Hardwood Silviculture Cooperative
Annual Report 2016

Staff

Glenn Ahrens
HSC Program Director
OSU Extension Forester
Email: glenn.ahrens@oregonstate.edu
Clackamas County Extension
200 Warner-Milne Rd.
Oregon City, OR 97045

Andrew A. Bluhm
Associate Program Director
Email: Andrew.Bluhm@oregonstate.edu
Department of Forest Ecosystems and Society
College of Forestry
321 Richardson Hall
Oregon State University
Corvallis, OR. 97331-5752
(541) 737-6100
http://hsc.forestry.oregonstate.edu/

Highlights of 2016

- Five more 22nd year measurements were collected on the Type 2 installations (variable-density red alder plantation), bringing the total to 19 of the 26 installations with 22 year data.
- Nineteen of the 26 Type 2 installations have had all treatments completed.
- Three more 22nd year measurements were collected on the Type 3 installations (red alder/Douglas-fir species mixtures), bringing the total to 4 of the 7 installations with 22 year data.
- Additional field data on tree taper was collected. The data was collected from the 26-year-old Clear Lake Hill Type 2 installation.
- Refitting of the taper equation with additional data was done by Aaron Weiskittel, at the University of Maine. Preliminary results indicate that even though older and larger trees were added to the dataset, the original equation was the best for predicting total stem volume.
- The HSC contributed to, and presented results at, a guided tour of red alder plantations organized by the Washington Hardwood Commission (WHC). "An Alder Day in the Woods" was held on Weyerhaeuser property and led by (now retired) Weyerhaeuser research forester Alex Dobkowski. The tour covered most aspects of intensively managed red alder plantation activities including site selection, planting stock, soil site index vs. expressed site index, pre-commercial thinning, commercial thinning, etc.
- Efforts were undertaken by the HSC to determine the feasibility, timing, and funding of a project to update RAP-ORGANON with additional, older tree data.

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

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

The HSC has also established seven mixed species plantations of red alder and Douglas-fir. They are located on land designated as Douglas-fir site class III or below. Each plantation is planted with 300 trees per acre with five proportions of the two species. The site layout is designed to look at the interactions between the two species. We are finding that in low proportions and when soil nitrogen is limited, red alder may 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 through time 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://hsc.forestry.oregonstate.edu 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 management on red alder growth and yield, and wood quality and to develop red alder growth and yield models.

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.

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).

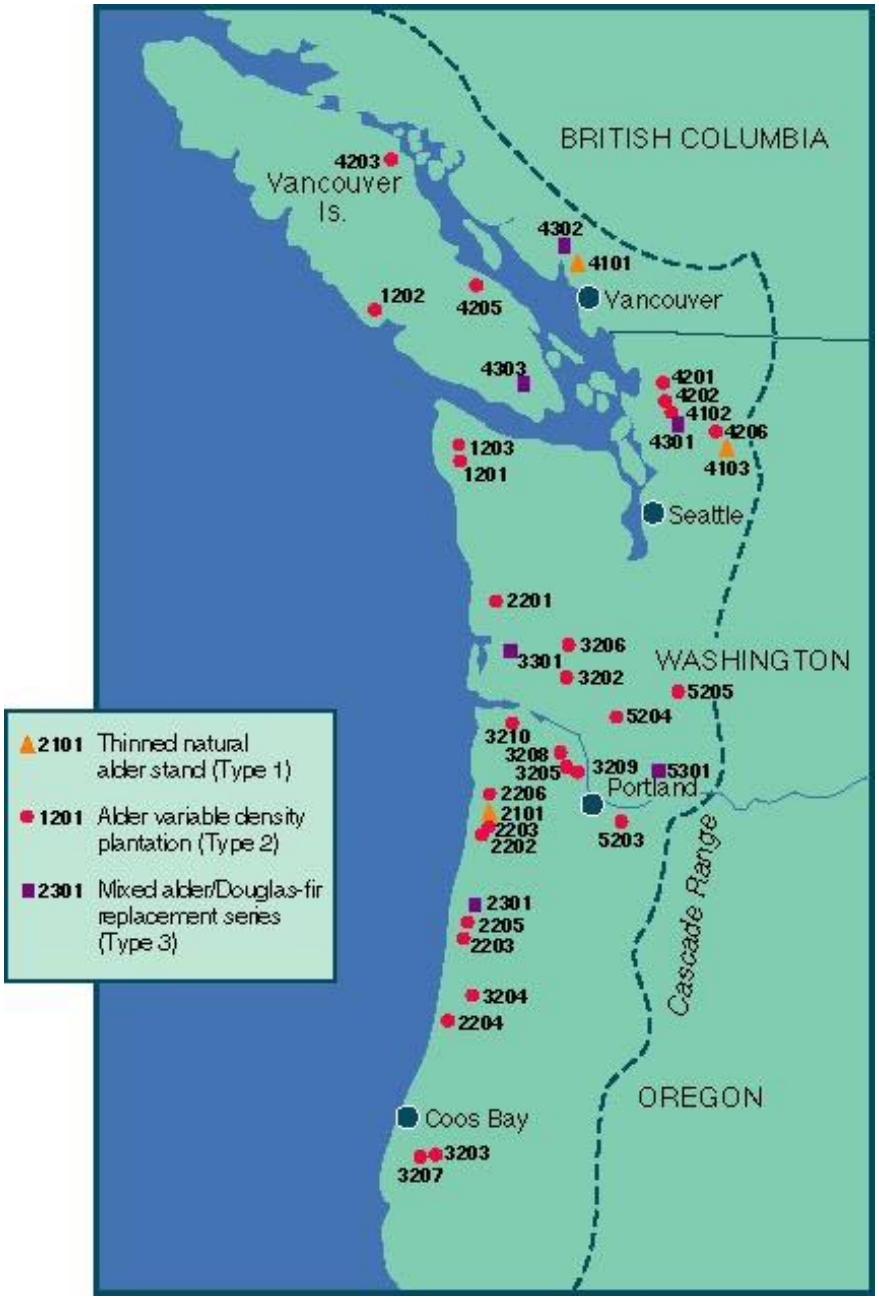


Figure 1. Location of installations for the Red Alder Stand Management Study.

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. There are seven Type 3 installations.

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 quality classes (Table 1).

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

	Site Quality		
Region	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 ANE ‘92 2204 SNF ‘94	2201 WHC ‘90 2205 ANE ‘94
3) Coast Range	3204 SNF ‘92 3209 BLM ‘95	3202 WHC ‘90 3205 ODF ‘92 3207 BLM ‘94 3208 ODF ‘97	3203 CAM '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

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

Table 2a. 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	1989	1990	1990	1990	1991	1991	1992	1992	1992	1992	1992	1993	1993
2nd yr Regen	1990	1991	1991	1991	1992	1992	1993	1993	1993	1993	1993	1994	1994
Plot Installation	1991	1992	1992	1992	1993	1993	1994	1994	1994	1994	1994	1995	1995
3rd yr Measure	1991	1992	1992	1992	1993	1993	1994	1994	1994	1994	1994	1995	1995
3-5 yr Thin	1992	1995	1995	1993	1995	1995	1996	1997	1996	1996	1995	1997	1997
Prune Lift 16ft	1994	1995	1995	1995	1995	1995	1996	1997	1996	1996	1995	1997	1997
6th yr Measure	1994	1995	1995	1995	1996	1996	1997	1997	1997	1997	1997	1998	1998
15-20' HLC Thin	1994	NA	1998	1995	1998	NA	1999	2000	2000	1999	1999	2001	NA
Prune Lift 2 12ft	1994	2001	1998	1995	2001	1999	1999	2000	1998	1999	1999	2001	2001
9th yr Measure	1997	1998	1998	1998	1999	1999	2000	2000	2000	2000	2000	2001	2001
Prune Lift 3 18ft	1997	2009	2001	1998	2007	2002	2003	2000	2008	2003	2003	2001	2006
12th yr Measure	2000	2001	2001	2001	2002	2002	2003	2003	2003	2003	2003	2004	2004
30-32' HLC Thin	2000	NA	NA	2001	2010	2007	2008	2003	NA	2006	2008	2006	2009
Prune Lift 4 22 ft	2000	NA	2001	2001	2017	2007	2008	2003	2013	2006	2008	2004	2009
17th yr Measure	2005	2006	2006	2006	2007	2007	2008	2008	2008	2008	2008	2009	2009
22nd yr Measure	2010	2011	2011	2011	2012	2012	2013	2013	2013	2013	2013	2014	2014
27th yr Measure	2015	2016	2016	2016	2017	2017	2018	2018	2018	2018	2018	2019	2019
32nd yr Measure	2020	2021	2021	2021	2022	2022	2023	2023	2023	2023	2023	2024	2024

