FOREST RESEARCH LABORATORY
OREGON STATE UNIVERSITY

CRAFTS

Annual Report 1986-87

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CRAFTS

Coordinated Research On Alternative Forestry Treatments & Systems

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CRAFTS HIGHLIGHTS

This report covers the seventh year of activity by the CRAFTS program on forest vegetation management. Highlights of this past year include:

- The degree of overtopping prior to treatment was found to influence Douglas-fir response to competition release in the Coast Range.
- The effectiveness of several herbicides and manual cutting was examined for bigleaf maple control.
- The effect of bigleaf maple sprout clumps on Douglas-fir wood yield is being determined.
- A compendium of abstracts on issues pertaining to the use of prescribed fire in Pacific Northwest forests was completed.
- A diagnostic model for predicting the influence of competitors on Douglas-fir will be constructed.
- First-year report on development of a competition index for the Siuslaw National Forest has been completed.
- A poster describing CRAFTS organization and activities was prepared and displayed at several locations.
- Six CRAFTS Policy, Technical, or subcommittee meetings were held to develop research direction and experimental approaches for the Cooperative.
- Several CRAFTS Technical reports were prepared and distributed. A vegetation management field trip was co-sponsored by CRAFTS and the Weyerhaeuser Company for the Cooperative membership.

INTRODUCTION

The purpose of the CRAFTS program is to provide leadership and direction within the discipline of forest vegetation management. The Cooperative also provides information to its members and others about such management in the Pacific Northwest. CRAFTS initiates research in young conifer plantations and conducts educational activities at Oregon State University. A forum for research coordination and information exchange among participating organizations is also provided.

The 1986-87 period was productive for the Cooperative. A new five-year plan was developed and adopted by the CRAFTS Policy Committee. Several new projects were established, while others are nearing completion. It was decided that CRAFTS should undertake the development of a region-wide diagnostic model for predicting the influence of competing vegetation on young Douglas-fir. Outside funding was obtained that augmented the commitment already made by CRAFTS for this project. Work should begin on the model by summer, 1987.

The publication of an annotated bibliography on prescribed fire was completed during 1986-87. This was a successful short-term project that was accomplished in response to Cooperator needs. Because of its success, other short-term projects of similar nature will be developed when appropriate.

One of the ways the Cooperative accomplishes its informational and leadership goals is through research. This research is conducted under the guidelines outlined in our updated prospectus, and through consultation with the Policy and Technical Committees of the Cooperative. The degree to which members participate in the research varies according to the type of study. The three types of studies in the Cooperative are *applied*, *adaptive*, and *basic*.

APPLIED RESEARCH

Applied studies are developed and funded directly by the Cooperative. These studies assess methods for suppressing competing vegetation through site preparation and competition release. The causes for the response of brush, trees, and herbaceous plants to these treatments also are determined.

Coast Range Competition Release Study

In 1987 the Coast Range competition release study will complete the fifth year since application of treatments. Third-year trends in Douglas-fir growth and survival were summarized in a recent technical report. Analysis of treatment means found that increased diameter growth relative to the control occurred only with removal of all competing vegetation. Height growth was not increased on any of the treatments.

The low degree of separation in treatment means was related to the level that shrubs and hardwoods were overtopping the Douglas-fir before the treatments were applied. A frequency distribution of the Douglas-fir by level of pretreatment overtopping (Figure 1) demonstrates that nearly half the trees were not overtopped before treatment.

Pretreatment competition level was examined by a comparison of treatments that represented three distinct competitor types:

1) untreated control (shrub/hardwood-dominated community),
2) Roundup® (herb-dominated community), and
3) complete removal (no competing vegetation).

Douglas-fir growth data were divided into three classes based on the degree of pretreatment overtopping: 0-33 percent, 33-66 percent, and 66-100 percent. Figure 2 demonstrates for the 66-100 percent pretreatment overtopped class the effect of the three treatments on subsequent overtopping of Douglas-fir by shrubs or hardwoods. Large reductions in overtopping resulted from both the complete removal and Roundup® treatments. When pretreatment overtopping was less than 66 percent, only the complete removal treatment markedly reduced the subsequent overtopping of Douglas-fir.

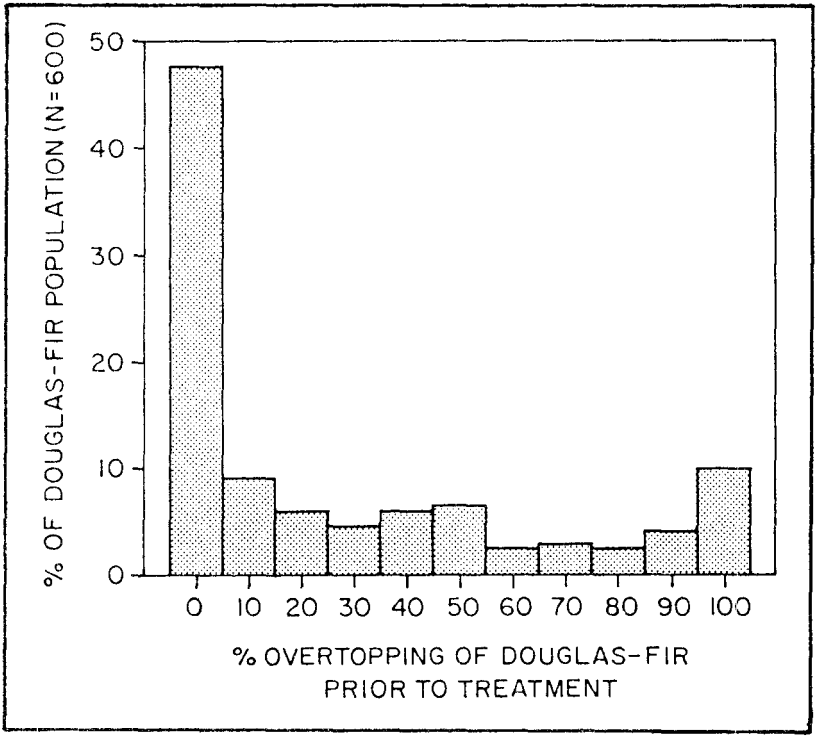

Figure 1. Frequency distribution of Douglas-fir by level of hardwood/ shrub overtopping prior to treatment. Overtopping estimates are based on 60° inverted cone projections from the base of Douglas-fir current-year height growth.

To quantify the effects of overtopping on Douglas-fir growth, stem diameter and height increment values were adjusted for pretreatment Douglas-fir size and averaged for the three classes of pretreatment overtopping. Figures 3a and 3b show the trends in Douglas-fir growth increment after adjustment for pretreatment size for 66-100 percent pretreatment overtopping class. Both the complete removal and Roundup® treatments resulted in increased diameter increment (Figure 3a) and height increment (Figure 3b) relative to the untreated control, if the trees were overtopped prior to the treatments. For levels of pretreatment overtopping that were less than 66 percent, only the complete removal treatment caused increases in Douglas-fir growth increment.

