Examination of the Educational and Scientific Value of Permanent Plot Studies at Waskowitz Outdoor School, Washington State

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

University of Washington

2012

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Program Authorized to Offer Degree:

School of Environmental and Forest Sciences

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Abstract

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Permanent plots are used in ecological studies to describe both the current state and changes in ecological variables and processes such as species composition, height and diameter of individuals, coverage, log decay, survival-mortality and succession. I was interested in examining the possible educational value of plot study exercises and data collection techniques with high school students utilizing Waskowitz Outdoor School. Near North Bend, Washington in the foothills of the Cascade Mountains, Waskowitz Outdoor School presented an opportunity to establish a system of permanent plots. The primary focus of this paper is a circular one-tenth hectare plot established within the boundaries of a variable retention harvest of a stand originally dominated by aging red alder to study the returning forest and vegetation following treatment. Within this plot, data were collected biannually and measurements included the condition, height and diameter of each tree, the understory vegetation, and log diameter and decay class. I facilitated the collection of these data using high school students. Students were instructed in measurement techniques and data collection protocols, woody and herbaceous plant identification, and general engagement in recording observations. These data were then entered into long-term storage for further analysis and possible use in future property management decisions. Trends in growth, mortality, understory composition and seedling recruitment changed and were noted over the study period. The process of collecting the data within the plot proved an effective educational tool for enhancing and re-enforcing science and mathematics skills. Students showed an improved understanding in concepts such as using an x,y grid, the metric system, forestry measurement tools, tree and vegetation identification, and estimating percent coverages. In addition to the educational benefits, the permanent plot now provides a foundation of data for further studies and possible inclusion into a more extensive plot network. Waskowitz Outdoor School intends to continue data collection within the permanent plot and has offered further access to property, facilities and resources to interested University of Washington students.

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ACKNOWLEDGEMENTS

I wish to acknowledge the following individuals:

Tom Hinckley- for supporting and inspiring me throughout my entire undergraduate and graduate education at the University of Washington. Thank you for the boundless advice, numerous thesis revisions, access to forestry tools, flexible structure and continued educational and moral support.

Mark Swanson- for helping me to survey the property and determine the plot location within the alder cut area at Waskowitz Outdoor School. Mark was an invaluable resource of support and information regarding plot studies and plot establishment protocols.

Roberta McFarland- for presenting this wonderful opportunity to establish, maintain and collect data within a permanent plot system. In addition to providing the location and students to collect data, she has also been an exceptional mentor and guide into the world of outdoor education.

Robert Edmonds- for stepping in as a committee member and volunteering his valuable time and expertise, it is greatly appreciated.

Erin Meehan- for technical and moral support throughout my project. She has provided valuable advice, presented superior methods for organizing large quantities of data and exposed me to a new world of graphs and figures.

Finally, I wish to acknowledge the staff of the School of Environmental and Forest Science Resources' Advising Office, especially Michelle Trudeau and Amanda Davis. They have helped me greatly.

INTRODUCTION

Both temporary and permanent plots are used in ecological studies to describe both the current state of and changes in species composition, coverage, biomass, mortality and succession (Bakker *et al.* 1996, Crimmins 2011, Smits *et al.* 2002, Wieslander 1935). Plots have been used in a wide range of ecosystems including desert (Goldberg and Turner 1986), chaparral (Horton 1941), wetlands (Czerepko 2007), alpine (gloria.ac.at 2011), and forests (Whittaker *et al.* 1998). Plot size, shape, and frequency vary depending upon study parameters and objectives (Van Dyne and Fisser 1963).

The optimal temporal and spatial scale at which to conduct and maintain plot studies depends on the hypothesis to be tested, the vegetation type, and technical and financial restraints (Bakker *et al.* 1996). When observing changes in a system over time, it is beneficial to coordinate the temporal scale of the plot study with the temporal element of the changes occurring, such as those observed as a result of succession. Scientists have stressed the importance of maintaining data collection long enough to answer relevant questions regarding succession.

Traditionally, early-successional forest ecosystems have been under represented in plot studies. Forest studies more commonly have focused on wood production, response to fertilization and thinning, and later, on conservation and development of late successional forests. With the eruption of Mt. St. Helens and the fires of 1988 in Yellowstone National Park, studies of recovery from disturbances and early successional dynamics increased in frequency. The post disturbance conditions result in shifts in environmental conditions, which favor some species, while making the site suboptimal or intolerable for others (Swanson et al. 2011). Scientists now recognize the need for further research on the function, structure and composition of early-successional ecosystems (Swanson et al. 2011).

Long-term monitoring is an essential tool for three primary tasks and these are to: (1) inform when a system is departing from a desired state, (2) measure the success of management actions, and (3) detect the effect of perturbations and disturbances (Legg and Nagy 2005). Current studies on the effects of climate change have clearly benefited from long-term monitoring (Crimmins 2011).

In addition to these scientific functions and benefits, the use of permanent plot studies (for example, at Waskowitz Outdoor School (WOS)) may also serve as a powerful educational tool. For many years, educators have explored various ways to incorporate ecology into the curriculum (Chamberlin 1973). Environmental education has been recognized as valuable to student learning by enhancing environmental awareness, increasing scientific understanding of the Earth and improving student achievement in science and mathematics (Finarelli 1998). European nations, such as Germany, have acknowledged the value and importance of, and implement, environmental education in all sectors of the formal and informal education system (Eulefeld 1995). Educators have advocated that the most natural learning occurs through personal experience (Zoldosova and Prokop 2006). Programs using hands-on environmental education have demonstrated improved student achievement in science and mathematics (Finarelli 1998). The Puget Sound Area has a number of environmental education centers (EEC) that partner with area middle and high schools. One such EEC is Camp Waskowitz, which has several environmental learning programs for area schools (e.g. Waskowitz Education Leaders).

One form of environmental education is the use of plot studies. The collection of data from plots successfully exposes students to ecological study procedures and ecological processes occurring over time. Students collecting the data incorporate various skill sets and learning pathways to complete accurately the collection and then during the post collection, the data analysis. Tree and understory identification, mathematics (including use of an x,y grid system), accurate documentation, team building, forestry tool use and retention of knowledge over time all are important skills gained and used when working in a plot and with plot data. While working within the post disturbance landscape, students examine early-successional ecosystem conditions and observe the value of capturing these rapid changes using plot study methods. The importance of matching the temporal scale of a study to the changes occurring is stressed to students collecting such data.

A system of permanent plots was established in 2003 at Waskowitz Outdoor School. This plot system included one activity plot, one mature forest plot, and one red alder cut plot. The red alder cut plot, has been measured twice a year for the first eight years following harvest with the exception of several collection periods where time and resources became limiting and no data were collected. This thesis reports on the establishment of this plot system, the student engagement in data collection, and the nature of the data collected. Due to limitations, all data were collected only within the red alder cut plot therefore this paper focuses primarily on these data and their subsequent analysis.

In addition to the educational benefits associated with data collection over time, such a plot system is useful to Waskowitz Outdoor School management when considering future treatment options to the forest stands on their property. On the WOS property, opportunity exists to create an even more extensive plot system to increase the spatial scale of the permanent study. For the permanent plot system, the method and execution of data collection have been established and future graduate students can be recruited by WOS to continue expanding the plot network. Results from single or multiple plot data may also inform WOS regarding forest recovery and changes in forest condition.

The development of the WOS plots followed a detailed protocol for their establishment, to data collection and finally to plot maintenance (Professor Jerry Franklin, personal communication; unreferenced). This attention to detail may make the plots candidates for being incorporated into other existing long-term studies. Although the data from the red alder cut plot were collected by students and used for educational goals, the establishment and collection methods adhere to strict scientific standards. In the Netherlands, pre-existing plots have later been incorporated into networks of ecological monitoring (Smits *et al.* 2002). The WOS red alder cut plot will continue to provide vital data to Waskowitz management. The plot system can serve as a valuable educational tool, and possibly provide future scientific opportunities on a larger spatial scale.

My association with the Waskowitz Outdoor School provided an opportunity to accomplish three major objectives. First, I was interested in early-successional ecosystems and changes occurring following a variable retention alder cut replanted with Douglas-fir seedlings; second, I wanted to explore how to engage students in the scientific collection and analysis of data related to succession; and third, I wanted to evaluate and understand how such an exercise in data collection and analysis can be an effective tool in science learning. Although plots are standard in much of field science, the use of novices (e.g., middle and high school students) to collect these data over an extended period of time was unique. A system was designed to preserve both the plot and the data collected within the plot. The success and challenges of this system are presented herein.

METHODS

Site Description

All data were collected at WOS, located 6 km east of North Bend in Washington State (47-28'09"N, 121-44'01"W). Waskowitz was founded in 1947 by Carl Jensen to serve the students of the Highline School District and is located in the valley of the South Fork of the Snoqualmie River at the western foot of the Cascade Mountain Range. With an elevation of 170 m, the area is wet and cold during winter, receiving periodic winter snow and has generally mild temperatures in summer.

The outdoor school uses the 142 ha (372 ac) for student activities such as hiking, ropes courses, trail maintenance and camping. Logging is not usually practiced within the property. The forest canopy at WOS is characterized by second-growth forests of Douglas-fir (*Pseudotsuga menziesii* or PSME), western hemlock (*Tsuga heterophylla* or TSHE), western redcedar (*Thuja plicata* or THPL), bigleaf maple (*Acer macrophyllum* or ACME), and red alder (*Alnus rubra* or ALRU). Beginning in the late 1990s, WOS management had student safety concerns regarding a 300 ac aging stand dominated by red alder. A variable retention clear cut was established in the summer of 2001 to eliminate the rapidly declining red alder. A circular one-tenth ha permanent plot was established in 2003 to collect data within the recently disturbed area and was located at an elevation of 230 m in a relatively flat area that gently slopes to the northwest (Figure 1). In this area, all red alders had been removed in 2001; three large diameter trees of mixed species (two western hemlocks, one bigleaf maple) were retained and Douglas-fir seedlings were replanted in spring 2002. The understory in the forest was minimally affected by the clear cut and was typically dominated by western sword fern (*Polystichum munitum*) and salal (*Gaultheria shallon*). Although the school property is used for student hiking, special arrangements have been made to protect the integrity of this permanent plot and the associated data collected from the plot. No trails have been made leading to the red alder cut plot, the site is only entered biannually in April and October and care is taken to minimize disturbance to the understory vegetation when collecting data.

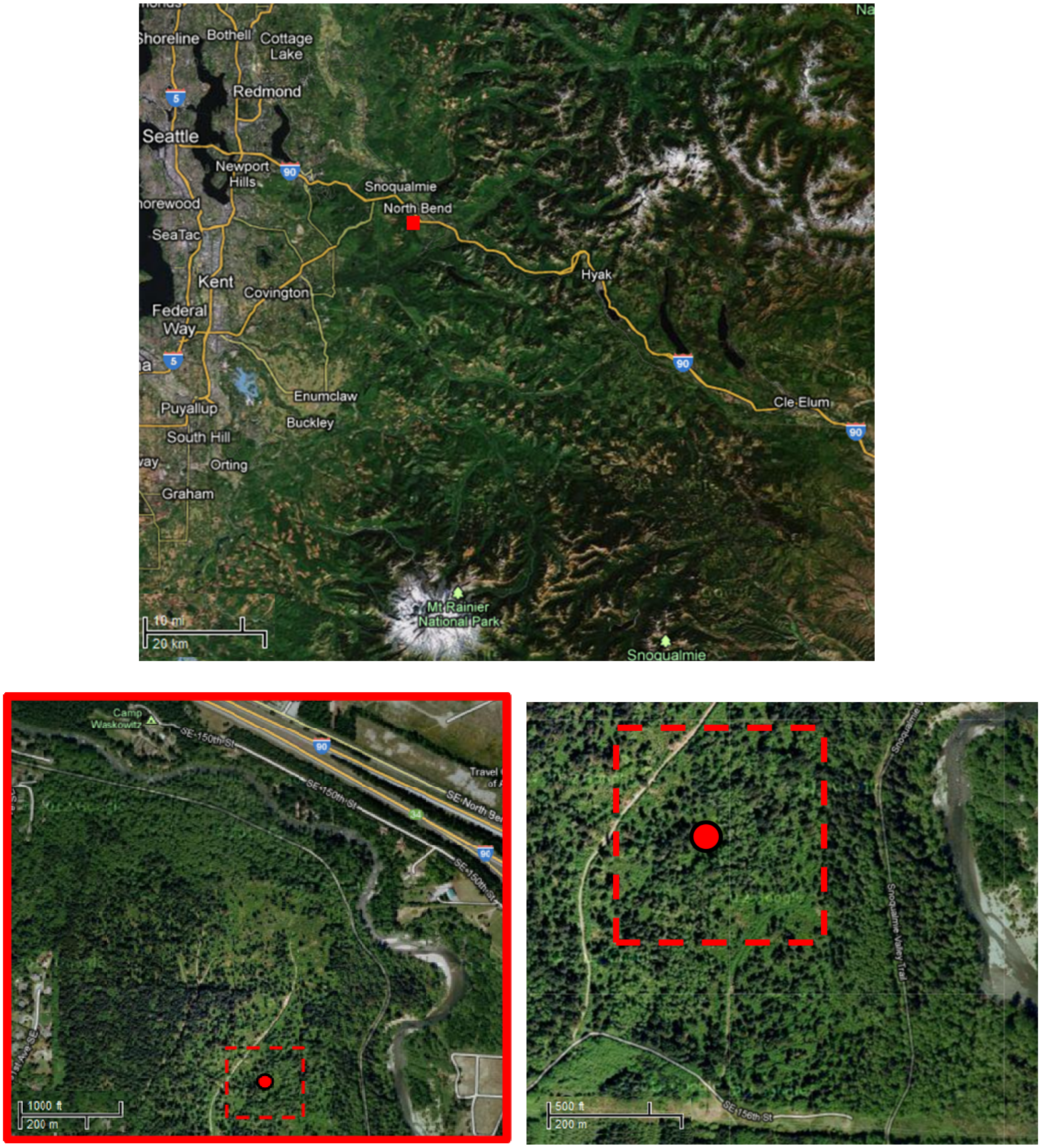


Figure 1. Study site area with red alder cut permanent plot location indicated by red circle (47-27’55”N, 121-43’35”W). The top of each picture frame is oriented to the North.

Permanent Plot Establishment and Data Collection

A three-plot system was established at WOS. It includes an activity plot for use by sixth grade students for instruction and skill practice, a mature forest plot and a red alder cut plot for use by high school students for data collection and long-term storage. Plot establishment and data collection methods were replicated for the three plots at WOS. The following methods apply to all permanent plots at WOS, with exception of within the activity plot where no trees were tagged or given coordinates. The description of the methods focused on the establishment and data collection from the red alder cut plot.

A 0.1 ha permanent plot was established in April 2003 within the red alder cut area (see Figure 1). After several surveys of the cut area, the permanent plot site was chosen with consideration of (1) distance from commonly frequented trails and (2) site composition such as the three retained large diameter trees. A circular plot with radius 17.8 m was established using rebar rods inserted approximately 1 m into the ground at all eight cardinal and sub-cardinal directions, utilizing a compass to assure proper placement. The rebar was then covered with 2 m fluorescent orange PVC pipes, which were also inserted approximately 0.5 m into the soil. An additional pole was placed in the center of the plot to be used when creating coordinates for all trees within the plot. These poles create a circle with four quadrants referred to as A, B, C, and D (Figure 2). Each tree within the plot was then tagged using galvanized steel wire necklaces with attached engraved steel tags. The wire necklaces were placed around the base of the seedlings with the attached tags. The three remnant large diameter trees were tagged at breast height on the north side of the trunk. The trees in the northeast quadrant (A) were tagged as tree 1-A1 through 1-A14. The trees in the three remaining quadrants were tagged in a similar manner. The 1 in this tagging system indicates that the tree is located within the first permanent plot; additional plots (2, 3, etc.) may be established at a later date. The letter A, B, C, or D indicates in which quadrant the tree is found. The number following the quadrant is simply the trees assigned number for long term data collection; smaller numbers indicate a location closer to the center of the plot. After tagging, each tree was given coordinates based on a simple x,y grid where the center of the plot represented the coordinates 0,0. The cardinal poles create the x and y axis for the coordinate system.

Once established, data were collected on every tree within the red alder cut plot on a biannual basis in April and October. Survival status, species, height, and diameter at breast height were recorded for each tree. The tree height of the seedlings was recorded using a metered tape until trees reached a height of approximately 2 m. When the seedlings grew taller, a meter-calibrated PVC pipe nested-height tool was utilized to measure tree height. The height of the three remnant large diameter trees was measured using a clinometer. The diameter at breast height was measured using DBH tape or calipers on smaller trees. The coordinate system was used to find the trees within the thick, returning or recovering vegetation. In the event of tree death, the date of death was recorded. Any comment that may be useful such as the topping of a tree, evidence of herbivory or an unusual growth pattern was also recorded.

Understory vegetation has also been studied within the red alder cut plot. To record the percent coverage of the understory, a metered tape was run from the center of the plot out 10 m along all four cardinal directions. A meter square constructed of four, 1-m long PVC pipes was then set down near the 10-m mark. All understory species within the square meter were recorded and a percent coverage ranging from 0-100% was assigned and recorded. The size of a fist was used to estimate 1% of the meter square. Each team member estimated the percent coverage for each species. The coverage is then discussed and each member must have a consensus value within 2% of each other or the exercise was repeated until consensus was reached. This process was repeated four times within the plot (see Figure 2).