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

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	1993	1994	1994	1994	1994	1994	1995	1995	1995	1996	1997	1997	1997
2nd yr Regen	1994	1995	1995	1995	1995	1995	1996	1996	1996	1997	1998	1998	1997
Plot Installation	1995	1996	1996	1996	1995	1995	1996	1997	1996	1997	1999	1999	1999
3rd yr Measure	1995	1996	1996	1996	1996	1996	1997	1997	1997	1998	1999	1999	1999
3-5 yr Thin	1997	1998	1998	1998	1998	1998	2000	1999	NA	2001	2002	NA	NA
Prune Lift 16ft	NA	1998	1998	1998	NA	1998	2000	1999	1999	2001	2002	2002	NA
6th yr Measure	1998	1999	1999	1999	1999	1999	2000	2000	2000	2001	2002	2002	2002
15-20' HLC Thin	2001	NA	2005	NA	2002/17	2002	NA	NA	NA	NA	NA	NA	NA
Prune Lift 2 12ft	NA	2005	2002	2002	NA	2002	2003	2003	2001	2004	2008	2005	NA
9th yr Measure	2001	2002	2002	2002	2002	2002	2003	2003	2003	2004	2005	2005	2005
Prune Lift 3 18ft	NA	2015	2012	2010	NA	2005	2011	2009	2003	2010	2011	2010	NA
12th yr Measure	2004	2005	2005	2005	2005	2005	2006	2006	2006	2007	2008	2008	2008
30-32' HLC Thin	2006	NA	2017	2010	NA	NA	2011	2009	2011	2010	2011	2010	NA
Prune Lift 4 22 ft	NA	NA	2017	2020	NA	2013	2016	2009	2006	2017	2013	2013	NA
17th yr Measure	2009	2010	2010	2010	2010	2010	2011	2011	2011	2012	2013	2013	2013
22nd yr Measure	2014	2015	2015	2015	2015	2015	2016	2016	2016	2017	2018	2018	2018
27th yr Measure	2019	2020	2020	2020	2020	2020	2021	2021	2021	2022	2023	2023	2023
32nd yr Measure	2024	2025	2025	2025	2025	2025	2026	2026	2026	2027	2028	2028	2028

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

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

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	1992	1994	1994	1994	1995	1996	1997
2nd yr Regen Survey	1993	1995	1995	1995	1996	1997	1998
Plot Installation	1993	1995	1995	1995	1997	1998	1999
3rd yr Measurement	1994	1996	1996	1996	1997	1998	1999
6th yr Measurement	1997	1999	1999	1999	2000	2001	2002
9th yr Measurement	2000	2002	2002	2002	2003	2004	2005
12th yr Measurement	2003	2005	2005	2005	2006	2007	2008
17th yr Measurement	2008	2010	2010	2010	2011	2012	2013
22nd yr Measurement	2013	2015	2015	2015	2016	2017	2018

Winter 2015/16 was a busy year with nine installations requiring field work. Measurements were completed on six Type 2 installations (Table 5). Five sites had their 22nd year measurement (Lucky Ck, Cape Mtn., Siletz, Dora, and French Ck). HSC's oldest Type 2 site, Humphrey Hill, had its 27th year measurement. Three Type 3 installations (Monroe-Indian, Turner Ck, and Holt Ck) had their 22nd year measurement. There were no orphaned sites requiring fieldwork- scheduling and completing these measurements went smoothly. There were no taper measurements collected.

Table 5. Hardwood Silviculture Cooperative Field Activities, Fall 2015-Spring 2016

Type	Activity	Installation	Cooperator
Type 1	Completed		
Type 2	3rd Pruning Lift	1202	BCMIN- Lucky Ck
	22yr Measure	1202	BCMIN- Lucky Ck
		2204	SNF- Cape Mtn
		2205	ANE- Siletz
		3207	BLM- Dora
		4205	BCMIN- French Ck
	27yr Measure	4201	GYN- Humphrey Hill
Type 3	22yr Measure	2301	ANE- Monroe-Indian
		4301	GYN- Turner Ck
		4303	BCMIN- Holt Ck

So, in the big picture:

- All scheduled measurements for the four Type 1 installations are completed.
- Nineteen of the twenty-six Type 2 installations have had their 22nd year measurement.
- The first 27th year measurement of the Type 2 installations was completed.
- Twenty of the twenty-six Type 2 installations have all treatments completed.
- Four of the seven Type 3 installations have had their 17th year measurement.

This coming field season (Winter 2016/17) will be an "average" year (Table 6). Two more of the oldest HSC sites (Ryderwood and Clear Lake Hill) will have their 27th year measurement. Then three Type 2 installations (Mt. Gauldy, Scappoose, Darrington) will need their 22nd year measurement and one of these (Mt. Gauldy) is due for the 4th and final pruning lift. Regarding the Type 3 installations, one site (Menlo) will need its 22nd year measurement. Luckily, these are no orphaned sites due for measurement or treatment.

Table 6. Hardwood Silviculture Cooperative Field Activities, Fall 2016-Spring 2017

Type	Activity	Installation	Cooperator
Type 1	Completed		
Type 2	4th Pruning Lift	2206	SNF-Mt. Gauldy
	22yr Measure	2206	SNF- Mt. Gauldy
		3209	BLM- Scappoose
		4206	DNR- Darrington
	27yr Measure	3202	WHC- Ryderwood
		4202	GYN- Clear Lake Hill
Type 3	22yr Measure	3301	DNR- Menlo

Current HSC Activities

An Alder Day in the Woods

On June 16, 2016, the Washington Hardwood Commission (WHC) held a guided tour of red alder plantations in the Castle Rock, WA area. The tour was held on Weyerhaeuser property and led by (now retired) Weyerhaeuser research forester Alex Dobkowski. The tour covered most aspects of intensively managed red alder plantation activities including site selection, planting stock, soil site index vs. expressed site index, pre-commercial thinning, commercial thinning, etc. The tour handout was a well-made and a thorough book(let) is now available on the WHC website: http://wahardwoodscomm.com/ppt/16AM/Experience_Alder_Day_in_the_Woods.pdf The HSC was involved in the organization of this event and gave two presentations. The first, by Glenn Ahrens, gave an overview of the HSC- its objectives, history, organization, members, and current research priorities. The second, by Andrew Bluhm, used the 26-year-old HSC Type 2 installation, Ryderwood, as a backdrop to discuss stand density management as it relates to intensively managed red alder plantations. Topics presented included: a comparison of heights and diameters of the Ryderwood control treatments with the average height and diameters of the thirteen HSC sites used in the subsequent analysis, a description the HSC treatments described, effect of stand density management on relative density, tree diameter, height, and live crown ratio, cubic foot volume at age 22, and projected board foot volume at age 35. The following are the key results presented.

- This stop- HSC #3202 is a top performing red alder site across the region. Using the "soil-site method" of estimating site index (Harrington 1986), site index (base age 50 years) was 105ft. Site index estimates of twelve other HSC sites greater than 20 years old ranged from 85ft to 115ft. Ryderwood DBH (Figure 2) and height (Figure 3) for the four control treatments are the maximum, or near maximum observed. Therefore, tree and stand growth responses (i.e. DBh and HT) from this site could be considered "optimal" or "exceptional".

