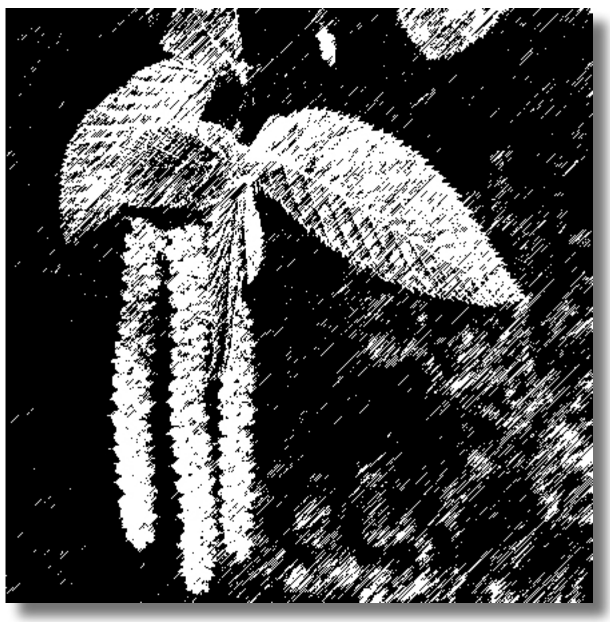

Hardwood Silviculture Cooperative

annual report 2008

Highlights of 2007-2008

- The HSC has another new member. Forest Capital Partners, LLC has decided to join the HSC.

- Dave, Andrew and Sean Garber (research assistant at OSU) continued their work with red alder taper equations by publishing a manuscript titled "Taper Equation and Volume Tables for Plantation-Grown Red Alder". This is a continuation of their work published in the Western Journal of Applied Forestry. This equation uses crown ratio as well as DBH and height and presents a suite of tables useful for the management of red alder.

- The "regional" modeling effort is continuing. Progress is still being made on both the FVS and ORGANON growth models.

- All HSC Type 1 sites have had at least the 14th year post-thinning measurement.

- Two more of the Type 2 sites have had the 17th year growth measurement, making a grand total of 6 (of the twenty six) sites with seventeen years of measurements.

- All 26 of the Type 2 sites have had at least the 12th year growth measurement.

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HSC Executive Summary 2008

Once again, this last year has been a very busy and productive year for the Hardwood Silviculture Cooperative (HSC). First established in 1988, the HSC was formed to learn more about hardwood management in general, and red alder plantation growth, specifically. The HSC's study design includes thirty-six study installations from Coos Bay, Oregon to Vancouver Island, British Columbia divided into three types:

- 4 thinning studies in natural stands
- 7 replacement series studies of red alder/Douglas-fir mixtures
- 26 variable density red alder plantations with thinning and pruning treatments

The data collected from these sites is accumulating rapidly. Many thanks go out to all of the cooperators in getting the data collected. Massive amounts of data are collected, used in various data analyses, and results presented to the public. The database is now large enough to investigate many aspects of red alder stand dynamics. Currently, all of our 26 plantations are at least 12 years old, and 6 are at least 17 years old. Next year, 5 more sites will reach the age of 17 making a grand total of 11 sites! These data will enable a robust analysis on many aspects of red alder plantation management; providing much needed information on growth responses following various treatments and the extrapolation of rotation ages and stand volumes.

Red alder growth and yield modeling is still underway. The USFS has made progress in using the "Regional database" to refit some of the equations used in FVS. Regarding ORGANON, we are currently investigating the potential "density effect" on tree growth and its possible implications on predicting site productivity and tree growth. Once this step is completed, we will fit new growth equations for the red alder plantation (RAP) version of ORGANON. Both of these models, once completed will predict growth and yield and be valuable tools for the management of red alder.

The HSC published another taper equation for plantation-grown red alder. This equation, using DBH, height and crown ratio provides reliable predictions for various tree attributes. This General Technical Report includes a suite of tables useful to the forest manager. They include: 1) total tree volume, 2) merchantable tree volume, 3) merchantable height, 4) stem volume to crown base, and 5) diameter inside bark at crown base.

Research on red alder also continues on other fronts. Craig Cootsona in conjunction with University of Washington and Weyerhaeuser looked at *Nectria* identification and distribution. Brennan Garrelts, at Oregon State University used 20 year data (from a site established with the help of Dave Hibbs) also published a MS thesis that described stand development of Douglas-fir and red alder species mixtures. Aaron Weisekittel, now faculty at the University of Maine used HSC data to investigate potential differences in the self-thinning line between Douglas-fir, western hemlock and red alder. Abstracts and summaries of these manuscripts are presented here.

Lastly, this year brought more good news as far as HSC membership goes. Forest Capital has decided to join the HSC. In Oregon, they own timberland in the central Oregon Coast Range. This region is heavily hit by Swiss Needle Cast, and thus Forest Capital is considering alternative species and starting a red alder management program on their lands. We look forward to their membership, knowing both parties will greatly benefit.

History of the HSC

The Hardwood Silviculture Cooperative (HSC) is a multi-faceted research and education program focused on the silviculture red alder (*Alnus rubra*) and mixes of red alder and Douglas-fir (*Pseutotsuga menzeisii*) in the Pacific Northwest. The goal of the HSC is to improve the understanding, management, and production of red alder. The activities of the HSC have already resulted in significant gains in understanding of regeneration and stand management, and have highlighted the potential of red alder to contribute to both economic and ecological forest management objectives.

The HSC, begun in 1988, is a combination of industry and both federal and state agency members, each with their own reasons for pursuing red alder management. For instance, some want to grow red alder for high-quality saw logs, while others want to manage red alder as a component of bio-diversity. What members have in common is that they all want to grow red alder to meet their specific objectives.

Members invest in many ways to make the HSC a success. They provide direction and funds to administer the Cooperative. They provide the land for research sites and the field crews for planting, thinning, and taking growth measurements.

The HSC's highest priority is to understand the response of red alder to intensive management. To accomplish this, the HSC has installed 26 variable-density plantations extending from Coos Bay, Oregon to Vancouver Island, British Columbia. The majority of plantations are located in the Coast Range, with a few in the Cascade Range. The plantation distribution covers a wide range of geographic conditions and site qualities. At each site, cooperators planted large blocks of red alder at densities of 100, 230, 525, and 1200 trees per acre. Each block is subdivided into several treatment plots covering a range of thinning and pruning options (twelve total treatments per site).

In addition to the 26 variable-density plantations, the HSC has related studies in naturally regenerated stands. Young stands (less than 15 years old) of naturally regenerated red alder, 5 to 10 acres in size, were pursued as a means of short-cutting some of the lag time before meaningful thinning results could be obtained from the variable-density plantations. It came as a surprise to find only four naturally regenerated stands of the right age and size available in the entire Pacific Northwest.

The HSC has also established seven mixed species plantations of red alder and Douglas-fir. They are located on land designated as Douglas-fir site class III or below. Each plantation is planted with 300 trees per acre with five proportions of the two species. The site layout is designed to look at the interactions between the two species. We are finding that in low proportions and when soil nitrogen is limited, red alder can improve the growth of Douglas-fir. This improvement is due to the nitrogen fixing ability of red alder. The management challenge is to find the right proportion of the two species to maintain a beneficial relationship.

Since the HSC was established, we have learned a great deal about seed zone transfer, seedling propagation, stocking guidelines, identification of sites appropriate for red alder, and the effects of spacing on early tree growth (see the HSC web-page http://www.cof.orst.edu/coops/hsc for more information). Furthermore, the data set is now complete enough to begin analyzing the growth response of red alder after thinning and/or pruning. Our ultimate goal is a better understanding of the effects of stand density on red alder growth and yield, and wood quality and to develop a red alder growth model.

The HSC red alder stand management studies are well designed and replicated on a scale rarely attempted in forestry. Over the next 20 years, we will harvest much from our investment. Our data set on growth of managed stands will make red alder one of the better-understood forest trees of the Pacific Northwest.

1. Location of installations for the Red Alder Stand Management Study.

Red Alder Stand Management Study

The Red Alder Stand Management Study is divided into three specific types of installations. Study installations are predominately located in the coastal mountain ranges of the Pacific Northwest from Coos Bay, Oregon to Vancouver Island, British Columbia (Figure 1). The three types of study installations are as follows:

- Type 1 is a natural red alder stand thinned to 230 and 525 trees per acre. There are four Type 1 installations.
- Type 2 is a variable-density red alder plantation. At each site, red alder is planted in large blocks at densities of 100, 230, 525, and 1200 trees per acre. Each block is subdivided into several thinning and pruning treatments. There are twenty-six Type 2 installations.
- Type 3 is a mixed species plantation of red alder and Douglas-fir. Each site is planted to 300 trees per acre with five proportions of the two species.

The primary focus of the Red Alder Stand Management study continues to be the Type 2 variable-density plantations. Type 2 installations are distributed across a matrix of five ecological regions and three site qualities (Table 1).

With each passing year, more and more treatments are applied and data collected. Tables 2, 3, and 4 describe the data collection schedules for the three installation types. The shaded areas of the tables indicate what activities have been completed and illustrate the tremendous accomplishments of the HSC to date.

