SMC Quarterly News

Stand Management Cooperative

School of Forest Resources, University of Washington

1st Quarter 2012

www.standmgt.org

Greg Ettl
SMC Director

From the Director

I am happy to take over for Dave Briggs as the Director of SMC with the start of the New Year. I think I speak for everyone in thanking Dave for his years of service to SMC. I was fortunate to meet with some of you at Dave's retirement party and I think we were all moved by the outpouring of affection from all who have worked with Dave. I have just begun my work in understanding the finances and getting to know the needs of SMC's members. My plan is to meet with some of you in the first weeks of February, prior to our strategic planning meeting the morning of February 15th. I hope to meet with most of you within the next couple of months. I appreciate Mike Mosman's offer to host the meeting at the Port Blakely Tumwater office. I will circulate an agenda in the coming week.

In this issue we highlight Paul Footen's results from a long-term study of the carryover effect of forest fertilization. The work demonstrates an important justification for maintaining a long-term plot network, as without the repeated measurements we would be unaware of the potential for fertilization to effect a second rotation. The carryover effects on growth are not as large as from initial fertilization but 2nd rotation fertilized stands were about 1 year ahead in growth a decade after establishment. The information should be useful to managers in determining the potential of fertilization to contribute to future return on investment. You will also find descriptions of ongoing research by Kim Littke, Kevin Ceder, Nai Saetern, Austin Himes and Jed Bryce.

inside:

SMC Spring Meeting Date Changed to April 19, 2012, 8:30-4:00

Gifford Pinchot National Forest Headquarters, Vancouver, WA.

GP Headquarters, Vancouver, WA

D. Briggs Thanks You

I am now in my third week of retirement but busy as ever; just a different agenda. I want to thank all of you for your advice and support over my 15 years as SMC Director. A special thanks to the staff, project leaders, and those who served as chair of the Policy Committee for all of their help. It was a journey that I thoroughly enjoyed. I always approach every day with two objectives; to have fun and make a difference, and during my term, the SMC achieved many accomplishments and we generally had fun on the way to get them done.

Dave and Anne Briggs

Dave's retirement party

I also want to thank you for the Retirement Party on December 2. My wife, Anne, son Jeremy, and I were overwhelmed by such a large turnout. Establishment of the David Briggs Scholarship in Forest Management is an incredible honor and I am especially pleased because it will make a difference for students in the future. Again, I thank all of you so much. I will continue to be active in my interest area as I wrap up a number of things that are on the back burner and hope to see you in the future.

Revision to ORGANON 9.1 and Using the ORGANON DLLs in R

Dave Hann has modified the ORGANON (**http://www.cof.orst.edu/cof/fr/research/organon/**) volume and taper equations to incorporate a revised equation for predicting stump diameter of Douglas-fir. Therefore this change will affect estimates of cubic foot and board foot volume. I have revised the ORGANON web site such that it now includes revised console version and revised DLLs (both executables and source code).

Dave also added to the ORGANON web site the procedures developed by Dr. Peter Gould of the Pacific Northwest Research Station, Olympia, WA and Dr. David Marshall of Weyerhaeuser Company for using the ORGANON DLLs in the R statistical package.

Meeting Announcement

Coastal Silviculture Meeting

Vancouver Island univeristy, Nanaimo, on Feb 22nd. The topic is "Intensive Silviculture – Miracle or Myth". **http://www.coastalsilviculturecommittee.com/Winter%202012/Home%20page.htm**

SMC Student Rersearch Updates

Type V Paired-Tree Project

Kim Littke and Rob Harrison

The Type V paired-tree project is starting the fifth year of measurements. Sixty-two paired-tree installations have been measured for two-year growth and fertilizer response. The last eleven installations will be measured after two years of growth in the fall of 2012. Soil characteristics and nutrients have been sampled from all 72 Douglas-fir installations and 2 ponderosa pine installations. Soil moisture and temperature is being continuously sampled at all installations. Kim Littke is analyzing data and writing her dissertation using the first sixty Douglas-fir installations to understand the best predictors of soil water and nitrogen availability, foliar N concentration and area, and Douglas-fir productivity. Also, mapped and measured climate, water availability, nitrogen availability, foliage, and productivity variables are being examined as predictors of current basal area, height, and volume growth and fertilizer response.