Figure 2- Control treatment, 22 year, all tree DBH for HSC site #3202 (Ryderwood) with the mean (and maximum) of 13 HSC installations.- All Trees

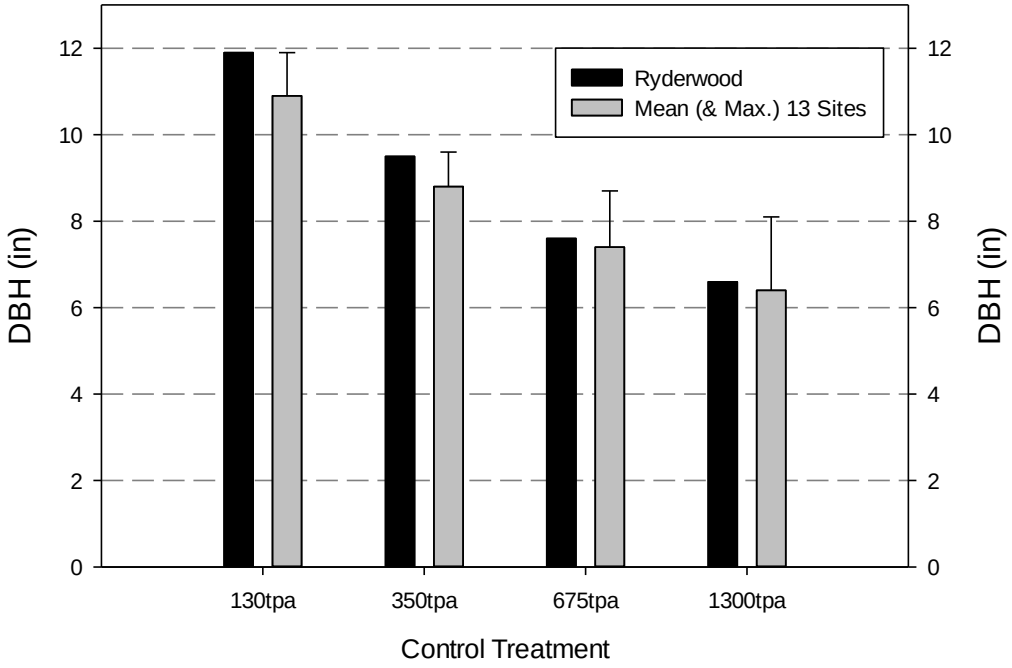
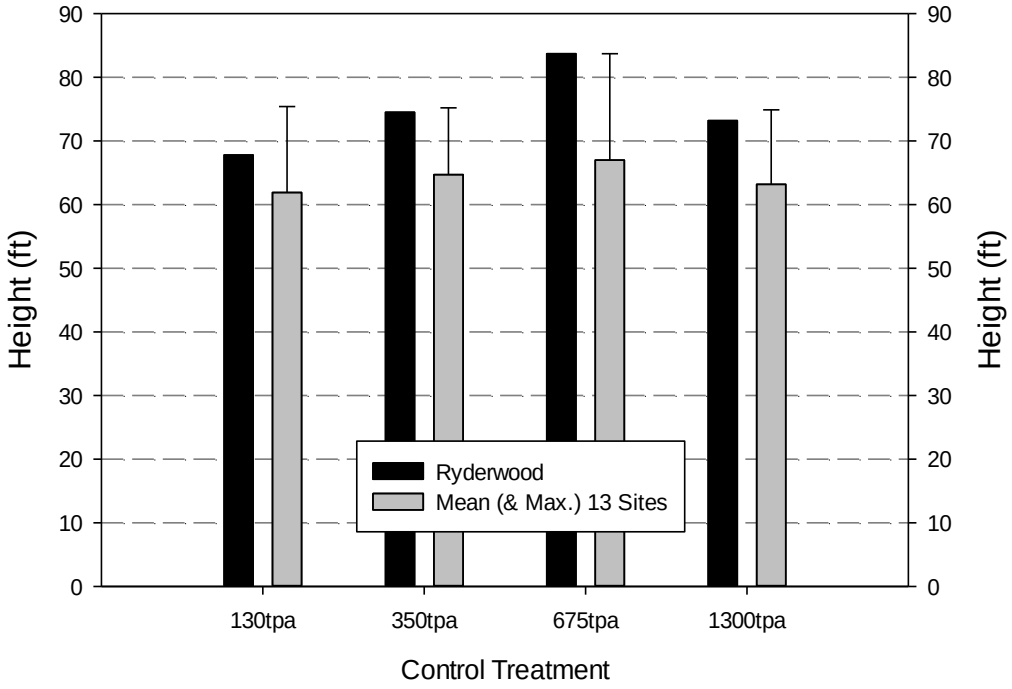
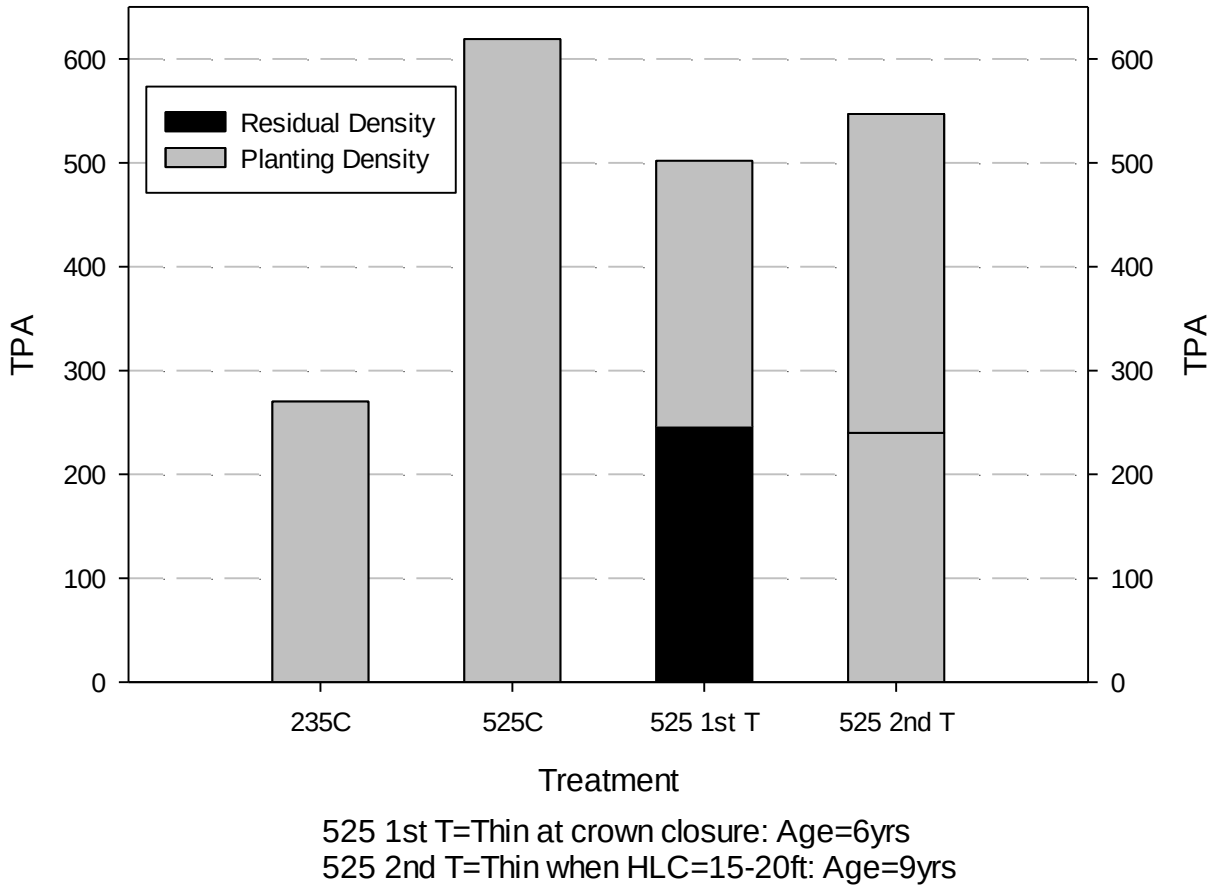


Figure 3- Control treatment, 22 year, all tree height for HSC site #3202 (Ryderwood) with the mean (and maximum) of 13 HSC installations.- All Trees



- The silvicultural treatments presented here (plant at 235tpa & leave alone [235C], plant at 525tpa & leave alone [525C], plant at 525tpa and thin to 240tpa at crown closure [525 1st T], and plant at 525tpa & thin to 240tpa when HLC=15-20ft [525 2nd T]) fall within what is currently considered operational (Figure 4) and furthermore, allow for meaningful comparisons across treatments.
-

