Hardwood Silviculture Cooperative

annual report 2002

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Highlights of 2001-2002

- Modeling efforts are underway. All of the Type 2 data have been given to George Harper with the BC Ministry of Forests. He has combined the HSC data with their own data and has processed preliminary runs in TASS. He is currently working with Dave and Andrew in the process of calibrating the output and developing a specific red alder version. For more information on TASS contact the website: www.for.gov.bc.ca/research/gymodels/TASS/

- Plans are moving forward to create a regional red alder database to facilitate development of additional red alder growth models.

- Four of our Type 2 sites have had the 12^{th} year growth measurement, and three of the four have had all of the treatments completed. After the twelfth year, the measurement cycle changes to every five years.

- The second thinning treatment (15-20' height to live crown thin) and the 9^{th} year growth measurement have been completed on over half of the Type 2 installations (14 of the 26 sites).

- Only 3 of Type 2 sites need the first thinning treatment (3-5 year thin) and the 6^{th} year growth measurement, all of which will be completed next field season.

- Six of the seven Type 3 (mixed red alder/Douglas-fir) installations have had their 6^{th} year growth measurement.

- Three of the four Type 1 (thinned natural red alder stands) installations have had their 9^{th} year growth measurement. After nine years, the measurement cycle changes to once every five years.

HSC Executive Summary 2002

Thirty-six study installations from Coos Bay, Oregon to Vancouver Island, British Columbia:

- 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

And up to 12 years data on these studies. An amazing accomplishment for such a small (but dedicated!) group.

The value of this data is becoming more apparent daily. HSC data is being used by the B.C. Ministry of Forests to develop a red alder version of TASS, the forest growth modeling system used in B.C. Efforts are also underway to create a regional red alder database to facilitate further model development. HSC data would be combined with red alder data from other research and land management programs. Then, modeling efforts like OREGANON and FVS can have use of the data.

Within the Cooperative, we have been doing some data analysis of our own which is summarized in this report. We presented a poster and are working on a manuscript on how density affects red alder growth. In addition, because of the rapid growth of red alder, we were able to use our data on red alder in a precommercial thinning workshop to illustrate the process of stand development, the effects of initial spacing, and the effects of thinning. Nine-year old red alder is the size of 20-year-old Douglas-fir. A side benefit of the workshop was exposing a lot of Douglas-fir foresters to the potential of red alder.

The coming field season will be a very busy one for the HSC. We have one 9- and one 14-year measurement in Type 1 (natural stand thinning) installations. We have one 6- and four 9-year measurements in Type 3 (replacement series) installations. We have three 6-year, five 9-year and two 12-year measurements in Type 2 (variable density plantations) installations plus many thinning and pruning treatments. We will see you all out in the woods!

Contents

History of the HSC

The Hardwood Silviculture Cooperative (HSC) is a multi-faceted research and education program focused on the silviculture of red alder (*Alnus rubra*) and mixes of red alder and Douglas-fir (*Pseutotsuga menzeisii*) in the Pacific Northwest. The goal of the HSC is to improve the understanding, management, and production of red alder. The activities of the HSC have already resulted in significant gains in the 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 collecting 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. Twelve years ago, 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 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.

In the 12 years since the first plantation 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 book *The Biology & Management of Red Alder* (1994) and 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, 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.

Cooperative Research

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. The three types of study installations are as follows:

1. Type 1 is a natural red alder stand thinned to 230 and 525 trees per acre. There are four Type 1 installations.
2. 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.
3. 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).

In winter 2002, field work was completed on 11 installations:

▲ Type 1 installations had no field work.

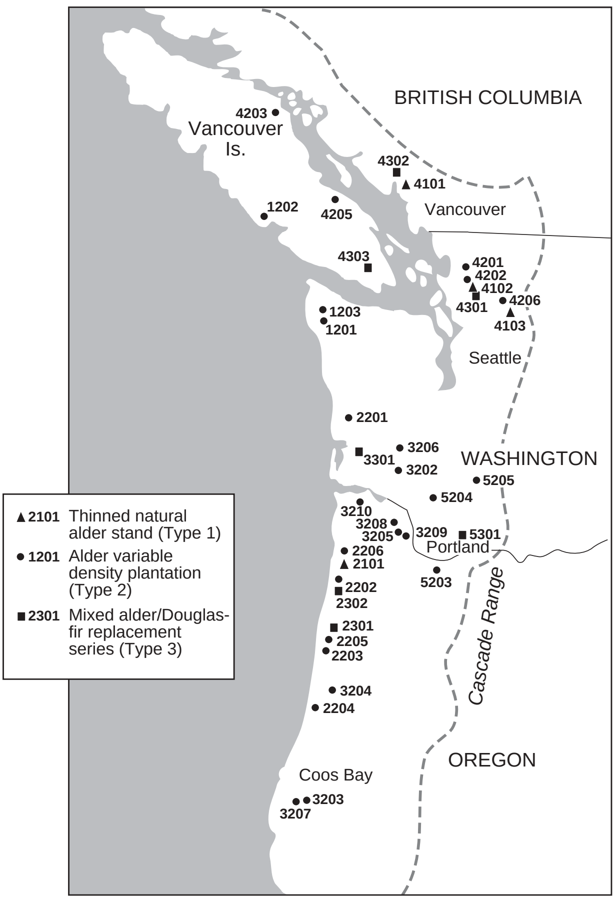

Figure 1. Location of installations for the Red Alder Stand Management Study.

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

Region	Site Quality: Low SI50 :23-27 M SI20 :14-17 M	Medium SI50 :28-32 M SI20 :18-20 M	High 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.

▲ In the Type 2's, a total of ten installations had field work. Specifically, three installations had the 12 year measurement completed, and two of the three had the final thin (30-32' height to live crown) and the final pruning lift (to 22'). Six installations were thinned; one for the first time (3-5 year thin) and five for the second time (15'-20' height to live crown). The 9 year measurement was completed on three installations and the 6 year measurement was completed on one installation.

▲ One Type 3 installation had the 6 year measurement completed.

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

Table 2. Data Collection Schedule for Type 1 Installations. Shaded areas indicate completed activities.

TYPE 1 Site Number Site Name	BCmin **4101** **Sechelt**	SNF **2101** **Battle Saddle**	DNR **4102** **Janicki**	MBSNF **4103** **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 3. Data Collection Schedule for Type 2 Installations. Shaded areas indicate completed activities.

TYPE 3 Site Number Site Name	BCmin **4302** **East Wilson**	NWH **2301** **Monroe-Indian**	GYN **4301** **Turner Creek**	BCmin **4303** **Holt Creek**	DNR **3301** **Menlo**	SNF **2302** **Cedar Hebo**	GPNF **5301** **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

Table4. Data Collection Schedule for Type 3 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 Hill**	**John's River**	**Ryderwood**	**Clear Lake**	**LaPush**	**Pollard Alder**	**Pioneer Trail**	**Sitkum**	**Keller-Grass**	**Shamu**	**Thompson Cat**	**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	1999/04?	1999	1996	1999	1999/02	2000	2001	2001	2000	2000	2002	2001/02
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	?	2002	1999	2004/05	2003	2004	2001	2004?	2004?	2003	2002	2005?
12th yr Measure	2001	2002	2002	2002	2003	2003	2004	2004	2004	2004	2004	2005	2005
30-32' HLC Thin	2001	?	NA	2002	?	?	2007?	?	NA	?	?	2005?	?
Prune Lift 4 22 ft	2001	?	2002	2002	?	?	?	2004?	?	?	?	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 4 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 Packin**	**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	2003?
Prune Lift 1 6ft	NA	1999	1999	1999	1999	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	2003?	2003?	2003	2003?	2003?	2004?	2003?	2002/04	2005?	?	?	?
Prune Lift 2 12ft	NA	2003?	2003	2003	2003?	2003	2004?	2003?	2002	2005?	?	?	NA
9th yr Measure	2002	2003	2003	2003	2003	2003	2004	2004	2004	2005	2006	2006	2006
Prune Lift 3 18ft	NA	?	?	?	?	?	?	?	2004	?	?	?	NA
12th yr Measure	2005	2006	2006	2006	2006	2006	2007	2007	2007	2008	2009	2009	2009
30-32' HLC Thin	2005?	?	?	?	?	?	?	?	?	?	?	?	?
Prune Lift 4 24 ft	NA	?	?	?	?	?	?	?	?	?	?	?	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

Current HSC Research

The data gathered thus far enables us to investigate specific aspects of red alder stand dynamics. Last year, Andrew Bluhm explored Height/Diameter ratios in the Type 2 installations. The analysis contained some expected and some unexpected results. As expected, denser stands have a higher H:D. Somewhat unexpectedly, the H:D dropped with age and we found no relationship with any ecological variable including elevation, slope, and latitude. The range of H:D values found in the analysis is high compared to conifers and indicates that standards for red alder need to be increased.