Winter 2007/08 had less than the average amount of fieldwork (Table 5). Measurements and various treatments were done on only 8 installations (5 being Type 2's). Many thanks go out to all of the cooperators for providing crews and special thanks go out to the HSC Management Committee for braving the knee-deep (thigh-deep?) snow to measure the Type 1 installation outside of

Table 1. Matrix of Type 2 installations. Each installation identified by number, ownership, and year planted.

	Site Quality		
	Low	Medium	High
Region	SI50 :23-27 M SI20 :14-17 M	SI50 :28-32 M SI20 :18-20 M	SI50 :33+ M SI20 :21+ M
1) Sitka Spruce North	X	1201 DNR '91	1202 BCMin '94
			1203 DNR '96
2) Sitka Spruce South	2202 SNF '91	2203 ANE '92	2201 WHC '90
	2206 SNF '95	2204 SNF '94	2205 ANE '94
3) Coast Range		3202 WHC '90	
	3204 SNF '92	3205 ODF '92	3203 MEN '92
	3209 BLM '95	3207 BLM '94	3206 WHC '93
		3208 ODF '97	3210 OSU '97
4) North Cascades	4205 BCMin '94	4202 GYN '90	
		4203 BCMin '93	4201 GYN '89
		4206 DNR '95	
5) South Cascades	5205 GPNF '97	5203 BLM '92	X
		5204 WHC '93	

Definition of Acronyms

1. ANE-ANE Hardwoods
2. BCMin-British Columbia Ministry of Forests.
3. BLM-Bureau of Land Management.
4. DNR-Washington Department of Natural Resources.
5. GYN-Goodyear-Nelson.
6. GPNF-Gifford Pinchot National Forest.
7. MBSNF-Mt. Baker Snoqualmie National Forest
8. MEN-Menasha
9. ODF-Oregon Department of Forestry.
10. OSU-Oregon State University Forest Research Laboratory.
11. SNF-Siuslaw National Forest.
12. WHC-Washington Hardwood Commission.

Darrington. Last years work included:

- Two Type 1 installations were measured. The 14th year measurement at Sauk River (MBSNF) and the 19th year measurement at Sechelt (BCMin).
- Five Type 2's had fieldwork. Maxfield Creek (WADNR) had its 12th year measure and one thinning treatment; LaPush (WADNR) had its 17th year measure and 3rd pruning lift; Pollard Alder (SNF) had its 17th year measure, 4th pruning lift, and the last thinning treatment; Lucky Creek (BCMin) had the second thinning treatment.
- One Type 3 installation (Cedar Hebo, SNF) had its 12th year

Table 2. Data Collection Schedule for Type 2 Installations. Shaded areas indicate completed activities.

TYPE 2	GYN	WHC	WHC	GYN	DNR	SNF	NWH	NWH	SNF	ODF	BLM	WHC	BCmin
Site Number	4201	2201	3202	4202	1201	2202	2203	3203	3204	3205	5203	3206	4203
Site Name	Humphrey	John's R.	Ryderwood	Clear Lake	LaPush	Pollard	Pioneer	Sitkum	Keller-Grass	Shamu	Thompson	Blue Mtn.	Mohun Ck.
Year Planted	1989	1990	1990	1990	1991	1991	1992	1992	1992	1992	1992	1993	1993
1st yr Regen	1990	1991	1991	1991	1992	1992	1993	1993	1993	1993	1993	1994	1994
2nd yr Regen	1991	1992	1992	1992	1993	1993	1994	1994	1994	1994	1994	1995	1995
Plot Installation	1992	1993	1993	1993	1994	1994	1995	1995	1995	1995	1995	1996	1996
3rd yr Measure	1992	1993	1993	1993	1994	1994	1995	1995	1995	1995	1995	1996	1996
3-5 yr Thin	1993	1996	1996	1994	1996	1996	1997	1998	1997	1997	1996	1998	1998
Prune Lift 1 6ft	1995	1996	1996	1996	1996	1996	1997	1998	1997	1997	1996	1998	1998
6th yr Measure	1995	1996	1996	1996	1997	1997	1998	1998	1998	1998	1998	1999	1999
15-20' HLC Thin	1995	1999/07	1999	1996	1999	1999/02	2000	2001	2001	2000	2000	2002	2001/03
Prune Lift 2 12ft	1995	2002	1999	1996	2002	2000	2000	2001	1999	2000	2000	2002	2002
9th yr Measure	1998	1999	1999	1999	2000	2000	2001	2001	2001	2001	2001	2002	2002
Prune Lift 3 18ft	1998	2010?	2002	1999	2008	2003	2004	2001	2009	2004	2004	2002	2007
12th yr Measure	2001	2002	2002	2002	2003	2003	2004	2004	2004	2004	2004	2005	2005
30-32' HLC Thin	2001	2012?	NA	2002	2010	2008	2009	2004	NA	2007	2009	2007	2010?
Prune Lift 4 22 ft	2001	2012?	2002	2002	2010	2008	2009	2004	2014?	2007	2009	2005	2010?
17th yr Measure	2006	2007	2007	2007	2008	2008	2009	2009	2009	2009	2009	2010	2010
22nd yr Measure	2011	2012	2012	2012	2013	2013	2014	2014	2014	2014	2014	2015	2015

Table 2 continued

TYPE 2	WHC	BCmin	SNF	NWH	BLM	BCmin	SNF	BLM	DNR	DNR	ODF	OSU	GPNF
Site Number	5204	1202	2204	2205	3207	4205	2206	3209	4206	1203	3208	3210	5205
Site Name	Hemlock Ck.	Lucky Ck.	Cape Mtn.	Siletz	Dora	French Ck.	Mt. Gauldy	Scappoose	Darrington	Maxfield	Weebe	Wrongway	Tongue Mtn.
Year Planted	1993	1994	1994	1994	1994	1994	1995	1995	1995	1996	1997	1997	1997
1st yr Regen	1994	1995	1995	1995	1995	1995	1996	1996	1996	1997	1998	1998	1998
2nd yr Regen	1995	1996	1996	1996	1996	1996	1997	1997	1997	1998	1999	1999	1998
Plot Installation	1996	1997	1997	1997	1996	1996	1997	1998	1997	1998	2000	2000	2000
3rd yr Measure	1996	1997	1997	1997	1997	1997	1998	1998	1998	1999	2000	2000	2000
3-5 yr Thin	1998	1999	1999	1999	1999	1999	2001	2000	2000/01	2002	2003	2003/06	2003/07
Prune Lift 1 6ft	NA	1999	1999	1999	NA	1999	2001	2000	2000	2002	2003	2003	NA
6th yr Measure	1999	2000	2000	2000	2000	2000	2001	2001	2001	2002	2003	2003	2003
15-20' HLC Thin	2002	2006/08	2006	2003/06	2003	2003/11	2004/07	2004/07	2002/07	2005/08	2007/09	2007/09	2009?
Prune Lift 2 12ft	NA	2006	2003	2003	NA	2003	2004	2004	2002	2005	2009	2006	NA
9th yr Measure	2002	2003	2003	2003	2003	2003	2004	2004	2004	2005	2006	2006	2006
Prune Lift 3 18ft	NA	2011?	2011?	2011?	NA	2006	2012	2010	2004	2011?	2014?	2011?	NA
12th yr Measure	2005	2006	2006	2006	2006	2006	2007	2007	2007	2008	2009	2009	2009
30-32' HLC Thin	2007	?	2011?	2011?	?	2011?	2012?	2010	2012	2011?	?	?	?
Prune Lift 4 22 ft	NA	?	?	?	NA	2011?	2012?	2012	2007	?	?	?	NA
17th yr Measure	2010	2011	2011	2011	2011	2011	2012	2012	2012	2013	2014	2014	2014
22nd yr Measure	2015	2016	2016	2016	2016	2016	2017	2017	2017	2018	2019	2019	2019

Table 3. Data Collection Schedule for Type 1 Installations. Shaded areas indicate completed activities.

TYPE 1	BCmin	SNF	DNR	MBSNF
Site Number	**4101**	**2101**	**4102**	**4103**
Site Name	**Sechelt**	**Battle Saddle**	**Janicki**	**Sauk River**
Plot Installation	1989	1990	1991	1994
1st yr Measurement	1989	1990	1991	1994
3rd yr Measurement	1992	1993	1994	1997
6th yr Measurement	1995	1996	1997	2000
9th yr Measurement	1998	1999	2000	2003
14th yr Measurement	2003	2004	2005	2008
19th yr Measurement	2008	2009	2010	2013
24th yr Measurement	2013	2014	2015	2018

Table 4. Data Collection Schedule for Type 3 Installations. Shaded areas indicate completed activities.