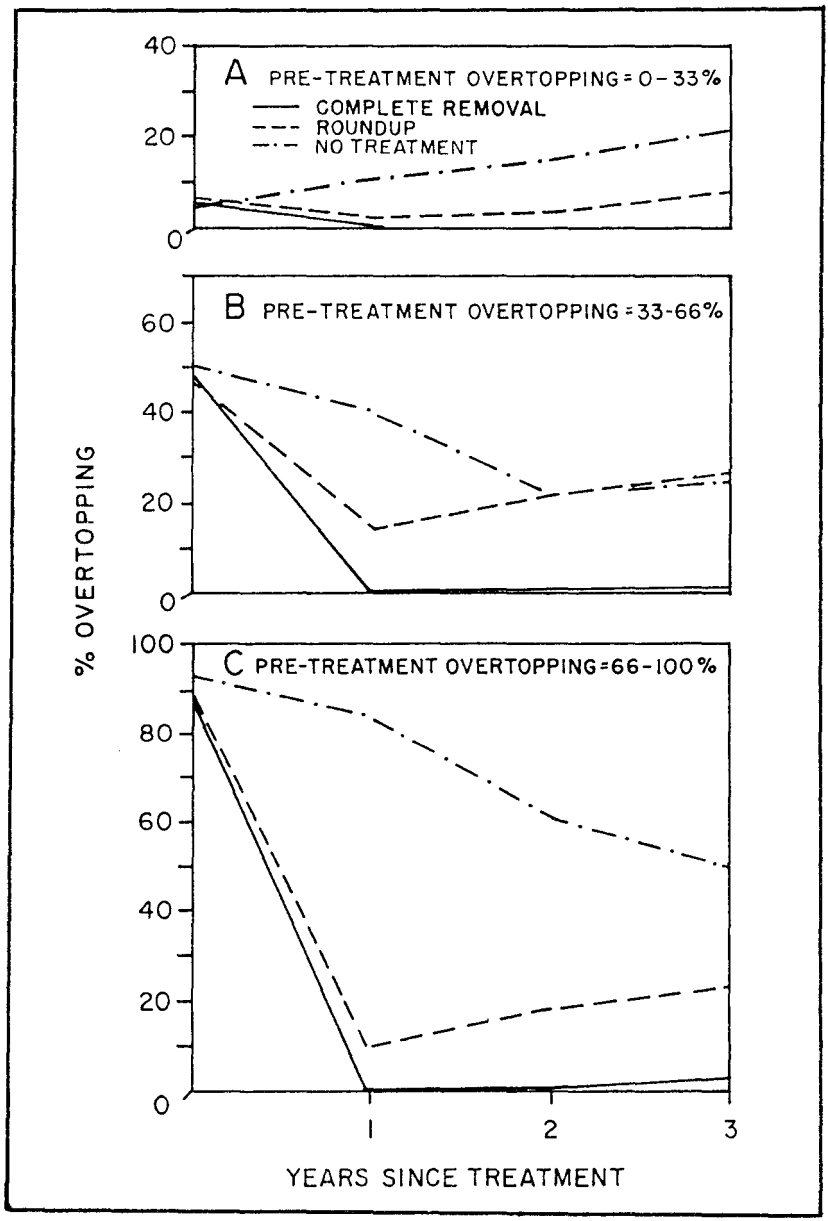

Figure 2. Effects of three treatments on percent overtopping of Douglas-fir for three pretreatment overtopping levels: (a) 0-33 percent, (b) 33-66 percent, and (c) 66 to 100 percent. Standard error bars are included.

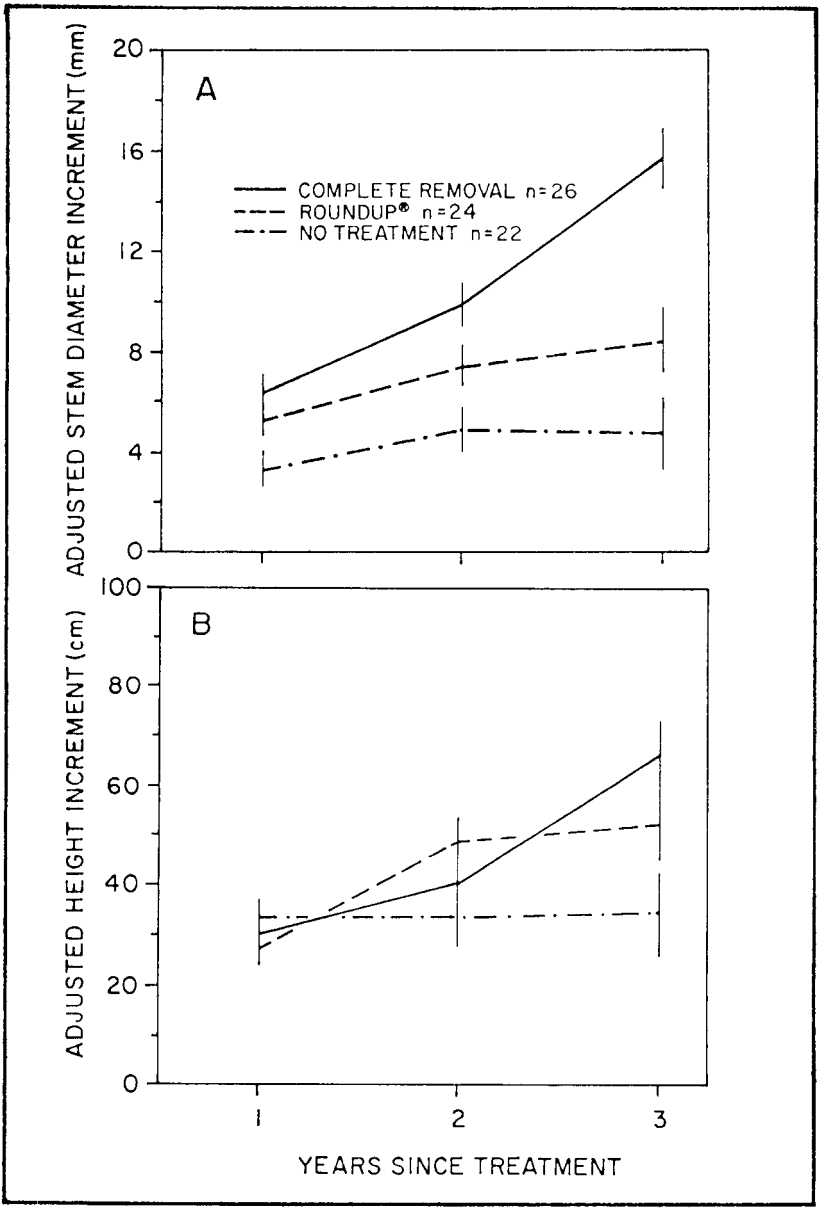

Figure 3. Effects of three treatments on Douglas-fir stem diameter increment (a) and height increment (b) for pretreatment overtopping levels ranging from 66 to 100 percent. Means with standard error bars have been adjusted for pretreatment Douglas-fir size.

The Coast Range study has provided insight into the mechanisms of competition release for Douglas-fir. To yield a positive growth response for Douglas-fir in the Coast Range, a competition-release treatment must reduce the degree of overtopping by surrounding shrub and hardwood vegetation. Increased Douglas-fir growth from competition release was greatest when overtopping exceeded a threshold value (66 percent) prior to the treatment and when both shrub and herb cover was reduced. Removal of shrub and hardwood competitors, such as with the Roundup® treatment, increased Douglas-fir growth only when the trees were overtopped before the treatment. Additional gains in Douglas-fir growth resulted when herbaceous vegetation was removed, probably because of increased soil water availability.

Measurements of Douglas-fir xylem potential have provided evidence that soil water availability in the Coast Range is a function of vegetation abundance. On the untreated control, Roundup®, and complete removal treatments, Douglas-fir pre-dawn xylem potential was measured during the period of maximum summer drought (August) in 1985 and 1986. Since plant xylem potential is generally in equilibrium with soil water potential just prior to sunrise, pre-dawn measurement of xylem potential provides an accurate assessment of soil water availability. Using regression analysis, a model was developed that explained 69 percent of the variation in Douglas-fir xylem potential. The most important factor, latitude, accounted for 41 percent of the variation. Latitude quantifies the regional variation in summer drought among the six study sites that range from Forks, Washington to Coos Bay, Oregon. A second factor, shrub cover, accounted for an additional 26 percent of the variation in Douglas-fir xylem potential, thus documenting the negative relationship between soil water availability and the level of competing vegetation. Average Douglas-fir stem volume accounted for an additional 2 percent of the variation. Douglas-fir average stem volume adjusted the overall regression relationship for the effect that tree size had on Douglas-fir water stress. When placed under similar conditions, large trees generally demonstrate lower levels of xylem potential than small trees probably because of differences in tree rooting volume, and therefore in their ability to extract soil water.

