From the Director

As we complete 2005 and 20 years of SMC operation, the faculty, staff, and students hope you all had a wonderful Holiday Season. With 2006 upon us, we hope to hold meetings of the TAC’s and Strategic Planning Committee during the first quarter of the year. Please be sure to mark January 23-24 on your calendar. We will hold a joint Nutrition/Silviculture TAC meeting on the 23rd just before the conference on the 24th titled “Managing Forest Nutrition in the Pacific Northwest: Has Nitrogen Stolen the Show?” Both of these events will be held at Oregon State University and further details are provided later in this issue.

In This Issue

Articles in this issue include a current summary of the carry-over effect study which we initiated in 1998. This study is examining the question “Does the fertilization regime of a stand have any effects that carry forward after harvesting into the replacement stand?” Rob Harrison summarizes what we have learned so far from a subset of RFNRP installations that were chosen to address this question.

Finally, we have added several new graduate students this year and introduced one of them, Nick Vaughn, in the last issue. In this issue we introduce Cindy Flint, and will introduce the others in the future.
January 23: SMC Nutrition and Silviculture Joint Technical Advisory Committee Meeting

The joint TAC meeting will be held the day before the nutrition conference (see next item) at Oregon State University in 115 Richardson Hall starting at 9:00 am. Some of the topics for discussion include:

1. Discussion to identify and clearly define questions and issues regarding nutrition and fertilization. We need to be sure that we understand and agree on these questions before we can define appropriate collaborations, methodologies and resources that will be necessary to address them.

2. We would like to have a brief presentation and discussion of the potential for using remote sensing (multi-spectral, lidar, ifsar, etc), GIS and other technologies to identify stands on a landscape with high potential to respond to fertilization treatment and to monitor response. Rob Harrison will send a preliminary plan in the next few weeks.

3. Plans for planting the 2006 genetic gain trial – type IV (GGTIV) installations

4. Other GGTIV discussion (follow up to the August 2005 Silviculture TAC meeting) including (a) need to replace mortality on the 2005 plantings, (b) procedure to measure basal caliper of seedlings consistently over time (c) procedure for site assessment (d) review draft schedule and responsibilities for monitoring vegetation development and applying control measures as needed, (e) review draft procedure for understory vegetation assessment designs and measurement procedures.

5. Follow-up to August 2005 meeting what designs will be needed to investigate the effects of silviculture on pure or mixed clonal or pure family plantations?

We will be sending a more detailed agenda and draft materials prior to the meeting.

January 24: Conference “Managing Forest Nutrition in the Pacific Northwest: Has Nitrogen Stolen the Show?”

For further details concerning the program, location, and registration please go to the following website [link provided]

Update on the Agenda 2020 Project “Non-destructive evaluation of wood quality in standing Douglas-fir trees and logs”

During 2005 the following aspects of the project were accomplished:

1. Collaboration with the Pacific Northwest Tree Improvement Research Cooperative on the genetics of wood stiffness.

Cindy Flint is beginning her masters program here at the College of Forest Resources in the Forest Soils program under Professor Rob Harrison. She plans on focusing her education on nutrient cycling and was awarded the Gessel Fellowship for her first year to pursue this line of study. She is currently beginning a thesis project that will explore the impact of forest fertilization on nitrate leaching and how this might contribute to the nutrient loading problem in Hood Canal. This project is closely related to the research at Matlock and is a partnership with SMC Member, The Green Diamond Resource Company.

Cindy has a bachelors degree in Environmental Science from Willamette University. She has over three years of experience in the field of stream restoration and environmental education. She worked for a non-profit organization in Seattle, Mid-Sound Fisheries Enhancement Group, for a year before returning to her hometown of Portland to work for a nonprofit organization called SOLV for 2 ½ more years. For both organizations she implemented a vegetation monitoring program and served as the volunteer coordinator. While working with volunteers to plant riparian vegetation, stabilize streambanks, and enhance in-stream habitat, she discovered her interest in nutrient cycling and soils.

Cindy married Ben Flint this past June and they recently adopted a puppy named Cedar. Last year, the couple spent 8 months in Guatemala where they volunteered for an organization doing rainforest conservation and organic farming.