Owner	BCmin	NWH	GYN	BCmin	DNR	SNF	GPNF
Site Number	4302	2301	4301	4303	3301	2302	5301
Site Name	East Wilson	Monroe-Indian	Turner Creek	Holt Creek	Menlo	Cedar Hebo	Puget
Year Planted	1992	1994	1994	1994	1995	1996	1997
1st yr Regen Survey	1993	1995	1995	1995	1996	1997	1998
2nd yr Regen Survey	1994	1996	1996	1996	1997	1998	1999
Plot Installation	1993	1996	1996	1996	1998	1999	2000
3rd yr Measurement	1995	1997	1997	1997	1998	1999	2000
6th yr Measurement	1998	2000	2000	2000	2001	2002	2003
9th yr Measurement	2001	2003	2003	2003	2004	2005	2006
12th yr Measurement	2004	2006	2006	2006	2007	2008	2009
17th yr Measurement	2009	2011	2011	2011	2012	2013	2014
22nd yr Measurement	2014	2016	2016	2016	2017	2018	2019

measurement.

This coming year's fieldwork (Fall 2008- Spring 2009) will be a very busy year. A total of 11 installations need to be measured, 5 plots will need to be thinned and 4 plots will need to be pruned. See Table 6 for the list of activities. Work will include:

- One Type 1 measurement.
- Three Type 2's will need their 12th year measurement.
- Five Type 2's will need their 17th year measurement.
- One Type 3 will need its 12th year measurement.
- One Type 3 will need its 17th year measurement.

Of note, there are four "orphaned" installations to be measured that do not have field crews available.

Table 5. Hardwood Silviculture Cooperative Field Activities, Winter 2007/08.

Type	Activity	Installation	Cooperator
Type 1	14 yr measurement	4103	MBSNF- Sauk River
	19 yr measurement	4101	BCMin- Sechelt
Type 2	15-20ft HLC Thin,	1202	BCMin-Lucky Ck (check plot 9 HLC)
	Measure & Prune	1203	WADNR- Maxfield (thin plot 4)
	12yr Measurement	1203	WADNR- Maxfield
	17yr Measurement	1201	WADNR- LaPush
		2202	SNF- Pollard Alder
	30ft HLC Thin	2202	SNF- Pollard Alder
	4th pruning lift	1201	WADNR- LaPush
		2202	SNF- Pollard Alder
Type 3	12yr Measurement	2302	SNF- Cedar hebo

Table 6. Hardwood Silviculture Cooperative Field Activities, Winter 2008/09

Type	Activity	Installation	Cooperator
Type 1	19 yr measurement	2101	SNF- Battle Saddle
Type 2	12yr Measurement	3208	ODF- Weebe Packin
		3210	OSU- Wrongway Ck.
		5205	GPNF- Tongue Mtn.
	15-20ft HLC Thin	3208	ODF- Weebe Packin
		3210	OSU- Wrongway Ck.
		5205	GPNF- Tongue Mtn.
	2nd-3rd Pruning Lift	3204	SNF- Keller-Grass
		3208	ODF- Weebe Packin
	17yr Measurement	2203	ANE- Toledo
		3203	NWH- Sitkum
		3204	SNF- Keller-Grass
		3205	ODF- Shamu
		5203	BLM- Thompson Cat
	30ft HLC Thin	2203	ANE- Toledo
		5203	BLM- Thompson Cat
	4th Pruning Lift	2203	ANE- Toledo
		5203	BLM- Thompson Cat
Type 3	12yr Measurement	5301	GPNF- Puget
	17yr Measurement	4302	MCMin- East Wilson

Current HSC Activities

Growth and Yield Modeling

Forest Vegetation Simulator (FVS)

Using the database generated from the "Regional Database" effort, the USFS Forest Management Service Center (FMSC), out of Fort Collins, CO agreed to refit the red alder equations in the growth and yield model, FVS (Forest Management Simulator). The FMSC provides products and technical support for forest vegetation modeling and forest product measurements to the National Forests and other partners.

The Forest Vegetation Simulator (FVS) is an individual tree, distance independent growth and yield model with the ability to simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, and development of understory tree vegetation. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed species stands.

The Pacific Northwest coast (PN) variant was developed in 1995. It covers an area bounded by a line between Coos Bay and Roseburg, Oregon on the south; the northern shore of the Olympic Peninsula in Washington on the north; the shore of the Pacific ocean on the west; and the eastern slope of the Coast Range and Olympic Mountains on the east. The original red alder data consists of 1,369 sample trees derived from forest inventories. The new database has 138,049 individual trees and 413,435 total observations from both natural and planted stands.

Despite a number of setbacks, work is still underway. As of this summer, three of the ten functional relationships (i.e. equations) have been refit (Height-Diameter, Bark Ratio, and Large Tree Diameter Growth) and preliminary testing of the "new" variant is underway. The scheduled completion date is uncertain because the FMSC has yet to determine the 2009 priority list/work schedule.

ORGANON

ORGANON is an individual tree growth model developed for Southwest Oregon, Northwest Oregon and the lands of the Stand Management Cooperative. It will project stand development for several species mixes, stand structures and management activities. ORGANON is an individual tree growth model that uses a list of trees, each with exact measurements, as input data. The user can specify periods of growth, in five year increments, and management such as thinning, fertilizing, and pruning. The program produces stand statistics at each step, and yield tables after final harvest of the stand. However the red alder data in the current version of ORGANON is from mixed-species stands of natural origin. Therefore, we are currently developing a new version of ORGANON for alder plantations (and to eventually update the current mixed species, natural stand version). The update will expand both the range of applicable stand conditions and the geographic scope of ORGANON. The new version of ORGANON will be the first alder growth and yield model that will specifically model the behavior of plantations. The majority of the funding from the project came from a wide range of agencies, both public and private. Further funding was received this year from the PNW Station's FY08-10 Agenda2020 fund.

While seeking project funds, additional data was collected and obtained from other agencies, checked for errors and properly formatted. We are currently in the data "exploration" phase (i.e. looking at the ranges and patterns of the data, identifying relationships, looking for "weird" behavior, etc.) and testing to see if there is an effect of density on growth, and if so, how to address it in the model. We are calculating the following modeling variables: number of trees per acre on each plot, basal area per acre (BA) of each plot, crown competition factor (CCF) for each plot, BA in larger diametered trees for each sample tree on each plot (BAL), CCF in larger diametered trees for each sample tree on each plot (CCFL), BA removed in each thinning (BAR), BA before the most recent thinning (BABT), number of years since each thinning (YT), average height of the forty largest diametered trees per acre (H40) on each plot, average DBH of the forty largest diametered trees per acre (D40) on each plot, and percent crown closure at the top of each sample tree on each plot (CCH). Site index (SI) of each installation involving planted stands will be added to the data sets after the dominant height growth equations are developed.

These data sets will then be used to develop the dominant height growth, largest crown width, height-diameter, height-to-crown-base, diameter growth rate, height growth rate and mortality rate equations needed to develop a new version of ORGANON (RAP-ORGANON). The model will then be tested.

The estimated completion date is by the end of 2008 but is contingent on acquiring additional funds.

Red Alder Volume Equations

The HSC and Sean Garber (Researcher Forester, Oregon State University), published a General Technical Report entitled "Taper Equation and Volume Tables for Plantation-Grown Red Alder". Many thanks go out to the USFS PNW Research Station in covering the publication costs. Copies if the report can be ordered from PNW Research Station (503-808-2138, pnw_pnwpubs@fs.fed.us), the HSC, or downloaded from www.fs.fed.us/pnw/pubs/pnw_gtr735.pdf

The following is a copy of the abstract.

> A taper equation and associated tables are presented for red alder (*Alnus rubra* Bong.) trees grown in plantations. The data were gathered from variable-density experimental plantations throughout the Pacific Northwest. Diameter inside bark along the stem was fitted to a variable exponent model form by using generalized nonlinear least squares and a first-order continuous autoregressive process. A number of parameterizations of the exponent were examined in a preliminary analysis, and the most appropriate form was determined. This was achieved by examining alternative models across geographic locations and silvicultural treatments on the basis of their ability to behave well outside the range of the modeling data by using an independent evaluation data set from across the region and a model validation procedure. Incorporating three easily measured tree variables- diameter at breast height, total tree height, and crown ratio- provided the best fit among location and treatment. This taper equation can be used to estimate diameter inside bark anywhere along the stem, inside bark volume of the entire stem to any top height diameter, and merchantable height and volume between any two points along the stem (i.e., individual log volumes). The flexibility of the model allows for accurate volume predictions across a range of operational stand conditions and management activities and is therefore an improvement over previously published red alder volume and taper equations.

Other Red Alder Research

Identification and distribution of *Neonectria major* causing cankers on red alder (*Alnus rubra*), Craig Cootsona, MS Thesis, University of Washington

The following is a copy of the abstract.