Comparison of Treatments to Control Bigleaf Maple Sprout Clumps

First-year results were collected from an experiment to compare the efficacy of various treatments to control bigleaf maple sprout clumps in young Douglas-fir plantations. The study was installed in 1985 and 1986 on six sites provided by CRAFTS cooperators in Oregon and Washington. Six herbicides (Garlon 4®, Garlon 3A®, Roundup®, Escort®, Arsenal® and Weedone 170®), were applied at three times of the year, June, August, and February, using four application methods: 1) foliar spray, 2) basal spray, 3) thinline (applied in a thin stream directly to the bark), and 4) cut-surface (applied to the cambium of a freshly cut stem). Manual cutting at three time intervals also was included in this experiment.

The effective crown volume (physical crown volume x percent foliage cover) of each clump was calculated before treatment and at the end of the first growing season after treatment. The percent change in effective crown volume from pretreatment size was used as a measure of treatment efficacy. The most effective treatments (Arsenal® foliage sprays, Garlon 4® thinline, dormant 3 percent Garlon 4® basal spray, late foliar and dormant Weedone 170® basal spray, and manual cutting with Roundup® and Garlon 3A® stump applications) yielded greater than 90 percent reduction in effective crown volume.

Basal sprays of 3 percent Garlon 4® in diesel oil were significantly less effective when applied during the growing season than when clumps were dormant. Full-strength Garlon 4® thinline treatments, however, showed little difference in effectiveness with season of application. A five-fold larger dose of triclopyr with the thinline treatment, relative to the 3 percent basal spray, probably compensated for the sensitivity of clumps to the timing of applications. Foliage sprays of Garlon 4® alone or Garlon 4® and Roundup® mixtures were not effective. Foliage sprays of Escort®, a new herbicide product, also were relatively ineffective.

All clumps that were manually cut sprouted vigorously in the first season after cutting. Clumps were able to regain over half their pretreatment crown volume, and about 75 percent of their

original height. No differences in effectiveness among June, August, or February cutting times were found, suggesting that a season of vulnerability, similar to that discovered for red alder, may not exist for bigleaf maple sprout clumps.

Details of the first-year results from this trial were reported at the March Technical Committee meeting and in a CRAFTS technical report that was distributed this spring. Analysis of Douglas-fir injury and other aspects of treatment effectiveness from the first-year data is underway and will be reported in the coming year. Second-year results from the trial will be collected by cooperators and CRAFTS personnel this summer. Annual measurement of this study is scheduled through the 1988 growing season.

Impacts of Bigleaf Maple Sprout Clumps on Douglas-fir Yield

New research underway by CRAFTS is examining the crown development of bigleaf maple sprout clumps and its effect on surrounding Douglas-fir wood volume through age 60 years. The objective of this study is to quantify the area lost to Douglas-fir wood volume production by a single sprout clump, and using this information to determine the economic thresholds for controlling individual clumps. The study is divided into two phases:

PHASE I: PREDICTING CROWN DEVELOPMENT OF 1- TO 10-YEAR-OLD BIGLEAF MAPLE SPROUT CLUMPS

Since maximum rates of crown development for bigleaf maple sprout clumps probably occur in the first 10 years after cutting, detailed measurements were needed to sample and model this growth stage. We assumed that, through age 10 years, the area lost to Douglas-fir wood volume production from bigleaf maple competition is directly related to the crown area occupied by sprout clumps. Techniques for measuring 1- to 10-year-old sprout clumps were developed by the Technical Committee at its 1986 spring and fall meetings. On a field trip following the October Technical Committee meeting these measurement techniques were reviewed and standardized. Nine CRAFTS cooperators participated in a field training session held at OSU

and at the University's MacDonald Forest: Bureau of Land Management (Coos Bay, Eugene, and Salem Districts), Champion International Corporation, International Paper Company, Lone Rock Timber Company, Oregon Department of Forestry, Washington Department of Natural Resources, and Weyerhaeuser Company.

The participating cooperators identified suitable 1- to 10-year-old bigleaf maple sites and collected growth data. The data set is now complete, and encompasses 19 sites in Oregon and Washington for a total sample size of 346 clumps. A preliminary analysis of the data has yielded multiple regression models that accounted for 81 percent of the variation in bigleaf maple clump height. Important predictors in this model include age, stump height, number of stumps, elevation, and King's site index. An equation predicting crown width accounted for 63 percent of the variation, and the important predictors were age, the sum of stump diameters, stump height, and number of stumps.

The ultimate size of the gap produced in a mature Douglas-fir stand by a bigleaf maple sprout clump may be determined early in stand development. Using data collected in Phase I, bigleaf maple height growth from previous years was reconstructed for individual clumps. The relatively strong relationship between bigleaf maple crown width and height ($r^2 = 0.67$) will be used to develop crown area growth trajectories for individual sprout clumps. These trajectories will be combined into a single growth model for predicting future sprout clump development as a function of site and parent stump factors.

PHASE II: PREDICTING WOOD VOLUME REDUCTIONS IN 10- TO 60-YEAR-OLD DOUGLAS-FIR STANDS FROM SINGLE BIGLEAF MAPLE SPROUT CLUMPS

The second phase of the study will extend the crown area growth curves, developed through age 10 in phase I, into Douglas-fir stands from 10 to 60 years old. The assumption of the study design for phase II is that the land area lost for Douglas-fir wood volume production from the presence of a single bigleaf maple sprout clump can be determined by assessing the wood volume lost at varying distances from the center of a clump.

Ten candidate study sites, ranging in age from 21 to 67 years, have been identified by cooperators in Oregon and Washington this year. These sites represent only two general locations in the region, however, and additional sites are needed. CRAFTS personnel will be searching for sites in the 10- to 60-year age range around the region in the coming year. Candidate sites should contain a minimum of five bigleaf maple sprout clumps that are relatively isolated within Douglas-fir stands. Nearly pure, even-aged Douglas-fir stands with less than five percent of the total basal area in bigleaf maple have proven most desirable. The stands also must be unthinned and must never have received a bigleaf maple control treatment.

A first draft of the experimental design was presented to the CRAFTS Technical Committee and discussed during a field trip to a candidate site at the October meeting. A revised design was developed with the assistance of several members of the Technical Committee and College of Forestry faculty, and presented for approval to the Technical Committee at the March meeting.

The experimental design will utilize variable-radius plots that are systematically placed along transects extending outward from the center of a clump. Douglas-fir basal area will be measured at each plot with a wedge prism. Tarif numbers and volume-basal area ratios that are developed for each stand will be used to determine the wood volume per acre at each plot. Changes in standing Douglas-fir wood volume at various distances from a bigleaf maple clump will be used to determine the effective area lost to wood production for a single clump. Present net worth analysis of the area lost to wood production will be used to assess the economic threshold for controlling individual bigleaf maple sprout clumps.

Bob Wagner and Tim Harrington will be working with cooperators in the coming year to select new sites and collect data from those sites that have been selected.

Prescribed Fire Bibliography

A computer search of pertinent bibliographic catalogues was conducted to obtain a listing of scientific literature on the effects

of prescribed fire in Pacific Northwest forests. Key words denoting important issues in prescribed fire were used to separate the retrieved citations and abstracts into useful categories. The original compendium of abstracts was produced and funded by CRAFTS (Figure 4). It has since been recopied by the Forest Research Laboratory and is offered for sale. The bibliography summarizes the currently available literature on the use and effects of prescribed fire for both slash removal and site preparation.

