SIERRA-CASCADE INTENSIVE FOREST MANAGEMENT REASEARCH COOPERATIVE

Cooperative Manager: Gary O. Fiddler Ph. (530) 242-2478 Fax: (530) 242-2460
Email:gfiddler@fs.fed.us Cooperative website: http//wric.ucdavis.edu/sierra cascade/

PROGRESS REPORT 2000

In early 1999, a group of industrial foresters, researchers and manufacturers met to discuss needs for more intensive management-oriented forestry research. In a highly political climate, it seems that much of current forestry research has been redirected to issues other than maximizing productivity. The group's goal was to create a structure for ensuring and sustaining research that tackled priority issues of regeneration and early stand management. The result was the formation of the Sierra Cascade Intensive Forest Management Research Cooperative.

The primary purpose of the co-op is to focus on improving plantation establishment and early stand growth in a Mediterranean climate. Research conducted within the Cooperative would center on a variety of factors which contribute to establishment success and early stand growth such as seedling technology, tree nutrition, stocking levels and vegetation management.

The co-op was designed to concentrate on the research interests most important to the members at any given time, thus providing its members with beneficial information to aid their forest management decisions.

Based on the show of interest from prospective Cooperative members, a membership agreement was developed, then mailed in October, 1999 to interested parties in 25 organizations. Membership types and fee structures were explained in the agreements. Invoices for the year 2000 were mailed in January, 2000. Membership fees for 2000 were due February 1st.

An informal meeting of parties showing an interest in forming the Cooperative was held in Redding in conjunction with the 2000 Forest Vegetation Management Conference during the week of January 16th. This meeting was well attended and provided a chance to review the charter and give an update on membership and the status of the budget. The date for the first official meeting of the Cooperative was set for June 13, 2000. We discussed four research proposals to determine which would merit submission to the membership for funding consideration.

General proposals were:

1. Doug-fir stock size/ incorporated slow release fertilizer/ vegetation control and/or plant timing trial,
2. Exponential fertilization/ nutrient loading study,
3. Nelder Study: ponderosa pine, Douglas-fir, white fir incorporating vegetation control and fertilization,
4. Remeasurement of 25-year weeding and fertilization results of ponderosa pine.

The attendees at this January meeting were encouraged to submit more proposals to the Cooperative for possible funding.

By early March nine proposals had been received. These were sent on March 6th along with a ranking sheet to everyone on the mailing list. Recipients were asked to prioritize the proposals in order of importance, based on future Cooperative involvement. After rankings were tabulated, the top five proposals were repackaged to include more detail and relevant costs and sent out on May 22nd to all potential members for their review. This mailing allowed sufficient time for review prior to the meeting scheduled in June. The agenda for the June meeting would allow time to evaluate the top five proposals and vote on funding levels.

The first official meeting of the Sierra Cascade Intensive Forest Management Research Cooperative was held June 13, 2000 at Sierra Pacific Industries headquarters in Anderson, CA. As this was our first working meeting, a primary objective was to discuss and evaluate the structure of the Cooperative in its present form which consisted of a three-person governing body of directors, co-op manager, and voting members, as well as a board of non-voting advisors as invited by the co-op directors. By consensus, the current structure was judged satisfactory. A discussion followed concerning the roles of leadership and responsibilities of membership.

The next item of discussion concerned establishing and developing priorities for the Cooperative. The membership voted to establish subcommittees that would recommend to the membership priorities of research relating to seedling production, stand establishment, and early stand management. The Cooperative would then accept proposals relating to these areas of research. Voting members of the Cooperative would determine which of the submitted proposals were to be funded.

Members indicated that more input from DiTomaso and Powers was needed in the discussion of the submitted proposals, and that more proposals should come from within the membership than from outside sources.

Two subcommittees were established at the June meeting. Working Group 1 will concern itself with "Seed to Establishment", Working Group 2 with "Outplanting through Precommercial Thinning". Working Group 1 had eight volunteers and Working Group 2 had seven.

Proposals submitted to the Cooperative are to be routed to the appropriate Working Group to decide if the proposals merit consideration by the full membership. It is the responsibility of the Working Groups to present proposals in a form that is logically organized and readily understandable. Studiess should produce results that are statistically sound and publishable.

A round-robin discussion was conducted to allow members to briefly describe the types of operations that were being conducted presently on their holdings and also to note areas of concern for Cooperative focus. This exercise was designed to generate proposals for research.

The next item of business concerned budget and membership. A total of 18 dues-paying memberships are active. Of these memberships, seven are Land Manager memberships, seven are Associate Corporate memberships, and four are Affiliate memberships. This breakdown of membership-type results in a total of 21 votes that can be applied to matters brought before the Cooperative. Membership dues paid by these memberships provide a budget of $84,000. The membership mailing list is comprised of 33 individuals.

