From the Director

The SMC staff hopes that you all had a great holiday season and wishes you the best for 2005. Since the last issue, we have been very busy readying the first three sites for the genetic gain trial-Type IV experiment in the Grays Harbor breeding zone. This experiment, a collaboration between the SMC and the Northwest Tree Improvement Cooperative will examine the effect of 3 planting spacings, 3 levels of genetic gain, and vegetation control on stand productivity and quality. Twenty two plots on each of three installations will be planted in early 2005 and three more installations to complete the experimental design will be planted in 2006. The three sites for 2005 were made available by the Quinault Tribal Lands, Rayonier Timberlands, and Weyerhaeuser Company. The SMC field crew, Bob Gonyea and Bert Hasselberg, have laid out all of the plots on them and the landowners have hired contractors to fence, spray, and pin-flag them. Plans are to plant the seedlings in late February or early March. The Silviculture TAC held a meeting on December 16 to review the final details for these first 3 installations, discuss possible sites for three installations that will be planted in 2006 and to discuss measurement and monitoring protocols and responsibilities. We will have a detailed accounting of the setup costs and protocols for these installations in a future issue.

John Haukaas, on the SMC database staff, has completed a graphical user interface for the Tree List Generator program. The Tree List Generator was developed as an SMC project by Kevin Gehringer but many found it difficult or inconvenient to use. As a result, John has provided a interface that allows the user to set it up and run it with a few simple clicks and entries. We are eager to have a few volunteers
test it and provide feedback before we make it available on the SMC website. If you are willing to do this, please contact John (jhaukaas@u.washington.edu).

During the Fall, Randy Collier, also on the SMC database staff, and Eric Turnblom, Silviculture Project Leader, have updated the SMC Field Manual. It will be included on the database CD each member receives in June and can be ordered separately on CD (rcollier@u.washington.edu), or downloaded from the SMC website. Also in this issue, we provide brief summaries of external grant funds faculty received that were leveraged from the existence of the SMC installations and database. These projects are a critical source of support for graduate students and provide important supplemental support of SMC staff. Finally be sure to note the dates planned for the SMC Spring and Fall meetings. Since 2005 marks the 20th Anniversary of the establishment of the SMC, we are planning a special event for the Fall meeting and will keep you informed in upcoming issues. The SMC and the Northwest Forest Soils Council will be hosting a workshop entitled “Predicting Response to Forest Fertilization” at the USFS Gifford Pinchot NF headquarters in Vancouver, WA on January 28. Details are available at: http://www.forestsoils.org/nwfsc/.

In This Issue

Last April SMC held a TAC meeting on forest nutrition and fertilization. As a follow-up, graduate student Yuzhen Li has been analyzing the response to fertilization of the SMC Type I installations and a summary of her findings is featured in this issue. Yuzhen is presently using the SMC database in analyzing fertilization response of the young plantations within the Regional Forest Nutrition Program (RFNRP) database along with a number of contract studies in young plantations that we have done over the years which are also in the database. The results and comparison with results presented in this issue will appear in a future issue.

External Grant Funds Generated in 2004

In total, $452,000 for 4 new grants were received in 2004 and a fifth continuing project received a major portion of its total funding. These grant proposals succeed in a large part as a result of the existence of the SMC and its resources, they complement the budget by supporting graduate students, staff and faculty affiliated with the SMC. Presented on the next page are brief descriptions of these projects.
### Investigators
David Briggs (UW CFR SMC), Eini Lowell (USFS PNWRS), Eric Turnblom (UW CFR SMC), Bruce Lippke (UW CFR RTI), Peter Carter (FibreGen)

### Project Title
Non-destructive evaluation of wood quality in standing Douglas-fir trees and logs

### Granting Agency, Amount, Year
USFS Rocky Mtn. Res. Station $87,500 (FY05 $29,700, FY06 $30,200, FY07 $27,600); UW College of Forest Resources $75,000; Project total $162,500

### Project Objectives
1. What are the relationships between the average stiffness of lumber or veneer in a log, stiffness of the log, and stiffness of the parent tree and to what extent are these relationships influenced by stand, tree, or log variables?
2. What are the effects of cultural treatments and genetics on these stiffness relationships?
3. How can the natural variability of stiffness among trees within a stand be monitored and incorporated into decision support tools that assist managers in assessing if stands and stand treatments are within desired specifications and in making improved marketing decisions?