Since 1998, a serious stem canker disease has been found in red alder (*Alnus rubra* Bong) plantations and natural stands in southwest Washington. Cankering is caused by an ascomycete fungus in the genus *Neonectria*. Subsequent investigation found several stands throughout southwest Washington with different levels of infection. The fungus was similar to the species proposed for use as a biological control on red alder around 1994. To identify the species of *Neonectria*, Elongation Factor 1-α PCR was performed on DNA extracted from isolates from geographically separated stands within Weyerhaeuser ownership in southwest Washington. Sequences showed that all isolates were the same species, *Neonectria major*, previously identified only on alder in the US, Canada, Norway, and France. Genetic variation among isolates from Washington was extremely low compared to that found in another closely related canker fungus, *Neonectria ditissima*. The low genetic variation may be due to the limited hosts on which *Neonectria major* has been found. In addition, growth rates were similar in culture. Although one isolate grew at half the rate of the others, no correlation was found between growth rate and phylogenetic tree position. Since little was known about the conditions conducive to infection, a general analysis of weather data was used to examine stand disease severity. Weather data from 1998-2003 were used to run regression analysis

2. An example of a stem canker on red alder caused by Neonectria major*.*

with data from the 2005 Weyerhaeuser red alder stand disease survey. Type-2 canker abundance was used to estimate severity of infection because they are readily visible, with characteristic vertical cracks in the bark, necrosis in the phelloderm, and discoloration of the cambium. A highly significant negative correlation was found between number of type-2 cankers and mean precipitation in autumn 2003. Since type-2 cankers were thought to take approximately two years to develop, the correlation fit with the hypothesized life cycle of *N. major*. In previous studies, drought stress was thought to increase susceptibility to fungal infection and possibly insect attack. A similarity in temporal patterns of canker development was found between *N. major* on red alder and beech bark disease associated with *C. fagisuga,* where cankering was negatively correlated with October rainfall. Although no relationship with insect vectors has been established in red alder plantations, the results suggest a direction for future studies. Information gained from this study can be used to develop management plans and optimal thinning times to reduce infection by *N. major*.

Stand Development after 20-years of Growth in Douglas-fir and Red Alder Mixtures, Brennan Garrelts, MS Thesis, Oregon State University

The following is a copy of the abstract.

This study examines the long-term role of interference on stand development of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) and red alder (*Alnus rubra* Bong.) planted mixtures in the Central Cascades

of Oregon, USA. The two species are common associates in naturally regenerated and planted conifer stands in the Pacific Northwest. Due to red alder's rapid height growth, Douglas-fir is often impeded when in the presence of red alder. However, because of red alder's ability to fix nitrogen and increase soil nutrient cycling rates Douglas-fir development can potentially be enhanced when in red alder presence.

The relationship between current stand structure, tree mortality, tree size and varying mixtures of species proportions were examined in this study. Treatments included four proportions of red alder either planted simultaneously with the Douglas-fir or delayed 5-years after initial Douglas-fir planting. The objectives of this study were to determine if species mixtures were capable of a greater yield when compared to monocultures and then to determine which form of interference was taking place within and between species.

A long-term replacement series study was established in 1986 to understand the role of interference on two commercially valuable species. Six treatments of each planting time were created with the following proportions (Douglas-fir/red alder, respectively): 1.0/0.0, 0.9/0.1, 0.7/0.3, 0.5/0.5, 0.25/0.75, 0.0/1.0. Each treatment was replicated three times in a randomized complete-block design. Measurement of diameter at breast height (cm) of each stem, total height (m), and number of live/dead stems were determined in 1988-1991, 1993, 1995, 1998 and 2007.

Yields of both the 0.5/0.5 simultaneous and delayed treatment mixtures were notably higher than the monocultures. Per-tree basal area, height, and survival decreased for both the Douglas-fir and red alder as the relative density (proportion) of red alder increased in the simultaneously planted mixtures. In the delayed mixtures, Douglas-fir per-tree basal area, height, and survival increased as red alder density increased. Red alder development indicated only minor decreases in survival as its density increased in the delayed treatment mixtures.

Competition was the dominant mechanism of stand development for all treatments. In the simultaneously planted treatments the Douglas-fir was driven most by interspecific competition, while red alder development exhibited trends for intraspecific competition. In the delayed planted treatments both species experienced intraspecific competition, although this effect was minor for red alder. These results support the competitive effects of red alder on Douglas-fir and itself when seedlings are established at the same time. The delayed treatments however, showed the importance of density on individual tree development over time.

Sources of variation in the self-thinning boundary line for Douglas-fir, red alder, and western hemlock.

2008. Weiskittel, A.Gould, P., Temesgen, H. Stand Management Cooperative (SMC) report.

The following is a summary of the research as they pertain to red alder.

Introduction

- Stand maximum stand density index (SDI_{max}) have been reported to vary significantly in the Pacific Northwest, but the values of the individual stands plotted over site index, latitude, purity, and stand origin have showed no distinct trends.
- The goal of this study was to examine maximum size-density relations in coastal Douglas-fir, red alder, and western hemlock. The primary objective was to test the influence of potential stand and site factors that may drive regional variation in this relationship.

Data

- One hundred twenty-one installations in western Oregon, Washington, and Vancouver Island, British Columbia were used in this analysis. The data consisted of 62 plantations and 59 even-aged natural stands. The data were obtained from a variety sources including the British Columbia Ministry of Forests, the Hardwood Siliviculture Cooperative, and the Weyerhaeuser Company.
- A total of 2,026 observations were available for this analysis.

Data analysis

- The influence of factors on the self-thinning boundary line intercept and slope was examined in two stages. First, several stand factors were examined for significance including: stand origin (natural vs. planted), site index, stand purity (proportion of basal area in the primary species), slope, aspect, and elevation. Site index for red alder was obtained using the equations of Nigh and Courtin.

- In the second stage of the analysis, mean climate information and soil attributes were obtained for each research installation. Variables such as mean annual precipitation, growing degree days, and soil water holding capacity were combined with the stand-level information to assess the influence of climate and soils information.

Results

- Of the three species, red alder had the smallest intercept and slope (Figure 3). The implied SDI_{max} (predicted TPH when QMD = 10 in) for Douglas-fir, red alder, and western hemlock were 592, 406, and 634, respectively. These estimates are considerably lower than previously published values
- The intercept of the self-thinning line increased with site index and stand purity. Higher sites are able to support greater levels of biomass and tend to progress through stand development at faster rates than sites of lower quality. Red alder was the most responsive to changes in site index as SDI_{max} increased by over 9% for a 10% increase in site index.
- The intercept of the self-thinning boundary line was significantly lower in plantations in all species (for red alder a decrease of 15%). Stand origin had the most significant impact on the self-thinning boundary line. This supports the idea that differences in initial stand conditions affect self-thinning behavior.
- The finding that plantations self-thin at a lower density supports the observation that highly clumped plants may experience less overall competitive effect than regularly spaced plants at the same initial density
- Climate and soils information significantly influenced the self-thinning boundary line only in red alder. The self-thinning boundary line in red alder was influenced by aspect and mean 25-year annual dryness index (DI; ratio of growing degree days above 5°C to annual precipitation (in)). The intercept of the self-thinning boundary line for red alder was significantly lower on north-facing slopes than south-facing ones and increased with the dryness index.

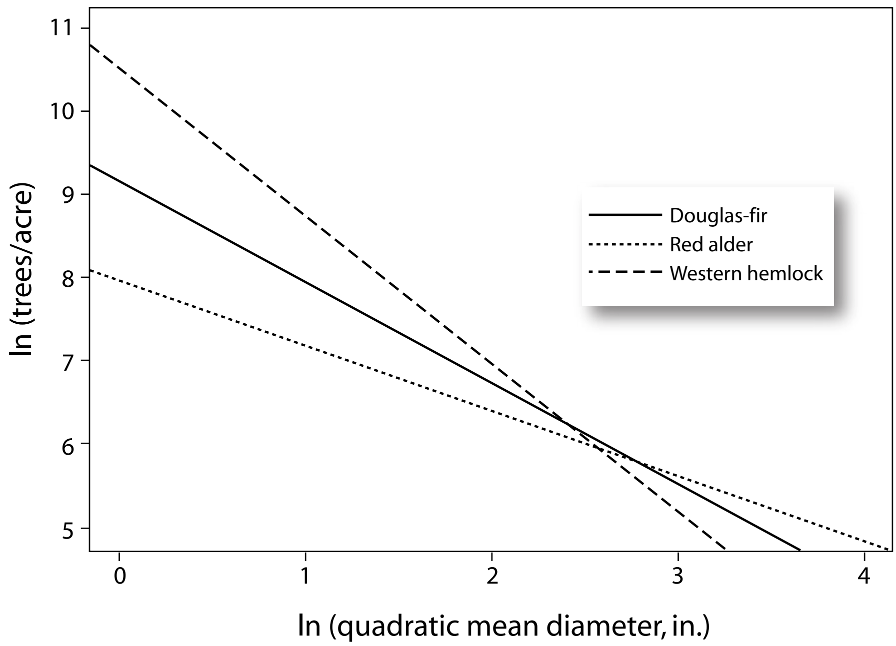

Figure 3. Plots of natural logarithm of trees per acre over the natural logarithm of quadratic mean diameter (in) with stochastic frontier analysis estimated self-thinning boundary line by species.

