four sites were high in calcium (high pH); precipitation was fairly even throughout the year. Better growth than that observed at the four test sites is probably possible; none of the four would be characterized as good alder sites in the PNW. On medium and better quality sites, red alder out-grew the native black alder (A. glutinosa).

**Genetics**

Large differences in growth were found between the four seed-source rivers:

Santiam, Nisqually, Hoh and Nooksack. Within a river system, there were relatively small differences between seed source locations but larger difference among parent trees within each seed-source location. Preliminary heritability calculations have shown a higher heritability for height than for diameter.

**Geographic and climate trends**

Among the four rivers, seed sources from the Hoh River had the largest average size. There was a trend in size with elevation in the Santiam and Nooksack rivers, with larger trees coming from lower elevations. Care is needed in interpreting this last observation because there also was a high level of variation in size at low elevations. At the two more continental plantation sites, sources from the Hoh river, the most coastal of the seed sources, were largest. At the two more coastally-influenced planting sites, sources from the Nisqually and Nooksack Rivers were largest. Sources from the Santiam, the most southerly river, were among the smallest at all four test sites.

**Conclusions**

The results so far are too incomplete to draw any hard conclusions; these will have to wait for the complete analysis. It is interesting, however, to ponder why the Hoh river sources have done so well at the two inland sites; frost damage was a potentially severe problem. Cold air drainage from the coldest of the two was good at the time of plantation establishment, but winter temperatures go down to near 0o F. This success may rekindle some old discussions of the value and safety of moving coastal sources inland in the PNW.

The French alder program has been evolving slowly since the provenance trials

were established. The most recent red alder trials have been in mixtures with cherry. These trials reflect interests in increased site productivity through nitrogen fixation and in forest diversity, two interests that have strong parallels in the PNW.

## Riparian Zone Management Study

Management of vegetation in riparian zones may increase their effectiveness for maintaining fish, wildlife and water quality resources while utilizing the timber resource. As part of the COPE (Coastal Oregon Productivity Enhancement) program, several investigators, led by David Hibbs, have begun a 6-year study of the dynamics of riparian areas with an emphasis on exploring management alternatives for optimizing the many riparian resources. The study is divided into 3 parts. These are:

1. A chronosequence examination of buffer strip conditions in relation to management activities, geography, and vegetation characteristics.

2. Development of tree regeneration systems through the use of replicated seedling trials with several levels of overstory and understory manipulation levels.

3. Development of a methodology for decisions concerning management for diversity and optimization of resource values.

For the chronosequence study, ninety-seven study sites were sampled over the last two years. A total of 28 conifer seedlings were found on red alder study sites compared to 617 seedlings on conifer-dominated study sites. Shrub cover averaged 99% for red alder-dominated sites. Red alder cover averaged 72% at sites on terraces, and 59% at sites on slopes. In conjunction with the chronosequence study of buffer strips, several permanent sample sites have been established. Both sites are within the Nestucca River drainage; one is hardwood-dominated and one is conifer-dominated. Overstory and understory vegetation, woody debris, topography, and stream characteristics are being mapped in order to provide additional information about vegetation dynamics in buffer strips over time.

Two study sites have been installed for examination of tree regeneration systems with overstory and understory manipulation. One site is located on Indian Creek several miles upstream from the Siuslaw River. The second site has been located on a tributary to the upper Little Nestucca River.

Plans for the future include:

1. Continued sampling of buffer strips for the chronosequence.

2. Establishment of several additional permanent reference sites in a variety of overstory types.

3. Measurement of seedling performance and environmental conditions at both regeneration study 2 sites

## Cottonwood Clones in the Willamette Valley

The OSU College of Forestry has funded a project involving clonal evaluation and growth and yield trials with various black cottonwood*eastern cottonwood hybrids. The project is led by David Hibbs. Planting stock has been donated by Paul heilman and the James River Corporation. The planting site is on sandy loam and has been fenced to reduce deer damage. Four clones are planted in large growth and yield plots that include three different spacings; an additional 22 clones are planted in smaller clone-evaluation plots.

First-year results have been promising. Survival of growth and yield clones ranged from 80 to 95%. Height growth ranged from 2-3 meters. Survival for trees in the clonal evaluation plots ranged from 33 to 100% with an average of 80%. Height growth averaged 2 meters.

One of the major hinderances to cottonwood culture in the southern Willamette valley has been the abundance of clay soils. In order to test the ability of these hybrid poplar clones on clay soils, a similar plantation has been established on a local landowners property. The plantation is similar in design to the original OSU plantation and should yield important information about the growth of hybrid cottonwood on these prevalent clay soil types.

## Basic Research

Basic research explores fundamental principles pertinent to hardwood silviculture. These studies provide a basis for future applied research, ideally leading to innovative technology and better management. Most basic research is

conducted by graduate students with funding from outside the HSC, although Cooperator participation is encouraged. Current basic research projects conducted by graduate students associated with the Cooperative are listed in Table 3.

Table 3. Research projects of graduate students.

| Student | Degree | Project description | Study location | Expected completion |
|---|---|---|---|---|
| Cynthia Froyd | M.S. | Growth and vegetation dynamics in riparian buffer strips dominated by red alder | W. Oregon | 9/92 |
| Reed Perkins | Ph.D. | ?????????????????? | W. Oregon | 6/94 |

In conjunction with various co-authors, Klaus Puettmann has written three manuscripts from his thesis work on modeling with the existing alder database:

Puettmann, K.J., D.S. DeBell, and D. E. Hibbs. Density management guide for red alder.