Next on the agenda was the evaluation of the top five proposals submitted to the Cooperative for funding consideration. Any changes needed were discussed and made as required. (A summary of these proposals can be found in Appendix 1.) The five proposals, principal investigator, and first-year requests for funding are:

1. "Determining the long-term effects of shrub control and nitrogen fertilization in ponderosa pine plantations"; Robert F. Powers; $5,000.
2. "Long-term effects of site establishment method and level of subsequent release on three conifer species"; W. Thomas Lanini and Joseph DiTomaso; $5,000.
3. "Fall planting literature review"; to be overseen by Gary Fiddler, no funds needed.
4. "Improving seedling nutrition in the nursery to increase seedling performance in the field"; Victor R. Timmer and Thomas Jopson; $30,000.
5. "Improving the establishment and growth of Douglas-fir and white fir on dry sites through fertilization and stock type"; Ed Fredrickson; $20,640.

Dues collected minus expenses of the Cooperative left $25,600 to be applied toward funding of the selected proposals. ($84,000 minus $8,400 overhead (10 %) minus $50,000 for manager's expenses.) The membership voted to fund proposals 1-3 and to consider funding items 4 and 5 after these two proposals were sent to Working Group 1 for revision and updating. (Progress reports for the three funded proposals are attached. See Appendix 2.)

Following selection of the funded proposals, discussion turned to the topics of contribution---of land, labor, etc.---needed to implement these proposals, and the roles of members and Cooperative leadership in implementation and follow-up.

This first meeting of the Cooperative was adjourned after the next order of business, which scheduled a meeting of Working Group 1 for the purpose of finalizing proposals 4 and 5 for resubmission to the membership for funding consideration.

FIRST MEETING OF WORKING GROUP 1

The "Seed to Establishment" working group met October 6, 2000 at the US Forest Service office in Redding. Twelve members attended. Thomas Jopson was chosen spokesman and primary contact for the group.

The Working Group established a flow pattern for future proposals. New proposals (preferably from within the Cooperative, but also from outside sources as well) will be submitted to the Cooperative directors (Fredrickson, DiTomaso, and Powers) who will then decide if the proposal has merit for the Cooperative. If so, the proposal may be returned to the author for needed revision. Once revised, the proposal will be submitted to all members of the Working Group for their review and recommendations. If the Working Group majority agrees that the proposal is worthwhile, the proposal will be presented to all members of the Cooperative for funding consideration. Once the proposal is accepted, Co-op directors will ensure a sound experimental design, and the Co-op Manager will oversee logistics and facilitate fieldwork.

The next agenda item concerned the two proposals referred to the Working Group at the June meeting. Specifically, the need existed to clarify the approach and logistics, and to refine the costs of, the Timmer-Jopson proposal, "Improving seedling nutrition in the nursery to increase seedling performance in the field", and to clarify the approach of the Fredrickson study, "Improving the establishment and growth of Douglas-fir and white fir on dry sites through fertilization and stock type". The full membership had decided at the June meeting that this last study could be funded with existing dollars, provided it was staggered with the time-table for the Timmer-Jopson study, and that it include at least one species common to all sites.

The Group decided on the following:

Timmer-Jopson proposal. Three sites representing high, medium and low site quality were selected. These sites are located on the lands of Soper-Wheeler, Boise Cascade, and Fruit Growers Supply Company, respectively. Seedlings with controlled levels of nutrition will be planted. Species include white fir, Douglas-fir, and ponderosa pine. A planting date of spring 2002 was selected. Site preparation will be pile and burn, coupled with appropriate herbicide for the competing species at each site. Subsoiling will be done. There will be no split plots in the study design--the entire plot will be kept weed-free. Seeds will be sown this fall/next spring. Seedlings will be grown as plugs. Site selection will be done in the summer of 2001.

Fredrickson proposal. Three sites representing high, medium, and low site quality based on water-holding capacity were selected. These sites were located on lands belonging to Roseburg Resources (dry/low), Boise Cascade (medium), and Sierra Pacific Industries (moist/high). Species include Douglas-fir (all sites) plus white fir or ponderosa pine. Seedlings will be grown at these nurseries: Pelton Reforestation (DF), Cal Forest Nurseries (PP), PRT (WF), and IFA Nurseries (1-1). Seedlings will be grown as plug 1 bare root, 1-1, and containers (stryofoam 8 and 20). Host land companies will provide seed.

The principal investigator will incorporate these modifications into his proposal. Proposals modified from this meeting were mailed to members of the Working Group on October 13th. Following Working Group acceptance, the two proposals will go before the entire membership for funding approval.