Direction for 2009

As always, the specific goals for 2009 are both continuations of our long-term objectives and new projects:

- Continue HSC treatments, measurements and data tasks.
- Keep the HSC website updated and current.
- Continue efforts in outreach and education.
- Continue efforts to recruit new members.
- Continue working with OSU statisticians (and a graduate student) in analyzing the Type 2 data. Specifically address the possible effect of density on tree growth.
- Assist in the analysis of specific (thinning and pruning) silvicultural treatments on red alder stem form.
- Continue ORGANON modeling efforts in the creation of both a plantation model and a natural-stand model.

Appendix 1

Summary of Red Alder Stand Management Study Treatments

Type 1- Thinned Natural Red Alder Stands

1. Control- measure only, stand left at existing density
2. 230 trees/acre (tpa) re-spacing density in year 3 to 5
3. 525 tpa re-spacing density in year 3 to 5
4. 230 tpa re-spacing density when height to live crown (HLC) is 15 to 20 feet
5. 525 tpa re-spacing density when HLC is 15 to 20 feet
6. Control- measure only, stand left at existing density
7. 100 tpa re-spacing density when HLC is 30 feet
8. 230 tpa re-spacing density when HLC is 30 feet
9. Control- measure only, stand left at existing density

Type 2- Red Alder Variable Density Plantations

1. 100 tpa control- measure only
2. 230 tpa control-measure only
3. 230 tpa pruned to 6 ft. lift, 12 ft lift, 18 ft lift, 24 ft lift
4. 525 tpa control -measure only
5. 525 tpa thin to 230 tpa in year 3 to 5
6. 525 tpa thin to 230 tpa when HLC is 15 to 20 feet

7. 525 tpa thin to 230 tpa when HLC is 30 to 32 feet

8. 1200 tpa control- measure only

9. 1200 tpa thin to 230 tpa in year 3 to 5

10. 1200 tpa thin to 230 tpa when HLC is 15 to 20 feet

12. 1200 tpa thin to 100 tpa when HLC is 15 to 20 feet

13. 525 tpa thin to 100 tpa when HLC is 15 to 20 feet

Type 3- Mixed Red Alder Douglas-fir Plantations

1. 100% red alder planted at 300 tpa density
2. 50% red alder and 50% Douglas-fir planted at 300 tpa density
3. 25% red alder and 75% Douglas-fir planted at 300 tpa density
4. 11% red alder and 89% Douglas-fir planted at 300 tpa density
5. 100% Douglas-fir planted at 300 tpa density

Appendix 2

HSC Management Committee Meeting Minutes

Summer Management Committee Meeting Minutes

Wednesday July 11, 2007:

Attendees: Andrew Bluhm, David Hibbs- OSU; Alex Dobkowski, Rod Meade- Weyerhaeuser; Nabil Khadduri, Viviana Olivares, John Trobaugh, Jeff DeBell, Jared Larwick, Scott Hancock, Lucy Winter- WA DNR; Randy Bartelt- Trillium Co.; Paul Kriegel- Goodyear Nelson; Mitch Taylor- OR Dept. of Forestry; Scott Ketchum, Walt Shields, Jerry Anderson- Forest Capital; Mark Wittenberg- Green Diamond ; Doug McCreary- University of CA Cooperative Extension

We started the meeting at 9:00 at the Castle Rock Park and Ride for a tour of Weyerhaeuser's Longview Resource Area. The 1st stop was an operational red alder plantation established in 1995 (12 years old). It was site prepped in the Fall with Accord and again in the Spring with Atrazine. It was then planted to 680tpa with 1-0 bareroot stock from the Aurora nursery. The discussion centered on site selection and plantation establishment. See the accompanying handout for tree growth data by thinning density. Key points from the discussion included:

- Prior experimentation indicated that bareroot seedlings performed as well as plug-transplants for 1/3 of the cost.
- Nursery practices for growing alder seedlings needed to be worked out especially the form and disease issues surrounding top pruning.
- Current research indicates that very large planting stock is preferable in terms of both survival (mainly competing vegetation and frost) and growth.
- Current specifications are for seedlings with a caliper greater than 5mm but they prefer 7-8mm and 1m in height.

- The larger seedlings (i.e. jumbos) have better survival and are therefore planted on harsher sites and microsites.
- These jumbo seedlings also seem to have greater, early expansion of the root systems.
- The spring planting window is generally from March 15th to April 15th.
- Seedlings should be planted deep (the root collar 2+ inches below the soil surface).

Another area of conversation is the observed growth reductions of alder planted on/near the WA coast. Analysis shows that alder height growth in this region is below what is expected, with diameter growth seemingly unaffected (i.e. short, fat trees). The culprit (or an indicator) is salal. However, it must also be a soils issue because salal occurs in the OR Coast Range without apparent growth reductions of this magnitude. Currently, WeyCo cannot reduce salal cover enough to meet their growth and yield projections.

Chemical methods of reducing competition were also discussed.

- Atrazine can be used both for pre-plant and release. Experimentally Atrazine worked well as a broadcast release but it is only labeled for direct spraying. In WA, it is only registered for alder as Conifer 90.
- Accord is safe both for direct and broadcast release as long as the alder buds are still tightly closed. It was mentioned that broadcast Accord would be safer for alder without using any surfactants.

The next stop was just across the road. This was planted in the spring of 2000 and failed due to an arctic frost event of 2nd week of November 2000. Although extensive, small differences in microsites affected mortality. For instance, the part of the site that was just slightly uphill had less mortality as well as trees planted on slightly raised microsites. Generally, mortality from frost is a concern up to age three. But in the worst case scenarios, bark damage can occur up to age five.

The 3rd stop was a genecology study conducted by the USFS PNW Research Station, the BLM, the OR Dept. of Forestry, and Weyerhaeuser to investigate the geographic patterns of genetic variation in alder and their implications for seed transfer and gene conservation. This site ("#1603"), in the Cascade foothills was one of three test sites; the other two being on the WA coast ("Aline") and the Willamette Valley. The later site was dropped due to extensive mortality from mice/voles. Please see the associated handout for study design, plot layout and preliminary results. The main variables of interest were survival, height growth, date of bud break and resistance to frost. Discussion centered on the latter and the data shows there was clearly an effect of seed source on frost damage.

After lunch (which was had overlooking a managed forest landscape of both Douglas-fir and alder) we visited an experimental plantation established and measured by the Hardwood Silviculture Cooperative (HSC). This plantation, Hemlock Creek, was established in 1993 and is one of 26 similar plantations scattered throughout the PNW. Comparisons were made between it and the other 22 HSC sites at least 12 years old. Then data was presented on crop tree (the largest 247tpa) DBH, height, and live crown ratio (LCR) for the four control plots, and all tree DBH and HT for the thinned plots. Finally per acre volumes for both the control and thinned plots was presented. Results include:

- With one exception, Hemlock Creek had slightly greater DBH's and HT's as compared to the rest of the HSC sites. However these differences were not significantly different.
- The 180tph control plot at Hemlock Creek had much smaller trees as compared to the rest of the HSC sites on account of frost and elk damage.
- Control plot crop tree DBH ranged from 14-19cm with the greatest diameters in the "intermediate" densities (690 and 1470tph plots).
- With the exception of the 180tph plot, crop tree height varied little (14-16m) across control plot densities.
- Crop tree LCR was very high for the two lowest densities and approximately 50% for the two highest densities. The data seems to indicate that for these latter plots, the rate of decline for LCR seems to be leveling off.
- Control plot merchantable volume (6in stump, 5in DOB top) was approximately 40m^3/ha (575 ft^3/acre) for the two "intermediate" densities, and about half that for the lowest and highest densities. Individual tree volume had minor differences across densities. Instead the number of merchantable trees per acre influenced stand volume the most. The 180tph plot had few merchantable trees; the 2570tph plot had many trees, few of merchantable size.

- Thinning resulted in an increase in diameter growth as compared to the corresponding unthinned plots.
- The earlier the thin, the greater the diameter growth response.
- Thinning did not affect tree height.
- Thinning early (age 5) resulted in dramatic increases (81%) in per acre volume for the 2570tph plots.
- Thinning late (age 9) resulted in slight (9%) or no increases in per acre volume for the 1470tph and the 2570tph plots, respectively.

The last stop of the day was at another operational WeyCo plantation established in 1992. Here, we discussed thinning, density management, and pruning. This site was thinned in 2001 (at age 9) to 180tpa and 250tpa. See the accompanying handout for tree characteristics by treatment. Surprisingly, DBH, HT, HLC, and LCR differed little between treatments. Of note though, was that in the control plot LCR varied considerably whereas the thinned plots had extremely uniform LCR. Basal area and per acre volume was greatest for the control plot as well as stand density index (SDI) and relative density index (RDI).