Figure 4- HSC #3202 (Ryderwood): Treatment Densities

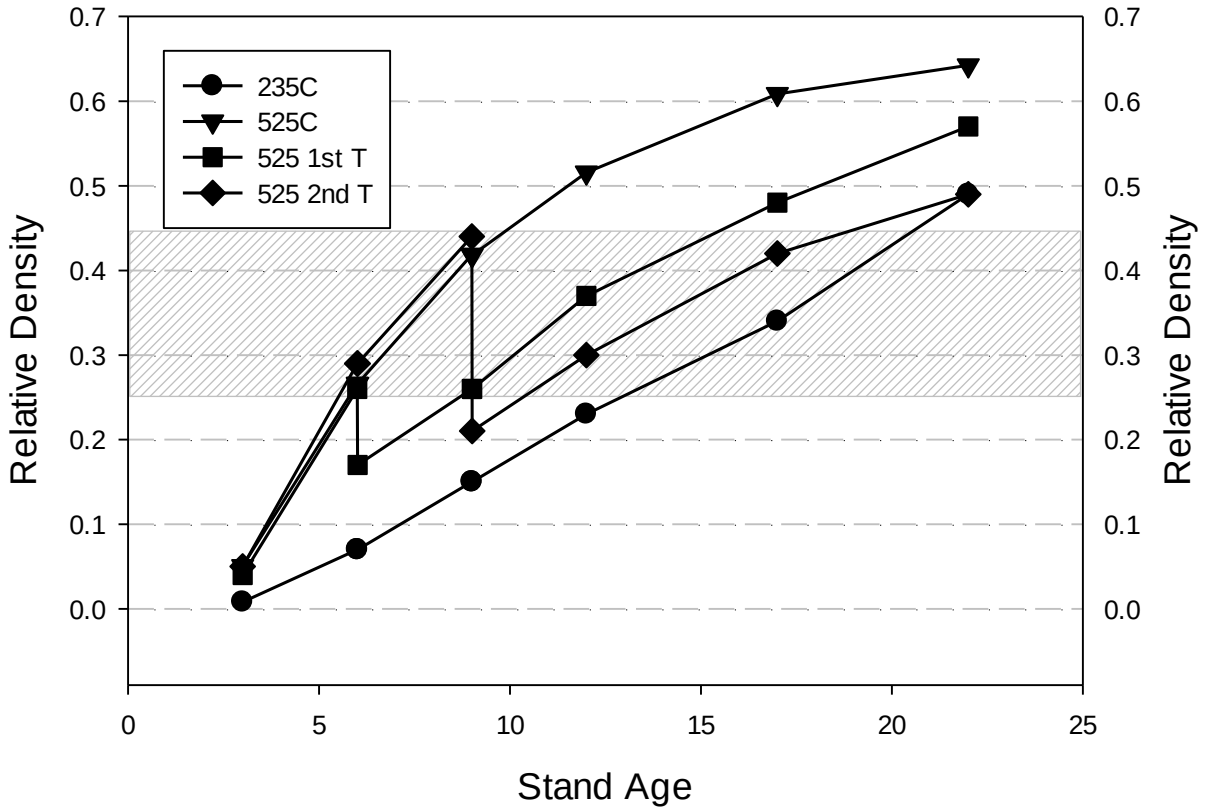


- Stand density management provides opportunities for foresters to influence stand yield, individual tree size, and stem form. Relative density and the associated relative density diagram developed by Puettman, et. al. (1993) is a useful tool in deciding the timing (i.e. "window") and intensity (post-thinning or residual density) of pre-commercial thinning. The recommended management zone (RD=25% to 45%) is the stand condition that is a compromise between individual

tree growth, stand yield, and mortality. Using data from this site the following were observed (Figure 5):

- For the 235C, the recommended management zone (RD=25% to 45%) occurred between the ages of 13 & 20.
- For the 525C, the plot was in the recommended management zone (RD=25% to 45%) between the ages of 6 &10.
- For the 525 1st T, thinning occurred at age 6; just as the stand was entering the management zone (RD=26%). It was thinned to a relative density below what is recommended (RD=16%).
- For the 525 2nd T, thinning occurred at age 9; just as the stand was approaching the upper limit of the management zone (RD=44%). It was thinned to a relative density just below what is recommended (RD=21%).
- By age 22, only the 525C treatment has reached the "self-thinning line" (RD=65%).
-

Figure 5- HSC #3202 (Ryderwood): Relative Density



- The increased diameter growth resulting from an increase in resources (i.e. thinning) is, among other factors, a function of crown size. Therefore, identifying crown size is another useful way of deciding when to pre-commercially thin. A simple and useful measure of crown size is live crown ratio (LCR). For red alder plantations, it is generally considered that a 50% LCR of the trees/stand is a desirable "trigger" for when to PCT- thinning when LCR>50% sacrifices stand yield, while thinning when LCR<50% sacrifices individual tree growth. In regards to LCR, the following were observed (data not shown):
    - For the 235C treatment, the trees/stand reached LCR=50% at age 20.
    - The 525C treatment was 12 years old when LCR dropped below 50%.
    - The LCR at time of thinning for the 525 1st T, and 525 2nd T was 84% and 66%, respectively. So, using the 50% rule, these treatments were thinned early.
    - PCTing maintained higher LCRs than the unthinned 525C treatment (~37% vs 27%).

- Diameter (Figure 6):
    - Trees either planted at a wider spacing (235C) or thinned to a wider spacing (525 1st T & 525 2nd T) had, on average, diameters 2 to 3 inches (30%) greater than the closer spaced treatment (525C) at age 22.

- Height (Figure 7):
    - Height at age 22 differed by treatment although differences were relatively small. Stands planted at a wider spacing (235C) were shortest (74ft) , followed by thinned stands (~79ft) with closer spaced stands (525C) were tallest (84ft).

