Hardwood Silviculture Cooperative

Annual Report
2005-2006

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Highlights of 2005-2006

- The HSC now has a new member. Trillium Corporation, based out of Bellingham, WA has decided to join the HSC.
- Dave, Andrew and Sean Garber (research assistant at OSU) have a manuscript currently in press with the Western Journal of Applied Forestry where they developed a taper equation for managed stands of red alder. Andrew and Sean are now working on incorporating other tree variables (namely crown ratio) in taper equations and specifically testing the effect of treatment (i.e. planting density, thinning, and pruning) on stem shape.
- The "regional" modeling effort is still underway. The Stand Management Cooperative (SMC) has completed assembling the database and a two pronged approach to modeling has been adopted. The database will be used to develop a growth model in both FVS and ORGANON.
- The oldest HSC Type II site, Humphrey Hill, has had its 17th year growth measurement.
- Five more of our Type 2 sites have had the 12th year growth measurement, making a grand total of nineteen (of the twenty six) sites with twelve years of measurements.
- All 26 of the Type II sites have had at least their 9th year growth measurement.

Contents

HSC Executive Summary 2006

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 plantations with thinning and pruning treatments

The data collected from these sites is accumulating rapidly. Massive amounts of data are collected, used in various data analyses, and communicated to the interested public. Many thanks go out to all of the cooperators in getting the data collected and setting research priorities. The database is now large enough to investigate many aspects of red alder stand dynamics. Currently, all of our 26 plantations are at least 9 years old, 19 are at least 12 years old, and one has reached the ripe old age of 17 years old. This last plantation is probably the oldest maintained alder plantation in the region. Included in this report is a preliminary analysis of this unique case study which will enable further comparisons between the possible growth benefits of plantations versus natural stands, and provide a much needed "launching pad" to extrapolate rotation ages, diameters, and volumes.

Efforts are still underway to create a red alder growth and yield model. The regional alder modeling database has been assembled and is currently being reviewed to look at the amount of available data for modeling. Once completed, modeling will commence along two fronts. The dataset will be incorporated into FVS and ORGANON. The ultimate goal would be to get red alder included in all PNW growth models.

Also this year, the HSC published a taper equation for plantation-grown alder. This equation provides reliable dib and merchantable volume predictions and is an improvement over previous red alder volume and taper equations. In addition to this manuscript we are currently investigating the effect of various tree crown characteristics (mainly the live crown ratio) and their effects on stem shape. We intend to publish these results as suites of tables including 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. After that, we will test, specifically and statistically, the effects of various silvicultural treatments (initial planting density, pruning, and thinning) on stem form.

The value of the HSC data was recognized by researchers who were interested in developing annualized diameter and height growth equations. They used our data to develop the first annualized growth equations for red alder. A preliminary report of that effort is included.

Lastly, this year brought good news as far as HSC membership goes. Trillium Corporation, based out of Bellingham, WA, has decided to join the HSC. They own timberland in the region (currently mostly under conifer management) but have started an alder management program on their lands. Trillium is also the major shareholder of three alder mills. We look forward to their membership, knowing both parties will greatly benefit. Welcome aboard, and may your trees grow fast and straight!

Andrew A Bluhm

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 improving 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.

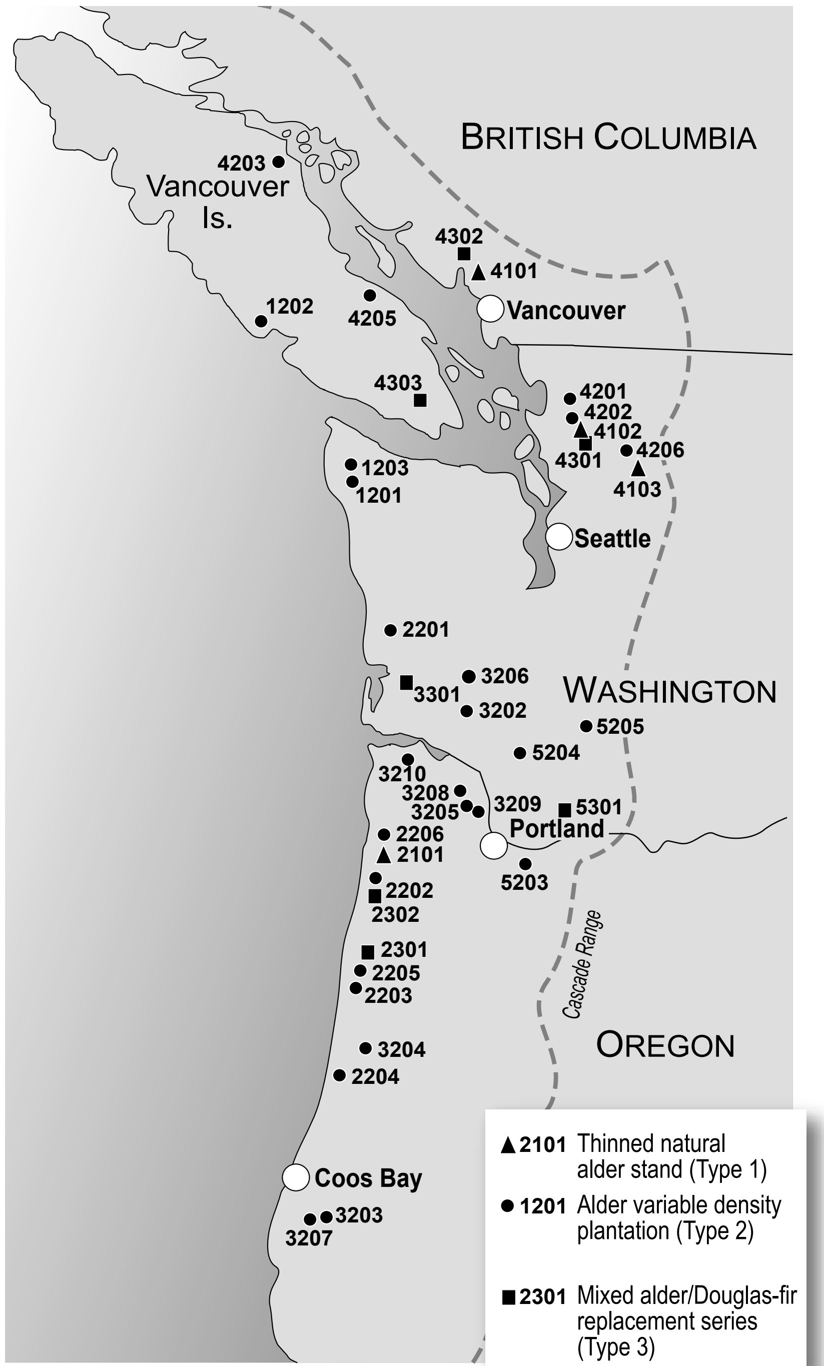
The HSC's highest priority is understanding the response of red alder to intensive management. To accomplish this, the HSC has installed 26 variable-density plantations extending from Coos Bay, Oregon to Vancouver Island, British Columbia. The majority of plantations are located in the Coast Range, with 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 2006 was a very busy year for fieldwork. Measurements and numerous thinning and pruning treatments were completed on 13 sites! Many thanks go out to all of the cooperators for providing crews and special thanks go out to the HSC Management Committee, the Siuslaw National Forest Hebo District, and Oregon Department of Forestry for helping out with the three orphaned sites (Table 5). Work included:

- No Type 1 measurements.
- Eight Type 2's had fieldwork. Weebe Packin (ODF), Wrongway Creek (OSU), and Tongue Mountain (GPNF) were the last installations to have their 9th year measure. Lucky Creek and French Creek (BCMIN), Cape Mountain (SNF), Siletz (ANE), and Dora (BLM) had their 12th year measurements. Humphrey Hill (GYN), our oldest site, had its 17th year measurement. A total of seven plots were thinned and three plots were pruned.
- One Type 3 installation (Cedar Hebo) had the 9th year measurement.

This coming year's fieldwork (Fall 2006- Spring 2007) will be another busy year. Although only 7 sites need to be measured, up to 12 plots will need to be thinned and 7 plots may need to be pruned. See Table 6 for the list of activities. Work will include:

- No Type 1 measurements.
- Three Type 2's will need their 12th year measurement.
- Three Type 2's will need their 17th year measurement.
- One Type 3 installation (Cedar Hebo) will need its 12th year measurement.
- Only one site (Wrongway Creek) is "orphaned".

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 2206 SNF '95	2203 NWH '92 2204 SNF '94	2201 WHC '90 2205 NWH '94
3) Coast Range	3204 SNF '92 3209 BLM '95	3202 WHC '90 3205 ODF '92 3207 BLM '94 3208 ODF '97	3203 NWH '92 3206 WHC '93 3210 OSU '97
4) North Cascades	4205 BCMin '94	4202 GYN '90 4203 BCMin '93 4206 DNR '95	4201 GYN '89
5) South Cascades	5205 GPNF '97	5203 BLM '92 5204 WHC '93	X

Definition of Acronyms

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

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	2007?	2002	1999	2010?	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	2007?	NA	2002	2008?	2008?	2009	2004	NA	2009	2009	2007	2010?
Prune Lift 4 22 ft	2001	2007?	2002	2002	?	2008?	2009	2004	?	2009	2009	2005	?
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	2003/06
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?	2007?	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?	2009?	NA	2006	2007?	2007?	2004	?	?	2011?	NA
12th yr Measure	2005	2006	2006	2006	2006	2006	2007	2007	2007	2008	2009	2009	2009
30-32' HLC Thin	2007	?	2011?	2009?	?	2008?	?	?	?	?	?	?	?
Prune Lift 4 22 ft	NA	?	?	?	NA	2011?	?	?	?	?	?	?	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

Table 5. Hardwood Silviculture Cooperative Field Activities, Winter 2005/06.

Type	Activity	Installation	Cooperator
Type 1	None		
Type 2	15-20ft HLC Thin, Measure & Prune	1202	BCMin- Lucky Ck. (thin 2 plots, 2nd lift)
		2204	SNF- Cape Mtn. (thin 2 plots)
		2205	ANE- Siletz (thin 1 plot)
		3207	BLM- Dora (thin 1 plot, 2nd lift?)
		4205	BCMin- French Ck. (thin 1 plot, 3rd lift)
		3210	OSU- Wrongway Ck. (2nd lift)
		5205	GPNF- Tongue Mtn. (thin 1 plot)
	9yr Measurement	3208	ODF- Weebe Packin
		3210	OSU- Wrongway Ck.
		5205	GPNF- Tongue Mtn.
	12yr Measurement	1202	BCMin- Lucky Ck.
		2204	SNF- Cape Mtn.
		2205	ANE- Siletz
		3207	BLM- Dora
		4205	BCMin- French Ck.
	17yr Measurement	4201	GYN- Humphrey Hill
Type 3	9yr Measurement	5301	GPNF- Puget
	12yr Measurement	2301	ANE- Monroe-Indian
		4301	GYN/DNR- Turner Ck.
		4303	BCMin- Holt Ck.

Table 6. Hardwood Silviculture Cooperative Field Activities, Winter 2006/07.