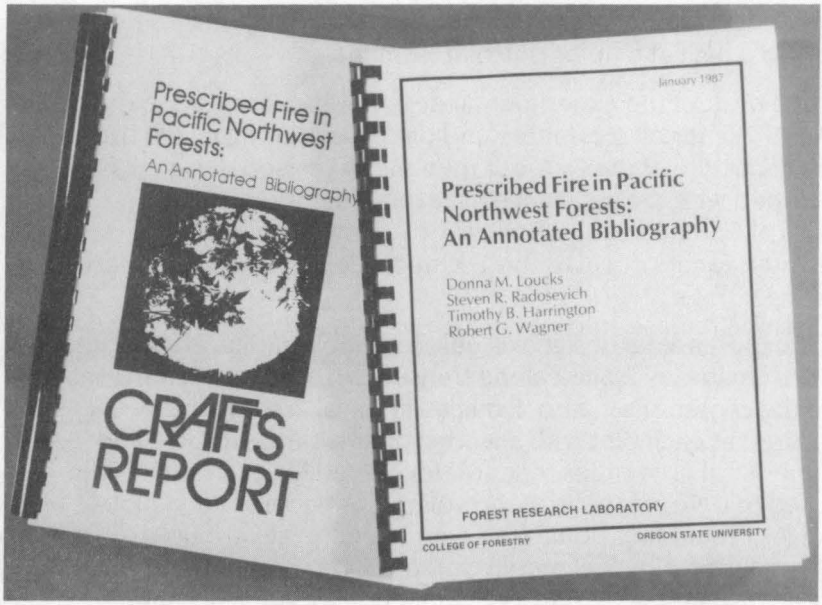

Figure 4. Two versions of *Prescribed Fire in Pacific Northwest Forests: An Annotated Bibliography.*

The compendium marks a first step in the research effort by both CRAFTS and the Laboratory concerning the use of prescribed fire for forest regeneration purposes. A second document, expected in spring 1989 and co-edited by Jack Walstad and Steve Radosevich, will synthesize much of the information offered in the compendium. Included will be information about the historical role of fire in forest ecosystems and about the effects of prescribed burning on reforestation, forest protection, site, air and water quality, and wildlife.

Methods of application, economic costs and benefits, regulation, and public perceptions of and attitudes toward prescribed burning also will be discussed in the new publication.

A Diagnostic Tool for Predicting the Effects of Interspecific Competition on Growth and Yield of Douglas-fir

Various models have been developed that predict the growth and yield of tree species. These models have been constructed generally at three levels of resolution: whole stand, size-classes within stands, and the individual tree. The stand growth and yield simulator in most common use in the Pacific Northwest, DFSIM, is used extensively to estimate the long-term yield potential of managed Douglas-fir stands. A major limitation of DFSIM and other growth and yield models is their inability to be applied to stands less than 25 years old. Thus, existing growth and yield models do not include the effects of early interspecific competition or vegetation management treatments that are applied during this stage of stand development.

Since research cannot be conducted on every set of site conditions, we postulate that existing data can be systematically organized according to important site characteristics and vegetation parameters to provide a framework for diagnostic-management models of young Douglas-fir stands. Recent efforts in young loblolly pine stands indicate that such empirically-derived models of young conifer responses to competition are possible and potentially of great management utility. Approximately 40 studies in the Oregon State University Forest Science data bank have been identified that may be appropriate as an initial data base for the construction of such predictive models for young Douglas-fir stands. Furthermore, several members of CRAFTS have indicated a willingness to provide additional data formerly of confidential status for this effort.

Our expected accomplishments in this project for the next several years include a series of models that predict the growth and survival of 3- to 25-year-old Douglas-fir as a function of:

1) species, stature, or proximity of major vegetative associates,
2) duration of competitor presence,
3) tree characteristics or condition (animal damage, tree size, vigor at planting, etc.), and
4) site (slope, aspect, elevation, soil type, etc.), and management (burning, scarification, etc.) factors.

These models will be used to interface young stand growth, attainable by various levels of vegetation management, to existing older stand-growth simulators, such as DFSIM.

Work on the development of this model is expected to begin during the summer of 1987.

ADAPTIVE RESEARCH

Adaptive studies are designed to explore new approaches for managing forest vegetation, or to improve existing ones. Although usually funded from outside sources, these studies have direct management implications that are of interest to the Cooperative membership. Members participate at their discretion through the donation of land, labor, or facilities. Examples of such studies conducted by CRAFTS include:

Interspecific Competition Index for the Siuslaw National Forest

In an effort to provide more quantitative decision-making techniques for vegetation management decisions in young Douglas-fir plantations, Bob Wagner and Steve Radosevich are conducting a study to develop an interspecific competition index for the Siuslaw National Forest. The study is divided into two phases:

PHASE I

The first phase of the study utilized plots from two site-preparation experiments on the Siuslaw National Forest.

These experimental plots were established by the USFS Pacific Northwest Research Station. Data collected from these experiments were used to develop a set of regression equations that predict the size of individual 4- to 9-year-old Douglas-fir trees. The equations describe the relationship of tree age, interspecific competition from woody vegetation, first-year height, animal damage, prescribed burning, slope, and aspect to the height, stem diameter, stem volume, and crown volume of individual trees.

Twenty-three indices of interspecific competition, calculated from vegetation measurements around individual trees, were evaluated. The index that gave the most precise estimate of interspecific competitive effects on stem diameter, stem volume, and crown volume was a visual estimate of woody vegetation cover that was equal to or taller than 66 percent of tree height (Figure 5). Woody vegetation cover equal to or taller than 125 percent of tree height was the most precise index for predicting total height (Figure 5). The competition index also interacted with tree age, indicating that the negative effect of woody vegetation increased with time.

Improvement in the index by excluding woody vegetation below 66 and 125 percent relative tree height apparently resulted from removing woody vegetation that had a competitive influence on tree growth equivalent to that of herbaceous vegetation. Herbaceous vegetation abundance tended to increase around each tree as the abundance of woody vegetation decreased. These data suggest that woody vegetation effects on young Douglas-fir plantations can not be differentiated from those of herbaceous vegetation until the woody vegetation is above two-thirds the height of the tree.

The regression models also indicated that tree size was positively correlated with both seedling height in the first year after planting and the use of prescribed burning for site preparation. Browsing and clipping damage by animals was negatively correlated with tree size. Slope and aspect functions in the regression models also indicated that trees performed better on steep southeast slopes.