After an update on the three funded proposals, the meeting was adjourned.

Status of funded proposals:

1. "Determining the long-term effects of shrub control and nitrogen fertilization in ponderosa pine plantations" – plots were relocated and remeasurement was completed in mid-November (see Appendix 2.)
2. "Long-term effects of site establishment method and level of subsequent release on three conifer species" – remeasurement completed in October (see Appendix 2.)
3. "Fall planting literature review" – literature searches were made using several sources (WEBCAT, TREE CD, DIALOG). Over 100 pages of references (185 publications) resulted from these searches. Sample references can be found in Appendix 2. A survey also will canvas members on their experiences with fall planting. These experiences will become part of the literature review.

Website established for the Cooperative!
http://wric.ucdavis.edu/sierracascade/
This **website** is maintained by UC Davis, and will be the **focus for announcements**, updates, and progress reports. **Members** are encouraged to post **research data and anecdotal information** in the members-only section. Your data may be sent to **Kitty Schlosser** at **msschlosser@ucdavis.edu**
Phone (530) 752-1748 Fax (530) 752-9659.

Cooperative Directors

Joe DiTomaso
University of California
Davis, CA

Ed Fredrickson
Roseburg Resources
Weed, CA

Robert Powers
PSW Research Station
USDA Forest Service
Redding, CA

Cooperative Manager

Gary Fiddler
Silviculture Development
USDA Forest Service
Redding, CA

Land Manager Membership

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

Associate Corporate Membership

Monsanto Company
Wilbur-Ellis Company
PRT
Cal Forest Nurseries
Dupont
Pro-Source One
American Cyanamid (BASF)

Affiliate Membership:

Silver Butte Timber Company
Pelton Reforestation
Dow Agro Sciences
UAP Northwest

Appendix 1 FIVE PRIORITY PROPOSALS

Proposal 1: "Determining the long-term effects of shrub control and nitrogen fertilization in ponderosa pine plantations". Robert F. Powers, Principal Investigator.

Objective: Determine the long-term (25 year) carryover effect of vegetation control and fertilization in planted ponderosa pine on two contrasting site qualities.

Balderston Plantation consists of 33-year-old ponderosa pine growing at 3,200 ft. on the Eldorado National Forest between Georgetown and Blodgett. The plantation was established in spring 1967 after windrowing a 20-year-old brushfield of whiteleaf manzanita. A release spray of 2,4,5-T was applied after 1 year. But by 1975, manzanita again dominated the site, averaging between 9 and 12 tons biomass/acre.

Six replicated treatments were applied to each of two soil types in fall 1975. Five-year findings were summarized in Powers 1983 and other papers.

The Balderston experiment has historical value. It is California's first well-designed study of interactions between competing vegetation and fertilization. The fact that plots have been protected for more than 2 decades affords an opportunity to examine long-term trends. Trees can be remeasured and periodic changes in long-term (25-year) response can be charted.

Proposal: Remeasure all trees in the Balderston plots for survival, dbh, height and annual height increment, current volume, crown dimensions, and density of competing shrubs. Periodic height growth will establish trends over time. Foliar samples will be taken for biomass and possible chemical analysis (at a later time). Findings will be presented to the Cooperative by spring 2001.

Proposal 2: "Long-term effects of site establishment method and level of subsequent release on three conifer species". W. Thomas Lanini and Joseph DiTomaso, Principal Investigators.

Objective: Evaluate survival and growth of ponderosa pine, sugar pine, and white fir in response to three types of site preparation and three levels of subsequent selective shrub control.

In 1978, a field study was initiated on a brushfield located at 5000 ft. on the **Tahoe National Forest**, west of Foresthill, CA. The site was cleared for conifer planting by a rotary masticator, fire, or a brushrake with each treatment replicated three times. Within each of these nine treatment plots, three species of conifers were planted – ponderosa pine, white fir, and sugar pine. Each of the nine plots were further subdivided into three levels of subsequent shrub control – a single herbicide release treatment one year after conifer planting, two release treatments at one and two years after conifer planting, and no release after conifer planting. Tree survival and growth were measured from 1978 to 1983 (Lanini and Redosevich 1986). In a preliminary visit in 1999, it was determined that tree survival and growth were vastly different among treatments. This site represents a unique opportunity to measure the long-term impacts of different site preparation methods in combination with subsequent release on a single site.

Proposal: We propose to make measurements of tree survival, diameter and height on all trees in the summer of 2000. This will allow evaluation of the long-term effects of site preparation and subsequent release. We will also measure brush volume and species composition to further assess the impacts of treatments. Finally, we will establish the original plot borders and permanently record the coordinates using a GPOS init. This will allow the site and individual plots to be easily identified at any point in the future and facilitate their use for tours, classes, etc.

