

Sierra-Cascade Intensive Forest Management Research Cooperative

Series Report No. 4



<http://wric.ucdavis.edu.sierracascade/>

ANNUAL REPORT
2003

The Co-op would like to acknowledge the contributions to the efforts of our organization made by Bob Carlson of the Pacific Southwest Research Station Lab at Redding. Not only has Bob helped in the installation of many of the new research plots we have established, including plot layout and planting, he has performed much of the data entry and all the data analysis runs needed for the information that appears in the Proposal updates that are reported in this and all previous Annual Reports. Discussions with Bob about data application and validity are always useful and helpful. His work is always of the utmost accuracy. The Co-op is indebted to Bob.

TABLE OF CONTENTS

Summary	2
Membership, Mission and Objectives	4
Meetings	5
Research Results	
Seedling Nutrition, Timmer and Jopson	7
Stock Type/Fertilization, Fredrickson	15
Long Term Competition, Newton	33
Western Pine Shoot Borer, Gillette and Webster	35
Research Implementation	
Slow Release Fertilization, Fredrickson	41
Agenda 2020, Powers	45
2003 Budget	49
Working Groups	50

The Sierra Cascade Intensive Forest Management Research Cooperative has been an organization for four years. The year 2003, as were the first three years, was a very busy and productive one for the Co-op. A new proposal that brought funds into the Co-op was presented to and accepted by the membership. Five funded proposals were measured for either first or second growing season values. A presentation about the Co-op was made at the Forest Vegetation Management Conference in Redding.

Three of the studies funded by the Co-op present new results in this issue of the annual report. These include Exponential Fertilization (Timmer/Jopson), Stock Type/Fertilization (Fredrickson), and Slow Release Fertilizer (Fredrickson). One study (Newton's Competing Vegetation) was remeasured with the data being furnished to the Pacific Southwest Research Station for growth model validation. The fifth funded study (Western Pine Shoot Borer - Gillette/Webster) was evaluated for retreatment. These last two studies are also updated in this issue. Site selections have been made for the newly accepted proposal (Agenda 2020 - Powers) and both sites have been harvested with the site preparation phase being completed on one of the sites. The weed species that are included in this study as part of the treatments are starting to be grown.

The Co-op did not host its own field trip in 2003. Instead it participated in the California Pest Council Weed Tour held near Auburn in July. One of the stops on the tour was Balderston Plantation which was remeasured in 2000, 25 years after receiving conifer release, thinning, and fertilization treatments as part of a PSW

research project. The Co-op funded this 25th year remeasurement and this data were presented at the stop. The point was made by several in attendance that the protecting and remeasuring of these older study sites is very important as we try to apply intensive forest management.

Membership in our cooperative decreased slightly during 2003. Company reorganizations and hard economic times were the main reasons for this drop. The current membership of 20 consists of a mix of land-owners, forestry-related industries, and federal/state agencies.

The year 2003 saw a new arrangement for the Co-op's accounting needs. The California Forestry Association was approached by the Directors in November, 2002 in an attempt to find ways to improve the accounting/payment process that was currently in place with the Co-op. CFA already had a research account set up to receive and distribute funds for forestry research. A proposal to change over from the University of California to CFA for the Co-op's accounting services was presented to the voting membership in December, 2002. The proposal was approved and the new accounting procedure was in place by February, 2003. We have finished the first field season using the CFA procedure for paying contractors and all indications are that the new system is working very well. Contractors report getting paid within 5 days after the invoice is submitted. Year-end accounting should be much easier under CFA.

The year 2004 looks to be another active one for the Co-op. Our annual business

meeting is scheduled for January 19, 2004 in Redding. This is the first chance in the year for new proposals to be presented to the membership.

Accomplishments of on-going studies will be reported. The two Working Groups will make reports. The process of deciding on the site for our annual field trip will be started at this meeting. The Agenda 2020 proposal is scheduled for implementation on both sites during 2004, and the Western Pine Shoot Borer study is set for retreatment in the spring. Three other studies are scheduled for remeasurement in the fall.

The Sierra Cascade Intensive Forest Management Research Cooperative continues to fund studies related to the practice of intensive forestry. This was one of the founding principles of the organization. More new proposals need to be presented to the Co-op membership in order to take advantage of this opportunity. As demonstrated by the remeasurement of the Balderston Plantation study, the Cooperative's efforts are making a difference.

Cooperative Directors:

Ed Fredrickson
Roseburg Resources
Weed, CA
Joe DiTomaso
University of California
Davis, CA
Robert F. Powers
PSW Research Station
U.S. Forest Service
Redding, CA

Cooperative Manager

Gary Fiddler
Silviculture Development
USDA Forest Service
Redding, CA

Land Manager Membership:

Boise Cascade
Collins Pine Company
Fruit Growers Supply Co.
Roseburg Resources
Sierra Pacific Industries
Soper-Wheeler
Timber Products
W.M. Beaty & Associates

Associate Corporate Membership:

Cal Forest Nurseries
Dupont
IFA Nurseries
Monsanto Company
PRT
Wilbur-Ellis Company

Affiliate Membership:

Dow Agro Sciences
Silver Butte Timber Company
UAP Northwest

Supporting Members

PSW Research Station
University of California, Davis
USDA Forest Service

ORGANIZATION FUNDAMENTALS

The Sierra-Cascade Intensive Forest Management Research Cooperative was founded in February 1999. Its goal was to create a structure for ensuring and sustaining research in the areas of regeneration and early stand management. The SCIFMRC currently has 20 members.

The Cooperative is located at the Pacific Southwest Research Station in Redding, California. The membership is comprised of private, state and federal entities. The voting members pay yearly dues of \$8,000 or \$4,000, while non-voting affiliates pay \$2,000. Research studies are approved by the full membership after review by the Board of Directors and the designated working groups. All members have full access to all the research results generated by the Cooperative.

MISSION STATEMENT

The SCIFMRC will conduct extensive research on conifer reforestation and young stand management in Northern California and Southwestern Oregon as a means of determining how trees react with their environment. The SCIFMRC will promote research on maximizing survival, growth and value while meeting other quality objectives of sound land stewardship.

OBJECTIVES

1. Develop, implement and evaluate intensive management methods to increase conifer productivity while protecting and enhancing other forest values.
2. Integrate various aspects of intensive management into one inclusive cooperative, focusing on improving establishment, growth and yield of forest plantations.
3. Focus research on problems of young stand management on interior forests of the Cascades and Sierra Nevada.
4. Inform members of current young stand management research.
5. Produce results that foresters can integrate into the decision process.

MEETINGS OF 2003

The annual business meeting for the Co-op was held in Redding on January, 13th. This meeting was open to members and potential members, principal investigators whose proposals had been or could be funded by the Co-op, and invited guests. Thirty people attended.

The first item of business was an update on the status of the 2002 Co-op budget by Joe DiTomaso. The budget showed a surplus of \$54,930.83 going into the new year after all obligations were met.

Following the update of the 2002 budget, a short discussion centered around the new accounting procedure for the Co-op. An explanation as to how the California Forestry Association was going to handle dues receipt, contractor payments, etc. was given to the members.

Joe encouraged the membership to make use of the web site as it is being updated regularly. Ed made the point that there needs to be more use of this site not only for information gathering but also for Co-op members to report on the studies they are conducting on their company lands.

Working Group I Chair Tom Jopson along with the principal investigators present reported on the progress of the proposals in his group. These proposals included Exponential Fertilization (Timmer/Jopson), Stock Type/Fertilization (Fredrickson), and Slow Release Fertilizer (Fredrickson).

The progress of the proposals in Working Group II (Brian Schlaefli Chair) was reported to the membership.

Proposals included in this working group include Competing Vegetation (Newton) and Western Pine Shoot Borer (Gillette/Webster). A complete report on the 2003 accomplishments of the proposals in both working groups can be found later on in this report.

The next item of business was the presentation of new proposals to the Co-op members for acceptance/funding.

During the Co-op field trip in September, 2002 Bob Powers informed the group that he had successfully competed for grant money from Agenda 2020 funds and offered the Co-op the opportunity to design a study that would be funded by this grant. Working Group II scheduled a meeting in December, 2002 to develop the proposal that would be used to present this study to the membership. This proposal was presented to the full membership at the January 13, 2003 meeting (it can be found under the Research Implementation section of this report).

This proposal generated much discussion among the members. One member stated that Mike Newton had a lot of this information already. Several members agreed but stated that the information might not be applicable to southern Oregon and northern California. It was the feeling of the group that they needed local data as opposed to Newton's data especially for political reasons. One member brought up the point that these political needs are every bit as important as the biological information needed by the group.

The discussion then moved on to the brush species to be studied. Manzanita and ceanothus were suggested in the proposal. Co-op membership was in complete agreement with these selections. The effects of these two species need to be more closely defined. Tom Jopson stated that growing the two brush species wouldn't be that hard. The ceanothus would be raised from seeds, the manzanita from cuttings. His concern was if the seedlings would grow after being outplanted on the study sites. He said that nursery-grown brush seedlings do not necessarily grow well when outplanted and recommended choosing sites which already have these two species present.

Site selection was the next step. The discussion was primarily centered around whether the sites selected for this study should be on good or poor sites. The membership seemed about equally divided on this issue. Bob Powers was not in favor of a poorer eastside site for either of the two sites for the study because there would be little response to the application of fertilizer which was a major treatment in the proposal. He suggested the Co-op fund an eastside site as a satellite installation which did not necessarily include all the treatments planned for the 2020 sites. This seemed to be acceptable with the membership and the decision was made to select sites for the proposal that would be on average or better Doug-fir sites.

With these changes the proposal was put to the membership for acceptance as a Co-op project. It was accepted by all voting members present. The first site was to be located on Boise Cascade lands. The membership was to send their proposals for the second site to the Co-op.

Bob closed the discussion by stating there would be opportunities to piggy-back other studies on the 2020 sites since they would have such a rigorous design. An example might be nutritional value of the brush species growing at the various levels of ground cover in the study proposal.

The meeting ended with some discussion on general items on the agenda. A request was made to the membership for suggestions on where the 2003 field trip could be held. The resolution of this item was that the members would send in their suggestions to the Co-op for ranking. The meeting ended with some discussion about how to best protect the Co-op research plots. It was suggested to GPS all plots and mail their locations to Co-op members. Signing of the plots and locating them on aerial photos was also discussed.

