Sierra-Cascade Intensive Forest Management Research Cooperative

Series Report No. 14

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

ANNUAL REPORT 2013

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The year 2013 marked the fourteenth year as an organization for the Sierra Cascade Intensive Forest Management Research Cooperative.

Membership remained constant from 2012. The current membership consists of a mixture of landowners, forestry-related industries, State of California and federal agencies. There are currently fifteen member organizations in the Co-op.

Two presentations of results from research supported by the Cooperative were presented by members of the Co-op at the Forest Vegetation Management Conference in January. Vanelle Peterson reported on her research on two new pesticides, Milestone VM and Pindar GT (Proposals 10-01 and 12-03). The title of her presentation was "New Site Preparation Chemistry for Chemically Intolerant Conifers". Ed Fredrickson reported on additional studies with Mat 28 (Proposal 11-03). His presentation was titled "Brush Control Results with Aminocyclopyrochlor (Mat 28) using Foliar, Basal, Cut Stem, and Hack and Squirt Application Methods". Both presentations were well received by the audience.

The annual business meeting was held at the Forest Service office March 5, 2013 in Redding (a summary of the meeting can be found in this Annual Report). Sixteen Co-op members and guests attended. The first item of business was a review of membership status and the budget. The Co-op ended 2012 with a surplus of $23,370.

Scott Worden agreed to assume the Chair position of Working Group II. This position became vacant when Jason Warshawer went to work for P.G. & E.

Following the discussion on the budget, updates on nine recently funded Co-op studies were presented: Proposal 11-01 Sunscald; Proposal 08-02 Cedar Stock Trials; Proposal 10-02 Vista; Proposal 10-01 Milestone; Proposal 11-02 GF9999; Proposal 11-03 Mat 28 Site Prep; Proposal 12-01 Soil Pits; Proposal 12-02 Garden of Eden; and Proposal 12-03 Pindar GT. Executive Summaries of most of these studies are presented in this Annual Report. Due to poor seedling survival (see 2012 Annual Report), the membership voted to abandon the Cedar Stock Trial study.

The final item of business at the annual meeting was the presentation of four new proposals for possible Co-op funding. The Co-op was able to finance all of these proposals (Proposal 13-01, Matrix Site Prep; Proposal 13-02, Pindar GT/GoalTender; Proposal 13-03, Pondosa Remeasurement; and Proposal 13-04, Co-op Study Plot Mapping).

Spring treatments for the Pindar GT and GoalTender "over the top" study approved in 2013 were applied on March 26th. The treatments for the spring Matrix site preparation study approved in 2013 were applied on March 28th.

The Co-op field trip scheduled for June 11th in the Shingletown area had a good turnout with 20 Co-op member and guests attending. Stops included studies of Pindar GT & Goal Tender release, Ponderosa Fire swale study; Rock Creek water monitoring station;

Matrix site preparation; and Pindar GT, Goal Tender, and Milestone site preparation.

Evaluations of results from the three ongoing herbicide studies (Mat 28, GF9999, and Pindar GT) were conducted in August and September. Evaluations for the two new 2013 studies (Pindar GT/GoalTender and Matrix site preparation) were also done in August.

Jeff Webster completed the study mapping for Proposal 13-04 in August. Each Co-op study location is represented with a labeled color photograph. The label includes Co-op proposal designation number, study name, property owner, landowner contact, legal description and GPS location. The maps were mailed to each landowner in September. Jeff did an excellent job and this effort was well received by the membership.

The fall treatment for the Pindar GT/GoalTender study was applied on October 1st. Since this treatment was applied so late in the season, it was not evaluated in 2013. This treatment will be evaluated in 2014 and 2015.

The plots in the three Garden of Eden sites (Whitmore, Elkhorn, and Feather Falls) included in Proposal 12-02 were logged by early fall. Site preparation was completed by December. These sites will be planted in the spring of 2014.

Jeff Webster completed the data collection for the Pondosa Remeasurement study (Proposal 13-03) in December. Data are being analyzed and results will be reported in the 2014 Annual Report.

The year 2014 should be another busy one for the Co-op. New proposals are currently being submitted to the Co-op for funding consideration. Several funded studies will have second year measurements made. Based on the interest shown for field trips featuring Co-op study sites, another trip will be planned for 2014. Interest in joining the Co-op in 2014 has been expressed by two potential new members.

20013 MEMBERSHIP

Land Manager Membership
- California Department of Forestry
- Fruit Growers Supply Co.
- Roseburg Resources Co.
- Sierra Pacific Industries, Inc.
- Soper-Wheeler Co.
- Timber Products Co.
- W.M. Beaty & Associates, Inc.

Associate Corporate Membership
- Cal Forest Nurseries & Mountain Gate Gardens

Affiliate Membership
- Dow AgroSciences
- Silver Butte Timber Co.
- Thunder Road Resources

Supporting Members
- California Forestry Association
- PSW Research Station
- University of California
- USDA Forest Service

Sierra Cascade Intensive Forest Management Research Cooperative

Annual Meeting March 5, 2013

The 2013 annual meeting was held at the Forest Service office in Redding, CA on March 5, 2013. Sixteen Co-op members and guests attended.

The 2012 Annual Report was the first item of business. Membership status was discussed. All members from 2012 have either paid 2013 dues or indicated that dues payments are on the way. There are currently fifteen member organizations in the Co-op. Ed Fredrickson is going to pursue the possibility of getting DuPont to join the Co-op.

The next item of business was a discussion on the budget. The Co-op ended 2012 with a surplus of $23,370. Dues received for 2013 at the time of the annual meeting totaled $42,000. Another $16,000 has been promised. To supplement the summary of the 2012 budget found in the Annual Report, spread sheets of the proposed budget/workload for 2013-2017 and the Co-op manager's time/contract costs through the same period were presented to the membership.

Following the discussion of the budget, a printout documenting the status of all the funded proposals was distributed. The Co-op, during its 13 year existence, has contributed $790,723.32 to forestry research. This research has resulted in sixty six publications/proceedings.

A discussion of the desirability of a Co-op field trip for 2013 was next. The 2012 field trip had been canceled because of the Ponderosa Fire. The Co-op will host a field trip on June 11th and will visit some Co-op study sites Ed Fredrickson has established around Manton and Round Mountain. Mark Gray will check on the possibility of including some stops showing the work Cajun James is doing with stream monitoring and sediment transport following a fire.

The next item on the agenda was funded proposal updates. Two year results were presented for Proposal 11-01 Sunscald. Because of seedling mortality in this study, the membership decided to abandon it. Results of Proposal 08-02 Cedar Stock Trial were presented next. This study was also abandoned due to survival issues. Roseburg (the host landowner) is free to return these two study sites to normal management activities. Roath's written report on Proposal 12-01 Soil Pits was next. Ed Fredrickson reported on results for Proposal 10-01 Milestone, Proposal 10-02 Vista, Proposal 11-02 GF 9999, Proposal 11-03 Mat 28 Site Prep, and Proposal 12-03 Pindar GT. A quick summary on the progress of Proposal 12-02 Garden of Eden completed this portion of the agenda. Executive summaries of these proposals are found in the 2012 Annual Report.

After discussion of funded proposals, four new proposals were presented to the membership for possible funding in 2013. Ed Fredrickson presented two proposals for herbicide trials (Pindar II and Matrix Site Prep). Jeff Webster also presented two proposals (15th year remeasurement of a compaction study at Pondosa and a proposal to map/document locations of all the Co-op study sites).

After questions/concerns from the membership were addressed, it was decided that the new proposals would be emailed to the voting membership for their decision as to which proposals would be funded. A quick turn around will be required in order to facilitate installation of some of the new proposals if they are selected for funding (this was done and resulted in all four proposals being funded).

The next item of business was to select a new Chair for Working Group II (Jason Warshawer was previous Chair). Scott Worden was elected to fill this spot.

Next on the agenda was a discussion about the Co-op website. Ryan DeSantis, UC Co-op Extension, agreed to look into the possibility of reworking the existing website to make it more functional. Ryan will work with Jianwei and Gary toward this possibility.

The possibility of precommercially thinning the Timmer/Jopson Study (Proposal 00-05) site located on Fruit Growers land was discussed. The membership felt it was agreeable to thin the site but the site should be remeasured before the thinning. It was suggested that Working Group II should come up with a proposal and present it to the membership for possible funding. This proposal should also include the remeasurement of the second replication of this study which is on Soper Wheeler lands. The third replication on former Boise Cascade lands will not be remeasured at this time.

Following the discussion of the Timmer/Jopson Study, the fate of the three Garden of Eden sites not included in Proposal 12-02 (Jaws, Pondosa, and Chester) was brought up. The decision was made by the host landowners to keep the study sites intact and not overlay any management activities on them at this time.

The final item of business was a suggestion by Bob Powers that a report on the comparison of subsoiling vs non-subsoiling at Pondosa and Lowell Hill LTSP site be presented at the next annual meeting. Jianwei and Gary were given this responsibility.

The meeting adjourned at this time.

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 11-03
Mat 28 Site Preparation and Conifer Tolerance

Principal Investigator: Ed Fredrickson

Title: Aminocyclopyrochlor Site Preparation and Conifer Tolerance

Year Funded: 2011

Executive Summary:

Aminocyclopyrochlor is a new product to the vegetation management market. It will be registered for use in 2011 for non-crop sites. Currently Dupont is compiling data to expand the registration to other uses, including forestry. Aminocyclopyrochlor is a pre and post emergent herbicide that controls a wide variety of broadleaf weeds and brush. It is a synthetic auxin and has both foliar and soil activity. The residual control is proving to be quite strong and the product is an excellent inhibitor of seed germination. It is also showing some unique properties for brush control when tank mixed with other products. It has very low use rates, with maximum proposed label rates of 9 ounces product per acre. The product is very safe to mammals with oral and dermal LD 50 values greater than 5000 mg/kg body weight. Half life ranges from 37 to 128 days depending on soil type and weather conditions. There is no bio-accumulation or magnification. It is also extremely safe to aquatic organisms including daphnia.

Previous testing has indicated no conifer tolerance for "over the top" applications, but directed applications around trees may be feasible. There is also a strong potential to broaden the spectrum of control when tank mixed with Velpar DF. The major questions surrounding this herbicide in forestry regard conifer tolerance as a site preparation spray, efficacy on forest weeds, and the duration of control by season. Aminocyclopyrochlor may potentially have a fit as a site preparation treatment for some of the chemically intolerant conifers such as sugar pine, cedar, and redwood, although testing has yet to be done.

The stated objective of this study is to evaluate the effect of aminocyclopyrochlor rate and timing on vegetation control and conifer tolerance of ponderosa and Douglas-fir when applied as a pre-plant site preparation spray. This proposal is for a trial that would look at the effect of site, rate, and timing on vegetation control and conifer tolerance of ponderosa pine and Douglas-fir for site preparation treatments with aminocyclopyrochlor alone and in combination with Velpar DF and Accord XRT II compared to Velpar DF as the operational standard. Specific questions to be answered are: Does Mat 28 rate effect vegetation control or conifer tolerance? Can tank mixes of Mat 28 and a low rate of Velpar DF achieve similar vegetation control and coniference tolerance to the operational standard of Velpar DF alone? How does Mat 28 alone compare to the operational standard of Velpar Df regarding vegetation control and conifer tolerance? Does the addition of Accord XRT II to Mat 28 improve vegetation control?