Previously, WeyCo's strategy for thinning was to plant to 680tpa, pre-commercial thin to 360tpa when the HLC=22ft, then commercial thin down to 180tpa five years later. However, recent observations of plantation growth in relation to the density management guideline have altered their thinning regime. It seems that they are seeing density dependent mortality at 0.5 RDI (instead of 0.66 RDI) and therefore they are shifting the upper management line from 0.45 to 0.35 RDI. To maximize diameter growth, LCR needs to be greater than 0.60 and RDI between 0.15 and 0.35. See the associated handout for growth data and thinning summaries. Other observations include:

- Hardwood mills want a 5 inch top and a minimum log length of 16 ft. Given these constraints, typical alder grown in plantations need to have a DBH of 7.5 in to be of commercial size.
- One of the most productive scenarios in computer simulations is to plant at 680tpa and thin at age seven to 200-220tpa.

- Thinning does not seem to increase epicormic branching or sun scald.
- Dead branch pruning is not worth the cost (as long as branches/knots are less than 2 in in diameter).
- Thinning early (age 5) resulted in dramatic increases (81%) in per acre volume for the 2570tph plots.
- Thinning late (age 9) resulted in slight (9%) or no increases in per acre volume for the 1470tph and the 2570tph plots, respectively.

The last discussion of the day was about a disease that has been frequently found in managed alder plantations in both the WA Coast and the Cascade foothills. Around the year 2000 foresters saw an increase in *Nectria ditissima*. Because this was a concern, a research project was developed. As it turns out, the agent causing the damage was not *Nectria* but *Neonectria major* (it was misclassified). Regardless, they identified three stages of an outbreak: 1) fruiting bodies on dead branches release their spores, 2) spores wash down the trunk and a small canker is formed, and then 3) the large canker grows into the xylem. Foresters inventoried the plantations and found at least 25% plantations in stage two. So, in 2002 WeyCo thinned all of their plantations in an effort to increase tree vigor (and thus their resistance to the fungus). A 2005 survey indicates that many of the cankers healed over. However, they are still unsure about the role that tree health versus the environment influences infection rate. For instance, there is a strong relationship between crown ratio as well as summer moisture with *Neonectria* infection.

Thursday July 12, 2007:

Attendees: Andrew Bluhm, David Hibbs- OSU; Nabil Khadduri, Scott McLeod, Viviana Olivares, John Trobaugh, Jeff DeBell- WA DNR; Randy Bartelt- Trillium Co.; Paul Kriegel- Goodyear Nelson; Mitch Taylor- OR Dept. of Forestry; Randall Greggs- Green Diamond ; Doug McCreary- University of CA Cooperative Extension; Jeanette Griese- BLM; Del Fisher- Washington Hardwood Commission; Peter Gould, Connie Harrington, Warren Devine- USFS PNW Research Station

The meeting began at 8:00 at the new conference room at Webster nursery. Andrew began with a review of last years' fieldwork, the coming years' fieldwork and an overview of the data collection schedule for all three installation types. Last year was a busy year with work being done on 14 sites. Next year there will be fewer measurements but plenty of thinning and pruning treatments. See the associated handouts or the newest HSC annual report for this information.

Andrew then summarized the taper equation project. This project has thus far resulted in two products. The first is an article published in the Western Journal of Applied Forestry (January 2007) which contains a taper equation using tree height and diameter and an associated volume table. The next product is currently in press and will be published as a USFS GTR. This equation uses tree height, diameter and crown ratio. Included in the manuscript are five sets of tables; total stem volume, merchantable volume (0.5 ft stump and 5 in diameter outside bark [DOB] top), merchantable height, volume to crown base, and DOB at crown base. He then presented a comparison of volume and taper equations based on HSC 12 year data. Three merchantable volume (4 inch top) estimates were compared; Johnson, et. al. (1949), Curtis, et. al (1968), and Hibbs, et. al (2007). For the two lowest densities (110tpa and 270tpa) all three estimates were relatively similar. However, for the two highest densities (560tpa and 980tpa), the estimates from Johnson were much lower than the other two. Curtis' and Hibbs equations predicted volume to within 2% of each other. Comparisons were then made between Hibbs' volume estimates to a 4 inch top and a 5 inch top (the latter being more realistic merchantability limit). Volume estimates declined with increasing density (7, 12, 16, and 20% less).

Andrew then showed two figures on the effect of crown ratio on tree volume. These figures are included in the handout and will be presented in the upcoming GTR. For trees of a given diameter and height, trees with a low crown ratio are more parabolic (i.e. more cylindrical) and trees with a high crown ratio are more neiloidic (i.e. more cone-like). These different stem shapes (profiles) affect volume (both total and merchantable) and merchantable height. As crown ratio increases all three measures decrease. Please see the handouts for these comparisons.

Dave then briefly went over the ORGANON modeling effort. Dave has acquired sufficient funds to start the modeling process. The first years' goals are to add the recent HSC data to the database, clean and format the database, and to investigate growth relationships. The second years' objectives are to develop all of the growth (and mortality) equations and to assemble the growth model. This will be done for both plantations and natural stands. Funding for the second year is not yet complete.

Andrew then presented a preliminary analysis of 17 year data. The following is a summary of those results.

Methods

- HSC Sites: 3202- Ryderwood (WeyCo), 4201- Humphrey Hill (Goodyear Nelson), and 4202- Clear Lake Hill (Goodyear Nelson)
- Trees were planted in blocks with target densities of 247, 568, 1297, 2967 tph
- Thinning treatments were performed on the two highest planting densities
    - 1st thin: when lower branch mortality commenced (~ age 4)
    - 2nd thin: when the HLC was 4.5-6.0 m (~ age 7)
    - 3rd thin: when the HLC was 4.5-6.0 m (age 12)
- All trees were permanently tagged and measured at age 3, 6, 9, 12, and 17
- Height was measured on a sub sample of 40 trees per plot
- Plot means were calculated for QMD, height, and height to live crown for:
    - Crop trees/largest 247tph (used for initial planting density comparisons) and
    - All trees (used for thinned versus unthinned comparisons)
- Individual tree volume was estimated using the equation in Hibbs, et.al (2007)
- Merchantable volume per hectare (6 inch stump, 5 inch top, 8 ft min. log)

Control Plot Results
DBH

- "Crossover" occurred between ages 7 and 13
- At age 17, DBH ranged from 19-27 cm
- Mean annual DBH increment ranged from 1.1-1.6 cm/yr
- Periodic annual DBH increment (12-17 year) ranged from 0.4-1.1 cm/yr
- Rotation age to a mean DBH of 38 cm (15 in) would range between about 24 and 47 years, increasing with increasing density

Height

- Increased with density except for highest density

- Ranged from 18-21 m
- Mean annual HT increment ranged from 1.0-1.2 m/yr
- However, PAI has slowed considerably (0.5-0.7 m/yr)
- Observed HT< Expected HT (~23m)

Stand Volume Estimates

- The densities with the greatest number of merchantable tpa had the greatest volumes
- Volume per acre at age 17 ranged from 1100-1800 ft^3/ac
- Volumes were slightly lower than reported for 20 year old stands of equivalent site index (Peterson 1996) but similar to that predicted from Worthington (1960)
- Projected merchantable volume was greatest for the intermediate densities
- At age 25, projected volumes ranged from 1900-3100 ft^3/acre
- Assuming 4bf/ft^3, these stands would reach 20 mbf/ac between 38 and 50 years
- Can not reach the "mythical" 20 mbf in 25 year target by planting alone

Thinned Plot Results

DBH

- The earlier the thin the greater the DBH response. The 1st, 2nd, and 3rd thin increased DBH 21%, 17% and 11%, respectively
- Thinning increased mean annual DBH increment as well as periodic annual DBH increment (12-17 year)
- The earlier the thin, the less time it takes to reach a given DBH. Rotation age to a mean DBH of 38 cm (15 in) would range from 37 to 65 years.

Height

- Thinning had little effect on tree height, averaging about 19 m
- Thinning had little effect on MAI
- Thinning did seem to affect PAI. Thinning early increased PAI substantially

Stand Volume Estimates

- The increase in individual tree volume coupled with the decrease in the number of merchantable tpa resulted in only slight differences in volume at age 17
- Thinning early resulted in a slight increase in volume
- Later thinning treatments decreased stand volume
- Thinning early increased volume by 9%
- Thinning early shortened the rotation age (to 20 MBF/ac) 5 years

Caveats

- Gains in crop tree diameter are hard to interpret until you look at actual volume by specific log size-classes (i.e. DBH vs. minimum log diameter)
- Logging costs can be 10-20% lower for thinned vs unthinned
- Accurate characterization of taper is very important for estimating yield in meaningful size-classes
- It is increasingly important to clarify what log rules, conventions, and conversions are being used- best if they match common practice of buyers and sellers
- There is a lot of error in conversions
- The "20 mbf/acre in 25-30 years" target volume estimate can be misleading if log rules and conventions are not defined (differences in log lengths, minimum log diameter, and log-rules are dramatic)
- These results are only a snapshot during stand development
- Using these results to estimate/project/predict is unwise for multiple reasons
    - This analysis uses only three site and is not representative of all the alder growing sites in the PNW
    - Diameter and height growth rates, and mortality rates differ by treatment and are difficult to project
    - Not accounted for are the trees just below the merchantable DBH limit
    - Stand growth will be affected by any environmental or stochastic changes that occur
- Caution: Use at own risk. In other words, don't bet the farm on this

Next, the topic turned to the HSC budget. All members paid dues in FY 2007 except for the Washington Hardwood Commission. Because of that the HSC only had enough income to fund Andrew for 8 months instead of 9 months. The balance of his time was made up for by external funding for the taper project. For FY 2008, the situation looks the same. Andrew's time will be made up with the ORGANON modeling project. The reduced time Andrew is spending on the HSC was concerning to all. There are two ways to increase the income; recruit new members and/or raise dues. Dave and Andrew have continuously been seeking new members and Dave asked all cooperators to check with their respective institutions about a potential dues increase. To help identify what Andrew has time for and conversely what he is not able to accomplished with his reduced time, Dave and Andrew will assemble a list of deliverables, what's being done, and what is not. Further discussion of the budget will take place at the next HSC meeting.