Proposal 3: Fall planting literature search.

Objective: Synthesize existing literature into one document summarizing the key components of fall planting.

Proposal: Conduct a thorough literature reviews on the various factors which influence success of fall planting including nursery issues, climatic conditions, species planted, stock types, seedling storage conditions, and site conditions. Copy and compile relevant papers into a form that can be easily distributed to co-op members. Determine where there are significant gaps in the data which may warrant further research. This information could then be synthesized into a single document.

Proposal 4: "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 outplanting 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.

Proposal 5: "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 outplanted 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 (groundline 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.

<u>Appendix 2</u> PROGRESS REPORTS – FUNDED PROPOSALS

<u>PROPOSAL 1</u>

Balderston Plantation Revisited: Does Vegetation Control or Fertilization Really Matter?

Robert F. Powers, Pacific Southwest Research Station, Redding, CA

Weed control is synonymous with plantation success in summer-dry California, and fertilization can improve 5-year volume growth by an average of 44% when combined with weed control (Powers *et al.* 1988). However, response to either treatment definitely varies by site quality (Powers and Reynolds 1999). Both weed control and fertilization make sizable demands on capital, but most reports of weeding or fertilization studies rarely cover more than 5 years. If investment is made early in the life of the stand--and if a response is obtained—two fundamental questions emerge: (1) "How long does it last?" (2) "How does it vary with site quality?" Fortunately, Balderston Plantation provides an excellent chance to address both questions.

Background.

The Setting. Balderston Plantation was established in 1967 at 3200 feet elevation on the Eldorado National Forest near Georgetown, CA. The site formerly supported a brushfield of whiteleaf manzanita that established in the wake of a 1947 wildfire. In 1966, brush and some topsoil were bulldozed into windrows set roughly a chain apart preparatory to planting with ponderosa pine. While this site preparation method was common throughout California and southwestern Oregon, Balderston Plantation has two unusual attributes.

Balderston plantation straddles two contrasting soil types separated by a draw. To the west are soils of the Mariposa series (fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults) weathered from slate formed from 200 million-year-old marine sediments. Site index is about 35 feet at 50 years. To the east are younger soils of the Cohasset series (fine-loamy, mixed, mesic Ultic Haploxeralfs) formed from a 50,000-year-old volcanic mudflow. Site index on the Cohasset soil is about 76 feet at 50 years--twice that of the Mariposa. Mariposa soil is moderately deep, but is infertile and stony. The Cohasset is deep with very few stones, and is relatively fertile. Because these contrasting soil types occur side-by-side on comparable aspects and elevations, because they were planted simultaneously, and because they receive the same precipitation (53 inches annually), the site is ideal for examining how soil type influences stand development and response to silvicultural treatment. The second unusual characteristic of Balderston Plantation is that it represents the West's first statistically valid field experiment involving factorial combinations of weed control and nitrogen fertilization.

Research History. In 1974 the entire plantation (then 8-years old) was choked with brush. Survival (640 trees/acre) was high, but growth was disappointing. I was asked to assess why the plantation was doing poorly. Trees on the Cohasset side were at or above the level of the thick understory of manzanita and deerbrush, but color was poor and trees weren't doing well. Those on the Mariposa side were even worse. Only a few trees were above the manzanita canopy, and all trees were yellow. Chemical analyses of the needles of even the best trees revealed a severe nitrogen deficiency on the Mariposa soil (0.8% N) and a borderline deficiency on the Cohasset (1.1% N). In 1975 Eldorado National Forest personnel and I installed 36 tenth-acre treatment plots, 18 on each soil type. The 18 plots consisted of 3 replications of brush removal treatments (none vs. complete removal by hand) crossed with 3 levels of fertilization with urea (0, 200, and 400 lbs N/acre). These six treatments were repeated three times on each soil type.

Both 1st year (Powers and Jackson 1978) and 5th year findings (Miles and Powers 1988) were dramatic. On the Mariposa soil, brush control alone nearly doubled 1st-year height growth and needle weight, and 5-year volume growth was tripled. Although trees were extremely deficient in N at the start of the experiment, fertilization had no effect if brush remained. Once brush was removed, tree volume growth on the Mariposa soil was increased 162% by 200 lbs N/acre and 255% by 400 lbs N. Results on the more fertile, deeper Cohasset soil were less spectacular. First-year responses were nil. Needle mass was increased only 35% by brush removal, and height growth was unaffected by any treatment. But differences strengthened over 5 years. Volume growth was doubled simply by brush control. It also increased more than 50% simply by fertilization with 200 lbs N/acre, and growth was tripled when brush control and fertilzation were combined. Fertilizing with 400 lbs N/acre did not improve growth further, regardless of brush.