Type	Activity	Installation	Cooperator
Type 1	None		
Type 2	15-20ft HLC Thin,	2201	WHC- Johns River (thin 2 plots, prune?)
	Measure & Prune	2206	SNF- Mt. Gauldy (thin 1 or 2 plots, prune?)
		3209	BLM-Scappoose (thin 1 plot, prune?)
		4206	WADNR-Darrington (thin 1 plot, prune)
		3208	ODF- Weebe Packin (check status Plot 4 and 7)
		3210	OSU- Wrongway Ck.(thin plots 7 and 8)
	12yr Measurement	2206	SNF- Mt. Gauldy
		3209	BLM-Scappoose
		4206	WADNR-Darrington
	17yr Measurement	2201	WHC- Johns River
		3202	WHC- Ryderwood
		4202	GYN- Clear Lake
	30ft HLC Thin	3206	WHC- Blue Mtn. (thin 1 plot)
		5204	WHC- Hemlock Ck. (thin 1 plot)
		3205	ODF- Shamu (check HLC status Plot 10)
	4th pruning lift	3205	ODF- Shamu (check HLC status Plot 4)
		4203	BCMin- Mohun Ck. (4th lift)
Type 3	12yr Measurement	3301	WADNR- Menlo

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Current HSC Activities

17th Year Data Summary

Introduction

Last year the HSC's oldest site, Humphrey Hill (#4201) reached 17 years of age and thus had its associated measurement. The data gathered is extremely valuable because 1) it is one of (if not the) oldest continually measured alder plantation established with nursery stock and is over half the expected rotation age, and 2) conclusions about the effect of silvicultural treatments (i.e. planting density, thinning intensity and timing, and pruning) should be more robust because the trees have had a long time to "respond". What follows is a preliminary summary of Humphrey Hill's 17th year measurement. However, it is important to note that that since this is only one site, the results should be interpreted with a great deal of caution.

Methods

The site is located a few miles north of Mt. Vernon, WA. Elevation is 120 m, slope is flat to 10%, aspect is slightly to the east. The site was originally occupied by alder and birch with a heavy understory of salmonberry. Site index, derived from ten dominant alder trees on site is 35 m, and derived from the soil-site method of Harrington (1986) was 33 m (base age 50 years). The site was harvested in 1988, scarified and pile burned. It was planted with small, poor quality (height= 37 cm, caliper= 3.8 mm) 1/0 alder stock in February 1989. First year seedling survival was excellent (94%) and competing vegetation was limited to 20-80% shrubs and herbs (mostly salmonberry).

Trees were planted in blocks with target spacings of 5.8 x 5.8 m, 3.8 x 3.8 m, 2.5 x 2.5 m, and 1.7 x 1.7 m (247, 568, 1297, 2967 tph). Each treatment plot is 0.50 ha containing a 0.13 ha measurement plot. Two thinning treatments were performed on the two highest planting densities (1297 and 2967 tph). The first treatment was thinning when the tree crowns closed and lower branch mortality commenced (occurring here at age 3). The second thinning treatment was thinning when the average height to the live crown was between 4.5 and 6.0 m (occurring at age 6). Residual target density for all thinning treatments was 568 tph.

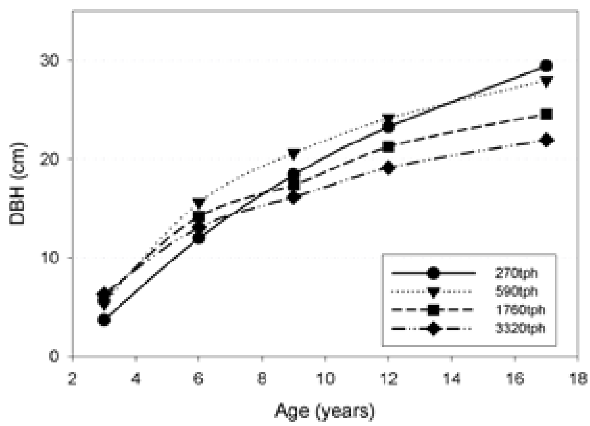
At age 3, 6, 9, 12, and 17, data was collected on permanently tagged individual trees. For every tree, stem diameter at 1.37 m (DBH), stem defect (fork, lean, sweep) and presence or absence of damage (animal, weather, etc) was recorded. Height was measured on a subsample of 40 trees that included the 10 trees of smallest diameter the 10 of largest diameter, and 20 mid-range trees (based on diameter). Mean tree diameter was calculated as quadratic mean diameter. Plot means were calculated for diameter, height, and height to live crown for 1) the sample of trees on the plot that would represent the 247 trees per hectare with the largest diameter (used for initial planting density comparisons), or 2) all the trees on the plot (used for thinned versus unthinned comparisons). Individual tree volume was estimated using the equation in Skinner (1959) and merchantable volume per hectare (DBH greater than 15 cm, 10 cm top) was calculated by multiplying mean individual tree volume by the number of merchantable trees per acre.

Results

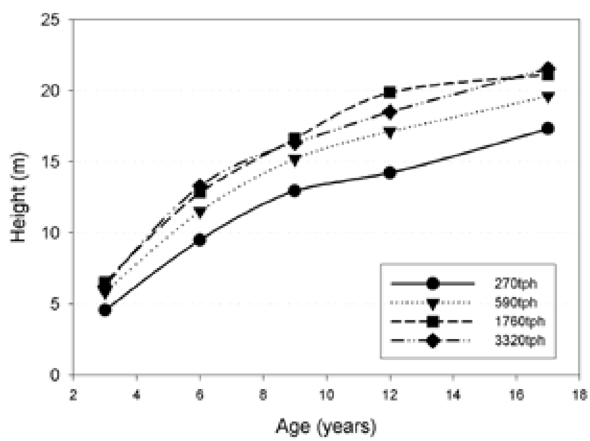
Planting Density

Through age 7, crop tree DBH increased with increasing density (Figure 2). After age 7 and through age 14, reduction of diameter with increasing density was observed (i.e. crossover effect). By age 17, the typical reduction in DBH with increasing density was observed. At age 17, DBH in the 3320 tph plot was 7.5 cm less (25% less) than the DBH in the lowest density (270 tph). Annual increment peaked near age 4 for all densities and then gradually declined. Mean annual DBH increment ranged from 1.3 cm/yr to 1.7 cm/yr. Periodic annual DBH increment from age 12 through 17 decreased with increasing density and ranged from 0.6 cm/yr to 1.2 cm/yr.

Unlike DBH, crop tree height was greatest in the two densest spacings (Figure 3). Tree heights were similar between the 1760 tph and the 3320tph densities and at age 17 differed by only 0.3 m. Height growth reductions of 8% and 19% were observed for the 590 tph and the 270 tph densities, respectively.



2. Comparison of diameter at breast height (DBH) by initial planting density for the 247 largest trees per hectare (crop trees). Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986).



3. Comparison of total tree height by initial planting density for the 247 largest trees per hectare (crop trees). Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986).

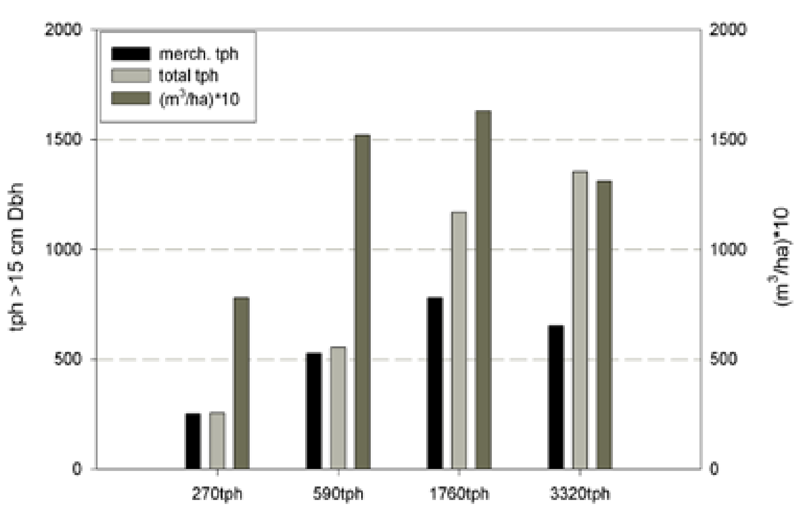
For every measurement date, the lowest two densities had the shortest trees. Mean annual height increment ranged from 1.0 m/yr to 1.3 m/yr. Periodic annual height increment from age 12 through 17 ranged from 0.2 m/yr to 0.6 m/yr.

Individual merchantable tree volume decreased with increasing density. Merchantable tree volume was approximately 0.22 m^3 for the 3320 tph and the 1760 tph densities, and 0.30 m^3 and 0.33 m^3 for the 590 tph and the 270 tph densities, respectively (data not shown). The number of merchantable trees per hectare (tph) was greatest for the 1760 tph density (778 tph), followed by the 3320 tph (652 tph), the 590 tph (526 tph) and the 270 tph (251 tph, Figure 4). The percentage of merchantable trees to total trees declined with increasing density and ranged from 48% for the highest density to 99% for the lowest density.

The differences in the number of merchantable trees per acre accounted for large differences in merchantable volume per hectare. The densities with the greatest number of merchantable trees per hectare had the greatest volumes per hectare. Volume per hectare for the three densest plots was 15.7 m^3/ha, 17.8 m^3/ha and 13.8 m^3/ha, respectively, compared to 8.3 m^3/ha for the lowest density. Total merchantable volume per hectare was directly proportional to the number of merchantable trees per hectare.

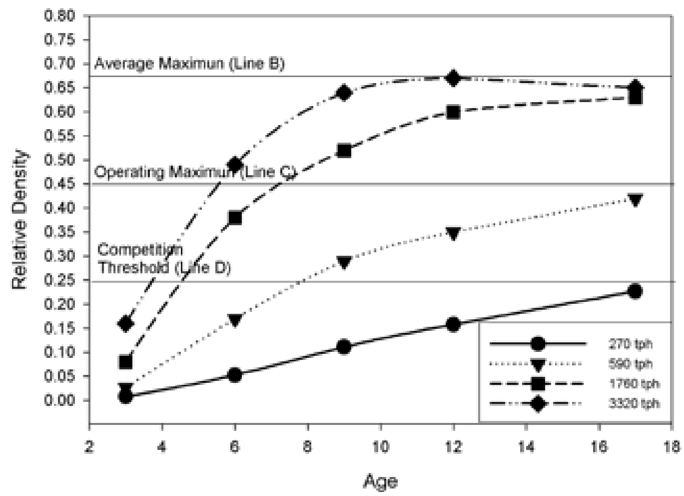
Live crown ratio, an important indicator of tree vigor, differed predictably by density. Crown ratio decreased through time and with increasing density (data not shown). For the two densest spacings, declines in crown ratio commenced immediately and rapidly through age 12. From 12 to 17 years, the decline in crown ratio somewhat leveled off, with crown ratio averaging 34% at age 17. Reductions in the two lowest densities (590 tph and 270 tph) did not occur until about age 9, at which point both densities started exhibiting a rapid decline. At age 17, crown ratios were 45% and 62% for the 590 tph and the 270 tph plots, respectively.

In this example, crown ratio and relative density (Puettman, et.al. 1993), appear to be inversely related. The densest spacing (3320tph) reached the average maximum (i.e. self thinning) line at age



*4. Comparison of 17 year merchantable tph (Dbh>15 cm, 10 cm dib top), total trees per hectare and volume ((m^3/ha)*10) by initial planting density. Data comes from one HSC red alder plantation. Volume estimates come from Skinner, E.C. (1959) "Cubic volume tables for red alder and Sitka spruce". USDA Forest Service, PNW For. Range Exp. Sta. Res. Notes No. 170.*

12, and the 1760 tph density at about at age 17 (Figure 5). The 590 tph control is just reaching the operating maximum line (RD=0.45) and the 270 tph control is just reaching the competition threshold (RD=0.25).



5. Comparison of relative density by initial planting density. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986). Figure is adapted from Puettman, et.al., 1993.