There were no meetings held by the Working Groups in 2003.

Improving Seedling Nutrition in the Nursery to Increase Seedling Performance in the Field

Victor R. Timmer and Thomas Jopson, Principal Investigators

Objectives: Determine optimal nutrition for planting stock of Douglas-fir, white fir, and ponderosa pine to ensure high field survival and rapid early growth. Secondly, identify nursery nutritional practices to accomplish the first objective.

Seedlings grown with constant and sufficient internal nutrient concentrations achieved through exponential fertilization are free of nutrient stress. Seedlings can be produced with balanced, high reserves of nutrients superior to those possible through late-season heavy fertilization. Presumably, balanced, surplus reserves of nutrients at planting affords growth that is rapid enough to offset weed competition and soil drought. Questions to be answered are: (1) what techniques are best for western species? (2) how does nutrition favoring rapid growth affect seedling resistance /susceptibility to drought, pests, and temperature extremes?

At one or more forest nurseries, seedlings will be raised according to various nutrient regimes including conventional fertilization and exponential fertilization. Growth and nutrient status of the seedlings will be assessed at 2-week intervals during the culture period to chart the progress and adjust nutrient supply schedules. At lifting, seedlings will have nutrient contents that vary incrementally from conventional to very high values, and should identify a treatment optimal for out-planting success. Survival and

growth of these seedlings will be followed for at least 5 years, at which time a firm decision can be reached on the best treatment(s) to apply to operational planting.

Status: A trial run using the fertilization rates specified in the proposal was made during 2001 at Cal Forest Nursery in Etna, CA. Three Co-op members supplied seedlings for the test, Boise Cascade, Fruit Growers Supply Co., and Soper-Wheeler. Three species were grown, Douglas-fir, ponderosa pine, and white fir

Problems with pH complicated the study while the seedlings were in the nursery. Over all, the constant rate fertilized seedlings outgrew the exponentially fertilized ones. Mortality was excessive with the latter application technique.

Vic Timmer visited Cal Forest Nursery in January of 2002.

The foliar analysis done at Davis showed a range of nitrogen levels in the seedlings, but only in the constant feed application. Timmer believed that nutrient concentrations were too low in the early stages for the exponential treatments, and that seedlings were stunted and not able to catch up to those in the constant feed treatment. A later foliar sample from Scott's Lab showed minor but consistent differences in nitrogen levels among the constant feed treatments. Whole seedling nitrogen concentrations generally increased in

proportion to nitrogen concentrations in the constant feed solution.

It was decided to out-plant only the two extreme treatments in the constant feed technique: 50 ppm and 300 ppm.

The seedlings were lifted in February. Seedling height and caliper were recorded for each treatment and needles were collected and sent to Scott's Laboratory for analysis. This data will serve as baseline data.

In order to make this and other studies under Working Group I more compatible with the needs from Working Group II, the original design for this study was changed (see meeting notes for February 19–20). Six replications of each treatment were to be out-planted if there were sufficient seedlings available. Spacing was to be increased to 10' X 10'. Plot size was to be 70' X 70' with 25 measure trees surrounded by a row of buffer trees in each plot. Seedling protection was to be applied at time of planting. The sites on Boise Cascade and Fruit Growers had been ripped; the site on Soper-Wheeler had not. To overcome this difference, the seedlings for the Soper-Wheeler site were to be auger planted. Vegetation control would be applied chemically to all plots and the plots will be kept weed-free during the life of the study.

All plots were established by the last week in March, 2002. Plot corners were marked by metal conduit and planting spots were designated with wire stake flags. All three sites had been planted as of the first week in April. Only ponderosa pine had sufficient numbers of seedlings to be out-planted on the Boise Cascade site. Six replications of

the 50 ppm and 300 ppm treatments were out-planted there. Fruit Growers had enough seedlings for 5 replications of each treatment for ponderosa pine and white fir; four replications of Douglas-fir were out-planted. Six replications of each treatment for ponderosa pine and white fir and five replications of Douglas-fir were out-planted on the Soper-Wheeler site.

Measurements for seedling height and caliper were taken at all three sites in October, 2002. Needle samples were taken at this time for foliar analysis. This foliar analysis is currently being done. Survival was noted at the time the measurements were being taken.

First year data were analyzed in December, 2002. The experimental design was completely randomized with one-way treatment structure. Two treatments were each replicated 4 to 6 times. To test for treatment effects and significant differences among treatments, one-way analysis of variance of treatment means and Tukey tests were applied. Statistical significance in all tests was at the 0.05 level.

Results: Survival at the end of the first growing season was uniformly high for both treatments with all species on the three sites. Survival was always higher for the 50 ppm treatment when compared to the 300 ppm treatment but not statistically higher. For the study as a whole (all three sites), ponderosa pine survival ranged from 97-100 percent; white fir from 91-100 percent; and Douglas-fir from 94-100 percent.

Caliper, height, and volume values for the seedlings are presented in Table 1 and Table 2. The first table shows

values at the time of lifting at Cal Forest Nursery in February of 2002. The second table shows the values at the end of the first growing season after out-planting. These measurements were taken in October, 2002. Volume is derived by multiplying squared caliper by the height.

For ponderosa pine, the only significant differences at time of lifting were for caliper of the Boise Cascade seedlings, where the 50 ppm treatment seedlings were larger than those in the 300 ppm treatment (a 19% increase), and height of the Fruit Growers seedlings, where the 300 ppm treatment seedlings were taller than those in the 50 ppm treatment (17% taller)

White fir seedlings showed no significant differences in caliper at time of lifting. Seedling height and volume for the 300 ppm treatment were always significantly larger than their counterparts in the 50 ppm treatment, however. The height of the seedlings receiving the 300 ppm treatment was about 45% greater than the height of those that received the 50 ppm treatment. The volume of the 300 ppm seedlings was about 50% more than volume of the 50 ppm seedlings.

For Douglas-fir, there were significant differences in height and volume at time of lifting for both Fruit Growers and Soper-Wheeler seedlings. The seedlings from the Fruit Grower's 300 ppm treatment also had significantly larger caliper than those seedlings in the 50 ppm treatment. Seedlings that were fertilized at the 300 ppm rate showed about a 30% increase in height over those fertilized at the 50 ppm rate. Volume was about 60% larger for the

300 ppm seedlings when compared to the 50 ppm seedlings.

It is obvious from the data presented in Table 1 that the seedlings are responding early on to the different levels of fertilization. For the most part, the seedlings that received the largest fertilizer rate (300 ppm) were bigger than those seedlings that received the smaller rate (50 ppm). At the time of their lifting in the nursery, white fir and Douglas-fir showed significant differences in height and volume for all seed lots. Those seedlings receiving the 300 ppm treatment were always larger than those receiving 50 ppm. Generally speaking, ponderosa pine seedlings did not show these differences.

The values shown in Table 2 represent the seedlings at the end of their first growing season after out-planting.

Even after one growing season in a plantation, ponderosa pine caliper does not differ significantly between the two fertilizer treatments. This is true for all three sites. The caliper for those seedlings receiving the 300 ppm treatment is always larger than that for the seedlings receiving 50 ppm, but not significantly so. Height and volume are a different story. Unlike at the time of lifting, these two values show significant differences between the two treatments after one growing season in a plantation. The values for the 300 ppm treatment are always significantly larger than those for the 50 ppm treatment. Height for the 300 ppm treatment shows about a 20% increase (average for the three sites) over the 50 ppm treatment. Volume shows about a 30% increase.

White fir seedlings showed significant differences in caliper, height, and volume between the treatments at the end of the first growing season on both sites. The 300 ppm treatment always had significantly larger seedlings than did the 50 ppm treatment. Caliper was about 17% larger, height about 43% larger, and volume about 97% larger for the seedling in the 300 ppm treatment when compared to those in the 50 ppm treatment.

Douglas-fir followed the pattern shown by white fir. In all instances except for the caliper of the Fruit Grower's seedlings, the values for the seedlings receiving the 300 ppm treatment were significantly larger than the values of those seedlings receiving the 50 ppm treatment. Height for the 300 ppm treatment was about 30% taller (two site average) than that of the 50 ppm treatment. Volume was about 65% more in the 300 ppm treatment than in the 50 ppm treatment.

In summary, after their first growing season, seedlings that were fertilized at the 300 ppm rate are always significantly taller and have significantly more volume than do their counterpart that received the 50 ppm rate. With the exception of ponderosa pine, this is also true for caliper. The percentage differences in height and volume that showed up at time of lifting are continuing to show after one year. The difference in volume is actually increasing. Survival is high regardless of treatment.

The seedlings will be measured at the end of their second growing season (fall 2003) to determine if these differences will continue to show. The higher level

of fertilization does produce a larger seedling at least through the first growing season

2003: The seedlings were remeasured for caliper and height at all three sites in the fall of 2003 at the end of their second growing season. Survival was noted at the time the measurements were being taken.

Survival at the end of the second growing season was still uniformly high for both treatments with all species on the three sites. Unlike at the end of the first growing season, survival was not always higher for the 50 ppm as compared to the 300 ppm. For the study as a whole (all three sites), ponderosa pine survival ranged from 95-99 percent; white fir from 83-99 percent; and Douglas-fir from 85-91 percent. These percentages are lower than those reported at the end of the first growing season, but not significantly so.

Caliper, height, and volume values for the seedlings are presented in Table 3. Volume is derived by multiplying squared caliper by the height. These values represent the seedlings at the end of their second growing season after out-planting.

At the end of two growing seasons in a plantation, ponderosa pine caliper does not differ significantly between the two fertilizer treatments. This is true on all three sites. The caliper for those seedlings receiving the 300 ppm treatment is always larger than that for the seedlings receiving 50 ppm, but not significantly so. Ponderosa pine height is significantly taller for the seedlings receiving 300 ppm when compared to those seedlings receiving 50 ppm. This

is true for all three sites. Height for the 300 ppm treatment showed about a 13% increase (average for the three sites) over the 50 ppm treatment. The ponderosa pines on the Fruit Growers site were the only ones to show significant differences for volume between the treatments. This is different than in 2002 when all three sites showed significantly more volume in the 300 ppm treatment as compared to the 50 ppm treatment. The 2003 volume for the seedlings receiving 300 ppm was about 35% more than the volume of the seedlings receiving 50 ppm.