Details of this analysis were presented in the first annual report to the Siuslaw National Forest. Growth models for salmonberry,

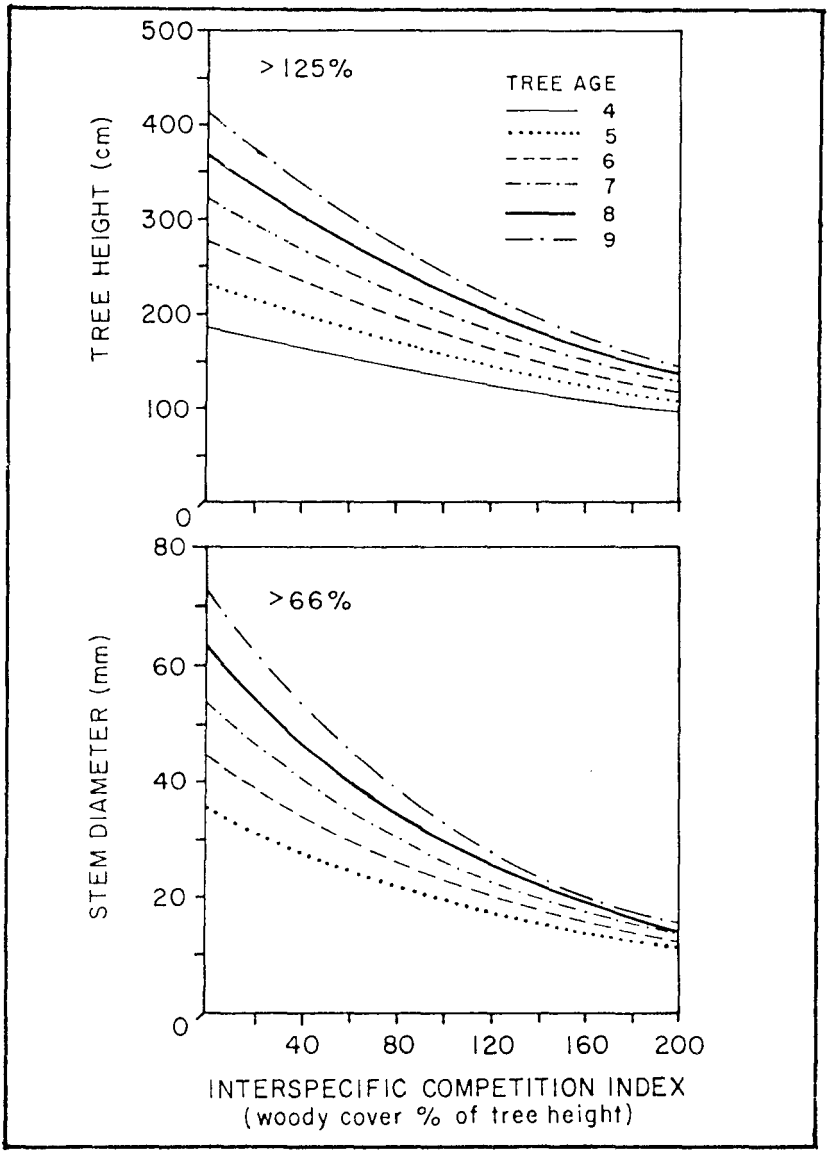

Figure 5. The relationship of tree age and the interspecific competition index to the height (top) and stem diameter (bottom) of individual Douglas-fir trees. The interspecific competition index was determined from a visual estimate of crown coverage by woody vegetation that was equal to or taller than 125 and 66 percent of tree height for predicting tree height and stem diameter, respectively.

thimbleberry, red alder, and vine maple from plots on the CRAFTS Coast Range release study also will begin in the coming year. The purpose of these growth models will be to provide a means for predicting future competition index values from data collected in surveys of vegetation in young plantations.

PHASE II

In the second phase, the interspecific competition indices developed in phase I are being tested and refined for Douglas-fir seedlings in salmonberry-dominated plant communities on the Forest. Four sites were established in 1985 on north and south slopes in the *Picea sitchensis* and *Tsuga heterophylla* zones. On each site, five levels of salmonberry recovery (100, 75, 50, 25, and 0 percent) are being maintained. In addition, 50 and 100 percent of herbaceous vegetation are being removed from plots where all salmonberry has been removed.

Douglas-fir growth and survival, soil water depletion, and light attenuation under each of the treatments in the second year were measured during 1986-87. Preliminary analysis of data from phase II support hypotheses developed from phase I. Similar soil water depletion patterns have been observed under both herbaceous- and salmonberry-dominated communities. Greater diameter growth has occurred on plots where both salmonberry and herbaceous vegetation have been removed, than on plots where only salmonberry has been removed. Consistent with results from the CRAFTS Coast Range competition release study, herbaceous vegetation appears to be a significant factor reducing the growth of young Douglas-fir, even in some of the wettest portions of the Oregon Coast Range.

Douglas-fir/Red Alder Replacement Series

Does nitrogen fixation by red alder increase Douglas-fir yields on low fertility sites? What stand proportions of red alder reduce Douglas-fir growth and survival on medium- to high-quality sites? When should red alder be introduced or removed from Douglas-fir stands to achieve potential yield benefits? These questions are being addressed in a long-term study directed by

Steve Radosevich and Dave Hibbs. On three different sites both replacement series and red alder density (Nelder) experiments have been installed:

1) Belfair, Washington site (Hood Canal area) (low fertility),
2) H.J. Andrews Experimental Forest site (40 miles east of Eugene, Oregon) (medium fertility), and
3) Cascade Head Experimental Forest site (50 miles northwest of Corvallis, Oregon) (high fertility).

Both the replacement series and Nelder experiments have been replicated three times at each site, thus allowing species interactions to be analyzed separately to determine the effects of site fertility. Nutrient capitals, rates of soil water depletion, and seedling xylem potentials have been measured at each site to document initial site conditions and baseline levels of resources. In the fifth and tenth growing seasons after study initiation these variables will be remeasured to quantify the effects of the various species mixtures.

The Belfair site is beginning its third growing season since planting. At this site first-year survival was moderate because of the droughty nature of the coarse-textured glacial soils. The other two sites are entering their second growing season and seedling establishment has been successful.

BASIC RESEARCH

Basic studies explore fundamental principles important to the science of vegetation management. They provide the basis for innovative technology and, ultimately, better management. They also trigger future adaptive and applied research. Basic studies are usually conducted by graduate students, often Ph.D. candidates. Funding for such projects is always from sources outside the Cooperative, although cooperator participation is encouraged.

Basic research projects conducted by graduate students associated with CRAFTS are listed in the table below. Although often fundamental in nature, these studies provide the Cooperative with information on the mechanism of species

interactions. This information subsequently can be translated into better management activities.

Student	Degree	Project description	Study site location	Expected completion date
Pamela Bold	MS	Effect of density and species proportion on biomass allocation patterns of red alder and Douglas-fir seedlings	near Belfair, Washington	4/87
Samuel Chan	PhD	Comparative physiology and growth of Douglas-fir and red alder	OSU	3/88
David Coates	MS	Growth responses of Engelmann spruce to various levels of shrub and herb cover	near Clearwater, British Columbia	6/88
James Dukes	PhD	Differential physiology between interacting Douglas-fir and red alder	OSU, Cascade Head Experimental Forest	6/90
Bruce Maxwell	PhD	Population growth and demographics of salmonberry and thimbleberry	near Philomath and Toledo, Oregon	6/88
Alison Nicholson	MS	Competitive interactions between Douglas-fir and pinegrass	near Williams Lake, British Columbia	12/87
Tim Harrington	PhD	Physiological mechanisms for competition of tanoak and Douglas-fir	near Glendale and Cave Junction, Oregon	6/89
Terry Petersen	PhD	Genotypic variations and stand structure of Douglas-fir as affected by interactions with red alder	OSU	6/88
Lauri Shainsky	PhD	Mechanism of interaction between Douglas-fir and red alder	OSU	3/88
Suzanne Simard	MS	Neighborhood analysis of competition between Sitka alder and Douglas-fir	near Kamloops, British Columbia	6/89

AUXILIARY RESEARCH

In addition to the three types of research described earlier, CRAFTS also encourages research being conducted by other scientists. In this way, information is made available on topics that are of interest to the cooperators but beyond the scope of the organization itself.

Screening Trials

Arsenal® and Escort® were found to control a number of Coast Range hardwood, shrub, and herb species. Mike Newton and associates now have completed second-year evaluations of these two herbicides at a coastal site near Toledo and an interior site near Eddyville, Oregon. Arsenal® was effective on bigleaf maple, either when used as a foliage spray on sprout clumps or as an injection of trees. Arsenal® also was effective on many species of herbs, including grasses and sedges. Red alder was controlled with Arsenal®; however, the compound was not effective on *Rubus* species.