Thinning

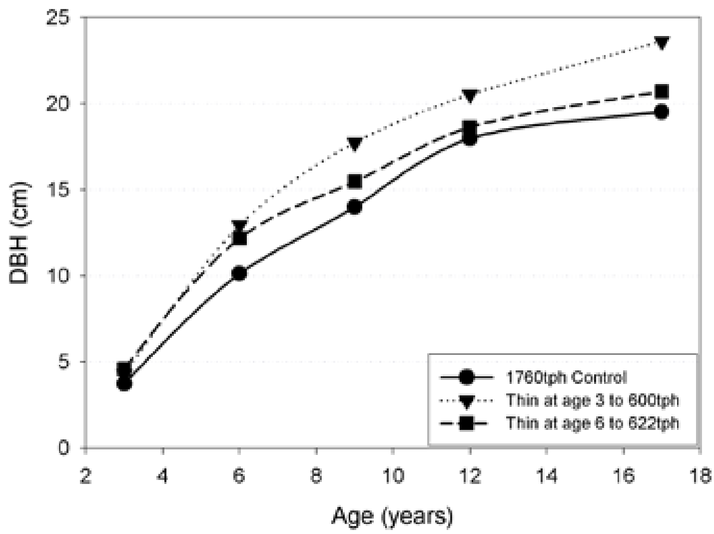
In the 1760 tph density (both the early thin and the late thin treatments), thinning removed 60% of the stems and about half of the basal area. For the 3320 tph density, thinning removed 80% of the stems and about 70% of the basal area (data not shown).

Unlike the above control plot comparisons (which used the dominant, or crop trees) the following thinning comparisons use all of the trees on the plots with the intent of comparing the stand-level effects of thinning treatments.

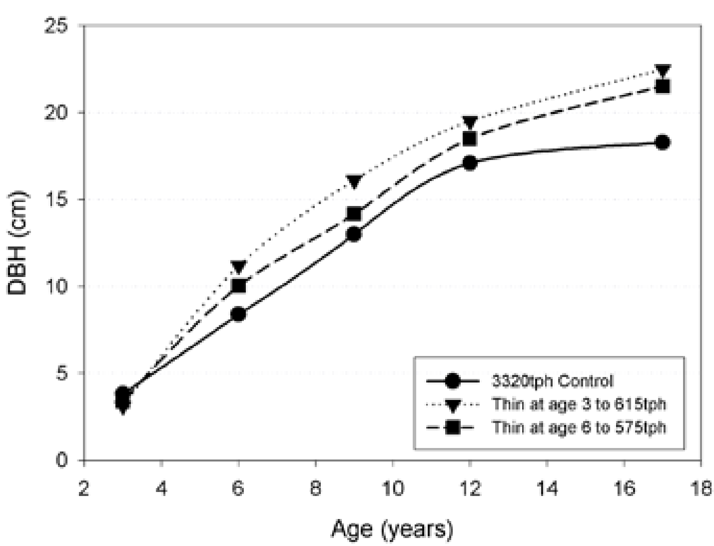
6. 17 year old red alder stand planted at 1760 tph.

In all cases, thinning increased diameter as compared to the control plot. The greatest increases in diameter occurred when thinning was done at age three compared to when thinning was done at age six (Figures 7 and 8). At age 17, diameters in the early thinned plot were 4.1 cm and 4.2 cm greater than the control for the 1760 tph and the 3320 tph densities. This corresponds to a 21% and a 14% increase. Thinning at age six resulted in little diameter improvement for the 1760 tph plot (1.2 cm and 6%) with greater diameter improvement for the 3320 tph plot (3.2 cm and 18%). Mean annual DBH increment for the 1760 tph density were 1.1 cm/yr, 1.4 cm/yr and 1.2 cm/yr for the control, early thin, and late thin respectively. Correspondingly, periodic annual DBH increment from age 12 through 17 was 0.3 cm/yr, 0.6 cm/yr, and 0.4 cm/yr, respectively. Mean annual DBH increment for the 3320 tph density were 1.0 cm/yr, 1.4 cm/yr and 1.3 cm/yr for the control, early thin, and late thin respectively. Correspondingly, periodic annual DBH increment from age 12 through 17 was 0.2 cm/yr, 0.6 cm/yr, and 0.6 cm/yr, respectively.

The effect of thinning on tree height differed by planting density and timing of thinning. Thinning in the 1760 tph density resulted in somewhat severe height reductions (Figure 9). Reductions in height were seen between ages 6 and 16 for the early thin, but currently are less than one meter shorter (4%). The late thinning treatment however, resulted in sustained, severe height reductions. Thinned trees were over four meters shorter than the control trees (a 19% reduction). However, thinning had no appreciable effect on height in 3320 tph density (Figure 10). Control trees were the tallest (21.5 m) followed by the early thin (20.5 m) and late thin (19.6), only a 5% and 9% reduction, respectively.

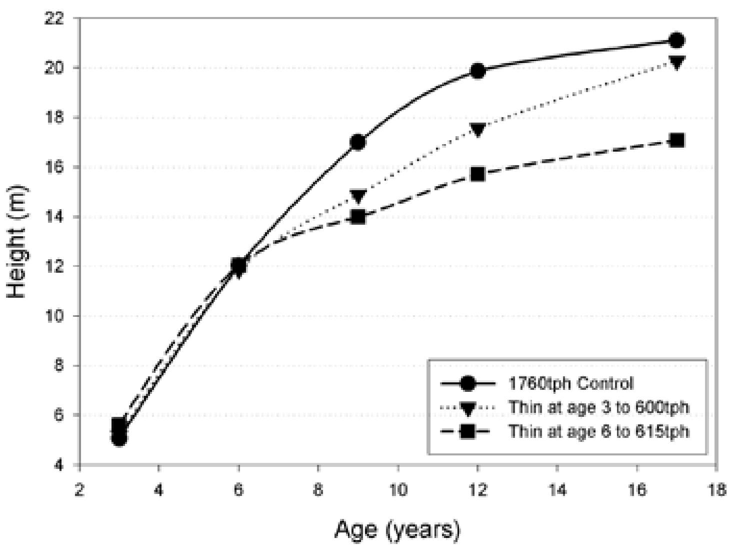


7. Comparison of diameter at breast height (DBH) for unthinned (control) trees, trees thinned at age 3 and trees thinned at age 6. All plots were planted at approximately 1760 trees per hectare (tph) and thinned to approximately 610 tph. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986).

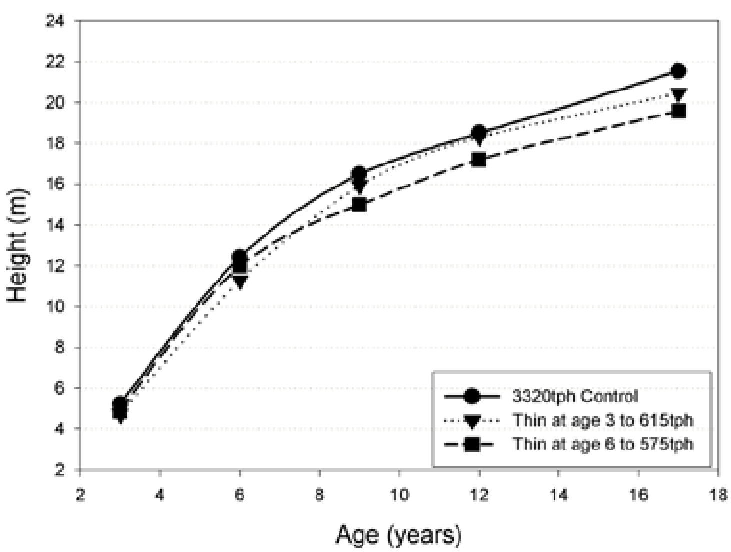


8. Comparison of diameter at breast height (DBH) for unthinned (control) trees, trees thinned at age 3 and trees thinned at age 6. All plots were planted at approximately 3320 trees per hectare (tph) and thinned to approximately 590 tph. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986).

Thinning substantially increased individual tree volume in all thinning treatments except one. For the 1760 tph plots, individual tree volume for plots thinned at age three was 0.33 m^3, a 57% increase compared to unthinned plots (0.21 m^3). The volume of trees thinned at age six was only 9% greater (0.23 m^3) than unthinned trees. For the 3320 tph plots, individual tree volume for plots thinned at age three was 0.30 m^3, a 50% increase compared to unthinned plots (0.20 m^3). The volume of trees thinned at age six was 40% greater (0.28 m^3) than unthinned trees (data not shown). Thinning reduced the number of merchantable trees per hectare. There were 778 tph of merchantable size in the unthinned (control) 1760 tph plot as compared to 563 tph in the early thin and 540 in the late thin; a 30% reduction (Figure 11). In the 3320 tph plots, there were 652 tph of merchantable size in the control plot as compared to 511 tph in the early thin and 563 in the late thin; about



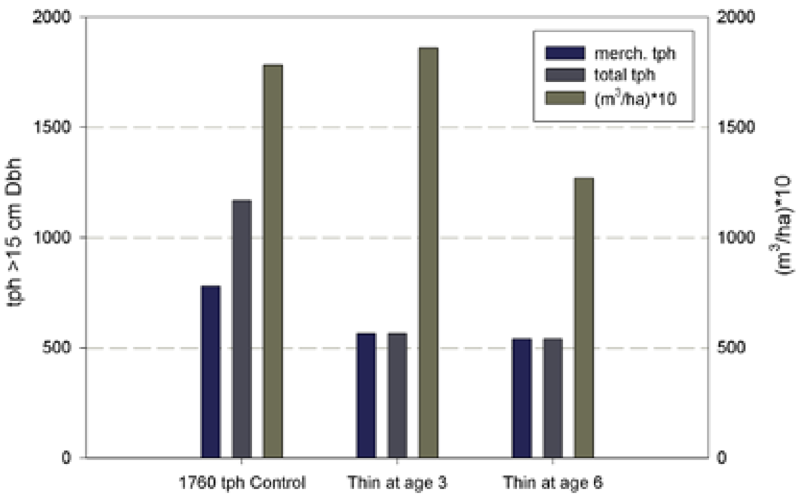
9. Comparison of total tree height for unthinned (control) trees, trees thinned at age 3 and trees thinned at age 6. All plots were planted at approximately 1760 trees per hectare (tph) and thinned to approximately 610 tph. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986).



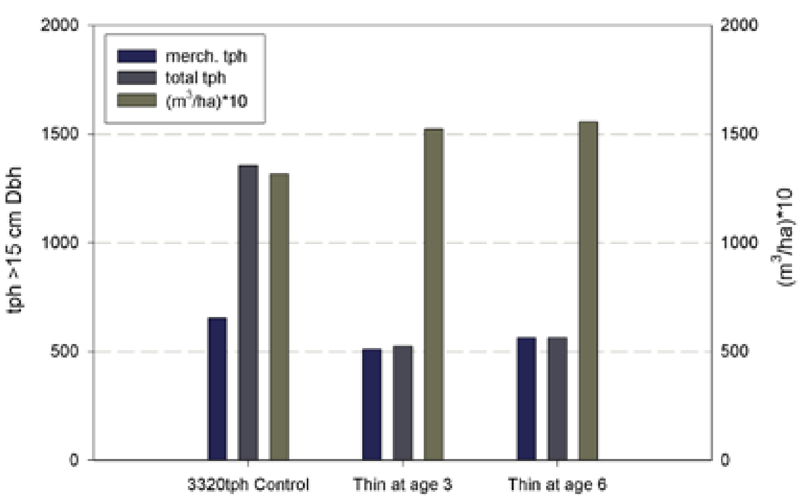
10. Comparison of total tree height for unthinned (control) trees, trees thinned at age 3 and trees thinned at age 6. All plots were planted at approximately 3320 trees per hectare (tph) and thinned to approximately 590 tph. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986).

an 18% reduction (Figure 12).