Silvicultural Manipulation Consequences Report

SMC Type III Analysis

Kevin Ceder and Eric Turnblom

Work continues on the analysis of the Type III portion of the larger Silvicultural Manipulation Consequences in Stand Management Cooperative sites Tech-Transfer project, a.k.a., the $(SMC)^2$ report. The primary focus of these SMC Type III installations is determining the true effects of planting density (100, 200, 300, 440, 680 or 1210 TPA) on growth and yield. Results presented at the 2011 spring meeting showed significant effects of planting density in preliminary yield models. While the design of the Type III installations was geared to test significant differences of yields at ages between different planting densities, actual planting densities ranged considerably around the target densities. This coupled with the timing of installation establishment and measurement cycle length caused different sets of site classes to be measured at each age. Accounting for these factors in conventional, experimental design-type statistical tests requires a large amount of work with some loss of information relative to using functional models to determine significance of planting density. The resulting models can be used to assess differences in yields given different planting densities and to construct yield tables. In the coming quarter we expect to publish a report summarizing our findings and presenting a set of yield models to predict per-acre stand-level yields including basal area, quadratic mean diameter, top height, total and merchantable cubic-foot volume, and board-foot volume. After the report we will build the models into software, as a web-based calculator or stand-alone application, allowing managers to easily use our models.

Silvicultural Manipulation Consequences Report
SMC Type I Analysis
Nai Saetern, Eric Turnblom, and Dave Briggs

Analysis is progressing on the SMC Type I portion of the larger Silvicultural Manipulation Consequences in Stand Management Cooperative sites Tech-Transfer project, a.k.a., the $(SMC)^2$ report. Regression models for the SMC Type I Stands have been constructed to predict per-acre stand-level yields of diameter at breast height (DBH), height, and board-foot volume. In these models DBH, height, and board-foot volume were individually modeled as a function of age, initial trees per acre, relative density, thinned or not thinned, site index, latitude, longitude, and elevation. Mortality rates were also determined for stands that were thinned at least once versus stands that did not receive any thinning.

The three models (DBH, height, and board-foot volume) share similar predictor variables that significantly affect their response. To summarize broadly, the three near-final models show that all predictors are significant, except for latitude in the board-foot volume yield model. For board-foot volume, whether or not the stand has been thinned seems to be the main determinant of yield. The final mortality model shows that there is significantly lower % mortality in thinned stands compared to unthinned stands.

Currently, the models are being fine-tuned and summarized for a Master's thesis.

Breast Height Branches as Indicators of Tree and Log Quality: SMC Type III Installations
Jed Bryce and Eric Turnblom

As branches grow and develop they become knots in wood, which are the primary structural features that diminish quality of lumber and remanufactured wood products. Recent decades have seen a decline in the quality of lumber in part due to lower density planting that promotes greater branching and crown development. Due to the lengthy time investment required to measure branches on the entire stem, the SMC is studying the diameter of the largest limb at breast height (DLLBH) as well as the number of branches in this whorl as an indication of overall wood quality. This is a quick, nondestructive measurement that could potentially be incorporated in a timber cruise. The current research focuses on the Type III installations in which the primary areas of interest are the effects of six different (100, 200, 300, 440, 680 and 1210 TPA) planting densities on growth and yield. Research presented at the 2011 spring SMC meeting confirmed previous studies on the significance of density on branch development. Current analysis involves developing fixed- and mixed-effects models to predict the DLLBH, the number of branches in this whorl and the age at which the branches die. The final goal is to provide managers with web-based tools to forecast branch growth and development accurately based on the above-mentioned planting densities.