Subsequent Treatments. By 1980 the study had completed its planned life span of 5 years, but the plots still had demonstration value. After the 1986 growing season, when the trees were 20 years old and 11 years past treatment, Gary Fiddler's Silviculture Development Unit restaked the plots and applied a second round of treatments. One of the three replicates received no further treatment. On the Mariposa side, the second of three reps originally receiving brush control was weeded again. The third remaining replicate received brush removal plus 200 lbs N/acre (regardless of whether it had been fertilized previously). On the Cohasset side, one replicate was left untreated, another was thinned, and a third was thinned and fertilized with 200 lbs N/acre. Thinning was from below to about 267 trees/acre, leaving trees at about a 13-foot spacing. Nothing further was done with the plots.

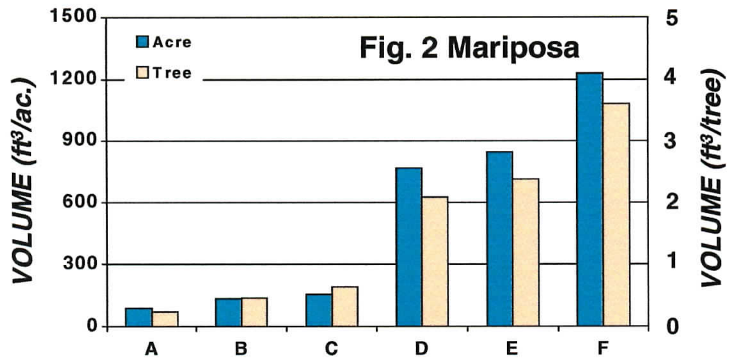
Year 2000. We returned to each 0.1-acre plot in November 2000--25 years after the original treatments. Trees were now 33 years old and all but two plots remained in good condition. We laid out 0.05-acre measurement plots within each treatment plot. Each measurement plot tree was tallied for DBH, and every 3rd tree was measured for current and past heights at intervals back to 1980 (the last measurement following the original treatments). Heights and DBHs were converted to inside bark cubic foot stem volumes (Oliver and Powers 1978). Volume:DBH equations were fit by regression and compared for each treatment and soil type. These equations were used to estimate standing tree volume for each treatment plot and results expanded to volumes per acre.

Findings.

General. Comparing tree volume and DBH trends for each plot indicated that a single general equation fit all trees on a given soil type, but that the equations differed by soil type.

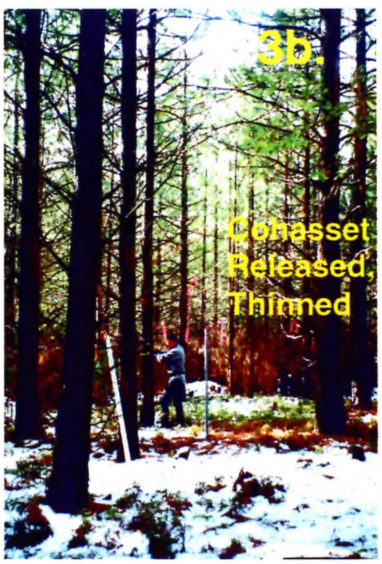
Mariposa. Figures 1a, 1b, 1c show the range of plantation conditions on the Mariposa soil type. After 33 years of brush development, tree survival had declined from the original planting density of 680 stems/acre to 268. Survival was 23% higher where brush had been removed at age 9. On plots with no previous treatment (the control), trees averaged only 16 feet tall and many were below the mean brush height of 8.2 feet (Fig. 1a). In all respects the plots had become brushfields. Where brush had been removed in 1975 without further treatment (Fig. 1b), trees were twice as tall (34 feet). Although a significant brush understory had reinvaded, these plots now resembled a minimally-tended tree plantation. Plots receiving both initial fertilization and brush control *and* subsequent thinning and fertilization now supported trees averaging 36 feet tall. These plots had the appearance of a well-managed plantation (Fig. 1c). (Arrows indicate heights of crewmembers standing in brush.)