Information on the presence, size and decay status of the course woody debris within the plot was also taken. Again, metered tapes running from the center pole to the four cardinal direction poles were used to collect data. Starting in the center and walking along a cardinal line, all woody debris over 5 cm in diameter was measured for diameter and decay class 1-5, where 1 indicated the least decayed and 5 the most decayed (Hinckley 1999). A metered tape was used to measure the diameter of the logs. This process was repeated along all four lines from the plot center to the cardinal direction poles.

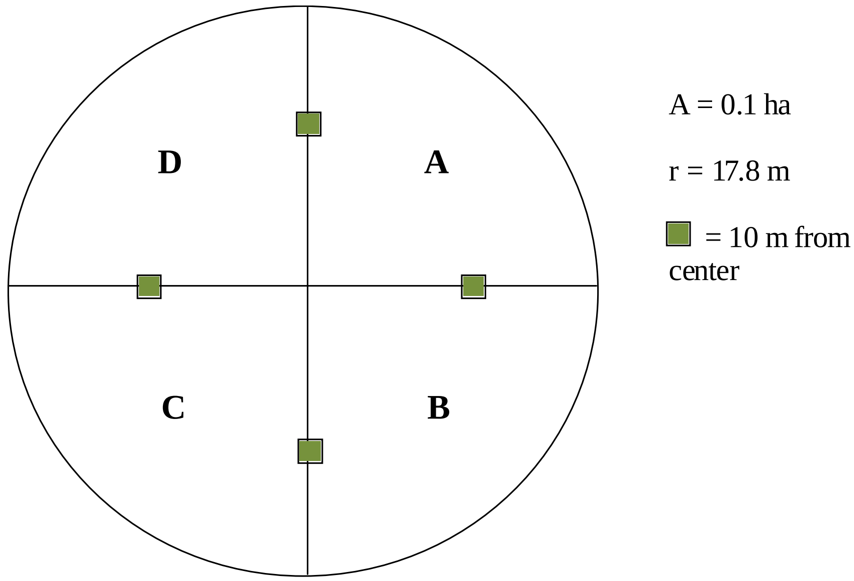


Figure 2. Diagram of permanent plot showing the four quadrants. Radius = 17.8 m; area = 0.1 ha. 1m² understory collection points, located at 10 m from plot center, shown in green. Diagram is not to scale.

DATA ANALYSIS

For years 1,2,4,5, and 6, the red alder cut plot was measured twice a year (April and October); for year 3 data were collected in April and for year 8, data were only collected in October; and for year 7, no data were collected. In any graphical or tabular display, these data gaps are indicated. Averages and standard deviations were only calculated when there was a complete measurement period. The aforementioned measurement holes are discussed later. Because data were collected biannually in spring and autumn, it was found that data storage and analysis were most easily done by assigning .33 to spring and .75 to autumn collection year dates. It was also noted that students found it easier to think about the sequence of events if they were presented in numerical form.

The following protocols were utilized with raw data analysis. For instance when a tree was found alive at year 8.75 the tree was designated as alive for the prior 3 non-collection periods at years 7.33, 7.75 and 8.33. In the case that a tree was recorded as dead or as ‘could not find’ at year 8.75 then the tree was designated as dead starting at year 7.33, the beginning of the 3 collection periods when data were not collected. The required plot study protocol states that a tree must be recorded as ‘could not find’ for two collection periods before declaring the tree dead. For the purpose of final data analysis, trees that were listed as ‘could not find’ for year 8.75 were treated as dead in the graphs below. The next data collection period will determine the final declaration of mortality in the trees that were not found at 8.75 data collection period.

For purposes of following growth and mortality, study trees within the red alder cut plot were placed into three groups and these were (1) remnant trees, (2) recruited trees, and (3) planted Douglas-fir seedlings. The remnant trees were further subdivided into five sub-groups and these were: (1) the two large diameter western hemlocks (C-2 and D-12), (2) the one large diameter bigleaf maple (D-4), (3) the small diameter remnant western hemlocks (A-8, A-13, and C-3), (4) the one remnant red alder (B-8), and (5) the one remnant western red cedar (B-1). The recruited trees, which had naturally propagated within the plot, were placed into two broad sub-groups and these were: (1) conifer species: the recruit western hemlocks (C-16, D-14, D-17 and D-18), the unknown species seedlings (C-14 and C-15), the one recruited western redcedar (C-13) and the two recruited Douglas-fir seedlings (D-19 and D-21), and (2) the hardwood species recruits: the recruited red alders (C-17, D-13, D-15, D-16, and D-20). The final group was comprised of the planted Douglas-fir seedlings.
(All of the raw tree survival and tree dimensional data, the understory data, and the downed wood and its decay class data are found in Appendices I, II, and III, respectively).

RESULTS AND DISCUSSION

The results of this long-term study consist of two parts. First, the collected data from the red alder cut plot provide a wealth of information for analysis of earlier successional patterns following a variable retention harvest. This includes data collected on all trees (species, height, DBH, and mortality), understory percent coverage, and diameter and decay class of course woody debris within the plot. Second, the process and implementation of the plot study itself serves as an experiment testing the value of using permanent plot studies in outdoor education programs. To begin, I will be reviewing the results of the data collected within the plot from spring of year 1 (e.g., April 2003) to autumn of year 8.

Tree Data

Tree Mortality

Data collected on each tree within the red alder cut plot included species, height, diameter at breast height (DBH), and mortality. First, I focus on mortality/ survival.

As described in the methods, the remnant trees within the plot were put into five sub-groups for comparison and analysis. Following the removal of the overstory red alder trees at time zero, two remnant large diameter western hemlocks (remnant sub-group 1) and one large diameter bigleaf maple (remnant sub-group 2) were noted at the first sampling period within the plot and they survived over the study period (Table 1 and Figure 3). The large diameter remnant trees were already well established and were not negatively affected by the alder cut. They continue to grow in both height and diameter. In addition to the three large remnant trees, there were three smaller hemlocks saplings that survived the red alder removal (remnant sub-group 3). Similarly, these three trees survived over the study period. One of these smaller hemlocks, tree C-3, remains small in height but continues to grow slowly. The one remnant red alder (remnant sub-group 4) died between the October sampling in the second year and the April sampling of the third year. The one remnant western redcedar (remnant sub-group 5) remained under 0.45 m in height and was dead as of year 8.75 (see Table 1).

Table 1. Number of live trees from five remnant sub-groups, two recruit sub-groups and planted Douglas-fir group from spring of year 1 to autumn of year 8.
*Assumes inclusion of D-12 from year 1.33.

	Group 1: Remnants					Group 2: Recruit		Group 3: planted
Year	Sub-group 1	Sub-group	Sub-group 3	Sub-group 4	Sub-group 5	Sub-group 1	Sub-group 2	Douglas-fi
1.33	2	1	3	1	1			42
1.75	2	1	3	1	1			39
2.33	2	1	3	1	1			39
2.75	2	1	3	1	1			38
3.33	2	1	3	0	1			36
3.75	2	1	3	0	1			34
4.33	2	1	3	0	1	8	4	34
4.75	2	1	3	0	1	7	4	32
5.33	2	1	3	0	1	4	4	31
5.75	2	1	3	0	1	5	5	30
6.33	2	1	3	0	1	5	5	30
6.75	2	1	3	0	1	5	5	30
7.33	2	1	3	0	0	3	4	29
7.75	2	1	3	0	0	3	4	29
8.33	2	1	3	0	0	3	4	29
8.75	2	1	3	0	0	3	4	29

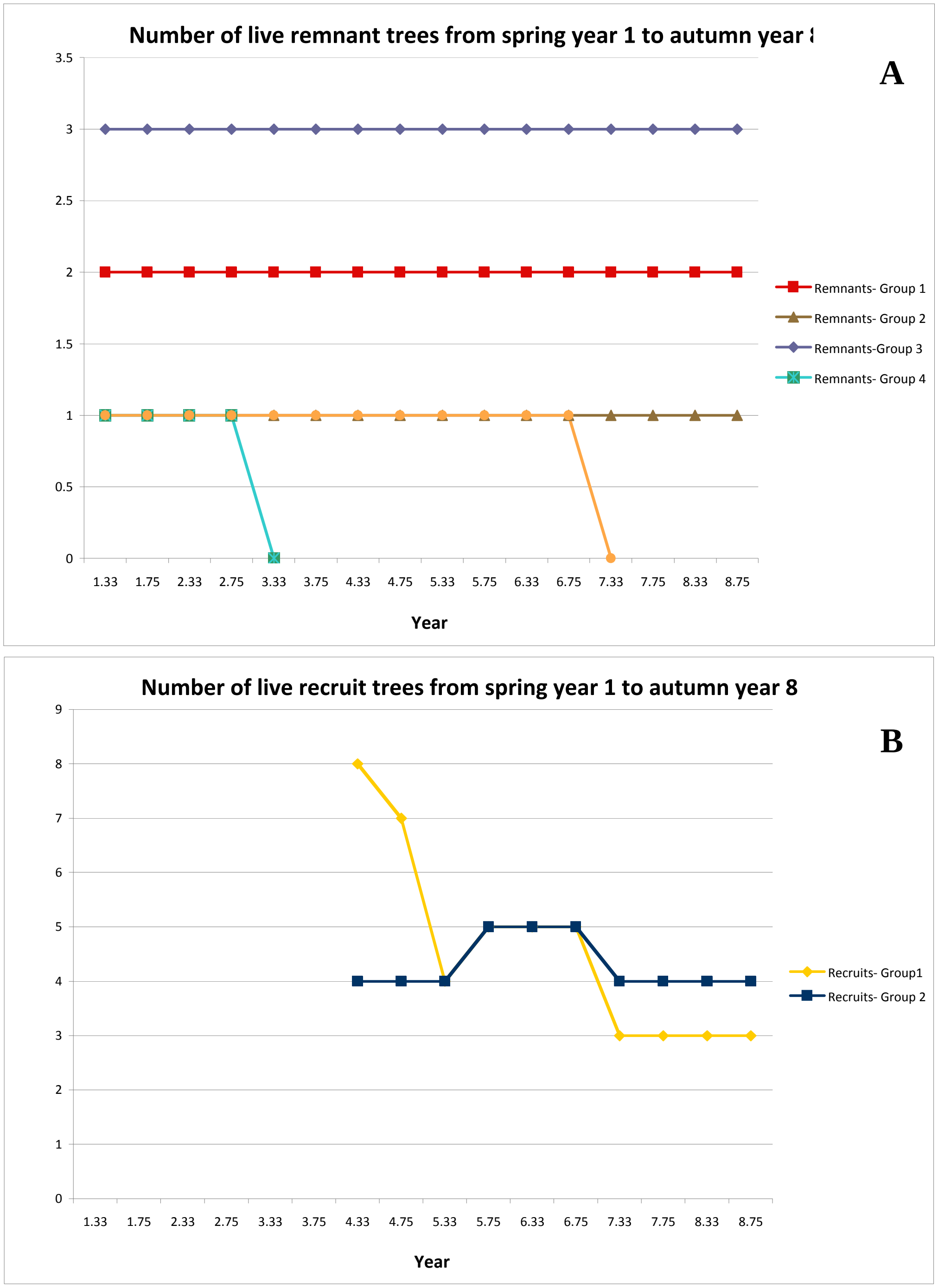


Figure 3. Number of live trees from three groups from spring of year 1 to autumn of year 8. Panel A: five remnant sub-groups (1= two western hemlocks, 2= one bigleaf maple, 3= small diameter western hemlocks, 4= one red alder, 5= one western redcedar). Panel B: two recruit sub-groups (1= conifers, 2= hardwoods). Remnant trees are shown for the measurement periods where no data were collected; it was assumed that their status did not change although there was no official tally during that period. In the legend to the right in the figures above, the word group = sub-group.

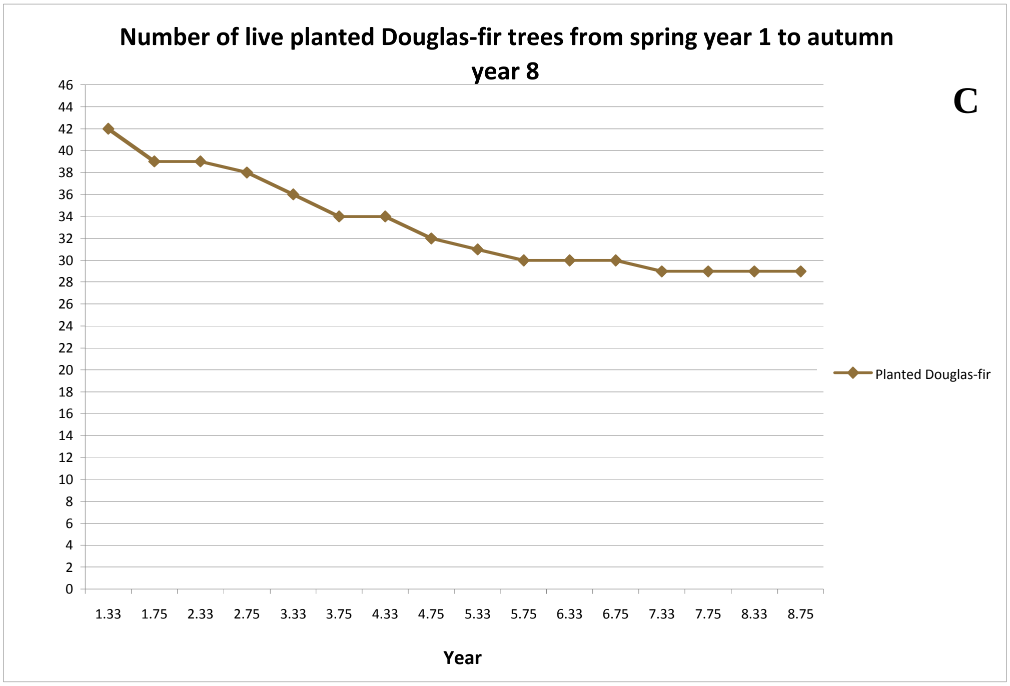


Figure 3 (continued). Number of live trees from three groups from spring of year 1 to autumn of year 8. Panel C: planted Douglas-fir group.

The remnant trees within the red alder cut plot were put into five sub-groups for comparison and analysis (see figure 3, panel A). Following the removal of the overstory red alder trees at time zero, two remnant large diameter western hemlocks (remnant sub-group 1) and one large diameter bigleaf maple (remnant sub-group 2) were noted at the first sampling time within the plot and they survived over the study period. The large diameter remnant trees were already well established and were not negatively affected by the alder cut. They continue to grow in both height and diameter. In addition to the three large remnant trees, there were three smaller hemlock sampling that also survived the red alder removal (remnant sub-group 3). Similarly, these three trees survived over the study period. Tree C-3 from this group remains small in height but continues to grow slowly. The one remnant red alder (remnant sub-group 4) died before the sampling was done at the beginning of the third growing season. The one remnant western redcedar (remnant sub-group 5) remained under 0.45 meters in height and was dead as of year 8.75.

The recruit seedlings within the red alder cut plot were put into two sub-groups. Recruit sub-group 1 is comprised of western hemlock seedlings, unknown species seedlings (likely Douglas-fir or western hemlock), two Douglas-fir seedlings, and one western redcedar seedling. This sub-group of recruits first appeared spring of the fourth growing season measured at eight individuals. At the end of the fifth growing season, this sub-group had been reduced to five individuals. This remained constant until spring of the seventh growing season when an additional two seedlings died. At final collection, three seedlings survived in recruit sub-group 1 (see Figure 3, panel B).

The recruited red alders (recruit sub-group 2) were also first recorded in the spring of the fourth growing season and four red alder seedlings were noted (see Figure 3, panel B). One additional red alder recruit was found autumn of the fifth growing season. Two of these red alders died by the spring of the seventh growing season. At final collection, three red alder recruits were observed and measured.

At beginning of measurements (year 1.33), the plot contained 42-planted Douglas-fir seedlings (or 420 trees per hectare). The Douglas-fir population slowly declined to 36 at year 3.33, 31 at year 5.33, 30 at year 6.75, and finally stabilized at 29 individuals from year 7.33 to year 8.75 (see Figure 3, panel C). Seedling mortality resulted from several factors including competition for light, nutrients and water as well as predation by elk. These factors contributed to a slow but steady decline in the total number of Douglas-fir seedlings. By the seventh growing season (year 7.33), the surviving seedlings had become well established and no further mortality occurred.

Tree height data

Tree height was recorded for each tree within the red alder cut plot. These data allow for comparison of height growth between remnant trees, recruitment trees and planted Douglas-fir seedlings.