Pre-Commercial Thinning

Following is a summary of results presented by David Hibbs at the Pre-Commercial Thinning Conference, November 16, 2001, Corvallis, OR. The full presentation can be obtained by contacting David Hibbs or Andrew Bluhm.

To thin or not to thin, that is the question.

As part of a daylong workshop on precommercial thinning (PCT) in Corvallis, Dave Hibbs with a lot of help by Andrew Bluhm used data from the HSC's Type 2 installations to explore general concepts of density and tree growth. The HSC data was particularly helpful to this largely conifer-oriented audience because red alder goes through the same basic developmental processes as Douglas-fir, but in a much shorter time.

Figures 2, 3, and 4 show how three important tree characteristics, height, diameter and live crown ratio, are affected by density and how they change with age. We used data from ten plantations through age 9.

Height demonstrates what we now recognize as a common phenomenon, a reduction of height at low densities (Figure 2). Also, we saw that density could be quite high, up to 2967 stems per ha (1200 tpa) with no height penalty. Diameter, if you consider all the trees, shows that size increases with spacing (Figure 3a). However, examining just the 247 largest trees per ha (100tpa) shows that the eventual crop trees do not follow this pattern (Figure 3b). The intermediate densities maximize tree diameter and there is little penalty even at the highest density.

Does live crown ratio drop to an unacceptable level? Using 60% as a threshold for concern, the answer is no, at least for the larger trees (Figure 4b). Comparing live crown ratio at age 6 and

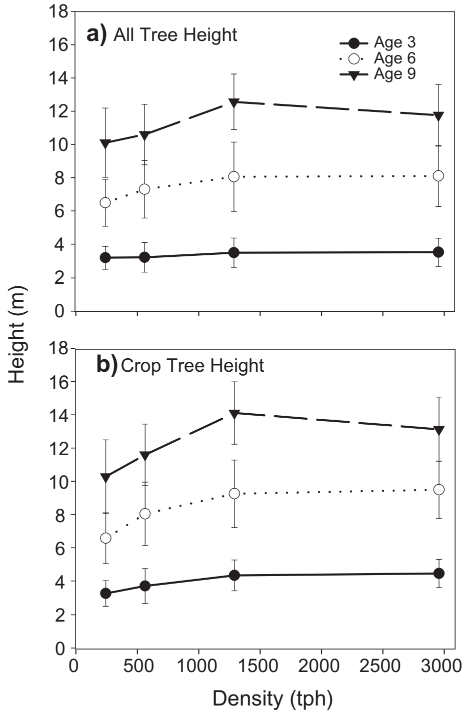

Figure 2 Height (m) by density (tph) by age (years) for all trees (a) and the largest 247 trees per hectare (b) for ten HSC red alder plantations.

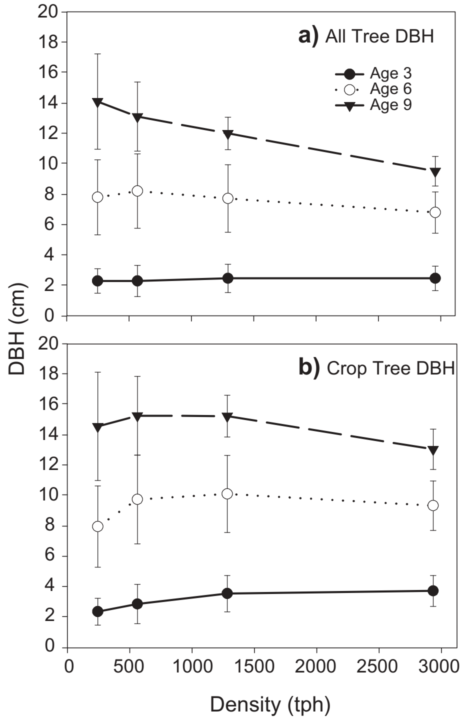

Figure 3. Diameter (cm) by density (tph) by age (years) for all trees (a) and the largest 247 trees per hectare (b) for ten HSC red alder plantations.

9 suggests that live crown ration is dropping fast and may become unacceptable by age 12 at the two higher densities.

So, should red alder be precommercially thinned in the first 9 years? Height, diameter and live crown ratio all look good so far for the largest trees in the stands, the trees that would be the eventual crop trees. The conclusion appears to be no, there is little to be gained by an early PCT.

Figure 5 confuses this conclusion. However, this data comes from a single

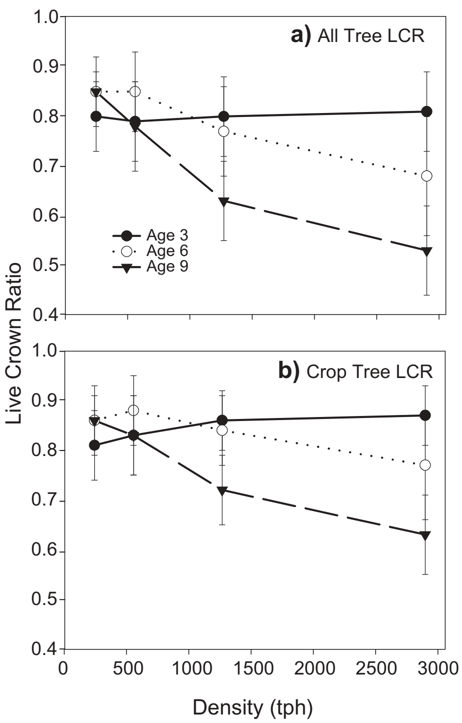

Figure 4. Live Crown Ratio (%) by density (tph) by age (years) for all trees (a) and the largest 247 trees per hectare (b) for ten HSC red alder plantations.

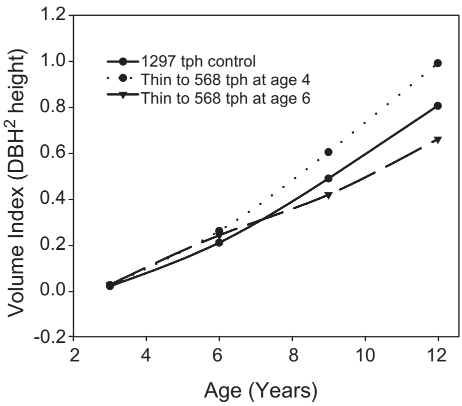

Figure 5. Volume Index by age for three plots planted at 1247tph; unthinned, and thinned to 568 at age 4 and age 6. Data is from HSC site #4201.

site so its generality is uncertain. The figure shows that a very early PCT (age 4) in a plantation at 1297 trees per ha (525 tpa) increased tree volume growth compared to no thinning or a thinning just a couple of years later. We have no clear explanation for this.

Effect of Planting Density and Site Quality on Height and Diameter of Red Alder Plantations

Following is a summary of results presented by Andrew Bluhm in poster form at the Silvicultural Options for Sustainable Management of Pacific Northwest Forests Symposium, March 5-6, 2002, Corvallis, OR. The full poster can be obtained by contacting Andrew Bluhm or David Hibbs.