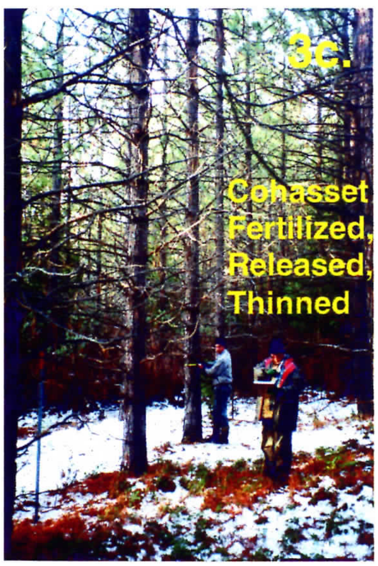
Retreatment in 1986 split the three replicate plots into separate, individual treatments, precluding analysis by inferential statistics. Spatial variation among plots caused further variability, but six distinct patterns in standing volume were apparent (Fig. 2). Plots lacking brush control had stand volumes varying between 88 and 157 ft^3/acre, with volume rising slightly with increasing N fertilization. Compared with the control treatment, brush removal in 1975 (year 9) led to standing volumes at age 33 that were nearly 9-fold greater (768 ft^3/acre) than controls—almost precisely the standing volumes predicted by Oliver and Powers (1978) yield tables. Mean stand diameters are 2.7 inches on control plots and 6.9 inches where trees had been released from brush 25 years earlier. Plots receiving both fertilization and brushing in 1975 showed an additional 10% volume response (846 ft^3/acre). The best response appeared in plots receiving both fertilization and brushing in 1975 and refertilization and brushing in 1986. There, standing volumes averaged 1228 ft^3/acre at 33 years—14-times greater volume than on the untreated controls and about what one would expect if the stand were 10-years older or 20 feet higher in site index. Mean stand diameter for the retreated plots averaged about 8 inches (Fig. 1c). Except for plots without brush control, no differences were apparent between plots receiving 200 or 400 lbs N/acre.



A - Control
B - Fertilized, 200N
C - Fertilized, 400N
D - Brushed
E - Brushed, fertilized
F - Brushed, fertilized, refertilized

Cohasset. Responses on the Cohasset soil contrasted strongly with those on the Mariposa. Survival was greater (407 trees/acre) and stand development had progressed further. Tree crowns had closed on control plots and understory vegetation was almost completely dead (Fig. 3a). Tree heights averaged 44 feet and diameters 7.3 inches on control plots and as much as 50 feet and 8.8 inches on those receiving N. Trees released from brush competition in 1975 and thinned in 1986 averaged 10.2 inches DBH and 52 feet in height (Fig. 3b). Those fertilized and released in 1975 and thinned a decade later averaged 11.1 inches in DBH and 58 feet in height (Fig. 3c).





Volume growth was substantially greater on the Cohasset soil than on the Mariposa, but treatment differences were more erratic (Fig. 4). Control plot volumes averaged 1784 ft^3/acre, 20-times those on the Mariposa control, and greater than the best treatment on Mariposa. Fertilization was effective on the Cohasset soil, even without brush control. Volumes were increased by 48% with 200 lbs N/acre and by 65% with 400 lbs N/acre. Simple brush removal at age 8 doubled net volume growth over the control--even though brush-free plots had been thinned in 1986 and the controls had not. The standing volume of 3344 ft^3/acre is about what is expected for unthinned plantations of that site quality, spacing, and age (Oliver and Powers 1978). Combining brush control with fertilization had little further effect. Where plots were refertilized and thinned, growth also followed this stair-step progression of 0N < 200N < 400N and the volume of the average tree was twice that of control plot trees. Surprisingly, net volume growth was consistently less on plots that had been refertilized in 1986 than on those fertilized only once. Further checking of stocking indicates that plots fertilized only once had 22% higher stocking (293 trees/acre compared with 240 trees/acre). Lower stocking density partially explains why trees on twice-fertilized plots produced less volume.

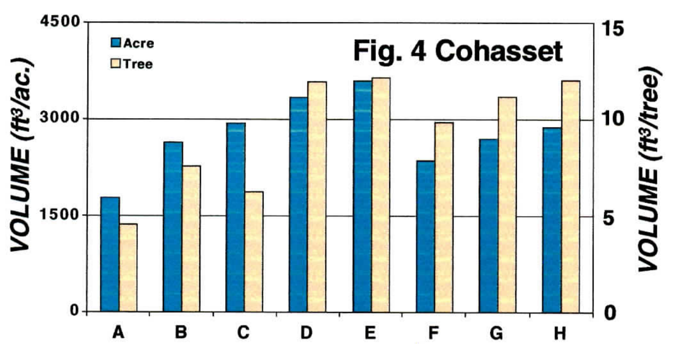


Fig. 4 Cohasset

A - Control
B - Fertilized, 200N
C - Fertilized, 400N
D - Brushed, thinned
E - Brushed, fertilized, thinned
F - Brushed, thinned, fertilized (200N)
G - Brushed, fertilized (200N) thinned, fertilized (200N)
H - Brushed, fertilized (400N) thinned, fertilized (200N)

Conclusions.