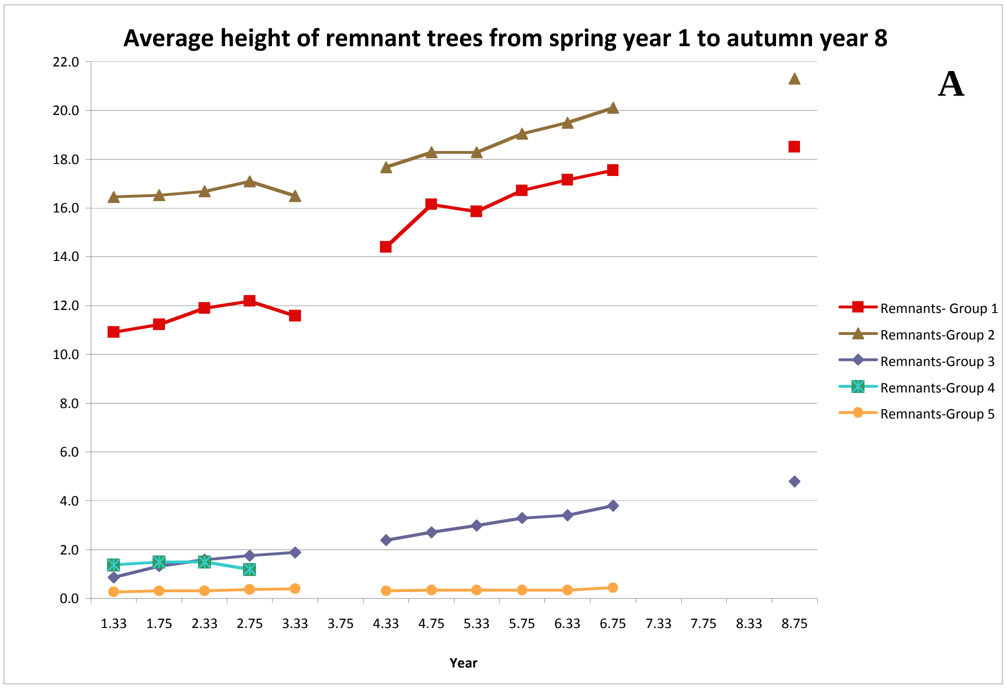
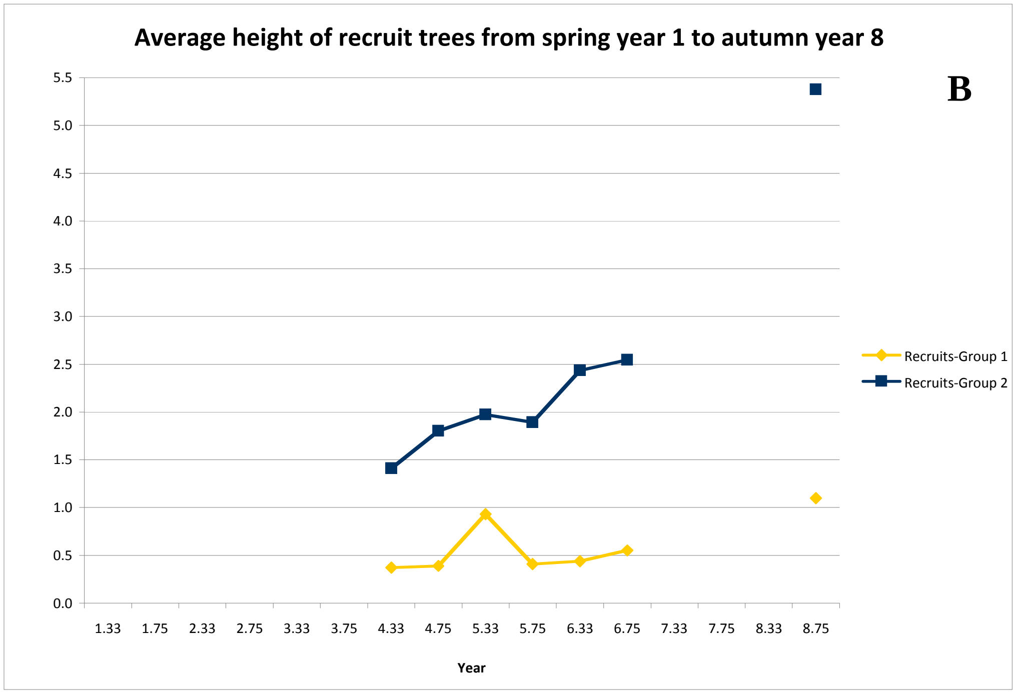


Figure 4. Average tree height from three groups from spring of year 1 to autumn of year 8. Panel A: five remnant sub-groups (1= two western hemlocks, 2= one bigleaf maple, 3= small diameter western hemlocks, 4= one red alder, 5= one western redcedar). In the legend to the right in the figure above, the word group = sub-group.



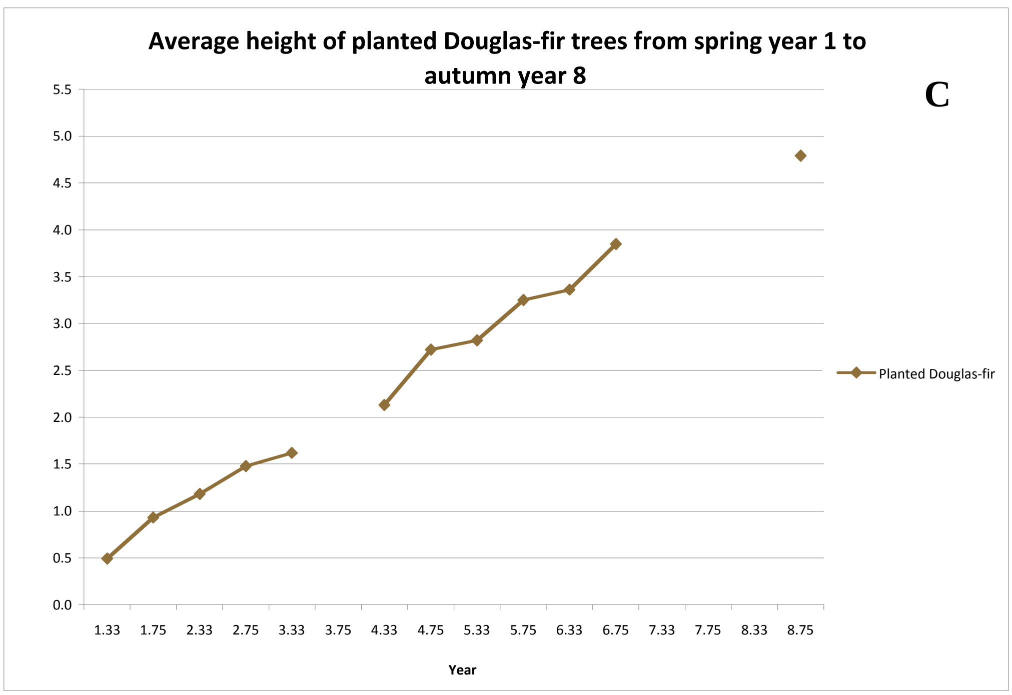


Figure 4 (continued). Panel B: two recruit sub-groups (1= conifers, 2= hardwoods). Panel C: planted Douglas-fir group. In the legend to the right in the figure above, the word group = sub-group.

Remnant sub-group 1 steadily grew in average height from year 1.33 to 2.75 (see Figure 4, panel A). At year 3.33, the average height was recorded as decreasing 0.61 m. This is believed to be an error resulting from rather old and heavily used clinometers of apparently variable accuracy. A similar average height reduction was measured at year 3.33 for remnant sub-group 2, which is the only other sub-group measured with the WOS clinometers and the only other to show a decrease in average height. For each collection period, clinometers were randomly selected from the WOS forestry tool supply bins. These data suggest that at year 3.33, less accurate clinometers may have been selected.

The third remnant sub-group was comprised of western hemlock advanced regeneration (i.e., likely regenerated before or soon after the alder harvest) saplings; these saplings steadily increased in average height over time and experienced no mortality within the study period (see Figure 4, panel A). Tree C-3 from this sub-group remains small in height, which lowered the average height of the group considerably. Remnant sub-group 4 represented the one remnant red alder within the plot. Initially this seedling grew slowly; its top had been removed by autumn of the second growing season, and it died by the following spring. This tree showed signs of elk herbivory resulting in height reduction and then death. Unable to grow up out of the thick understory, an advanced regeneration western redcedar sapling (the only member of remnant sub-group 5) grew a total of 0.14 meters from year 1.33 to 3.33. The western redcedar was topped at year 4.33 reducing its height to 0.30 m. This sapling continued slowly growing to a maximum height of 0.43 m. It was recorded as dead at year 8.75. This remnant sapling was unable to compete with the surrounding dense salmonberry and other understory vegetation was likely topped by elk herbivory, and then subsequently died.

Recruit sub-group 1(composed of the recruit western hemlocks, Douglas-fir recruits and unknown recruit seedlings) showed a steady increase in average tree height over time with a dramatic increase to near 1 m at year 5.33 (see Figure 4, panel B). By the following collection period at year 5.75 the average height decreased to just under 0.5 m. The dramatic increase at year 5.33 resulted from the death of two smaller seedlings of unknown species that raised the average height of recruit sub-group 1. The subsequent decrease at year 5.75 relates to the topping of two western hemlock seedlings, which lost a combined 1.65 m in height from elk herbivory.

Recruit sub-group 2 also demonstrated a steady increase in average height over time, except for one dip at year 5.75 (see Figure 4, panel B). This decrease in average tree height resulted from the appearance of a small red alder seedling (C-17), which was only 0.2 m in height. The addition of this small seedling to recruit sub-group 2 temporarily lowered the average height of this sub-group. At the next measurement period (year 6.33), that seedling had grown to 1.56 m and the average height of sub-group 2 increased to nearly 2.5 m.

The average height of the planted Douglas-fir seedlings progressively increased from 0.49 m at the first measurement date to 4.79 m at final measurement at year 8.75 (see Figure 4, panel C). As expected, the data showed a pattern of less growth from autumn to spring than from spring to autumn. More careful recording of phenology (i.e., autumn budset and spring bud burst and shoot expansion) would separate true growth from measurement error. A laser clinometer will be required within the next several data collection periods to accurately continue monitoring the Douglas-fir seedlings height.

Tree diameter at breast height data (DBH)

The plot study design required the diameter at breast height to be recorded for each tree within the red alder cut plot once they had achieved a height of 1.37 m, or breast height. Unfortunately, a lack of resources and proper equipment limited the DBH measurements to include only the large diameter remnant trees until year 5.75, at this time, WOS was able to acquire a 5 m DBH tape and one pair of DBH calipers. From that measurement period on, all trees reaching breast height or taller were measured for diameter.

Diameter data for the various groups and sub-groups are shown below in Figure 5. It is important to note the scale differences between the three panels. The smallest diameter was less than one cm whereas the largest diameter measured approached 60 cm.

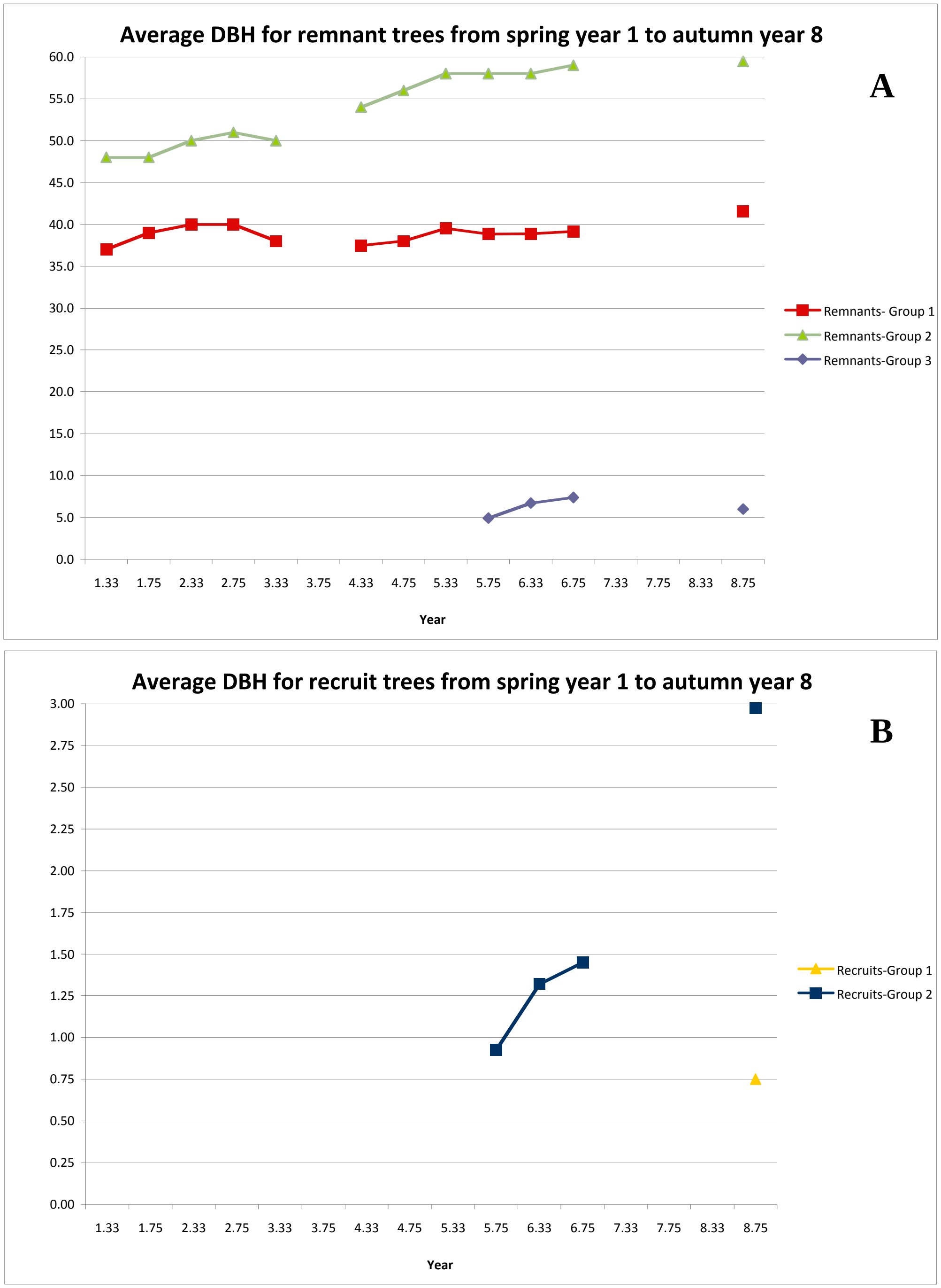


Figure 5. Average diameter at breast height (DBH) from three groups from spring of year 1 to autumn of year 8. Panel A: three remnant sub-groups (1= two western hemlocks, 2= one bigleaf maple, 3= small diameter western hemlocks). Panel B: two recruit sub-groups (1= conifers, 2= hardwoods). Remnant sub-groups 4 and 5 are not included, as the trees in these sub-groups had not reached breast height. In the legend to the right in the figures above, the word group = sub-group.

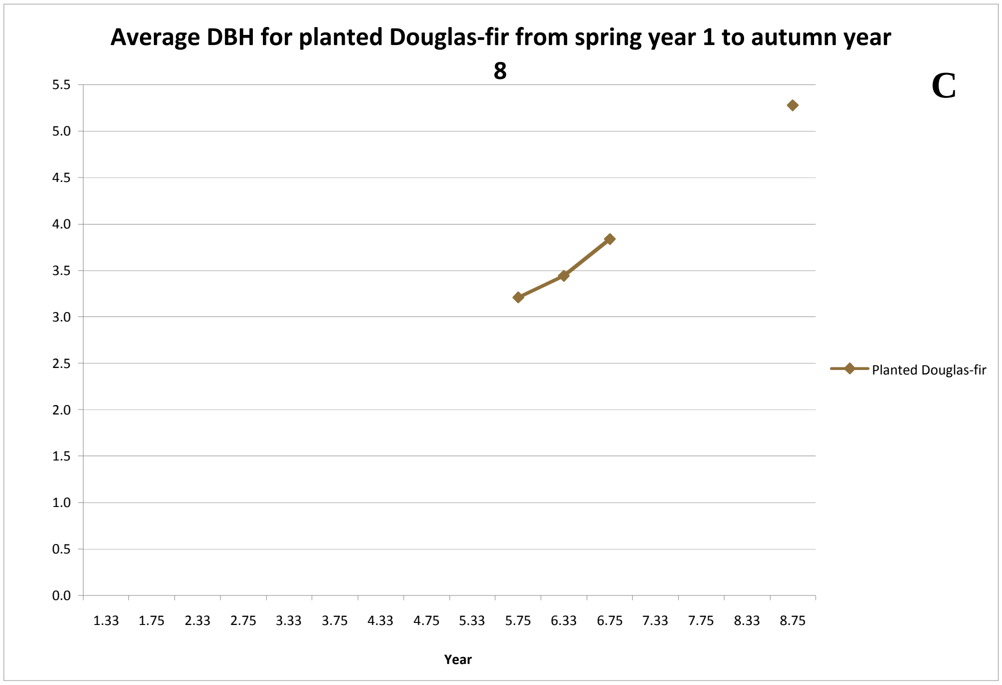


Figure 5 (continued). Panel C: planted Douglas-fir group.

Remnant sub-group 1 was comprised of the two large diameter western hemlocks and the average DBH of this sub-group was first recorded at year 1.33 at 37 cm and steadily increased to 40 cm by year 2.75. This sub-group showed a general trend of increasing DBH over time (see Figure 5, panel A). A decrease of less than 5 cm occurred at year 3.33. This most likely resulted from inaccuracy when placing the measuring tape around the circumference of the tree. The ground surrounding the base of the trees is uneven and can create difficulty repeating DBH measurement in precisely the exact same breast height location on the tree. To help avoid this source of error, I placed orange flags on the north side of the large diameter trees indicating where the students should start measuring from the base up to breast height. Remnant sub-group 1 consisted of only two trees; therefore slight error in measuring tape placement can easily affect the average DBH results.