Unlike at the end of the first growing season at which time both sites showed significant differences in white fir caliper, only the Soper Wheeler site shows significant difference between the treatments in 2003. The caliper of the seedlings receiving 300 ppm was about 18% larger than the caliper of the seedlings receiving 50 ppm. As they were in 2002, height and volume for white fir is significantly larger on the 300 ppm treatment as compared to the 50 ppm treatment on both sites, although the differences are getting smaller. Height is about 27% larger and volume about 63% larger.

Douglas-fir showed no significant differences between treatments in caliper

or volume on either of the sites. The values for the 300 ppm treatment were always larger than for the 50 ppm treatment but not significantly so. This is different than in 2002 at which time there were significant differences in volume on both sites and significant differences in caliper on one of the sites. Douglas-fir height was significantly different between the two treatments on both sites. For the study as a whole, height was about 24% larger in the 300 ppm treatment than in the 50 ppm treatment. This percentage difference is less than that found at the end of the 2002 growing season.

In summary, after their second growing season, seedlings that were fertilized at the 300 ppm rate are always significantly taller than are their counterparts that received 50 ppm. But the differences are less than at the end of the first growing season. Many of the significant differences among treatments in caliper and volume that showed up at the end of the first growing season are no longer there. The 300 ppm treatment always gives the higher values for these two variables but many of the differences among the two treatments are no longer statistically different. Survival continues to be high for all treatments.

Table 1-- Values for caliper, height, and volume for seedlings for the Timmer/Jopson Proposal at time of lifting, February, 2002.

	Caliper (cm)	Height (cm)	Volume (cm ³)
Ponderosa Pine			
Boise Cascade			
50 ppm	0.487a	15.000a	3.602a
300 ppm	0.409b	17.000a	2.928a
Fruit Growers Supply			
50 ppm	0.495a	16.200b	4.040a
300 ppm	0.457a	19.000a	3.909a
Soper-Wheeler			
50 ppm	0.476a	14.450a	3.295a
300 ppm	0.436a	16.850a	3.267a
White Fir			
Fruit Growers Supply			
50 ppm	0.347a	15.056b	1.842b
300 ppm	0.347a	23.889a	2.915a
Soper-Wheeler			
50 ppm	0.371a	16.600b	2.298b
300 ppm	0.384a	22.300a	3.313a
Douglas-fir			
Fruit Growers Supply			
50 ppm	0.383b	21.553b	3.229b
300 ppm	0.429a	30.580a	5.727a
Soper-Wheeler			
50 ppm	0.406a	26.000b	4.404b
300 ppm	0.440a	32.100a	6.252a

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 2-- Values for caliper, height, and volume for seedlings for the Timmer/Jopson Proposal at end of first growing season, October, 2002.

	Caliper (cm)	Height (cm)	Volume (cm ³)
Ponderosa Pine			
Boise Cascade			
50 ppm	0.756a	26.818b	16.948a
300 ppm	0.803a	29.170a	20.435a
Fruit Growers Supply			
50 ppm	0.896a	24.360b	21.178b
300 ppm	0.940a	29.976a	28.244a
Soper-Wheeler			
50 ppm	0.879a	19.977b	16.582b
300 ppm	0.921a	26.186a	24.009a
White Fir			
Fruit Growers Supply			
50 ppm	0.416b	20.628b	3.791b
300 ppm	0.484a	29.217a	7.282a
Soper-Wheeler			
50 ppm	0.490b	19.653b	5.045b
300 ppm	0.579a	28.399a	10.259a
Douglas-fir			
Fruit Growers Supply			
50 ppm	0.584a	28.475b	10.757b
300 ppm	0.659a	36.941a	17.544a
Soper-Wheeler			
50 ppm	0.592b	25.319b	9.663b
300 ppm	0.669a	33.945a	16.136a

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 3-- Values for caliper, height, and volume for seedlings for the Timmer/Jopson Proposal at end of second growing season, October, 2003.

	Caliper (cm)	Height (cm)	Volume (cm ³)
Ponderosa Pine			
Boise Cascade			
50 ppm	1.81a	43.79b	176.23a
300 ppm	2.02a	48.11a	219.36a
Fruit Growers Supply			
50 ppm	1.52a	38.89b	102.12b
300 ppm	1.65a	45.82a	137.57a
Soper-Wheeler			
50 ppm	1.97a	40.52b	176.53a
300 ppm	2.08a	45.83a	218.40a
White Fir			
Fruit Growers Supply			
50 ppm	0.77a	28.60b	18.74b
300 ppm	0.84a	36.69a	29.65a
Soper-Wheeler			
50 ppm	0.80b	27.31b	20.31b
300 ppm	0.94a	34.11a	33.88a
Douglas-fir			
Fruit Growers Supply			
50 ppm	0.83a	31.72b	27.52a
300 ppm	0.93a	40.40a	43.16a
Soper-Wheeler			
50 ppm	0.90a	33.46b	33.69a
300 ppm	1.00a	40.55a	45.42a

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Improving the Establishment and Growth of Douglas-fir and White Fir On Dry Sites Through Fertilization and Stock Type

Ed Fredrickson, Principal Investigator

Objectives: (1) To determine the partial contributions of stock size and fertilization to Douglas-fir and white fir survival, growth and total above ground biomass on dry sites in the interior Sierra Cascade region of northern California and southwest Oregon under vegetation-free conditions. (2) To determine the partial contributions of stock size and fertilization on initial root growth and total root volume (dry weights) after the first growing season in the field. (3) To determine differences attributable to site based on low and high precipitation zones.

Douglas-fir and white fir seedlings in four stock sizes will be subjected to two fertilization regimes and out-planted on three sites. Treatments will be replicated four times per site. Twenty-five trees will be planted per replication. Assume 3 years complete vegetation control for all treatments. Root volume measurements will be made at time of lifting and at the end of the first growing season in the field. Trees will be measured (ground-line diameter, height, survival) when planted and at years 1, 2, 3, 4, and 5. Foliar nutrient samples and dry weights per 100 needles will be collected and analyzed at years 1, 3, and 5.

Status: Seedlings were grown at Pelton Reforestation, Cal Forest Nurseries, PRT, IFA Nurseries, and Fowler Nursery for outplanting in the spring of 2003. Co-op members in this study include Roseburg Resources, Sierra Pacific Industries, and Boise Cascade.

Plot establishment and lay-out was completed on the first two sites in the fall of 2002 and on the third site prior to planting in February, 2003.

All three sites were planted during March, 2003. All sites had adequate soil moisture at time of planting and there was no snow on the ground. Each site received substantial moisture following the planting, so the seedlings got off to a good start.

The sites were set up according to the revised specifications: 10' X 10' spacing, 56 trees/plot, etc.

Preplanting measurements of caliper (1 inch above ground line) and height (from ground line to tip of bud) were taken on 50 randomly selected seedlings from each stock type/fertilization treatment for every species that was to be planted on each company's land. Twenty of these seedlings were taken back to Redding where they were oven dried and root/shoot ratios determined.

The two bare root stock types that were to receive the fertilization treatment were fertilized at the time of planting by placing one Wil-Gro briquette (9-9-4) in the bottom of the planting hole.

Boise Cascade

Two clearcut blocks were used for this installation – one for the pine and one for the Doug-fir. Both blocks are located near the town of Prospect, OR,

which is about 50 miles east of Medford, OR.

The plug-1s and the 1-1s were shovel planted; all other stock types were planted with hoedads. All pine stock looked fine, although the plug-1s were very large. With the Doug-fir, the plug-1s and the styro 8 unfertilized were slightly yellow; the rest of the stock types looked fine.

The pine block has 5 replications of each treatment. There was just enough room in the Doug-fir block for 4 replications of each treatment.

Sierra Pacific Industries

Two clearcut blocks were used at this site, also, one for the Doug-fir and one for the white fir. The blocks are located near the town of Feather Falls, CA which is east of Oroville. All stock types were shovel planted. The styro 8 Doug-fir (both fertilized and unfertilized) were slightly yellow.

The Doug-fir block has 5 replications of each treatment.

The 1-1 stock type for the white fir looked very poor. Size variability was large. There were not enough good trees to plant all the replications needing 1-1s, so only the 5 replications of the unfertilized treatment were planted. The 5 plots set up for the 1-1 fertilized treatment were left unplanted.

All styro 20 white fir were fertilized despite the boxes being labeled as fertilized or unfertilized. All boxes labeled as unfertilized were opened and sampled: all were fertilized. The boxes labeled as fertilized were also fertilized. The planting was done as if the labels on

the boxes were correct – seedlings from the boxes labeled unfertilized were planted in the 5 plots designated for the unfertilized treatment and seedlings from boxes labeled fertilized were planted in the 5 plots set up for that treatment. In reality, these 10 plots have the same treatment = fertilized styro 20 white fir.

The white fir styro 8 and plug-1 treatments each have 5 replications.

Roseburg Resources

Both species (Doug-fir and white fir) were planted in the same clearcut at this site. The planting site is located near Nubieber, CA.

All stock types were shovel planted.

The Doug-fir has 5 replications of each treatment.

As was the case with the stock for the Sierra Pacific site, the 1-1 white fir Roseburg stock looked very poor. There were not enough good seedlings to plant all replications needing 1-1s, so only the 5 plots of the unfertilized treatment were planted. The 5 plots designated to receive fertilized 1-1s were left unplanted.

The white fir plug-1 and styro 8 treatments each have 5 replications.

None of the styro 20 white fir were fertilized even though some of the boxes were labeled as being fertilized. A Wil-Gro briquette was placed in the bottom of the planting hole in the 5 plots designated to receive fertilized styro 20s. The 5 plots designated to receive unfertilized styro 20s received the proper seedlings.

In July, foliar samples for each species/stock type/treatment combination from all three study sites were collected. These samples were sent to the J.R. Peters Laboratory for nutrient analysis. In addition, dry weights per 100 needles were determined from these samples.

In October, representative seedlings from each species/stock type/treatment combination were dug up from each of the three sites. These samples were taken to Redding where they were washed and oven dried. Root/shoot ratios were determined from this procedure.