### Progress
Nondestructive testing tools, HM200 and ST300 have been purchased. Initial test for both planned in January 2005

### Investigators
David Briggs (UW CFR SMC), Rob Harrison (UW CFR SMC)

### Project Title
Long-term Site Productivity (LTSP) Integrated Database

### Granting Agency, Amount, Year
USFS Pacific Southwest Res. Station. $100,000, 9/15/04-12/31/07

### Project Objectives
1. To gather datasets associated with the various LTSP study sites and organize them into an integrated, consistent database. This database will provide access to data and information within and across LTSP sites, thereby fostering improved collaboration, integration and analysis across North America.
2. To develop a plan and process for continued technology support for the continued integration of re-measurements and new data from these sites and others into the database. Procedures will be recommended for database updating and other technical support. Options and estimated budgeting to accomplish this continuing support will be presented.

### Progress
An initial meeting to discuss the research plan and establish contacts was held November 2004 at the Soil Science Society of America meeting in Seattle, WA.

### Investigators
Rob Harrison (UW CFR SMC), Tom Terry (Weyerhaeuser Co.), A.B. Adams (UW CFR SMC)

### Project Title
Organic Matter and Management Effects on Forest Productivity

### Granting Agency, Amount, Year
National Council on Air and Stream Improvement (NCASI) $40,000, 2004 supplement and extension (cumulative total since 1998 = $332,000)

### Project Objectives
To determine the impacts of organic matter retention and management (fertilization, vegetation control, and tillage) on the long-term productivity of Douglas-fir stands.

### Progress
Established test site in 1998 with re-measurements and assessments since.

### Investigators
Rob Harrison (UW CFR SMC), Tom Terry (Weyerhaeuser Co.), A.B. Adams (UW CFR SMC), Steve Schoenholtz (OSU), Tim Harrington (USFS Olympia)

### Project Title
Forest Management Effects on Nitrogen Retention and Cycling

### Granting Agency, Amount, Year
USFS Agenda 2020 PNW Station through Olympia Lab $80,000 per year 2005-2007, $150,000 total

### Project Objectives
To determine the impacts of organic matter retention and management (fertilization, vegetation control, and tillage) on the retention and cycling of N at the new Molalla, OR and Matlock WA LTSP sites.

### Progress
Another grant established Matlock treatments in 2004; UW instrumented them last month; Molalla will be installed in 2005.

### Investigators
Eric Turnblom, Associate Professor; Andrew Hill, PhD student, University of Washington, College of Forest Resources

### Project Title
Using climate-related information to improve short-term growth projections

### Granting Agency, Amount, Year
USFS Forest Inventory and Analysis (FIA); $62,087 1 Jan 2003 to 31 Jun 2005

### Project Objectives
1. Evaluate the availability and quality of supplemental weather information for incorporation into basal area growth models.
2. Examine various methodologies for employing the most suitable climate / weather-related information into growth and yield models for basal area
3. Test methodologies by analytical comparison of methodological outcomes with re-measured FIA forest inventory data
4. Propose technique or algorithm for including best methodology into FIA estimation procedures

### Progress
Study plan has been developed. FIA data have been acquired for Eastern and Western Washington state. Appropriate PRISM precipitation and temperature data have been acquired from “The Climate Source.” Both weather and inventory data are being summarized and examined from several perspectives. Various methods will be incorporated to determine the impact of current weather and climate information into extant individual-based tree list models as well as more general modeling approaches and frameworks are now being explored.
Effects of Fertilization and Density on Growth and Yield of Young Douglas-fir Plantation in SMC Type I Installations

Yuzhen Li, Graduate Research Assistant, University of Washington
Eric C. Turnblom, Associate Professor, and SMC Silviculture Project Leader
David G. Briggs, Professor; SMC Director

Introduction

SMC Type I installations were established in thifty juvenile stands at several initial density levels, with and without later thinning and supplementary treatments. In this study, sixty-three plots from nine Type I Douglas-fir installations were available for analysis with each installation containing seven plots. Treatment regimes included two factors: fertilization and density. For fertilization, urea was applied at a rate of 200 lbs/acre in the establishment year and every fourth year thereafter. The density factor was the combined treatment regime of spacing in the establishment year and subsequent thinning. It had four levels: 1) the plantation remained at its initial stem per acre (ISPA) with no further thinning; 2) the plantation started at its initial density (ISPA), but was repeatedly thinned later; 3) the plantation was spaced to one-half of its initial density (ISPA/2) with minimal thinning later; 4) the plantation was spaced to one-fourth of its initial density (ISPA/4) with no further thinning. With the exception of the ISPA plot with no further treatments, the three remaining density levels described above had both a fertilized and unfertilized plot, hence there were seven treatment regimes. Table 1 summarizes stand attributes at the beginning of this study.