The Fate and Uptake of Enhanced Efficiency Urea Fertilizers in Douglas-fir Plantations of Western Oregon and Washington

Austin Himes, Kim Littke, Rob Harrison, Betsy Vance, Brian Strahm, Tom Fox and Jose Zerpa

Nitrogen fertilizer is commonly applied to intensively managed Douglas-fir stands as an investment in increased yields. However, recent fluctuations in the price of urea have demonstrated the possibility that Douglas-fir fertilization may not be cost effective in the future. Furthermore, concerns about water pollution have brought fertilizer practices into question. Increasing the efficiency of nitrogen delivery to target trees reduces leaching losses that contaminate water and potentially increases productivity per unit of fertilizer applied. Nitrogen uptake and use efficiency have been increased in agricultural systems using "coated" or "enhanced efficiency" urea formulations. To explore the viability of some enhanced efficiency urea formulas in Douglas-fir plantations we are applying ^{15}N labeled fertilizer and utilizing stable isotope techniques to track the uptake and fate of fertilizer nitrogen. Four treatments of ^{15}N labeled fertilizer are being applied at ten SMC sites in western Washington and Oregon selected to represent the range of conditions in the region. The four treatments are urea, urea coated with NBPT (*Agrotainâ*), polymer coated urea (*ESN* by Agrium Advanced Technologies), and coated urea fertilizer (*Arboriteâ CUF*). By tracking the ^{15}N label in samples of different ecosystem components through one year, we will determine the performance of these four treatments in terms of uptake efficiency, system losses, and ecosystem partitioning. Labeled fertilizer was applied to five sites in the spring of 2011, and will be applied to the last five sites in the spring of 2012. By the summer of 2012 analysis of system losses and uptake efficiency of the first five installations will be complete.

Risk Assessment for Projected Nitrogen Lost From Different Harvesting Intensities in Pacific Northwest Douglas-fir

Rob Harrison, Austin Himes, Eric Turnblom, Patrick Wauters, David Briggs, W. Devine, I. Eastin, E. O'Neil, Paul Footen, Erica Knight and Betsy Vance

The growth of seventy-two intensively managed, mid-rotation, Douglas-fir stands in western Oregon, Washington, and British Columbia will be projected to 50 years of age using the SMC variation of the ORGANON growth and yield simulator. From the ORGANON output, component biomass removal will be estimated for a standard bole-only harvest and a more intense biomass removal treatment. Utilizing allometric equations for the region and existing SMC data on total site nitrogen and foliar nitrogen of trees in the 72 stands, we will estimate nitrogen removal under the two harvest intensities as a proportion of total site nitrogen. Based on the proportion of total site nitrogen removed we can assess the risk associated with different harvest intensities on the long-term nitrogen availability of the region. This broad assessment should assist managers in future decisions about biomass removal. Currently we are simulating the stands' growth in ORGANON and researching the best allometric equations to use for component biomass and nitrogen partitioning of Douglas-fir for the Pacific Northwest. We hope to present a region wide risk assessment by the summer of 2012.

Feature Article

The Carryover Effect: Assessments of the Continued Effects of Nitrogen Fertilization of a Previous Stand on the Productivity of a Subsequent Douglas-fir Stand in the Pacific Northwest

Paul W. Footen, Bob Gonyea, Bert Hasselberg, Gage Wagoner, Brian Strahm, Royce Anderson, Natalie Schmidt, Dave Briggs, Eric Turnblom and Rob Harrison

Introduction and Methods

Increases in nutrients and water holding capacity suggest fertilization treatments could have even long-term effects on forest productivity, however few studies have assessed the long-term residual effects of fertilization on the productivity of a subsequent stand replanted on the same site (i.e. fertilization "carryover effects"). We studied the carryover effect at five western Washington sites: Pack Forest, Coyle, Hank's Lake, Simpson Log Yard and Camp Grisdale. Each site included at least one (untreated) control plot and at least one adjacent plot fertilized repeatedly with urea (totaling 896-1120 kg N ha^{-1}) (Table 1). The productivity of the five study sites were measured in 2000, 2006 and 2008 (Figure 1), and seedling or tree heights and diameter at breast height (DBH) were recorded in the study plots after each growing season in the fall from 1997-2008 (except in 2004 and 2007). Tree biomass estimates were calculated using equations from Bruce and DeMars (1974) and biomass ratio equations from Jenkins *et al*. (2003). Aboveground C pools of the tree and understory vegetation cover was found by multiplying the dry weight biomass by 0.512 (Birdsey, 1992).