Escort®, on the other hand, proved to be lethal on salmonberry and thimbleberry at one-half ounce per acre in June-July, and provided excellent control of Himalaya and evergreen blackberries. Only marginal control of bigleaf maple was provided by this compound, and little or no effect was observed when it was tested on red alder and salal.

Arsenal® also was tested on evergreen species at one site in southwestern Oregon. This compound caused severe first-year injury to manzanita, Pacific madrone, and snowbrush ceanothus, but these species were recovering from injury in the second year.

Both Arsenal® and Escort® caused severe injury to Douglas-fir either from foliage uptake or soil activity. Soil residue effects were tested by planting 2-0 Douglas-fir seedlings eight months after herbicide treatment on a coastal site and a site in southwestern Oregon. At the coastal site no signs of herbicide injury were visible two growing seasons after planting. However, seedlings exhibited significant herbicide injury and had poor survival at the southwestern Oregon site.

Starane® (Fluroxypyr) has demonstrated effective control of snowbrush ceanothus and greenleaf manzanita in a study located near Bend, Oregon. First-year evaluations of a July release treatment for ponderosa pine will be conducted this year.

Oust® (sulfometuron methyl) has been tested at sites near Alsea and Toledo, Oregon. This compound provides effective control of many herb species, with the exception of thistles. *Rubus* species also are effectively controlled by Oust®. This compound causes some Douglas-fir injury, and is not effective on red alder.

EDUCATIONAL ACTIVITIES

Cooperative Technical Reports

Four CRAFTS technical reports were distributed to cooperators in 1986-1987. These include two reports on the Coast Range competition release study: a third-year summary of Douglas-fir growth and survival responses, and a comparison of herbicide and competition effects on Douglas-fir growth. Preparation and distribution of the annotated bibliography on prescribed fire was expedited in 1986 to meet the needs of cooperators. In addition, the first-year results of the bigleaf maple screening trial also were distributed.

Forthcoming technical reports on the Coast Range competition release study will include a summary of regression relationships describing the effects of competition on tree growth and a report examining late-summer Douglas-fir xylem pressure potential. Equations that predict crown development of young bigleaf maple sprout clumps (phase I) will be presented in a future technical report. In addition, several technical reports will be prepared on the bigleaf maple screening trial.

New Text on Forest Vegetation Management Available

A new book entitled *Forest Vegetation Management for Conifer Production*, co-authored by Jack Walstad and Peter Kuch,

consolidates the current information available about forest vegetation management (Figure 6). The book provides the conceptual framework as well as a data base for improving forest vegetation management decisions. For example, it quantifies opportunities for enhancing forest productivity, illustrates the value of vegetation management treatments in protecting forest resources and investments, outlines the concept of economic thresholds, and consolidates information on treatment efficacy.

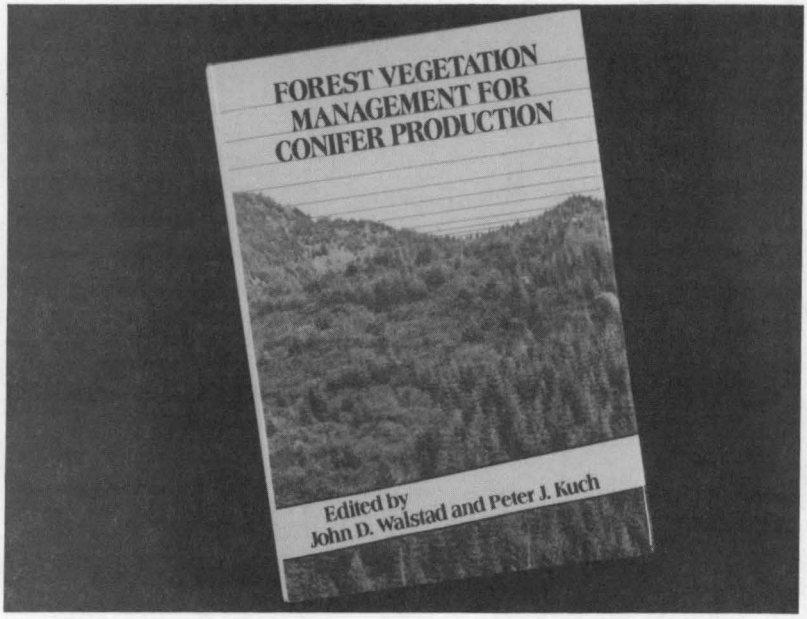

Figure 6. A new textbook on forest vegetation management.

The text represents the work of an interdisciplinary team of 20 specialists, so that it integrates vegetation management practices with other silvicultural considerations. It also provides guidance for future research needed to sustain progress in this important aspect of silviculture.

Presentations by CRAFTS Personnel at Meetings

This year CRAFTS personnel gave the following presentations at symposiums, workshops, and college classes:

- University of California Statewide Pest Management Seminars. S.R. Radosevich. Modesto and Yuba City, California and Klamath Falls, Oregon. January 1986.
- A comparison of two research designs for effects of density and proportion on interspecific competition. S.R. Radosevich, M.L. Roush, R.G. Wagner, B. Maxwell, and T.D. Petersen. Weed Science Society of America Annual Meetings. Houston, Texas. February 1986.
- Principles of forest vegetation management. R.G. Wagner. Forestry for teachers class lecture, College of Forestry, Oregon State University, Corvallis, Oregon. May 1986.
- Vegetation management options: when and where to use available tools. R.G Wagner. Invited presentation. Vegetation Management Options in Southern Interior Forests Symposium, Southern Interior Silviculture Committee and Association of B. C. Professional Foresters, Nelson, British Columbia. August 1986.
- Factors determining the growth response of Douglas-fir seedlings to weed control. T.B. Harrington. Invited presentation. Oregon Vegetative Management Association. Annual Conference, Bend, Oregon. October 1986.
- Research methods for vegetation management research. S.R. Radosevich. Keynote address. British Columbia Expert Committee on Vegetation Management. Victoria, British Columbia. November 1986.
- Current modeling approach for tanoak, Pacific madrone, and chinkapin sprout clumps. T.B. Harrington. Invited presentation. Hardwood modeling symposium sponsored by the U.S. Forest Service and the University of California. Berkeley, California. December 1986.
- Species shifts in response to site preparation and subsequent herbicide treatments in Sierran forest land. W.T. Lanini and S.R. Radosevich. Weed Science Society of America Annual Meetings. St Louis, Missouri. February 1987.
- Growth and water relations of ponderosa pine (*Pinus ponderosa* Dougl. ex P&C Lawson) seedlings in competitive regimes with greenleaf manzanita (*Arctostaphylos patula* Greene) seedlings. L.J. Shainski and S.R. Radosevich. Weed Science Society of America Annual Meetings. St. Louis, Missouri. February 1987.
- Neighborhood measures of interspecific competition in young Douglas-fir plantations. R.G. Wagner and S.R. Radosevich.

Weed Science Society of America National Meeting. St. Louis, Missouri. February 1987.

- Release of Douglas-fir (*Pseudotsuga menziesii*) from shrub and herb competition in the Oregon and Washington Coast Range. T.B. Harrington, R.G. Wagner, and S.R. Radosevich. Weed Science Society of America Annual Meetings. St. Louis, Missouri. February 1987.
- Comparing physiological, morphological, and biomass partitioning strategies of Douglas-fir and red alder under varying light and soil moisture levels. S.S. Chan, S.R. Radosevich, and J.D. Walstad. Weed Science Society of America Annual Meetings. St Louis, Missouri. February 1987.
- Competitive interactions between Douglas-fir (*Pseudotsuga menziesii*) and red alder (*Alnus rubra*) seedlings: growth analysis, resource use, and physiology. L.J. Shainski and S.R. Radosevich. Weed Science Society of America Annual Meetings. St. Louis, Missouri. February 1987.
- Meeting the biological requirements of conifer seedlings during site preparation. R.G. Wagner. Invited presentation. OSU Reforestation Methods Workshop. Bend, Oregon. March 1987.
- Site-preparation cost control. R.G. Wagner. Invited presentation. OSU Reforestation Methods Workshop, Bend, Oregon. March 1987.
- University of California short course on forest weed management. S.R. Radosevich. Invited lecture. Davis, California. March 1987.
- Vegetation management seminar. S.R. Radosevich. Invited presentation. Council of Forest Industries of British Columbia. Prince George, British Columbia. March 1987.