The study will have two sites, one high elevation or east side Cascade site and a low elevation west side Cascade site (only one site was funded in 2011). Each site should be a fresh clear-cut or wildfire that has not had any chemical treatment prior to the trial. All plots will be laid out in the spring or fall of 2011. The plan will be to spray the high elevation site in the fall of 2011 and the low elevation site in the spring of 2012. Both sites will be planted in the spring of 2012.

The study design will be a completely randomized block design with three replications. Plot size will be 12' x 36' (0.01 acre). Plots will be planted with 10 trees each of ponderosa and Douglas-fir in the same plot (two rows of each species). Stock type will be similar to what is operationally planted on the site. Seedlings are to be provided by the cooperator as well as one or two planters to plant the plots. Planting will be supervised by Thunder Road Resources.

Two spray timings will be utilized in this study (October 2011 – high elevation and March of 2012 – low elevation). Treatments will include Mat 28 at 1.125, 2.25, and 4.5 ounces a.i. per acre; Mat 28 at 2.25 ounces a.i. per acre combined with Velpar DF at 1.0 pound a.i. per acre; Mat 28 at 2.25 ounces a.i. per acre combined with Velpar DF at 2.0 pounds a.i. per acre; Velpar DF at 2.5 pounds a.i. per acre; Mat 28 at 2.25 ounces a.i. per acre combined with Accord XRT II at 2.6 pounds a.i. per acre; and a control. Plots will be sprayed with a twelve foot boom sprayer at ten gallons per acre. All plots will be sprayed with one timed pass. The boom will be set with 4-9503 nozzles which provide a similar drop size spectrum to a helicopter set up with D-8 nozzles at a 45 degree angle. All chemical will be provided by Dow AgroSciences.

Seedling caliper and height will be measured initially at time of planting. End of season evaluations, which will take place at the end of the first and second growing seasons after treatment, consist of ocular estimation of vegetation percent cover by species for the weeds and brush, measurement of conifer seedling caliper and height, and an ocular rating of conifer damage. Stem volume will be calculated for analysis. Analysis of variance and multiple procedures for a completely randomized block design will be utilized to analyze data.

2011: The study site was established in October on ground owned and managed by Sierra Pacific Industries near Shingletown, CA. Elevation is approximately 4200 feet. Slope is 0 to 5 percent and of relatively negligible aspect. The site was pre-harvest sprayed with four percent Accord XRT II and two percent MSO, logged, and ripped. No further site preparation activities have been conducted.

The trial was staked and sprayed on October 20th.

2012: The trial was planted on March 24th. The trial was planted with Styro 6 ponderosa pine and Styro 8 Douglas-fir from Cal Forest Nursery of Etna, CA. Ten trees of each species were planted in rows in each plot.

The trial was evaluated on August 12th. Visual assessments of vegetation control and conifer damage were recorded at the time. Initially this trial was slated to

have conifer measurements taken at the end of the first and second growing seasons. The trial site was confounded by severe frost damage to the Douglas-fir. It was decided to not measure conifer seedlings in 2012, but to take visual assessments only. The measurements that were to be taken in 2012 will be put off until 2014. The 2013 measurements will occur as planned.

Data were analyzed using SAS statistical software. Analysis of variance was used to determine significance of the main effects of treatment and orthogonal contrasts were used to make specific comparisons among treatments. Analysis of variance was used to determine if there were any differences in initial seedling size among treatments. If initial seedling size was found to be significantly different among treatments, analysis of co-variance was used to adjust for initial seedling size difference with initial tree size as the co-variate. Vegetation data was analyzed using analysis of variance for the main effects, and multiple comparisons of means were done using Student Neuman Kewls least significant difference procedure. Orthogonal contrasts were used to make specific comparisons among treatments.

The herbicide treatments had significantly less total cover and more bare ground than the controls ($P<=0.05$). The treatments with Mat 28 alone at any rate had significantly more cover than the operational standard of 2.66 pounds of Velpar DF alone (Table 1). The addition of 4.5 ounces of Mat 28 to 2.66 pounds of Velpar DF did not significantly improve vegetation control. The two treatments with a combination of Mat 28 plus Velpar DF and the Mat 28 plus Accord XRT II treatment were not significantly different than Velpar DF alone for either percent bare ground or percent total cover.

Although this site was not pre-treated with imazapyr prior to logging, total cover on the site was generally low and consisted mainly of bull thistle. All herbicide treatments greatly reduced the bull thistle cover compared to the controls.

Ponderosa pine survival was not significantly affected by treatment ($R<=0.05$). Douglas-fir survival was affected by treatment (Table 2). The treatments with Mat 28 alone (except 4.5 ounces/acre Mat 28) and all three of the tank mix treatments with Mat 28 had higher survival than the operational standard of Velpar DF alone. The same treatments were also higher than the control, but were not significant.

The damage ratings for ponderosa pine significantly varied by treatment ($P<=0.05$). The Velpar DF alone treatment and the controls had significantly less damage than any treatment containing Mat 28. Damage in general was severe with Mat 28. Bud swelling, terminal dieback, shortened needles, and twisting were some of the most common symptoms. Douglas-fir damage was severe for all treatments and did significantly differ by treatment. This was a direct result of severe frost damage.

Regardless of the frost damage on the Douglas-fir, it does not appear that Mat 28 will be a suitable pre-plant site preparation chemical due to the severe seedling damage it causes. Analogous trials with the Forest Stewardship

Council Research Group demonstrated the same trends in the spring or fall and across three different conifer species. Like Milestone alone, treatments with Mat 28 alone also provided little vegetation control. Due to its efficacy on brush, Mat 28 may still have a fit as a pre-harvest site preparation treatment. Several trials are underway to test this hypothesis.

2013: The Mat 28 trial was evaluated on September 9th. This trial was heavily impacted by a May 2013 frost event. All the Douglas-fir and white fir were killed. Even the ponderosa pine was severely impacted. Survival was high enough in the pine that these seedlings were measured. This was mainly due to the pine having such severely stunted terminal buds that the trees never broke bud in the spring and were less susceptible to the frost.

The 2013 data were analyzed using the same procedures as those used in 2012.

Ponderosa pine survival varied among treatments, but high variability for two of the treatments resulted in no significant differences among treatments with multiple comparisons (Table 4). However, all seedling parameters (survival, caliper, height, stem volume, and needle and bud damage) indicated a significant negative impact of increasing Mat 28 rate on ponderosa pine ($P<=0.05$). All treatments that included Mat 28 at any rate were significantly shorter and smaller in caliper and stem volume than either the operational standard of 2.66 pounds Velpar DF or the control ($P<=0.05$).

Ponderosa pine vigor and bud and needle damage ratings also showed severe damage from any application including Mat 28. All treatments with Mat 28 had significantly more bud and needle damage and lower vigor than either the operational standard Velpar DF treatment or the controls ($P<=0.05$). All three damage ratings also showed a significant increase in damage with increasing rates of Mat 28 ($P<=0.05$).

All tree factors were only slightly better with the operational standard Velpar DF treatment than the controls, but were not significantly different.

In general, Mat 28 alone provided poor vegetation control at any rate (Table 3). The best vegetation control was achieved with the operational standard of 2.66 pounds of Velpar DF alone or in combination with 4.5 ounces of Mat 28. These two treatments provided significantly less total cover than all other treatments including the control ($P<=0.05$), but were not significantly different from each other.

The only species of vegetation in heavy abundance on this site was bull thistle. The operational standard and the 2.66 pounds of Velpar DF plus 4.5 ounces Mat 28 provided significantly better bull thistle control than all treatments with the exception of the highest rate of Mat 28 alone or the combination of 4.5 ounces of Mat 28 plus 1.33 pounds of Velpar DF ($P<=0.05$). Bull thistle control did show a significant increase in control with increasing rate of Mat 28 alone ($P<=0.05$).

Overall, Mat 28 treatments alone or in combination with other forestry herbicides are not a suitable treatment for forestry site preparation. Conifer damage is high and Mat 28 adds very

little to vegetation control. The effects of Mat 28 on conifer growth appear to be fairly long lasting and it doesn't appear likely that seedlings will outgrow the stunting in the first couple of years after application.

Due to the heavy conifer mortality from frost events, this study is no longer viable and will be terminated. No more field work or evaluations will be done. The complete report and all supporting data are available at the Coop's office in Redding.

APPENDIX 1

CONIFER DAMAGE CODES
0= NO DAMAGE
1= SLIGHT DISCOLORATION
2= SLIGHT CHLOROSIS, NO BUD DAMAGE, NO NEEDLE CURL
3= SLIGHT CHLOROSIS, NO BUD DAMAGE WITH NEEDLE CURL
4= MODERATE CHLOROSIS, NO BUD DAMAGE WITH NEEDLE CURL
5= HEAVY CHLOROSIS, NO BUD DAMAGE WITH NEEDLE CURL
6= MODERATE CHLOROSIS, WITH BUD DAMAGE AND NEEDLE CURL
7= HEAVY CHLOROSIS, WITH BUD DAMAGE AND NEEDLE CURL
8= LESS THAN 50% BROWN WITH BUD DAMAGE
9= GREATER THAN 50% BROWN WITH BUD DAMAGE
10= DEAD

ROOT NUMBER SCALE
0= NO NEW ROOTS
1=1 TO 5 NEW ROOTS
2= 6 TO 10 NEW ROOTS
3= 11 TO 15 NEW ROOTS
4= 16 TO 20 NEW ROOTS
5= 21 TO 25 NEW ROOTS
6= >25 NEW ROOTS

ROOT LENGTH SCALE
0= NO NEW ROOTS
1= 0.1 TO 1 CM
2= 1.1 TO 2 CM
3= 2.1 TO 3 CM
4= 3.1 TO 4 CM
5= 4.1 TO 5 CM
6= 5.1 TO 6 CM
7= 6.1 TO 7 CM
8= 7.1 TO 8 CM
9= 8.1 TO 9 CM
10= >9 CM

Product and Rate	% Bare Ground	% Total Cover	% Cover Bull Thist	% Cover Grass	% Cover Squaw Carp	% Cover Snow Berry	% Cover G.L. Manz
2.25 oz MAT 28	95.0	5.7	1.0	1.3	0.3	0.3	1.0
4.5 oz MAT 28	95.7	5.3	2.7	0.3	0.3	0.3	0.3
9.0 oz MAT 28	93.3	7.0	1.0	0.3	0.0	0.7	0.3
4.5 oz MAT 28 + 1.33 lbs Velp DF	95.7	4.7	1.0	0.0	0.0	1.0	0.0
4.5 oz MAT 28 + 2.66 lbs Velp DF	98.7	1.3	0.0	0.0	0.0	0.3	0.0
2.66 lbs Velp DF	98.0	2.0	2.0	0.0	0.0	0.0	0.0
4.5 oz MAT 28 + 2 qts Acc XRT II	98.0	2.7	1.0	0.3	0.0	0.0	0.0
Control	81.0	21.0	16.7	0.3	0.7	0.7	0.3

Table 1. Total percent cover, percent bare ground and percent cover by species for MAT 28 site prep trial 10 months after treatment. All rates are pounds product per acre. Acc = Accord XRT II, Velp = Velpar DF

Product and Rate	P. Pine % Survival	Doug Fir % Survival	P. Pine Dam Code	Doug Fir Dam Code
2.25 oz MAT 28	100.0	70.0	6.7	8.3
4.5 oz MAT 28	96.7	50.0	7.3	8.7
9.0 oz MAT 28	93.3	60.0	7.3	8.3
4.5 oz MAT 28 + 1.33 lbs Velp DF	93.3	60.0	7.3	8.3
4.5 oz MAT 28 + 2.66 lbs Velp DF	93.3	63.3	7.0	8.3
2.66 lbs Velp DF	96.7	50.0	1.0	8.7
4.5 oz MAT 28 + 2 qts Acc XRT II	96.7	56.7	7.3	8.8
Control	100.0	50.0	1.7	8.7

Table 2. Ponderosa pine and Douglas-fir percent survival and damage ratings for MAT 28 site prep trial 10 months after treatment. Damage codes: 0 = No Damage, 10 = Dead.