At establishment there were no significant differences in quadratic mean diameter (QMD), height, age, and site index among the seven treatment regimes. Due to the different spacing treatments imposed in the establishment year, basal area (BA), volume, trees per acre and relative density did show significant differences as would be expected. Within each density level, there were no statistically significant differences in the stand attributes between fertilized and unfertilized treatment counterparts.

Table 1. The average attributes in the establishment year for 63 Type I Douglas-fir plots.
Methods

Growth analysis was conducted on average net periodic annual increment for every four-year growth period and yield analysis was conducted on net yield in the establishment, 4th, 8th and 12th year. Data were analyzed as an augmented two-factor fixed-effect model with initial trees per acre, breast height age and plot site index as covariates. The main effects of fertilization and density, their interaction effect, along with covariance effects, were tested by using analysis of covariance (ANCOVA) in SAS at the 0.05 significance level. Based on ANCOVA results, non-significant effects were deleted from the initial models.

Results and Discussion

Table 2 summarizes the stand attributes at the end of three four-year growth periods, a total of 12 years. Comparing it to Table 1, one can see that, after 12 years, QMD, BA, and volume have changed and within each density level, the fertilized plot had a significantly greater QMD, BA, and volume than its unfertilized counterpart. Although height changed over the 12 year period, there continued to be no significant differences in height among the treatments. The remainder of this article will focus on the effects of treatments on diameter and volume.

Effects of Thinning and Fertilization on Diameter

As previously stated, there were no significant differences among the treatments in QMD at establishment (Table 1). After 12 years, QMD had significantly increased and was progressively greater from ISPA to ISPA/2 to ISPA/4 (Table 2) since the wider spacing experienced by ISPA/4 and ISPA/2 gave remaining trees more room to grow. In fact, ISPA/4 exhibited the greatest QMD growth for all three growth periods. For each density, the fertilized plots have a significantly greater QMD than the unfertilized counterpart.

1 Repeated thinning: first thin when RD = 55 and thin to RD = 35; next when RD = 55 again thin to RD = 40; subsequently whenever RD = 60 thin to RD = 40
2 Minimal thinning” when RD = 55 thin to RD = 35; no further thinning
Not only did widely spaced treatment regimes exhibit larger QMD, they also had a higher proportion of trees in larger diameter classes. When established, diameter distribution curves were very similar among the treatment regimes (Figure 1a) but 12 years later, they differentiated as shown in Figure 1b. The diameter distribution for ISPA/4 moved further to the right than ISPA/2 and ISPAs, implying that ISPA/4 had a greater proportion of trees in larger diameter classes. Figures 1a and 1b also show that, while the diameter distributions of the fertilized and unfertilized plots were the same at establishment, 12 years (3 fertilizer applications) later the diameter distribution curve for a fertilized plot was to the right of the unfertilized counterpart for each density level. Thus the fertilized plots have more large trees than their unfertilized counterparts. This can be better visualized by bar graphs in Figures 2. At the start of the study, all seven treatment regimes had about the same diameter class proportions (Figure 2a); 86% 1-4 inch trees and 14% 5-8 inch trees. Twelve years later, about half of the trees in ISPA/4 were 13-17 inches and another half was 9-12 inches (Figure 2b). For ISPAs, the 13-17 inch diameter class accounted for only 1-2% of the trees, while the 5-8 inch diameter class accounted for about 50%. The greater proportion of larger trees in fertilized versus non-fertilized counterparts is also readily apparent.

**Effects of Thinning and Fertilization on Volume**

Figure 3 presents cubic foot volume per acre at establishment and the 4th, 8th and 12th year since. The greatest yield in absence of fertilization is in the ISPA and ISPA_Repeat_Thin; the latter has recently caught and slightly surpasses the former. As would be expected from the initial treatments, the ISPA/2 and ISPA/4...
densities have lower trajectories. In each case, the curves for fertilized plots are above the unfertilized counterparts. The yield gains due to fertilization during the first growth period were not statistically significant but became significant in the second and third growth periods.