Cindy Flint, New CFR Grad Student
In March, parental clones at the Hood Canal seed orchard were harvested. Data gathered includes standing tree and felled log acoustic velocities, cookies from each log end were taken and measured for specific gravity, moisture content, total ring count and diameter (ring 10, ring 20, heartwood region, and dib); cookies are being stored pending other analyses. Seed orchard ramet foliage samples were sent to UC Davis for genetic analysis. During the summer trees at the Shine progeny test were measured for dbh and standing tree acoustic velocity. Next 2475 of these trees were felled and 9 foot butt logs were measured for log acoustic velocity and disks taken and measured for the same characteristics as the parental clones. 403 of these logs were milled into 2x4’s that are now being evaluated for stiffness and strength.

In addition to the personnel of PNWTIRC and SMC, this study has benefited from contributions by many others including Olympic Resources Management which donated the parents and progeny, Dan Cress who assisted in much of the logistics, Brad St Clair, USFS PNWRS, who assisted with data collection, Fred Pfund who arranged for the sawmilling, Thompson Timber Sort Yard, who provided a location for milling, Barnaly Pande and Dave Neale at UC Davis, Randall Greggs of Green Diamond Resources who air dried and stored cookie samples, Randy Johnson, USFS PNWRS, who loaned his acoustic log tool, and OSU Wood Science Dept. for providing a drying kiln, storage space, and testing equipment.

2. Evaluation of acoustic velocity in the SMC Type I Installations with fertilization

Six of the nine installations with the density control/fertilization experiment were visited by a summer field crew. In each of the 7 plots, the standing tree acoustic velocity was taken at multiple points and the tree locations were mapped so we can examine the trade-offs between number of samples per tree, plot size, etc. We plan to gather data from the remaining installations in summer of 2006. Preliminary analyses with the data gathered to date do show some treatment effects. We expect to have a full analysis completed by the end of the year.

3. Tree-to-log-to-mill recovery study

This portion of the study will use SMC Type II installations to develop baseline relationships between tree acoustic velocity, acoustic velocity of logs within the tree, and stiffness of lumber and veneer recovered from the logs. At this time Green Diamond Resource Co., Port Blakely Tree Farms, and Washington DNR have agreed to let us harvest trees from Type II installations on their land. A fourth installation is also being reviewed for possible inclusion in the study. The Wood Quality TAC has recommended a stratified sampling procedure, based on tree acoustic velocity and dbh, for selecting sample trees within each of the 5 plots on these installations. We plan to visit the installations this spring to obtain the acoustic velocity data and select sample trees and plan to conduct the harvesting and milling over the summer. All of the lumber and veneer will be tested for stiffness with a subsample of the lumber destructively tested. Cookies from the log ends will also be collected for measuring wood density, moisture content, and juvenile wood content.
INTRODUCTION

Douglas-fir growth in the coastal PNW is commonly limited by the supply of plant-available nitrogen (Chappell et al. 1991). Evaluating response to N fertilization was one of the primary reasons for establishing the Regional Forest Nutrition Research Project (RFNRP) in 1969. In 1991, the RFNRP was incorporated into the SMC, and it was almost immediately noted that many of the original RFNRP sites were reaching or passing commercial maturity. The original FPI investment in those studies was enormous, but the utility of continuing measurements on the sites indefinitely was questioned as it diverted efforts away from other, potentially more productive work.

A great deal of data is now available on the effects of that original application on the growth of trees, as normally, only the tree diameters and total heights were measured during the study. The SMC Silviculture and Nutrition TAC members, and the SMC as a whole has considered what to do with the original RFNRP sites, and in 1997, a “carryover” study was initiated.

The basic idea of the carryover study is shown in Figure 1. First, sites were selected to represent a range of responses seen in the original, much larger RFNRP study. An original RFNRP study that reaches maturity is converted to a “carryover” study by harvesting the original forest, and redistributing the tree tops and branches back on to the site that the stems originated from.

Carryover studies were established at seven different SMC installations after the study was approved, and data is now available for up to 7 years of growth following the study. They include Little Ohop Creek #17, Camp Grisdale #53, Pack Forest #134, Coyle #156, Hanks Lake #167, Simpson Log Yard #168, and Pack Forest Lookout #177. Installations Little Ohop Creek #17, Pack Forest #134 and Coyle #156 had single comparisons of 0 lb N/ac as a control vs 1000 lb/ac (multiple applications) as a treatment. Camp Grisdale #53 and Hanks Lake #167 had comparisons of 0, 400 and 1000 lb N/ac, Simpson Log Yard #168 0, 200, 800 and 1000 lb N/ac, and Pack Forest Lookout #177 0, 800 and 1000 lb N/ac.