TREAT	% BARE GROUND	% TOT COVER	% COV GRASS	% COV SNOW BERRY	% COV G.L. MANZ	% COV BULL THISTLE	% COV TURK MULL	% COV COM MULL	% COV OTHER
2.25 OZ MAT 28	78.2	20.3	5.7	0.0	0.7	11.0	0.3	1.7	1.7
4.5 OZ MAT 28	83.2	15.3	1.0	0.0	0.7	10.3	0.0	1.7	2.0
9 OZ MAT 28	76.5	21.9	1.3	0.0	0.3	4.4	14.7	1.0	1.3
4.5 OZ MAT 28 + 1.33 LBS VELP	83.2	17.5	1.0	0.3	0.7	3.1	1.0	1.7	10.7
4.5 OZ MAT 28 + 2.66 LBS VELP	96.9	3.8	0.3	0.3	0.3	2.2	0.0	0.0	0.7
2.66 LBS VELP	97.2	2.8	0.3	0.0	0.0	2.5	0.0	0.0	0.0
4.5 OZ MAT 28 + 2 QTS ACC XRT II	73.2	25.3	0.3	0.0	0.0	19.7	0.0	1.7	4.0
CONTROL	74.9	24.4	1.0	0.0	0.3	20.4	0.7	0.3	2.0

Table 3. Percent bare ground, percent total cover and percent cover by species for Fall MAT 28 Site Preparation Trial 22 months after treatment.

TREAT	CALIPER mm	HEIGHT cm	STEM VOL CM^3	% SURV	TREE DAMAGE	BUD DAMAGE	NEEDLE DAMAGE
2.25 OZ MAT 28	9.4	25.8	26.6	76.7	5.3	5.3	4.7
4.5 OZ MAT 28	6.8	21.1	10.3	33.3	8.0	7.3	8.0
9 OZ MAT 28	5.9	16.3	6.5	33.3	9.0	8.0	9.0
4.5 OZ MAT 28 + 1.33 LBS VELP	8.2	22.2	20.3	56.7	7.3	6.3	7.3
4.5 OZ MAT 28 + 2.66 LBS VELP	7.0	19.6	10.6	73.3	7.3	6.0	7.0
2.66 LBS VELP	10.1	29.0	34.5	76.7	2.7	2.0	2.0
4.5 OZ MAT 28 + 2 QTS ACC XRT II	6.5	19.4	8.6	40.0	8.7	7.3	8.3
CONTROL	10.1	28.2	32.8	63.3	3.7	2.7	2.7

Table 4. Tree measurements for ponderosa pine for the Fall MAT 28 Site Preparation Trial 22 months after treatment. Needle and bud damage rated on a scale from 0 to 10 with 0 being no damage and 10 is dead. See appendix 1 for tree damage codes.

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 12-03
Pindar GT Site Preparation

Principal Investigator: Ed Fredrickson

Title: Intolerant Conifer Site Preparation with Pindar GT (Penoxsulam + Oxyflourfen), Dimension EC (Dithiopyr), Goaltender (Oxyflourfen), and Milestone (Aminopyralid)

Year Funded: 2012

Executive Summary:
Mixed conifer plantations are becoming more and more popular in industrial forestry due to better seedling stock and the desire to diversify plantations. Unfortunately, conifer species such as Douglas-fir, white and red fir, incense cedar, and sugar pine have a lower tolerance to the operational standard chemical site preparation herbicide, hexazinone. This poses a significant challenge to foresters who wish to establish a diverse mix of conifer species in their plantations, and often leads to vegetation management treatments that are inferior in control and at a higher cost. With the potential loss of atrazine, foresters currently have no available chemical tool that exhibits a high degree of tolerance to these species of conifers. It is the goal of this trial to evaluate several new herbicides that may provide effective residual control of herbaceous vegetation and conifer safety.

Pindar GT, Dimension EC, Goaltender, and Milestone are four residual herbicides manufactured by Dow AgroSciences. Pindar GT is a liquid formulation that contains 0.083 pounds per gallon of the active ingredient penoxsulam plus 3.93 pounds per gallon of the active ingredient oxyflourfen; Dimension EC is a liquid formulation that contains 4 pounds per gallon of the active ingredient dithiopyr; Goaltender is a liquid formulation containing 4 pounds per gallon of the active ingredient oxyflourfen; and Milestone is a liquid that contains 2 pounds per gallon of the active ingredient aminopyralid. Currently, all products are registered for a variety of uses in California, however none are registered for forestry site preparation. All products can be applied as either a pre or post emergent herbicide for broadleaf weed control and some grasses.

None of the products have been extensively tested as a forestry site preparation tool under field conditions, with the exception of Milestone. Two of the four active ingredients have demonstrated a high degree of conifer tolerance. Oxyflourflen has long been used in forest nurseries and even the most chemically intolerant conifer species such as coast redwood show a high degree of tolerance. Aminopyralid is currently being tested as a site preparation chemical with ponderosa and Douglas-fir and early results show a high degree of tolerance. Seedling conifer tolerance with penoxsulam and dithiopyr has not been tested, although ornamentally planted conifers have shown tolerance to dithiopyr.

Combinations of Milestone with Pindar GT, Dimension EC, and Goaltender have exhibited long-term residual control of herbaceous vegetation in non-forestry settings. These combinations have been some of the most encouraging

bare ground treatments tested to date. With the known tolerances of several of the active ingredients in this trial, one or more of these combinations may have the potential to replace atrazine as a site preparation treatment for intolerant conifers.

The stated objective of this study is to evaluate the effect of Pindar GT, Dimension EC, Goaltender, and Milestone alone and in combination for vegetation control and conifer tolerance of Douglas-fir and white fir when applied as a pre-plant site preparation spray. This proposal is for a trial that would evaluate vegetation control and conifer tolerance of Douglas-fir and white fir with pre-plant spring applications of Milestone, Pindar GT, Dimension EC, and Goaltender alone and in combination. The specific questions to be addressed are: Do any of the new herbicides alone or in combination with Milestone provide similar vegetation control compared to the operation standard of 3.3 pounds product Velpar DF per acre? Do any of the new herbicides alone or in combination with Milestone provide better conifer tolerance to Douglas-fir or white fir compared to the operational standard of 3.3 pounds product Velpar DF per acre?

This proposal is for a spring application on a low elevation site (below 4000'). This should be a site that would normally be treated with hexazinone in the spring.

The study design will be a completely randomized block design with four replications. Plot size will be 12' x 36' (0.01 acre). Plots will be planted with 10 trees each Douglas-fir and white fir in the same plot (two rows of each species). Stock type and seed-lot will be the same for all trees of each species in the study. The stock type will be similar to what is operationally planted on the site. Seedlings are to be provided by the cooperator as well as one or two planters to plant the plots. Planting will be supervised by Thunder Road Resources.

Spray timing will be approximately March of 2012 with planting being done shortly after. Treatments will include Milestone at 0.11 pounds a.i. per acre; Pindar GT at 1.5 pounds a.i. per acre; Dimension EC at 0.5 pounds a.i. per acre; Goaltender at 1.5 pounds a.i. per acre; Milestone at 0.11 pounds a.i. per acre combined with Pindar GT at 1.5 pounds a.i. per acre; Milestone at 0.11 pounds a.i. per acre combined with Dimension EC at 0.5 pounds a.i. per acre; Milestone at 0.11 pounds a.i. per acre combined with Goaltender at 1.5 pounds a.i. per acre; Velpar GF at 2.5 pounds a.i. per acre; and a control. Plots will be sprayed with a twelve foot boom sprayer at ten gallons per acre. All plots will be sprayed with one timed pass. The boom will be set up with 4-9503 nozzles which provide a similar drop size spectrum to a helicopter set up with D-8 nozzles at a 45 degree angle. All chemical will be provided by Dow AgroSciences.

Seedling caliper and height will be measured initially at planting and at the end of the first growing season. Ocular estimates of percent bare ground, percent cover by species, percent conifer foliar brownout, and terminal bud and needle damage will be made at the end of the first and second growing seasons. Stem volumes will be calculated for analysis as will conifer survival. Analysis of

variance and multiple comparison procedures using orthogonal contrasts will be used to analyze all data.

2012: A trial was established on April 2nd on land owned and managed by Sierra Pacific Industries near Burney, CA in an existing plantation that had poor survival and heavy herbaceous cover. Elevation is approximately 3500 feet with 0 to 5 percent slope. Due to the heavy vegetation at time of treatment, all treatments included one quart per acre of Accord XRT II to brownout the existing cover to allow us to look at the residual activity of the products. An Accord XRT II alone treatment was also included to compare with the other treatments. The site has not been treated with residual chemicals in several years.

Plots were laid out and sprayed on April 2nd. Ten seedlings each of Douglas-fir and white fir were planted into each plot on April 20th. Seedlings were measured at planting for caliper and height. Future seedling measurements will not occur until the end of the second growing season (this is a change from the original proposal).

Ocular evaluations of percent cover by species, percent bare ground, seedling survival, seedling percent brownout, and seedling damage ratings were taken on August 31st (end of first growing season). Similar evaluations will be done at the end of the second growing season.

Data were analyzed using SAS statistical software. Analysis of variance was used to determine significance of the main effects of treatment and orthogonal contrasts were used to make specific comparisons among treatments. Analysis of variance was used to determine if there were any differences in initial seedling size among treatments. If initial seedling size was found to be significantly different among treatments, analysis of co-variance was used to adjust for initial seedling size difference with initial tree size as the co-variate. Vegetation data were analyzed using analysis of variance for the main effects, and multiple comparisons of means were done using Student Newman Kewls least significant difference procedure. Orthogonal contrasts were used to make specific comparisons among treatments.

In general, vegetation control was excellent with all products tested with the exception of the Accord XRT II alone treatment which vigorously germinated soon after treatment (Table 1). All treatments were significantly different from the control ($P<=0.05$). Even the Milestone plus Accord XRT II increased percent bare ground twofold over the Accord XRT II alone treatment. This shows that once the vegetation is burned down, Milestone has the ability to suppress germination. The addition of Pindar GT, Goaltender, or Dimension 2EW (slightly different formulation from the one listed in the original proposal) to Accord XRT II significantly decreased total cover and increased per cent bare ground compared to Accord XRT II alone. While the addition of Milestone to Pindar GT, Goaltender, or Dimension 2EW did decrease total cover and increased bare ground, the results were not significant although the Dimension 2EW comparisons were close.

The addition of 1.33 pounds per acre of Velpar DF to 7 ounces of Milestone per acre with Accord XRT II significantly

decreased total cover compared to the Milestone plus Accord XRT II treatment (P<=0.05). Neither percent bare ground or total cover were significantly different with the Velpar DF, Milestone plus Accord XRT II treatment compared to the operational standard of Velpar DF alone at 3.33 pounds per acre. However, the 1.33 pounds per acre treatment of Velpar DF plus Accord XRT II was also not significantly different from either the operational standard of Velpar DF alone or the Velpar DF plus Accord XRT II combination with Milestone.