This preliminary research explores some general principles between stand growth and density and site quality; principles that underlie many forest management practices. The first principle is that there is a ubiquitous negative relationship between density and diameter growth. Secondly, height growth is relatively insensitive to density. In fact, the most common method of determining site productivity, site index curves, is based on the later assumption. Third, that both diameter and height growth are positively correlated with site quality. Recently, however, some experimental results question the validity of these two principles (MacFarlene, et. al, 2000; Quicke, et. al, 1999; Scott, et. al, 1998). Therefore, the purpose of this study was to test 1) if managed plantations of red alder exhibit a negative relationship between diameter and density, 2) if height is independent of density, and 3) if both mean diameter and height of red alder plantations increase with increasing site quality (i.e. site index). There objectives were tested for both every tree in the plot and the 250 ??? at DBH trees per hectare (n.e. crop trees.)

Using red alder to explore these principles was desired because; 1) intensive management of red alder is in it's infancy and these relationships have yet to be tested, 2) an extremely large dataset is now currently available, spanning most of the species range, and 3) the extremely rapid juvenile growth rates of red alder result in this species moving through stand developmental stages very quickly.

Density Effects (see Table 5, Figure 6)

- ▲ Early in stand development, diameter increased with density, especially for crop trees. Then as stands aged, a negative relationship developed between density and diameter for all trees. However, by year nine, crop trees did not exhibit this relationship but trends indicate it may occur later in stand development. These responses indicate that managed stands of red alder benefit from high initial stocking and that these stands differentiate into crown classes very early in development with the larger trees maintaining similar diameter growth rates across a range of densities.

- ▲ A negative relationship existed between density and height. This relationship got stronger with age. However, the strengthening was more pronounced for all trees than for crop trees. This result is contrary to the general belief that height is independent of stand density.

Site Index Effects (see Table 6, Figure 6)

- ▲ Very early in stand development diameter and height were positively correlated with site index. However, this relationship weakened with age

Table 5. Effect of density class on dbh, ht, and lcr at age 3, 6, and 9 for red alder plantations. Percent is the 9 year percent of the highest density.

	All Trees											
	DBH (cm)				HT (m)				LCR (%)			
Density (tph)	3 year	6 year	9 year	%	3 year	6 year	9 year	%	3 year	6 year	9 year	%
294	2.28[a]	7.79[a]	14.10[a]	148	3.22[a]	6.52[a]	10.13[a]	86	0.80[a]	0.85[a]	0.85[a]	160
696	2.28[a]	8.20[a]	13.10[a]	138	3.24[a]	7.33[a,b]	10.62[a,b]	90	0.79[a]	0.85[a]	0.78[a]	147
1501	2.46[a]	7.71[a]	11.99[a,b]	126	3.52[a]	8.08[b]	12.58[b]	107	0.80[a]	0.77[b]	0.62[b]	117
2858	2.45[a]	6.78[a]	9.51[b]	—-	3.55[a]	8.13[b]	11.78[a,b]	—-	0.81[a]	0.68[c]	0.53[c]	—-

	Crop Trees											
	DBH (cm)				HT (m)				LCR (%)			
Density (tph)	3 year	6 year	9 year	%	3 year	6 year	9 year	%	3 year	6 year	9 year	%
294	2.39[a]	8.03[a]	14.67[a]	112	3.33[a]	6.65[a]	10.35[a]	78	0.81[a]	0.86[a]	0.86[a]	136
696	2.89[a,b]	9.83[a,b]	15.38[a]	117	3.78[a,b]	8.12[b]	11.67[a,b]	88	0.83[a]	0.88[a]	0.83[a]	132
1501	3.59[b,c]	10.19[b]	15.35[a]	117	4.42[a,b]	9.33[b,c]	14.17[c]	107	0.86[a]	0.84[a]	0.72[b]	114
2858	3.77[c]	9.42[a,b]	13.15[a]	—-	4.54[c]	9.57[c]	13.19[b,c]	—-	0.87[b]	0.77[b]	0.63[c]	—-

Means with the same letter did not significantly differ using Tukey's means separation test (alpha=0.05).

Table 6. Effect of site index class on dbh, ht, and lcr at age 3, 6, and 9 for red alder plantations. Percent is the 9 year percent of the highest site index class.

	All Trees											
	DBH (cm)				HT (m)				LCR (%)			
Site Index Class	3 year	6 year	9 year	%	3 year	6 year	9 year	%	3 year	6 year	9 year	%
Low (23-27m)	1.91^{a}	6.66^{a}	11.19^{a}	90	2.87^{a}	6.72^{a}	10.09^{a}	86	0.80^{a}	0.82^{a}	0.70^{a}	103
Medium (28-32m)	2.39^{a,b}	7.58^{a,b}	12.16^{a}	98	3.47^{b}	7.42^{a,b}	11.19^{a}	96	0.79^{a}	0.77^{a}	0.71^{a}	104
High (33+)	2.71^{b}	8.50^{b}	12.44^{a}	—-	3.66^{b}	8.35^{b}	11.69^{a}	—-	0.82^{a}	0.80^{a}	0.68^{a}	—-
	Crop Trees											
	DBH (cm)				HT (m)				LCR (%)			
Site Index Class	3 year	6 year	9 year	%	3 year	6 year	9 year	%	3 year	6 year	9 year	%
Low (23-27m)	2.65^{a}	8.34^{a}	13.32^{a}	87	3.59^{a}	7.66^{a}	11.12^{a}	86	0.84^{a}	0.86^{a}	0.75^{a}	100
Medium (28-32m)	3.14^{a,b}	9.23^{a,b}	14.41^{a}	94	4.02^{a,b}	8.31^{a,b}	12.10^{a}	93	0.83^{a}	0.82^{a}	0.77^{a}	103
High (33+)	3.63^{b}	10.47^{b}	15.24^{a}	—-	4.38^{b}	9.25^{b}	12.97^{a}	—-	0.86^{a}	0.84^{a}	0.75^{a}	—-

Means with the same letter did not significantly differ using Tukey's means separation test (alpha=0.05).

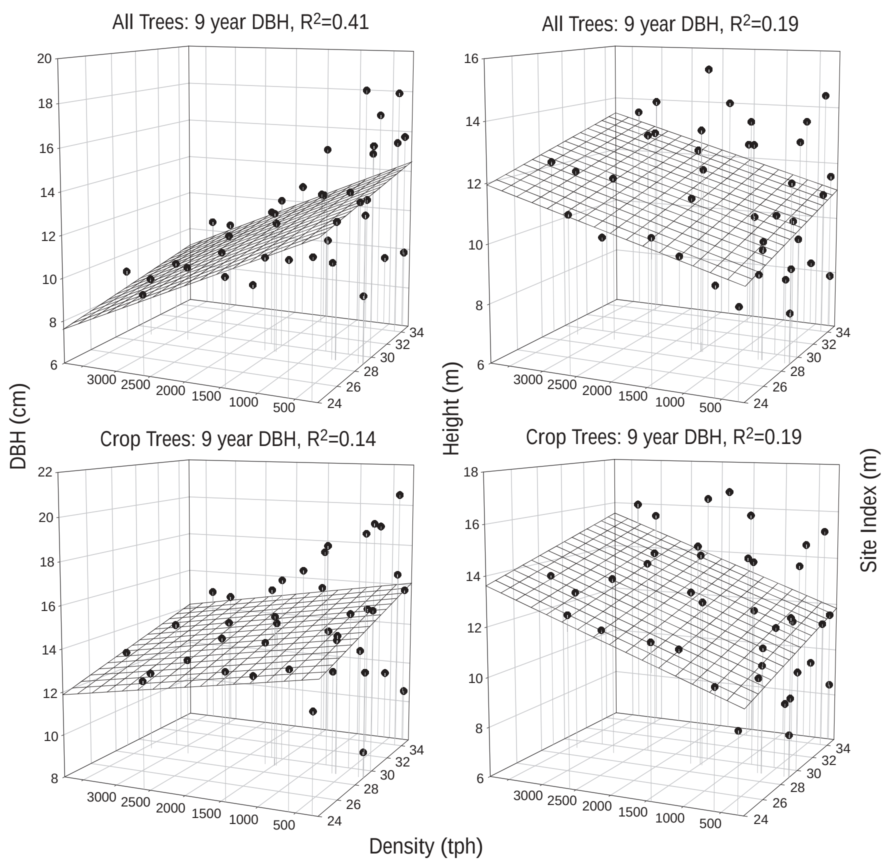

Figure 6. Relationships between dbh and height with density and site index for both all trees and crop trees at age 9.

for both all trees and crop trees- by year nine site index did not significantly effect either diameter or height. This result is contrary to what is generally believed in forest management and indicates that the growth of managed plantations of red alder is relatively independent of site quality.