The increase in individual tree volume coupled with the decrease in the number of merchantable trees following thinning resulted in only slight differences in volume per hectare, except in one case. The control trees in both densities had small trees, but many of them, whereas trees in the early thin had larger trees but fewer of them. In both cases, the early thinned plots had the greatest volume (186 m^3/ha for the 1760 tph and 152 m^3/ha for the 3320 tph). This corresponded to a 14% and a 16% increase in volume, respectively. The 3320 tph plot that was thinned late followed the same pattern as above (an 18% increase), whereas the 1760 tph plot thinned late had less volume than the control due to both fewer trees as well as smaller trees (a 22% reduction in volume).



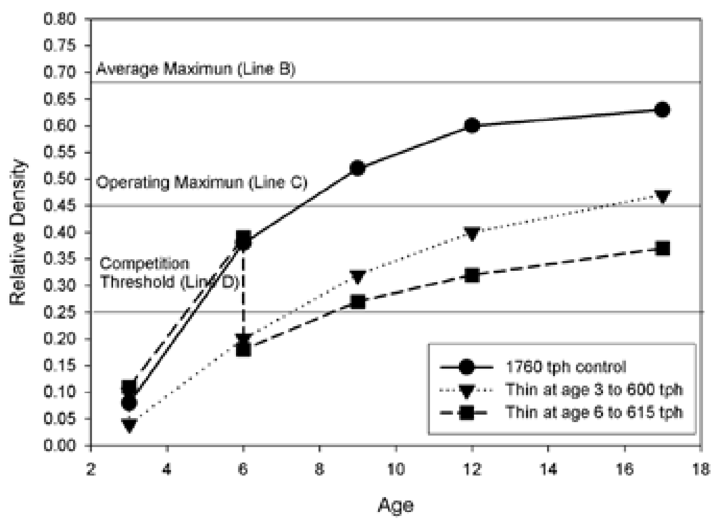
*11. Comparison of 17 year merchantable tph (Dbh>15 cm, 10 cm dib top), total trees per hectare and volume ((m3/ha)*10) for the 1760 tph unthinned (control) and thinned plots. Data comes from one HSC red alder plantation. Volume estimates come from Skinner, E.C. (1959) "Cubic volume tables for red alder and Sitka spruce". USDA Forest Service, PNW For. Range Exp. Sta. Res. Notes No. 170.*



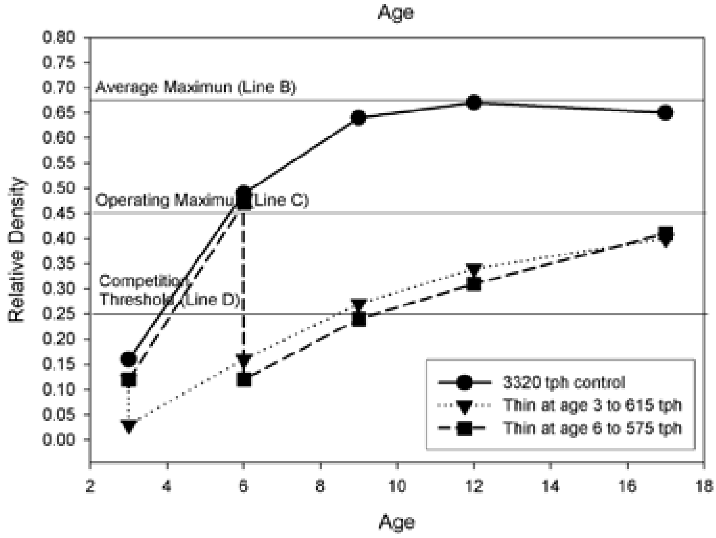
*12. Comparison of 17 year merchantable tph (Dbh>15 cm, 10 cm dib top), total trees per hectare and volume ((m3/ha)*10) for the 3320 tph unthinned (control) and thinned plots. Data comes from one HSC red alder plantation. Volume estimates come from Skinner, E.C. (1959) "Cubic volume tables for red alder and Sitka spruce". USDA Forest Service, PNW For. Range Exp. Sta. Res. Notes No. 170.*

As expected, thinning temporarily slowed the decline of crown ratio. For both planting densities and both the early and late thinnings, crown ratio remained relatively stable for about four to six years post- thinning. After that, decline in crown ratio paralleled that of the control plot. Currently, the unthinned control plots for both densities had slightly lower crown ratios than the thinned plots. Both thinned plots (the early and the late) in the 1760 tph density had a crown ratio of 44% compared to 35% for the control. In the 3320 tph plots, crown ratio in the early thin was 38%, the late thin was 44%, and the unthinned control was 33% (data not shown).

The thinning at age 3 reduced relative density from about 0.10 to 0.03 (a 65% reduction). For both densities, this thinning occurred well before the plots reached the competition threshold line (RD=0.25). For the 1760 tph plot, the thinning at age 6 reduced relative density from 0.38 to 0.20 (a 47% reduction). By age 17, the relative density increased to 47% for the early thin and 37% for the late thin (Figure 13). In the 3320 tph plot, the thinning at age 6 reduced relative density from 0.49 to 0.16 (a 67% reduction). After thinning, the relative density increased to 41% for both the early thin and the late thin (Figure 14).



13. Comparison of relative density for the 1760 tph unthinned (control) and thinned plots. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986). Figure is adapted from Puettman, et.al., 1993.



14. Comparison of relative density for the 3320 tph unthinned (control) and thinned plots. Data is derived from one HSC red alder plantation with a site index of 35 m (base age 50 years) calculated from Harrington (1986). Figure is adapted from Puettman, et.al., 1993.

Pruning

The pruning treatment consisted of four 1.8 m lifts to a total lift height of approximately 6.7 m. The last lift occurred at age 12. Pruning had virtually no effect on diameter and height. At age 17, pruned trees averaged 29.0 cm DBH, while unpruned trees averaged 28.0 cm DBH. Likewise with height; pruned trees averaged 20.4 m in height, while unpruned trees averaged 19.6 m.

15. 17 year old tree planted at 1760 tph and thinned to 600tph at age three.

Discussion

The results reported here generally agree with the previously reported results presented at the "Red Alder- A State of Knowledge" symposium (see the website http://www.ruraltech.org/video/2005/alder_symposium/index.asp for videos of the presentations and the published proceedings in Deal and Harrington, 2006). Of most value, however is that the results presented here are from a 17 year old plantation; one of, if not, the oldest continually measured alder plantation.

16. 17 year old tree planted at 590 tph and pruned to 6.7m.

Planting Density

Early diameter and height increased with stand density. Up through age 6, diameter growth increased with density until a crossover effect occurred between ages 7 through 13. Optimal diameter growth was maximized in the intermediate densities through about 10 years of age, after that, optimal diameter growth shifted to the lowest density (270 tph). Only by age 13 was the pattern of decreasing diameter with increasing density observed. It could be argued that these results are not unique at all since the typical relationship of diameter and density did occur and (most likely) will continue and intensify as the stands age.

Unique or not, it would be unwise to ignore this early phase of growth. If one reason to manage alder is to capture the difference in early growth between alder and conifers it follows that one should also try to capture the difference in early growth between alder densities. These early differences are important for at least three reasons. First, due to the short rotation ages predicted, 10 years old is about half to a third of a rotation. Second, since thinning can maintain diameter growth rates, one could possibly continue to build off of these increased growth rates. Third, since a huge improvement in tree form occurs with increasing density, log quality and thus value is maximized.

Mean annual diameter growth rates reported here (1.52 cm/yr, averaged across all densities) compare favorably to those reported in DeBell and Harrington (2002). They report annual diameter growth rates of 1.2 and 1.0 cm/yr for 20 year old trees grown in a plantation on a comparable site. Across their lowest density plots (within the range of densities presented here and potential operational planting densities), the similar pattern of decreasing diameter increment with increasing density was detected. In a review of density management studies, Puettman (1994) reported annual diameter growth rates between 0.6 and 1.2 cm/yr. He then extrapolates that under optimal management regimes "good" sites could average trees 38 cm in diameter in approximately 27 years. Using the most recent periodic increment observed here, final rotation age would be between 22 years (for the 270 tph plot) and 45 years (for the 3320 tph plot).

Height increased with stand density through age 17 except at extremely high densities. Tree heights in the 3320 tph plot "crossed over" at age 16. Trends also indicate that the 1760 tph plot will also "crossover" but not for another few years.

Individual crop tree volumes reported here (0.26 m^3, averaged across all densities) were greater than that reported by Hibbs et al. (1989) for 14-year-old trees found in a natural stand (0.15 m^3). Individual merchantable tree volume decreased with increasing density but differences were slight. Total merchantable volume per hectare was more closely linked to the number of merchantable trees. The number of merchantable trees varied considerably, mainly as a function of the absolute number of trees and minimum merchantability limits. Trees in the lowest densities were generally larger in diameter than the other densities and therefore had a very large percentage (but not number) of merchantable trees. Conversely, the densest plots had lots of trees but few above the merchantable diameter limit. At this time, the best balance between tree size and number was found in the intermediate densities (590 tph and 1760 tph). The volume per hectare estimates reported here are slightly lower than those reported for 20 year old stands of equivalent site index (Peterson, et.al. 1996). The average per hectare volume in this study (approx. 157 m^3/ha) was greater than what would be predicted from Worthington et al. (1960) using interpolation to adjust for site index and age (133 m^3/ha).

However, these volume estimates are only a snapshot during stand development. Using these reported values to predict volume at final rotation age is unwise for multiple reasons. First and foremost, this is only one site and is not representative of all the alder growing sites in the region.

Second, diameter and height growth rates, and mortality rates differ by treatment and are difficult to accurately account for. Third, not accounted for are the trees just below the merchantable DBH limit. Fourth, stand growth will be affected by any environmental or stochastic changes that occur.

In this example, crown ratio and relative density appear to be related to one another. In the two densest spacings (1760 tph and 3320 tph), crown ratio seemed to reach its asymptotic lower limit (near 33%) around age 12, the same time both plots approached a relative density of 0.67 (i.e. the self-thinning or average maximum line). The 590 tph control had a relative density of 0.45 (i.e. the operating maximum line) and a crown ratio of 0.45, and the 270 tph control had a relative density of 0.22 (near the competition threshold line) and a crown ratio of 0.62. Figure 5, an adaptation of the density management diagram (Puettman, et.al. 1993), represents the stand conditions and thus the possible management activities associated with each plot. The densest plot started suffering mortality and growth reductions as early as age six (crossing the operating maximum, Line C) and reached the self-thinning line (or average maximum line) at about age 12. The 1760 tph plot behaved similarly as the densest but crossed the operating maximum line at age seven and has just reached the self-thinning line. The 560 tph plot crossed the zone of little or no competition (competition threshold line) at about age eight and has yet to cross the operating maximum line. The 270 tph plot is just reaching the competition threshold line. According to the management guidelines, the recommended management zone lies between lines C and D. Therefore, the two densest plots would have needed thinning somewhere between the ages of four and seven, the 590 tph plot between age eight and about age eighteen, while the 270 tph seems to have just closed crown and is starting to experience interspecific competition.

Thinning

Two main factors affect tree and stand response to thinning; the timing and the intensity of thinning. For DBH, thinning early resulted in a slightly increased level of growth response. And this pattern was observed for both planting densities (i.e. thinning intensities). For height, the timing of the thinning affected only the 1760 tph plots but not the 3320 tph plots. However, personal observation of the 1760 tph plot thinned at age 6 revealed some stem breakage following thinning. As reported elsewhere (Bluhm and Hibbs 2006), thinning had virtually no effect on tree height. However, before sweeping generalizations are made, more research should be done testing specific residual densities, thinning intensities, timings (precommercial or commercial), and single or repeated entries.