Mariposa. Despite a severe N deficiency and a linear response to N fertilization, volume production remained low if brush was present (Fig. 2), and what remains is a dense brushfield. Weak fertilization response indicates the immense influence of soil moisture in controlling forest development on droughty sites (in this case, droughty from high stone content and a high density of aggressive shrubs). Brush removal early in the life of the plantation reduced tree mortality and permitted the development of a reasonably productive, young forest. Plots free of shrub competition responded positively to N fertilization, but differences between 200 and 400 lbs N/acre were not apparent by age 33. Nor was the 25-year response to N particularly impressive (a volume increase of only 10% over brush control, alone). This is because thinning improved moisture availability temporarily so that trees could respond to fertilizer N. But once stand growth had increased sufficiently or understory brush had reinvaded, moisture again limited production. Retreating such plots in 1986, 10 years after the original treatments, did boost growth substantially (382 ft^3/acre more than those treated only once).

Cohasset. Because Cohasset soils are less stony and have greater water holding capacities than Mariposa soils, brush competition does not threaten plantation survival. By age 33, trees in control plots averaged 390 stems/acre and had shaded out all but a few shrubs (Fig. 3a). The consequence, however, is a fuel ladder of dead brush averaging more than 9 feet tall that merges with dead lower limbs of the trees (Fig. 3a). Although brush competition is not as serious on this productive soil, early brush control stimulated volume growth considerably. Brushed plots were thinned to two-thirds the stocking of those with brush. Even so, net volume production easily compensated for fewer stems per acre, and average volume per tree was doubled (Fig. 4). Despite better native fertility of the Cohasset soil, fertilization at 400 lbs N/acre produced a volume response nearly that of brush removal. Fertilization combined with brush removal substantially improved growth, but the effect diminished as standing volume exceeded 3000 ft^3/acre. Because of variability in stocking of individual plots, it wasn't clear whether benefits from refertilization exceeded those from a single fertilization a decade earlier.

Conclusions are:

- A forest will *not* develop in 33 years on droughty sites without brush control.
- Even on extremely infertile sites, response to fertilization is blocked by brush competition if the site is droughty.
- With early brush control, a stand *will* develop.
- Fertilization response is possible on droughty sites if brush is controlled, but follow-up treatments may be needed for the greatest volume response.
- On better sites, a stand will develop even without brush control.
- Trees on better sites will shade out understory brush by age 33, but an extremely hazardous fuel ladder will persist. On poorer sites, it takes longer.
- Growth on better sites can be improved by either brush control or fertilization.
- Better sites give a far-greater return in volume production than poorer sites for the same silvicultural investment.
- Regardless of site quality, silvicultural investments made early in the life of the plantation will carry for periods of at least 25 years.

The Balderston study exemplifies the long-range value of well-designed experiments. However, the 0.1 acre treatment plots now support trees approaching 60 feet tall. This means that many trees were affected by conditions on adjoining areas (walls of brush, brush-free clearings). This "edge effect" from small plot size tends to reduce the differences between treatments and suggests that results reported here probably are conservative. Plot size and long-term value are important considerations for field experiments yet to be designed by the Cooperative.

Literature Cited.

Miles, Scott R., and Robert F. Powers. 1988. Ten-year results of forest fertilization in California. USDA Forest Serv. Earth Resources Monograph 15: Region 5. 87 p.

Oliver, William W., and Robert F. Powers. 1978. Growth models for ponderosa pine: I. Yield of unthinned plantations in northern California. USDA Forest Serv. Res. Pap. PSW-133. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 21 p.

Powers, Robert F., and Grant D. Jackson. 1978. Ponderosa pine response to fertilization: influence of brush removal and soil type. USDA Forest Serv. Res. Pap. PSW-132. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 9 p.

Powers, Robert F., and Phillip E. Reynolds. 1999. Ten-year responses of ponderosa pine plantations to repeated vegetation and nutrient control along an environmental gradient. Canadian Journal of Forest Research 29: 1027-1038.

Powers, Robert F., Steve R. Webster, and P.H. Cochran. 1988. Estimating the response of ponderosa pine forests to fertilization. p. 219-225. In: Future Forests of the Mountain West: a Stand Culture Symposium. USDA Forest Serv. Gen. Tech. Rep. INT-243: Intermountain Research Station, Ogden, UT.