First year growth measurements were taken on all three sites during October – December. Measurements taken included caliper (at 1 inch above ground line) and height (ground line to tip of bud). Seedling volume will be calculated from these measurements. Survival was noted at this time as well as any pest problems.

The results from the various measurement and data collection operations that were done in 2003 are reported in nine tables found at the end of this narrative.

Table 1 (page 20) shows dry weights of 100 needles by treatment and species collected from the sites at the end of the first growing season in August, 2003. In general, the fertilized treatments had the larger values when compared on a stock type basis.

Table 2 (page 21) shows plant tissue analysis results for selected macro nutrients. These samples were collected at the end of the first growing season in

August, 2003. Other macro nutrients and a full set of micro nutrients were run. A full data set is on file at PSW in Redding and is available on request.

Table 3 (page 22) shows seedling survival by treatment and species at the end of the first growing season in August, 2003. The survival of the pine on the Boise Cascade site ranged from 94-100%; the Doug-fir ranged from 71-100%. The Doug-fir on the Roseburg site ranged from 38-96%; the Doug-fir on the Sierra Pacific site ranged from 42-68%. On the Roseburg site in 3 out of the 4 stock types, the seedlings in the unfertilized treatment had better survival than those in the fertilized treatment. This was reversed on the Sierra Pacific site where in 3 out of the 4 stock types, the seedlings in the fertilized treatment had a higher survival rate than did their unfertilized counterparts. On the Boise pine site, the seedlings that were fertilized generally had a lower survival rate than did the unfertilized ones in the various stock types. On the Boise Doug-fir site in two of the stock types the fertilized seedlings had a better survival rate than the unfertilized ones. In the remaining two stock types, the unfertilized seedlings survived better. There was only minor browsing damage to the seedlings on the Roseburg and Sierra Pacific sites. The Doug-fir on the Boise site showed browsing damage on 12 percent of the seedlings. The pine on the Boise site showed little browsing.

Table 4 (page 23) shows root/shoot ratios by treatment and species at the time of lifting in February, 2003. Significant differences between treatments are indicated. The bare root fertilized treatments have no values as

these treatments were fertilized at the time of planting.

Table 5 (page 24) shows root/shoot ratios by treatment and species at the end of the first growing season in October, 2003. Significant differences are indicated by letters following the numerical values. On the Boise and Roseburg Doug-fir sites there were no significant differences between the treatments. There are significant differences between treatments on the Sierra Pacific site and the Boise pine site.

Table 6 (pages 25-26) shows values for caliper, height, and volume at time of lifting in February, 2003. Significant differences within a stock type between fertilized and unfertilized seedlings are indicated. The 1-1 fertilized and the plug 1 fertilized treatments have no values as these treatments were fertilized at the time of planting. Volume is calculated by multiplying squared caliper by height. There were no significant differences in volume between fertilized and unfertilized treatments within a stock type for any species or land owner. All seedlings started out equal at planting time.

Table 7 (pages 27-28) shows values for caliper, height, and volume at the end of the first growing season, October, 2003. Significant differences within a stock type between fertilized and unfertilized seedlings are shown by letters following the numerical values. Only Boise Cascade pine showed any significant differences in volume within a stock type between fertilized and unfertilized seedlings. Plug 1 fertilized seedlings were significantly larger than their counterpart unfertilized ones. With this

exception, as at time of lifting, at the end of the first growing season, the seedlings within a stock type whether fertilized or not were still equal.

Table 8 (pages 29-30) shows significant differences between treatments for caliper, height, and volume at the time of lifting in February, 2003. Volume is calculated by multiplying squared caliper by height. Volume for the bare root treatments (1-1 fertilized and plug 1 fertilized) are missing as these two treatments were fertilized at time of planting. For all ownerships and all species, volume is always significantly higher for the bare root treatments than for the container treatments. With the exception of the Doug-fir on the Roseburg site where there is no difference, in all ownerships and species plug 1 volume is always significantly higher than 1-1 volume.

Table 9 (pages 31-32) shows significant differences between treatments for caliper, height, and volume at the end of the first growing season in October, 2003. As was the status at the time of lifting, for all ownerships and all species, volume is always significantly higher for the bare root treatments than for the container treatments. But different from the results at the time of lifting, in the bare root treatments, plug 1 volume is not always significantly higher than 1-1 volume at the end of the first growing season. By land owners, the treatments with the most and the least volume were: Boise Cascade pine = plug 1 fertilized and styro 8 fertilized; Boise Cascade Doug-fir = 1-1 fertilized and styro 8 fertilized; Sierra Pacific Doug-fir = plug 1 fertilized & nonfertilized and styro 8 fertilized; Roseburg Doug-fir = 1-1 fertilized and styro 8 unfertilized.

This study is scheduled for remeasurement at the end of its second growing season which would be the fall of 2004. In general, at the end of the first growing season, the treatments that had the biggest seedlings at the time of planting still have the biggest seedlings. The fertilized seedlings are not always larger than their unfertilized counterparts. Considering volume only, in about 60 percent of the time are fertilized seedlings larger than their counterpart unfertilized ones.

Since several of the seedlings, although still alive, were not very thrifty when measured in October 2003, survival could continue to be an issue on the Roseburg and Sierra Pacific sites for the container treatments, both fertilized and unfertilized.

Table 1—Dry weight values of 100 needles from seedlings of the Stock Type/Fertilization Proposal at end of the first growing season, August, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
Dry Weight/100 needles (grams)				
Plug 1 No/Fert.	0.16	0.18	0.24	1.68
Plug 1 Fert.	0.17	0.21	0.18	1.92
1-1 No/Fert	0.19	0.24	0.23	1.74
1-1 Fert.	0.19	0.23	0.26	2.12
Styro 8 No/Fert.	0.14	0.21	0.22	1.68
Styro 8 Fert.	0.20	0.23	0.24	1.57
Styro 20 No/Fert.	0.15	0.18	0.21	2.49
Styro 20 Fert.	0.19	0.23	0.28	2.83

Table 2—Plant tissue analysis results for selected macro-nutrients listed by the treatments showing the high and low values for seedlings of the Stock Type/Fertilization Proposal at the end of the first growing season, August, 2003.

	Nitrogen	Phosphorus	Potassium
	Percentage		
Boise Doug-fir			
Plug 1 F	2.25	Plug 1 N/F	0.188
St 8 F	1.50	1-1 F	0.109
		St 8 N/F	0.822
		Plug 1 N/F	0.511
Boise Pine			
St 8 F	1.59	St 20 F	0.194
1-1 N/F	1.05	1-1 F	0.134
		Plug 1 N/F	1.090
		1-1 F	0.972
SPI Doug-fir			
Plug 1 F	2.13	Plug 1 F	0.182
St 20 F	1.49	1-1 F	0.105
		St 8 N/F	0.738
		Plug 1 F	0.516
Roseburg Doug-fir			
Plug 1 F	2.64	St 20 N/F	0.190
St 8 N/F	1.47	1-1 F	0.121
		St 20 N/F	0.663
		1-1 F	0.519

F = fertilized; N/F = not fertilized.

Table 3—Seedling Survival by treatment and species for the Stock Type/Fertilization Proposal at end of first growing season, August, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
Percent Survival				
Plug 1 No/Fert.	61	47	85	98
Plug 1 Fert.	46	42	77	98
1-1 No/Fert	96	65	97	100
1-1 Fert.	86	68	100	99
Styro 8 No/Fert.	49	42	75	95
Styro 8 Fert.	82	56	71	94
Styro 20 No/Fert.	44	53	70	98
Styro 20 Fert.	38	58	78	94

Table 4 – Root/shoot ratios by treatment and species for seedlings from the Stock Type/Fertilization Proposal at time of lifting, February, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
	Ratio			
Plug 1 No/Fert.	1.61ab	1.58bc	1.40c	1.51b
Plug 1 Fert.	*	*	*	*
1-1 No/Fert.	1.91a	1.52c	1.90a	2.07a
1-1 Fert.	*	*	*	*
Styro 8 No/Fert.	1.42b	1.60bc	1.89a	1.56b
Styro 8 Fert.	1.38b	2.01ab	1.69abc	1.21bc
Styro 20 No/Fert.	1.74ab	2.12a	1.80ab	1.08c
Styro 20 Fert.	1.85a	2.20a	1.47bc	1.04c

* Fertilized at time of planting.

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 5 – Root/shoot ratios by treatment and species for seedlings from the Stock Type/Fertilization Proposal at end of first growing season, October, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
	Ratio			
Plug 1 No/Fert.	1.89a	1.86ab	1.72a	1.87b
Plug 1 Fert.	1.84a	1.55b	1.72a	1.71b
1-1 No/Fert.	1.82a	1.49b	1.73a	2.06b
1-1 Fert.	1.66a	1.59ab	1.94a	1.83b
Styro 8 No/Fert.	1.46a	1.65ab	1.87a	3.04a
Styro 8 Fert.	1.62a	2.25a	1.83a	2.47ab
Styro 20 No/Fert.	2.01a	1.60ab	1.92a	2.05b
Styro 20 Fert.	2.00a	1.61ab	2.00a	2.48ab

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 6—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at time of lifting, February, 2003.

Boise Pine	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	1.05	24.51	29.93
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.53	36.04	89.56
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.55b	25.82b	8.03a
	Styro 8 Fertilizer	0.43a	17.33a	3.37a
	Styro 20 No Fertilizer	0.54a	22.35a	6.72a
	Styro 20 Fertilizer	0.57a	20.46a	6.99a

Boise Doug-fir	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	0.97	43.83	44.73
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.17	37.97	53.76
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.37a	31.82a	4.46a
	Styro 8 Fertilizer	0.35a	29.27a	3.82a
	Styro 20 No Fertilizer	0.57a	37.57a	12.84a
	Styro 20 Fertilizer	0.56a	42.17b	13.94a

* Fertilized at time of planting.

This table shows significant differences within a stock type between fertilized and non-fertilized seedlings. For land-owner and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 6 contd.