Of all treatments tested, the ones with Velpar DF provided the best control of houndstongue and commom mullen. Downy brome was controlled well with all treatments with the exception of the Dimension 2EW plus Accord XRT II and the Accord XRT II alone treatment. It should be noted that control of downy brome was enhanced when 7 ounces of Milestone was added to Dimension 2EW. All treatments except the Accord XRT II alone provided good control of tumble mustard.

Frost severely impacted both white and Douglas-fir, however, treatment effects were still readily apparent. White fir survival was significantly affected by treatment (P<=0.05). All treatments had significantly greater survival than either the control or the operational standard of 3.33 pounds per acre of Velpar DF alone (Table 2). Survival of the Velpar DF standard was similar to the control (42.5 percent and 47.5 percent, respectively). The remaining treatments ranged from 67 to 90 percent survival and were not significantly different from each other. All treatments with Pindar GT, Goaltender, or Dimension 2EW alone or in combination with Milestone did have significantly greater white fir survival than the operational standard of Velpar DF alone. White fir percent brownout was also higher for the Velpar DF standard compared to other treatments. The Velpar standard had significantly more brownout compared to the 1.33 pounds Velpar DF plus 7 ounces of Milestone and Accord XRT II treatment. The Dimension 2EW plus Accord XRT II treatment had significantly less brownout compared to the same treatment with Milestone. White for damage rating did not significantly vary among treatments.

Douglas-fir survival was not affected by treatment other than all herbicide treatments has significantly greater survival than the control (P<=0.05). Although the main effect of treatment was not significant on Douglas-fir percent brownout or damage rating, one contrast did show that the addition of Milestone to the Dimension 2EW plus Accord XRT II mix significantly increased percent brownout and damage. This was similar to the white fir results for these treatments.

This trial produced several good alternatives to Velpar DF where conifer tolerance is a concern. Excellent conifer tolerance was seen in both Douglas-fir and white fir for Pindar GT, Goaltender, Dimension 2EW, and Milestone. Even though frost damage confounded results, treatment effects were clearly visible. Vegetation control was excellent for most treatments, especially when comparing Pindar GT and Goaltender to the operational standard of Velpar GT alone. Control was comparable with better conifer tolerance, especially with white fir. In this case, the addition of Milestone to any of the products did

show a trend in reducing cover, however the differences were slight and not significant. It was clearly demonstrated however that Milestone when added to Accord XRT II did suppress germination compared to the Accord XRT II alone treatment.

2013: The Pindar GT trial was evaluated on August 14th. Frost severely damaged all seedlings on this site in late May. Douglas-fir survival averaged 9 percent and white fir was 29 percent. Percent brownout was heavy on the white fir that survived rendering any measurement data useless. Therefore, the evaluations in 2013 consisted of all previous vegetation assessments, conifer survival, and percent brownout only (Table 3). No significant differences existed between treatments for percent survival or percent brownout ($P<=0.05$).

The 2013 data were analyzed using the same procedures as those used in 2012.

From previous year's data, it was shown that all treatments with Milestone, Pindar GT, GoalTender, and Dimension 2EW alone or in combination had excellent conifer tolerance and survival (Table 2). White fir survival and brownout were worse with the operational standard of Velpar DF at 3.33 pounds per acre. The earlier data showed there were several good alternatives to Velpar DF concerning conifer tolerance and vegetation control (Table 1).

Percent bare ground and total cover did show significant differences by treatment at the end of the second year (Table 4). Orthogonal contrasts indicated that there were some differences that were not reflected in the multiple comparison tests. This was true for individual species comparisons as week.

By the end of the second growing season, vegetation had recovered in most treatments. Treatments of Pindar GT, Dimension 2EW, and GoalTender with Accord XRT II only were not significantly different from the non-treated controls or the Accord XRT II only treatment ($P<=0.05$). This was a marked difference from the previous year data where all treatments provided significantly better vegetation control than either the non-treated control or the Accord XRT II alone treatment.

The addition of 7 ounces of Milestone to Pindar GT did significantly increase the percent bare ground, but did not significantly decrease total cover, though it was close ($P<=0.05$). There were no significant differences in vegetation control with the addition of Milestone to either GoalTinder or Dimension 2EW. The combination treatments of 7 ounces of Milestone with Pindar GT and GoalTender did significantly increase the percent bare ground compared to the non-treated controls, but not to the Accord XRT II only treatment ($P<=0.05$). Percent cover did not show any significant differences for the same comparisons. The combinations of Pindar GT plus Milestone and GoalTender plus Milestone were not significantly different from the operational standard of Velpar DF at 3.33 pounds for either percent bare ground or total cover.

There were some significant differences by species among treatments. Cheat grass control was significantly better with all treatments compared to the non-

treated controls, but multiple comparison tests did not indicate any differences compared to the Accord XRT II only treatment. Orthogonal contrast data showed that the operational standard Velpar DF treatment at 3.33 pounds provided more cheat grass control than the 1.33 pound Velpar DF treatment. The addition of Milestone to Pindar GT, GoalTender, and Dimension 2EW did reduce cheat grass cover compared to treatments without Milestone, but the results were not significant (P<=0.05). Orthogonal contrasts also indicated that all treatments provided significantly more control of other annual grasses than the non-treated control (P<=0.05).

Mullein was controlled significantly better with treatments containing Velpar DF. Orthogonal contrast data indicated the addition of 1.33 pounds of Velpar DF to 7 ounces of Milestone significantly improved control. The Velpar DF standard of 3.33 pounds also provided significantly better mullein control when compared to all other treatments.

Houndstongue was best controlled with the operational standard of 3.33 pounds Velpar DF. Contrast data indicated this treatment provided more control when compared to all other treatments combined and also provided significantly more control than the tank mix of 1.33 pounds Velpar DF with 7 ounces of Milestone. Some other contrasts were significant, but this appears to be an anomaly in the data due to variability in houndstongue density among plots.

The combination of 7 ounces of Milestone with 1.33 pounds Velpar DF with Accord XRT II significantly reduced total cover compared to either Milestone or Velpar DF alone at the same rates. Percent bare ground was not significantly different (P<=0.05). The Milestone plus Velpar DF combination was also not significantly different from the operational standard of 3.33 pounds Velpar DF for either total cover or percent bare ground. The 3.33 pound Velpar DF treatment did significantly reduce total cover compared to the 1.33 pound treatment of Velpar DF alone, but did not significantly effect percent ground cover. Overall, the operational standard Velpar DF treatment did not provide significantly more bare ground than any treatment other than the controls, but did reduce total cover significantly compared to all treatments with the exception of Pindar GT, GoalTender, or Velpar DF with Milestone (P<=0.05).

Most treatments evaluated in this trial provided excellent first year control of vegetation. The addition of 7 ounces of Milestone to Pindar GT, GoalTender, and Velpar DF at the low rate enhanced control through the second growing season. Treatments with Pindar GT, GoalTender, and Dimension 2EW by themselves were similar to the Accord XRT II only treatment at the end of the second growing season. Several treatments provided control similar to the operational standard of 3.33 pounds of Velpar DF at the end of the second growing season including the low rate of Velpar DF, Pindar GT, and Dimension 2EW, in combination with 7 ounces of Milestone.

Conifer tolerance was good with all new products tested at the end of the first growing season. The only treatment causing significant damage in the first

season was the operational standard of 3.33 pounds Velpar DF on white fir. It appears that the addition of Milestone aided in control of cheat grass in the second year, and the addition of Velpar DF was needed to reduce mullein cover.

Due to the heavy conifer mortality from the frost events, this study is no longer viable and will be terminated. No more field work or evaluations will be done. The complete report and all supporting data are available at the Co-op's office in Redding.

Product & Rate	% Bare Ground	% Total Cover	% Cover Downy Brome	% Cover Tumble Mustard	% Cover Hounds Tongue	% Cover Bull Thistle	% Cover Common Mullen
7 oz MVM	86.2	14.0	3.2	1.0	5.2	0.0	3.0
1.5 qts Pindar GT	88.0	13.0	1.2	0.8	4.0	0.5	3.0
1 qt Dimension 2EW	71.2	33.2	20.8	2.0	3.8	0.5	2.8
1.5 qts Goaltender	82.5	19.2	2.0	0.5	4.0	0.8	9.5
1.5 qts Accord XRT II	41.2	58.2	21.2	8.0	3.2	0.8	5.0
1.5 qts Pind GT + 7 oz MVM	94.0	7.2	1.0	0.0	1.2	0.5	4.2
1 qt Dim 2EW + 7 oz MVM	86.2	13.8	1.5	0.0	5.2	0.2	0.5
1.5 qts GoalT + 7 oz MVM	87.5	12.8	1.2	0.2	3.8	0.0	6.5
1.33 lbs Velp DF + 7 oz MVM	97.8	2.2	0.5	0.0	0.8	0.0	1.0
1.33 lbs Velp DF	95.8	4.8	0.2	0.0	0.8	0.2	0.2
3.33 lbs Velp DF	98.5	1.5	0.2	0.0	0.2	0.2	0.2
Control	23.8	91.2	63.8	9.2	5.5	3.2	2.0

Table 1. Total percent cover, percent bare ground and percent cover by species for Pindar GT site prep trial 4 months after treatment. All rates are pounds product per acre. Acc = Accord XRT II, Velp = Velpar DF, MVM = Milestone, Pind GT = Pindar GT, Dim 2EW = Dimension 2EW, GoalT = Goaltender.

Product & Rate	White Fir % Survival	Douglas-Fir % Survival	White Fir % Brownout	Douglas-Fir % Brownout	White Fir Dam Code	Douglas-Fir Dam Code
7 oz MVM	70.0	77.5	17.5	18.8	4.0	5.2
1.5 qts Pindar GT	77.5	82.5	13.8	11.2	3.0	3.2
1 qt Dimension 2EW	85.0	85.5	5.0	7.5	2.0	2.0
1.5 qts Goaltender	80.0	90.0	17.5	20.0	3.2	4.0
1.5 qts Accord XRT II	80.0	77.5	11.2	12.5	3.2	3.0
1.5 qts Pind GT + 7 oz MVM	90.0	80.0	11.2	18.8	3.2	4.2
1 qt Dim 2EW + 7 oz MVM	67.5	72.5	13.8	21.2	4.2	6.0
1.5 qts GoalT + 7 oz MVM	77.5	82.5	12.5	16.2	3.8	3.5
1.33 lbs Velp DF + 7 oz MVM	72.5	75.0	11.2	15.0	3.2	4.5
1.33 lbs Velp DF	82.5	92.5	15.0	13.8	3.8	3.0
3.33 lbs Velp DF	42.5	80.5	32.5	12.5	5.5	2.5
Control	47.5	57.5	37.5	23.8	5.8	5.5

Table 2. White and Douglas-fir percent survival, percent brownout and damage rating for the Pindar GT site prep trial 4 months after treatment.