Figure 4 presents the average annual growth in cubic feet per acre per year during each of the growth periods for the seven treatments. As would be expected, there was more volume growth on the denser treatments and fertilization generally increased growth. However, closer inspection reveals that growth on the ISPA (control) with no thinning or fertilization has slowed the most during the last growth period and the growth boost provided by fertilization in the ISPA_Repeat_Thin has essentially disappeared. In the ISPA/2, growth is continuing to increase and growth on the fertilized ISPA/2 has just about caught the ISPA control. The ISPA/4 has lower growth but the effect of fertilization seems to be gaining some momentum. Across all densities, fertilization effects on volume growth were significant during the first and second growth periods but not in the third growth period. Density effects were significant through all three growth periods with denser stands having more volume annual increment. However, statistical testing indicated that there was no significant interaction between fertilization and density treatments and the effects from these two were additive.
Comparing the volume growth and volume yield results, this study found significant effects on growth during the first two, but not the last, growth period. However, no significant effect of fertilization on volume yield was found in the first growth period (after the first fertilization application) but significant effects did appear in the two subsequent periods (after the second and third fertilizer applications). Either we are observing the cumulative effect of repeated fertilization, a time lag until the significant effect of growth rate translates into significant yield accumulation, or a mix of both.

Many operational foresters are interested in the percentage changes associated with treatments. Figure 5 shows the percentage gain in cubic foot growth rate between the fertilized and unfertilized counterparts for each growth period. These percents were calculated by dividing the fertilized growth rate by the unfertilized growth rate for each growth period and each density regime. They are properly interpreted as the marginal periodic percentage gain due to fertilization for each density and should not be interpreted as evidence of interactions between density and fertilization. Statistical analysis using actual cubic foot volume growth found that there were no significant interactions.

Conclusion

1. While height increased over the 12 year period investigated, there were no significant effects of the treatments on height.

2. Fertilization produced additional growth in QMD and volume at all densities; growth rates were significantly increased by the first and second fertilization applications but not by the third. Volume per acre and average diameter were not significantly increased in the growth period following the first fertilization but significant increases were observed in the second and third growth periods (after the second and third fertilizer applications). Possible explanations could be a repeated fertilization effect, a lag between observation of significant change in growth rate and translation into significant yield, or a mix of both phenomena.

3. The density treatments had a greater effect on QMD and volume growth and yield than did fertilization. Initially, the densest stand had the greatest overall stocking and growth. However, accumulation in the dense stands is declining with time and the less dense stands are catching or exceeding them.
Abstracts and Publications


Abstract
The mean crown diameters of stand-grown trees 5.0-in. dbh and larger were modeled as a function of stem diameter, live-crown ratio, stand-level basal area, latitude, longitude, elevation, and Hopkins bioclimatic index for 53 tree species in the western United States. Stem diameter was statistically significant in all models, and a quadratic term for stem diameter was required for some species. Crown ratio and/or Hopkins index also improved the models for most species. A term for stand-level basal area was not generally needed but did yield some minor improvement for a few species. Coefficients of variation from the regression solutions ranged from 17 to 33%, and model R² ranged from 0.15 to 0.85. Simpler models, based solely on stem diameter, are also presented. West. J. Appl. For. 19(4):245–251.


Abstract
Equations to predict uncompacted crown ratio as a function of compacted crown ratio, tree diameter, and tree height are developed for the main tree species in Oregon, Washington, and California using data from the Forest Health Monitoring Program, USDA Forest Service. The uncompacted crown ratio was modeled with a logistic function and fitted using weighted, nonlinear regression. The models were evaluated using cross-validation. Mean squared error of predicted uncompacted crown ratio was between 0.1 and 0.15, overall bias was negligible, and correlation between the predicted and observed uncompacted crown ratio was high for most species. The sensitivity of crown fire risk to crown ratio estimation method was evaluated using the Fire and Fuels Extension of the Forest Vegetation Simulator. Torching index, an estimate of the wind speed needed for a crown fire to develop, was significantly greater when compacted crown ratio was used instead of uncompacted crown ratio. The close agreement in torching indices simulated using predicted and observed uncompacted crown ratio provides further evidence of the utility of the models developed in this study.