Thinning elevated diameter increment levels and thinning early resulted in greater diameter increment when compared to thinning later. At age 17, the mean diameter of plots thinned at age three (on average) was 2.1 cm greater than plots thinned at age six. This increase would likely be maintained throughout the rotation as seen by the apparent parallel diameter trajectories of the thinned plots as illustrated in Figures 6 and 7 and as previously reported (once again, with the exception of the damage to the 1760 tph plot thinned at age six).

Again, using the above example (growing trees to 38 cm in DBH) and current periodic annual increment, one can calculate the expected rotation length. For the 1760 tph plots the control plot would reach rotation at age 76, while the early thin and late thin would reach rotation at ages 40 and 59, respectively. For the 3320 tph plots both the early and late thin would reach a rotation age of 44 years, less than half the time it would take for the control. However, this estimate is extremely conservative since it includes all of the trees (not just the dominant or "crop trees") and the associated reduced DBH growth rates of the suppressed trees, both currently and in the future.

As mentioned earlier, thinning resulted in increased volumes compared to the unthinned plots (except that one case due to broken tops). This "premium" in both DBH growth rate and volume is the result of the removal of competition and the "opening up" of growing space associated with thinning. However, as seen in Figures 12 and 13, these four thinned plots are reaching a condition where competition will cause growth reductions and mortality (i.e. the operating maximum line). Therefore, in this example, the landowner would need to decide if some growth loss and mortality would be acceptable, or if they should keep the stand in the recommended management zone by conducting a commercial thin.

Thinning in alder plantations increased individual tree diameter with minimal effect on height growth. Volume data at age 17 indicated that the reduction in stand density through thinning is offset by the increased diameter growth rates associated with thinning. Furthermore, the accelerated diameter growth rates would result in shorter rotations because the remaining trees would reach commercial size sooner. Therefore, as with all species, the goal of thinning is to balance the maintenance of vigorous individual tree growth with overall stand growth and, more exclusively with alder, optimal stem quality.

Conclusion

This case study supports the conclusions made previously using data from younger stands, enables further comparisons between the possible growth benefits of plantations versus natural stands, and provides a much needed data point to extrapolate rotation ages, diameters, and volumes. However, it is prudent to be cautious when projecting this data into the future or to other sites.

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Regional Red Alder Modeling Effort

Development of alder growth models has long been seen as a necessary tool both to demonstrate the potential productivity of alder plantations and to allow better alder silvicultural decision- making. The first step towards building models has been the compilation of a regional alder data base, a project managed by the Stand Management Cooperative. Data was submitted from natural and plantation plots in Oregon, Washington and British Columbia in the fall of 2005. Database compilation was largely completed a year ago but small problems have delayed its release.

Two alder modeling efforts are being organized. First, Barri Herman of Weyerhaeuser has been working with the US Forest Service to facilitate their work in FVS. This is a public domain modeling system used by a variety of public agencies and private companies. Second, the OSU Hardwood Silviculture Cooperative (David Hibbs, David Hann, and Andrew Bluhm) are beginning work in the summer of 2006 on two new versions of ORGANON, one for natural alder stands and one for alder plantations. The time line for completion is about 2 years.

Red Alder Volume Equations

Introduction

Last year, the HSC partnered up with the USFS PNW Research Station to develop taper equations for alder plantations. The specific objectives of this effort were to:

- Develop a taper equation for plantation-grown red alder
- Develop volume equations/ volume tables
- Test if various silvicultural treatments a) initial planting density, b) pruning, and c) thinning affect tree form/taper.
- Report findings

The first objective has been completed and the taper equation and an associated volume table are currently in press with the Western Journal of Applied Forestry. The title of the manuscript is "Stem Taper and Volume of Managed Red Alder". The abstract is as follows:

A taper equation and a volume table are presented for red alder (*Alnus rubra* Bong.) trees grown in plantations. Fourteen diameter measurements from each of 234 trees were collected from nine plantations throughout the Pacific Northwest. Diameter inside bark (dib) along the stem was fitted to a variable exponent model form. Individual tree merchantable volume was then estimated as volume inside bark by integrating the taper function from 6 inches (stump height) to the height at a 5 inch (diameter outside bark) top. Incorporating two easily measured tree variables - diameter at breast height and total tree height- provided an accurate fit. Model results and the use of an independent evaluation data set of plantation-grown trees indicated that the model presented here was a better predictor of dib in managed stands than previously published red alder taper equations. This equation provides reliable dib and merchantable volume predictions and is an improvement over previous red alder volume and taper equations.

In addition to this manuscript we are currently investigating the effect of various tree crown characteristics (mainly the live crown ratio) and their effects on stem shape. Preliminary analysis does suggest that trees (of a given DBH/HT) with deep, long crowns and trees with smaller, shorter crowns differ in stem form. We intend to publish these results in a Forest Service General Technical Report as various suites of tables including 1) total tree volume, 2) merchantable (6 inch stump and 5 inch dib top) tree volume, 3) merchantable height in feet (5 inch dib top), 4) stem volume to crown base, and 5) diameter inside bark (dib) at crown base.

When this project is completed, we will commence specifically and statistically testing the effects of various silvicultural treatments (initial planting density, pruning, and thinning) on stem form.

Current research has shown treatment effects in conifers, but no work has been done on hardwoods. This dataset/project provides a great opportunity to test these effects.

Red Alder Diameter and Height Growth Equations

The value of the HSC dataset extends beyond the realm of this cooperative and into many other aspects of regional forestry research. As previously mentioned, the HSC dataset will be used in conjunction with the taper project data to test how stand conditions (i.e. treatments) affect tree shape. In addition, researchers interested in developing annualized diameter and height growth equations knew about this dataset and therefore asked the HSC if they could use the dataset to develop these equations for red alder. The full manuscript will be published in the very near future but included below are the preliminary results pertaining to red alder.

Development of Annualized Diameter and Height Growth Equations for Red Alder: Preliminary Results

Aaron Weiskittel[1], Sean M. Garber[1], Greg Johnson[2], Doug Maguire[1], and Robert A. Monserud[3]

Introduction

Most individual-tree based growth and yield models use a 5- to 10-year time step, which can make projections for a fast-growing species like red alder quite difficult. Further, it is rather cumbersome to simulate the effects of intensive silvicultural treatments such as thinning or pruning on a time step longer than one year given the highly dynamic nature of growth following treatment. The goal of this project was to provide preliminary annualized individual tree diameter and height growth equations for untreated red alder using a technique that can incorporate data with varying remeasurement intervals. An additional modeling technique was used to partition out the variation in growth unexplained by attributes of the tree and stands and an attempt was made to relate it to installation edaphic characteristics.

Methods

For this analysis, the untreated control plots from Hardwood Silviculture Cooperative Type 2

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(variable density alder plantations) were used (Table 7). The diameter and height growth equations of Hann et al. (2003) were used:

[1]

$$\Delta DBH = e^{\beta_{10}+\beta_{11}\log(DBH+1)+\beta_{12}DBH^2+\beta_{13}\log\left(\frac{UCR+0.2}{1.2}\right)+\beta_{14}\log(SI\text{-}1.37)+\beta_{15}\frac{BAL^2}{\log(DBH+5)}+\beta_{16}\sqrt{SBA}+\beta_{17}I_{CR}} + \varepsilon_1$$

[2]

$$\Delta HT = PHT * \beta_{20}\left[\beta_{21}\, e^{\beta_{22}CCH} + (e^{\beta_{23}\sqrt{CCH}} - \beta_{21}\, e^{\beta_{22}CCH})\, e^{-\beta_{26}(1-UCR)^2}\, e^{\beta_{25}\sqrt{CCH}}\right] + \varepsilon_2$$

where: ΔDBH is the annual diameter growth in cm, DBH is diameter at breast height (cm), UCR is uncompacted crown ratio estimated using the equation of Monleon et al. (2004), SI is 25-year site index, BAL is basal area in larger trees (m^2 ha^{-1}), SBA is stand basal area (m^2 ha^{-1}), I_{CR} is an indicator crown ratio measurement (1 if CR wasn't measured, 0 otherwise), PHT is potential height growth estimated from a dominant height growth curve and tree growth effective age (Ritchie and Hann, 1986), CCH is percent crown closure of the plot at the tip of the subject tree estimated with the largest crown width equation of Hann (1997) the β_i's are parameters to be estimated from the data using the iterative method of Cao (1999), and $\varepsilon_i \sim$ MVN(0, Σ). Site index was calculated using the equations of Harrington (1986), Harrington and Curtis (1986), and Nigh and Courtin (1998).

Table 7. Description of the diameter and height growth rate data sets for red alder. Definition of variables are: DBH is diameter at breast height (cm), UCR is uncompacted crown ratio, BAL is basal area in larger trees (m^2 ha^{-1}), SBA is stand basal area (m^2 ha^{-1}), BH AGE is mean breast-height stand age, and SI is site index

	Diameter growth		Height growth	
Variable	Range	Mean	Range	Mean
Individual Tree	*N = 46, 546*		*N = 11, 816*	
DBH (cm)	0.1 – 35.1	5.9	0.1 – 28.2	5.6
UCR	0.47 – 0.99	0.73	0.1 – 0.99	0.78
BAL (m^2 ha^{-1})	0.0 – 36.9	4.7	0.0 – 36.9	4.7
Individual Plot	*N = 132*		*N = 132*	
SBA (m^2 ha^{-1})	2.0 – 37.0	6.8	2.0 – 37.0	6.8
BH AGE	6.1 – 33.6	8.5	6.1 – 33.6	8.5
SI (Nigh and Courtin 1998; m at 25-yr)	15.9 – 40.0	26.05	15.9 – 40.0	24.8
length of growing period (years)	2.0 – 4.0	3.0	2.0 – 4.0	3.0

Results

The models fit well and the parameter estimates were consistent with biological expectations (Tables 8, 9). The diameter growth model had a R^2 of 0.66 and a residual standard error of 1.23 cm, while the height growth model had a R^2 of 0.54 and a residual standard error of 0.96 m. The models were significantly better with site index values estimated from Nigh and Courtin (1998) when compared to those of Harrington (1986) and Harrington and Curtis (1986).

Examining the installation random effects uncovered a few interesting relationships (Table 10). The intercept of the diameter growth equation (β_{10}) was related to longitude, slope, and aspect. The parameter estimates indicated that the intercept tended to be highest on north areas with no slope. For the height growth equation, the asymptote (β_{20}) was related to percent slope and aspect. The parameter estimates again indicated that the asymptote was highest on east facing slopes. These models, however, explained a limited amount of the original variation.

Table 8. Parameters and asymptotic standard errors for predicting the diameter growth rate (equation [1]) of untreated red alder fitted using maximum likelihood and multi-level mixed effects. R^2, residual standard error, and AIC value for each model are also given.

Parameter/ Standard error	Maximum Likelihood	Multi-level mixed effects
β_{10}	-3.616555	-3.480545
SE(β_{10})	(0.05921907)	(0.4565763)
β_{11}	0.384745	0.395343
SE(β_{11})	(0.01246730)	(0.0064997)
β_{12}	-0.001467	-0.000780
SE(β_{12})	(0.00009227)	(0.0000294)
β_{13}	1.300054	1.589029
SE(β_{13})	(0.01793383)	(0.0249642)
β_{14}	1.361945	1.268489
SE(β_{14})	(0.02765335)	(0.1402212)
β_{15}	-0.008478	-0.002222
SE(β_{15})	(0.00034888)	(0.0000703)
β_{16}	-0.242575	-0.392638
SE(β_{16})	(0.00578318)	(0.0042780)
β_{17}	-0.064802	-0.019347
SE(β_{17})	(0.00675081)	(0.0037130)
R^2	0.66	0.83
Residual standard error	1.23	1.04
AIC	157,431.4	147,099.2

Table 9. Parameters and asymptotic standard errors for predicting the height growth rate (equation [2]) of untreated red alder fitted using maximum likelihood and multi-level mixed effects. R^2, residual standard error, and AIC value for each model are also given.