TREATMENT	% WF SURVIVAL	% DF SURVIVAL	WF % BROWNOUT	DF % BROWNOUT
7 OZ MILE	22.5	7.5	77.0	94.8
3 PTS PIND GT	45.0	15.0	62.5	89.5
1 QT DIM 2EW	42.5	17.5	75.0	91.2
3 PTS GOAL TENDER	35.0	5.0	72.0	99.5
1.5 QTS ACC XRT II	12.5	5.0	72.5	97.5
7 OZ MILE + 3 PTS PIND GT	50.0	5.0	76.2	99.5
7 OZ MILE + 1 QT DIM 2 EW	12.5	10.0	81.2	89.8
7 OZ MILE + 3 PTS GOAL TENDER	40.0	2.5	72.5	98.8
1.33 LBS VELP + 7 OZ MILE	35.0	7.5	65.0	99.2
1.33 LBS VELP	35.0	17.5	82.5	90.0
3.33 LBS VELP	17.5	17.5	94.8	95.0
CONTROL	10.0	7.5	62.5	94.8

Table 3. Percent survival and percent brownout for white fir and Douglas fir in the Spring Pindar GT Site Preparation Trial 16 months after treatment.

TREAT	% BARE GROUND	% TOT COVER	% COV CHEAT GRASS	% COV TUMBLE MUST	% COV HOUNDS TONGUE	% COV BULL THISTLE	% COV COM MULLEIN	% COV TAR WEED	% COV WILLOW HERB	% COV OTHER GRASS	% COV OTHER HERBS
7 OZ MILE	53.8	47.2	22.5	3.5	6.0	0.0	8.8	0.5	1.2	1.8	3.0
3 PTS PIND GT	43.8	57.5	27.5	2.5	6.2	2.5	9.5	1.8	1.2	0.5	5.8
1 QT DIM 2EW	52.5	67.8	28.0	4.0	2.5	1.8	8.2	1.8	3.2	13.2	5.0
3 PTS GOAL TENDER	56.2	45.8	10.8	3.2	5.8	1.8	18.8	0.2	1.0	0.5	3.8
1.5 QTS ACC XRT II	51.2	43.5	8.2	3.5	4.5	0.8	15.8	1.5	2.0	1.5	5.8
7 OZ MILE + 3 PTS PIND GT	71.2	30.2	10.0	3.2	2.0	0.8	12.0	0.0	0.2	0.2	1.8
7 OZ MILE + 1 QT DIM 2 EW	60.0	42.2	9.2	4.5	5.8	0.8	3.2	1.5	0.8	1.5	15.0
7 OZ MILE + 3 PTS GOAL TENDER	76.2	35.8	11.5	2.8	5.8	0.2	10.8	0.0	1.0	0.0	3.8
1.33 LBS VELP + 7 OZ MILE	80.0	23.0	8.8	1.5	5.8	0.0	1.2	0.2	0.0	1.2	4.2
1.33 LBS VELP	53.8	45.5	26.2	2.2	2.0	1.0	1.5	0.5	0.2	0.5	11.2
3.33 LBS VELP	87.0	12.8	5.5	0.2	0.8	0.0	0.2	0.0	0.0	0.0	6.0
CONTROL	30.0	70.0	38.8	2.2	5.8	3.2	3.8	2.0	2.5	10.0	6.2

Table 4. Percent bare ground, percent total cover and percent cover by species for the Spring Pindar GT Site Preparation Trial 16 months after treatment.

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 11-02
GF 9999 Site Preparation

Principal Investigator: Ed Fredrickson

Title: GF 9999 Site Preparation and Conifer Tolerance

Year Funded: 2011

Executive Summary:

GF 9999 is a foliar and soil active herbicide which has been in development for nearly six years. Due to the proprietary nature of this product, this trial must be done under a secrecy agreement and the actual active ingredient cannot be divulged at this time. GF 9999 is similar to other residual herbicides used in forestry. It has a broad spectrum of weed control and can be used at much lower rates than other residual herbicides used in forestry and is of low hazard to the environment. It also has extremely low toxicity to aquatic organisms and fish. It can be applied as either a pre or post emergent herbicide. It controls both grasses and broadleaved weeds.

This product has not been tested on forestry sites and conifer tolerance has not been established. It is also unclear how vegetation control will be influenced by forest soils, climate, and timing of application. There is however a strong potential that this will be an effective tool for forestry site preparation, especially on annual grasses and broadleaved weeds.

The stated objective of this study is to evaluate the effect of GF 9999 rate and timing on vegetation control and conifer tolerance of ponderosa pine and Douglas-fir when applied as a pre-plant site preparation spray. This proposal is for a trial that would look at the effect of site, rate, and timing on vegetation control and conifer tolerance of ponderosa pine and Douglas-fir for site preparation treatments with GF 9999 alone and in combination with Velpar DF and Accord XRT II compared to Velpar DF as the operational standard. Specific questions to be answered are: Does GF 9999 rate effect vegetation control or conifer tolerance? Can tank mixes of GF 9999 and a low rate of Velpar DF achieve similar vegetation control and conifer tolerance compared to the operational standard of Velpar DF alone? How does GF 9999 alone compare to the operational standard of Velpar DF regarding vegetation control and conifer tolerance? Does the addition of Accord XRT II to GF 9999 improve vegetation control?

The study will have two sites, one high elevation or east side Cascade site and a low elevation west side Cascade site (only one site was funded in 2011). Each site should be a fresh clear-cut or wildfire that has not had any chemical treatment prior to the trials. All plots will be laid out in the spring or fall of 2011. The plan will be to spray the high elevation site in the fall of 2011 and the low elevation site in the spring of 2012. Both sites will be planted in the spring of 2012.

The study design will be completely randomized block design with three replications. Plot size will be 12' x 36' (0.01 acre). Plots will be planted with

10 trees each of ponderosa pine and Douglas-fir in the same plot (two rows of each species). Stock type and seed-lot will be the same for all trees of each species in the study. The stock type will be similar to what is operationally planted on the site. Seedlings are to be provided by the cooperator as well as one or two planters to plant the plots. Planting will be supervised by Thunder Road Resources.

Two spray timings will be utilized in this study (October 2011 – high elevation and March 2012 – low elevation). Treatments will include GF 9999 at 2.1, 4.2, 6.3, and 8.4 ounces a.i. per acre; GF 9999 at 6.3 ounces a.i. per acre combined with Velpar DF at 1.0 pound a.i. per acre; GF 9999 at 6.3 ounces a.i. per acre combined with Accord XRT II at 2.6 pounds a.i. per acre; Velpar DF at 2.5 pounds a.i. per acre; and a control. Plots will be sprayed with a twelve foot boom sprayer at ten gallons per acre. All plots will be sprayed with one timed pass. The boom will be set with 4-9503 nozzles which provide a similar drop size spectrum to a helicopter set up with D-8 nozzles at a 45 degree angle. All chemical will be provided by Dow AgroSciences.

Seedling caliper and height will be measured initially at time of planting. End of season evaluations, which will take place at the end of the first and second growing seasons after treatment, consist of ocular estimation of vegetation percent cover by species for the weeds and brush, measurement of conifer seedling caliper and height, and an ocular rating of conifer damage. Stem volumes will be calculated for analysis. Analysis of variance and multiple comparison procedures for a completely randomized block design will be utilized to analyze data.

2011: The study site was established in October on ground owned and managed by Sierra Pacific Industries near Shingletown, CA. Elevation is approximately 4200 feet. Slope is 0 to 5 percent and of relatively negligible aspect. The site was pre-harvest sprayed with four percent Accord XRT and two percent MSO, logged, and ripped. No further site preparation activities have been conducted.

The trial was staked and sprayed on October 20th.

2012: The trial was planted on March 24th. The trial was planted with Styro 8 Douglas-fir and white fir and Styro 6 ponderosa pine. Seedlings were from Cal Forest Nursery. Ten trees of each species were planted in rows in each plot.

The trial was evaluated on August 12th. Visual assessments of vegetation control and conifer damage were recorded at the time. Initially this trial was slated to have conifer measurements taken at the end of the first and second growing seasons. The trial site was confounded by severe frost damage to the two fir species. It was decided to not measure conifer seedlings in 2012, but to take visual assessments only. The measurements that were to be taken in 2012 will be put off until 2014. The 2013 measurements will occur as planned.

Data were analyzed using SAS statistical software. Analysis of variance was used to determine significance of the main effects of treatment and orthogonal

contrasts were used to make specific comparisons among treatments. Analysis of variance was used to determine if there were any differences in initial seedling size among treatments. If initial seedling size was found to be significantly different among treatments, analysis of co-variance was used to adjust for initial seedling size difference with initial tree size as the co-variate. Vegetation data was analyzed using analysis of variance for the main effects, and multiple comparisons of means were done using Student Neuman Kewls least significant difference procedure. Orthogonal contrasts were used to make specific comparisons among treatments.

The trial site had relatively low vegetative cover (Table 1). Treatment main effects were not significant for percent bare ground ($P<=0.05$), however, they were for percent total cover. The treatments with GF 9999 alone at any rate had greater total cover than the control or operational standard of 3.33 pounds Velpar DF. GF 9999 did not appear to have any effect on bull thistle whatsoever, which was the predominant species present. The best treatment overall was the Velpar DF alone.

While vegetation control appeared to be poor with GF 9999, conifer tolerance was excellent, even though all fir seedlings were seriously injured by frost. Neither survival or damage rating was affected by treatment for any species in the trial (Table 2). Survival was poor for Douglas-fir in general. The damage seen on the Douglas-fir and white fir did not significantly differ from that seen in the control or the operational standard of Velpar DF alone.

It was difficult to gauge the ability of GF 9999 to control competing vegetation due to the inherent low cover on the site. Annual grasses did appear to be reduced although the total presence of grass on the site was low. Conifer tolerance however, appears to be excellent for all species tested. Normally, phytotoxicity from herbicides is enhanced when there is some environmental stress added. There did not appear to be any associated with these treatments. Follow up evaluations should provide a clearer picture.

2013: The GF 9999 trial was evaluated on August 13th. This trial was heavily impacted by a May 2013 frost event. All the Douglas-fir and white fir were killed. Even the ponderosa pine was severely impacted, averaging only 30% survival. Any conifer data that would have been collected on the pine would have been severely confounded by the frost and therefore, no data were collected. Only visual conifer assessments and vegetation data were collected for this trial.

The 2013 data were analyzed using the same procedures as those used in 2012.

The site was fairly clean with the exception of bull thistle and some light grass (Table 3). Treatment effect was significant for total cover, percent bare ground, and bull thistle cover, but some trends varied among the variables. No significant differences were found when comparing any of the GF 9999 alone treatments to the control treatments. The operational standard of 3.33 pounds Velpar DF provided significantly more bare ground and less total cover when compared to GF 9999 alone at any rate and less total cover than the tank mixes

of GF 9999 with either Velpar DF or Accord XRT II (P<=0.05). Adding 1.33 pounds of Velpar DF to 9 ounces of GF 9999 significantly increased percent bare ground and decreased total cover compared to 9 ounces of GF 9999 alone (P<=0.05).

In the case of bull thistle cover, treatments with GF 9999 alone had significantly higher bull thistle cover than the controls (P<=0.05) The operational standard of Velpar DF also provided significantly more bull thistle control than any rate of GF 9999 alone or the tank mixes of GF 9999 with either Velpar DF or Accord XRT II (P<=0.05). The addition of 1.33 pounds of Velpar DF to 9 ounces of GF 9999 also significantly reduced bull thistle cover (P<=0.05). Although not analyzed due to low percent covers, annual grasses did not appear to be controlled with GF 9999 alone at any rate.

GF 9999 provided virtually no vegetation control whatsoever. Conifer tolerance was good at the time of the first year evaluation, but without vegetation control this point is mute. Dow AgroSciences has decided not to pursue GF 9999 as a potential herbaceous herbicide for any use including forestry.

Due to the heavy conifer mortality from frost events, this study is no longer viable and will be terminated. No more field work or evaluations will be done. The complete report and all supporting data are available at the Co-op's office in Redding.