PROPOSAL 2

The Effect of Site Preparation Method and Secondary Release Treatments on Three Conifer Species at 21 Years after Planting

W. Thomas Lanini, University of California, Davis

A field study was conducted to compare site preparation methods and shrub control after planting on the survival and growth of ponderosa pine, sugar pine, and white fir. The seven-acre site used for this study is located in Tahoe National Forest approximately 15 miles northeast of Foresthill, CA., at a 5000 ft. elevation. The study site was occupied by mature shrub species when the study was initiated in 1978. The study design was a split plot, with site preparation being the main plots and level of shrub control being the subplots, with all plots replicated three times. Site preparation was performed in the fall of 1978, and methods included rotary mastication (Hydroax®), brush rake, and a controlled burn. Ponderosa pine, sugar pine (both 1 yr-old) and white fir (2 yr-old) were planted in the spring of 1979 on a 6 ft. by 6 ft. spacing, for a total of 88 trees per species per subplot (264 total trees per subplot). Three levels of shrub control were imposed on each main plot; no treatment after site preparation, a single herbicide treatment (September 1980), or two herbicide treatments (June 1979 – shielded application, and September 1980). Tree survival and growth were intensively measured until 1983 (Lanini and Radosevich 1986). In September 2000, tree survival, height, diameter at breast height, shrub composition and shrub volume were measured on each plot.

Data from the September measurements are currently being analyzed. Observationally, survival of ponderosa pine and white fir declined a few percent from the last measurements made in 1982. Sugar pine survival declined by over 50%, primarily due to disease (blister rust). Height and diameter growth of the all conifer species increased, with the greatest increase observed in the ponderosa pine. In subplots that received two herbicide treatments, ponderosa pine were 25 to over 40 feet tall, with diameters ranging from 8 inches to over 14 inches. In plots with no subsequent shrub control after site preparation, ponderosa pine were about 50% smaller. White fir were somewhat larger in plots with two release treatments, but the difference between trees in plots with two release treatments versus those with no release treatments was not as great as with the ponderosa pine. The surviving sugar pines were intermediate between the ponderosa pine and the white fir in their response to release. Once data are analyzed, a complete report will be submitted.

Literature Cited:

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

Shrubs are more than 6 feet tall, making it difficult to find and measure conifers.

Steve Radosevich and crew preparing to measure conifers.

Ponderosa pine in brushed-raked plots with two release treatments.

White fir sticking out of shrubs in plots with one release treatment after site preparation (fire).

Whitehorn and black oak competing with ponderosa pine.

PROPOSAL 3

Fall Planting Literature Review

Gary O. Fiddler, Silviculture Development Unit, USDA Forest Service, Redding, CA

Preliminary literature searches have been conducted using several sources (WEBCAT, TREE CD, DIALOG, etc.) Over 100 pages of references resulted (185 publications.) Less than one-half of these publications had reports on research conducted in the United States. An even smaller number had reports on research conducted in northern California and southern Oregon, the region of primary interest to Cooperative members. Most of these latter references concerned nursery practices for producing good seedlings with little, if any relevancy specific to fall planting. An important part of the literature review, once completed, will be derived from a survey given to all members, the results of which will chronicle their own personal experiences with fall planting.

The following are two superior examples of the type and style of references found:

Jenkinson, James L. 1980. ***Improving plantation establishment by optimizing growth capacity and planting time of western yellow pines.*** Res. Paper PSW-154. Pacific Southwest Forest and Range Exp. Station, Forest Service, U.S. Dep. Agric., Berkeley, CA.

Seedlings of 27 sources of western yellow pines, selected in climates typical of the species, were raised in a nursery in the western Sierra Nevada. Seedling top and root growth capacities were periodically assessed during fall and winter, and field survivals of outplanted seedlings were evaluated in different climates with summer drought. In the nursery, four distinct, innate seasonal patterns of root growth capacity were defined in ponderosa pine from within and outside California, and two distinct patterns were defined in Jeffrey pine. Below snow line in the western Sierra Nevada, seedling survivals were higher in spring plantings than in a winter one, and for California sources than for others. In spring plantings above snow line, survivals for diverse local sources of ponderosa and Jeffrey pines were uniformly high, both on the western slope and east of the Sierra Nevada crest. The results demonstrate that seedlings of any source will have adequate growth capacity and will survive the first year on any well-prepared site if they are lifted at the right time, stored properly, and planted in phase with warming soil trends.

Adams, D.L., Graham, R.T., Wendy, D.L., Mohamed, D.A. 1991. ***Effect of planting date on survival and growth of three coniferous species of container seedlings in northern Idaho.*** Tree Planters Notes, 1991, 42:2, 52-55.

One-year old seedlings of Pseudotsuga menziesii var. glauca, Pinus monticola and Pinus ponderosa were planted on a uniform site at 2 week intervals from late August to early November 1988. Seedling survival and growth were assessed during the 1989 growing season. Planting date did not affect first-year survival, which was 95-100%. Although the differences were not significant, the earliest planting date produced the largest seedlings at the end of August 1989. It is concluded that these species can be planted in early autumn if soil moisture is satisfactory.