Figure 6- HSC #3202 (Ryderwood): All Tree DBH

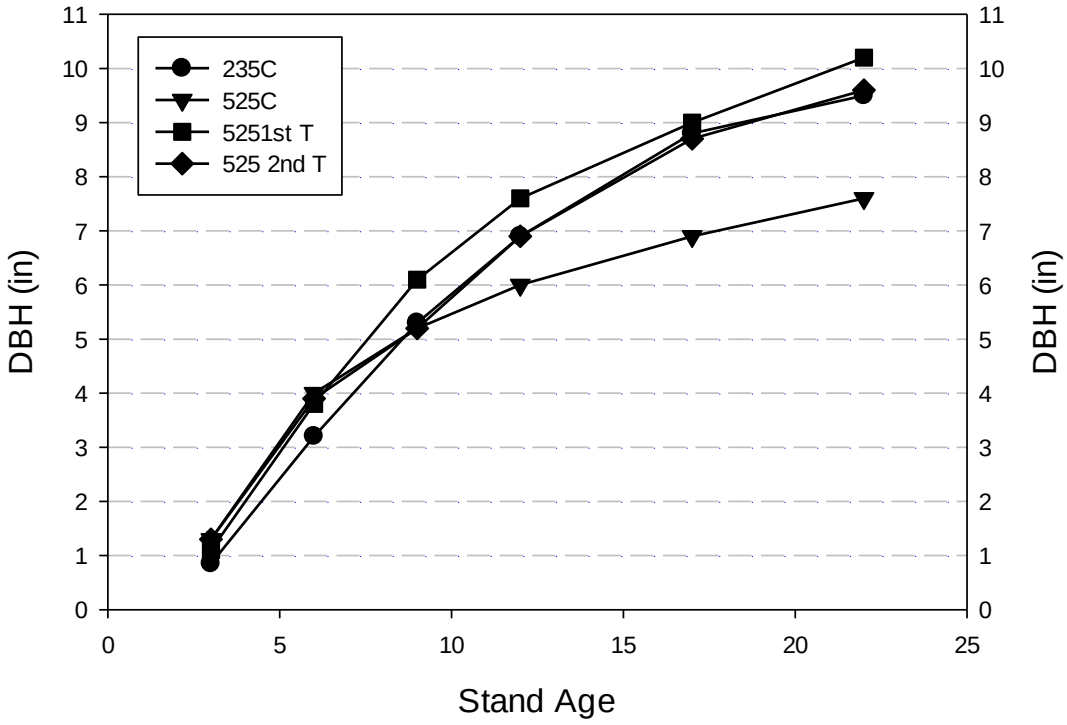
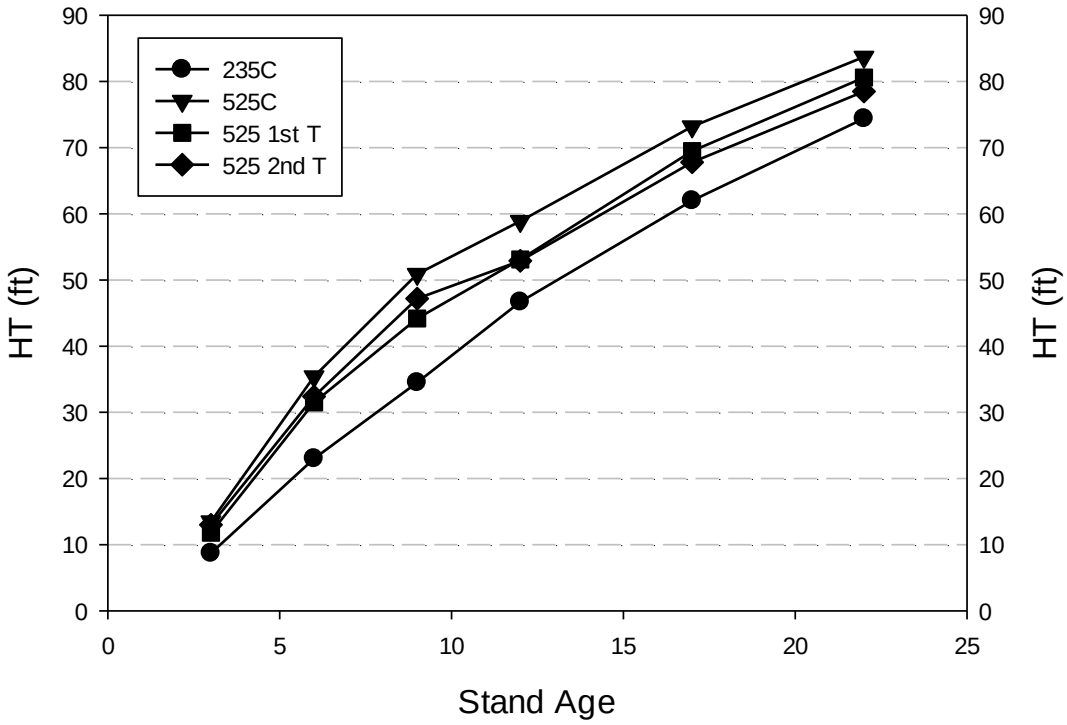
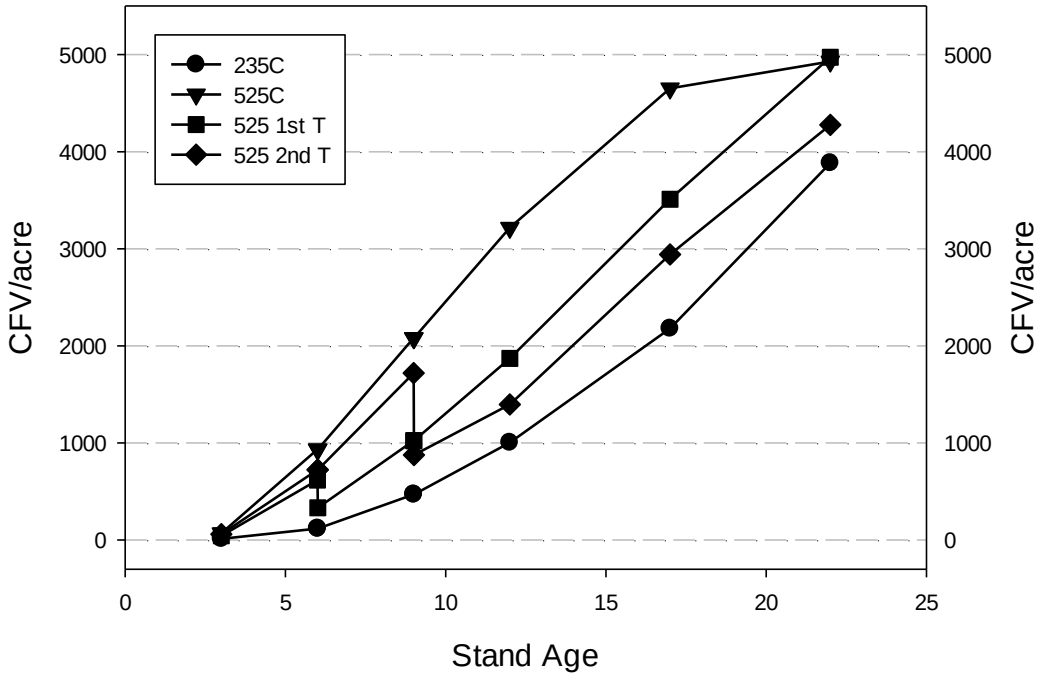


Figure 7- HSC #3202 (Ryderwood): All Tree Height



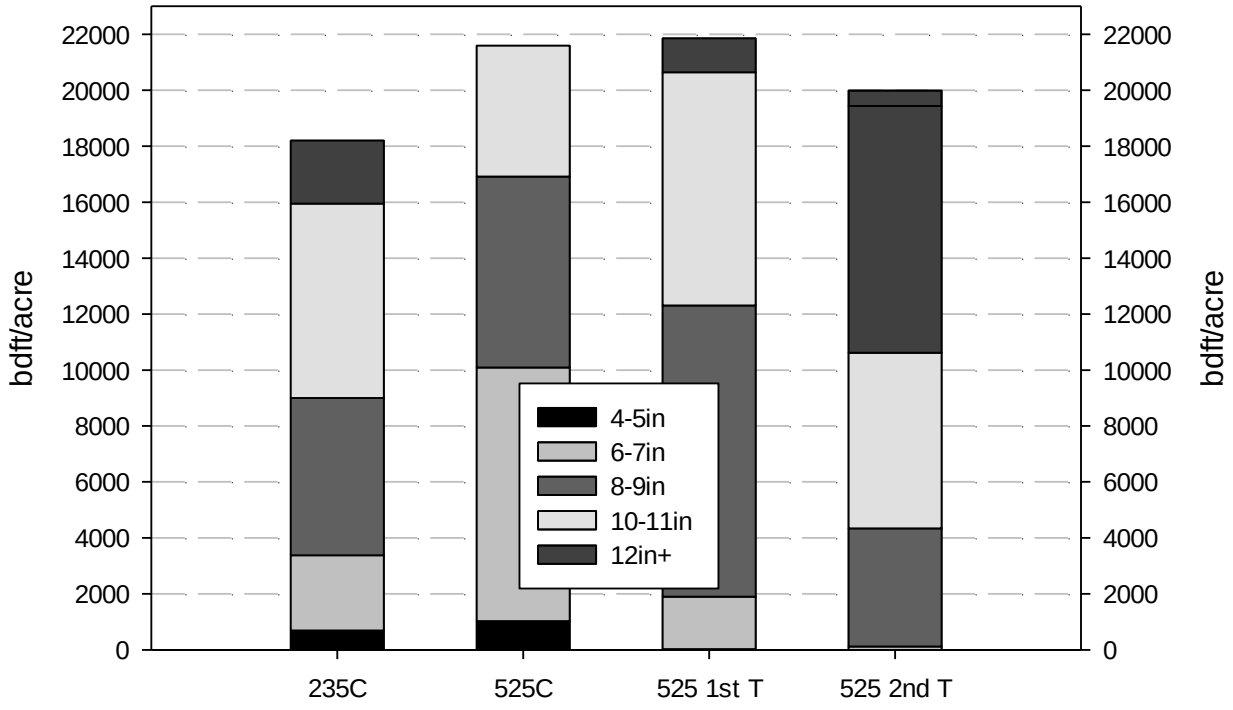
- Total cubic foot volume at 22 years (Figure 8):
    - Through age 20, total stand cubic foot volume per acre (CFV) followed the same patterns as height: stands planted at a wider spacing had the least volume followed by thinned stands followed by closer spaced stands. However, a severe weather event in 2010/2011 damaged the 525C treatment, resulting in a significant loss of volume.
    - The stand planted at the wider spacing (235C) had the least volume (3900ft^3/acre).
    - Thinning at age 6 (525 1st T) resulted in more volume (5000ft^3/acre) than thinning at age 9 (4300ft^3/acre).

Figure 8- HSC #3202 (Ryderwood): Total Cubic Foot Volume (CFV)



- Board foot volume (BDFV) at 35 years (Figure 9):
    - Using the data collected at age 22 and the red alder growth and yield model (RAP-ORGANON), board foot volume per acre by log diameter class was projected to age 35 (merchandising specifications= log length 32ft, minimum log length 12ft, minimum log diameter 4in, stump height 1ft, and trim 6in).
    - At age 35, BDFV ranged between 18MBF and 22MBF.
    - The greatest volumes were found in the 525C stand (21.6MBF) and the 525 1st T (21.8MBF). Although these two stands had nearly identical total volumes, log diameter distributions varied greatly- the 525C stand had a much higher proportion of smaller logs.
    - The 235C stand had the lowest volume (18.2MBF) as well as the greatest range in log sizes.