Discussion then turned to the HSC's future directions. The data has accumulated rapidly and many members are asking "What's the next step"? The main topics brought up were:

- Type 1's: Are these worth continuing? Andrew and Dave will look at the growth patterns of these stands over time, determine the duration of the thinning effect, and report back to the cooperators with a recommendation.
- Type 2's: Is there a way to incorporate a commercial thinning treatment into the existing study design?
- Type 3's: Are these at a stage where analysis is warranted?
- A lumber recovery study from commercial thinning.
- Develop a mixed-species stand precommercial thinning guide.

Next was a presentation by Nabil Khadduri on the WADNR Webster nursery alder program. Attached is the full presentation. Topics covered, in brief, were:

- Alder seedling production has skyrocketed in the last few years. From 2001 to 2004 they produced about 25,000 seedlings. This year it is up to about 325,000.
- There are six alder seed transfer zones in WA.
- Seedling specifications are: height 30-80cm, caliper >5mm, buds along entire stem, full, fibrous root system with evidence of *Frankia*.
- Stock type is plug 1/2s (4 months in greenhouse and 4 months bareroot).

- Seedlings are grown in 1 in^3 containers, moved outside around July and planted in beds at six seedlings per ft^2.
- This method of culture allows for two chances to grade.
- *Frankia* used to be sprayed on outdoor beds but is no longer because recent evidence indicates sufficient natural inoculation in containers.
- Many methods have been tried to keep the seedlings from growing too big. They include adjusting container size and transplant date, drought stress, and top mowing.
- Currently top mowing (to 26 inches) late in the season (September) seems to be the preferred method.

Lastly, we watched (in part) a DVD entitled "A Landowner's Guide for Restoring and Managing Oregon White Oak Habitats". If interested, copies can be obtained through Connie Harrington (USFS PNW Research Station, Olympia, WA) or by contacting Andrew Bluhm.

We then went out into the nursery for a brief look at an outplanting trial looking at the effect of top mowing on the loss of apical dominance. Although difficult to quantify, it did seem that top mowing increased the incidence of loss of apical dominance (although it was also observed in the controls as well).

Next we walked over to an oak outplanting trial. This trial is four years old and investigates the effect of different tree shelters, weed control, fertilization, and irrigation. Warren Devine (USFS PNW Research Station) presented these results:

- In the first year, irrigation doubled height growth. In the second year this was reversed because of the height growth loss of the irrigated seedlings as they grew out of the tube.
- Seedlings in solid shelters had much better height growth than mesh shelters. Shelter type did not affect seedling diameter.
- For non-irrigated seedlings, there were no growth differences between mulching and not mulching. Mulching irrigated seedlings increased growth mainly in the first year.

The last stop before lunch was another oak outplanting trial the effect of irrigation and fertilization on root morphology. Peter Gould (USFS PNW Research Station) explained that the ultimate goal of this project is to determine if (or how) the different root types influence later tree growth.

After lunch we drove out to the Fort Lewis military base. At 100,000 acres, this base contains some of the last intact Puget Sound prairies. Historically covering 150,000 acres, these prairies have been reduced to about 20,300 acres

today (with native vegetation), mainly through agricultural and municipal conversion. Oregon white oak occupies the fringes of these prairies but without repeated fires, conifers (mainly Douglas-fir) encroach on these areas and eventually overtop the oaks.

Connie Harrington got involved in oak research at Fort Lewis after officials there decided to initiate their own oak research to develop a management plan. At the base, Connie's program has a few areas of research including the effects of burning on acorn production, simulating different oak management scenarios, and the effects of oak release.

Dave Peter found that acorn production decreased the first year following burning. Then when they conducted burns under different conditions (i.e. hot vs. cold burns) they found that flower production was not reduced due to the temperature but due to the production of ethylene in the smoke. They also found that acorn production varied little from year to year and instead was mostly affected by stand and climatic factors. For instance, acorn production was better when the basal area of competitors was lower and when there was less crown contact between oaks.

Dave Peter is also working on a project on the Tenalquot prairie trying to predict the effect of different management scenarios on oak woodlands. Four scenarios were projected ranging from the current management regime of thinning and burning to removing overtopping conifers and establishing new oak areas. However, to project stand growth, an oak growth model was needed. The SWO version of ORGANON did contain oak but was based on only a few trees (37 trees). Therefore, Dave collected as much existing data as possible, collected his own, and developed a new oak version of SWO. His efforts (and results) will be found in an article titled "Prediction of Growth and Mortality of Oregon White Oak in the Pacific Northwest" in an upcoming issue of Western Journal of Applied Forestry. Results include: the DBH increment of open-grown oaks is greater than previously thought, oak sensitivity to competition is greater than previously thought, and that the window to restore oaks is narrow.

The last stop was at an ongoing study of oak release by Warren Devine. The main questions are if oaks are released will they respond and if so, what characteristics influence release? Individual (mature) oaks were treated by removing all conifers in a radius of either half of the trees height or all of the trees height. Results include that the basal area growth response of oaks was (as expected) greatest for the full release and declined with the half release, followed by the control. What was unexpected was that the response was much greater and happened much faster than expected. Acorn production and epicormic branch formation followed the same pattern as basal area growth. Most epicromic branch formation occurred in the first year and low down on the bole. Furthermore, Warren monitored regeneration responses (of oak and Douglas-fir) in these plots. He found that oak regeneration (growth) was moderate and similar across all treatments whereas Douglas-fir regeneration growth response doubled in the full release treatments. Thus, a double-edged sword effect is found when fully releasing oaks- the mature oaks respond well from release but so does the Douglas-fir regeneration.

The meeting ended there and many thanks go out to Connie Harrington, Alex Dobkowski, Rod Meade, and Nabil Khadduri for their generosity in leading the tours.

Finally, Dave and Andrew will decide when to have HSC winter meeting. There are no "orphaned sites" to measure so instead we will focus on the budget and the future direction of the HSC. Stay tuned for more information.

Winter Management Committee Meeting Minutes

Tuesday January 8, 2008:

Attendees: Andrew Bluhm, David Hibbs- OSU; Randy Bartelt- Trillium Co.; Glenn Ahrens- OSU Extension; Robert Deal- PNW Research Station; Del Fisher- Washington Hardwood Commission; Jeanette Griese- Bureau of Land Management; Paul Courtin, George Harper, Rod Negrave, Peter Fielder- BC Ministry of Forestry.

We started the meeting at 9:00 at the Mt. Baker Snoqualmie National Forest Darrington Ranger Station with the idea of attempting to conduct the 14th year (post-thinning) measurement at a Type I site. Word had it that the snow level was low and that the road was only partially plowed. However, with much perseverance, tire chains, and shuttling, we were able to reach the site. Then with the help of maple sprouts cut to 4.5 ft, all measurements were completed.

After the measurements, we sat and discussed the relevance of these Type I sites in regards to the HSC research program. The group identified many potential values, including: continued measurements to characterize thinning responses for both silvicultural and modeling applications, the value of these older (appx. 30 years) managed stands for modeling purposes, and potential resource for commercial thinning and taper studies.

Although the working conditions were not ideal, the day was a success in terms of collecting the data and adding some adventure to the lives of the participants. Many thanks go out to those that "toughed it out".

Wednesday January 9, 2008:

Attendees: Andrew Bluhm, David Hibbs- OSU; Randy Bartelt- Trillium Co.; Glenn Ahrens- OSU Extension; Robert Deal- PNW Research Station; Del Fischer- Washington Hardwood Commission; Jeanette Griese- Bureau of Land Management; Paul Courtin, George Harper, Rod Negrave, Peter Fielder- BC Ministry of Forestry; Paul Kriegal- Goodyear Nelson; Alison Hitchcock- WA DNR.

The meeting began at 8am at the WA DNR work center in Arlington, WA. After welcomes and introductions, the first topic of the day was to schedule the next summer meeting. Potential dates were mid-week of July 7th or the 14th depending on when the LOGS meeting was scheduled. Follow-up inquiries determined that LOGS has not chosen a date so therefore, it was decided that to keep with tradition, the HSC summer meeting will be held on July 8-9th. The location will be decided.

Andrew then briefly went over the status of the HSC fieldwork this season. It was a light year this year. There are six sites to measure this winter. Two Type I sites have already been measured and the other four sites have already been scheduled.