Remnant sub-group 2 was comprised of the only large diameter bigleaf maple within the plot (see Figure 5, panel A). The DBH for this tree also steadily increased over time with one exception at year 3.33 when it decreased by 1 cm. This slight error most likely resulted from a problem properly positioning the measuring tape at the exact same place each collection period. The steady increase of DBH continued and was last recorded at 59.5 cm.

Remnant sub-group 3 showed a similar trend of increasing DBH over time (see Figure 5, panel A). This sub-group was comprised of the three small diameter western hemlocks within the plot. Average DBH for this sub-group was first recorded at year 5.75 and it only included the average DBH of trees A-8 and A-13. Tree C-3 was not included until year 8.75 when it reached breast height and it only had a DBH of 0.5cm. The average DBH of the sub-group at year 8.75 was 6 cm. The small DBH value of tree C-3 when averaged with the other two trees resulted in the average DBH of remnant sub-group 3 decreasing. This is not an error and the individual trees all showed increasing DBH over time. Both remnant sub-groups 4 and 5 never reached breast height and therefore have no average diameter at breast height data.

Recruit sub-group 1 contained the recruited western hemlocks, Douglas-firs, and unknown seedlings. From this sub-group, only tree D-18 reached breast height by the final data collection period and had a DBH of 0.75 cm. The other individuals within this sub-group are either dead or have yet to reach breast height (see Figure 5, panel B).

Recruit sub-group 2 contained the red alder recruits that had an average DBH of just less than one cm starting at year 5.75 (see Figure 5, panel B). The average DBH showed steady increase over time and at the last collection period was just below 3 cm.

Diameter at breast height for the Douglas-fir seedlings was first recorded at year 5.75 with an average of 3.21 cm, which then slightly increased to 3.44 cm by year 6.33 (see Figure 5, panel C). The average DBH increased more dramatically to 3.84 cm by year 6.75. At final data collection, the increasing DBH trend continued showing an average of 5.28 cm.

Within all remnant, recruit and Douglas-fir sub-groups, the average DBH increased over time. The slight errors (all less than 5 cm) most likely resulted from difficulty placing the measuring tape accurately repeatedly. This problem has been addressed by placing an orange indicator flag on the north side of the large diameter trees, hopefully resulting in more accurate DBH values.

Understory Data

To study the remnant and returning understory vegetation within the red alder cut plot, the total percent coverage of all species present within four 1 m-squared understory sample plots was recorded. All of the understory raw data are found in Appendix II. Four understory species were selected for further analysis: salmonberry (*Rubus spectabilis*), western sword fern (*Polystichum munitum*), trailing blackberry (*Rubus ursinus*), and bracken fern (*Pteridium aquilinum*). The percent coverage provides information on the success of a species and understory species composition over time. For each of these species the average, maximum, and minimum percent coverage was calculated using the total percent coverage of an individual species from each of the four-understory sample plots. Data for each sample date provided a maximum, a minimum, and an average percent coverage for each species.

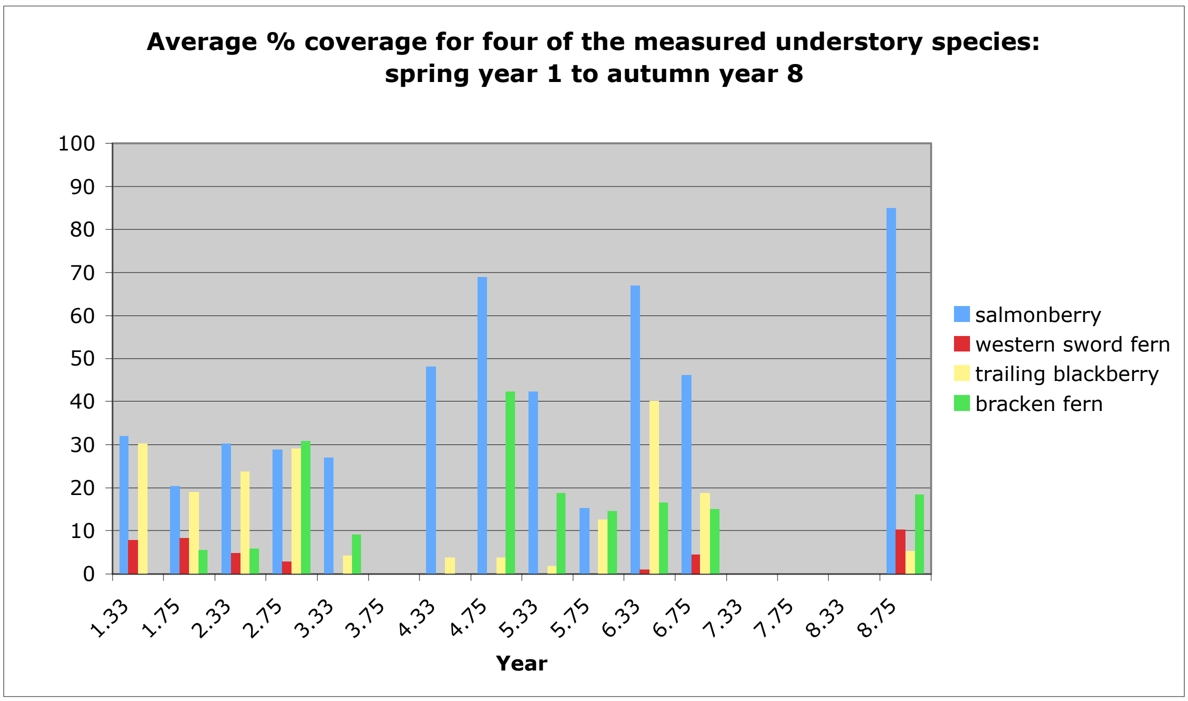


Figure 6. The average percent coverage for four selected understory species from spring of year one to autumn of year 8 are shown.

Western sword fern remained present within the plot after the alder cut, with an average percent coverage of about 8% in the first measurement year. These individuals represent remnant sword fern from the pre-cut forest. The remnant light-intolerant western sword ferns steadily declined in the presence of an increased open light environment after the cut. Western sword fern was not found within the plot at year 3.33. Western sword fern was not present again until year 6.33 and then at just 1%. It was not able to reestablish within the plot until the Douglas-fir seedlings created shade sufficient for western sword fern growth. At final collection at year 8.75, the population reached its maximum recovery at 10.3%.

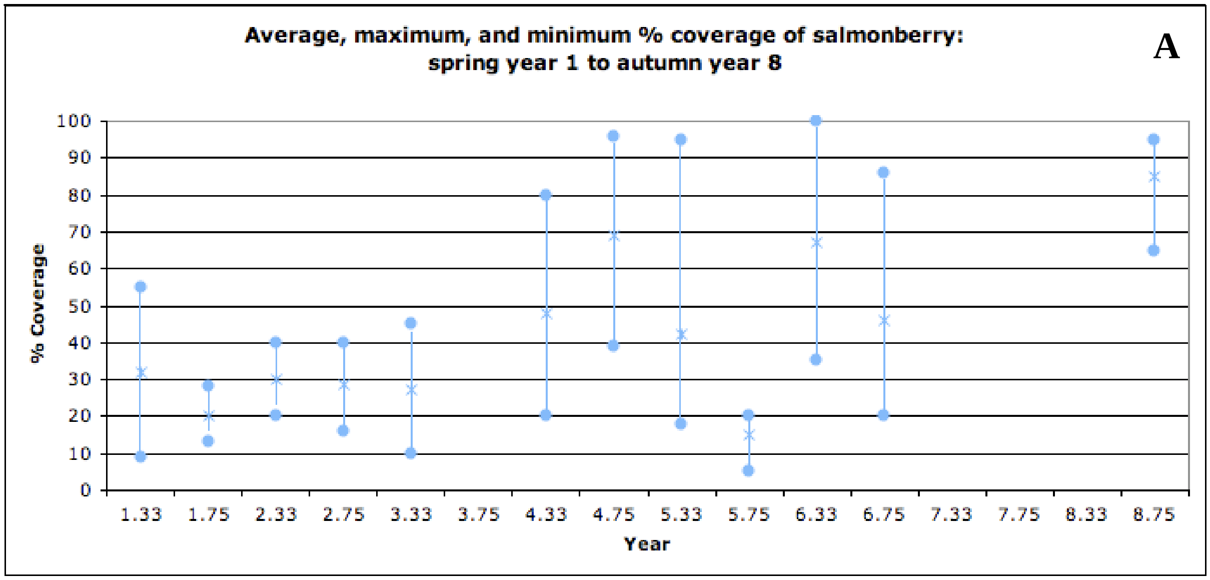
The average percent coverage for salmonberry was first recorded as 32% at year 1.33, and followed a general seasonal trend of dying back in autumn to 20.3% at the 1.75 collection period. The seasonal trend continued with an average of 30.3% at year 2.33, reducing to 28.8% by 2.75. It remained present, ranging from 27% at year 3.33, to a dramatic increase to 69% at year 4.75. The seasonal trend reversed in year 4.33 and the average percent coverage actually increased from 48% in spring to 69% in autumn (4.75). The salmonberry population then fluctuated between 42.25% at year 5.33, to 15.25% at 5.75, and then increased again to 67% at year 6.33. Again, the average percent coverage appears to be following a general seasonal trend. At final collection at year 8.75, the salmonberry reached its maximum average percent coverage at 85%. The overall growth pattern was that of salmonberry successfully establishing and becoming more dominant within the plot over time.

The initial data collection at year 1.33 showed trailing blackberry at an average percent coverage of 30.3%. Percent coverage then fluctuated over time from 19% at year 1.75, up to 29% at year 2.75, then down to about 4% at years 3.33 and 4.75 respectively. Trailing blackberry remained under 20% average coverage until it reached its maximum of 40% average coverage at year 6.33. Its presence then dramatically declined to 18.8% at year 6.75, and at final collection at year 8.75 was present at 5.3%. Trailing blackberry growth initially increased and then dramatically decreased. Its percent coverage was the most variable perhaps reflecting a response to the initial opening and then a variable response as competing vegetation repeatedly overtopped it, the trailing blackberry would then re-establish itself higher in the understory canopy only to be overtopped again. If this growth pattern is indeed real, perhaps labeling individual stems would allow observers to verify this species' flexibility.

Bracken fern was not present within the plot at year 1.33. The surrounding uncut forest does not contain a bracken fern component. Therefore the absence of bracken fern at the first data collection indicates its propagules had yet to reach the cut area. The average percent coverage rose from 5.5% at year 1.75 up to 30.8% at year 2.75. It then declined to 9% at year 3.33 and was not present at year 4.33. The maximum average percent coverage of bracken fern was found at year 4.75 at 42.3%. This dramatic increase is likely related to favorable wet autumn conditions. Its average presence then declined to 18.8% at year 5.33.

The average percent coverage of bracken fern became increasingly stable and varied between 14.5% at year 5.75, 15% at year 6.75, and 18.3% at year 8.75. Because it is deciduous and perhaps subject to herbivory, much of the early fluctuations after establishment may reflect this.

The average percent coverage values for the four selected understory species are useful descriptors of the changing understory. A comparison of the maximum, minimum and average percent coverage values also provide further insight regarding the returning understory vegetation and the variability from one understory sampling plot to another (see Figure 7 below).



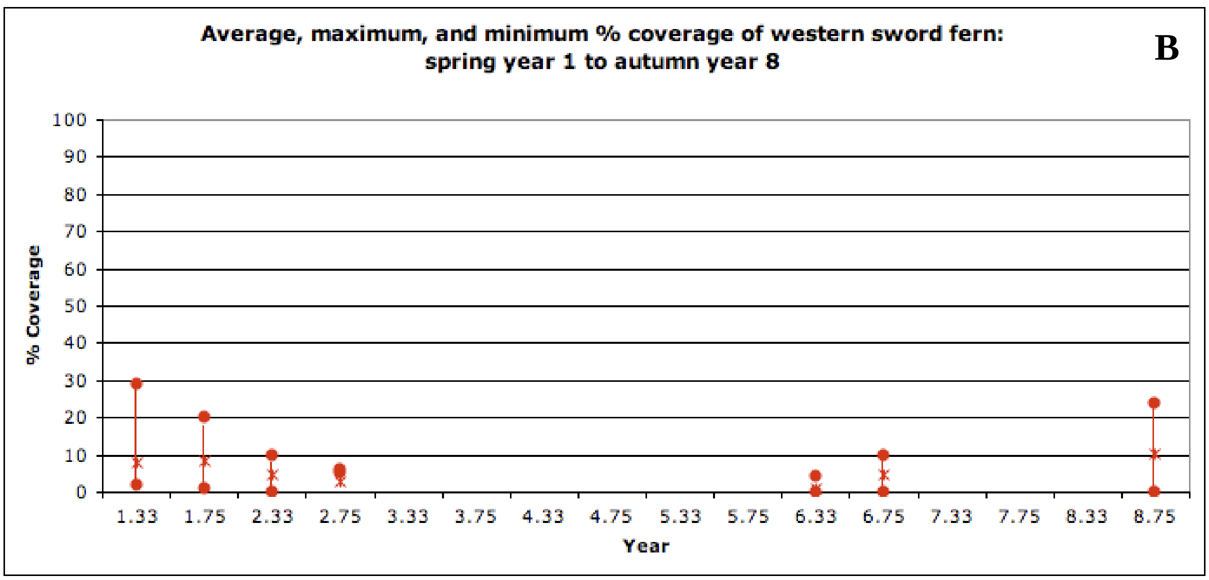
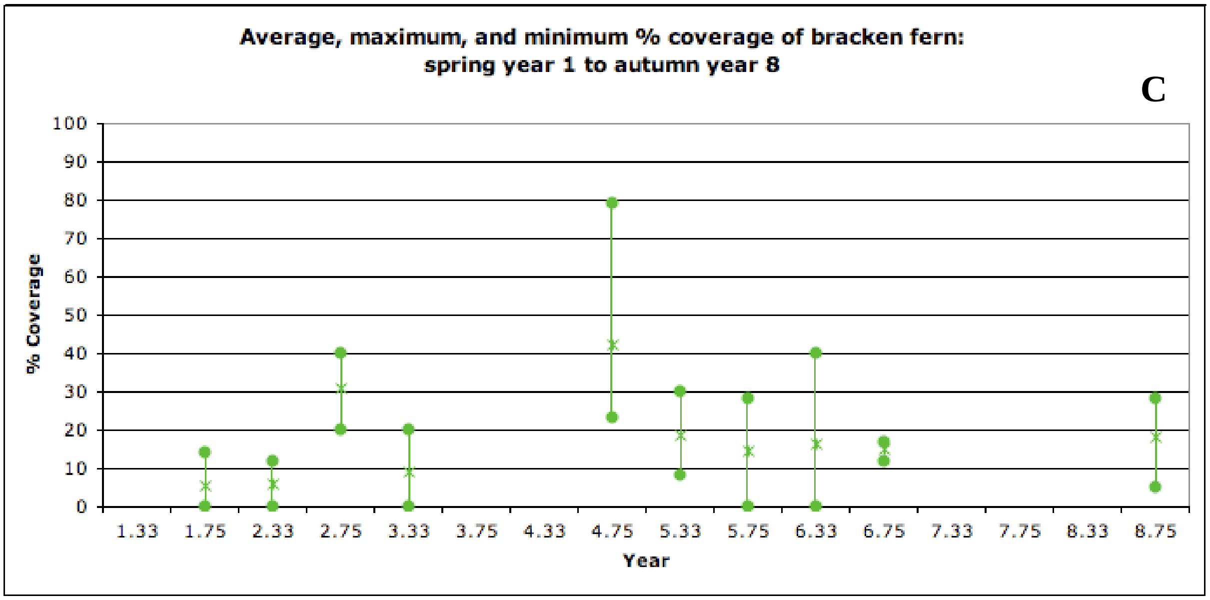


Figure 7. The average (avg), maximum (max), and minimum (min) of total percent coverage for four understory species from spring of year one to autumn of year 8 are shown. Panel A: avg, max, and min of the total percent coverage of salmonberry. Panel B: avg, max, and min of the total percent coverage of western sword fern.