Plantations Affect Site Index Curves

The following are results from data analysis conducted by Andrew Bluhm

What is site index?

Traditional site index curves have been developed for natural stands of red alder (Bishop et al., 1958; Worthington, et. al 1960), using a base age of 50 years, and with no data below 10 years of age. These curves do not capture the dynamics of rapid juvenile height growth of red alder and are therefore not applicable to short-rotation forestry. As a result, new site index curves have been developed for red alder in western Washington and Oregon using a base age of 20 years (Harrington and Curtis, 1986) and for British Columbia using a base age of 25 years (Nigh and Courtin, 1998). However, these curves are still only for natural stands, the influence of site quality on managed stands remains unknown.

How the quality of a site affects the growth of various species and the effect of successive rotations on site quality are relatively unclear. Since many red alder plantations are established on sites formerly occupied by other species, the site index curves of the previous species may not apply. To address this issue, Harrington (1986) developed a method of predicting site index based on soil-site characteristics. This system predicts site quality based on three factors: 1) geographic and topographic position, 2) soil moisture and aeration, and 3) soil fertility and physical condition. However, this system was developed using data from natural stands.

Actual data on the growth of planted red alder in relation to site productivity is limited and ambiguous. One, for very young stands the relationship of growth with site productivity may not be discernable. Two, changes in site quality with forest management and/or genetically improved plant materials are not well known (Harrington, 1986). Three, existing data is mostly from short-term, uncoordinated studies in which the type of site preparation, planting stock, planting density, vegetation control, etc. are not controlled/standardized.

Observed vs. Predicted Site Index

The objective of this research is to compare the height growth curves of red alder plantations with the site index curves from Harrington and Curtis (1986). Now that the HSC plantations are getting older (approximately half of the rotation age), we can compare our observed site index - how tall the trees are - with the predicted site index. The site index for ten HSC Type 2 installations was estimated using the soil-site method of Harrington (1986). These indices were then placed into three classes (low, SI=16.5m; medium, SI=19.0m; and high, SI=22.6m). For each class, the average height of the 100 largest trees per hectare was calculated at age 3, 6, and 9 and plotted against the 15, 20, and 25m site index classes from Harrington and Curtis (1986).

As Figure 7 illustrates, observed tree heights are greater than the predicted tree heights, especially for lower quality sites. Observed tree heights in the low and medium classes are approximately 2m taller than the predicted tree heights for the equivalent classes. Observed and predicted tree heights for the high site class are similar.

These differences could be explained by two general factors: 1) the errors associated with assigning a site index value using the soil-site method, 2) growth differences between plantations and natural stands (or a combination of both). In any event, it is clear that height growth benefits are achieved for managed plantations of red alder. These early benefits are good news for the forest manager. However, it is unknown whether these differences will last the entire rotation.

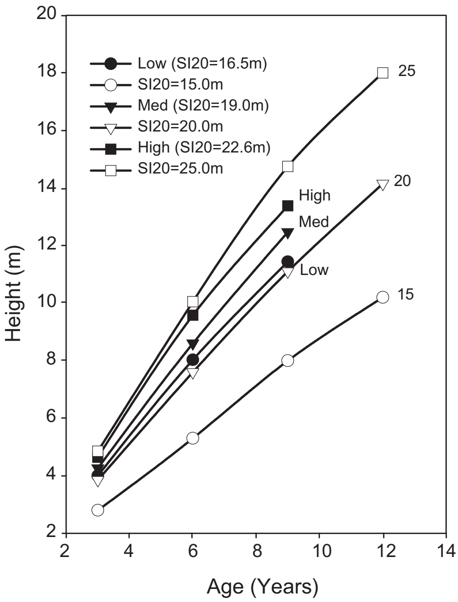

Figure 7. Comparison of low, medium, and high site index classes (base age 20 years, using the 100 largest trees per hectare) derived from red alder plantations across all planting densities with 15m, 20m, and 25m site index classes derived from natural red alder stands (from Harrington and Curtis, 1986).

Red alder Related Research Outside the HSC

Spatial interference dynamics in mixed red alder (*Alnus rubra* Bong.) and Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) stands

Anthony W. D'Amato, Klaus J. Puettmann, and David E. Hibbs, Department of Forest Science, Oregon State University.

The results of this experiment are part of a master's thesis.

Abstract

Forty-seven years of stand development in mixed red alder and Douglas-fir stands were evaluated to determine the long-term interference (i.e. competition and facilitation) dynamics in mixed red alder and Douglas-fir stands in western Oregon and Washington. Spatial measurements were analyzed to evaluate the influence of tree spatial arrangement on interference over time in sample stands. Thirty-eight years of stand measurements from a stem-mapped mixed red alder and Douglas-fir stand at Delezene Creek, WA were utilized. In addition, nine years of stand measurements from mixed red alder and Douglas-fir test plantations at the Cascade Head and H.J. Andrews Research Forests were also utilized. The fit of models incorporating various measures of interference were compared at different stages of stand development to determine the nature and degree of interference occurring in these stands.

Competitive interactions in young Douglas-fir/red alder mixtures: implications for wood quality

Amy Grotta, Department of Forest Science, Oregon State University.

The results of this experiment are part of a master's thesis.

Abstract

Douglas-fir and red alder commonly regenerate and occupy the same sites in the Pacific Northwest. Interactions between these species can be

competitive, facilitative, or a combination of both over time. A number of factors have recently led to increased interest in managing these two species in mixture for commercial production, and ongoing investigations are yielding important information about how interactions between the two species affect stand structure and productivity.

Many wood quality attributes are ultimately controlled by physiological processes, which in turn are affected by competition within a forest stand. This research addresses how stand structure in young, mixed red alder/Douglas-fir plantations is associated with variations in stem form, knot size and distribution, and the phenology of wood formation. With better information about such implications for wood quality, forest managers will be able to make more informed choices about management of red alder and Douglas-fir mixtures.

Tolerance of red alder to various herbicides when applied at three timings and two rates

Doug Belz, WA DNR.

Following is a summary of the preliminary results from a red alder phytotoxicity trial established near Chehalis, WA.

WARNING: This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and Federal agencies before they can be recommended.

Summary

In the past, research has focused on which herbicides result in good control of red alder. Currently, however, the ability to establish and maintain a plantation of red alder is increasing in importance for many reasons (e.g., wood production, species diversity, riparian protection), and today, herbicide use is often critical in the successful establishment of plantations. Therefore, the objective of this study was to determine the tolerance of red alder seedlings to various herbicides, timings, and rates. Eight herbicides (atrazine, azafenidin, glyphosate, hexazinone, imazapyr,

metsulfuron, sulfometuron, and thiazopyr) plus a control (no herbicide) were applied at two rates (the operational rate and 2 times the operational rate) at three different times (fall, before planting; early spring, 3 weeks before planting; and late spring, 1 week after planting) for a total of 54 (9x2x3) treatments. Sixteen red alder seedlings (1+0) were planted per treatment and total height, basal diameter, mortality, damage (on a scale of 0-5) were measured at the end of the first growing season as well as cover; percent and size, total and by species.