Current-year foliar samples were collected from each plot at the end of the growing season in the fall. Total N concentration was determined by dry combustion (Perkin-Elmer CHN Analyzer Model 2400, Norwalk, CT). Mean tree needle biomass was estimated using Jenkins *et al.* (2003) biomass ratio equations. Nitrogen content for each sample was determined by multiplying the average N concentration by needle biomass.

Soil pits were dug at plot center leaving one undisturbed face about one meter wide and to at least one meter in depth of mineral soil. On two of the plots a 50 cm depth could only be reached due to highly compacted glacial till. Because 50 cm was the shallowest depth, only the 0-50 cm depth was considered in statistical comparisons of all soil pits. Samples were then ground to <1 mm and total C and N concentration was determined by dry combustion (Perkin-Elmer CHN Analyzer Model 2400, Norwalk, CT). The equations used to calculate C and N content per hectare were:

$$\text{Mg C ha}^{-1} = (\text{mg C / g soil})(\text{g soil / cm}^3\text{ soil})(\text{cm soil / 1})(\text{Mg C / }10^9\text{ mg C})(10^8\text{ cm}^2\text{ / ha})$$

$$\text{kg N ha}^{-1} = (\text{mg N / g soil})(\text{g soil / cm}^3\text{ soil})(\text{cm soil / 1})(\text{kg N / }10^6\text{ mg N})(10^8\text{ cm}^2\text{ / ha})$$

Forest floor samples were collected from the same locations as the soil pits using a 0.25 m^2 (0.5 x 0.5 m) sample frame. Dried material was ground to <1 mm and a subsample analyzed for nutrient content by dry combustion (Perkin-Elmer CHN Analyzer Model 2400, Norwalk, CT). Plot level C and N content was calculated by multiplying concentration levels by biomass using the following equation: [Nutrient concentration (mg/kg) * 1 g / 1000 mg * O horizon weight (g) / 0.25 m^2 * 10000 m^2 / 1 ha * 1 kg / 1000 g]. Mean tree needle biomass was estimated using Jenkins *et al.* (2003) biomass ratio equation. Nitrogen content for each sample was determined by multiplying the average N concentration by needle biomass.

Results and Discussion

Mean tree height on carryover plots was significantly ($p < 0.1$) greater than the unfertilized controls from 2001 to 2006 (Figure 2). In 2008, the year of the most recent study, the carryover plots and the controls were not significantly different ($p = 0.2$), though tree growth was 14% greater (Figure 2). Mean DBH was significantly greater on the carryover plots than on the unfertilized controls in 2005, 2006 and 2008 (Figure 3). In 2008 mean DBH was 22% greater ($p = 0.07$) on the carryover plots (Figure 3). The overall differences in tree growth between the carryover plots and the controls has generally increased over the time in this study causing the carryover stands to be at least one full growing season ahead of the unfertilized controls. When measured in 2008 the 9-11 year old Douglas-fir trees on the carryover plots contained a mean biomass of 3960 kg ha^{-1}, which was significantly greater ($p = 0.04$) than the controls. Mean tree C pools for Douglas-fir trees were 33% (500 kg C ha^{-1}) greater on the carryover plots than the controls (Table 3).

The increases in tree growth on the carryover sites is comparable to growth responses found after the initial application of fertilizer said to only last 5-10 years. This strongly demonstrates the ability of a subsequent stand of trees to benefit from an application of fertilizer to a previous stand applied over 17-25 years ago, challenging the conventional wisdom of past studies (Figure 1).
Both mean understory biomass and N content were significantly greater on the carryover plots than on the unfertilized controls. Mean understory biomass was 86% ($p = 0.05$) greater on the carryover plots when compared to the controls (Figure 6). Mean understory N content, when compared to controls was 111% ($p = 0.04$) greater on the carryover plots.

The total soil nitrogen and carbon content of the unfertilized controls was consistently greater than the carryover plots. Mean soil N content of 0-50 cm depth (including O horizon) on the control plots was 10% greater, but not significantly different ($p = 0.33$) than the carryover plots (Figure 4). Belowground soil carbon content on the control plots was 18% higher ($p = 0.01$) than on the previously fertilized carryover plots (Figure 5). Nearly all forest C and N pools were measured in this study. However, due to time and budget constraints C and N pools for roots and N content of bolewood and tree branches were not measured. Douglas-fir trees and understory vegetation comprise the total aboveground C pool and were 80% (11.8 Mg ha^{-1}) greater in the carryover plots than the unfertilized controls (Table 3). Nitrogen content of

Douglas-fir foliage and understory vegetation were measured to determine the total aboveground N pool, which was 104% (352.5 kg N ha^{-1}) greater on the carryover plots than the controls (Table 2).