Roseburg Doug-fir		Caliper (cm)	Height (cm)	Volume (cm³)
Treatment				
1-1 No Fertilizer		1.06	45.72	57.02
1-1 Fertilizer		*	*	*
Plug -1 No Fertilizer		1.12	35.76	49.50
Plug -1 Fertilizer		*	*	*
Styro 8 No Fertilizer		0.37a	22.11a	3.12a
Styro 8 Fertilizer		0.37a	23.00a	3.22a
Styro 20 No Fertilizer		0.56a	32.30a	10.73a
Styro 20 Fertilizer		0.52a	34.27a	9.73a
SPI Doug-fir		Caliper (cm)	Height (cm)	Volume (cm³)
Treatment				
1-1 No Fertilizer		0.96	35.08	34.46
1-1 Fertilizer		*	*	*
Plug -1 No Fertilizer		1.17	39.70	63.24
Plug -1 Fertilizer		*	*	*
Styro 8 No Fertilizer		0.34a	21.86a	2.55a
Styro 8 Fertilizer		0.34a	26.13b	3.12a
Styro 20 No Fertilizer		0.54a	35.54a	11.01a
Styro 20 Fertilizer		0.55a	35.47a	11.28a

* Fertilized at time of planting.

This table shows significant differences within a stock type between fertilized and non-fertilized seedlings. For land-owners and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 7—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at end of the first growing season, October, 2003.

Boise Pine	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	1.38a	30.17a	65.85a
	1-1 Fertilizer	1.49b	31.45a	77.08a
	Plug -1 No Fertilizer	1.65a	42.87a	125.37a
	Plug -1 Fertilizer	1.79b	45.11a	154.52b
	Styro 8 No Fertilizer	0.85a	30.11a	24.70a
	Styro 8 Fertilizer	0.83a	27.24a	20.29a
	Styro 20 No Fertilizer	1.04a	35.19a	41.19a
	Styro 20 Fertilizer	1.07a	33.79a	44.37a

Boise Fir	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	1.06a	44.56a	55.46a
	1-1 Fertilizer	1.10a	45.96a	60.95a
	Plug -1 No Fertilizer	1.07a	35.24a	46.84a
	Plug -1 Fertilizer	1.17b	36.41a	55.17a
	Styro 8 No Fertilizer	0.62a	31.43b	13.39a
	Styro 8 Fertilizer	0.54a	23.66a	7.97a
	Styro 20 No Fertilizer	0.76a	41.83a	26.30a
	Styro 20 Fertilizer	0.76a	39.20a	25.16a

This table shows significant differences within stock types between fertilized and non-fertilized seedlings. For land-owners and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 7 contd.

**Roseburg
Doug-fir**

Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
1-1 No Fertilizer	1.15a	45.53a	67.33a
1-1 Fertilizer	1.21a	48.91a	78.44a
Plug -1 No Fertilizer	1.13a	35.24a	55.21a
Plug -1 Fertilizer	1.06a	31.02a	39.92a
Styro 8 No Fertilizer	0.52a	23.64a	7.19a
Styro 8 Fertilizer	0.61a	27.49a	11.26a
Styro 20 No Fertilizer	0.69a	34.81a	18.57a
Styro 20 Fertilizer	0.64a	34.38a	16.00a

**SPI
Doug-fir**

Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
1-1 No Fertilizer	1.02a	40.88a	47.32a
1-1 Fertilizer	1.07a	39.75a	51.51a
Plug -1 No Fertilizer	1.20a	45.19a	77.01a
Plug -1 Fertilizer	1.28a	43.38a	78.92a
Styro 8 No Fertilizer	0.58a	26.59a	9.93a
Styro 8 Fertilizer	0.57a	26.96a	9.76a
Styro 20 No Fertilizer	0.67a	32.59a	16.45a
Styro 20 Fertilizer	0.79b	39.19b	26.40a

This table shows significant differences within stock types between fertilized and non-fertilized seedlings. For land-owners and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 8—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at time of lifting, February, 2003.

Boise Pine	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	1.05b	24.51bc	29.93b
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.53a	36.04a	89.56a
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.55c	25.82b	8.03c
	Styro 8 Fertilizer	0.43d	17.33e	3.37c
	Styro 20 No Fertilizer	0.54c	22.35cd	6.72c
	Styro 20 Fertilizer	0.57c	20.46d	6.99c
Boise Doug-fir	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	0.97b	43.83a	44.73b
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.17a	37.97b	53.76a
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.37d	31.82c	4.46d
	Styro 8 Fertilizer	0.35d	29.27c	3.82d
	Styro 20 No Fertilizer	0.57c	37.57b	12.84c
	Styro 20 Fertilizer	0.56c	42.17a	13.94c

* Fertilized at time of planting.

This table shows significant differences between treatments. For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 8 contd.

Roseburg Doug-fir		Caliper (cm)	Height (cm)	Volume (cm³)
Treatment				
1-1 No Fertilizer		1.06a	45.72a	57.02a
1-1 Fertilizer		*	*	*
Plug -1 No Fertilizer		1.12a	35.76b	49.50a
Plug -1 Fertilizer		*	*	*
Styro 8 No Fertilizer		0.37c	22.11c	3.12b
Styro 8 Fertilizer		0.37c	23.00c	3.22b
Styro 20 No Fertilizer		0.56b	32.30b	10.73b
Styro 20 Fertilizer		0.52b	34.27b	9.73b
SPI Doug-fir		Caliper (cm)	Height (cm)	Volume (cm³)
Treatment				
1-1 No Fertilizer		0.96b	35.08b	34.46b
1-1 Fertilizer		*	*	*
Plug -1 No Fertilizer		1.17a	39.70a	63.24a
Plug -1 Fertilizer		*	*	*
Styro 8 No Fertilizer		0.34d	21.86d	2.55c
Styro 8 Fertilizer		0.34d	26.13c	3.12c
Styro 20 No Fertilizer		0.54c	35.54b	11.01c
Styro 20 Fertilizer		0.55c	35.47b	11.28c

* Fertilized at time of planting.

This table shows significant differences between treatments. For land-owners and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 9—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at end of the first growing season, October, 2003.

Boise Pine	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	1.38d	30.17d	65.85c
	1-1 Fertilizer	1.49c	31.45cd	77.08c
	Plug -1 No Fertilizer	1.65b	42.87a	125.37b
	Plug -1 Fertilizer	1.79a	45.11a	154.52a
	Styro 8 No Fertilizer	0.85f	30.11de	24.70ef
	Styro 8 Fertilizer	0.83f	27.24e	20.29f
	Styro 20 No Fertilizer	1.04e	35.19b	41.49de
	Styro 20 Fertilizer	1.07e	33.79bc	44.37d

Boise Fir	Treatment	Caliper (cm)	Height (cm)	Volume (cm³)
	1-1 No Fertilizer	1.06b	44.56a	55.46ab
	1-1 Fertilizer	1.10ab	45.96a	60.95a
	Plug -1 No Fertilizer	1.07b	35.24cd	46.84b
	Plug -1 Fertilizer	1.17a	36.41c	55.17ab
	Styro 8 No Fertilizer	0.62d	31.43d	13.39cd
	Styro 8 Fertilizer	0.54d	23.66e	7.97d
	Styro 20 No Fertilizer	0.76c	41.83ab	26.30c
	Styro 20 Fertilizer	0.76c	39.20bc	25.16c

This table shows significant differences between treatments. For land-owners and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 9 contd.

**Roseburg
Doug-fir**

Treatment	Caliper (cm)	Height (cm)	Volume (cm ³)
1-1 No Fertilizer	1.15ab	45.53a	67.33ab
1-1 Fertilizer	1.21a	48.91a	78.44a
Plug -1 No Fertilizer	1.13ab	35.24b	55.21bc
Plug -1 Fertilizer	1.06b	31.02bc	39.92c
Styro 8 No Fertilizer	0.52d	23.64d	7.19d
Styro 8 Fertilizer	0.61cd	27.49cd	11.26d
Styro 20 No Fertilizer	0.69c	34.81b	18.57d
Styro 20 Fertilizer	0.64cd	34.38b	16.00d

**SPI
Doug-fir**

Treatment	Caliper (cm)	Height (cm)	Volume (cm ³)
1-1 No Fertilizer	1.02b	40.88ab	47.32b
1-1 Fertilizer	1.07b	39.75b	51.51b
Plug -1 No Fertilizer	1.20a	45.19a	77.01a
Plug -1 Fertilizer	1.28a	43.38ab	78.92a
Styro 8 No Fertilizer	0.58d	26.59d	9.93cd
Styro 8 Fertilizer	0.57d	26.96d	9.76d
Styro 20 No Fertilizer	0.67d	32.59c	16.45cd
Styro 20 Fertilizer	0.79c	39.19b	26.40c

This table shows significant differences between treatments. For land-owners and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Long-Term Competition Threshold Studies in Southwestern Oregon

Mike Newton, Principal Investigator; Ed Fredrickson, Co-op Sponsor

Objective: Determine the long-term (20 year) effects of various levels of shrub and herbaceous competition on planted ponderosa pine and Douglas-fir on four contrasting study sites.

In the early 1980s, Mike Newton established a series of studies in southwestern Oregon designed to look at how the growth of planted conifers was affected when the conifers were grown with various levels of competition. Four separate studies are still intact and have been measured regularly, but they have not been evaluated since 1994. The Applegate Study consists of ponderosa pine and Douglas-fir growing in various levels of manzanita competition. The study looks at no competition, 25%, 50%, 75%, and full competition from the manzanita. The Shoestring Study looks at Douglas-fir growth at four levels of competition from pacific madrone (none, low, medium, and high). The Fir Point and Squaw Studies are similar in design but focus on Douglas-fir growth with varying densities of tanoak cover. Three of the studies also look at the interactions with herbaceous cover (with and without).

These studies present an excellent opportunity to obtain growth and yield information based on various levels of competition which could be used to either validate, or make projections using the growth simulators SYSTUM-1 or its later variant, CONIFERS. These

data would allow us both to improve these young stand simulators and to make projections as to what these treatments might produce farther down the line.

Proposal: Re-measure all trees in those study sites which have not been compromised by subsequent management activities. Collect the type of measurements needed in order to make long-term projections using SYSTEM-1 or CONIFERS. Martin Ritchie of the Pacific Southwest Research Station at Redding will work with Mike as to what measurements need to be made.

Provided that sufficient data were collected to either validate, or make projections using the growth simulators, the Co-op agreed to funding at a level of about \$5000 for 2002. Some of the study sites may have been compromised. In one case, some of the numbered trees and tanoak have been cut by the landowner. In another, some of the plots have been brushed recently. Thus, some of the original group of study sites may have been lost. Mike will determine which of the study sites remain viable and report to the Co -op.