Product and Rate	% Bare Ground	% Total Cover	% Cover Bull Thist	% Cover Grass	% Cover Squaw Carp	% Cover Snow Berry	% Cover G.L. Manz
3 oz GF 9999	88.3	12.0	10.0	0.7	0.0	0.3	0.0
6 oz GF 9999	86.7	13.3	8.3	1.0	1.3	1.0	0.7
9 oz GF 9999	90.7	10.3	7.0	0.7	0.3	1.7	0.0
12 oz GF 9999	88.3	11.7	4.3	3.3	0.3	3.0	0.3
9 oz GF 9999 + 1.33 lbs Velp DF	90.0	10.0	10.0	0.0	0.0	0.0	0.0
9 oz GF 9999 + 2 qts Acc XRT II	96.7	3.7	0.7	0.0	0.3	1.0	0.7
3.33 lbs Velp DF	97.7	2.3	1.0	0.0	0.0	0.3	0.3
Control	93.3	7.0	1.3	2.3	0.3	1.7	0.3

Table 1. Total percent cover, percent bare ground and percent cover by species for GF 9999 site prep trial 10 months after treatment. All rates are pounds product per acre. Acc = Accord XRT II, Velp = Velpar DF

Product and Rate	White Fir % Survival	P. Pine % Survival	Doug Fir % Survival	White Fir Dam Code	P. Pine Dam Code	Doug Fir Dam Code
3 oz GF 9999	96.7	96.7	60.0	7.0	3.0	8.0
6 oz GF 9999	86.7	100.0	80.0	7.3	2.7	7.7
9 oz GF 9999	90.0	93.3	53.3	7.0	2.7	8.3
12 oz GF 9999	70.0	100.0	60.0	7.7	4.3	8.0
9 oz GF 9999 + 1.33 lbs Velp DF	73.3	96.7	63.3	8.0	4.3	8.0
9 oz GF 9999 + 2 qts Acc XRT II	73.3	100.0	76.7	7.3	2.7	7.3
3.33 lbs Velp DF	90.0	100.0	86.7	7.0	2.7	7.7
Control	80.0	90.0	93.3	7.7	4.3	7.7

Table 2. White fir, ponderosa pine and Douglas-fir percent survival and damage ratings 10 months after treatment. Damage codes: 0 = No Damage, 10 = Dead.

TREAT	% BARE GROUND	% TOT COVER	% COV GRASS	% COV SQUAW CARPET	% COV SNOW BERRY	% COV G.L. MANZ	% COV BULL THISTLE	% COV OTHER
3 OZ GF 9999	71.7	29.7	1.7	0.3	0.3	0.3	25.0	2.0
6 OZ GF 9999	80.0	22.0	3.7	0.3	0.0	1.0	15.0	2.0
9 OZ GF 9999	71.7	31.0	1.0	0.3	0.3	0.3	26.7	2.3
12 OZ GF 9999	80.0	22.0	4.0	0.0	1.0	0.3	15.7	1.0
9 OZ GF 9999 + 1.33 LBS VELPAR DF	90.0	11.3	0.0	0.3	0.3	0.0	10.0	0.7
9 OZ GF 9999 + 2 QTS ACCORD XRT II	91.0	9.7	0.7	0.3	0.3	0.7	6.7	1.0
3.33 LBS VELPAR DF	96.3	4.7	0.0	0.0	0.3	0.3	3.0	1.0
CONTROL	81.7	19.3	4.3	0.7	0.0	0.7	11.3	2.3

Table 3. Percent bare ground, percent total cover, and percent cover by species for the Fall GF 9999 Site Preparation Trial twenty two months after treatment. Values with the same letter are not significantly different at the P <= 0.05 level.

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 13-02
Pindar GT/GoalTender "Over the Top"

Principal Investigator: Ed Fredrickson

Title: Broadcast Release "Over the Top" with Pindar GT and GoalTender

Year Approved: 2013

Executive Summary:

Over the last several years, there has been a concerted effort to find a residual site preparation chemical that not only provides effective vegetation control but also provides better conifer tolerance to hexazinone intolerant conifers such as Douglas-fir, white fir, sugar pine, and incense cedar. Much progress has been made, a large part of which has been a direct result of this cooperative. As of January 26, 2013, Milestone has been registered in California forestry by Dow AgroSciences and they are currently evaluating three other alternative site preparation chemicals: Pindar GT (oxyfluorfen + penoxulam), GoalTender (oxyfluorfen), and Dimension (dithiopyr). Pindar GT and GoalTender are two of the most promising residual chemicals to be tested to date. Several trials have been established to evaluate pre-plant site preparation efficacy and conifer tolerance. The results to date have been extremely good. Both products show excellent conifer tolerance and provide comparable vegetation control to the operational standard of Velpar DF.

Often it is not logistically possible to apply residual herbicides before planting occurs. Velpar DF applications have the advantage of being able to be applied pre or post planting without added risk of conifer injury. It would be highly advantageous for any new residual chemistry to have the same flexibility. Goal 2XL (GoalTender's predecessor) has been tested over many conifer species in forest nurseries with excellent tolerance, but neither GoalTender or Pindar GT has been tested over seedlings under field conditions. This proposal is for a series of trials that would evaluate the conifer tolerance associated with applications broadcast "over the top" of newly planted conifer seedlings in the spring and fall with Pindar GT and GoalTender,

This trial will be established in a freshly logged clearcut or wildfire that was slated for planting in the spring of 2013. The selected unit should not have had any residual chemical treatment to date. This trial will be completely randomized with four replications per treatment. Plot size will be 12 feet by 36.3 feet (0.01 acres). Plots would be established and marked prior to planting. All plots would be planted prior to application in the spring of 2013 with 15 trees each of ponderosa pine, Douglas-fir, and white fir. Five trees of each species would be designated as "dig" trees for destructive sampling to evaluate root growth. The remaining ten trees would be

measurement trees. The first ten trees by species in each plot would be initially measured for caliper and height at time of planting.

Two sets of plots would be established on the same site, one for a spring application and one for a fall application (all plots would be planted in the spring of 2013). Spring applications would occur within several weeks of planting. The fall timing would occur in October 2013. All applications would be at ten gallons per acre and applied with a C02 powered backpack sprayer with a twelve foot boom at 30 psi. The sprayer would be calibrated prior to application and each plot would be sprayed with one timed pass.

Treatments will include: 3 pts. Pindar GT per acre applied in the spring and fall; 6 pts. Pindar GT per acre applied in the spring and fall; 3 pts. GoalTender per acre applied in the spring and fall; 6 pts. GoalTender per acre applied in the spring and fall; and control.

Evaluations will occur in the fall of 2013, 2014, and 2015 (fall timing only in 2015). Only spring applications would be evaluated in the fall of 2013. Evaluations for the spring applications in the fall of 2013 would consist of percent bare ground, percent cover by individual competitive plant species and total percent cover to access vegetation control. The five trees designated for destructive sampling would be excavated and roots evaluated for number of new roots and root length. The measurement trees would be evaluated for percent survival, percent brownout, and vigor. No caliper or height measurements would be taken in 2013. Both spring and fall timings would be evaluated in the fall of 2014 including all ratings taken in the fall of 2013, plus caliper, height, and stem volume for the spring timing only for all ten measurement trees per species. Only the destructive sampling trees from the 2013 fall application would be evaluated for root effects in the fall of 2014. All previous evaluation criteria plus caliper, height, and stem volume would be evaluated in the fall of 2015 for the fall timing only.

Analysis of variance and multiple comparison procedures using orthogonal contrasts will be used to analyze all data.

2013: A trial was established in 2013 on property owned and managed by Sierra Pacific Industries on the Pondosa Fire near Manton, CA. The objective of the trial was to evaluate the "over the top" conifer tolerance of Douglas-fir, white fir, and ponderosa pine to applications of Pindar GT and GoalTender at a standard and 2X standard rate.

All plots were planted on March 25th with 15 trees each of Douglas-fir, white fir, and ponderosa pine. Ponderosa pine were Styro 5 and all fir were Styro 8 container stock from Cal Forest Nursery. Ten of the 15 trees planted are measurement trees and the remaining five trees were slated as "dig" trees to evaluate root growth based on treatment.

Two spray timings were utilized for this trial consisting of a spring and fall application. The spring timing was applied on March 26th one day after planting. The fall application was on October1st. Treatments included Pindar GT and GoalTender at 3 and 6 pints per acre at ten gallons per acre spray volume for both timings. Treatments also included a non-treated control. Due to the lateness of the fall treatment, data were only collected in 2013 for the spring application timing.

Evaluations were done on August 13th. Evaluations included percent bare ground, percent cover by species, conifer survival, conifer percent brownout, and number of new roots and root length for each conifer species.

Data were analyzed using SAS statistical software. Analysis of variance was used to determine significance of the main effects of treatment and orthogonal contrasts were used to make specific comparisons among treatments. Analysis of variance was used to determine if there were any differences in initial seedling size among treatments. If initial seedling size was found to be significantly different among treatments, analysis of co-variance was used to adjust for initial seedling size difference with initial tree size as the co-variate. Vegetation data were analyzed using analysis of variance for the main effects, and multiple comparisons of means were done using Student Neuman Kewls least significant difference procedure. Orthogonal contrasts were used to make specific comparisons among treatments.

Seedling survival or percent brownout did not significantly differ by treatment for any species in the trial. Therefore, it can be inferred that applications of either Pindar GT or GoalTender had no effect on seedling health. Survival was greater than 96 percent for all species and percent brownout was under 10 percent. The only brownout that occurred on site was due to a May frost, and it was relatively minor (Table 2).

The main effect of treatment was not significant regarding the number of new roots or root length (see Appendix 1, page 11 for conifer damage and root codes). Orthogonal contrasts indicated that the combined treatments were not significantly different from the controls. Multiple comparison procedures also failed to show any significant differences between treatments (Table 3).

Treatment was a significant factor regarding vegetation control. This site was heavily dominated by squaw carpet which had not yet germinated at the time of the spring application. Both Pindar GT and GoalTender inhibited the germination of squaw carpet seedlings, but Pindar GT provided significantly better control than GoalTender ($P<=0.05$). All Pindar GT treatments had significantly more bare ground and less squaw carpet cover than the control. There was no significant difference in percent bare ground between Pindar GT and GoalTender although Pindar GR provided slightly more bare ground. Applications of Pindar GT at either rate provided significantly more control of squaw carpet than the lower rate of

GoalTender. Squaw carpet control with the low rate of GoalTender was not significantly different than the control. There was no significant difference between the low and high rates within either the Pindar GT or GoalTender treatments (Table 1).

This trial provided several important observations. The conifer safety of Pindar GT and GoalTender appears to be excellent either as a pre-plant site preparation treatment or as an "over the top" release treatment. Neither the number of new roots or root length was affected by any treatment. Probably the most unexpected result was the inhibition of squaw carpet seedling germination with Pindar GT. GoalTender suppressed squaw carpet germination somewhat, but Pindar GT virtually stopped it altogether. This has significant implications to any vegetation management strategy.

TREATMENT	% BARE GROUND	% COVER SQUAW C.	% COVER G.L. MANZ	% COVER BRACKEN	% COVER OTHER
3 PT PIND GT	89.5	3.0	0.8	5.0	2.8
6 PT PIND GT	96.0	2.0	0.5	2.0	0.3
3 PT GOAL T	85.0	14.0	0.8	1.0	1.3
6 PT GOAL T	82.0	8.0	0.5	6.3	2.5
CONTROL	59.0	29	1.0	5.0	3.7

Table 1. Spring timing. Percent bare ground and percent cover by species for the Pindar GT Over the Top trial five months after treatment.