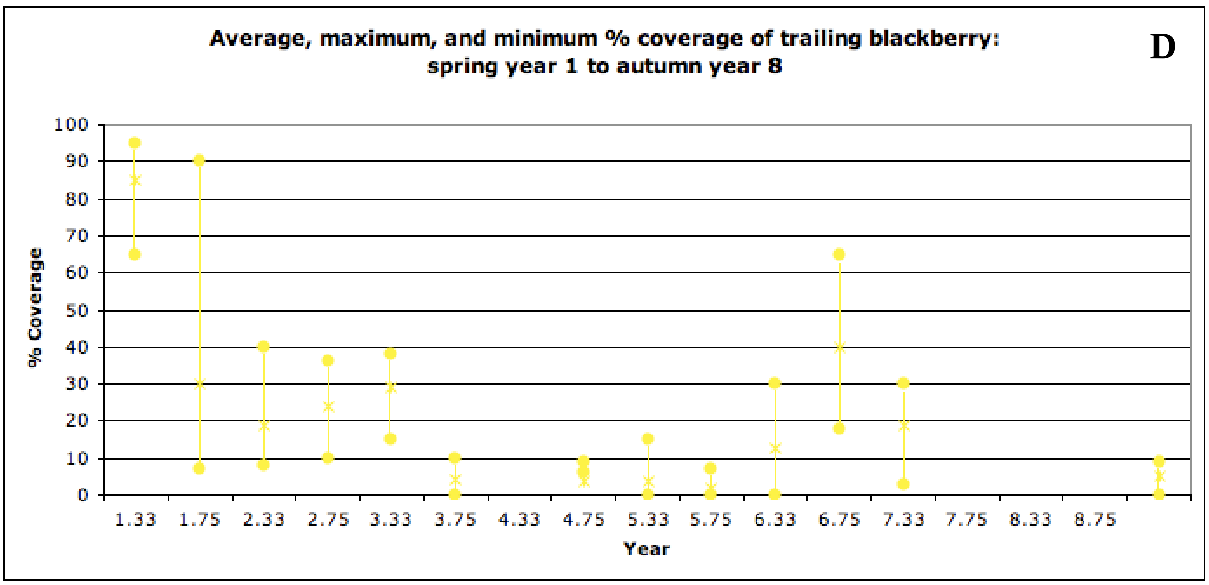


Figure 7 (continued). The average (avg), maximum (max), and minimum (min) of total percent coverage for four understory species from spring of year one to autumn of year 8 are shown. Panel C: avg, max, and min of the total percent coverage of trailing blackberry. Panel D: avg, max, and min of the total percent coverage of bracken fern.

The maximum, minimum, and average percent coverage for salmonberry was most variable. The range of salmonberry coverage values was most wide between year 4.33 and 6.75. As the planted Douglas-fir seedlings became established and grew in height, a general trend appeared where the range between maximum and minimum salmonberry coverage values increased (see Figure 7, panel A). For approximately six years following the harvest, competition and shading from the tree seedlings greatly influence the percent coverage of the salmonberry. By the final data collection at year 8.75, the range of salmonberry percent coverage had decreased, while the average and minimum values were the highest recorded. The salmonberry has increased in percent coverage throughout the plot as it has become further established.

Western sword fern had the smallest range in percent coverage, where the maximum and minimum values were more tightly grouped around the average percent coverage values. This indicated the presence of western sword fern was the most consistent within the four sample understory plots at each collection period of the four selected species (see Figure 7, panel B). The western sword fern component and its associated percent coverage values followed a pattern of decreasing coverage beginning at year 1.75 to 0% by year 3.33, followed by increased percent coverage starting at year 6.33 to year 8.75.

Trailing blackberry percent coverage values varied greatly throughout the study period. The range between maximum and minimum values were greatest at year 1.75, ranging from a minimum of less than 10% to a maximum of approximately 90% (see Figure 7, panel C). Subsequent data collection periods showed more tightly grouped maximum and minimum values around the average percent coverage.

The bracken fern maximum and minimum values were relatively tightly grouped around the average percent coverage values. The range was only notably large at year 4.75 when the values ranged from a minimum of just over 20% to a maximum of almost 80%.

Log Diameter and Decay Class Data

The logs within the red alder cut plot are remnant structural legacies from the pre-cut forest and residual material left following the harvest (Franklin et al. 2000). As remnants from the former forest, they generate environmental patterns that persist through a disturbance and are incorporated into the recovering system. Structural legacies can provide critical habitat for other organisms and/or can influence hydrological and geomorphic processes such as by trapping sediment or impeding runoff.

The log diameter and decay class data provide information on the total number, diameter, and decay class of all logs (over 5 cm in diameter) found crossing the four lines aligned with four cardinal directions. Data on number, size and decay class indicate the quality and quantity of remnant logs from before the cut as well as similar data on the course woody debris left behind from logging activities.

Table 2. Average, maximum, and minimum values for log diameter (cm) and decay class (1-5) from spring of year 1 to autumn of year 8.

	Log Diameter Data (cm)				Decay Class Data (1-5)			
Sample Year	average	maximum value	minimum value	standard deviation	average	maximum value	minimum value	standard deviation
1.33	10.7	32	5	5.7	1.8	4	1	0.9
1.75	11.0	31	5	6.6	1.9	3	1	0.6
2.33	11.6	30	5	6.6	2.2	3	2	0.4
2.75	12.6	30	5	7.2	2.3	4	2	0.6
3.33	12.8	30	5	6.1	2.0	4	1	0.9
3.75	No data	No data	No data	No data	No data	No data	No data	No data
4.33	10.0	36	6	5.4	2.6	4	2	0.7
4.75	7.9	28	5	4.2	2.6	4	1	0.9
5.33	12.9	30	5	7.7	2.3	4	1	0.6
5.75	7.7	13	5	2.3	2.6	4	2	0.6
6.33	8.9	30	5	5.7	2.7	4	2	0.8
6.75	7.7	13	5	2.3	2.6	4	2	0.56
7.33	No data	No data	No data	No data	No data	No data	No data	No data
7.75	No data	No data	No data	No data	No data	No data	No data	No data
8.33	No data	No data	No data	No data	No data	No data	No data	No data
8.75	8.6	26	5	5.7	3.1	4	2	0.4

The log diameter data show a general trend of decreasing average diameters over time (see Table 2). This is consistent with the decay process reducing the size of the logs. The average diameter declined from first to last collection and was 10.7 cm at year 1.33, 10 at year 4.33 and 8.6 cm at year 8.75. An examination of the average, maximum, and minimum values and the standard deviation indicate that more of the logs sampled were likely closer to the 5-8 cm diameter range. This results from many alder branches left behind after the cut. The slight increase in diameter, such as the 12.8 cm average at year 3.33 results from varying total logs measured each year. The logs were not specifically tagged so the number of logs found at each collection period varied dependent on the thickness of understory coverage at the time and student persistence in locating buried logs.

The log decay class data showed a trend of increasing average decay class over time. This is consistent with the process of the relatively rapid decay of the alder branches left from the cut and the increasing decay of the remnant pre-cut logs. Several of the larger diameter pre-cut logs were believed to be western hemlock (*Tsuga heterophylla*). Literature on decay from Pacific Northwest studies suggests that course woody debris of western hemlock decompose at a significantly higher rate than that of Douglas-fir logs (Marra and Edmonds 1996).

Spatial Patterns

Average values such as tree height, understory percent coverage, mortality and log decay class and diameter are useful for analysis of successional changes within the whole red alder cut plot. In addition, differences in quadrant characteristics can provide further insight into spatial patterns associated with temporal changes in such variables as tree mortality and seedling recruitment.

Tree mortality varied greatly between the four quadrants. Quadrant A had the highest mortality rate of 50%, losing 7 of the total 15 trees by autumn of 2010. This quadrant had no recruit seedlings. Quadrant B had the least mortality, losing only 2 of the 11 total trees. This quadrant also had no recruit seedlings. In the C quadrant, 6 of the 17 trees died by final data collection. Five recruit seedlings established in quadrant C. One-third of total trees in the D quadrant died, with 7 out of 21 dead at final collection. Quadrant D had the most recruits with a total of nine seedlings.

Although the understory vegetation showed seasonal variability, density of the understory vegetation also varied between the four quadrants. The A quadrant showed relatively thick understory vegetation but never as dense as quadrant B. Over the study period, the B quadrant had the densest understory, especially the salmonberry component. The thick understory may have hindered elk herbivory that may have reduced seedling mortality in this quadrant. The dense salmonberry may have also impeded the establishment of recruit seedlings. The C and D quadrants had noticeably less dense understory vegetation throughout the study period. These quadrants also contained large diameter western hemlocks that likely produced most of the recruit seedlings. The planted trees and recruit seedlings in the C and D quadrants were more exposed to the elements and were more easily accessed by elk herbivory. The A and B quadrants were characterized by relatively thick understory and no recruits, while the C and D quadrants had a less dense understory component and received all recruit seedlings and showed variable mortality.

Examination of the Educational Role of Plot Studies at Waskowitz Outdoor School

Evaluating the educational value of using a system of plots for studies of ecological processes at WOS involves examination of several components. These include intended plot study design and protocol versus actual implementation, emergence of best practices, my roles at Waskowitz, and future study opportunities using this and other study plots at WOS.

Intended plot study design and protocol and actual implementation

With regards to the process of implementation and data collection using a permanent plot system, I found myself constantly comparing the intended plot measurement and data collection protocol with the reality of limited resources, variable student interest and background and logistical restrictions. The initial design I created for WOS involved a three-plot system including an activity plot, a mature forest plot, and a plot within the red alder harvest site.

The activity plot is a replica of the two other permanent plots (i.e., the mature forest and red alder harvest) and was intended for use by sixth grade classes, high school leaders, and their teachers as a learning/practice tool. Like the other plots, the activity plot is circular with a radius of 17.8 m. The plot is marked with PVC pipe poles at the eight cardinal and sub-cardinal directions. The trees are not tagged, allowing different groups to simulate setting up coordinates for tree location. Unlike the other two permanent plots, the activity plot is purposely located at a site easier to access and closer to Waskowitz facilities. Sixth grade classes can use the activity plot to simulate the data collection process done in the permanent plot by the high school students. The goal in utilizing the activity plot is to teach the sixth graders about permanent plots and data collection skills. Some of these sixth grade students would stay within the district, returning to WOS as high school leaders. The skills learned as a sixth grader could be built upon as a returning high school leader in the permanent plots. The skills gained in the activity plot could potentially result in an increased understanding and efficiency as well as reduced time and foot traffic when students return to collect data within the permanent plots. Skills gained in the activity plot include plant identification, use of the metric system, running out lines using a compass and metered tape, clinometer use, exposure to forestry, forest and understory succession talks, knowledge of x,y grids, percent coverage measurements of the understory and decay class measurements and guidelines. The students in the activity plot also must work as a team to collect and record data accurately. It is hoped that this experience will provide a foundation of data collection skills that will later be useful when working within the permanent plots. In addition, the hands on skills learned may more broadly benefit students in their other classes.

A permanent plot was also established within a mature forest stand dominated by second growth Douglas-fir. The mature plot was established using the same protocol and data collection methods as those used to create the alder cut plot. This circular one-tenth hectare area plot was intended for use in conjunction with the alder cut plot, allowing students to compare structure, species, decay and understory composition and to exemplify different stages of succession. The plot was established in a relatively isolated stand of forest not affected by the logging activity. All trees within the plot were tagged, given coordinates and are ready for current or future use.

The mature plot was intended for measurement biannually, just as the red alder cut plot. However, the dense forest cover made it impractical to use traditional clinometers for tree height measurement. Waskowitz has yet to acquire a laser clinometer, therefore the mature plot has remained currently inactive. However, parameters such as diameter and mortality as well as understory coverage could be currently measured.

The permanent plot within the alder cut area was established and utilized as described in the methods section of this paper. It was intended for use in coordination with the activity and mature plot to provide comprehensive exposure to plot studies and opportunity to build science and data collection skill sets. Although not currently utilized, the mature stand is established and ready to be a part of the plot studies at WOS. The activity plot has been used by numerous classes, but could benefit from incorporation into curricular offerings by teachers while at WOS. Currently, not every sixth grade class uses the activity plot. Time and resource limitations as well as varying teacher backgrounds result in many classes missing the opportunity to actively study permanent plots and data collection. If all sixth grade students were required to experience the activity plot, an increased number of returning high school student leaders would possess basic knowledge of plot studies and data collection; these skills might then be used to measure the remaining two plots.

Emergence of best practices and future recommendations

In addition to the procedures and protocols discussed in the methods, the process of data collection revealed several examples of best practices and future recommendations. This information is intended to aid in future plot establishment and on-going measurements.

Regarding the collection of tree height data, the best measuring tools for each range of trees are as follows; metered tape for small seedlings, calibrated PVC pipe pole for larger seedlings up to approximately 3.5 m, and laser clinometer for all trees 3.5 m or taller including all trees within the mature forest plot.

For all tools required for data collection, ideally the collection team would possess a set of two or more of each, permitting students to break into to smaller groups. This would facilitate efficient time use and allow multiple groups to perform different measurements simultaneously. The clinometers used thus far have displayed various levels of accuracy resulting in several errors. New clinometers would provide more accurate readings for trees within the plots.

The initial data collection within the red alder cut plot was scheduled biannually to capture quickly changing conditions after the harvest and replanting. For mature forest plots, biannual collection may prove unnecessary. Within the alder harvest plot, as the Douglas-fir seedlings grow taller than 4 m, WOS may soon choose to reduce collection to once per year. If data were collected only annually, the October data period would be preferable in order to measure changes occurring over the spring/summer growth season. Personal, logistical, and resource limitations resulted in no data collected for four periods (sample periods 3.75,7.33,7.75, and 8.33). The lack of measurements left gaps in the dataset. However, sufficient sampling coverage was maintained so that patterns in growth survival and percent coverage are clear. The data gaps themselves might have instructional value.

During initial red alder cut plot establishment, coordinates for all trees were recorded incorrectly resulting from holding the compass over the center-marking pole. The PVC pipe pole contained a stabilizing rebar pole that altered the compass readings. The incorrect tree coordinates were discovered later in spring of 2006 when attempting to use them to locate specific trees in the thick returning understory. The process of designating new coordinates revealed that an additional large western hemlock tree (D-12) was located just within the corrected plot boundaries. All trees within the plot received new coordinates and no trees changed quadrants or fell outside the corrected plot boundaries. Any future plots should be established and given tree coordinates before inserting rebar pole for center marking.

Role at Waskowitz Outdoor School

I performed several roles at WOS. These roles served two major functions: (1) I established, maintained and oversaw data collection and analysis associated with the permanent plot system (in this role, I worked with high school students), and (2) I facilitated science and forestry education to sixth grade students and their teachers (over time, some of these students returned as high school students and assisted with role 1). Depending upon background, other undergraduate seniors and graduate students may assume or even add to these roles in the future.

As the first University of Washington graduate student to coordinate with and utilize Waskowitz resources, I was interested in establishing a permanent plot system while assisting the staff in teaching ecology and science. I designed and established a three-plot system including an activity plot, a mature forest plot, and an alder cut plot (described in detail in the preceding section). At WOS, I oversaw the collection of all data from within the alder cut plot and entered the data into long-term electronic storage.

In addition to managing the permanents plots, I worked with the sixth grade teachers to facilitate in outdoor activities, science and ecology lessons, ropes courses and hiking. The Highline District teachers have widely varying backgrounds in participating in or leading outdoor and science activities. Some teachers had specific goals and planned activities for their time at WOS. Others required additional guidance and assistance with leading ecology activities and forestry talks. I was preferentially assigned to help work with teachers who expressed interest in plot studies and data collection. To address concerns relating to the alder harvest, I often delivered talks to teachers and classes on why WOS chose to perform a variable retention cut. Other talks given in the field included subjects such as the value and uses of permanent plots, succession, data collection, dwarf mistletoe, plant identification and ecosystem interactions.

Future opportunities at Waskowitz Outdoor School

Waskowitz provides learning opportunities for its Highline Districts students, but is also interested in expanding its relationship with University of Washington students. Undergraduate and graduate students are encouraged to utilize WOS facilities and property for use in senior papers, thesis work, and other projects. Numerous opportunities exist such as further collection and analysis within the plot system, facilities for longer duration stays, property for additional studies, educational leader roles, and experience with students of various ages from sixth grade to twelfth grade.

CONCLUSIONS

The data collection process and the dataset itself served several roles. The data collected and stored were shown to be generally accurate. Causes for most errors made were fairly easily understood and solutions were discovered and applied to ensure increasing accuracy in data collection in the future. For example, the slight variance in DBH values was attributed to difficulty accurately placing the measurement tape at exactly breast height. Orange flags now indicate the proper location from which to start measurement from the base of the tree up to breast height. Solutions such as this are easily incorporated into the data collection methods and will increase the accuracy of the data in the future.

The vast amount of stored data can be used as an educational resource for all WOS students and staff, not just those involved in the data collection process. These data are available for further analysis, incorporation into other curriculum, and as a tool aiding in future property management decisions. The data were collected and stored in a manner that lends them to incorporation into other plot networks on WOS or elsewhere. The data is stored in spreadsheet form using Microsoft Excel. It has been stored on my personal computer and periodically provided to WOS on zip drives.

The process of collecting the plot study data also served as a valuable educational tool. The various measurements and procedures involved in plot study data collection put the students through rigorous lessons in tree and understory plant identification, x,y grids, the metric system and use of scientific tools. Students who worked within the plot have varying math and science skill levels. Through the process of collecting data these students acquire new proficiency and understanding of mathematical and scientific concepts. Although it is difficult to measure or describe how individual students respond to the collection procedures, my experience with the nearly twenty student groups showed certain plot activities had a strong positive effect on the majority of the students. Most notably, the process of determining the percent coverage for the understory vegetation quickly and effectively taught students understory plant identification. Students left the plot with strong plant identification skills as well an understanding of how to reach a scientific consensus amongst a data collection group.

The permanent plot study has provided valuable data, educational opportunities and insight into the returning forest at Waskowitz Outdoor School. The established plot system can be used for further instruction and analysis, future management decisions, or even incorporation into other plot networks. WOS also provides resources and opportunities for University of Washington students who may aspire to work within the plot system or create a project of their own. The experience of establishing and collecting data provided an important lesson in scientific planning and implementation and revealed the numerous possibilities for use of plot studies in education.