Typically, the “carryover” was installed by marking all trees within the original plots (Figure 2) at ground level. Then all trees outside of the plots were removed. The tops and
branches of the original study trees were spread evenly over the original plot area, and the site was planted according to a company's standard procedures. Vegetation control was also practiced according to company standards. The sites were not fertilized again, and are not supposed to be fertilized in the future.

RESULTS

Results of Previous Studies Other studies have noted different impacts on forest stands and soils. For instance, a number of previous studies were carried out relative to the long-term impacts of fertilization, and its potential to impact site factors. Nitrogen fertilization generally increases the growth rates of target trees and therefore the amount of aboveground woody biomass produced. One study reported an increase in aboveground Douglas-fir tree biomass of 13.8% (478 vs. 420 metric tons of carbon ha⁻¹) compared to unfertilized control treatments. This increase corresponded to 62 kg of carbon (C) sequestered for each kg of N added (Canary 1994, 2000). Nitrogen fertilization has also been associated with increased foliar N concentrations (Heilman and Gessel 1963; Turner 1977) and total N contents (Pang et al. 1987). In addition to wood biomass, N fertilization also increases the production of other tree components such as branches and foliage. Following harvesting, this additional organic matter is typically retained on site and through its decomposition may act as an important pool of available nutrients, including increasing leaching and accumulation of organic matter in the lower soil horizons (Adams et al., 2005). However, the specific long-term effects of this additional organic matter on the availability of N and the growth of the subsequent stand are not well understood. A better understanding of the long-term implications of N fertilization and its secondary effects will have important forest management implications.

Many researchers have demonstrated that the beneficial effects of N fertilization in N-limited forest ecosystems may be long-lasting (Binkley and Reid 1985; Strader and Binkley 1989; Prescott et al. 1995) and possibly extend to the next rotation (Prietzel et al. 1999, 2004), although this is not always the case (Miller 1988; Chappell et al. 1999). Fertilization has been reported to cause lower carbon/nitrogen ratios of litter and forest floor organic matter and increased overall N pools (Chappell et al. 1999; Prietzel et al. 1999, 2004). Prietzel et al. (1999, 2004) suggested that N-limited forest systems are able to efficiently retain fertilizer N in the forest floor for more than one rotation. He estimated that 20 to 30% of applied N fertilizer was retained in the forest floor 7-15 years after N application.

Following harvesting, nutrients are released from forest floor organic matter by increased rates of microbial decomposition and mineralization (Bormann et al. 1967). Understory vegetation may take up a significant part of the mineral N being produced after site disturbance, thus preventing available N from being utilized by seedlings or being lost from the ecosystem through soil water leaching (Mellert et al. 1998).

Understory vegetation plays a substantial role in N accumulation and recycling when N becomes available during stand regeneration (Cowley 1998). In the plots studied in this paper and others visual differences have been noted in the amount of aboveground understory biomass and species composition between fertilized and control plots (Prietzel et al. 1999, 2004; Chappell et al. 1999).

Klinka et al. (1989) proposed that the composition of understory vegetation species
change in relation to changing site nutrient conditions in a predictable way. Should N fertilization have long-term impacts on nutrient availability, it would be expected that fertilized plots would have a greater availability of resources than paired controls. Increased nitrogen availability post-harvest may be reflected in understory vegetation composition, amount and N content differences between control and fertilized plots. Understory vegetation also competes with tree seedlings for light, water, and nutrients and therefore differences in understory competition may have important implications for the growth of the subsequent stand (Chappell et al. 1999; Prietzel et al. 1999).

Results from the Carryover Study. There were obvious visual differences in some of the plots at the start of the study. First, some of the plots had responded to the original N treatments, and increased growth of the trees resulted in additional tree biomass being returned to the sites after harvest as slash. Understory growth was also quite different, more high site indicator species (i.e. sword fern) on fertilized plots and low site indicator species (i.e. salal) on control sites (Figure 3). Noting visual differences can be deceiving, but these differences were borne out in some measurements.