When C and N pools of the forest floor and mineral soil pits (to 50 cm) were added to the aboveground pools, total forest pools could be estimated. Total forest C pools on the controls were 10% (14.7 Mg C ha^{-1}) greater than the carryover plots (Table 3). Total forest N pools were 6% (271 kg N ha^{-1}) greater on the carryover plots than on the controls. The fact that the carryover plots had 271 kg N ha^{-1} more N than the controls strongly supports the carryover effect hypothesis (Table 2).

The carryover effect is not well known and few studies like this one exist. Therefore, more research of carryover sites is necessary to properly assess these long-term effects of N fertilization on second and even third rotation Douglas-fir. The need to understand how fertilization can continue to influence above and belowground C and N pools of a subsequent stands is important. The ability to understand this phenomenon will help land managers and policy makers make better decisions about how to manage forestlands for long-term productivity and increased C sequestration. It is our hope that this study will also influence policy makers regarding the importance of belowground C pools on managed forestlands, and that they will consider these pools when calculating C budgets in the future.

References

Birdsey, R.A. 1992. Carbon storage accumulation in United States forest ecosystem. General Technical Report WO-59. US Department of Agriculture, Forest Service, Global Change Research, Northeastern Forest Experiment Station, Radnor, PA.

Bruce, D., and D.J. DeMars. 1974. Volume equations for second growth Douglas-fir. United States Department of Agriculture. Research Note. PNW-239.

Jenkins, J.C., D.C. Chojnochky, L.S. Heath and R.A. Birsey. 2003. National-scale biomass estimators for United States tree species. Forest Science. 49:12-15.

Table 1: Carryover study site descriptions

	Camp Grizdale	Pack Forest	Coyle	Simpson Log Yard	Hank's Lake
Latitude	47°15'4"N	46°50'2"N	47°50'56"N	47°14'25"N	47°18'34"N
Longitude	123°35'31"W	122°17'38"W	122°45'25"W	123°15'50"W	123°16'54"W
Elevation (m)	420	548	189	152	177
Precipitation (mm)	2900	1000	1000	1800	2000
Slope, aspect	15%, W	40%, S	20%, SE	Flat	Flat
Parent Material	Old alluvium, glacial drift	Colluvial andesite	Glacial outwash	Glacial outwash + tephra	Glacial outwash
Soil type, texture	Umbric Dystrochrept, fine-loamy	Ultic Haploxeralf, fine-loamy	Dystric Xerochrept, sandy, skeletal	Dystric Xerochrept, sandy, skeletal	Dystric Xerochrept, sandy, skeletal
Installation establishment (year)	1969	1972	1972	1975	1975
Stand Establishment	1941	1930	1937	1923	1920
SI 50 (m)	38	30	33	29	20
Fertilization (kg N ha^{-1})	0/1120	0/896	0/1120	0/1120	0/1120
Fertilization dates	1969-1977-1981-1985	1972-1980-1984	1972-1980-1984-1988	1975-1983-1987-1991	1975-1983-1987-1991
Fertilization regime (kg N ha^{-1})	448-224-224-224	448-224-224	448-224-224-224	448-224-224-224	448-224-224-224
Date of logging (month/year)	Jul-99	Mar-97	Dec-98	Jan-99	Mar-99
Stand age at harvest (years)	58	67	61	76	79
Date of planting (month/year)	Jul-99	Mar-97	Jan-99	Jun-99	Jun-99