TREATMENT	PONDEROSA PINE		DOUGLAS-FIR		WHITE FIR	
	SURVIVAL	% BROWN OUT	SURVIVAL	% BROWN OUT	SURVIVAL	% BROWN OUT
3 PT PIND GT	98.2	1.2	98.2	6.2	100.0	6.2
6 PT PIND GT	100.0	0.0	100.0	7.5	100.0	6.2
3 PT GOAL T	98.2	0.0	98.2	5.5	98.2	6.2
6 PT GOAL T	100.0	0.0	98.2	8.0	100.0	8.0
CONTROL	100.0	0.0	100.0	5.0	96.5	7.5

Table 2. Spring timing. Percent survival and percent brownout for ponderosa pine, Douglas-fir and white fir five months after treatment.

TREATMENT	PONDEROSA PINE		DOUGLAS-FIR		WHITE FIR	
	# NEW ROOTS	LENGTH OF NEW ROOTS	# NEW ROOTS	LENGTH OF NEW ROOTS	# NEW ROOTS	LENGTH OF NEW ROOTS
3 PT PIND GT	6.0	9.2	6.0	8.9	6.0	6.4
6 PT PIND GT	6.0	6.9	5.8	7.0	5.8	4.6
3 PT GOAL T	6.0	8.8	6.0	7.2	6.0	7.2
6 PT GOAL T	6.0	9.1	6.0	9.4	6.0	7.5
CONTROL	6.0	7.9	6.0	8.4	5.8	6.4

Table 3. Spring timing. Number of new roots and root length ratings for ponderosa pine, Douglas-fir and white fir five months after treatment.

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 13-01
Matrix SG

Principal Investigator: Ed Fredrickson

Title: Pre-Plant Site Preparation with Matrix SG (Rimsulfuron)

Year Approved: 2013

Executive Summary:

One of the main priorities the last several years has been to find an alternative site preparation treatment for conifers intolerant to hexazinone. Many new and existing herbicides have been tested with mixed results. One product manufactured by DuPont that may have considerable potential is Matrix SG. Matrix SG is in the sulfonylurea family of herbicides and is primarily an ALS inhibitor, an enzyme necessary for plant growth. Matrix has been successfully used as a bare ground herbicide in non-crop applications and has tolerance on fruit, grapes, and nut crops. It is also labeled for range and pasture applications to control invasive species. Bare ground applications have been extremely successful with Matrix alone or in combination with Telar XP (chlorsulfuron), Milestone (aminopyralid), and Oust XP (sulfometuron). Given the tolerance to fruit and nut crops along with grapes, Matrix may provide adequate tolerance to conifers.

It also has the benefit of being an extremely low use rate product, typically in the two to four ounce per acre range. It has a very favorable toxicity profile with oral LD-50 values greater than 5000 mg/kg of body weight in rats and very little toxicity to birds, fish or aquatic invertebrates. It has a moderately short half- life, generally around 30 days.

This proposal is for a trial that would evaluate the potential of Matrix SG alone and in combination for pre-plant site preparation applications on ponderosa pine, Douglas-fir, and white fir with spring and fall applications.

This trial would be established on a recent clearcut or wildfire that was ready for planting but had not been previously treated with any residual herbicides. The site for this trial should be on the west side of the Cascade Range on good site ground. Preferably, high site two or better. The preferred timing for this site would be a spring treatment followed by a spring plant.

This trial will be completely randomized with four replications per treatment. Plot size will be 12 feet by 36.3 feet (0.01 acres). The trial would be sprayed in the spring of 2013 and planted shortly after. All plots would be planted with 15 trees each of ponderosa pine, Douglas-fir, and white fir. Five trees of each species would be designated as "dig" trees to evaluate root growth. The remaining ten trees would be measurement trees. The first ten trees by

species in each plot would be initially measured for caliper and height at planting.

All applications will be at ten gallons per acre and applied with a CO2 powered backpack sprayer with a twelve foot boom. The sprayer will be calibrated prior to application and each plot will be sprayed with one timed pass.

Treatments will include: 2 oz/acre, 4 oz/acre, or 8 oz/acre Matrix SG; 1.33 lbs/acre Velpar DF with 2 or 4 oz/acre Matrix SG; 1.33 lbs/acre Velpar DF; 3.33 lbs/acre Velpar DF; 7 oz/acre Milestone; 4 oz/acre Matrix SG + 7 oz/acre Milestone; and control. (Due to heavy herbaceous cover at the time of treatment, 1.5 quarts Accord XRT II were added to all treatments to provide burn down to enable evaluation of the residual control of the herbicides tested. An Accord XRT II control was also added to the trial).

Evaluations will occur in the fall of 2013 and the fall of 2014. Evaluations for the spring timing in the fall of 2013 and the fall of 2014 will consist of percent bare ground, percent cover by species, and total percent cover to assess vegetation control. The five trees designated for digging will be excavated and roots evaluated for number of new roots and root length. The measurement trees will be evaluated for percent survival, percent brownout, and vigor. No caliper or height measurements will be taken in 2013. The trial will be evaluated at the end of the second growing season and include all previous evaluation criteria (except "dig" tree data) plus caliper, height, and stem volume for all ten measurement trees per species.

2013: A trial was installed on property owned and managed by Sierra Pacific Industries on March 18th to evaluate DuPont's Matrix SG herbicide alone and in combination with Velpar DF and Milestone for conifer site preparation. The site is located approximately three miles southwest of Round Mountain, California.

Plots were planned to be planted with 15 trees each of ponderosa pine, Douglas-fir, and white fir. Due to a shortage of white fir, only 12 white fir were planted per replication. Trees were planted on March 28th. Ten trees were marked for measurement and the remainder were slated as "dig" trees to evaluate root growth.

Evaluations (August 20th) included percent bare ground, percent cover by species, conifer survival, conifer percent brownout, conifer damage rating, number of new roots and root length for each conifer species.

Data were analyzed using SAS statistical software. Analysis of variance was used to determine significance of the main effects of treatment and orthogonal contrasts were used to make specific comparisons among treatments. Analysis of variance was used to determine if there were any differences in initial seedling size among treatments. If initial seedling size was found to be significantly different among treatments, analysis of co-variance was used to adjust for initial seedling size difference with initial tree size as the co-variate. Vegetation

data were analyzed using analysis of variance for the main effects, and multiple comparisons of means were done using Student Neuman Kewls least significant difference procedure. Orthogonal contrasts were used to make specific comparisons among treatments.

Seedling survival, percent brownout, or damage rating did not significantly differ by treatment for any species tested in this trial. Conifer safety was high for all treatments tested. Ponderosa pine and Douglas-fir had excellent survival overall. Survival was lower for white fir, but there was high variability among blocks (Table 2).

Treatment variables also did not affect number of new roots or length of new roots (see Appendix 1 page 11 for conifer damage and root codes). Number of new roots could not be analyzed due to no variability between observations (all seedlings had the maximum root number rating). No herbicide effect was apparent on any root observations (Table 3).

Vegetation control was very good for all treatments (Table 1). No significant differences existed for percent bare ground between herbicide treatments, but all herbicide treatments had significantly more bare ground than the control ($P<=0.05$). All treatments controlled other annual grasses, rattail fescue, and hedge parsley significantly more than the controls, with the exception of the 7 ounce Milestone treatment for rattail fescue which was not significantly different than the control.

Overall, conifer tolerance was exceptional for all treatments. White fir mortality did not appear to be related to treatment. It was difficult to assess how much Matrix contributed to vegetation control at this 2013 rating. Treatments with Matrix only provided slightly more control than the Accord XRT II only treatment, but that was the case for the operational standard of Velpar DF as well. It appears the initial knock down from the addition of Accord XRT II to all treatments held the site fairly well.

TREAT	% BARE GROUND	% COV HEDGE PARSLEY	% COV TARWEED	% COV DEER BRUSH	% COV RATTAIL FESCUE	% COV OTHER ANN GR.	% COV ANN BLUE GRASS	% COV YEL NUT SEDGE	% COV MULLEIN	% COV BLACK BERRY	% COV OTHER
2 OZ MATRIX	95.5	0.8	1.0	0.0	0.5	0.0	0.2	0.2	0.2	0.0	2.0
4 OZ MATRIX	96.5	0.5	0.5	0.2	0.2	0.0	0.0	0.5	0.0	0.8	1.5
8 OZ MATRIX	96.5	0.0	0.5	0.2	0.2	0.2	0.2	0.0	0.0	0.5	1.8
2 OZ MATRIX + 1.33 LBS VELPAR DF	98.5	0.2	0.0	0.2	0.2	0.0	0.2	0.0	0.0	0.2	1.0
4 OZ MATRIX + 1.33 LBS VELPAR DF	96.8	0.5	0.5	0.0	0.5	0.5	0.8	0.2	0.0	0.5	1.2
4 OZ MATRIX + 7 OZ MILEST.	96.8	0.2	0.0	0.0	0.0	0.0	0.2	0.2	0.0	1.0	2.0
1.33 LBS VELPAR DF	96.0	1.0	0.0	0.0	0.0	0.2	0.5	0.8	0.5	1.0	1.2
7 OZ MILESTONE	93.8	0.0	0.0	0.5	3.2	0.5	0.5	0.5	0.0	0.0	1.2
3.33 LBS VELPAR DF	98.8	0.0	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.5
1.3 QTS ACCORD XRT II	93.8	0.8	0.8	0.5	1.5	0.5	0.0	0.0	1.0	1.2	2.0
CONTROL	61.2	3.0	3.2	0.0	5.5	19.5	2.0	0.5	0.2	1.5	3.8

Table 1. Percent bare ground and percent cover by species for the Spring Matrix Site Preparation Trial five months after treatment.

TREAT	PONDEROSA PINE			DOUGLAS-FIR			WHITE FIR		
	% SUR	% BO	DAM	% SUR	% BO	DAM	% SUR	% BO	DAM
2 OZ MATRIX	96.5	5.0	1.2	88.2	8.8	1.8	52.0	51.2	5.9
4 OZ MATRIX	98.2	3.8	0.2	96.5	3.8	0.8	75.0	28.8	4.2
8 OZ MATRIX	96.5	7.5	1.5	91.8	9.2	1.8	75.0	32.5	5.0
2 OZ MATRIX + 1.33 LBS VELPAR DF	95.0	5.0	1.2	91.5	10.0	1.8	56.0	45.0	6.2
4 OZ MATRIX + 1.33 LBS VELPAR DF	96.8	3.8	0.5	95.0	5.0	0.8	54.2	47.5	5.6
4 OZ MATRIX + 7 OZ MILEST.	94.8	3.8	0.8	98.2	7.5	2.5	81.2	31.2	4.5
1.33 LBS VELPAR DF	98.2	2.5	1.5	93.2	5.0	1.0	79.0	21.8	3.8
7 OZ MILESTONE	96.5	2.5	1.0	93.2	8.8	3.0	91.5	13.8	2.8
3.33 LBS VELPAR DF	94.8	5.0	0.8	88.2	11.2	1.8	52.2	53.8	6.5
1.3 QTS ACCORD XRT II	96.5	3.8	1.0	96.5	3.8	0.8	87.5	20.0	2.5
CONTROL	96.5	5.0	2.2	81.8	16.2	2.5	70.8	35.0	4.0

Table 2. Percent survival, percent brownout and conifer damage rating for the Spring Matrix Site Preparation Trial five months after treatment.