Results included:

- The best treatment (as measured by tall trees and short weeds) was metsulfuron (i.e. Escort). The rate and timing had little influence.
- The control, glyphosate (Accord, Roundup), azafenidin (Milestone) and thiazopyr (Visor) resulted in little damage (or height loss) to red alder but also had little effect on weed size and abundance).
- Imazapyr (Arsenal) and hexazinone (Velpar) had great weed control but also killed the red alder.

The upshot of all this is that Escort (metsulfuron) is clearly the best herbicide to use in red alder establishment. This result is also backed up by research by DuPont and WeyCo. in the Coast and Longview areas. Subsequently, DuPont is pursuing the registration of Escort for use on red alder.

Effect of thinning on red alder tree form and volume

Glenn Ahrens, OSU Extension Forester, Astoria, OR.

The following is a continuation of a previous study: Hibbs, D.E., W.H. Emmingham, and M.C. Bondi. 1989. Thinning red alder: Effects of method and spacing. Forest Science Vol. 35(1), pps. 16-29.

Abstract

The effect of thinning type and spacing on individual tree form and volume of red alder is being investigated. A 35-year-old (originating in

1967), natural stand of red alder was thinned at age 14 (1981). Please refer to the above manuscript for experimental design and treatment specifications. In the spring of 2002 (21 years after thinning), the breast height diameter was re-measured on all trees and diameter at 32 feet, total height, height to a 6-inch top, and height to base of the live crown was measured on a sample of at least 20 trees per plot (0.2-ac plots). The data will be used to test the differences in the method and spacing of thinning on various aspects of merchantable log volume and economic returns. Specific aspects may include effects of thinning on the size and total number of logs, Girard form class, length of branch-free bole, volume per acre by log grade, etc. These estimates then can be combined with market prices and logging costs to derive the economic value of thinned natural red alder stands. The density and condition of inter-mixed conifers will also be investigated in a separate study examining management options for residual conifers after removal of the red alder.

Direction for 2003

The specific goals for 2003 are a continuation of our long-term objectives:

- Continue treatment and measurement of Red Alder Stand Management Study installations.
- Continue working with the BC Ministry of Forests in developing a red alder growth model.
- Work with the Washington Hardwood Commission and Weyerhaeuser Company to organize support for additional red alder growth modeling efforts.
- Publish the results of "Testing assumptions of site quality and planting density on tree height and diameter", "Tolerance of red alder to various herbicides when applied at three timings and two rates", and "Effects of thining on re alder tree form and volume".
- Continue efforts to recruit new members.

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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, June 5-7, 2001, Vancouver Island, BC

Tuesday June 5, 2001:

Attendees: Dave Hibbs and Andrew Bluhm- OSU; Paul Courtin, Kevin Brown, Mark Palmer, Peter Poland, and Larry Sigurdson- BC Ministry of Forests; Dale Anders- ODF; Norm Anderson- WA DNR; Floyd Freeman and Larry Larsen- BLM; Karl Buermeyer and Connie Harrington- PNW, Olympia, WA; John Johansen- USFS; Neil Hughs- WeyCo.

The summer 2001 meeting began in Port Alberni, BC. The first stop was an HSC Type II site called Lucky Creek (#1202). We discussed various topics including the rounded/globular shape of the crowns (possibly indicating a loss of apical dominance) and the strange deformity of some of the trees that is either genetic or caused by a virus. Approximately 3% of the trees are deformed and no one knows what it is or why it occurs here. The topic of pruning was also brought up. The trees in this plot seemed to be healing over the pruning wound slower than normal. The timing of pruning was discussed. Connie Harrington summarized her pruning study in which she found the worst time to prune was in January or February, but overall, the timing did not make that much difference in the incidence of rot. She also wondered if live branch pruning would heal over faster than dead branch pruning so she deliberately wounded dead branch collars. However, no significant increase in healing was detected.

Then, as we walked through the installation, both Paul Courtin and Karl Buyermeyer explained that this site is underlain by heavy duff and overlying fingers of colluvium. Both of these conditions are not great for red alder growth and is most likely causing the differential growth and mortality found here. Kevin Brown commented on the different ‘type’ of leaves found here. Some patches were small and chlorotic with brown spots on them and others were the ‘normal’ looking red alder leaf. It was brought up that maybe there is some nutrient limitation here, and that it may be a good topic for future investigation.

After lunch we met up with Louise De Montigny who showed the group around a mixed species planting trial. Although red alder was not one of the study species, the group was still amazed at the scope and breadth of the study and the growth characteristics of the component species. The Douglas-fir had great survival and grew well but had a very poor form (knotty). It seems this site is too wet and rich. The Sitka spruce looked great and had the greatest total volume of all the species. Port Orford cedar had massive diameters, but a short height with lots of limbs and forks. The understory beneath this species was noticeably darker. The grand fir looked good and the Amabilis fir was off site- it grew poorly and had large blisters on the trunk. The original western hemlock stock was poor and had very low survival. Therefore, naturals were allowed to come in but the growth results still show western hemlock as a poor performer. However, Louise has looked at the surrounding stands and has concluded that this species would have done great if planted with healthy stock. The western red-cedar source was also collected off site. However, members brought up that this should not matter that much because its genetic variability is low. The understory beneath the western red-cedar was significantly different than the others and had very little cover and a much lower number of wood decomposers. Louise then discussed the distribution of the understory species. Salmonberry occurred almost always in the depressions while salal was found on the humps. The two species rarely mix. If salmonberry cover was greater than 20% then salal was never more than 10%, and vice versa. Also, a strong (r-square=0.70) negative linear relationship was detected between total tree cover and total understory cover.

Wednesday June 6, 2001:

Attendees: Dave Hibbs and Andrew Bluhm- OSU; Paul Courtin, Kevin Brown, and Larry Sigurdson- BC Ministry of Forests; Dale Anders- ODF; Norm Anderson- WA DNR; Floyd Freeman and Larry Larsen- BLM; Karl Buermeyer and Connie Harrington- PNW, Olympia, WA; John Johansen- USFS; Neil Hughs-WeyCo.

The meeting was held in Uclulet, looking out over a misty fleet of fishing boats. Dave Hibbs welcomed all of the attendees and Andrew Bluhm summarized the Winter 2001 fieldwork. We finished all of the scheduled fieldwork on 13 sites. Compared to other years, this last years' workload is lower than most. Next year (Winter 2002) will be a busier year (with approximately 16 sites to do). Andrew then indicated that, unlike last year, he would not be able to get to every site, every day. Instead, he will schedule and organize the fieldwork, and try to be at every site the first day or two to answer questions and to get data collection started.

As always, the orphaned sites are problematic. However the good news is that there is only one orphaned site to measure this winter. In addition, the amount of time required for the field measurements should decrease with time because: 1) most tags are now stapled to the trunk, 2) with each thinning treatment the number of trees to measure decreases, and 3) some plots are now entering a longer measurement cycle.

Andrew then presented a bar chart illustrating the progress of our Type II installations. What was impressive about the chart was that the HSC has collected more than half of the total data. Furthermore, during the next two years, all of the sites will have had their first thin treatment and the sixth year measure and 19 of the 26 installations will have their ninth year measure.

The next presentation was by Kevin Brown, who has worked six years with the BC Ministry of Forests. His original job description was as a hardwood physiologist; however he has taken an interest in tree, especially red alder, fertilization. The topic of his presentation was 'Effects of differences in P nutrition on growth of red alder'. He brought up many interesting ideas that sparked discussions within the group. He did a superb job summarizing the often-inconsistent results of red alder fertilization trials and hopefully we will learn much from his upcoming data.

Neil Hughs, with Northwest Hardwoods (NWH) and formerly with Coast Mountain Hardwoods (CMH), discussed red alder utilization in British Columbia. His discussion was divided into five areas: 1) Geographical distribution of red alder in BC, 2) history and operation of the mill, 3) supplying the mill, 4) management of red alder, and 5) the future of red alder production in BC. Following is a summary of his presentation.