Figure 9- HSC #3202 (Ryderwood): Projected Volume; Age 35 by Log Diameter Class



Refitting the Red Alder Taper Equation

Project Rationale/Objectives

The HSC built the first-ever taper equation for managed stands of red alder using data from 234 trees across nine of the Type 2 installations (see Bluhm, et.al. 2007. Taper Equation and Volume tables for Plantation-Grown Red Alder. USDS GTR-735). The resulting equation fit the data nicely, however, due to the age of the plantations, the sampled trees were young (~15 years) and of pre-merchantable size. Therefore, it is important to determine if the taper equation built from these younger stands and used in RAP-ORGANON will accurately predict diameters along the profile of the tree and, thus, stem volume. Yet, because the data used to build the taper equation was from smaller, pre-merchantable trees (Table 7), and that preliminary evaluations of the taper equation by the HSC revealed mostly consistent underpredictions of dib, and thus volume (See HSC 2015 Annual Report, http://hsc.forestry.oregonstate.edu/sites/hsc/files/HSC2015.pdf), the HSC gathered more taper data on larger, older trees (Table 8) with the goal of eventually refitting the taper equation.

Table 7- Red alder taper equation (Bluhm et al. 2007) source data

DBH	Height (ft)																	
(in)	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	Total
1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
4	--	--	1	5	4	2	3	3	1	--	--	--	--	--	--	--	--	19
5	--	--	3	5	14	11	11	10	3	3	--	--	--	--	--	--	--	60
6	--	--	1	1	5	7	9	10	4	1	--	--	--	--	--	--	--	38
7	--	--	--	1	4	11	10	7	7	3	3	--	--	--	--	--	--	46
8	--	--	--	--	--	9	11	5	9	2	3	--	--	--	--	--	--	39
9	--	--	--	--	--	2	2	--	10	2	2	--	1	--	--	--	--	19
10	--	--	--	--	--	--	1	3	2	3	1	--	--	--	--	--	--	10
11	--	--	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	3
12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
Total	0	0	5	12	27	42	47	38	38	15	9	0	1	0	0	0	0	234

Table 8- Red alder taper equation "additional" data

DBH	Ht (ft)																	
(in)	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	Total
1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
6	--	--	--	--	--	--	--	1	--	--	1	--	--	--	--	--	--	2
7	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
8	--	--	--	--	--	--	--	--	1	--	8	1	--	--	--	--	--	10
9	--	--	--	--	--	--	--	--	3	10	5	1	3	--	--	--	--	22
10	--	--	--	--	--	--	--	--	3	4	3	3	2	3	--	--	--	18
11	--	--	--	--	--	--	--	--	--	9	6	9	3	3	1	--	--	31
12	--	--	--	--	--	--	--	--	--	1	3	5	4	1	2	--	--	16
13	--	--	--	--	--	--	--	--	--	--	2	7	6	1	1	--	--	17
14	--	--	--	--	--	--	--	--	--	1	4	4	1	3	--	--	--	13
15	--	--	--	--	--	--	--	--	--	--	--	--	1	--	1	--	--	2
16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
Total	0	0	0	0	0	0	0	1	7	25	33	30	20	11	5	0	0	132

Objectives

The goal of this analysis was to develop and evaluate a new stem taper equation using the new (i.e. "additional") data and the data used in Bluhm et al (2007). Specific objectives were to: (1) refit the Bluhm et al (2007) equation using the combined dataset; (2) compare the performance of this new equation to an alternative model form and the existing equations. Equations compared were the following:

-[1] Refit Bluhm et al. (2007) equation (n=366)
-[2] Refit Kozak (2004) equation (n=366)
-Bluhm et al. (2007) equation (n=234)
-Kozak (2004) equation (n=234)

Results

The predicted stem profiles for each of the equations were rather similar (Figure 10) and equation [1] showed the strongest predictive performance for dib (Figure 11). However, when looking at the largest trees (the lower right graph in Figure 11), Eqn. [1] predicts a larger dib for a given relative height. This is also reflected in Figure 11 (the upper-right are of the regression line in the lower left graph) where Bluhm et al. (2007) under predicts dib.

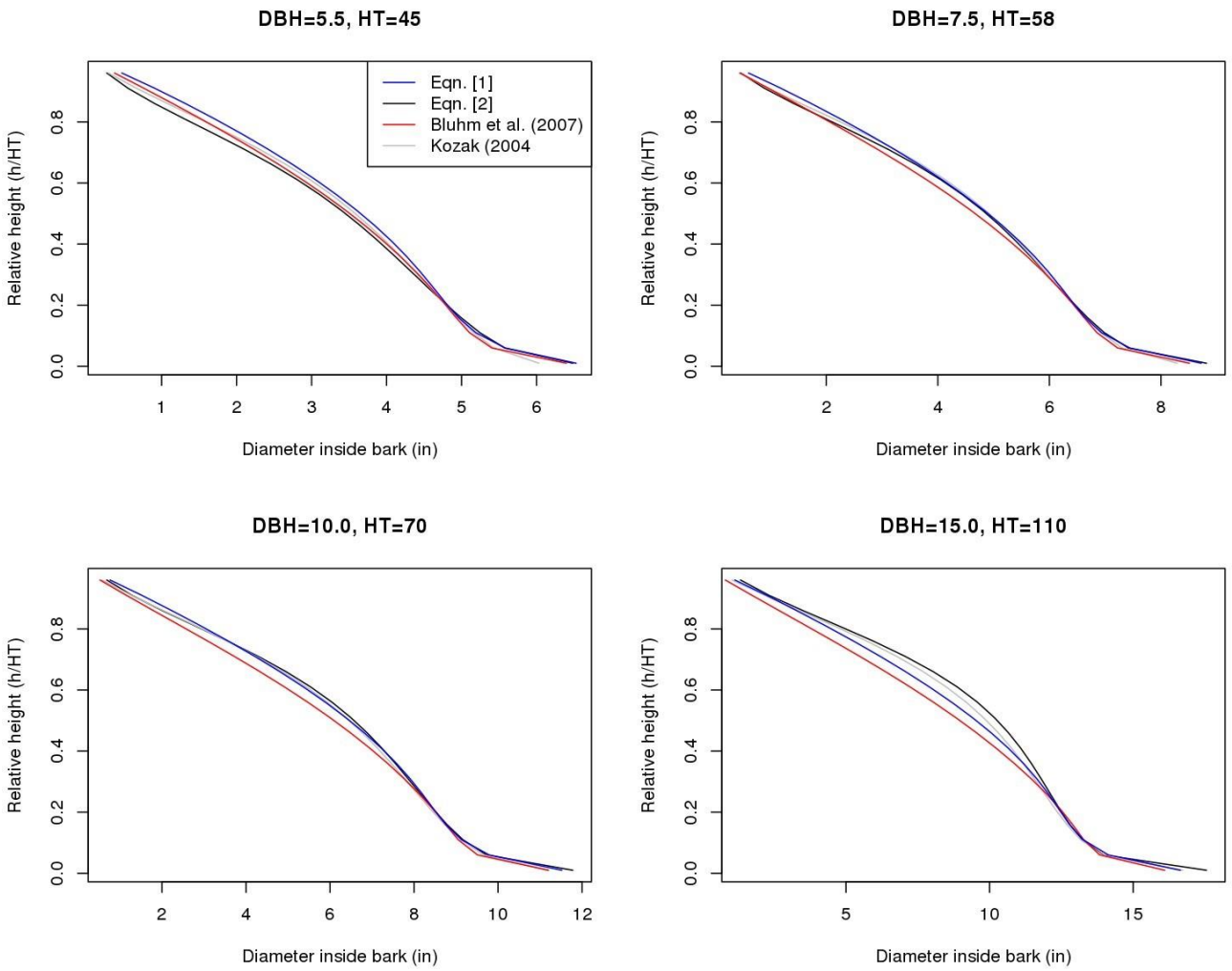


Figure 10. Predicted stem profiles for 4 different sized trees using equations [1], [2], Bluhm et al. (2007), and Kozak (2004).