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Appendix I: Tree data

Note: yellow highlighting = dead tree and red highlighting = important comment

			PERMANENT PLOT STUDY DATA				
		ALDER CUT AREA-SPRING 2003					
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	0.38			3.8	5.9	
1-A2	PSME	0.48			5.3	9.1	
1-A3	PSME	0.53			5.3	9.1	
1-A4	PSME	0.6			2.1	12.5	
1-A5	PSME	0.44			4.9	13.5	
1-A6	PSME	0.3			6.4	16	
1-A7	PSME	0.32			6.6	13.1	
1-A8	TSHE	1.2			11.9	14.3	
1-A9	PSME	0.37			2.3	2	
1-A10	PSME	0.42			7.6	4.2	
1-A11	PSME	0.56			11.1	1.7	
1-A12	PSME	0.5			10	8	
1-A13	TSHE	0.7			12.6	11.6	
1-A14	PSME	0.4			12.6	10.9	
1-A15	PSME	0.45			17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.26			1	-1.8	
1-B2	PSME	0.48			5.6	0	
1-B3	PSME	0.4			9.5	-3.7	
1-B4	PSME	0.43			7.9	-6.1	
1-B5	PSME	0.5			7.9	-6.1	
1-B6	PSME	0.4			11.7	-1.3	
1-B7	PSME	0.63			11.5	-8.1	
1-B8	ALRU	1.37			14.4	-2.8	
1-B9	PSME	0.46			8.2	-10.8	
1-B10	PSME	0.65			7.8	-14.4	
1-B11	PSME	0.47			10.7	-12.7	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	0.65			-0.6	-8.4	
1-C2	TSHE	10.9	115	37	-2.6	-12.8	
1-C3	TSHE	0.68			-4.2	-9	GROWING HORIZONTALLY NEAR GROUND
1-C4	PSME	0.53			-4.3	-15.7	
1-C5	PSME	0.51			-7.6	-13.5	
1-C6	PSME	0.5			-3.3	-0.7	
1-C7	PSME	0.5			-8.7	-1.5	
1-C8	PSME	0.78			-8.2	-7.9	
1-C9	PSME	0.46			-11.8	-3.8	
1-C10	PSME	0.5			-11.3	-8.4	
1-C11	PSME	0.74			-14.9	-1.4	
1-C12	PSME	0.59			-15.9	-6.4	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	0.56			-1.3	1.8	
1-D2	PSME	0.47			-7	2.1	
1-D3	PSME	0.45			-11.5	1.1	
1-D4	ACMA	16.45	15	48	-10.2	4.9	
1-D5	PSME	0.48			-15.5	2.3	
1-D6	PSME	0.44			-14.9	3.5	
1-D7	PSME	0.49			-14	6.4	
1-D8	PSME	0.14			-14.3	7.4	
1-D9	PSME	0.77			-0.8	8.2	
1-D10	PSME	0.53			-3.7	10.2	
1-D11	PSME	0.48			-10.9	12.7	

PERMANENT PLOT STUDY DATA

ALDER CUT AREA- Autumn 2003

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	1.21			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	0.93			5.3	9.1	
1-A4	PSME	1.21			2.1	12.5	
1-A5	PSME	0.89			4.9	13.5	
1-A6	PSME	0.75			6.4	16	
1-A7	PSME	0.68			6.6	13.1	
1-A8	TSHE	1.90			11.9	14.3	
1-A9	PSME	0.98			2.3	2	
1-A10	PSME	0.83			7.6	4.2	
1-A11	PSME	0.98			11.1	1.7	
1-A12	PSME	0.59			10	8	
1-A13	TSHE	1.20			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	0.89			17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.30			1	-1.8	
1-B2	PSME	0.94			5.6	0	
1-B3	PSME	0.69			9.5	-3.7	
1-B4	PSME	0.95			7.9	-6.1	
1-B5	PSME	0.97			7.9	-6.1	
1-B6	PSME	1.18			11.7	-1.3	
1-B7	PSME	1.29			11.5	-8.1	
1-B8	ALRU	1.48			14.4	-2.8	
1-B9	PSME	0.80			8.2	-10.8	
1-B10	PSME	1.06			7.8	-14.4	
1-B11	PSME	0.79			10.7	-12.7	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	0.99			-0.6	-8.4	
1-C2	TSHE	11.22		39.0	-2.6	-12.8	
1-C3	TSHE	0.89			-4.2	-9	GROWING HORIZONTALLY NEAR GROU
1-C4	PSME	0.93			-4.3	-15.7	
1-C5	PSME	0.99			-7.6	-13.5	
1-C6	PSME	1.03			-3.3	-0.7	
1-C7	PSME	0.88			-8.7	-1.5	
1-C8	PSME	1.19			-8.2	-7.9	
1-C9	PSME	0.97			-11.8	-3.8	
1-C10	PSME	0.53			-11.3	-8.4	
1-C11	PSME	1.19			-14.9	-1.4	
1-C12	PSME	1.09			-15.9	-6.4	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	1.02			-1.3	1.8	
1-D2	PSME	0.89			-7	2.1	
1-D3	PSME	0.46			-11.5	1.1	
1-D4	ACMA	16.52		48.0	-10.2	4.9	
1-D5	PSME	0.83			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	0.86			-14	6.4	
1-D8	PSME	0.56			-14.3	7.4	
1-D9	PSME	1.13			-0.8	8.2	
1-D10	PSME	0.96			-3.7	10.2	
1-D11	PSME	1.19			-10.9	12.7	

PERMANENT PLOT STUDY DATA

ALDER CUT AREA- Spring 2004

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	1.35			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	1.05			5.3	9.1	
1-A4	PSME	1.78			2.1	12.5	
1-A5	PSME	1.13			4.9	13.5	
1-A6	PSME	0.91			6.4	16	
1-A7	PSME	0.97			6.6	13.1	
1-A8	TSHE	2.22			11.9	14.3	
1-A9	PSME	1.03			2.3	2	
1-A10	PSME	1.10			7.6	4.2	
1-A11	PSME	1.46			11.1	1.7	
1-A12	PSME	0.70			10	8	
1-A13	TSHE	1.60			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	1.30			17	1.8	

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.31			1	-1.8	
1-B2	PSME	1.18			5.6	0	
1-B3	PSME	0.80			9.5	-3.7	
1-B4	PSME	1.46			7.9	-6.1	
1-B5	PSME	1.20			7.9	-6.1	
1-B6	PSME	1.70			11.7	-1.3	
1-B7	PSME	1.94			11.5	-8.1	
1-B8	ALRU	1.49			14.4	-2.8	
1-B9	PSME	1.01			8.2	-10.8	
1-B10	PSME	1.80			7.8	-14.4	
1-B11	PSME	1.08			10.7	-12.7	

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	1.30			-0.6	-8.4	
1-C2	TSHE	11.90		40.0	-2.6	-12.8	
1-C3	TSHE	0.95			-4.2	-9	GROWING HORIZONTALLY NEAR GR
1-C4	PSME	1.05			-4.3	-15.7	
1-C5	PSME	1.10			-7.6	-13.5	
1-C6	PSME	1.14			-3.3	-0.7	
1-C7	PSME	0.93			-8.7	-1.5	
1-C8	PSME	1.31			-8.2	-7.9	
1-C9	PSME	1.11			-11.8	-3.8	
1-C10	PSME	0.54			-11.3	-8.4	
1-C11	PSME	2.06			-14.9	-1.4	
1-C12	PSME	1.26			-15.9	-6.4	

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	1.23			-1.3	1.8	
1-D2	PSME	1.09			-7	2.1	
1-D3	PSME	0.46			-11.5	1.1	
1-D4	ACMA	16.69		50.0	-10.2	4.9	
1-D5	PSME	1.01			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	1.09			-14	6.4	
1-D8	PSME	0.69			-14.3	7.4	
1-D9	PSME	1.26			-0.8	8.2	
1-D10	PSME	1.14			-3.7	10.2	
1-D11	PSME	1.43			-10.9	12.7	

PERMANENT PLOT STUDY DATA

ALDER CUT AREA- AUTUMN 2004

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	1.58			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	1.2			5.3	9.1	
1-A4	PSME	2.19			2.1	12.5	
1-A5	PSME	1.71			4.9	13.5	
1-A6	PSME	1.18			6.4	16	
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	2.34			11.9	14.3	
1-A9	PSME	1.24			2.3	2	
1-A10	PSME	1.28			7.6	4.2	
1-A11	PSME	1.87			11.1	1.7	
1-A12	PSME	0.8			10	8	
1-A13	TSHE	1.83			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	1.57			17	1.8	

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.37			1	-1.8	
1-B2	PSME	1.43			5.6	0	
1-B3	PSME	1			9.5	-3.7	
1-B4	PSME	1.89			7.9	-6.1	
1-B5	PSME	1.47			7.9	-6.1	
1-B6	PSME	2.05			11.7	-1.3	
1-B7	PSME	2.18			11.5	-8.1	
1-B8	ALRU	1.19			14.4	-2.8	
1-B9	PSME	1.14			8.2	-10.8	
1-B10	PSME	2.06			7.8	-14.4	
1-B11	PSME	1.25			10.7	-12.7	

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	1.68			-0.6	-8.4	
1-C2	TSHE	12.19	127	40	-2.6	-12.8	
1-C3	TSHE	1.05			-4.2	-9	GROWING HORIZONTALLY NEAR GRO
1-C4	PSME	1.16			-4.3	-15.7	
1-C5	PSME	1.24			-7.6	-13.5	
1-C6	PSME	1.31			-3.3	-0.7	
1-C7	PSME	1.03			-8.7	-1.5	
1-C8	PSME	1.68			-8.2	-7.9	
1-C9	PSME	1.35			-11.8	-3.8	
1-C10	PSME	0.55			-11.3	-8.4	
1-C11	PSME	2.3			-14.9	-1.4	
1-C12	PSME	1.93			-15.9	-6.4	

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	1.75			-1.3	1.8	
1-D2	PSME	1.65			-7	2.1	
1-D3	PSME	0.47			-11.5	1.1	
1-D4	ACMA	17.1	16	51	-10.2	4.9	
1-D5	PSME	1.43			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	1.49			-14	6.4	
1-D8	PSME	0.99			-14.3	7.4	
1-D9	PSME	1.44			-0.8	8.2	
1-D10	PSME	1.42			-3.7	10.2	
1-D11	PSME	2.3			-10.9	12.7	

PERMANENT PLOT STUDY DATA

ALDER CUT AREA- PLOT 1- SPRING 2005

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	5.1			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	1.26			5.3	9.1	
1-A4	PSME	2.2			2.1	12.5	
1-A5	PSME	1.7			4.9	13.5	
1-A6	PSME	1.2			6.4	16	
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	2.47			11.9	14.3	
1-A9	PSME	1.25			2.3	2	
1-A10	PSME	1.3			7.6	4.2	
1-A11	PSME	1.89			11.1	1.7	
1-A12	PSME	0.58			10	8	
1-A13	TSHE	2.2			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	1.6			17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.4			1	-1.8	
1-B2	PSME	1.45			5.6	0	
1-B3	PSME	1.03			9.5	-3.7	
1-B4	PSME	1.91			7.9	-6.1	
1-B5	PSME	1.48			7.9	-6.1	
1-B6	PSME	2.1			11.7	-1.3	
1-B7	PSME	2.22			11.5	-8.1	
1-B8	ALRU	dead			14.4	-2.8	dead as of spring 2005
1-B9	PSME	1.2			8.2	-10.8	
1-B10	PSME	2.35			7.8	-14.4	
1-B11	PSME	1.27			10.7	-12.7	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	1.28			-0.6	-8.4	
1-C2	TSHE	11.58	12	38	-2.6	-12.8	
1-C3	TSHE	0.96			-4.2	-9	GROWING HORIZONTALLY NEAR GR
1-C4	PSME	1.7			-4.3	-15.7	
1-C5	PSME	1.5			-7.6	-13.5	
1-C6	PSME	1.68			-3.3	-0.7	
1-C7	PSME	1.1			-8.7	-1.5	
1-C8	PSME	1.94			-8.2	-7.9	
1-C9	PSME	1.36			-11.8	-3.8	
1-C10	PSME	1.6			-11.3	-8.4	
1-C11	PSME	2.3			-14.9	-1.4	
1-C12	PSME	1.96			-15.9	-6.4	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	1			-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring 20
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	16.5	167	53	-10.2	4.9	
1-D5	PSME	1.45			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	1.45			-14	6.4	
1-D8	PSME	0.42			-14.3	7.4	
1-D9	PSME	1.68			-0.8	8.2	
1-D10	PSME	1.45			-3.7	10.2	
1-D11	PSME	1.46			-10.3	12.7	

PERMANENT PLOT STUDY DATA

ALDER CUT AREA- SPRING 2006

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	2.23			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	dead			5.3	9.1	dead as of spring 2006
1-A4	PSME	2.86			2.1	12.5	
1-A5	PSME	2.36			4.9	13.5	
1-A6	PSME	1.94			6.4	16	
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	3.45			11.9	14.3	
1-A9	PSME	1.7			2.3	2	
1-A10	PSME	dead			7.6	4.2	dead as of spring 2006
1-A11	PSME	2.62			11.1	1.7	
1-A12	PSME	0.65			10	8	starting to die as of spring 20
1-A13	TSHE	2.35			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 200 3
1-A15	PSME	2.52			17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.3			1	-1.8	
1-B2	PSME	1.88			5.6	0	
1-B3	PSME	1.35			9.5	-3.7	
1-B4	PSME	2.49			7.9	-6.1	
1-B5	PSME	2.03			7.9	-6.1	
1-B6	PSME	3.4			11.7	-1.3	
1-B7	PSME	3.4			11.5	-8.1	
1-B8	ALRU	dead			14.4	-2.8	dead as of spring 2005
1-B9	PSME	1.4			8.2	-10.8	
1-B10	PSME	3.3			7.8	-14.4	
1-B11	PSME	1.45			10.7	-12.7	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	2.2			-0.6	-8.4	
1-C2	TSHE	11.12	130	41.0	-2.6	-12.8	
1-C3	TSHE	1.36			-4.2	-9	GROWING HORIZONTALLY NEAR GROUND
1-C4	PSME	2.29			-4.3	-15.7	
1-C5	PSME	1.55			-7.6	-13.5	
1-C6	PSME	1.87			-3.3	-0.7	
1-C7	PSME	dead- 1.38 at death			-8.7	-1.5	dead as of spring 2006
1-C8	PSME	2.58			-8.2	-7.9	
1-C9	PSME	1.9			-11.8	-3.8	
1-C10	PSME	1.86			-11.3	-8.4	
1-C11	PSME	3.64			-14.9	-1.4	
1-C12	PSME	2.78			-15.9	-6.4	
1-C13	THPL	0.25			-4.7	-11.9	
1-C14	UNKNOWN	0.4			-4.6	-12.9	TOO SMALL TO IDENTIFY
1-C15	UNKNOWN	0.3			-9	-10.45	TOO SMALL TO IDENTIFY
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	1.85			-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring 2005
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	17.67	170	54.0	-10.2	4.9	
1-D5	PSME	2.5			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	1.95			-14	6.4	
1-D8	PSME	0.68			-14.3	7.4	
1-D9	PSME	2.1			-0.8	8.2	
1-D10	PSME	2.15			-3.7	10.2	
1-D11	PSME	1.54			-10.3	12.7	
1-D12	TSHE	17.67	106	34.0			
1-D13	ALRU	1.4			-13.8	3.9	
1-D14	TSHE	0.30			-14.5	3.25	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D15	ALRU	1.45			-14.5	3.2	
1-D16	ALRU	1.3			-14.6	3.6	
1-D17	TSHE	0.25			-14.8	7.6	
1-D18	TSHE	0.45			-16.5	6.2	
1-D19	PSME	0.35			-15.2	6.1	
1-D20	ALRU	1.5			-17	6.6	
1-D21	PSME	0.64			-14.3	4.35	under ferns

