

2

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

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## 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 1<sup>st</sup>-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 1<sup>st</sup>-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  $^{13}\text{C}$  and  $^{12}\text{C}$  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
<b>Total by year</b>	<b>24,000</b>	<b>21,000</b>	<b>34,500</b>

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 layout 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 that Tom has ordered from the Lawyer Nursery. Both shrubs will be raised by Cal Forest at their Etna, CA location.

**2004:** Site preparation was completed on the Sierra Pacific Industries site during the summer of 2004. Plot layout on both sites was completed by September. Some changes were made to the original proposal prior to plot installation. Conifer spacing was changed from 12x12 to 8x8 feet resulting in 168 trees per plot. Of these 168 trees, 80 are measure trees. There will be a total of 8736 seedlings (4368 pine and 4368 Doug-fir) planted per site. There are thirteen treatments replicated four times per site. This makes a total of 52 plots per site. Contracts for marking the planting spots at both sites were let during November. The conifer seedlings for this study are being raised at Cal Forest Nursery. Ceanothus seedlings are growing at Cal Forest nursery, also. Nursery crews collected plant material in November from the sites in order to start raising the manzanita plants required by the study. The treatments will be installed in the spring of 2005 as originally planned.