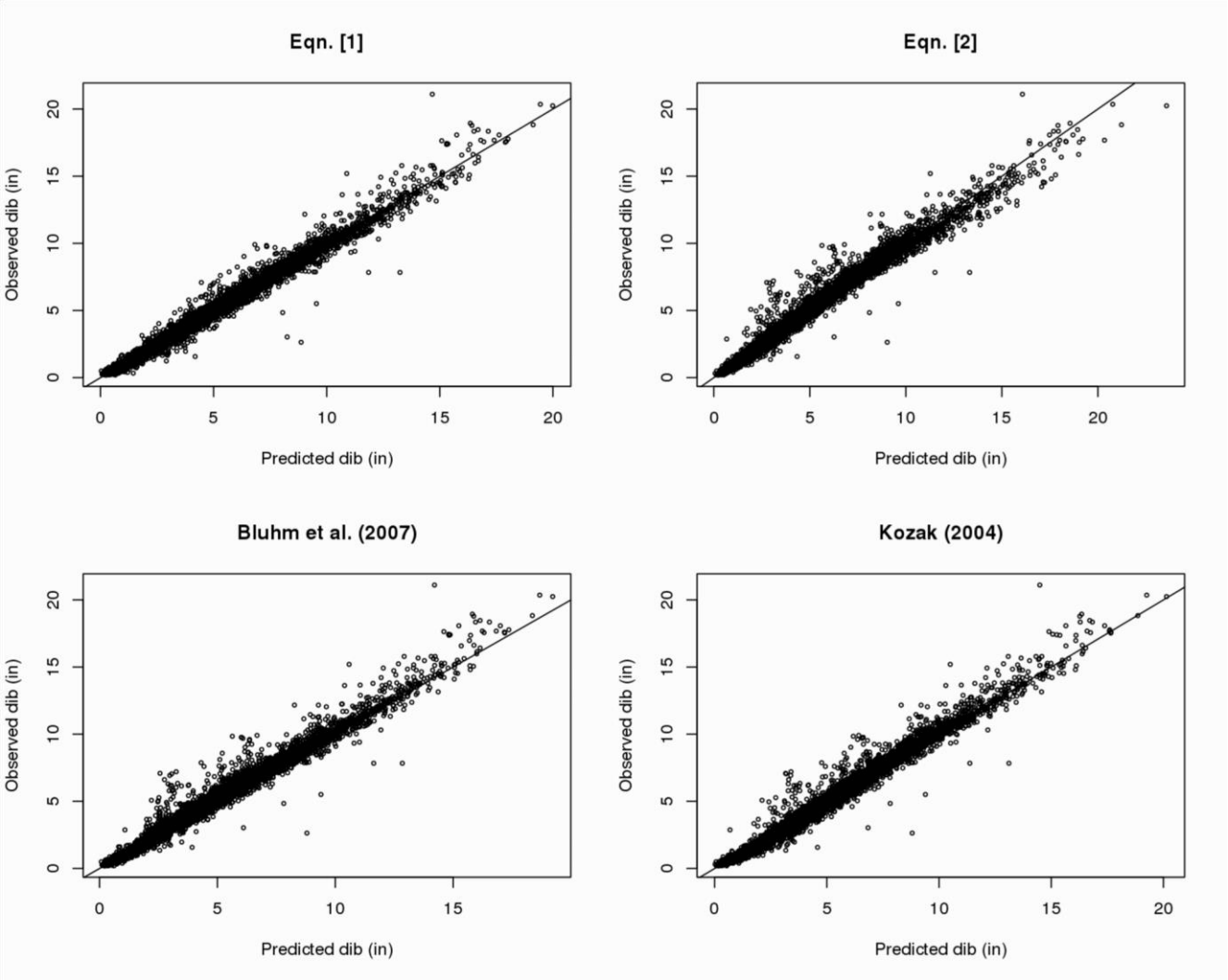


Figure 11. Relationship between observed and predicted diameter inside bark (in.) for the four equations evaluated in this study.

When assessed for predicting total stem volume, the best performing equation in terms of mean bias and RMSE was Bluhm et al. (2007) (Figure 12). So, despite the inclusion of additional data, the Bluhm et al. (2007) equation showed strong performance and actually outperformed the refitted equations for predicting total stem volume across a range of tree sizes. However, the differences between the equations in predicting dib for large trees warrants further attention.

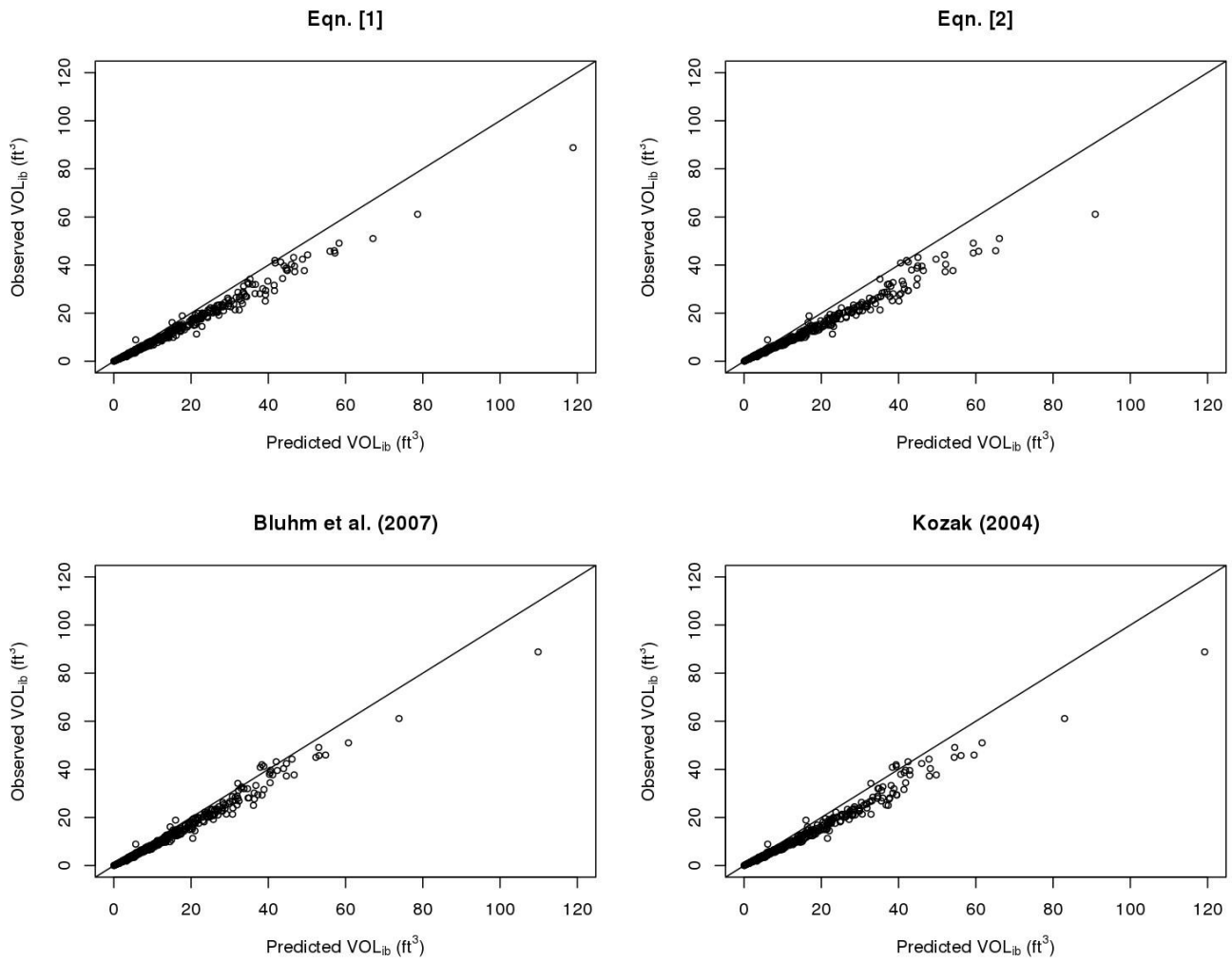


Figure 12. Relationship between observed and predicted total stem volume inside bark (VOL_{ib}; ft^3) for the four equations evaluated in this study.

Outreach and Education

Red Alder Silviculture Workshop

On May 11, 2016, Peter Hurd with the NW Region of WA DNR organized and hosted an informal workshop for DNR foresters interested in red alder management. The day started with a tour of an old red alder thinning and western redcedar underplanting study. In this studay, a 20 year old natural alder stand was thinned to various levels of basal area in 1998 with redcedar planted in 1999. Although no recent data exists for this study, it did provide a forum for discussing species mixtures. This discussion then led for Andrew Bluhm to discuss recent results and conclusions obtained from the HSC Type 3 species mixture experiments. After lunch, Andrew then led the group through the 26 year old HSC Type 2 installation Clear Lake Hill to look at and discuss the effects of stand management activities on red alder plantations.

Forest Owner Field Day

This workshop, sponsored by Washington State University Extension was held in Francis, WA August 15, 2015. This educational event provided practical "how-to" information to a wide array of forest owners. Glenn Ahrens, director of the HSC taught the "Basics of Red Alder Management" and the "Advanced Hardwood Management" courses.