Status: The principal investigator received permission from the Co-op to measure these plots in the winter of 2003 (instead of 2002 as originally planned).

The measurements on the Doug-fir plots were finished by February 11, 2003. The pine plots were scheduled to be finished by February 26th. Mike met with Martin Ritchie of PSW earlier in the month on some of the plots to show Martin what kind of data he would be receiving. This data will be forwarded to Martin when Mike gets it entered and verified.

The forwarding of this data to Martin was done in the fall of 2003 and this fulfilled the obligations under the original contract Mike had with the Co-op.

In January, 2003 Mike was in discussion with the Directors of the Co-op regarding some other benefits that could be derived from the data being collected. He offered to provide some additional outputs from the data collection funded by the Co-op combined with data collected earlier from the sites. These included a straight-forward report on methods and what initial regressions show in terms of conifer yield at a variety of ages under the influences of various levels of competition.

A second output would be a comprehensive report that does cutting edge analysis of mixed conifer anovas of how curves develop in time in response to initial densities of weeds or changing levels thereof. This report would also have data about estimated increments of the brush with time in terms of where the brush or hardwood is going while the trees are developing. Guesses can be made as to whether the trees have dominated the brush completely, or whether the brush is still beating up on the trees and whether that situation is

changing. Is it the same for ponderosa pine as Doug-fir?

The second output would be in a manuscript form and would follow the initial report by a number of months. Preparation of a final publication would come later but would be well underway with the comprehensive report.

Mike offered to do this additional work for another \$5,000 from the Co-op.

This proposal was presented to the membership in August and was approved by the voting members by the end of the month. Mike has been notified and the Co-op has started the process of getting the second installment of funds allocated. Results will be reported in 2004.

Evaluation of New Formulation for Mating Disruption of the Western Pine Shoot Borer

Nancy Gillette and Jeff Webster, Principal Investigators

Introduction: The western pine shoot borer (WPSB), *Eucosma sonomana*, is a pest that causes severe height reduction in several pine species in western North America. Forest industry has invested considerable resources in planting sites subjected to wildfire, but the incidence of WPSB is on the increase, probably as a result of the increased acreage devoted to large, even-aged pine plantations. Many plantations are experiencing infestation levels of 30-40% of stems and in some cases, such as parts of the Pondosa plantation, infestation levels are in the 80-90% range. Attacks occur when tree heights are between 1 – 15 m tall. Female moths prefer terminal shoots and can reduce height growth more than 20% per year (Sower et al. 1984). This reduction in height growth results in considerable volume loss. Past studies showed that WPSB selectively attacks the fastest growing trees in the stands, and that elimination of WPSB can increase volume growth over a five-year period by 17-24%, depending on the background level of infestation (based on actual tree measurements) (Williams et al. 1989). Several different types of dispensers are effective for mating disruption with synthetic semiochemicals (Sower et al. 1982, Sower et al. 1984, Williams et al. 1989). However, the older pheromone release systems are limited because of their physical characteristics: Hercon® lures must be applied from the ground, when sites are often inaccessible, and Hercon® flakes require specialized aircraft that are no longer available. A new, microencapsulated (MEC) pheromone release system has been developed that shows promise for other forest pests (Rappaport et al. 2001). The MEC is a water suspension of microscopic beads containing the pheromone, and it is fully compatible with existing pesticide aerial application equipment. Thus, no specially equipped aircraft are needed to spray the MECs, and application can be made regardless of season, snow-pack, or road conditions. A MEC pheromone registered for eastern pine shoot borer (*Eucosma gloriola*) (Grant et al. 1994) is essentially the same as the pheromone for the WPSB, and thus is likely to also be effective against WPSB. We propose to test the MEC formulation of the eastern pine shoot borer pheromone as an aerial application for mating disruption of the WPSB.

Objectives:

- Evaluate a microencapsulated blend of Z-9 and E-9-dodecenyl acetate for mating disruption of WPSB.
- Determine reduction in host damage levels.
- Establish guidelines for operational use.

Justification: Cost-benefit analyses clearly demonstrate the value of prophylactic treatments for the control of WPSB damage in pine plantations; for young stands, the return on the investment was seven-fold (Williams et al. 1987, Daterman, unpublished). Estimates of infestation rates in the Pondosa plantation average 70-80% of the standing trees, with a concomitant potential height loss of 20% per year (i.e. a 5% loss in volume at harvest). There currently exist hundreds of thousands of acres of pine plantations in

the Pacific Northwest that are susceptible to WPSB or that will soon become susceptible. These plantations resulted from catastrophic wildfires such as the Pondosa, Scarface, Day and Fountain Fires, and are of necessity pine monocultures. As such, they are particularly susceptible to plantation pests, and steps must be taken to prevent further losses before these younger plantations reach the vulnerable stage. The new pheromone product is already registered with the US EPA, so very little expense or regulatory work will be required to implement this product for use in forest stands once efficacy is demonstrated.

Methods: The test sites will be located in pine plantations in northern California or southern Oregon that are heavily infested with WPSB, such as the Pondosa, Day, or Scarface plantations. Sites will be selected with trees that are 10-20 years old and range up to 7m tall. Two treatments (untreated controls, pheromone at 12g ai/A) will be replicated as five 50 acre plots (larger plots are better than smaller plots because of the risk of immigrating mated females from outside the treated area; however, 50 acres is the maximum we can treat without triggering an EUP requirement). Application will be made using standard procedures using helicopters or fixed-wing aircraft (as required by the terrain) equipped with booms for pesticide spray application. Plots will be separated by 1 kilometer for maximum isolation from treatment influence. A monitoring subplot of nine acres will be located in the center of each of the ten plots (5 treated and 5 control plots). Within each subplot, efficacy of mating disruption will be measured using 5 randomly placed male response traps ("sentinel" traps baited with the equivalent of one female moth's pheromone), monitored at biweekly intervals. Damage reduction will be assessed by measuring height and diameter growth of 50 randomly selected trees per nine-acre subplot. Post treatment impact evaluation will occur during the month of August 2002. Subsequent measurements will be made at two 5-year intervals if funding or in-kind services are available to cover the labor costs for the measurements. If results warrant, more 5-year or 10-year measurements could be taken until the end of the rotation. FHTET, in concert with the MEC manufacturer, will assess release rates of the formulation over the winter to ensure that release rates match those of Hercon® luretapes and flakes, which have demonstrated efficacy for western pine shoot borer. The treatments will be considered successful if the rate of damage reduction equals or exceeds that of the Hercon® flake release system (i.e. a 70% reduction in infested terminals).

Principal Investigators/Cooperators: Nancy Rappaport – Pacific SW Research Station; Jeff Webster – Roseburg Resources Co.; Ed Frederickson – Sierra-Cascade Forest Intensive Management Research Cooperative; Gary Daterman – Pacific NW Research Station; Gary G. Grant – Canadian Forest Service; John Stein and Richard Reardon – Forest Health Technology Enterprise Team; Grant Oliver – 3M Canada.

Duration: October 2001 – December 2003. We will conduct just a single application of the microencapsulated pheromone (March 2002). Post-treatment measurements will be done for one year post-treatment, but may continue for 5 years or more if treatment is sufficiently successful to warrant extra follow-up costs. Efficacy of mating disruption will be summarized and reported by November, 2002; impact on height and volume growth in 2002 will be reported by December 2002.

***Proposed Budget - FY 2002 (only):**

Organization	Contributed Resources
FHTET	\$14,000
3M Canada	\$10,000
PSW	\$8,000
PNW	\$5,000
Cooperative (Sierra-Cascade)	\$7,500
Roseburg Resources	\$2,000
Total	\$46,500

* Alternative budget, below, assumes that Coop will do post-treatment measurements.

References cited:

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- Grant G.G., MacDonald L, Frech D., Hall K., and Slessor K.N. 1985. Sex attractants for some eastern species of *Rhyacionia*, including a new species, and *Eucosma gloriola* (Lepidoptera: Tortricidae). *The Canadian Entomologist* 117: 1498-96.
- Rappaport, N.G., D.R. Owen and J.D.Stein. 2001. Interruption of semiochemical-mediated attraction of *Dendroctonus valens* (Coleoptera: Scolytidae) and selected nontarget insects by verbenone. *Environmental Entomology*
- Sower, L.L., D.L. Overhulser, G.E. Daterman, C. Sartwell, D.E. Laws, and T.W. Koerber. 1982. Control of *Eucosma sonomana* by mating disruption with synthetic sex attractant. *Journal of Economic Entomology* 75: 315-318.
- Sower, L.L. and M.D. Shorb. 1984. Effect of western pine shoot borer (Lepidoptera: Oelthreutidae) on vertical growth of ponderosa pine. *Journal of Economic Entomology* 77: 932-935.
- Williams, C.B., E.L. Smith and T.W. Koerber. 1989. Damage appraisal and management of the western pine shoot borer, *Eucosma sonomana*, in pine plantations in California: a case study. Pp. 110-123 in: R.I. Alfaro and S.G. Glover, *Insects affecting reforestation: Biology and Damage.* Forestry Canada, Pacific Forestry Centre, Victoria, British Columbia, Canada.

Alternative Proposed Budget - FY 2002 (only):

Organization	Contributed Resources
FHTET	\$14,000
3M Canada	\$10,000
PSW	\$8,000
PNW	\$5,000
Cooperative (Sierra-Cascade)	\$5,000
Roseburg Resources	\$2,000
Total	\$44,000

Status: A new study was initiated this year (2002) in northern California to test mating disruption of the western pine shoot borer (*Eucosma sonomana*). This moth is a serious pest, known to reduce height growth of pines up to 20% per year in western North America. A synthetic pheromone registered for the eastern pine shoot borer (*E. gloriola*) is also effective against the western pine shoot borer. This year, FHTET sponsored a new microencapsulated formulation of the pheromone for aerial application, and tested it for an area-wide effect on five 50-acre plots.

Preliminary results indicate that 12g/acre, applied aerially as a microencapsulated formulation of the active pheromone ingredient, significantly reduced early season trap catch (we report only results for the first month post-treatment, since moth flight was nearly over by that point).