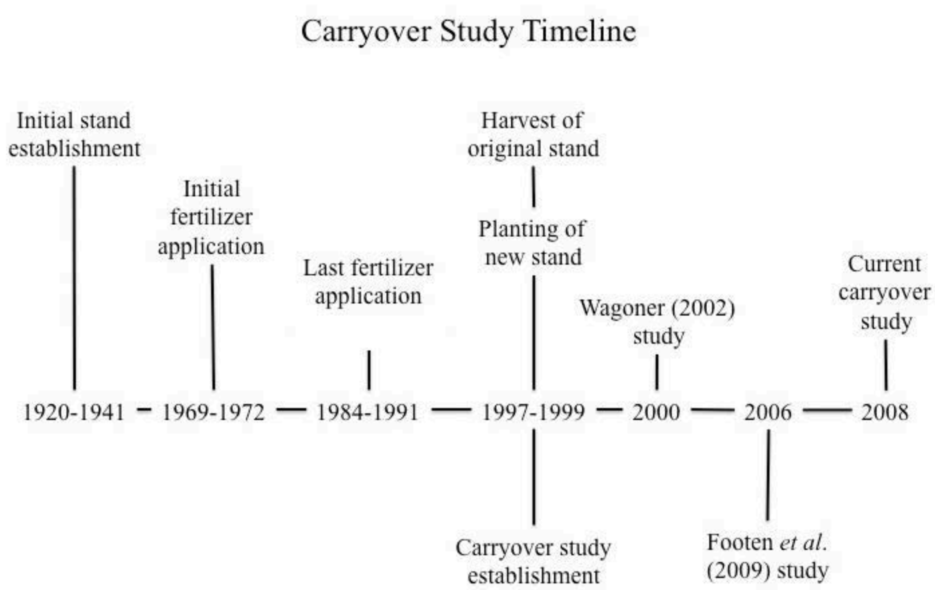

Figure 1: Timeline of the history of the carryover study highlighting the year (or range of years) when important events occurred such as: stand establishments, fertilization applications, harvest of stands, dates studies were conducted.

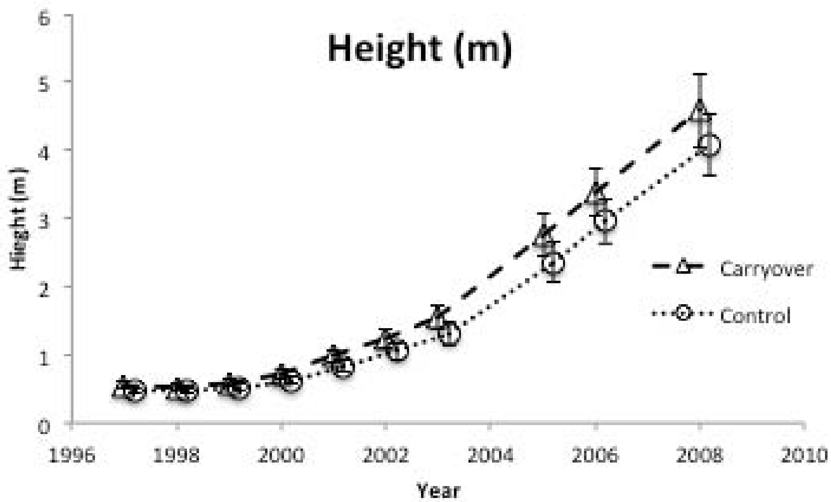

Figure 2: Mean tree height (m) of Douglas-fir on five carryover stands from beginning of the study in 1997 to 2008. Tree heights on carryover plots were significantly greater ($p < 0.1$) than the controls from 2001 to 2006. In 2008 mean height on carryover plots was 14% ($p = 0.2$) greater than the controls. Note that the x-axis is offset slightly to allow differentiation of treatment mean data points.