Dave then announced that the HSC has a new member, Forest Capital Partners, LLC. Forest Capital is an independent investment firm that acquires and manages forests across North America. The have extensive landholdings in the Northern Oregon Coast Range and consider red alder as a prime candidate to manage in this region. The regional headquarters is in Monmouth, OR and Jerry Anderson is the Regional Manager. Welcome aboard!

Andrew then briefed the group on the nearly completed taper work he has been involved with. Two products have been produced this year. The first is an article in the Western Journal of Applied Forestry entitled "Stem Taper and Volume of Managed Red Alder" (January 2007). In it, the authors (Hibbs, Bluhm, Garber) present a taper equation based on DBH and height and an associated merchantable volume table. The second product is a US Forest Service general technical report entitled "Taper Equation and Volume Tables for Plantation-Grown Red Alder" (PNW-GTR-735, October 2007). Presented is an equation that uses DBH and height as well as crown ratio. Also presented are five sets of tables: total stem volume, merchantable volume (0.5 ft stump and 5 in diameter outside bark [DOB] top), merchantable height, volume to crown base, and DOB at crown base.

The group agreed that this was valuable work but more research was needed, especially in the context of the results presented by Brodie and Harrington ("Response of Young Red Alder to Pruning"; found in Red Alder: A State of Knowledge, PNW-GTR-669) and observed by Glenn Ahrens.

Bluhm, et. al. found that for trees of a given DBH and height, a decrease in crown ratio caused to shape of the trunk to become more cylindrical. In other words, the diameter at points higher on the stem (near the base of the live crown) increased at rates greater than lower down the bole. As it turns out, this result is in complete agreement with Brodie and Harrington. They found the same result (although not significant) in their 10 year old pruned trees. (Furthermore, preliminary analysis by Bluhm and Garber of the specific pruning effect on stem shape seems to indicate a significant increase in bole "cylindricity" following pruning. More concerning however is the result that Ahrens detected in stem shape following thinning in natural alder stands. Here, he found that trees that had been thinned (i.e. greater crown ratios) had less taper than unthinned trees. Without getting into excruciating details, these results may not be in direct opposition because; 1) different methods of measuring taper can yield different conclusions, especially if 2) absolute versus relative measures of taper are used, 3) the relative position of crown base in regards to 32 ft (what is used to calculate form class), 4) there is an "age effect" (a natural tendency for tree form to become more cylindrical as trees age) so comparing trees of different ages is difficult.

Regardless, more work on stem form is needed. Two areas of work were identified. The first is to try to integrate the plantations and natural stands in regards to stem form. This may require measuring stem form in the Type I sites as well as further thought and analysis. The second is to collect more stem form data on the Type II trees once they have a longer time to respond to thinning and pruning.

Andrew then updated the group on the ORGANON modeling project. Things are going well but slightly behind schedule. Data cleaning is almost complete (finally!) and the next step is to quantify the effect of density on site productivity and to develop the equation parameters for the control/untreated trees. The former is especially important in regards to the news that the FVS model effort found no correlation between tree (I assume height) growth and estimates of site index. Please see the associated handout for a status of the ORGANON project and a summary of the data. We hope to have this first step completed by spring. The next step, planned for completion by late summer is to model thinning (and possibly pruning) effects. Beta testing will then occur, with a final release by the end of the year. Following that, we will switch our efforts to updating the existing natural stand version of ORGANON. No specific timeline regarding this effort has been established.

Lastly, in regards to modeling, it was expressed that growth models would be much more applicable if they outputted volume in board feet.

The next main topic was to discuss specific questions that the committee had from the last summer meeting. There were questions regarding each of the three types of HSC plots.

Type III (red alder Douglas-fir replacement series)

There were questions regarding whether these were at a stage where analysis was warranted.

Analysis of these Type III's was done by the HSC in 2003 (using 6 year data) and by the BC Ministry of Forestry in 2005 (using 12 year old data). In the former study, it was difficult to determine any effects of species proportion since the two species had hardly started interacting. The latter analysis (see http://www.for.gov.bc.ca/hfd/pubs/Docs/En/En76.pdf) indicated both negative and positive interactions between the species depending on age and species proportion.

The group agreed that maintaining the Type III installations was of high priority and Dave asked each cooperator to identify what exactly it is they are interested in and report back to the summer meeting. Topics identified presently include:

- How much alder is tolerable in a Douglas-fir plantation?
- How to manage scattered versus clumped alder in a Douglas-fir plantation?
- How do species mixtures affect the stem shape of alder?
- Can we, and if so, how do we manage roadside alder?

Type II (variable density plantations)

There were questions regarding whether these could incorporate a commercial thinning study.

Looking over the experimental design, all plots are accounted for, so to incorporate a CT study, we would have to superimpose this treatment over existing plots. Since all thinned plots were thinned to a density (230tpa) lower than what would be needed for a CT, only the control plots could be used. This would jeopardize the integrity/applicability the entire Type II installations. Possible solutions included:

- Use a split plot design?
- Use the Type I's for a CT.
- Find applicable external plantations.

However, the topic was raised about why we are even interested in commercial thinning. At present, this is not an operational consideration due to finances and logistics.

However, the question remains that even if CT is not cost-effective today, does it (and if so, how much) the long-term bottom line. So, there seemed to be a two-step approach to solving this.

1) Using the HSC dataset, calculate volume by log diameter class. Then by subtracting logging costs the present financial feasibility could be assessed.
2) To answer if/how much CT adds value to a longer-term rotation, we

could initiate an external study using an operational stand of desired characteristics, and conduct a CT.

In this light it was decided that Dave and Andy would look at the data and determine the feasibility of answering #1 above, while the cooperators would look around for potential sites to answer#2 above.

The last issue to be asked about the Type II plantations was if there is a potential for any disease/pest problems/outbreaks in managed alder. Once again, the cooperators were asked to identify their own disease/pest concerns and report back to the group for future discussion.

Type I (thinned natural alder stands)

There were questions whether these were worth continuing measuring

To answer this, Andrew conducted some analysis and presented it to the group. Please see the attached presentation outline for details. Briefly, to see if these stands were still responding to thinning, three factors were looked at:

- relative density (i.e. self-thinning)
- growth rate (DBH, height), and
- dbh distributions.

It was seen that the stands have different growing conditions and growth characteristics and are therefore still responding to thinning. Furthermore, the group identified many reasons to continue the measurements.

- Already the sites are relatively mature (about 30 years) and we have extensive post-thinning measurements (at least 14 years)

- All sites are now on a 5 year re-measurement interval. That, combined with relatively few plots, results in a minimal time/personnel commitment.
- As identified, growth responses following thinning are still occurring. This was supported by Glenn Ahrens observation

that his study site (Olney) is still very dynamic in nature 25+ years after thinning.

- Currently there is only one thinning study that has been carried to rotation (Olney). If we carry the Type I's to rotation and combine them, the results will be much more robust.
- Long-term, operational thinning data is limited. Many thinning studies exist but were either discontinued, outside the range of operational management, or both.
- Likewise, this data is potentially valuable for growth modeling.
- Understanding the growth responses following thinning is important to some cooperators and using this data to provide recommendations/ guidelines is important for small landowners.

One of the Type I's (Sechelt) suffered extensive wind damage early post-thinning. Because of this, it has limited uses in modeling "normal" or "typical" responses to thinning. Therefore, it was questioned whether or not to drop this from the study. Cooperators agreed to keep measuring the site since wind damage following thinning is such a common occurrence that it actually may be "typical" and represent more operational (and not experimental) conditions.

The next main topic was a list of other opportunities/subjects the HSC may pursue. Most of these have been discussed in the past, newly brought up by cooperators, or identified by Dave and Andrew.

Other Opportunities

- Continue analyzing data and publish results.
- Test/compare growth models.
- Create management guides focused on small woodland owner alder management. Possible areas of emphasis are:
    - Fine scale resolution on sites suitable to plant alder.

    - ◎ Differences in alder management between forestland and farmland.
    - ◎ Examples/scenarios of alder site selection, planting, thinning, etc. in an easy to follow format.
- ◎ Website update/improvement.
- ◎ Lumber quality/recovery.
- ◎ Genetics.
- ◎ Outreach.

It was decided that Dave and Andrew would breakdown this list into possible actions and come up with some kind of timeline and cost. Meanwhile the cooperators would discuss these topics among their organizations and prioritize them. We will all then get together at the summer meeting and hopefully decide on much of the future direction of the HSC.

Appendix 3

Financial Support Received in 2007-2008

Cooperator	Support
BC Ministry of Forests	$8,500
Bureau of Land Management	$8,500
Forest Capital	$4,250
Goodyear-Nelson Hardwood Lumber Company	$4,500
Oregon Department of Forestry	$8,500
Siuslaw National Forest	------
Trillium Corporation	$8,500
USDA Forest Service PNW Station	In kind
Washington Department of Natural Resources	$8,500
Washington Hardwood Commission	$8,500
Subtotal	$59,750
Forestry Research Laboratory	$46,700
Total	$106,450