			PERMANENT PLOT STUDY DATA				
		ALDER CUT AREA- PLOT 1- AUTUMN 2006					
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	2.72			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	dead			5.3	9.1	dead as of spring 2006
1-A4	PSME	3.84			2.1	12.5	
1-A5	PSME	2.64			4.9	13.5	
1-A6	PSME	2.2			6.4	16	
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	3.9			11.9	14.3	
1-A9	PSME	2.23			2.3	2	
1-A10	PSME	dead			7.6	4.2	dead as of spring 2006
1-A11	PSME	3.4			11.1	1.7	
1-A12	PSME	dead			10	8	dead as of autumn 2006
1-A13	TSHE	3.45			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	3.35			17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.34			1	-1.8	
1-B2	PSME	2.42			5.6	0	
1-B3	PSME	1.56			9.5	-3.7	
1-B4	PSME	3.17			7.9	-6.1	
1-B5	PSME	2.67			7.9	-6.1	
1-B6	PSME	4.13			11.7	-1.3	
1-B7	PSME	3.71			11.5	-8.1	
1-B8	ALRU	dead			14.4	-2.8	dead as of spring 2005
1-B9	PSME	1.86			8.2	-10.8	
1-B10	PSME	3.92			7.8	-14.4	
1-B11	PSME	2			10.7	-12.7	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	2.66			-0.6	-8.4	
1-C2	TSHE	14.62	128	41	-2.6	-12.8	
1-C3	TSHE	0.78			-4.2	-9	GROWING HORIZONTALLY NEAR GROUND
1-C4	PSME	2.99			-4.3	-15.7	
1-C5	PSME	1.95			-7.6	-13.5	
1-C6	PSME	2.38			-3.3	-0.7	
1-C7	PSME	at death-1.38	dead		-8.7	-1.5	dead as of spring 2006
1-C8	PSME	2.93			-8.2	-7.9	
1-C9	PSME	2.15			-11.8	-3.8	
1-C10	PSME	2.84			-11.3	-8.4	
1-C11	PSME	5.13			-14.9	-1.4	
1-C12	PSME	3.53			-15.9	-6.4	
1-C13	THPL	0.25			-4.7	-11.9	
1-C14	unknown	0.4			-4.65	-12.9	too small to tell species-dying Aut 06
1-C15	unknown	0.41			-9	-10.45	too small to tell species
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	2.37			-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring 2005
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	18.28	174	56	-10.2	4.9	
1-D5	PSME	2.77			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	2.45			-14	6.4	
1-D8	PSME	0.69			-14.3	7.4	
1-D9	PSME	2.48			-0.8	8.2	
1-D10	PSME	2.47			-3.7	10.2	
1-D11	PSME	1.58			-10.3	12.7	
1-D12	TSHE	17.67	110	35	NEED COORDINATES		
1-D13	ALRU	1.7			-13.7	3.8	
1-D14	TSHE	0.29			-13.7	3.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D15	ALRU	2.2			-14.5	3.35	
1-D16	ALRU	1.81			-14.6	3.6	
1-D17	TSHE	0.3			-14.8	7.6	
1-D18	TSHE	0.52			-16.6	6.2	
1-D19	PSME	dead			-15.2	6.1	dead as of autumn 2006
1-D20	ALRU	1.5			-17	6.6	NEEDS METAL TAG
1-D21	PSME	0.54			-14.3	4.35	under ferns spring 06-topped by aut06-10cm smaller

PERMANENT PLOT STUDY DATA

ALDER CUT AREA- PLOT 1- SPRING 2007

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	2.8			3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	dead			5.3	9.1	dead as of spring 2006
1-A4	PSME	3.68			2.1	12.5	
1-A5	PSME	2.85			4.9	13.5	
1-A6	PSME	dead			6.4	16	dead as of spring 2007
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	4.3			11.9	14.3	
1-A9	PSME	2.25			2.3	2	
1-A10	PSME	dead			7.6	4.2	dead as of spring 2006
1-A11	PSME	3.6			11.1	1.7	
1-A12	PSME	dead			10	8	dead as of autumn 2006
1-A13	TSHE	3.92			12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	3.68			17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.34			1	-1.8	
1-B2	PSME	2.45			5.6	0	
1-B3	PSME	1.54			9.5	-3.7	
1-B4	PSME	3.12			7.9	-6.1	
1-B5	PSME	2.8			7.9	-6.1	
1-B6	PSME	4.1			11.7	-1.3	
1-B7	PSME	3.73			11.5	-8.1	
1-B8	ALRU	dead			14.4	-2.8	dead as of spring 2005
1-B9	PSME	1.89			8.2	-10.8	
1-B10	PSME	3.43			7.8	-14.4	
1-B11	PSME	2.14			10.7	-12.7	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-C1	PSME	2.77			-0.6	-8.4	
1-C2	TSHE	13.41	130	41	-2.6	-12.8	
1-C3	TSHE	0.73			-4.2	-9	GROWING HORIZONTALLY NEAR GROUND
1-C4	PSME	3.25			-4.3	-15.7	
1-C5	PSME	2.05			-7.6	-13.5	
1-C6	PSME	2.35			-3.3	-0.7	
1-C7	PSME	at death-1.38	dead		-8.7	-1.5	dead as of spring 2006
1-C8	PSME	3.05			-8.2	-7.9	
1-C9	PSME	2.02			-11.8	-3.8	
1-C10	PSME	2.95			-11.3	-8.4	
1-C11	PSME	4.4			-14.9	-1.4	
1-C12	PSME	3.71			-15.9	-6.4	
1-C13	THPL	dead			-4.7	-11.9	dead as of spring 2007
1-C14	unknown	dead			-4.65	-12.9	dead as of spring 2007
1-C15	unknown	dead			-9	-10.45	dead as of spring 2007
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETER)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	2.3			-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring 2005
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	18.29	182	58	-10.2	4.9	
1-D5	PSME	3.1			-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	2.51			-14	6.4	
1-D8	PSME	0.67			-14.3	7.4	
1-D9	PSME	2.9			-0.8	8.2	
1-D10	PSME	2.72			-3.7	10.2	
1-D11	PSME	2.2			-10.3	12.7	
1-D12	TSHE	18.29	120	38	-13.7	3.8	
1-D13	ALRU	1.6			-13.7	3.8	
1-D14	TSHE	1.42			-13.7	3.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D15	ALRU	2.3			-14.5	3.35	
1-D16	ALRU	2.1			-14.6	3.6	
1-D17	TSHE	0.9			-14.8	7.6	
1-D18	TSHE	0.65			-16.6	6.2	
1-D19	PSME	dead			-15.2	6.1	dead as of autumn 2006
1-D20	ALRU	1.9			-17	6.6	needs metal tag
1-D21	PSME	0.73			-14.3	4.35	under ferns autumn06-topped aut 06- 10cm shorter

			PERMANENT PLOT STUDY DATA				
		ALDER CUT AREA- PLOT 1- Spring 2008					
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	3.52		3.07	3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	dead			5.3	9.1	dead as of spring 2006
1-A4	PSME	4.14		4.55	2.1	12.5	
1-A5	PSME	3.43			4.9	13.5	
1-A6	PSME	dead			6.4	16	dead as of spring 2007
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	4.48		9.3	11.9	14.3	
1-A9	PSME	2.78		2.6	2.3	2	
1-A10	PSME	dead			7.6	4.2	dead as of spring 2006
1-A11	PSME	3.98		5.05	11.1	1.7	
1-A12	PSME	dead			10	8	dead as of autumn 2006
1-A13	TSHE	4.53		4.15	12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	4.2		5.25	17	1.8	
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-B1	THPL	0.34			1	-1.8	
1-B2	PSME	3.44		3.95	5.6	0	
1-B3	PSME	1.75		1.0	9.5	-3.7	
1-B4	PSME	3.96		3.65	7.9	-6.1	
1-B5	PSME	3.26		3.0	7.9	-6.1	
1-B6	PSME	4.07		5.25	11.7	-1.3	needs bigger wire
1-B7	PSME	4.15		4.9	11.5	-8.1	needs bigger wire
1-B8	ALRU	dead			14.4	-2.8	dead as of spring 2005
1-B9	PSME	2.42		2.1	8.2	-10.8	needs bigger wire
1-B10	PSME	3.4		4.25	7.8	-14.4	needs bigger wire. Drastically leaning-shorter height recorded spring2008
1-B11	PSME	2.52		2.1	10.7	-12.7	needs bigger wire

			PERMANENT PLOT STUDY DATA				
		ALDER CUT AREA- PLOT 1- Spring 2008				continued	
PLOT- QUADRANT- TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CE**	**BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATES (METERS)**	**COMMENTS**
1-C1	PSME	3.28		2.55	-0.6	-8.4	
1-C2	TSHE	16.0		41.72	-2.6	-12.8	
1-C3	TSHE	1.2			-4.2	-9	THIS TREE HAS BEEN GROWING AT A
1-C4	PSME	3.58		3.08	-4.3	-15.7	
1-C5	PSME	2.46		1.9	-7.6	-13.5	
1-C6	PSME	3.02		2.66	-3.3	-0.7	
1-C7	PSME	at death-1.38	dead		-8.7	-1.5	dead as of spring 2006
1-C8	PSME	3.44		3.32	-8.2	-7.9	
1-C9	PSME	dead			-11.8	-3.8	dead as of autumn 2007
1-C10	PSME	3.9		3.4	-11.3	-8.4	
1-C11	PSME	5.37		5.75	-14.9	-1.4	
1-C12	PSME	4.36		5.05	-15.9	-6.4	
1-C13	THPL	dead			-4.7	-11.9	dead as of autumn 2007
1-C14	unknown	dead			-4.65	-12.9	dead as of autumn 2007
1-C15	unknown	dead			-9	-10.45	dead as of autumn 2007
1-C16	TSHE	0.43			-17.1	-4	HAS METAL TAG-NEEDS WIRE!
1-C17	ALRU	1.56		2.1	-5	-11.5	GREW VERY FAST 07-08
PLOT-QUADRANT- TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CENTIMETERS)**	**BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATE (METERS)**	**COMMENTS**
1-D1	PSME	3.26		2.8	-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring 20
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	19.5		58.0	-10.2	4.9	
1-D5	PSME	3.7		3.7	-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	3.0		3.0	-14	6.4	
1-D8	PSME	0.38			-14.3	7.4	Dying as of Spring 2008. Topped Spring 2008
1-D9	PSME	3.22		3.55	-0.8	8.2	
1-D10	PSME	3.4		2.5	-3.7	10.2	
1-D11	PSME	dead			-10.3	12.7	dead as of autumn 2007
1-D12	TSHE	18.3		36.0	-13.7	3.8	
1-D13	ALRU	2.06		0.8	-13.7	3.8	
1-D14	TSHE	0.25			-13.7	3.8	
1-D15	ALRU	3.6		2.4	-14.5	3.35	
1-D16	ALRU	2.16		0.6	-14.6	3.6	
1-D17	TSHE	0.51			-14.8	7.6	
1-D18	TSHE	0.53			-16.6	6.2	
1-D19	PSME	dead			-15.2	6.1	dead as of autumn 2006
1-D20	ALRU	2.8		0.7	-16.6	6.2	
1-D21	PSME	0.48			-14.3	4.35	under ferns autumn06-topped aut 06- 10cm shorter-topped again autumn 2007

PERMANENT PLOT STUDY DATA

Alder Cut Area- Plot 1-Autumn 2008

PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-A1	PSME	3.9		3.6	3.8	5.9	
1-A2	PSME	**dead**			5.3	9.1	**dead as of autumn 2003**
1-A3	PSME	**dead**			5.3	9.1	**dead as of spring 2006**
1-A4	PSME	4.9		4.7	2.1	12.5	
1-A5	PSME	3.56		3.3	4.9	13.5	
1-A6	PSME	**dead**			6.4	16	**dead as of spring 2007**
1-A7	PSME	**dead**			6.6	13.1	**dead as of autumn 2004**
1-A8	TSHE	4.91		10.1	11.9	14.3	
1-A9	PSME	3.4		2.8	2.3	2	
1-A10	PSME	**dead**			7.6	4.2	**dead as of spring 2006**
1-A11	PSME	4.7		5.55	11.1	1.7	
1-A12	PSME	**dead**			10	8	**dead as of autumn 2006**
1-A13	TSHE	5.2		4.7	12.6	11.6	
1-A14	PSME	**dead**			12.6	10.9	**dead as of autumn 2003**
1-A15	PSME	5.05		5.65	17	1.8	
PLOT-QUADRANT-TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CENTIMETERS)**	**DIAMETER AT BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATE (METERS)**	**COMMENTS**
1-B1	THPL	0.43			1	-1.8	
1-B2	PSME	3.96		3.95	5.6	0	
1-B3	PSME	1.9		1.25	9.5	-3.7	
1-B4	PSME	4.67		3.95	7.9	-6.1	
1-B5	PSME	3.9		3.11	7.9	-6.1	
1-B6	PSME	4.64		6.23	11.7	-1.3	
1-B7	PSME	4.89		5.30	11.5	-8.1	
1-B8	ALRU	**dead**			14.4	-2.8	**dead as of spring 2005**
1-B9	PSME	2.87		2.40	8.2	-10.8	
1-B10	PSME	3.5		4.41	7.8	-14.4	**[illegible] shorter height recorded spring 2008**
1-B11	PSME	2.84		2.25	10.7	-12.7	

			PERMANENT PLOT STUDY DATA				
			Alder Cut Area- Plot 1-Autumn 2008			continued	
PLOT- QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CE	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATES (METERS)	COMMENTS
1-C1	PSME	3.54		2.95	-0.6	-8.4	
1-C2	TSHE	16.3		42.30	-2.6	-12.8	
1-C3	TSHE	1.3			-4.2	-9	TREE HAS BEEN GROW
1-C4	PSME	3.85		3.45	-4.3	-15.7	
1-C5	PSME	2.94		2.10	-7.6	-13.5	
1-C6	PSME	3.3		3.10	-3.3	-0.7	
1-C7	PSME	at death-1.38	dead		-8.7	-1.5	dead as of spring 2006
1-C8	PSME	3.66		3.75	-8.2	-7.9	
1-C9	PSME	dead			-11.8	-3.8	dead as of autumn 2007
1-C10	PSME	4.55		4.05	-11.3	-8.4	
1-C11	PSME	6.9		6.60	-14.9	-1.4	
1-C12	PSME	5.2		5.40	-15.9	-6.4	
1-C13	THPL	dead			-4.7	-11.9	dead as of autumn 2007
1-C14	unknown	dead			-4.65	-12.9	dead as of autumn 2007
1-C15	unknown	dead			-9	-10.45	dead as of autumn 2007
1-C16	TSHE	0.39			-17.1	-4	topped autumn 2008
1-C17	ALRU	1.1			-5	-11.5	topped autumn 2008
PLOT-QUADRANT-TREE NUMBER	SPECIES	HEIGHT (METERS)	CIRCUMFRENCE (CENTIMETERS)	DIAMETER AT BREAST HEIGHT (CENTIMETERS)	X-COORDINATE (METERS)	Y-COORDINATE (METERS)	COMMENTS
1-D1	PSME	3.8		3.20	-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	20.1		59.00	-10.2	4.9	
1-D5	PSME	4.23		3.90	-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	3.2		3.60	-14	6.4	
1-D8	PSME	0.40			-14.3	7.4	Dying as of spring 2008. Topped spring 2008
1-D9	PSME	3.56		4.20	-0.8	8.2	
1-D10	PSME	4.0		2.80	-3.7	10.2	
1-D11	PSME	dead			-10.3	12.7	dead as of autumn 2007
1-D12	TSHE	18.8		36.00	-13.7	3.8	
1-D13	ALRU	2.1		0.90	-13.7	3.8	
1-D14	TSHE	0.3			-13.7	3.8	
1-D15	ALRU	4.3		3.40	-14.5	3.35	
1-D16	ALRU	2.2		0.70	-14.6	3.6	
1-D17	TSHE	0.64			-14.8	7.6	
1-D18	TSHE	0.92			-16.6	6.2	
1-D19	PSME	dead			-15.2	6.1	dead as of autumn 2006
1-D20	ALRU	3.02		0.80	-16.6	6.2	
1-D21	PSME	0.49			-14.3	4.35	Under ferns and topped autumn 06- 10cm shorter. Topped again autumn 2007

			PERMANENT PLOT STUDY DATA				
		Alder Cut Area- Plot 1- Autumn 2010					
PLOT-QUADRANT-TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CENTIMETERS)**	**DIAMETER AT BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATE (METERS)**	**COMMENTS**
1-A1	PSME	4.5		4.6	3.8	5.9	
1-A2	PSME	dead			5.3	9.1	dead as of autumn 2003
1-A3	PSME	dead			5.3	9.1	dead as of spring 2006
1-A4	PSME	6.3		5.8	2.1	12.5	
1-A5	PSME	4.0		4.9	4.9	13.5	
1-A6	PSME	dead			6.4	16	dead as of spring 2007
1-A7	PSME	dead			6.6	13.1	dead as of autumn 2004
1-A8	TSHE	6.4		10.3	11.9	14.3	
1-A9	PSME	4.61		5	2.3	2	
1-A10	PSME	dead			7.6	4.2	dead as of spring 2006
1-A11	PSME	6.1		8.5	11.1	1.7	
1-A12	PSME	dead			10	8	dead as of autumn 2006
1-A13	TSHE	6.4		7.2	12.6	11.6	
1-A14	PSME	dead			12.6	10.9	dead as of autumn 2003
1-A15	PSME	6.4		7.65	17	1.8	
PLOT-QUADRANT-TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CENTIMETERS)**	**BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATE (METERS)**	**COMMENTS**
1-B1	THPL	dead			1	-1.8	dead as of autumn 2010
1-B2	PSME	4.65		5.3	5.6	0	
1-B3	PSME	2.1		1.5	9.5	-3.7	
1-B4	PSME	5.6		5.7	7.9	-6.1	
1-B5	PSME	4.7		4	7.9	-6.1	
1-B6	PSME	5.64		9.9	11.7	-1.3	
1-B7	PSME	6.1		7.4	11.5	-8.1	
1-B8	ALRU	dead			14.4	-2.8	dead as of spring 2005. Topped autumn 2004
1-B9	PSME	3.5		2.8	8.2	-10.8	
1-B10	PSME	4.7		5.4	7.8	-14.4	Drastically leaning-shorter height recorded spring 2008
1-B11	PSME	3.21		3.7	10.7	-12.7	