Clackamas Tree School

For the 26th year, OSU Extension Service put on the Clackamas Tree School. This huge event is an important part of the comprehensive OSU Extension education program. Tree school offered 74 classes covering key topics to support successful management of diverse woodlands. Since Glenn Ahrens was busy organizing the event he recruited Andrew Bluhm to take over teaching the class "Red Alder Management: Silviculture to Marketing". To a large audience, Andrew gave an overview of hardwoods and red alder in general, discussed why or why not to grow red alder presented probably management scenarios and finished with topics about marketing red alder.

Direction for 2017

As always, the specific goals for 2016 are both continuations of our long-term objectives and new projects:

- Continue efforts to recruit new members.
- Continue HSC treatments, measurements and data tasks.
- Continue adding content and updating the HSC website.
- Continue efforts in outreach and education.
- Continue working with and analyzing the HSC data.
- Continue assisting HSC members with their specific red alder management needs and projects.
- Create a new version of RAP-ORGANON. Efforts are underway modeling experts including the Center for Intensive Planted-forest Silviculture (CIPS) to identify modeling options and potential timelines for updating and improving RAP-ORGANON using additional and older tree data from the HSC.

Appendix 1- HSC Management Committee Meeting Minutes

Thursday June 16, 2016:
The HSC 2016 Summer meeting was held in conjunction with the Washington hardwood Commission (WHC) Annual Symposium. This event titled "Experience an Alder Day in the Woods" toured operational, mid-rotation red alder plantations on Weyerhaeuser property in the Kelso & Ryderwood, WA area. Most aspects of operational red alder management were covered but special emphasis was placed on:

- Site productivity
- Site selection
- Plantation establishment
- Stand density management
- Commercial thinning

As part of the meeting, Glenn Ahrens spoke to the group about the HSC- its history, goals and importance to foresters and forestry in the PNW. In addition, Andrew Bluhm talked about stand density management using results from 22 year data from the HSC site #3202.
The tour was jam packed with information which is nicely assembled into a pdf found at the following: http://wahardwoodscomm.com/2016_AnnualMtg.html.

Friday June 17, 2016:
Attendees: Andrew Bluhm, Glenn Ahrens- OSU; Brian Morris- WA DNR; Michael Johnson- Hancock Forest Management /Washington Hardwood Commission; George McFadden- Bureau of Land Management; Florian Deisenhofer- Hancock Forest Management; Joe Monks- Northwest hardwoods/Washington Hardwood Commission.

The meeting started at 8:30 AM at the WA DNR Pacific Cascade Region Office in Castle Rock, WA with a welcome from the HSC program leader, Glenn Ahrens. As most are aware by now, Dave Hibbs has retired and Glenn has taken his place. The group then the highlights of the WHC tour from the day before. Discussion, here, centered on:

- Feasibility of commercial thinning
- Two site preparation treatments
- Seedling issues, specifically the lack of quality seedlings currently available
- Reduction of rotation ages

Next was a presentation given by Andrew Bluhm titled "HSC Red Alder Taper Project". This analysis was a continuation of the ongoing project investigating how well the red alder taper equation predicted DIB and thus volume. Andrew reviewed the previous results of "testing" the accuracy of the taper equation. Briefly, these are:

- DIB was most often under predicted above DBH
- DIB under predictions increased with increasing measurement point height
- Merchantable tree volume and log volume was consistently under predicted

This obviously raised the question whether the taper equation needed to be refit with using the now, much more robust dataset. To that end, the HSC in partnership with Aaron Weiskittel at the University of Maine evaluated the performance of the taper equation using the entire red alder taper database. The goal was to refit the Bluhm et al (2007) equation using the combined dataset and compare the performance of this new equation to an alternative model form and the existing equations. The (preliminary) results presented here showed that while the "new or refit" Bluhm equation did the best job at predicting diameter inside bark, the "old or original" Bluhm equation did the best job at predicting tree volume.

The group then discussed additional sources of taper data.

- Processor-gathered data
  - C & C logging
  - SE US pine processors
- Elochoman stands- old WeyCo density trial now owned by DNR

Andrew then moved on to HSC business with a review of last years' fieldwork, the coming years' fieldwork and an overview of the data collection schedule for all three installation types.

Last year (Winter 2015/16) had fieldwork on nine installations. Measurements included:

- Six Type 2 installations needed fieldwork.
- Humphrey Hill (4201, GYN) was the first installation receiving its 27th year measure.
- Five Type 2 installations- Lucky Creek (1202, BCMIN), Cape Mtn. (2204, SNF), Siletz (2205, Stimson), Dora (3207, BLM) and French Creek (4205, BCMIN) having their 22nd year measurement.
- Of these installations there was one pruning treatment (Lucky Creek) needed.
- Three Type 3 installations- Monroe-Indian (2301, Stimson), Turner Creek (4301, GYN), and Holt Creek (4303, BCMIN) having their 17th year measurement.

This upcoming year (Winter 2016/17) will have the "usual" amount of fieldwork with a total of six sites needing either a measurement or a treatment. Work will include:

- Two Type II installations- Clear Lake Hill (4202, GYN) and Ryderwood (3202, WHC) will have the 27th year measurement.
- Three Type II installations- Mt. Gauldy (2206, SNF), Scappoose (3209, BLM), and Darrington (4206, WADNR) will have the 22nd year measurement.
- Of these installations there will be one pruning treatment (Mt. Gauldy).
- One Type III installation- Menlo (3301, WADNR) will have the 17th year measurement.

As fall approaches, Andrew will contact each HSC member to provide specific on the activities and schedule the fieldwork. In theory, all sites have cooperator support, but depending on the status of Goodyear Nelson, there may not be a crew available to conduct the 27th year measurements on Clear Lake Hill. Therefore, it was decided for Andrew to stay in touch with Paul Kriegal, and if there is no support, to possibly have an HSC winter work party this coming winter to complete the measurements.

Next, Andrew presented the HSC budget. Highlights included:

- Dues received in 2016 were $47,500, down $5,000 from the year before.
- Actual costs, with the exception of Andrew's cost, were in line with what was projected.
- Therefore, with the increase in Andrew's costs and the reduction in revenue, Andrews's time was decreased from 0.40FTE to 0.35FTE.
- Looking ahead to 2017, and using the worst-case scenario in terms of dues income, Andrews's time will be decreased again from 0.35FTE to 0.30FTE.

After a break, the grouped discussed many topics including:

- Annual dues vs. project-based funding- inquire with Dave Hibbs and OSU accounting how flexible the mechanisms are to bring in "extra" or non-dues money
- Seedling availability
- Seed sources, relative performances, and climate change
- Clonal stock trial
    - WSU is developing some clonal material that may be available this fall
    - WSU and WeyCo are currently negotiating proprietary issues
    - Test sites for clonal stock- quantifying amount of gain
    - Seedling trials- bareroot vs. plug
    - Should the HSC coordinate test site selection, establishment, measurements, and data analysis? What would the time and cost be?
    - Hancock is very interested in this trial and already have a test site selected.
    - DNR and BLM could also provide test sites
    - Alex has the authority to share results from his clonal outplanting trial.
        - Realized gain trial
        - Planted in 2006 at 680tpa
        - 2 sites Westside of Coastal mountains
        - Appx. 12 clones and a local seed source/site
        - 6 reps, blocked by slope position, 40 trees/plot
        - Needs to be PCTd, could be done for free upon request
        - Would require measuring and maintenance
        - J&M has measured these sites in the past. Ask them for an estimate to do the measurements

        - Timeline- this winter?
- Mixed species and/or natural alder stand growth and yield model
    - Ask HSC members their degree of interest in a creating a new version of the plantation model vs. developing a mixed-specie/natural stand model.
- Mill trial for commercial thinned lumber
    - Randy Bartelt said this type of trial is easy and they are good at it but the right of 1st refusal HNW has with WeyCo would need to be addressed before Randy could buy a timber sale and do the mill study. Michael Johnson and Alex Dobkowski volunteered to take the lead on this effort
- WHC data request
    - Road Map
    - Deliverables
    - Proposal
    - HSC Member approval
    - Review RAP ORGANON validation
    - Stand tables

Appendix 2- Financial Support Received in OSU Fiscal Year 2016

Cooperator	Support
BC Ministry of Forests	$8,500
Bureau of Land Management	$9,000
Goodyear-Nelson Hardwood Lumber Company	$4,500
Hancock Forest Management	$8,500
Oregon Department of Forestry	$8,500
Siuslaw National Forest	------
Washington Department of Natural Resources	$8,500
Washington Hardwood Commission	------
Subtotal	$47,500
Oregon State University	$16,370
Total	$63,870


Hardwood
Silviculture
Cooperative