Table 1. Numbers of moths responding to pheromone-baited traps, by week

	2 Weeks	2 Weeks	4 Weeks	4 Weeks
Location	Treatment	Control	Treatment	Control
Pondosa 1	0	15	2	127
Pondosa 2	0	82	0	41
Scarface 1	0	182	1	141
Scarface 2	0	24	19	168
Crank	0	96	7	44

The effect on infestation level was variable, with the best results seen in the two Pondosa plots and the worst results seen in the two Scarface plots (Table 2):

Table 2. Percent infestation of leaders by WPSB, treatment vs. control plots

Location	Treatment	Control	% Reduction
Pondosa 1	14	62	77.4
Pondosa 2	6	48	75.0
Scarface 1	32	70	54.3
Scarface 2	30	38	21.1
Crank	20	56	64.3

The reduction on infestation level varied between 21.1% and 77.4%, with the best results seen in the two Pondosa plots and the worst results at Scarface 2.

We have not yet determined the reason for the differences in efficacy at the different plots, but there are several possible explanations. First, differences in temperature and humidity may have caused the active ingredient to release at a more rapid rate on the Scarface and Crank plots than at Pondosa. Second, differences in weather may have caused differential degradation of the active ingredient (this possibility is not likely considering the nature of the pheromone). Third, there were different WPSB population pressures at the different sites (Scarface 2, in particular, started out with a very low pre-treatment infestation rate (2%), but infested leaders at the control site increased astronomically (to 38%, between 2001 and 2002) (Table 3).

Fourth, and probably most likely, differences in temperature and/or snow cover may have resulted in later emergence at some sites, thus missing the window of pheromone elution from the microcapsules. Results from the monitoring traps (Table 1), support this conclusion. For example, if the higher levels of infestation in treated plots resulted simply from increased population pressure, then we would expect Pondsosa 1 to have had a high infestation level, because by one month following treatment the Pondsosa 1 control plot had one of the highest trap catches. But in fact, Pondsosa 1 had the second-lowest level of infestation in the treated plot. We conclude, therefore, that the greater levels of control seen at the Pondsosa plots resulted from better synchrony of local phenology with spray timing. This conclusion suggests a need for a longer-releasing microcapsule, perhaps on the order of just 7-14 days longer.

Table 3: Percent infestation of leaders by WPSB, 2001 vs. 2002 (control plots only):

Location	2001	2002
Pondsosa 1	54	62
Pondsosa 2	48	48
Scarface 1	64	70
Scarface 2	2	38
Crank	50	56

The striking increase in background populations at Scarface 2 suggests that those plots constituted a stronger challenge to the treatments than did the Pondsosa plots, where background populations were either flat or only increased moderately. A second year of testing and statistical analyses is necessary to determine stand growth benefits. We will clearly need to assess treatment effects using the annual increase in infestation as a covariate, since it appears that rapid increases in background populations can affect efficacy.

These results, while somewhat disappointing, compare favorable in terms of efficacy with results from the luretape technology. We feel that the technology still has promise for use in western plantations, because it remains the only formulation that can be aerially applied using conventional spray equipment. We are currently trying to recruit funding for a second application, which we hope would further suppress moth populations.

2003: The Principal Investigators reported on the results of the 2002 application at the January 2003 business meeting of the Co-op. If 3M could develop a better/longer lasting formulation, the Investigators were proposing a second treatment in the spring of 2003. In March, the Co-op membership was notified that the new formulation had been developed and the Investigators were requesting funding amounting to \$1850 from the Co-op for this 2003 application. Funding for the second application was approved by the membership on March 24, 2003.

The pheromone got held up in customs (it was coming from Canada) and by the time it cleared customs and reached the researchers, the weather on the test site had deteriorated and prevented the application. By the time the weather improved, the insects were already flying and it was too late to apply the treatment in 2003. The plan is to store the

pheromone and apply for Co-op funding for a spring 2004 application. This request will be made at the January 2004 business meeting in order to distribute the funds to the researchers in time to apply the treatment in early spring.

Evaluating the Effect of Slow Release Fertilizers Incorporated into Containerized Seedlings in Mediterranean Climates

**Ed Fredrickson
Roseburg Forest Products Co.**

Objectives:

1. To evaluate the partial contributions of fertilizer type and rate to seedling survival and growth in the field for Douglas fir and ponderosa pine.
2. To determine the influence of site quality and precipitation on seedling response to incorporated slow release fertilization.

Introduction:

Over the last several years, the use of slow release fertilizers incorporated into container seedling media has become increasingly popular. Early results from studies done by the Nursery Technology Cooperative (Oregon State University) and others on Douglas fir response to slow release fertilizers were encouraging and showed strong potential for volume increases at the early stages of seedling growth.

These early results prompted timber companies to experiment with this process in other regions, specifically northern California and southwestern Oregon. The majority of the work done extrapolated the fertilizer data from Oregon to a more Mediterranean climate. Initial results were promising, however, as time went on significant problems with survival and growth were encountered with the fertilizer type and rates used from the Oregon data.

The purpose of this study is to determine appropriate fertilizer ratios and rates for typical conifer species grown in a Mediterranean climates and to evaluate survival and growth responses over a range of site qualities and moisture regimes.

Methods:

The experimental design within sites will be a completely randomized 2x2x4 factorial treatment structure split across sites. The treatments will be as follows:

- 3 sites (20-30" ann. Precip., 30-50" ann. Precip., >50" ann. Precip.)
- 2 species (Douglas-fir & ponderosa pine, sugar pine on Soper Wheeler Site)
- 1 stock size per species (ST-8, pine & ST-10, doug-fir)
- 1 fertilizer blend (Nutra-cote), ratio to be determined
- 4 rates per species (ST-8 pine = 0, 0.8, 1.6 & 3.2 grams per cell), (ST-10 doug-fir = 0, 1, 2 & 4 grams per cell)
- 2 plant timings (fall and spring)
- 16 total treatments per site x 5 replications = 80 plots per site.

Plots will contain 25 trees per plot spaced 5' x 5'. This will require 2000 total trees per site (1000 p. pine & 1000 d. fir)

Total land area needed will be approximately three acres. Buffer rows of trees should not be necessary since the experiment will be of short duration.

The low precipitation site will be on land managed by W.M. Beaty & Associates, the moderate precipitation site will be on land managed by Silver Butte Timber Co. and the high precipitation site will be on land managed by Soper-Wheeler Company.

Site Prep: All sites will be double ripped and site prepped with 4 lbs a.i./ac of atrazine. Follow up foliar treatments will be applied as necessary.

Soil Temperature: Since the release rate of the fertilizer is temperature dependent, soil temperatures will be monitored at two points on each site at a depth of six inches using Hobo data recorders over the entire first growing season. The Co-op will also look into installing a local weather station as an alternative option.

Status: The seed for this study was sent to PRT in Campbell River, B.C. in the fall of 2002 for sowing.

The site located on Silver Butte Timber Co. lands was site prepped and double ripped in the summer of 2002. The site on Soper-Wheeler lands was logged and the slash was piled in the summer of 2003. This site was not double ripped. The site on W.M. Beaty & Associates land was part of the Devil Fire which burned in May of 2001. The site was logged and double ripping was done in the summer of 2002.

Plot layout was done on all three sites in the summer of 2003. The Silver Butte

and Beaty sites have 80 plots each; the Soper site has 120.

Weather stations were installed at the Silver Butte and Beaty sites in August. The Soper site received a station in September. The continuous-recording stations measure soil and air temperature, soil moisture, and precipitation. They will be left in place over the winter.

After some rains in the early part of the month, the planting of the fall treatments started on the sites in October. The Silver Butte site was planted on October 24, the Soper site on November 4, and the Beaty site on November 5. The soil was moist at about the six inch depth on the Silver Butte site at the time of planting and the temperature was cool. The soil was dry at the other two sites and it was hot and windy on these sites. The planting was done by early afternoon at all three locations. The seedlings were auger planted on the Soper site to compensate for the lack of ripping. The other two sites were shovel planted. Within a week after planting, all sites had received rain.

There were some changes to the specifications as set forth in the original proposal. All seedlings were grown in Styro-10 containers, the fertilizer was Nutra-Cote 16-10-10, and the fertilization rates were 0, 1, 2, and 3 grams per cell. All the seedlings looked very healthy and each treatment was properly packed and labeled.

At the time of planting, sample seedlings representing all species by land owner were taken back to Redding where measurements of caliper and length were taken on 100 trees per species per land

owner (**Table 1**). At the time of measurement, the seedlings were visually examined for fertilizer. None of the seedlings that were treated at the "0" rate (no fertilizer) showed any signs of having been fertilized regardless of species. The ponderosa pines that were supposed to have received one of the three rates of fertilizer (1, 2, or 3 grams/cell) all showed evidence of fertilizer. It was impossible to estimate the rate, but all the seedlings had received some fertilizer. The Doug-fir showed a 13% error in fertilizer application – thirteen percent of the trees that should have been fertilized at one of the 3 rates were in fact not fertilized. The error for the sugar pine was 16%. Trees with as few as one prill per cell were considered fertilized.

The spring planting treatment will be applied in the spring of 2004. Similar measurements/observations like those taken on the fall planted seedlings will be made on seedlings from this planting. Caliper and height will be measured for all seedlings in each treatment at the end of the growing season. Seedling volume will be derived from these measurements. Survival will be noted at the time of measurement. First year results will be reported in the 2004 Annual Report.

Table 1—Values for caliper, height and volume for seedlings of Slow Release Proposal at time of lifting (fall treatment) fall, 2003.