CRAFTS Poster

The CRAFTS staff prepared a poster this year that describes the objectives, scope, organization, and activities of the Cooperative. This poster was part of our effort to keep forest land managers in the Pacific Northwest informed of our activities. The poster was displayed at the Oregon State Society of American Foresters Annual Convention (Salem), Starker Forests Reforestation Clinic (Philomath), and the Society of American

Foresters, Mary's Peak and Emerald Chapter meeting on vegetation management (Junction City). The poster is now on display at the Forest Science Laboratory in Corvallis.

ORGANIZATIONAL ACTIVITIES

Committee Meetings

CRAFTS committees met six times this year to address various aspects of the Cooperative. The Policy and Technical Committees met during the year to determine funding levels and experimental designs for upcoming experiments. A special Research Directions Subcommittee was formed this year to develop a 5-year plan for the Cooperative.

POLICY COMMITTEE

Policy Committee meetings were held in June and August this year. The first meeting was part of the OSU Research Cooperative Policy Day held every June. At the June meeting, cooperators voted Bob Metzger (Bureau of Land Management) as executive officer for 1986-87, discussed policies concerning availability of raw data to cooperators, established a policy for liaison membership to CRAFTS, and voted to form a subcommittee to develop a 5-year research plan for the cooperative.

The Policy Committee met again in August to review and vote on four budget alternatives that were developed by the Research Directions Subcommittee. The Committee selected an alternative that provided for measurement of the Coast Range Release study through the fifth year, with remeasurement in the tenth year, and continued annual maintenance of the complete removal treatment. The bigleaf maple treatment screening trial and the bigleaf maple growth model will continue through 1989 as planned. A discretionary fund for short-term studies will begin in 1988-89. The most significant addition was an increase in annual funding to begin development in 1988-89 of a regional

forest vegetation management diagnostic tool. This alternative increased cooperator dues by $500 per cooperator in 1986-87 ($5,000/year) and another $500 per cooperator in 1987-88 ($5,500/year).

RESEARCH DIRECTIONS SUBCOMMITTEE

At the direction of the the Policy Committee, a CRAFTS Research Directions Subcommittee was formed from 13 representatives of both the Policy and Technical Committees. The Subcommittee met in July and August with the objective of developing a set of proposed research agendas and funding alternatives for the next five years. From these meetings, four alternatives were developed that would accomplish the general objectives of the Cooperative. The current five-year plan is a direct result of this Subcommittee. We thank Tom Terry (chairman), Doug Belz, Jerry Chetock, David Handley, Ron Heninger, Greg Johnson, Ken Munson, Bon Metzger, Tharon O'Dell, and Bill Voelker for their effort.

TECHNICAL COMMITTEE

The Technical Committee met in January and October of this year to review CRAFTS experimental designs and research results from experiments around the region. Accomplishments for the Committee include:

- design of the format for the Prescribed Fire Bibliography
- review of a proposed study on woody and herbaceous competitive effects in the Cascade foothills
- installation of the remaining dormant treatments in the bigleaf maple treatment screening trial
- maintenance of the complete removal treatments in the Coast Range Competition Release Study
- approval of the design for and participation in a training day at OSU for phase I of the bigleaf maple growth model study
- site selection and data collection for phase I of the bigleaf maple growth model study
- review of phase II design and site selection for the bigleaf maple growth model study

At the October meeting, the Weyerhaeuser Company and CRAFTS staff organized a one-day field tour of Weyerhaeuser

and CRAFTS experimental sites in southwestern Washington (Figure 7). About 30 people attended the field tour. Visited were a proposed site for phase II of the bigleaf maple growth model study and sites for 2,4-D effectiveness demonstration, timing of red alder release in Douglas-fir stands, red alder density effects on Douglas-fir growth, bigleaf maple-Douglas fir competition study, and a bigleaf maple treatment screening trial.

Figure 7. Field trip co-sponsored by CRAFTS and Weyerhaeuser Corporation.

APPENDIX I

Publications and Papers Prepared by CRAFTS Personnel (1986-87)

Chan, S.S., R.W. McCreight, J.D. Walstad, and T.A. Spies. 1986. Evaluating forest vegetative cover with computerized analysis of fisheye photographs. Forest Science 32:1085-1091.

Chan, S.S., S.R. Radosevich, and J.D. Walstad. 1987. Comparing physiological, morphological and biomass partitioning strategies of Douglas-fir and red alder under varying light and soil moisture levels. Weed Science Society of America Abstracts 27:138.

Cole, E.C., and M. Newton. 1987. Fifth-year responses of Douglas-fir to crowding and non-coniferous competition. Canadian Journal of Forest Research 17:181-186.

Cole, E.C., and M. Newton. 1987. Nutrient, moisture and light relations in 5-year-old Douglas-fir plantations under variable competition. Canadian Journal of Forest Research 16:727-732.

Cole, E.C., M. Newton, and D.E. White. 1986. Response of northwestern hardwoods, shrubs and Douglas-fir to Arsenal® and Escort®. P. 93-101 *in* Proceedings, Western Society of Weed Science. San Diego, California.

Harrington, T.B. 1986. Factors determining the growth response of Douglas-fir seedlings to weed control. *In* Proceedings, Oregon Vegetative Management Association Annual Conference, Bend, Oregon.

Harrington, T.B. 1987. The relative effects of herbicide exposure and competing vegetation on Douglas-fir growth in the Coast Range competition release study. CRAFTS Technical Report. Department of Forest Science, College of Forestry, Oregon State University, Corvallis, Oregon.

Harrington, T.B., and R.G. Wagner. 1986. Three years of Douglas-fir growth and survival following six competition release treatments in the Oregon and Washington Coast Range. CRAFTS Technical Report. Department of Forest Science, College of Forestry, Oregon State University, Corvallis, Oregon.

Harrington, T.B., R.G. Wagner, and S.R. Radosevich. 1987. Release of Douglas-fir (*Pseudotsuga menziesii*) from shrub and herb competition in the Oregon and Washington Coast Range: third-year results. Weed Science Society of America Abstracts 27:149.

Hart, J.J., and S.R. Radosevich. 1986. Water relations in two shrub species. American Journal of Botany 74:371-384.

Lanini, W.T., and S.R. Radosevich. 1986. Response of conifer species to site preparation and shrub control. Forest Science 32:61-77.

Lanini, W.T., and S.R. Radosevich. 1987. Species shifts in response to site preparation method and subsequent herbicide treatments in Sierran forest land. Weed Science Society of America Abstracts 27:113.

Loucks, D., S.R. Radosevich, T.B., Harrington, and R.G. Wagner. 1987. Prescribed fire in Pacific Northwest forests: an annotated bibliography. Forest Research Laboratory, Oregon State University, Corvallis, Oregon.

Maxwell, B.D., M.V. Wilson, and S.R. Radosevich. 1987. Use of a refined leafy spurge population simulation model to identify hypotheses and develop control strategies. *In* Proceedings, Western Society of Weed Science, March, Boise, Idaho.

Newton, M. 1986. Residues from organic arsenical herbicides in chemically thinned forests. Journal of Environmental Quality 15(4):388-394.