TREATMENT	PONDEROSA PINE		DOUGLAS-FIR		WHITE FIR	
	# NEW ROOTS	LENGTH OF NEW ROOTS	# NEW ROOTS	LENGTH OF NEW ROOTS	# NEW ROOTS	LENGTH OF NEW ROOTS
2 OZ MATRIX	5.8	7	6.0	6.2	6.0	8.5
4 OZ MATRIX	6.0	10.0	6.0	8.0	6.0	8.0
8 OZ MATRIX	6.0	9.2	6.0	6.0	6.0	5.7
2 OZ MATRIX + 1.33 LBS VELPAR DF	6.0	8.0	6.0	6.8	6.0	6.3
4 OZ MATRIX + 1.33 LBS VELPAR DF	6.0	8.0	6.0	8.0	6.0	6.0
4 OZ MATRIX + 7 OZ MILEST.	6.0	7.8	6.0	8.8	6.0	5.7
1.33 LBS VELPAR DF	6.0	10.0	6.0	8.2	6.0	8.2
7 OZ MILESTONE	6.0	7.5	6.0	6.5	6.0	4.8
3.33 LBS VELPAR DF	6.0	9.5	6.0	8.0	6.0	6.0
1.3 QTS ACCORD XRT II	6.0	8.8	6.0	8.8	6.0	7.5
CONTROL	6.0	8.5	6.0	6.5	6.0	6.3

Table 3. Number of new roots and length of new roots by treatment for the Spring Matrix Site Preparation trial five months after treatment.

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 12-02
Garden of Eden II

Principal Investigator: Jianwei Zhang

Title: Do Silvicultural Treatments Applied in a First Rotation Ponderosa Pine Plantation Affect Growth and Carbon Sequestration in the Second Rotation of the Plantation?

Year Approved: 2012

Executive Summary:

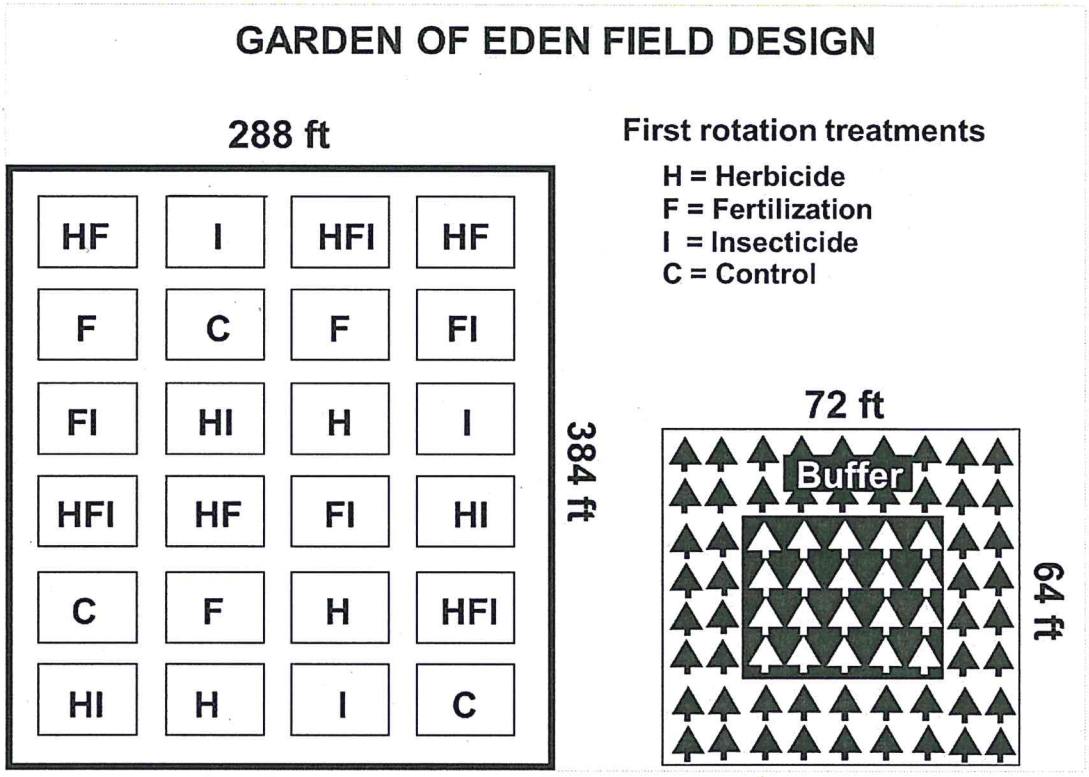
Forest plantations have been regarded as an important wood supply source to meet an increasing wood demand due to the rapid growth of the world's population along with standard of living (FAO 2009). Recently, they have been used as a tool sequestering more atmospheric carbon dioxide to offset an exponential increase in this gas caused by human beings. Concerns arise whether productivity of these plantations, often with monocultures, can be sustained with future rotations. Limited long-term studies yielded mixed results that seem related to the silvicultural practices when the first rotation plantations were harvested and to silvicultural treatments that were applied in the second rotation plantations. Based on our knowledge, no study has been established in ponderosa pine to test the biological sustainability in second rotation plantations.

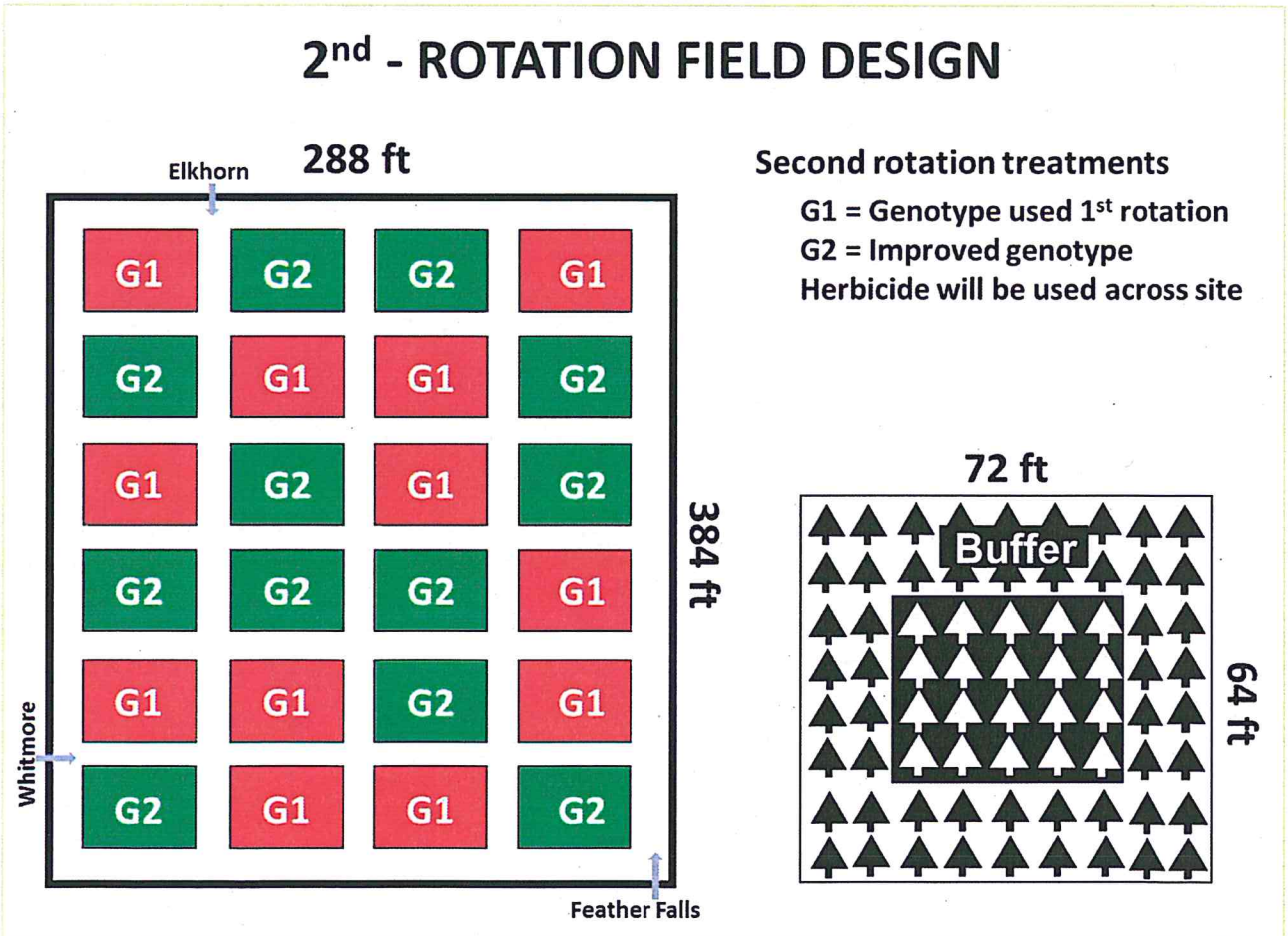
The stated objective of this study is to determine the effects of fertilization and vegetation control, applied in the first rotation of a plantation, on growth and carbon sequestration in the second rotation of that plantation.

The study will have three different sites with a range of site qualities. Three Garden of Eden installations will be used in this study: Feather Falls, the most productive site, Elkhorn, the least productive site, and Whitmore, a site of intermediate productivity. Before harvesting, the original plot boundaries will be reestablished. Soil samples will be collected from each original plot using McFarlane et al sampling intensity. Whole-tree harvesting will be used and forest floor will be retained. New seedlings will be planted with power augers and seedling protection will be applied to assure full stocking. After planting, competing vegetation will be controlled with herbicides on all 24 plots (Figure 1). Including the original treatments, the experiment becomes a completely randomized design with eight treatments replicated three times. Tree height and survival and understory vegetation will be measured/recorded at the end of the first, third, and fifth growing season and at five year intervals after that. Soil samples will be collected the first year following vegetation measurements starting at age three.

2012/2013: All plot corners were remonumented and all preharvest measurements were taken. Soil samples were collected from each original plot prior to the harvesting. All three sites were harvested and all harvested material had been removed from the sites by December, 2013. Seedlings are being grown for out-planting in spring 2014.

Figure 1. A layout of the original Garden of Eden study (3 acres) and proposed treatments to the second rotation plantation.





Sierra Cascade Intensive Forest Management Research Cooperative

Income/Expense Statement

Calendar Year Report for the Period Jan. 1 to Dec. 31, 2013

Beginning Balance on January 1, 2013	$23,370.00
Total Income (Membership Dues)	$58,000.00
Expenses	
Matrix Study	$6,250.00
Pindar/GoalTendar Study	$9,500.00
Pondosa Study	$9,500.00
Vista Study	$123.00
Milestone Study	$123.00
Mat 28 Study	$123.00
GF 9999 Study	$123.00
Research Study Mapping	$1,305.00
Total Expenses	$62,047.00
Year End Balance as of December 31, 2013	$19,323.00

WORKING GROUP MEMBERSHIP

Working Group I
Seed to Establishment

Tom Jopson, Chair
Bob Amesbury
Scott Carnegie
Mark Gray
Scott Worden
Tom Young

Working Group II
Out-planting through Precommercial Thinning

Scott Worden, Chair
Bob Amesbury
Scott Carnegie
Mark Gray
Ken Scott
Tom Young