	Caliper (cm)	Height (cm)	Volume (cm ³)
Ponderosa Pine			
Soper Wheeler	0.47	22.24	5.17
Silver Butte	0.46	20.21	4.38
Beaty	0.42	17.39	3.18
Douglas-fir			
Soper Wheeler	0.37	27.73	4.00
Silver Butte	0.37	28.69	3.99
Beaty	0.36	23.66	3.12
Sugar Pine			
Soper Wheeler	0.30	16.68	1.55

AN EXPERIMENT TO EVALUATE THE COMPETITIVE AND ECOLOGICAL EFFECTS OF UNDERSTORY VEGETATION ON THE PRODUCTIVE POTENTIAL OF YOUNG DOUGLAS-FIR PLANTATIONS

Robert F. Powers
Senior Scientist, PSW Research Station

Background

In 1994 the American Forestry and Paper Association (AF&PA) formed a partnership with the U.S. Department of Energy (DOE) to begin a competitive grants program called "Agenda 2020." The purpose was to focus research on industrial priorities for increasing productivity and energy efficiency. One of the priorities was "Sustainable Forestry." This Agenda 2020 priority centers on four research pathways: Biotechnology and Tree Improvement, Basic Physiology of Forest Productivity, Sustainable Forest Productivity, and Remote Sensing to Improve Forest Inventory and Stand Management. The goal is to substantially improve the productivity of our forests which provide the raw material for the industry. Forest Service Research joined the partnership in support of Sustainable Forestry in 1998. The Forest Service and DOE provide funds and technical support. AF&PA provides oversight and establishes priorities through various working groups. The National Council of the Paper Industry for Air and Stream Improvement (NCASI) provides technical expertise.

A national call for Forest Service Research proposals went out in 2002. Proposals were reviewed and ranked by AF&PA foresters for geographic regions of the U.S. R.F. Powers submitted a proposal titled "Treatments to Enhance Forest Productivity." The proposal was based on priorities raised at the February 2002 session of the Sierra-Cascade Intensive Forest Research Cooperative (SCIFMRC) in Mt. Shasta. A top priority was to determine the limits of plantation productivity for Douglas-fir and other species under various silvicultural alternatives. Powers' proposal received high marks by AF&PA, and in July 2002 he was awarded a 3-year grant of \$56 thousand per year. He notified the SCIFMRC Executive Team that he'd like to use the funds to enhance the Co-op's efforts. He then asked Brian Schlaefli, Chair of Working Group 2, to convene a meeting of SCIFMRC individuals to hone this research proposal. The original proposal was a modified "Garden of Eden" study expanded to Douglas-fir and other geographic regions. With this as a talking point, a half-day discussion was held December 3 in Mt. Shasta. A consensus was reached to initiate the study described below.

The Study

Problem statement. Early productivity of pine plantations declines as understory competition increases. Growth drops as ground cover of woody shrubs approaches 20 to 30%, with the effect persisting well after trees have overtopped the brush. Consequently, managers have tried to keep understory cover well-below the 20 to 30% threshold. However, the role of N-fixing shrubs is controversial. Some ecologists argue that the long-term value of N-fixing species exceeds their early competitive effect. Arguments such as these largely are speculative, because critical experiments have not been designed

to test the concept. Further, with the exception of work by Newton and colleagues in Oregon, few findings have surfaced on the competitive effect of woody and herbaceous species on the development of Douglas-fir plantations in drier climates characterizing the interior sites managed by SCIFMRC members.

Critical questions. Our group defined a series of major questions for research:

- How are interior Douglas-fir plantations affected by understory species?
- Are there understory density thresholds?
- Is there a competitive difference between herbaceous plants and woody shrubs?
- Is there a difference between N-fixing and non N-fixing shrubs?
- Do effects vary by site?
- Does fertilization make a difference?
- How do treatments affect the time to reach a target tree size?

Approach. The experiment will center on freshly prepared sites within the natural range of Douglas-fir in southern Oregon and Northern California. The treated area will encompass 15 acres, bordered by a cleared buffer with a minimum width of 100 feet. Sites will be wing-subsoiled in two directions before planting to minimize any legacy of skid trails or landings. Sites will be planted at a 12-ft spacing with superior quality Douglas-fir and a second species, such as ponderosa pine. Tree spacing and size of treatment plots (1/4 acre) are appropriate to maintain stand-like conditions until trees reach a DBH of 8 inches. Six main effect treatments applied randomly to each of four replicate plots are:

- No vegetation control (4 plots)
- Complete vegetation control using appropriate herbicides (4 plots)
- Herbaceous competition, only (no herb control vs 1st-year only = 8 plots)
- Woody shrubs, only (non N-fixing = 16 plots)
- Woody N-fixing shrubs, only (16 plots)
- Fertilization with a nutrient complete mix at lower levels of competition (12 plots)

Herbaceous competition will be at two levels: no initial treatment of herbs, and 1st-year only. For the woody shrub treatments, manzanita and ceanothus seedlings appropriate for the site will be produced in a nursery and planted with tree seedlings to achieve, by 5 years, ground covers of 5, 15, 30, and 50 percent. Planting densities will be based on assumed rates of mortality and estimated diameters of shrub crowns at 5 years. Each ground cover density will be maintained by spot treating individual plants when a ground coverage treatment has increased to one-third of the target level of the next highest cover treatment

Treatments with a target ground cover of 15% will be fertilized with mixtures of macro and micro nutrients at two intervals: (1) at 3 to 5 years when trees are well established; (2) when tree crowns have reached about two-thirds ground cover (the rapid stage of crown building).

Measurements. Soil profiles will be characterized according to the national standards of the Natural Resource Conservation Service. Meteorological data (plus soil moisture and temperature) will be recorded continuously using data loggers. Tree survival, height, crown length and width, and ground cover will be measured at growth years 1, 3, 5, 7, and 10. Foliar samples will be taken from current and 1-year foliage for nutrient analysis at each measurement interval. Samples also will be analyzed for cumulative water stress as indexed by ^{13}C and ^{12}C isotopic ratios. Soil samples will be analyzed for microbial abundance and diversity (functional and numerical).

Costs per installation through the 3-year life of the grant

Activity	Year 1	Year 2	Year 3
Site identification and preparation (20 acres)	5,000		
Slash abatement	1,300		
Tree seedlings	4,000		
Brush seedlings	12,000		
Plot layout	1,700		
Meteorological station		6,000	
Plant trees		2,500	
Plant brush		4,500	
Herbicide treatment		3,000	
Tree and brush measurements		5,000	
Brush density adjustments			2,500
Chemical analyses			12,500
Soil sampling			5,000
Microbial analysis			8,000
Data analysis			6,500
Total by year	24,000	21,000	34,500

Approximately \$168 thousand are available over three years for this study. The estimated total of \$79,500 per site covers 47 percent of PSW's available funds. This means that we can fund two installations and must decide on where they will be.

Demands on SCIFMRC

Powers takes overall funding and research responsibility. SCIFMRC will propose candidate sites. While 15 acres are needed for the 60 treatment plots, total cleared area probably will approach 30 acres. The first site is projected for Boise land in southern Oregon in the western Cascades. A second site should be established the following year in the eastside Cascades (on the most productive land), or in the northwestern Sierras or Cascades on very productive ground. Which way to go is the prerogative of the Co-op. Harvesting/clearing the site is the responsibility of the SCIFMRC partner, as is protection from other uses. If approved as a SCIFMRC project, Gary Fiddler will oversee the first three years of work to establish the experiment and SCIFMRC will assist by underwriting his time through membership dues. We will seek new grants to fund further work and to encourage piggybacking of other studies, such as forage production and wildlife use.

Status: As a follow-up to the January 13, 2003 Co-op meeting at which the Agenda 2020 proposal was accepted as a Co-op project, the membership was contacted in order to get suggestions on possible sites for the study (originally the first site was going to be located on Boise Cascade lands but the site nominated was not selected). In response to this request, two companies, Roseburg Resources (Ed Fredrickson) and Sierra Pacific Industries (Mark Gray) offered possible sites.

The Roseburg site consisted of two clearcut blocks located east of Redding near Big Bend. The stands had been harvested in the summer of 2003 and the additional site preparation required for implementation could be done in the fall. The stands harvested were high-site mixed conifer and the topography was almost flat. There were no restrictions on either of the blocks that would hinder the installation of the study. After two confirmation visits the Roseburg blocks were selected as the first Agenda 2020 site.

The SPI site was located northeast of Burney near the intersection of Highway 89 and the Dana Cutoff road. This site consisted of a single block that was scheduled for harvest in the fall of 2003. The stand was mixed conifer growing on a good site. Topography was flat. As with the Roseburg site, there were no restrictions on this stand that would hinder installation of the Agenda 2020 study. This block was chosen as the second site for the study.

As of December, the Roseburg site has been harvested and site preparation has been completed. The SPI site has been harvested with site preparation to follow in 2004. The goal is to install the Agenda 2020 study on both sites during the same time period. Plot lay-out is scheduled for the summer of 2004 with planting to be done in the spring of 2005.

Tom Jopson (Cal Forest Nurseries) has started the collection of manzanita cuttings in order to raise the seedlings (rooted cuttings) of this species that will be needed for the study. The ceanothus seedlings will be raised from seed which Tom has ordered from the Lawyer Nursery. Both shrubs will be raised by Cal Forest at their Etna, CA location.

Sierra Cascade Intensive Forest Management Research Cooperative
 Income/Expense Statement
 Calendar Year Report for the Period Jan. 1 to Dec. 31, 2003

Beginning Balance on January 1, 2002		\$54,930.83
Total Income (Membership Dues)		\$78,000.00
Expenses:		
Plot Lay-Out Supplies	1,003.02	
Plot Measurement/Lay-Out Contracts	5,976.08	
Plot Measurement/Lay-Out PSW Per Diem	1,570.14	
Foliar Analysis	1,152.00	
Weather Stations	2,690.75	
New/Old Proposals, Funding	5,000.00	
Co-op Manager Expenses	48,429.86	
Total Expenses		\$65,821.85
Year End Balance as of December 31, 2003		\$67,108.98

Co-op Manager's Time Breakdown

Annual Report	5%
Annual Business Meeting	4%
Proposal Work	80%
Field Trip	1%
Weed Tour	2%
Literature Searches	1%
Billings, Invoices, etc.	7%

Total time: 119 days

WORKING GROUP MEMBERSHIP

Working Group I Seed to Establishment

Tom Jopson, Chair
Ed Fredrickson
Jerry Gallagher
Mark Gray
Stuart Gray
Ron Hague
Tom Harvie
Lewis Howe
Duane Nelson
Glenn Novak
George Severson
Tom Young

Working Group II Out-planting Through Precommercial Thinning

Brian Schlaefli, Chair
Ed Fredrickson
Mark Gray
Stuart Gray
Scott Johnson
Jason Warshawer
Pat Minogue
Duane Nelson
Bob Powers
Tom Young
Lewis Howe