Parameter/ Standard error	Maximum Likelihood	Multi-level mixed effects
β_{20}	0.9286	0.9415
SE(β_{20})	(0.0067)	(0.0230)
β_{21}	0.6176	0.3833
SE(β_{21})	(0.0411)	(0.0816)
β_{22}	-0.0050	-0.0075
SE(β_{22})	(0.0015)	(0.0063)
β_{23}	-0.0048	-0.0089
SE(β_{23})	(0.0024)	(0.0020)
β_{24}	4.1802	2.9185
SE(β_{24})	(0.8516)	(0.6589)
β_{25}	0.0418	0.0
SE(β_{25})	(0.0298)	(NA)
R^2	0.54	0.65
Residual standard error	1.14	0.96
AIC	37,584.1	34,943.6

Table 10. Model, equation form, R^2, and root mean square error (RMSE) for model predicting the influence of physiographic features on the random effects of each model. All parameter estimates were significant at α = 0.05. Variable definitions are: ELEV is elevation (m), SLOPE% is percent slope, SINA is the sine transformation of aspect [sin(2*π*(aspect/360))], ASP12 is cosine transformation of slope and aspect [%SLOPE* cos(4*π*(aspect/360))], ASP2 is the percent slope multiplied by SINA, and ASP22 is sine transformation of slope and aspect [SLOPE% * sin(4*π*(aspect/360))]. The transformations of slope and aspect follow those suggested by Stage (1976).

Model	Response parameter	Equation form	R^2	RMSE
[1]	β_{10}	0.5147 – 0.0754*ln(ELEV) – 0.0053*SLOPE% -0.4640*ASP12	0.42	0.10
[2]	β_{20}	-0.0083 + 0.0735*SINA – 0.2458*ASP2 + 0.1978*ASP22	0.30	0.07

Discussion

The diameter growth equation demonstrates a well-defined peaking behavior over initial diameter. There is a rapid increase in diameter growth, peaking around 10 cm, followed by a rapid decrease. The parameter estimates on the transformations of site index and crown ratio were greater than 1.0 suggesting an increasing response in diameter growth with progressive greater site index and larger crowns. This equation also demonstrates the impact of competition on the diameter growth rate via the effect of stand basal area. Red alder is highly responsive to increasing stand basal area relative to similar fits for Douglas-fir (Weiskittel et al., in review).

The dominant height growth equation of Nigh and Courtin (1998) represented the dominant height growth in these plots better than the equations of Harrington (1986) and Harrington and Curtis (1986). Density effects on dominant height growth in red alder are well-known and documented. However, none of the existing red alder dominant height growth equations account for this. A preliminary attempt was made to fit a new a dominant height growth curve that accounted for the effects of density, but the dataset was not extensive enough to provide adequate fits. Efforts were also made to address the effects of density within the height growth modifier; however, the residuals showed no bias with stand density or other variables of importance. Currently, the ability of other individual tree competition variables (e.g. Biging and Dobbertin, 1995) to better account for stand density are being explored.

The equations presented in this report represent a first attempt to model the annual diameter and height growth patterns of red alder. The model forms used here are those that are currently used in ORGANON (Hann, 2003). However, the fit statistics were not as good as those for Douglas-fir (Weiskittel *et al.*, in review). A likely reason for this is these models were primarily developed for coastal Douglas-fir. This suggests that Douglas-fir model forms may need additional adjustments for red alder. Similar findings were made modeling other species in southwest Oregon (Hann and Hanus, 2002; Hann *et al.*, 2003).

The current red alder dataset has limited data from the later stages of stand development. For example, only one installation with its remeasurement at age 17 was available. Therefore, the widest initial planting densities have not reached relative densities where density-dependent mortality is occurring. The continued remeasurement of the HSC Type 2 installations will prove invaluable for developing more robust parameter estimates. Moreover, the iterative technique used to fit the equations proved quite useful and robust. This analytical technique is especially advantageous for these plots because the changing remeasurement interval after year 12 from three to five years. Future efforts will be made to refine the current models, develop silvicultural treatment modifiers for these equations, and develop annualized crown recession and mortality functions.

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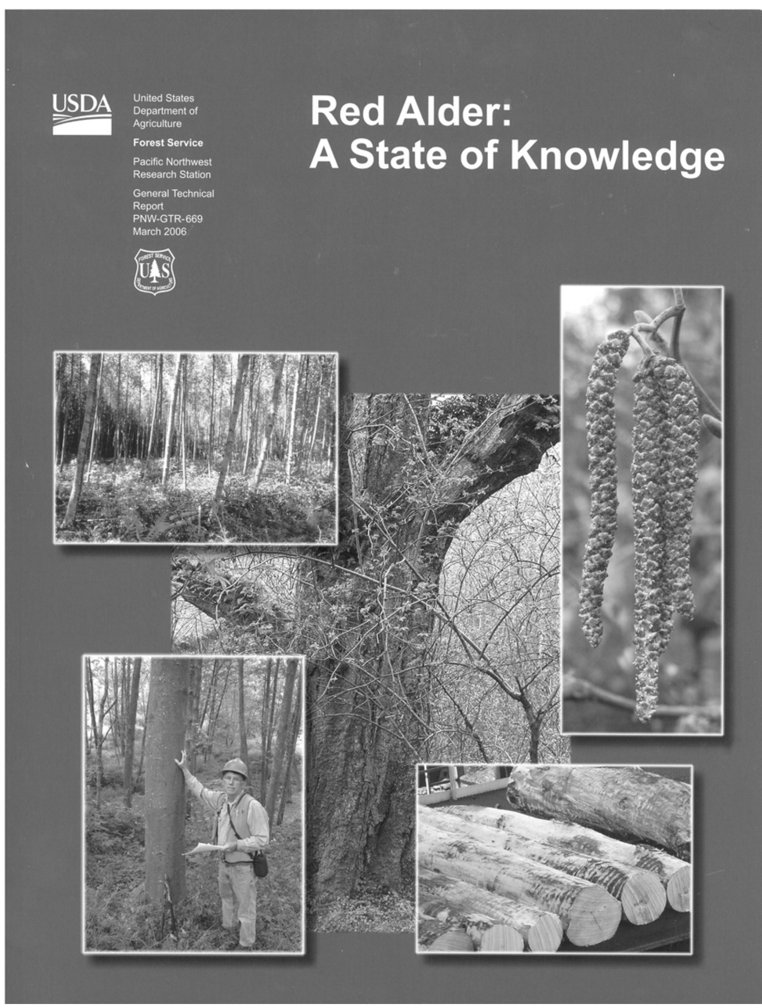
Alder Symposium Proceedings

Robert Deal (PNW Research Station, Portland) and Connie Harrington (PNW Research Station, Olympia) assembled a proceedings manuscript using many of the presentations given at the "Red Alder- A State of Knowledge" symposium (held in Seattle, WA on March 23-25, 2005). Fourteen manuscripts have been divided into three sections; biology/ecology, management/silviculture, and economics. The three presentations given by the HSC at the symposium were synthesized into one chapter providing a very broad yet up-to-date report on the current status of alder plantation management. Hardcopy versions can be requested from the Forest Service and electronic (pdf) versions of these proceedings can be viewed and downloaded from the following website: http://www.treesearch.fs.fed.us/pubs/22325.



17. The 2006 Forest Service publication of the proceedings from the "Red Alder- A State of Knowledge" symposium held in Seattle, WA, March 23-25, 2005.

New Member Information

Trillium Corporation

The HSC would like to warmly welcome our newest member; Trillium Corporation. The HSC and members of this group have known each other for a few years but the momentum of the Red Alder Symposium in Seattle, WA last spring convinced both parties that teaming up would be beneficial for all.

Trillium Corporation is a private company based out of Bellingham, WA. It was started in 1974 by David Syre as a PNW real estate company and since has gone global with real estate, agricultural, and forestry interests. Concerning forestry, Trillium has both domestic and international forest products/timber interests. Internationally, they own approximately ¼ million acres in South America, an OSB project in Venezuela, and Lenga hardwood operation in Tierra del Fuego.

PNW Land Management

Closer to home, Trillium owns timberlands and is the major shareholder of three alder mills. They own or manage 24,000 acres of timberlands in Northwest WA (as well as some in Alaska). Most of the acreage is in conifers but they are starting to manage alder. They are considering leasing several thousand acres from various tribes in Whatcom county to grow alder and just this spring have established their first alder plantation.

This spring they planted 55 acres at 600 trees per acre and in 2007 they want to plant approximately 150,000 seedlings, with a goal of 500 acres/year in alder production by 2008. Many of the lands are old agricultural fields and they previously have had experience reforesting agricultural land with hybrid poplars. This spring they are working with Greenwood Resources to plant various hybrid poplar clones and will experiment with mixed poplar/alder plantations. In addition, they have offered and are interested in providing land for any research topics the HSC may be interested in.

Lumber Mill Operations

As previously mentioned, Trillium have shares in three hardwood lumber mills in Washington. One has been in operation from 1961 and one just opened up this spring. Below is a brief description of the mills but please see the included website for more information.

Washington Alder

WASHINGTON ALDER L.L.C.
13421 Farm to Market Rd.
Mt. Vernon, WA. 98273 USA.

Tel: (360) 848-1684
Toll Free: (877) 952-5337
Fax: (360) 848-1693

Washington Alder, based in Mt. Vernon Washington has been specializing in red alder, bigleaf maple and birch since 1999. They provide kiln dried products of multiple thicknesses and various grades. The president Dick Tinney and log buyer Dick Whitmore are supporters of forestry research, the mill helped sponsor the Red Alder Symposium, and the mill was a tour stop for the symposium.

Website: http://www.washingtonalder.org/

Cascade Hardwood

Cascade Hardwood is located in Chehalis, WA and first began operations in 1961. They started by clean pulp chips to local pulp mills. Today, they provide red alder and bigleaf maple lumber, pallet stock and pulp chips. They also provide kiln dried products of multiple thicknesses and various grades. Visit their website for a grade descriptions, a virtual tour of the mill, and contact information.

Website: http://www.cascadehardwood.com/

Port Angeles Hardwood

As the name implies, this mill is located in Port Angeles, WA and should be operational in early 2006. This brand new mill will be nearly identical in structure and operation as the WA Alder mill and produce approximately 32 million board feet of hardwoods each year.

Website: http://www.portangeleshardwood.com/

We are pleased to have Trillium as the newest member of the coop and are sure the relationship will be beneficial for all parties involved.

Direction for 2007

The specific goals for 2007 are both continuations of our long-term objectives and two new projects:

- Continue treatments and measurements of Red Alder Stand Management Study installations.
- Continue working with OSU statisticians in the Type II data analyses, for publication in a peer-reviewed journal.
- Keep the HSC website updated and current.
- Continue efforts to recruit new members.
- Continue working with the "Regional Alder Modeling Group" in acquiring funding and developing a strategy for the final modeling process.
- Continue the analysis of volume equations for red alder plantations. Try to publish results in a journal and as a tool for practicing foresters.