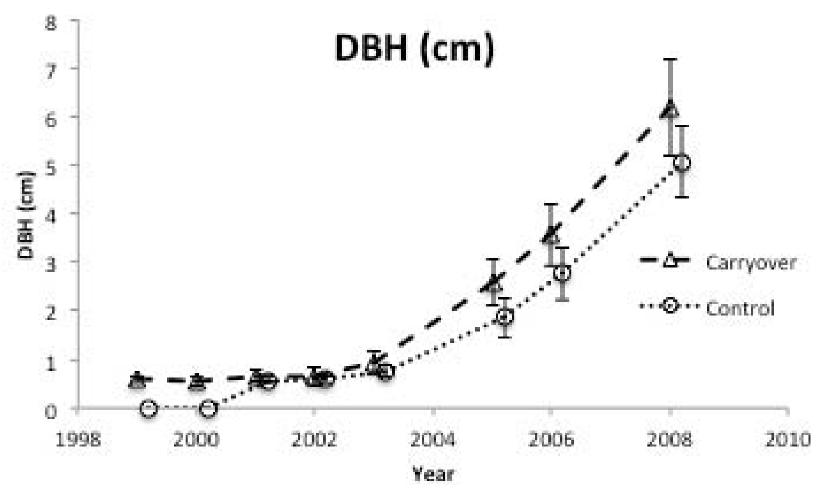

Figure 3: Mean diameter (cm) at breast height (DBH) of Douglas-fir trees on five carryover stands from beginning of the study in 1997 to 2008. DBH on carryover plots was significantly greater ($p < 0.1$) than controls in 2005, 2006 and 2008. DBH was 22% ($p = 0.07$) greater than controls in 2008. Note that the x-axis is offset slightly to allow differentiation of treatment mean data points.

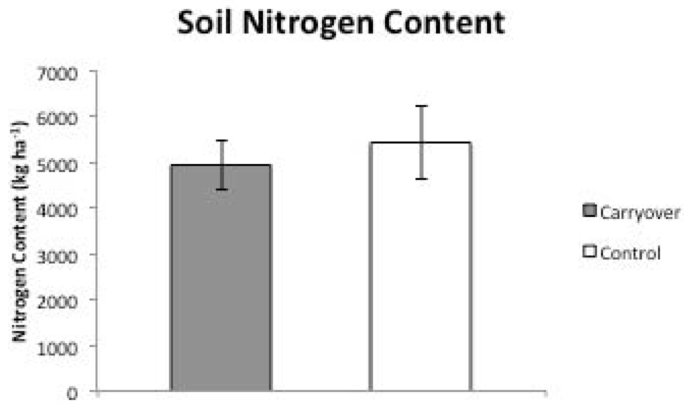

Figure 4: Mean soil nitrogen (kg N ha^{-1}) for 0-50 cm of mineral soil including O horizon on five carryover sites measured in 2008. Mean soil N content was 10% ($p = 0.33$) greater on control plots than on carryover plots. However, these differences were not significant.

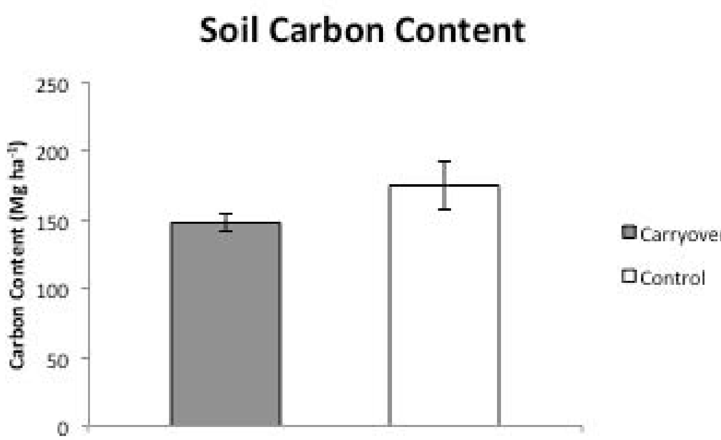

Figure 5: Mean soil carbon (Mg C ha^{-1}) for 0-50 cm of mineral soil including O horizon on five carryover sites measured in 2008. The control plots were significantly greater ($p < 0.1$) than the carryover plots.

Table 2: Total above- and belowground nitrogen pools (kg N ha^{-1}) of five carryover study sites assessed in 2008.

N Pools (kg N ha^{-1})	Carryover	Control	% Difference
Aboveground			
Tree Needles	245	131	87
Understory Veg.	532	250	113
Total N Aboveground	777	381	104
Belowground			
Forest floor	217	144	51
Soil (0-50 cm)	4710	4864	3
Total N Belowgound	4927	5008	2
TOTAL Stand N	**5704**	**5389**	**6**

Table 3: Total above- and belowground carbon pools (Mg C ha^{-1}) of five carryover study sites assessed in 2008.