Approximately 14% of North America's red alder resource is in coastal BC with an estimated volume of 33.4 million m^3. The primary area for red alder production occurs throughout the Coastal Western Hemlock Biogeoclimatic Zone ranging from the very dry maritime subzone (CWHxm), the submontane very wet maritime variant (CWHvm1), and the southern dry submaritime variant (CWHds1).

The mill that Neil is currently responsible for supplying is in Delta, BC, an old hemlock mill that was converted to red alder in 1988. Currently, the mill uses 90% red alder, 10% maple, and a small but increasing amount of birch. The mill produces a full range of grades and products and has a capacity of 200,000 m^3 /year. In 1999, the mill produced 43 million board feet of lumber making it the largest hardwood mill in Canada. As with all mills, a guaranteed supply of wood is crucial. The log supply comes from private owners, small business licenses, and major forest licenses. In 1996, four new licenses were awarded to the mill with a total volume of 135,000 m^3 /year. These licenses were 15 year non-replaceable, did not require a conversion from deciduous to coniferous trees, and required a 50% hardwood component by cruise.

The large hardwood component required by the license makes finding the wood difficult. A large number of people are required to delineate these forest types using forest cover maps, aerial surveys, and ground truthing. Procurement problems include: low volumes per hectare, difficult locations often requiring the use of boats, decadent stands and poor wood quality (red heart in red alder and maple decay being the most serious defects), and constrained operations due to riparian protections and the Forest Practices Code. Harvest blocks are very irregularly shaped and usually about 10 ha in size. Operable stands are hard to find. They need to contain a minimum volume of 230-250 m^3 /ha (28cm minimum DBH to a 15cm top), have low incidences of red heart, and have reasonable access. Harvesting is difficult because red alder falls with the lean (i.e. no directional falling), and work is usually under winter conditions to fill in gaps in supply.

The management of red alder in BC is a relatively recent event. Traditionally it was desired to convert deciduous stands to coniferous stands and it was not considered worthwhile to manage for hardwoods on Crown land. However, CMH pushed to promote red alder. They persuaded BC Ministry staff to visit WeyCo. red alder operations in the US and afterwards, the Ministry decided to establish 500 ha in five years in the Vancouver region (appx. 30% of the area logged each year). In it's infancy, the management of red alder by CMH had its problems. These were overcome by experience, and according to Neil, by "ruthlessly copying" everything the HSC and the BC ministry have done. They quickly learned to avoid poor planting stock and to effectively prepare the site through brushing and/or the use of herbicides. However, herbicide use is fairly restricted due to the controversial nature of herbicides perceived by the Canadian public. They can only easily use herbicides on 50% of their plantations. Other damaging agents include sunscald, frost, deer/elk, bark beetles, and voles. In establishing red alder, they very rarely use natural regeneration except in areas of pure mineral soil, and their target density is 1,600 trees per hectare (648 trees per acre) with a minimum of 1,100 tph (445 tpa). To date, Neil has never achieved 100% stocking.

The future of red alder management in BC looks promising. In addition to conifer production, red alder production can increase timber supplies, increase biodiversity, provide quick cover in 'viewsheds', and generally create a more "diversified portfolio". NWH's position is that now is the time to produce a provincial management plan for red alder. They believe they're taking the initiative by planting 280 ha/year, soon to be 500 ha/year. However, Neil wants to plant more red alder to keep production sustainable. Therefore, NWH has an intensive nursery program. They are improving the location and timing of seed collection, *Frankia* inoculation techniques, and nursery operations. All of this has resulted in better germination rates and seedling vigor allowing more successful plantation establishment and an increase of red alder on the landscape.

Dave informed the members that the modeling process is still underway. We are working with George Harper of the B.C. Ministry of Forests to use their TASS model. In addition, WeyCo. has also approached Dave to try to develop another more interactive model.

Dave then stated he has not been able to recruit a student to work on a specific aspect of the red alder dataset.

As far as the measurement cycle goes, we decided that the Type I sites would switch to a five-year measurement interval after year nine and the Type II and III sites after year twelve.

Connie Harrington suggested that everyone should think about the limited budget and try to decide if we want to keep the same formula for running the HSC or to shift strategies.

Dale Anders asked if there is a potential market for red alder pulpwood because he has a stand needing a precommercial thin and he would like to get some return out of the activity. Most members did not really have an answer to this but Neil Hughs stated that there was a market for red alder pulpwood cut in Canada to be trucked to the US, but not anymore. Dave then indicated that mill utilization is always changing and that minimum usable size is decreasing.

John Johansen, followed by Paul Courtin, asked if there is anything to be done about roadside red alder. Specifically, what are it's effects on adjacent conifer plantations and is there any worth in these stands. John says he has been considering thinning many of his roadside stands to increase growth and to make it easier to log them later.

Dave then asked if there were any specific areas of interest where Andrew could spend some time analyzing the data. Three topics were identified. 1) Using the 3-year data, could we develop a table of 'benchmarks' by site index? 2) What is a 'successful' or 'failed' plantation and what were the best site preparation/herbicide treatments used for a successful plantation establishment? 3) What is the response of the understory to our thinning treatments and conversely, what is the effect of the understory on the thinning response we observe? Dave and Andrew will discuss this idea further and start investigating these topics.

Dave then presented the budget. He indicated that because membership in the HSC has remained steady, the HSC remains fiscally stable.

The Winter 2002 committee meeting will be held in Longview, WA area January 8-9. There are numerous HSC sites to visit in the region and the committee can measure one of our orphaned sites near there.

It was also suggested that the HSC should start thinking about another red alder conference. The first conference raised awareness of red alder management. We had information on nursery practices and stand establishment. For this next one, we should have data on growth and treatment responses. Connie suggested that if we can decide on a date well in advance then people could/would start pulling it together. After some discussion it was decided to shoot for a conference in Corvallis, OR, June 2003.

The group then visited a maple site just outside Port Alberni. Mark Palmer led us through the site and provided a handout describing the experiment. Everyone in the group seemed very interested in what we currently know (or do not know) about maple management and discussions could be heard throughout as we wandered through the treatments.

Thursday June 7, 2001:

Attendees: Dave Hibbs and Andrew Bluhm- OSU; Paul Courtin and Louise de Montigny- BC Ministry of Forests; Norm Anderson- WA DNR; Floyd Freeman and Larry Larsen- BLM; Karl Buermeyer and Connie Harrington- PNW, Olympia, WA; John Johansen- USFS; Neil Hughs- WeyCo.

The day started off just outside Campbell River in the Sayward forest. Louise started us off by indicating this forest is all one, even-aged stand as the result of an 800,000 (?) ha fire. It is set aside to develop alternative silvicultural practices. One of these studies is the STEMS project (Silviculture Treatments for Ecosystem Management). This experiment is an extremely large, long term study designed to investigate the stand dynamics following seven different cutting regimes (see the attached handout). The experiment covers a total of 140 ha, the area was cruised with a 10% sample and a total of 141 measurement plots were established. Every unit has been marked and logging will commence this fall. Louise showed us around a few of the units and topics of discussion included:

Dave noted that the leaf area of the Douglas fir seemed a little lower than that in more southern forests and that it reminded him of Swiss needle cast. Louise did not seem familiar with this disease and indicated that this disease was not present on the island. Floyd then pulled out the hand lens and soon found evidence of some parenthecia but not enough to cause concern. Paul Courtin noted that we were just 100 miles short of the northern limit of Douglas-fir on the coast.