Gage Wagoner quantified some of these differences for his M.S. thesis, though he didn’t study all of the current carryover sites specifically (they weren’t all selected yet). His results can be seen in Figure 4. The previously N-treated plots showed about double the average biomass of the untreated controls in understory species.

The total amount of N in understory biomass was also quantified. It accounted for between 18 and 128 kg N/ha, with the highest amount at the Pack Forest #134 fertilized site. In all cases, N-fertilized plots had higher understory total N when compared to control plots (Figure 5) on the same installation.

Gage also found that the species composition did shift along with the total biomass, though the results were mixed. In some cases, species normally associated with low sites (i.e. bracken fern and salal) also increased in total biomass. Its impossible to consider the species shifts that he saw in any detail in this writeup. A computer link to his thesis is given at the end of this paper, as well as to several other products of SMC research.

The results of growth of seedlings are becoming available, though the stands still range in age from 5-7 years since planting. Total height differences were measured, with an average increase of 15% in total height for plots previously fertilized. These differences are significant at a 0.0002 level (Table 1).
Some trees have crossed DBH and others haven’t, so we will wait until all cross DBH to begin to consider basal area and volume growth projections. There were some diameter (at ground level) differences noted, with an overall average diameter increase of 11%. These differences are significant at the 0.018 level (Table 2).

Overall, it looks like previous N fertilization resulted in changes other than the targeted change of increased growth of the trees originally fertilized. Trees will continue to be measured over time, and when time and funding are available, additional studies will be carried out on these sites. It is suggested that we might want to consider something similar for SMCType I installations as they become ready to harvest in order to get as much information out of the original studies as possible.

Figure 4. Total aboveground understory biomass for 5 RFNRP sites.

Figure 5. Total aboveground understory biomass N for 5 RFNRP sites.
Table 1. Effect of Prior Fertilization on Seedling Height Growth.

<table>
<thead>
<tr>
<th>Install.</th>
<th>Name</th>
<th>App. Rate</th>
<th>Yr Since Planting</th>
<th>Height Control</th>
<th>Height +N</th>
<th>% Height Difference</th>
</tr>
</thead>
<tbody>
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<td>1000</td>
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<td>4.59</td>
<td>5.46</td>
<td>16</td>
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<tr>
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<td>3.39</td>
<td>3.74</td>
<td>10</td>
</tr>
<tr>
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<td>400</td>
<td>5</td>
<td>3.39</td>
<td>4.04</td>
<td>16</td>
</tr>
<tr>
<td>134</td>
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<td>7</td>
<td>5.69</td>
<td>7.29</td>
<td>22</td>
</tr>
<tr>
<td>156</td>
<td>Coyle</td>
<td>1000</td>
<td>5</td>
<td>3.86</td>
<td>4.63</td>
<td>17</td>
</tr>
<tr>
<td>167</td>
<td>Hanks Lake</td>
<td>1000</td>
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<td>3.38</td>
<td>3.81</td>
<td>11</td>
</tr>
<tr>
<td>167</td>
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<td>400</td>
<td>6</td>
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<td>4.52</td>
<td>25</td>
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<td>3.79</td>
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<tr>
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<td>28</td>
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Average 15
prob = 0.0002

Table 2. Effect of Prior Fertilization on Seedling Basal Dia Growth.

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<th>Install.</th>
<th>Name</th>
<th>App. Rate</th>
<th>Yr Since Planting</th>
<th>Basal Dia Control</th>
<th>Basal Dia +N</th>
<th>% Basal Dia Difference</th>
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<td>0.68</td>
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Average 11
prob = 0.0183
REFERENCES

Several of these are available for download as follows:


Abstracts and Publications


Abstract
Genetic parameters for height (HT), diameter (diameter at breast height [dbh]), and volume for a shortleaf pine (Pinus echinata Mill.) population in Missouri were estimated from a single progeny test comprising 44 half-sibling families assessed at 3, 5, 7, 10, and 17 years. Individual tree heritability estimates for growth traits at age 10 years and younger were high (0.30–0.43), and those at age 17 years were low (0.11–0.24). Heritability estimates for dbh were lower than those for HT. Family mean heritability estimates were moderate to high (0.32–0.66). Genetic correlations were higher than their phenotypic counterparts for all growth traits. Age-age genetic correlations for growth traits were moderate to high (0.68–0.98), indicating opportunity for early selection. Genetic correlations between different growth traits were high (0.81–1.00). Indirect selection on age 5- or 7-year HTs may be expected to produce over 25% more volume at 17 years compared with direct selection for volume at age 17 years. Efficiencies of selection suggest that early HT is a better selection criterion for volume at older ages than dbh because of the high heritability at young ages and strong juvenile-mature genetic correlations. Genetic gain in an unrogued seed orchard was predicted to be 6.7 and 27.2% for 10- and 17-year volume, respectively. These results suggest that growth traits in shortleaf pine in Missouri have high genetic variation, and genetic improvement was effective.


Abstract
Timber supply analyses are used to estimate the possible harvest level of timber volume over the long term. Site index is one of the inputs of these analyses. When site index is underestimated, as is often the case for older stands, it will lead to underestimated yields. This creates a significant negative effect on harvest levels in the timber supply analyses. Better site index information is obtainable by using ecologically based site indices; however, an efficient way of applying the site index estimates is needed. The purpose of this project was to develop a technique for incorporating better site index estimates into timber supply analyses. We used simple random sampling to determine the proportion of each site series in a management unit. Site index estimates were available for these site series. To link the site index information to timber supply analysis units, we initially created analysis units using inventory information. The site series proportions were then used to form new ecologically based analysis units, and yield tables were generated from the associated site index information. After an area was harvested in the timber supply model from an inventory-based analysis unit, it was allocated to an ecologically based analysis unit in proportion to the area that the site series occupied in the timber harvesting land base. Once an area was placed into a new analysis unit, it remained there for the duration of the timber supply analysis. We tested this method in the Bulkley Timber Supply Area, where it resulted in a 26% increase in the long-term sustainable harvest level.


Abstract
Ecologists have tried to link plant species composition and ecosystem properties since the inception of the ecosystem concept in ecology. Many have observed that biological communities could feed back to, and not simply result from, soil properties. But which group of organisms, plants or microorganisms,
drive those feedback systems? Recent research asserts that soil microorganisms preclude plant species feedback to soil nitrogen (N) transformations due to strong microbial control of soil N cycling. It has been well documented that litter properties influence soil N cycling. In this review, we stress that under many circumstances plant species exert a major influence over soil N cycling rates via unique N attainment strategies, thus influencing soil N availability and their own fitness. We offer two testable mechanisms by which plants impart active control on the N cycle and thereby allow for plant–litter–soil–plant feedback. Finally, we describe the characteristics of plants and ecosystems that are most likely to exhibit feedback.


Abstract
Seed source testing of loblolly pine (Pinus taeda), which began in the 1920s, has allowed large realized genetic gains from using nonlocal seed sources in operational plantations. Seed source testing continues, and deployment guidelines are still being refined. Some general effects of seed source movement can be described, but there are still gaps in (1) understanding exactly how far certain seed sources can be moved, (2) the degree of risk involved, and (3) how certain traits such as wood quality vary by seed source, especially with seed source movement. In some cases, seed source movement gains can be achieved with little risk; for example, planting Livingston Parish, Louisiana material for rust resistance in more easterly Gulf Coastal areas. Also, movement of seed sources one plant hardiness zone north can result in increased growth with little concern for winter damage. Big gains in growth, however, from using nonlocal seed sources may come at significant risk. Two industrial examples of planting nonlocal seed sources and how risks were managed are covered: (1) South-to-north movement: MeadWestvaco’s use of loblolly pine north of the native range in Kentucky and surrounding areas, and (2) East-to-west movement: Weyerhaeuser’s use of North Carolina coastal plain families in southern Arkansas and southeast Oklahoma. To deal with the significant risks of seed source movements, one must be aware of the risk factors, understand historical climatic data (are the risks high or low within a typical harvest rotation period), and have silvicultural and genetic strategies to mitigate or reduce risk. Possible genetic strategies include thorough testing and allocation of orchard families of the nonlocal seed source, development of a “land race” (breeding and testing for local adaptation of the nonlocal seed source), interprovenance hybrids, and interspecific hybrids. Examples of these are discussed in this article.