Abstract
Five-year growth and survival responses of lodgepole pine and hybrid spruce to manual cutting of Sitka alder were studied in two montane vegetation complexes in interior British Columbia. The effects of brushing on plant community diversity and structure also were examined. Alder cover and height were reduced throughout the 5-year post-treatment measurement period, but this had no effect on growth or survival of either 5- to 7-year-old lodgepole pine growing in the Dry Alder complex or 4- to 7-year-old hybrid spruce in the Wet Alder complex. Moderate alder cover, which was characteristic at these sites, did not appear to inhibit diameter growth of lodgepole pine or spruce. This was supported by competition thresholds for conifer diameter of 30 and 37% alder cover in the Dry Alder and Wet Alder complexes, respectively. In neither complex did manual cutting result in any changes in species richness, species diversity, or structural diversity of the vascular plant community. The results of this study suggest that brushing of Sitka alder is unnecessary for release of healthy lodgepole pine growing on mesic sites in the Dry Alder complex and is ineffective at alleviating growth limiting factors to spruce on Wet Alder sites.

Abstract
With fire suppression, many western forests are expected to have fewer gaps and higher stem density of shade-tolerant species as light competition becomes a more significant influence on stand pattern and composition. We compared species composition, structure, spatial pattern, and environmental factors such as light and soil moisture between two old-growth forests: Pacific Northwest western hemlock/Douglas-fir at the Wind River Canopy Crane Research Facility exhibiting gap-phase replacement and southern Sierra Nevada mixed conifer at the Teakettle Experimental Forest after 135 years without a fire. We hypothesized that fire suppression at Teakettle would create a current tree composition and distribution more like Wind River where light is an important influence on stand dynamics. Wind River has nearly continuous canopy cover and a high foliage volume that severely reduces understory light and stratifies the canopy composition by shade tolerance. Large trees are regularly spaced from 0 to 15 m and shade-tolerant and intolerant species are “repelled.” In contrast, Teakettle’s canopy cover is discontinuous, foliage volume is one-fifth that of Wind River, and understory light is 15 times higher. Trees at Teakettle are significantly clustered in groups containing a mix of shade-tolerant and -intolerant species, separated by large gaps. Although Teakettle’s gaps have higher moisture and a thinner litter layer than tree groups, regeneration in gaps is scarce. Fire suppression has increased stem density at Teakettle but it has not filled in gaps, stratified the canopy by shade tolerance, or produced a composition consistent with patterns at Wind River. Teakettle’s distinctly clustered stem distribution may result from a minimum canopy cover threshold needed for tree establishment. If high temperatures produced by direct sunlight inhibit stem patterns, traditional stand management that reduces canopy cover to release regeneration should be applied with caution in the southern Sierra Nevada.


Abstract
Height data from 89 Douglas-fir provenances planted at seven sites in northern Spain were used to explore and discuss the utility of the relative height growth trend as an early selection parameter. Total height was measured at each site at different ages between 2 and 18 years after planting. A modification of the joint regression analysis was used to analyze and interpret the provenance × age interaction at each site. The analyses of variance showed a significant provenance × age interaction in five out of the seven sites. Most of this interaction at these sites was explained by the linear relation over years between the provenance mean height at each site and the overall site mean height. The relative growth trend was defined as the slope of these linear relations for each provenance and was considered as a temporal stability parameter. Both the high genetic variability and the biological significance of this parameter suggest its applicability in early selection. A strong linear relationship was observed between this growth parameter and the initial provenance mean height at all sites where provenance × age interaction was significant except one. This relationship indicates that the differences between provenances at an early stage will hold up and be amplified in future measurements, and then there is a relative security of early selection. One site showed no significant relation between the relative growth trend and the initial performance. At this site, rank changes among
measurements are likely to be more frequent, and early selection becomes harder. The use of the relative growth trend as an early selection parameter in these sites improves the early selection efficiency. The results suggest that the relative growth trend can help in both the early selection and the evaluation of the early selection efficiency.


Abstract
Recent authors have asserted that the original form of Reineke’s stand density index is flawed, and that an additive version represents the correct form. An examination of the literature provides no historical or mathematical reason why additivity should be required in the original index. Reineke’s stand density index, and the additive or area-based stand density index, should be considered as separate indices with different properties. The sensitivity of the area-based index to stand diameter distribution is illustrated with the Weibull distribution. Its sensitivity provides testable hypotheses that could be used in empirical studies to determine the better index.

Upcoming Meetings and Events


February 6-11, 2005 – Forest Stand Dynamics. Pack Forest, University of Washington, Eatonville, WA. Yale School of Forestry & Environmental Studies, Global Institute of Sustainable Forestry 5-day course. For more information visit: http://www.safnet.org/events/eventlist.cfm.

February 22-23, 2005 – New Zealand Douglas-fir Cooperative Meeting. Rotorua, NZ. For more information contact Leith Knowles: leith.knowles@forestresearch.co.nz.