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

Tuesday July 19, 2005:

Attendees: Andrew Bluhm and Dave Hibbs- OSU; Doug Robin and Mike Cafferata- ODF; Florian Deisenhofer, George McFadden- WA DNR; Lyle Almond- Makah Tribe; Larry Larsen and Jeannette Griese- BLM; Robert Deal- PNW, Portland, OR; Larry Mason- UW, Rural Technology Initiative; Wayne Patterson- Siuslaw National Forest

The meeting began at 8:00am at the Hebo District Ranger Station, Siuslaw National Forest. Many thanks go out to Wayne Patterson (Siuslaw National Forest) and Sarah Greene (PNW Research Station, Corvallis, OR) for providing the meeting space, tour stop locations and much of the logistical planning.

The day was spent touring three alder research experiments on Cascade Head Experimental Forest. According to their website (http://www.fsl.orst.edu/chef/), "the 11,890-acre Cascade Head Experimental Forest was established in 1934 for scientific study of typical coastal Sitka spruce-western hemlock forests found along the Oregon Coast. The forest stands at Cascade Head have been used for long-term studies, experimentation, and ecosystem research since then. In 1974 an act of Congress established the 9,670-acre Cascade Head Scenic Research Area that includes the western half of the experimental forest (see map), several prairie headlands, the Salmon River estuary to the south, and contiguous private lands. Direction for the Scenic Research Area encourages scientific study while promoting a sensitive relationship between humans and their environment. The combination of the two areas has resulted in a more diverse and coastal related research program. In 1980 the entire area was designated a Biosphere Reserve as part of the United Nations Biosphere Reserve system." Please see the website for much more information regarding the forest.

The first tour stop was a red alder provenance trial set up in 1969 by Dean DeBell. His publication, published in 1989, is available on the web at: www.treesearch.fs.fed.us/pubs/9242. Please see the publication for detailed results. Although the trees are 36 years old data is available only through age 15. The group agreed that more measurements would be extremely valuable; however no plot maps were found. Dave Hibbs and Andrew Bluhm said they would "dig a little deeper" for detailed plot maps.

At the site Dave provided a history of this study by placing it in context of other contemporary studies which hinted at geographic differences in red alder. Andrew Bluhm then provided a summary of DeBell's results. These included:

- This experiment is thought to be the very first time red alder was ever planted and is currently 36 years old.
- It was planted with natural (i.e. pulled) seedlings collected from 8 locations throughout the PNW as well as one from Juneau, AK and Sandpoint, ID on a 3.0m x 1.5m spacing (2222 trees per hectare or 900 trees per acre).
- Survival, height, and diameter were measured periodically through age 15.
- The site was thinned to a 3.0m x 3.0m spacing at age 8 (1111 trees per hectare or 450 trees per acre).
- Seedling survival ranged from 95-99% and showed no significant differences by provenance.
- Provenances from northern WA (Concrete and Sequim) were consistently tallest and with the greatest diameter while provenances from Juneau and Sandpoint were consistently smallest.
- The "local" collection (Lincoln City) was significantly lower in mean bole volume than the northern WA provenances.
- The percentage of superiority for the most vigorous provenance (Concrete, WA) was 15% for diameter and 32% for biomass.

The next tour stop was at a thinning study established way back in 1935-37 by Carl Berntsen. He investigated and compared the growth and development of pure alder, pure conifer, and mixed species stands, both thinned and unthinned. The stands regenerated naturally in 1926-27 on abandoned farm land. His results are published in "Growth and development of red alder compared with conifers in 30 year old stands" PNW Forest and Range Experiment Station, Research Paper #38, 1961. A summary of results after thirty years of measurement included:

- The unthinned, pure alder had the greatest volume, by far, until about age 29 when it was surpassed by the thinned, pure conifer.
- Yield of the thinned, pure alder was less than that of the unthinned, pure alder.
- Yield of the unthinned alder-conifer mixture was the lowest of all treatments.

Data has also been continually collected and Andrew's summary of 1996 data included:

- Density was similar across all treatments and ranged from 800-1200 trees per hectare.
- Basal area of the thinned, pure conifer (appx. 100 m2/hectare) far exceeded all other treatments and is still increasing while all other treatments have basically "leveled off" at values between 48 and 65 m^2/hectare.

- Both the thinned and unthinned, pure alder had the lowest basal area.
- The unthinned, pure alder and the thinned, pure alder had very similar diameter distributions.

Observations and discussion at this site included:

- Although the group all agreed that long-term growth and yield studies like this are valuable, the lack of replication, the variable stand and treatment establishment dates, and differences in the site and topographic features limit the quantified comparisons.
- The group was pretty amazed at how good the 80 year old pure alder looked.
- Dave Hibbs had previously plotted both the unthinned and thinned, pure alder on the stand density management diagram and found both of them were tracking self-thinning line. In other words, the growth advantage from thinning has been lost.
- Both alder treatments had only Sitka spruce sharing canopy space with the alder (no Douglas-fir or Western hemlock)
- The thinned alder plat has substantial Sitka spruce ingrowth, in contrast to the unthinned alder.
- Sitka spruce diameter was greater, and alder vigor was less in the thinned, mixed species treatment than in the unthinned, mixed treatment. Alder diameter was about the same.

After lunch we visited a study established by Dave Hibbs and Steve Radosevich in 1986. This study investigates inter- and intraspecific interactions of alder and Douglas-fir. This site is one of three sites established along a site productivity gradient and in combination will improve the understanding of where and how to mix alder and Douglas-fir to improve forest productivity. For more detailed information regarding the study design and research results please see the included handouts and list of references.

Interspecific interactions were studied using a replacement series design. Six proportions of alder and/or Douglas-fir were used, once with simultaneous planting and once with delayed alder planting of 5 years. These 12 treatments were then replicated three times. Intraspecific interactions were investigated using a Nelder plot design with each plot split with Phosphorus fertilization and replicated three times.

As mentioned earlier, results are published and available (and too lengthy to go into detail here). The most recent measurements and results have been generated by Radosevich, Hibbs, and Ghersa and are currently in the process of review.

Observations and discussion at this site included:

- Phosphorus additions at this site had no effect on growth of alder.

- Positive yield improvements were possible only with the delayed alder planting; under most species proportions red alder dominated (and suppressed) the Douglas-fir when planted simultaneously.
- In the delayed planting, Douglas-fir performance was unaffected by alder.
- The five year delay in planting alder resulted in about a 40% decrease in alder average tree height.
- Understory species composition and abundance varied greatly due to phonological and architectural characteristics of the stands.
- Trees growing as pure stands at narrow spacing were statistically equal in height as trees grown at the wider spacing.
- A slight positive influence on relative yield was observed only with the delayed alder planting.
- In the 50/50 mix (Tmt 6) almost all of the Douglas-fir was dead.
- In the 70% Douglas-fir /30% alder mix (Tmt 4) the Douglas-fir was growing fairly well but still overtopped.
- In the 25% Douglas-fir /75% alder delayed planting (Tmt 11) the Douglas-fir was overtopped, and the alder growth rate and tree form seemed entirely unaffected by the presence of the Douglas-fir.
- In the 50/50 delayed planting (Tmt 7), the Douglas-fir was still overtopped.
- It's not until the 75% Douglas-fir /25% alder delayed planting (Tmt 5) that the Douglas-fir shared dominance with the alder. However, the sizes of both species were smaller than when either was grown in pure stands. From the ground it looked as if both species shared dominance. However, Dave Hibbs, after climbing a big Douglas-fir reported that the Douglas-fir was 10-20 feet taller than the alder.
- Finally, in the 90% Douglas-fir /10% alder delayed planting (Tmt 3) the alder was overtopped. It was mentioned that commercially one could enter this stand, widen the spacing for the Douglas-fir and recover the alder.
- Alder in the 100% pure, narrow spacing (Tmt 12) looked good but not up to the expectation of 20mbf in 25-30 years. The trees however had very good form and still vigorous as indicated by their 40-50% crown ratio.
- Alder in the 100% pure, wide spacing (Tmt 15) seemed to be larger in diameter than those in the narrow spacing, but had less desirable form due to multiple, big branches.

Wednesday July 20, 2005:

Attendees: Andrew Bluhm and Dave Hibbs- OSU; Doug Robin and Mike Cafferata- ODF; George McFadden- WA DNR; Lyle Almond- Makah Tribe; Larry Larsen and Jeannette Griese- BLM; Robert Deal- PNW, Portland, OR; Larry Mason- UW, Rural Technology Initiative;

After welcomes and introductions, Andrew reviewed the last year and the coming year measurements. Last year had very minimal field work (6 sites). This coming year has the most he's seen in 5 years (13 sites). Furthermore there are three "orphaned sites" to measure. Please see the annual report included here for a description of the fieldwork schedules. The overall data collection matrix is impressive:

- 3 of the 4 Type 1 sites have had their 14th year measure.
- After next year, all of the Type 3 sites will have had their 9th year measurement and 4 of the 7 will have had their 12th year measurement.
- Also, after next year, all of the Type 2 sites will have had their 9th year measurement and 19 of the 26 will have had their 12th year measurement.

Next, Andrew updated the group on the HSC's two main "side projects"; the regional growth model effort and the taper equation effort. Once again, these are both described in the annual report. The group was eager to see modeling begin and agreed that not just releasing a model would be a success but releasing a model that the public WOULD and CAN use. Although the HSC is not officially leading the effort on model choices, Dave Hibbs has and will coordinate this effort because of its importance to hardwood management.

Other activities the HSC is peripherally involved in are the Sustainable Wood Production Initiative (SWPI) and the Technology Transfer Advisory Group.

Bob Deal (PNW Research Station) is organizing a synthesis of findings from the SWPI that will be presented at a two day symposium on November 30 and December 1, 2005. The symposium objectives are to present key findings on information synthesized on some of the barriers and opportunities for wood production in the region including sustainable markets (timber harvest potential, market opportunities and lumber manufacturing), sustainable land use (land use changes and forest fragmentation) and sustainable forestry options (riparian management, public perceptions, innovative technologies including wood-plastic composites and potential of red alder for future markets). Since the funding of the taper equation effort was from the SWPI, the HSC will present the results at this meeting.

The other effort, the Technology Transfer Advisory Group (TTAG) is being led by George McFadden (WA DNR). The TTAG is an informal technology transfer group made up primarily of technology consumers but with the cooperation of technology producers. It is not intended to compete with the technology transfer efforts of technology providers. It is intended to help coordinate technology transfer and make the effort of technology producers efficient in serving the needs of field resource managers.

Technology transfer remains a goal for most research cooperatives but continues to be handled by the cooperatives individually and discussions with several participants at recent research co-operative meetings have identified the desire on the part of cooperative members to develop a coordinated strategy for technology transfer. Therefore a vision was had for a technology transfer oversight group comprised of technology consumers, research cooperatives, independent researchers and consultants along with federal and state research organizations is to facilitate technology transfer in the region.

Exactly who will participate and how and when this effort will take place remains to be seen. The HSC has agreed to participate since one of our main functions is to perform education/outreach projects. George said that the level of interest in this group was high, and hopes that an exploratory meeting can be held soon. For more information, contact George McFadden at: george.mcfadden@wadnr.gov.

After a break, Larry Mason of the Rural Technology Initiative (RTI) described the "streaming video" technology his organization currently uses to capture both indoor and outdoor presentations. Larry is a firm believer in this technology because of it's compatibility with all types of media (i.e. CD's, DVDs, internet, modems) quick turn around time, user friendliness and ease of production. He then explained that with very minimal investments in training (a couple days, at most, to become proficient) and equipment (around $2,000) any individual or organization can produce their own streaming videos. RTI, has in fact, published a streaming video tutorial on their website (www.ruraltech.org/video/2004/howto/index.asp) and would even be willing to provide personnel support for setting up a streaming video system. It is marvelous technology and has far-reaching potential. If interested, please see the RTI website or contact Larry (larrym@u.washington.edu).