C Pools (Mg ha^{-1})	Carryover	Control	% Difference
Aboveground			
Tree	4	3	33
Understory	48	26	86
Total C Aboveground	52	29	80
Belowground			
Forest floor	20	16	27
Soil	137	185	35
Total C Belowground	157	201	28
TOTAL Stand C	209	230	10

Abstracts and Publications

Sooyoung Kim; Thomas Hinckley; David Briggs. Classifying individual tree genera using stepwise cluster analysis based on height and intensity metrics derived from airborne laser scanner data. Remote Sensing of Environment (December 2011), 115 (12), pg. 3329-3342

http://ejournals2.scholarsportal.info/details.xqy?uri=/00344257/v115i0012/3329_citgusdfalsd.xml

Abstract:

This paper evaluates the ability of small footprint, multiple return and pulsed airborne scanner data to classify tree genera hierarchically using stepwise cluster analysis. Leaf-on and leaf-off airborne scanner datasets obtained in the Washington Park Arboretum, Seattle, Washington, USA were used for tree genera classification. Parameters derived from structure and intensity data from the leaf-on and leaf-off laser scanning datasets were compared to ground truth data. Relative height percentiles and simple crown shapes using the ratio of a crown length to width were computed for the structure variables. Selected structure variables from the leaf-on dataset had higher classification rate (74.9%) than those from the leaf-off dataset (50.2%) for distinguishing deciduous from coniferous genera using linear discriminant functions. Unsupervised stepwise cluster analysis was conducted to find groupings of similar genera at consecutive steps using *k*-medoid algorithm. The three stepwise cluster analyses using different seasonal laser scanning datasets resulted in different outcomes, which imply that genera might be grouped differently depending on the timing of the data collection. When combining leaf-on and leaf-off LIDAR datasets, the cluster analysis could separate the deciduous genera from evergreen coniferous genera and could make further separations between evergreen coniferous genera. When using the leaf-on LIDAR dataset only, the cluster analysis did not separate deciduous from evergreen genera. The overall results indicate the importance of the timing of laser scanner data acquisition for tree genera separation and suggest that the potential of combining two LIDAR datasets for improved classification.

Kantavichai, Rapeepan 2011. Effects of Climate and Thinning on Coastal Douglas-fir Annual Biomass Growth at Four Sites. PhD Dissertation, School of Forest Resources, University of Washington, Seattle, Wa. 148pp. Contact Megan O'Shea moshea@uw.edu if you would like a copy.

Abstract:

Issues related to global warming and human releases of CO_2, primarily from the use of fossil fuels, have simulated interest in using forest biomass and forest products to remove store carbon through photosynthesis which removes atmospheric CO2 and using forest biomass for energy as a fossil

Abstracts and Publications cont.

fuel substitute. Unfortunately, current methods for estimating forest biomass and the amount of carbon and energy it contains are crude and inaccurate and relatively little research has been done to understand how silviculture and climate affect a tree's annual biomass growth and its distribution within the tree. This study uses a unique set of x-ray densitometer data obtained from five positions along the stems of Douglas-fir trees from a thinning trial on four sites in western Oregon and Washington to examine how thinning and climate affect the biomass increment and its distribution. The x-ray densitometer data, combined with local climate data over the life of each stand permitted examination of how variations in climate at each site and imposition of thinning between 1987 and 1991 and harvested in 2006 at age 33-50. Not surprisingly responses differed greatly between the sites due to great geographic dispersion and soil differences which affect water deficit conditions. However, it was found that, compared to unthinned controls, thinning increased annual biomass increment. Immediately following thinning, there was greater ring mass and relatively more latewood produced toward the lower stem and relatively less toward the upper stem. This is consistent with stresses due to wind sway and heavier crowns after thinning and the reduction of competition for water by the residual stand. Although ring mass gains due to thinning were still evident 12 years, later response was lower and there was a reversal of the mass distribution patterns along the stem. Ring mass production and distribution were also affected by climate. Higher summer temperatures worsened drought and water stress conditions and lowered ring mass growth; likely a reduction in growth when dense latewood would typically be produced. This did not occur on one site seemed to always be in drought-induced summer dormancy. It was also apparent that the an early return of cold winter-like storms in the fall, the continuation of such storms into the spring, or winter flooding can reduce ring mass growth and alter the