Newton, M., and E.C. Cole. 1987. A sustained-yield scheme for old-growth Douglas-fir. Western Journal of Applied Forestry 2:22-25.

Newton, M., E.C. Cole, and D.E. White. 1986. What influences control of coastal deciduous brush with glyphosate. P. 86-92 *in* Proceedings, Western Society of Weed Science, San Diego, California.

Newton, M., M.L. McCormack, Jr., R.L. Sajdak, and J.D. Walstad. 1987. Forest vegetation problems in the northeast Lake States/provinces. *In* Forest Vegetation Management for Conifer Production. J.D. Walstad and P.J. Kuch, eds. John Wiley and Sons, New York, New York.

Radosevich, S.R. 1986. Vegetation management problems and principles: observations in British Columbia. *In* Vegetation Management Symposium. Association of British Columbia Professional Foresters and Southern Interior Silviculture Committee, Kamloops and Vancouver, British Columbia.

Radosevich, S.R., and K. Osteryoung. 1987. Interaction of plants with their environment. *In* Forest Vegetation Management for Conifer Production. J.D. Walstad and P.J. Kuch, eds. John Wiley and Sons, New York, New York.

Radosevich, S.R., M.L. Roush, R.G. Wagner, B. Maxwell, and T. Petersen. 1986. A comparison of two research designs for effects of density and proportion on interspecific competition. Weed Science Society of America Abstracts 26.

Radosevich, S.R., R.G. Wagner, and D.R. Orcutt. 1986. Predicting effects of modified cropping systems: forestry examples. Horticulture Science 21:413-418.

Ross, D.W., W. Scott, R.L. Heninger, and J.D. Walstad. 1986. Effects of site preparation on ponderosa pine (*Pinus ponderosa*), associated vegetation, and soil properties in south central Oregon. Canadian Journal of Forest Research 16:612-618.

Ross, D.W., and J.D. Walstad. 1986. Estimating aboveground biomass of shrubs and young ponderosa and lodgepole pines in southcentral Oregon. Forest Research Laboratory, Oregon State University, Corvallis, Oregon. Research Bulletin 57.

Ross, D.W., and J.D. Walstad. 1986. Vegetative competition, site preparation, and pine performance: a literature review with reference to southcentral Oregon. Forest Research Laboratory, Oregon State University, Corvallis, Oregon. Research Bulletin 58.

Shainsky, L.J., and S.R. Radosevich. 1986. Effects of manzanita density on the growth and water status of conifer seedlings. Journal of Applied Ecology 23:957-966.

Shainsky, L.J., and S.R. Radosevich. 1987. Competitive interactions between Douglas-fir (*Pseudotsuga menziesii* Mirb. Franco.) and red alder (*Alnus rubra*) seedlings: growth analysis, resource use, and physiology. Weed Science Society of America Abstracts 27:139.

Shainsky, L.J., and S.R. Radosevich. 1987. Growth and water relations of ponderosa pine (*Pinus ponderosa* Dougl. ex P&C Lawson) seedlings in competitive regimes with greenleaf manzanita (*Arctostaphylos patula* Greene) seedlings. Weed Science Society of America Abstracts 27:225.

Tappeiner, J.C., and R.G. Wagner. 1987. Principles of silvicultural prescriptions for vegetation management. *In* Forest Vegetation Management for Conifer Production. J.D. Walstad and P.J. Kuch, eds. John Wiley and Sons, New York, New York.

Wagner, R.G. 1986. Thresholds of interspecific competition in young forest plantations: the implications for mechanical, manual, fire, and chemical tools. *In* Vegetation Management Symposium. Association of British Columbia Professional Foresters and Southern Interior Silviculture Committee, Kamloops and Vancouver, British Columbia.

Wagner, R.G. 1987. First-year results from treatments to control bigleaf maple sprout clumps. CRAFTS Technical Report. Department of Forest Science, College of Forestry, Oregon State University, Corvallis, Oregon.

Wagner, R.G., and S.R. Radosevich. 1987. Interspecific competition indices for vegetation management decisions in young Douglas-fir stands on the Siuslaw National Forest: report No. 1. Forest Science Department, College of Forestry, Oregon State University, Corvallis, Oregon.

Wagner, R.G., and S.R. Radosevich. 1987. Neighborhood measures of interspecific competition for vegetation management decisions in young Douglas-fir stands. Weed Science Society of America Abstracts 27:148.

Walstad, J.D., J.D. Brodie, B.G. McGinley, and C.A. Roberts. 1986. Silvicultural value of chemical brush control in the management of Douglas-fir. Western Journal of Applied Forestry 1:69-73.

Walstad, J.D., and F.N. Dost. 1986. All the king's horses and all the king's men: the lessons of 2,4,5-T. Journal of Forestry 84(9):28-33.

Walstad, J.D., M. Newton, and R.J. Boyd, Jr. 1987. Forest vegetation problems in the Northwest. *In* Forest Vegetation Management for Conifer Production. J.D. Walstad and P.J. Kuch, eds. John Wiley and Sons, New York, New York.

Walstad, J.D., M. Newton, and D.J. Gjerstad. 1987. Overview of vegetation management alternatives. *In* Forest Vegetation Management for Conifer Production. J.D. Walstad and P.J. Kuch, eds. John Wiley and Sons, New York, New York.

White, D.E., T. Harrington, and T. Hughes. 1986. Effects of herbs and brush on growth of young conifers. P. 41-45 *in* Forest Pest Management in Southwest Oregon. Proceedings of a workshop. O.T. Helgerson, ed. Forest Research Laboratory, Oregon State University, Corvallis, Oregon.

White, D.E., M. Newton, and E.C. Cole. 1986. Enhanced herbaceous weed control in conifers with combinations of nitrazine fertilizer formulations and hexazinone. P. 102-106 *in* Proceedings, Western Society of Weed Science, San Diego, California.

APPENDIX II

Financial Support Received in 1986-87

Cooperators	Financial Support
Boise Cascade Corporation	$ 5,000
British Columbia Ministry of Forests	4,500
Bureau of Land Management	5,000
Cavenham Forest Industries	5,000
Champion International Corporation	5,000
International Paper Company	5,000
ITT-Rayonier, Inc.	5,000
Lone Rock Timber Company	2,250
Longview Fibre Company	5,000
MacMillan Bloedel Limited	5,000
Oregon State Department of Forestry	5,000
Rex Timber	5,000
Simpson Timber Company	5,000
Starker Forests, Inc.	2,250
USDA Forest Service, Pacific Northwest Forest and Range Experiment Station[1]	
Washington Department of Natural Resources	5,000
Weyerhaeuser Company	5,000
Willamette Industries, Inc.	5,000
Subtotal	$ 79,000
Forest Research Laboratory, Oregon State University	111,717
Subtotal	$190,717
Other Sources[2]	
USDA, Siuslaw National Forest[3] (Radosevich and Wagner, 1986)	30,286
USDA, Forest Service NAPIAP Program (Radosevich, 1986)	37,202
USDA Competitive Grants: Biological Stress[3] (Hibbs and Radosevich, 1985 and 1986)	80,000
USDA Competitive Grants: Biological Stress[3] (Radosevich, 1986 and 1987)	65,800
USDA Competitive Grants: Biological Stress[3] (Newton, Cole, and Radosevich, 1986-1991)	134,000
COPE[3] (Walstad and Radosevich, 1987)	27,000
COPE[3] (Radosevich and Newton, 1987-1988)	36,000
Washington DNR (Radosevich, 1987)	15,000
Subtotal	$425,288
Total	$616,005

[1] Support given by in-kind contributions.
[2] Leader for project funded shown in parentheses.
[3] Includes university overhead.

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Address correction requested

Oregon
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University