He then handed out DVD's of the Alder symposium and CDs of Grant Sharpe's presentation "Western Alder: It's worth more than you may think". We then watched this presentation as an example of this technology. Streaming video of the symposium can be viewed free of charge at www.ruraltech.org/video/2005/alder_symposium/index.asp or purchased for $10.

Then, the topic turned to the HSC budget. Every member paid their full dues in FY 2005 and mainly due to reduced travel expenses; there was a little carryover to FY 2006. This carryover, in addition to the likelihood of a new member joining the HSC will (most likely) allow income to exceed expenditures in FY 2006. However, as Doug Robin (ODF) pointed out, income remains relatively constant while expenditures increase annually. Therefore, a dues increase was mentioned as a possible solution. However, Dave Hibbs considers a dues increase as a "last option". Instead he would prefer to procure outside/additional funds to pay for Andrews's salary. These finding options include project specific grants, AMERICORP, and/or OFRI. All of these options would necessitate increased public relation efforts, and long-term planning. Dave and Andrew said they would explore outside funding options.

Discussion of the budget then led into the future direction of the HSC. In addition to maintaining the integrity of the study and continued data collection, many members felt that the HSC could/should start investigating the connections between management and products and that manufacturers would be critical in these efforts. Several specific topics were identified:

- How and in what way do silvicultural activities affect product quality?
- What specific management activities are necessary to produce a "veneer" log?
- At what age or stand conditions would commercial thinning be profitable and beneficial?
- What products would likely be in demand when these alder plantations reach rotation age?

These are just a few of many potential topics of study. To identify others, it was suggested to survey members and nonmembers alike about what are the current and expected log to product questions.

Finally it was decided that the HSC winter meeting will be in the Siletz/Toledo/Newport area of the OR coast. The weather will be a lot worse than this summer's meeting but it will allow the group to measure one or two "orphaned sites" located near there. The meeting will be held Wednesday and Thursday January 11-12, 2006. Stay tuned for more information.

Winter Management Committee Meeting Minutes

Wednesday January 11, 2006:

Attendees: Andrew Bluhm and Dave Hibbs- OSU; George McFadden- WA DNR; Jeannette Griese- BLM; Robert Deal- PNW, Portland, OR; Wayne Patterson- Siuslaw National Forest; Glenn Ahrens- OSU Extension

The meeting began at 8:00am at Richardson Hall on the OSU campus in Corvallis, OR.

Despite concerns over flooding, landslides, and pouring rain, we headed out to conduct the 12th year measure on a Type 2 plantation owned by ANE Hardwoods (#2205) with comments such as "Well, of all days this week, the weather is supposed to be nicest today".

It in fact, turned out to be a beautiful day on the Oregon Coast Range. We measured 7 of the 10 plots. Tree growth there is about average across all HSC sites. Specific plot growth is variable due somewhat to soil condition and definitely due to previous elk damage. Please see the file on the associated CD entitled "SiletzComparison.doc" for specific site information and growth data.

Many thanks go out to those who assisted in the measurements.

Thursday January 11, 2006:

Attendees: Andrew Bluhm and Dave Hibbs- OSU; George McFadden- WA DNR; Jeannette Griese- BLM; Robert Deal- PNW, Portland, OR; Wayne Patterson- Siuslaw National Forest; Glenn Ahrens- OSU Extension; Dave Sweitzer- Washington Hardwood Commission; Paul Kriegal- Goodyear Nelson; Doug Robin- Oregon Department of Forestry; Warren Devine- USFS PNW Research Station, Olympia, WA

After welcomes and introductions, Dave informed the group that the HSC now has an official new member. The new member is Trillium Corporation, a private company based out of Bellingham, WA. Among other assets, Trillium is a majority owner of three alder sawmills in Northern Washington and owns 24,000 acres in NW Washington. Please see the file on the associated CD entitled "Trillium.ppt" for a more detailed description of the company and why they are interested in joining the HSC. We are pleased to have them as the newest member of the coop and are sure the relationship will be beneficial for all parties involved.

Andrew then reviewed this winter's fieldwork. This measurement year is busy but fieldwork is going as planned. There are a few "orphaned sites" to measure but with the help of the committee and some OSU graduate students these measurements will get completed. A couple of highlights this year was that Humphrey Hill was the first site to have its 17th year measure and after this winter all sites will have had at least their 9 year measure. He then went over next years fieldwork. Again, it will be a busy year but there are no "orphaned sites". Please see the file on the associated CD entitled "Fieldwork Schedule.doc" or the HSC website http://www.cof.orst.edu/coops/hsc/ for details regarding specific sites to be measured.

Andrew Bluhm then discussed another research project that the HSC is involved in. With funding from Bob Deal (PNW Research Station, Portland, OR) Andrew, Dave and Sean Garber (Research Assistant at OSU) have finished modeling stem taper of plantation-grown alder. A presentation of the project is found on the associated CD entitled "Taper.ppt". Briefly:

- It was determined that crown ratio (CR) affected stem profile and thus stem volume.
- Therefore a final equation (incorporating CR as well as DBH and height) was developed.
- However, another equation (and associated tables) based only on diameter at breast height (DBH) and total tree height is also presented for those databases without CR.
- Five sets of tables were created:

  1) total stem volume

  2) merchantable volume

  3) merchantable height

4) volume to crown base

5) diameter inside bark (dib) at crown base

These equations, tables, and results are deemed "preliminary" only because the manuscript is still in review. However, we do not expect the volumes given in the tables will change and thus, the five sets of tables are also included in the CD and contain:

- Appendix G- Total and merchantable tree volume in cubic feet and merchantable height in feet using DBH and HT (3 tables)
- Appendix H- Total tree volume in cubic feet, using DBH, HT and CR (10 tables)
- Appendix I- Merchantable (6 inch stump and 5 inch dib top) tree volume in cubic feet, using DBH, HT and CR (10 tables)
- Appendix J- Merchantable height in feet, using DBH, HT and CR (10 tables)
- Appendix K- Stem volume to crown base in cubic feet, using DBH, HT and CR (10 tables)
- Appendix L- Diameter inside bark (dib) at crown base in inches, using DBH, HT and CR (10 tables)

This manuscript will be published as a general technical report (GTR), be available both as a hardcopy and electronically, and should be available later this year.

The group was supportive of the project and agreed with it's importance, but many believed the project needed to go further. What is desperately needed, they said, is a tool that a landowner/cruiser/timber buyer can use to calculate board feet (not cubic feet) volume by log diameter and length. For example, what percentage of volume of any given tree will fall in logs of different sizes? Tools like this (either a set of tables or a computer program) exist for conifer species but not for alder. Glenn Ahrens concurred and as far as he saw it, this tool is essential to convince landowners to manage alder. Until this tool is created there are no hard numbers on the value of existing stands or, by extension, the value of management. The options surrounding the design and creation of such a tool are seemingly endless so Dave and Andrew told the group they would pursue this topic further and try to come up with possible alternatives and report back to the group.

The group also desired that this taper equation be incorporated into the future alder versions of FVS and ORGANON.

Switching gears slightly, Stephanie Hart, an MS student studying under Dave Hibbs, gave a presentation on the results of her thesis work. Her project titled "Riparian Litter Inputs to Streams in the Central Oregon Coast Range" addressed the potential impacts of overstory vegetation on vertical and lateral inputs of litter to streams with varied slopes and vegetation composition. Her objectives were to measure amounts and identify sources of vertical and lateral inputs and to characterize the seasonal pattern of vertical and lateral litter movement. Results include:

- Deciduous (i.e. alder) dominated sites provided 32% more litter to streams than coniferous (i.e. Douglas-fir) sites.
- Vertical inputs of litter comprised more than 90% of total litter inputs for both types of sites.
- Seasonal patterns of vertical litter fall (November peak for deciduous) distinguish these two vegetation types.
- Litter type, as expected, differed between the two vegetation types.
- Deciduous litter was common in coniferous-dominated sites whereas the opposite was not found.
- Litter type varied by season. In winter, litter inputs were dominated by twigs and in deciduous-dominated sites by catkins. Spring/summer inputs were populated by the dominant overstory needles or leaves.
- Contrary to what was expected, understory vegetation (or the absence thereof) does not affect lateral movement of litter.
- Steeper slopes are associated with greater lateral litter movement.
- These results indicated that deciduous-dominated riparian forests provide more vertical and lateral litter and have a more pronounced seasonal litter contribution than coniferous-dominated sites.
- These results suggest that forest management activities that promote the dominance of coniferous overstories would reduce litter inputs to aquatic communities.

More information can be optained by contacting Stephanie (Stephanie.hart@oregonstate.edu) or visiting the CFER website (www.fsl.orst.edu/cfer).

Warren Devine then gave a talk summarizing recent oak and alder research at Olympia Forestry Sciences Laboratory being performed by Connie Harrington, Dave Peter, Warren Devine, Leslie Chandler Brodie of the Silviculture and Forest Models Team. Research efforts into Oregon white oak (Quercus garryana) focus on the following:

- *Q. garryana* bibliography

Biology

- Acorn production survey
- Long-term growth/mortality
- Effects of fire
- Root systems

Management / Restoration

- Releasing oaks from conifers
- Oak regeneration
- Modeling stand development in response to management

While current research effort on red alder investigate whether alder has a chilling requirement for rapid spring bud break.

Please see the file on the associated CD entitled "Oak and Alder Research.ppt" for the full presentation.

Other topics discussed during the meeting included:

- According to one source, alder is now the most valuable species in the PNW, worth more than export Doug-fir. Camp runs are worth about $750/mbf and veneer is around $1300/mbf.
- The future price trends of alder look good; however, long-term supply is a concern is generally what is driving up the current high prices.
- Bob Deal told the group that the final PDF file of the Proceedings of the Red Alder Symposium held in Seattle last March will be completed by the end of next month and the printed version will be available by early this coming summer.
- Wayne Patterson announced that logging on federal lands might increase due to the fact that individual counties now get a share of the timber receipts and are thus pushing for increased harvests.
- The WHC is actively pursuing/promoting the idea of developing and planting alder clones which may reach final rotation at age 17-20 years.
- After a few setbacks, the Regional Red Alder Database will be completed by the end of January.
- ORGANON Modeling Effort- Dave has been busy and successful acquiring the commitment of various agencies and companies to fund the creation of an alder version of ORGANON. To date approximately half of the total amount required has been committed and he expects the effort to commence soon. It is expected to be completed in about two years time.

Finally, scheduling the HSC summer meeting met with mixed success. A majority of the group desired the HSC meeting to "piggyback" on the LOGS meeting which is July 11th and 12th in the Victoria, BC area. The group thought that the HSC meeting could then happen the 12th and 13th. However, before the location and dates of the HSC meeting can be set, Andrew said he would contact Dave Marshall about the LOGS meeting details and contact Paul Courtin (BC Ministry of Forests) about potential hardwood tour stops. As soon as the location and date of the summer meeting is decided, Andrew will let all interested parties know.

Appendix 3

Financial Support Received in 2005-2006

Cooperator	Support
BC Ministry of Forests	$8,500
Bureau of Land Management	$8,500
Goodyear-Nelson Hardwood Lumber Company	$4,500
Oregon Department of Forestry	$8,500
Siuslaw National Forest	$8,500
Trillium Corporation	$8,500
USDA Forest Service PNW Station	In kind
Washington Department of Natural Resources	$8,500
Commission	$8,500
Subtotal	$64,000
Forestry Research Laboratory	$45,600
Total	$109,60

www.cof.orst.edu/coops/hsc/