Puettmann, K.J., D. Hann, and D.E. Hibbs. Development and comparison of size-density for red alder and Douglas-fir stands.

Puettmann, K.J., D.E. Hibbs, and D. Hann. Extending the size density analysis to mixed species populations and investigation of underlying dynamics using red alder and Douglas-fir stands.

Peter Giordano and David Hibbs have prepared a manuscript based on Peter's thesis on the Cascade Head alder density study:

P.A. Giordano and D.E. Hibbs. Morphological response to competition in red alder: the role of water.

## Educational Activities

### Reports

The Cooperative produces reports and other documents for its members. A preliminary report titled "Effects of stand characteristics and tree growth rate on lumber grade recovery in red alder" was prepared. Three other reports/publications are in preparation:

"Seedling production and nursery practices for red alder"

"Preliminary model forms for predicting growth and yield in managed stands of red alder: diameter growth equations."

"Growth of 5-year-old red alder in response to interacting effects of stand density and competing vegetation."

### Books

With assistance from Dean DeBell, David Hibbs is reviewing and editing

21 chapters for a book tentatively titled "The Biology and Management of Red Alder". This work is in conjunction with the organization of a symposium of the same name to be held November 1992.

**Presentations**

Hardwood management issues. Glenn R. Ahrens. Oregon Hardwood Symposium. Creswell, OR. October 4, 1991.

Effects of spacing and vegetation control on 4-year-old alder in the Oregon Coast Range. Glenn R. Ahrens. Hardwood Silviculture Cooperative, Technical Committee meeting. Olympia, WA. November 18, 1991.

History and performance of alder plantations on Phellinus sites in Oregon. Glenn R. Ahrens. Hardwood Silviculture Cooperative, Technical Committee meeting. Olympia, WA. November 18, 1991.

Hardwood management. Glenn R. Ahrens. Master Woodland Manager workshop. Corvallis, OR. February 22, 1992.

Managing hardwoods. Glenn R. Ahrens. Small woodland stewardship. Annual meeting, Oregon small woodlands association. Eugene, OR. April 2, 1992.

Managing and growing hardwood stands. Glenn R. Ahrens. New opportunities in hardwood forestry. Annual workshop, Coos Chapter, Society of American

Foresters.

Alder plantation management on sites infected with Phellinus. Glenn R. Ahrens. Oregon Department of Forestry, Annual Reforestation Conference. Astoria, OR. June 2, 1992.

## Directions for 1992-1993

Establish one Type 1 and four Type 2 installations for the Stand Mangement Study. Continue reconnaisance and site selection for future installations.

Remeasure permanent plots in one Type 1 installation. Install permanent plots in two Type 2 installations.

Publish reports: "Effects of stand characteristics and tree growth rate on lumber grade recovery in red alder" and "Seedling production and nursery practices for red alder".

Prepare reports: "Preliminary model forms for predicting growth and yield in managed stands of red alder: diameter growth equations."
"Growth of 5-year-old red alder in response to interacting effects of stand density and competing vegetation."

Finish drafting new book on red alder in conjunction with the symposium:

"Biology and management of alder" (November 1992).

Begin second phase of Alder Wood Quality and Stem Form study.

Continue growth of the Cooperative.

## Appendix 1: Publications

Ahrens, G.R., A. Dobkowski, and D.E. Hibbs. 1992. Red alder: guidelines for successful regeneration. Forest Research Laboratory, Special Publication #24, Oregon State University, Corvallis. 24 p.

Leidholt-Bruner, K., D.E. Hibbs, and W.C. McComb. 1992. Beaver dam locations and their effects on distribution and abundance of coho salmon fry in two coastal Oregon streams. NW Science in press.

Puettmann, K.J., D.E. Hibbs, and D.W. Hann. 1992. Extending the size-density analysis to misced species populations and investigation of underlying dynamics using red alder and Douglas-fir stands. J. of Ecol. In press.

Puettmann, K.J., D.W. Hann, and D.E. Hibbs. 1992. Development and comparison of size density for red alder and Douglas-fir stands. Forest Science. Accepted for publication.

Submitted for publication:

Puettmann, K.J., D.S. DeBell, and D.E. Hibbs. Density managment guide for red alder. Special Publication, Forest Research Laboratory, Oregon State Universtiy, Corvallis.

Giordano, P.A. and D.E. Hibbs. Morphological response to competition in red alder: the role of water. Submitted to Functional Ecology.

## Appendix 2: Financial Support Received in 1991-1992

| Cooperator | Support |
|---|---|
| Bureau of Land Management | $5,000 |
| British Columbia forest Service | 5,000 |
| Diamond Wood Products, Inc. | 3,000 |
| Gifford Pinchot National Forest | 5,000 |
| Oregon Department of Forestry | 5,000 |
| Siuslaw National Forest | 5,000 |
| Goodyear-Nelson Hardwood Lumber Co. | 3,000 |
| University of Washington[1] | - |
| USDA Forest Service Pacific Northwest Research Station[1] | - |
| Washington Department of Natural Resources | 5,000 |
| Weyerhaeuser Company | 5,000 |
| Subtotal | 41,000 |
| Forest Research Laboratory, OSU | 46,388 |
| Total | $87,388 |

[1] In-kind contributions.