The nest stop was another HSC Type II site called Mohun Creek (#4203). Unlike the first HSC site we visited, this stand was farther along in development and had a nice trail winding through it. The first stop was the prune plot in which the trees looked good, most still with strong apical dominance. We then looked at a plot planted to 525 tpa and thinned to 230 tpa. Neil then asked how the HSC chose the planting densities. Dave responded that we were interested in a wide range of densities for modeling purposes and the chosen values are an approximate log division of this range. Neil also asked why was 230tpa chosen as the residual density; which Dave said seemed to be a desired density to carry to rotation and that this residual density matched one of the initial planting densities and would allow strong comparisons between the two. It was also noticed that salmonberry was not only present on this unit but in almost all red alder stands throughout the Pacific Northwest. Where did all of this come from? Why are red alder and salmonberry seemingly always together? Paul and Karl then pointed out that this stand was swordfern before and during the red alder establishment but now is completely dominated by salmonberry in every planting density. The last stop was at a plot planted to 1200 tpa and thinned just a few months ago down to 230 tpa. Immediately adjacent to it was an unthinned stand of the same density and the visual contrast was striking. Connie commented that the live crown ratio here was too low (i.e. less than 50%) according to the HSC criteria (always keep at least 60% live crown) and therefore that it was thinned a little too late. Sapsucker damage was also noticed but no one in the group knew how to predict or limit the damage.

Just across the road from this site was an operational planting of Neil's (NWH). It is an red alder after red alder planting, entering its third year. He is very concerned about this site because of a high incidence of the red alder bark beetle (Alniphagus aspericollis). This beetle is boring into the leaf axils, weakening many of the stems, and therefore causing a lot of forking and slowing growth. He knows that these beetles can build up large populations in the slash and that the best way to prevent the problem is to delay planting for one year and let the slash decompose. But this then results in a big salmonberry problem due to the restrictions placed on herbicide use.

The last stop of the summer meeting was at Pacific Regeneration Technologies (PRT). This is a privately owned nursery specializing in operational planting stock. Bert Fleming, of PRT, explained that this nursery was self-owned since 1988 as a result of privatization. PRT produces 150 million seedlings annually and has about 20% of the total greenhouse space, making it the largest of the thirteen Canadian nurseries. This particular nursery produces 12 million seedlings annually and is currently growing the fourth crop of red alder for NWH (200-250,000 seedlings next spring).

For red alder, they grow W + W plugs which require one year from the time of sowing to planting. They use two seed lots, Bowser and Powell River, contract out the seed extraction and germination tests are provided. They sow two seeds per plug, usually in the middle of

March, and use 60ml plugs (3 x 10cm) filled with sphagnum peat. In the past, they inoculated the plugs by adding *Frankia* into the irrigation system but no longer do so. They try to keep the seedlings wet. However, it is difficult to be sure water gets into every plug due to the 'umbrella' effect of the leaves. Therefore they found that by letting the leaves wilt and droop down, watering is more uniform. Furthermore, by letting the plugs dry down, they get better root development. They closely monitor growth and, if necessary, fertilize with 50-100 ppm N. Transplanting is a difficult process and instead of size being the criteria for transplanting, their goal is to get the plugs to an 'extractable stage' where the roots will firmly hold the media. This criterion determines the transplanting date, usually around July 1st and the seedlings are usually about 10cm tall. They extract the plugs using a pin extractor and have unsuccessfully tried various transplant machines. Instead, they transplant by hand, under overcast conditions. It is a labor-intensive process but they hire a crew of 25 people and each can plant 3-4,000/person/day. The approximate bed density is 86/m^2 (8/ft^2). They do not inoculate the beds with *Frankia*. However, they try to use the same beds for red alder year after year and are considering switching from actively inoculating in the greenhouse to passively inoculating in the beds. *Septoria* is a common problem in the beds and they use fungicide once a month. Dave suggested to as a way to reduce cost they could use fungicide once *Septoria* is found, instead of proactively spraying. The seedlings are observed to go through a growth spurt in August/September and the goal is a 60 cm tall seedling. They are left in the beds until January, frozen, and outplanted in the end of March, beginning of April.

The summer 2001 meeting ended looking over a huge, green carpet of healthy red alder seedlings; a poignant reminder to all of us that, yes, the future of red alder management is promising.

Winter Management Committee Meeting, January 8-9, 2002, Kelso, WA

Tuesday January 8, 2002:

Attendees: Dave Hibbs and Andrew Bluhm- OSU; Paul Courtin- BC Ministry of Forests; Dale Anders- ODF; Norm Anderson, Doug Belz and Tony Ramirez- WA DNR; Floyd Freeman, Larry Larsen and Jeanette Griese- BLM; Connie Harrington- PNW, Olympia, WA; Robert Deal- PNW, Portland, OR; John Johansen- USFS; Rod Meade-WeyCo.; Del Fisher- Washington Hardwood Commission; Jim Plampin-Quinault Indian Nation; Paul Kriegel-Goodyear Nelson.

The meeting was heldin Kelso, WA. Dave Hibbs welcomed all of the attendees. It was a large group for a winter meeting: seventeen people in all. As introductions went around the room, some of the new faces in the crowd explained their interests and why they were attending. Tony Ramirez who works for the Webster nursery was interested in increasing (and improving) the production of red alder nursery stock. What is the feasibility of growing red alder? Can we grow bareroots, or plug 1/2s? What is the best way to store red alder seedlings? Jeanette Griese,just moved up to the Portland office from Southern Oregon and may have future dealings with the HSC. Robert Deal is interested in mixed conifer and hardwood stands. Jim Plampin stated there is a desire to more actively manage red alder on the Quinault and was interested in a red alder growth model as well.

Andrew Bluhm updated the group on modeling efforts and summarized the Winter 2002 fieldwork. As previously decided, all of the Type 2 data was cleaned, formatted, and sent up to BC Ministry of Forests to be used to develop an red alder model. George Harper has been busy with preliminary analysis of both this dataset and a dataset of older, naturally regenerated red alder. He has made several trial runs with the datasets in TASS and (as of December) has been looking at the discrepancies between the datasets and the model output. The original TASS model was developed for conifers and it is a big job to apply the model to hardwoods. George and his colleagues are busy with the conceptual differences between red alder growth and conifer growth. Their hope is that once these differences are understood and quantified, TASS can be modified to produce accurate results. However, there is and always ahs been a big demand in British Columbia for TASS runs, and currently the management and modeling of quaking aspen has become a priority. Progress has been made, and when Andrew went up to Victoria to see George he was impressed with the amount of work that has been accomplished.

Andrew then went over fieldwork. There is fieldwork scheduled on 12 Type 2 sites and 1 Type 3 site. All of the work has been scheduled and should be completed by the middle of February. A large portion of the work is on WeyCo. land and Rod Meade, Del Fisher and Dave Sweitzer were very accommodating in providing access and crews to complete the work. There was only one orphaned site to measure this winter. Next year will be even busier and Andrew indicated that he might not be able to get to every site, every day.

Andrew then presented tables illustrating the progress of our data collection. What was impressive about the charts was that the HSC has collected well more than half of the total data. The days of stand establishment are well over and it’s time to start thinking about the future.

The future is what was discussed next. The main topic was modeling. Who's doing it? How long will it take? How much will it cost? Del Fisher, commissioner of the WA Hardwood Commission, is instrumental in encouraging the management of red alder. He believes a growth model is needed. He said there has been a strong push in WA to develop a public model and rumor has it that one may get developed by later this year. There has been talk with the Stand Management Cooperative (SMC) to do the actual modeling and talk with WeyCo. concerning the release of proprietary data. According to Del, WeyCo. has agreed to release some data and that it is now just a matter of finding someone to clean the data, do the actual modeling and finding funds. Del asked the group if it was feasible to get a final model by the end of the year for less than $40,000. The general consensus was that it would take much longer and run closer to $200,000. Some members of the group asked why the SMC and not the HSC. Reasons include that the SMC already developed a model for hemlock, it has 2 full time programmers, and that all members would accept this group. Dave Hibbs expressed his opinion that the modeling effort, whatever it may turn out to be in the future, should have the HSC involved (due to their expertise in red alder), and could be a hybrid of both groups. Many people in the group agreed with this.

The only other issue that came up was the request that the HSC should purchase a GPS unit. Doug Belz pushed this idea and indicated that it would be much easier to find the plots in the future (with changing roads and personnel) and easier to find start corners. It was agreed that we should buy one and Dave and Andrew will look into which one to buy.

Dave Hibbs then presented a talk titled "Density Effects and Red Alder". Included are copies of his slides. Some of his main points included:

1) Early in stand development (age 3) density had no effect on tree height. However, by year 9 tree height was greater in the 2 highest densities (525 and 1200tpa) both for all trees and crop trees (the largest 100tpa).

2) When the Type 2 sites were broken into 3 site index classes (base age 20 years) with all densities pooled, and the heights were compared to the site index curves of natural stands presented in Harrington and Curtis (1986), the heights from our planted stands were consistently greater, especially for the low and medium site classes.

3) Along the same lines as #2, if we plot predicted vs. observed heights by density, our observed heights are consistently greater than predicted heights.

4) Early in stand development (age 3) density had no effect on tree diameter. However, by year 9 tree diameter was inversely related to density (as density

increases, diameter decreases) especially for all trees in the plot.

5) The length of the live crown, a commonly used predictor of tree response after thinning, was greater than 6m for all trees and 8m for crop trees at age 9 across all densities. Likewise, liver crown ratio at age 9 was greater than 0.5 for all trees and 0.6 for crop trees. This seems to indicate that by age 9 there would still be a growth response of red alder following thinning.

6) Following the early thinning treatment (when the base of the live crown starts to recede) there is a positive diameter response and a negative height response for the 525tpa and 1200 tpa densities. However, just how long these responses will last is unclear.

Following a break, Doug Belz (WA DNR) presented preliminary results from a red alder phytotoxicity trial he established near Chehalis, WA. Some of his main points included:

1) Eight herbicides (plus a control) were applied at two rates (the operational rate and 2 times the operational rate) at three different times (fall, before planting; early spring, 3 weeks before planting; and late spring, 1 week after planting) for a total of 54 (9x2x3) treatments.

2) 16 red alder seedlings (1+0) were planted per treatment and total height, basal diameter, mortality, damage (on a scale of 0-5) were measured at the end of the first growing season as well as cover; percent and size, total and by species.

3) The best treatment (as measured by tall trees and short weeds) was metsulfuron (i.e. Escort). The rate and timing had little influence.

4) The control, glyphosate (Accord, Roundup), azafenidin (Milestone) and thiazopyr (Visor) resulted in little damage (or height loss) to red alder but also had little effect on weed size and abundance).

5) Imazapyr (Arsenal) and hexazinoe (Velpar) had great weed control but also killed the red alder.

The upshot of all this is that Escort is clearly the best herbicide to use in red alder establishment. This result is also backed up by research by DuPont and WeyCo. in the Coast and Longview areas. Subsequently, DuPont is pursuing the registration of Escort for use on red alder.

Also of interst is that it was asked what works best on Himalyian blackberries (Escort) and salal (Chopper, oil soluble Arsenal).

After lunch, the group went to an HSC Type II site called Shamu (#3205), age 10 years old managed by the Oregon Department of Forestry (ODF). Andrew passed out information and maps of the site. Of primary interest to Andrew and of the group was what the treatment of thinning down to 100tpa from 1200tpa looked like (treatment #12). This is a very severe thin (leaving only 8% of the trees). This treatment is relatively new to the HSC and is the substitute for treatment #11 (1200tpa thinned to 230tpa when HLC=30ft). This plot was thinned 2 years ago in the winter of 1999-2000. What came as much surprise to everyone was the fact that there seemed to be no post-thinning damage. There were not any broken tops or uprooting. In fact, the plot looked very good. A myth that the HSC is slowly disproving is that red alder is very susceptible to windthrow (or ice damage) after thinning. Although it can happen, there has been only one instance in the HSC plots. This occurred on a West-facing slope, right on the coast in LaPush, WA. Within the next two years the HSC will have growth data from a handful of plots with this treatment.

We next went down hill and looked at the 525tpa control (treatment #4) and the 525tpa thinned to 230 tpa at age 8 (treatment #6). Both of these plots are growing very well and have nice tree form. Many in the group believe that treatment #6 is very close to what may be desired in future operational management of red alder. In fact, WeyCo., who plant approximately 10% of their WA land into red alder, uses a similar planting density, residual density, and timing of thin. Walking back uphill we looked at the 525tpa thinned to 230 tpa at age 5 (treatment #5). These trees were also pretty big, but they had poor form, with large, low branches.

Our last stop at this site was in the 230tpa prune plot (treatment #3). From a distance, this plot is inviting aesthetically pleasing; very little brush, nicely spaced, and clear, straight boles up to 4m.

At closer look we discovered some sunscald issues on edge trees and that it has been two years since the last lift and wounds have yet to heal over due to that large size of the pruned branches.

Our final stop of the day was not at a hardwood site, but at a site of potential interest to any forest manager in the Pacific Northwest. The site was on the Blodgett forest (owned and operated by OSU) and is an experiment by Dr. Michael Newton. His experiment is investigating the response of both overstory and understory trees in thinned stands of 50-60 year old Douglas-fir. The experiment is repeated both at the Blodgett forest and the MacDonald State forest. At the Blodgett site there are 3 levels of overstory thinning, each with a uniform and a ‘gappy’ distribution (3 levels x 2 distbs.=6 plots) replicated 3 times for a total of 18, 6 acre plots. Each of these plots is split into two more treatments, one with chemical site preparation and one untreated. Douglas-fir, western redcedar, western hemlock, and grand fir were planted in all of the plots. This is a very ambitious experiment and will address the needs of forest managers wanting to accelerate old-growth characteristics or follow structure-based management. Dr. Newton presented 11 rules-of-thumb when it comes to thinning and underplanting:

1) If a land manager is very motivated, the creation and management of 2 storied stands is possible, but much more difficult than 1 storied stands.

2) Keep the overstory cover low enough so the planted, intolerant Douglas-fir seedlings will not die.

3) However, to achieve #2 (low overstory cover) overstory growth will be reduced.

4) Furthermore, to achieve #2, repeat thinnings will be necessary.

5) Every thinning entry will damage understory trees.

6) Good, healthy growing stock is essential for understory survival and growth.

7) Protection of seedlings may be necessary due to heavy deer/elk browse.

8) Western hemlock and grand fir are more tolerant of shade and are less browsed than Douglas-fir or western red cedar.

9) Pre-harvest chemical treatment is more important/effective when there is existing, heavy brush.

10) Planted seedlings grow better in gaps than in uniform distributions but still have to compete with the naturally regenerated western hemlock.

11) Overstory trees in gappy distributions utilize light better than overstory trees in uniform distributions.

Wednesday January 9, 2002:

Today was reserved to measure the HSC Type 2 installation #3210 on OSU property. Many of the group from the previous day had conflicts so only about 10 people made it out to the field. This site, according to the file notes, was supposedly ready for its first thinning treatment and pruning lift. However, Andrew visited the site earlier and found that growth is poor and therefore the site is not ready for treatments. The poor growth seemed to be attributable to the south facing aspect, heavy salal cover and heavy elk damage. This did not deter the group from performing the necessary plot maintenance activities of retagging the trees. In addition, the buffers were flagged and the ‘leave’ trees were marked for the plots needing treatments. These activities will save a lot of time for next years work.

Dave and Andrew hope that this meeting was informational and would like to thank all the people who attended. For those that came, and those that could not, we hope to see everyone at the next summer meeting, July 10-11, 2002 in the Wind River area.

Appendix 3

Financial Support Received in 2001-2002

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
USDA Forest Service PNW Station		In kind
Washington Department of Natural Resources		$8,500
Washington Hardwood Commission		$8,500
	Subtotal	$55,500
Forestry Research Laboratory		$51,483
	Total	$106,983