			PERMANENT PLOT STUDY DATA				
		Alder Cut Area- Plot 1- Autumn 2010					continued
PLOT-QUADRANT-TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CENTIMET**	**DIAMETER AT BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATE (METERS)**	**COMMENTS**
1-C1	PSME	4.5		3.8	-0.6	-8.4	
1-C2	TSHE	17.1		45.1	-2.6	-12.8	
1-C3	TSHE	1.45		0.5	-4.2	-9	TREE HAS BEEN GROWING AT A SLA
1-C4	PSME	4.3		4.6	-4.3	-15.7	
1-C5	PSME	4.0		3.5	-7.6	-13.5	
1-C6	PSME	4.0		5.5	-3.3	-0.7	
1-C7	PSME	at death-1.38	dead		-8.7	-1.5	dead as of spring 2006
1-C8	PSME	5.1		4.3	-8.2	-7.9	
1-C9	PSME	2.53		1.4	-11.8	-3.8	presumed dead in aut '07, found alive under thick brush in autumn 2010
1-C10	PSME	5.2		5.9	-11.3	-8.4	
1-C11	PSME	7.3		9.3	-14.9	-1.4	
1-C12	PSME	6.1		7.1	-15.9	-6.4	
1-C13	THPL	dead			-4.7	-11.9	dead as of autumn 2007
1-C14	unknown	dead			-4.65	-12.9	dead as of autumn 2007
1-C15	unknown	dead			-9	-10.45	dead as of autumn 2007
1-C16	TSHE	dead			-17.1	-4	dead as of autumn 2010
1-C17	ALRU		could not find autumn 2010		-5	-11.5	Grew significantly between '07-'08. Topped autumn '08. Couldn't find aut 10
PLOT-QUADRANT-TREE NUMBER	**SPECIES**	**HEIGHT (METERS)**	**CIRCUMFRENCE (CENTIMETERS)**	**DIAMETER AT BREAST HEIGHT (CENTIMETERS)**	**X-COORDINATE (METERS)**	**Y-COORDINATE (METERS)**	**COMMENTS**
1-D1	PSME	5.1		5.3	-1.3	1.8	
1-D2	PSME	dead			-7	2.1	no metal tag-dead spring 2005
1-D3	PSME	dead			-11.5	1.1	dead as of spring 2005
1-D4	ACMA	21.3		59.5	-10.2	4.9	
1-D5	PSME	4.45		5.3	-15.5	2.3	
1-D6	PSME	dead			-14.9	3.5	dead as of autumn 2003
1-D7	PSME	4.2		4.7	-14	6.4	
1-D8	PSME		could not find as of autumn 2010		-14.3	7.4	Dying as of spring 2008. Topped spring 2008. Could not find autumn 2010
1-D9	PSME	4.9		5.9	-0.8	8.2	
1-D10	PSME	5.12		4.3	-3.7	10.2	
1-D11	PSME	dead			-10.3	12.7	dead as of autumn 2007
1-D12	TSHE	19.9		38.0	-13.7	3.8	
1-D13	ALRU	3.9		1.9	-13.7	3.8	
1-D14	TSHE	0.43			-13.7	3.8	
1-D15	ALRU	8.2		6	-14.5	3.35	
1-D16	ALRU	3.8		1.5	-14.6	3.6	
1-D17	TSHE	0.82			-14.8	7.6	
1-D18	TSHE	1.95		0.75	-16.6	6.2	
1-D19	PSME	dead			-15.2	6.1	dead as of autumn 2006
1-D20	ALRU	5.6		2.5	-16.6	6.2	
1-D21	PSME		could not find as of autumn 2010		-14.3	4.35	under ferns and topped autumn '06-10cm shorter-topped again autumn 2007

Appendix II: Understory data

Understory Vegetation Plot Data		
	Alder Cut Area-Spring 2003	
Line	**Species**	**Percent Coverage**
Center to East	western sword fern	2%
	vine maple- Acer circinatum	4%
	trailing blackberry	10%
	Pacific bleeding heart	11%
	miner's lettuce	15%
	salmonberry	34%
	coarse woody debris	10%
	exposed soil	30%
Center to North	**Species**	**Percent Coverage**
	moss	2%
	trailing blackberry	7%
	Pacific bleeding heart	12%
	bracken fern	23%
	miner's lettuce	31%
	salmonberry	55%
	coarse woody debris	14%
Center to West	**Species**	**Percent Coverage**
	Pacific bleeding heart	1%
	salmonberry	9%
	miner's lettuce	27%
	bracken fern	73%
	trailing blackberry	90%
Center to South	**Species**	**Percent Coverage**
	moss	2%
	miner's lettuce	13%
	trailing blackberry	14%
	Pacific bleeding heart	19%
	western sword fern	29%
	salmonberry	30%
	course woody debris	22%

Understory Vegetation Percent Coverage Data		
Alder Cut Area -Plot 1- Autumn 2003		
Line	**Species**	**Percent Coverage**
Center to East		
	western sword fern	1%
	trailing blackberry	15%
	miner's lettuce	9%
	salmonberry	20%
	moss	13%
	course woody debris	6%
Center to North	**Species**	**Percent Coverage**
	trailing blackberry	8%
	western sword fern	2%
	salmonberry	20%
	coarse woody debris	10%
	bracken fern	8%
Center to West	**Species**	**Percent Coverage**
	salmonberry	13%
	bracken fern	14%
	moss	2%
	trailing blackberry	40%
	western sword fern	10%
Center to South	**Species**	**Percent Coverage**
	trailing blackberry	13%
	salmonberry	28%
	western sword fern	20%
	moss	2%
	miner's lettuce	5%

Understory Vegetation Percent Coverage Data		
Alder Cut Area -Plot 1- Spring 2004		
Line	**Species**	**Percent Coverage**
Center to East		
	salmonberry	35%
	moss	22%
	Pacific bleeding heart	6%
	trailing blackberry	20%
	coarse woody debris	3%
	vine maple	5%
Center to North	**Species**	**Percent Coverage**
	trailing blackberry	10%
	bracken fern	11%
	salmonberry	26%
	miner's lettuce	5%
	bracken fern	20%
	moss	9%
Center to West	**Species**	**Percent Coverage**
	trailing blackberry	36%
	moss	9%
	western sword fern	9%
	salmonberry	20%
	Pacific bleeding heart	2%
Center to South	**Species**	**Percent Coverage**
	salmonberry	40%
	trailing blackberry	29%
	moss	5%
	western sword fern	10%
	bracken fern	12%

Understory Vegetation Plot Data		
Alder Cut Area- Autumn 2004		
Line	**Species**	**Percent Coverage**
Center to East		
	bracken fern	30%
	trailing blackberry	38%
	salmonberry	40%
	moss	20%
Center to North	**Species**	**Percent Coverage**
	bracken fern	40%
	western sword fern	9%
	trailing blackberry	15%
	salmonberry	16%
	moss	5%
Center to West	**Species**	**Percent Coverage**
	bracken fern	33%
	trailing blackberry	31%
	salmonberry	23%
	western sword fern	3%
	moss	6%
Center to South	**Species**	**Percent Coverage**
	bracken fern	20%
	trailing blackberry	32%
	salmonberry	36%

Understory Vegetation Plot Data		
Alder Cut Area- plot 1-Spring 2005		
Line	**Species**	**Percent Coverage**
Center to East		
	salmonberry	45%
	Pacific bleeding heart	35%
	trailing blackberry	10%
	moss	9%
Center to North	**Species**	**Percent Coverage**
	salmonberry	18%
	Pacific bleeding heart	38%
	bracken fern	4%
	false solomons seal	4%
	moss	4%
Center to West	**Species**	**Percent Coverage**
	Pacific bleeding heart	17%
	bracken fern	12%
	false solomons seal	9%
	salmonberry	10%
	trailing blackberry	7%
	false lily-of-the-valley	4%
Center to South	**Species**	**Percent Coverage**
	salmonberry	35%
	false solomons seal	18%
	Pacific bleeding heart	13%
	bracken fern	20%
	moss	5%

Understory Vegetation Plot Data		
Alder Cut Area- Spring 2006		
Line	**Species**	**Percent Coverage**
Center to East		
	salmonberry	52%
	Pacific bleeding heart	50%
	trailing blackberry	6%
	false lily-of-the-valley	3%
	woody debris	25%
	exposed soil	3%
Center to North	**Species**	**Percent Coverage**
	salmonberry	40%
	Pacific bleeding heart	50%
	false lily-of-the-valley	5%
	woody debris	11%
	exposed soil	14%
Center to West	**Species**	**Percent Coverage**
	salmonberry	20%
	Pacific bleeding heart	54%
	trailing blackberry	9%
	false lily-of-the-valley	7%
	exposed soil	37%
	trail forming in corner	
Center to South	**Species**	**Percent Coverage**
	salmonberry	80%
	Pacific bleeding heart	17%
	false lily-of-the-valley	7%
	moss	6%
	bracken fern	1%
	exposed soil	6%

Understory Vegetation Plot Data		
Alder Cut Area- Autumn 2006		
Line	**Species**	**Percent Coverage**
Center to East		
	bracken fern	25%
	trailing blackberry	15%
	vine maple	5%
	salmonberry	96%
Center to North	**Species**	**Percent Coverage**
	sword fern	69%
	bracken fern	42%
	salmonberry	46%
Center to West	**Species**	**Percent Coverage**
	salmonberry	39%
	bracken fern	79%
Center to South	**Species**	**Percent Coverage**
	salmonberry	95%
	bracken fern	23%

Understory Vegetation Plot Data		
Alder Cut Area- plot 1- Spring 2007		
Line	**Species**	**Percent Coverage**
Center to East		
	bracken fern	25%
	salmonberry	30%
	Pacific bleeding heart	25%
	vine maple	6%
Center to North	**Species**	**Percent Coverage**
	bracken fern	30%
	salmonberry	18%
	Pacific bleeding heart	23%
	trailing blackberry	7%
	miner's lettuce	6%
Center to West	**Species**	**Percent Coverage**
	salmonberry	26%
	Pacific bleeding heart	22%
	miner's lettuce	11%
	bracken fern	8%
	exposed soil	56%
Center to South	**Species**	**Percent Coverage**
	salmonberry	95%
	Pacific bleeding heart	15%
	bracken fern	12%
	moss	5%

Understory Vegetation Plot Data		
Alder Cut Area- plot 1-Autumn 2007		
Line	**Species**	**Percent Coverage**
Center to East		
	salmonberry	18%
	trailing blackberry	16%
	bracken fern	24%
Center to North	**Species**	**Percent Coverage**
	salmonberry	5%
	trailing blackberry	4%
	western sword fern	84%
Center to West	**Species**	**Percent Coverage**
	salmonberry	18%
	trailing blackberry	30%
	bracken fern	28%
Center to South	**Species**	**Percent Coverage**
	salmonberry	20%
	bracken fern	6%

Understory Vegetation Plot Data		
Alder Cut Area- plot 1- SPRING 2008		
Line	**Species**	**Percent Coverage**
Center to East		
	bracken fern	18%
	salmonberry	35%
	vine maple	17%
	Pacific bleeding heart	3%
	traiing blackberry	35%
Center to North	**Species**	**Percent Coverage**
	Pacific bleeding heart	trace
	trailing blackberry	65%
	salmonberry	100%
	false lily-of-the-valley	1%
	bracken fern	8%
Center to West	**Species**	**Percent Coverage**
	bracken fern	40%
	trailing blackberry	42%
	Pacific bleeding heart	3%
	salmonberry	35%
	false lily-of-the-valley	2%
Center to South	**Species**	**Percent Coverage**
	trailing blackberry	18%
	salmonberry	98%
	western sword fern	4%

Understory Vegetation Plot Data		
Alder Cut Area- plot 1-Autumn 2008		
Line	**Species**	**Percent Coverage**
Center to East		
	salmonberry	22%
	western sword fern	10%
	trailing blackberry	24%
	moss	11%
	bracken fern	14%
Center to North	**Species**	**Percent Coverage**
	salmonberry	56%
	western sword fern	8%
	trailing blackberry	18%
	moss	4%
	bracken fern	17%
Center to West	**Species**	**Percent Coverage**
	salmonberry	20%
	trailing blackberry	30%
	moss	10%
	bracken fern	17%
Center to South	**Species**	**Percent Coverage**
	salmonberry	86%
	trailing blackberry	3%
	moss	4%
	bracken fern	12%
	elderberry	1%

Understory Vegetation Percent Coverage Data		
Alder Cut Area -Plot 1- Autumn 2010		
Line	**Species**	**Percent Coverage**
Center to East		
	western sword fern	24%
	salmon berry	65%
	moss	14%
	trailing blackberry	9%
	bracken fern	17%
Center to North	**Species**	**Percent Coverage**
	bracken fern	23%
	salmonberry	87%
	trailing blackberry	7%
	moss	8%
Center to West	**Species**	**Percent Coverage**
	bracken fern	28%
	salmonberry	93%
	moss	9%
	trailing blackberry	5%
Center to South	**Species**	**Percent Coverage**
	salmonberry	95%
	moss	8%
	western sword fern	17%
	miner's lettuce	2%
	bracken fern	5%

Appendix III: Log Diameter and Decay Class Data

Decay Class Data- Plot 1- Spring 2003			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	10	1
	2	20	3
	3	10	1
	4	11	1
	5	8	1
	6	13	2
	7	8	1
	8	10	2
	9	7	2
	10	5	1
	11	7	1
	12	9	1
	13	21	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	15	2
	2	11	2
	3	7	1
	4	9	1
	5	6	1
	6	12	2
	7	20	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	21	4
	2	32	2
	3	10	2
	4	6	1
	5	6	1
	6	7	1
	7	9	1
	8	7	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	11	2
	2	15	2
	3	12	2
	4	5	2
	5	5	2
	6	7	3
	7	6	3
	8	9	4
	9	8	3
	10	10	3

Decay Class Data- Plot 1- Autumn 2003			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	9	1
	2	20	2
	3	11	1
	4	10	1
	5	8	2
	6	12	1
	7	8	1
	8	5	2
	9	6	2
	10	7	1
	11	11	2
	12	9	1
	13	23	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	31	3
	2	13	2
	3	10	2
	4	8	2
	5	6	1
	6	11	2
	7	22	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	20	3
	2	31	2
	3	9	2
	4	6	2
	5	7	2
	6	6	2
	7	8	2
	8	7	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	10	2
	2	13	2
	3	10	2
	4	6	2
	5	5	2
	6	7	1
	7	5	2
	8	10	3
	9	8	3
	10	10	2

Decay Class Data- Plot 1- Spring 2004			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	9	2
	2	20	2
	3	10	2
	4	7	2
	5	12	2
	6	11	2
	7	12	2
	8	6	2
	9	7	2
	10	9	2
	11	19	2
	12	11	2
	13	24	2
			2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	30	3
	2	13	2
	3	20	3
	4	9	2
	5	10	2
	6	23	2
	7	5	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	20	3
	2	29	2
	3	8	3
	4	6	2
	5	6	2
	6	6	3
	7	7	2
	8	6	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	9	2
	2	10	2
	3	11	2
	4	8	2
	5	7	2
	6	6	2
	7	8	2
	8	9	3
	9	8	3
	10	10	2

Decay Class- Plot 1- Autumn 2004			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	25	2
	2	10	2
	3	5	2
	4	14	2
	5	12	2
	6	11	4
	7	11	2
	8	12	2
	9	8	2
	10	9	2
	11	18	2
	12	11	2
	13	25	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	30	4
	2	13	2
	3	19	4
	4	10	2
	5	13	2
	6	27	2
	7	5	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	10	2
	2	28	3
	3	6	3
	4	6	2
	5	9	2
	6	6	4
	7	6	2
	8	6	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	10	2
	2	6	2
	3	7	2
	4	9	3
	5	12	2
	6	6	2
	7	9	2
	8	8	2
	9	8	3
	10	10	2

Decay Class Data- Plot 1- Spring 2006			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	9	2
	2	10	2
	3	10	2
	4	7	2
	5	15	3
	6	10	4
	7	7	2
	8	8	2
	9	7	2
	10	6	2
	11	16	4
	12	7	2
	13	6	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	8	2
	2	13	2
	3	8	3
	4	14	4
	5	6	3
	6	11	3
	7	7	3
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	36	3
	2	6	3
	3	6	3
	4	9	4
	5	15	3
	6		
	7		
	8		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	9	2
	2	15	3
	3	12	2
	4	6	2
	5	9	2
	6	9	2
	7	11	2
	8	6	4
	9	10	2
	10	8	2
	11	7	2

Decay Class Data- Plot 1- Autumn 2006			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	10	2
	2	12	2
	3	8	2
	4	10	3
	5	7	2
	6	6	2
	7	11	2
	8	9	2
	9	5	2
	10	7	2
	11	6	2
	12	5	2
	13	10	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	6	2
	2	10	3
	3	5	3
	4	14	4
	5	5	1
	6	5	2
	7		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	28	2
	2	7	2
	3	6	2
	4	5	2
	5	8	2
	6	5	3
	7	10	3
	8	5	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	8	3
	2	9	4
	3	8	4
	4	5	4
	5	5	4
	6	5	4
	7	5	1
	8	5	4
	9	10	3
	10	9	4

Decay Class Data- Plot 1- Spring 2007			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	20	2
	2	21	2
	3	15	2
	4	22	3
	5	17	2
	6	20	2
	7	5	2
	8	16	2
	9	8	2
	10	30	3
	11	7	2
	12	8	3
	13	25	3
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	30	2
	2	7	2
	3	8	2
	4	9	2
	5	10	2
	6	6	2
	7	5	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	8	4
	2	10	2
	3	7	2
	4	12	3
	5	16	2
	6	7	2
	7	6	2
	8	10	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	30	4
	2	25	2
	3	17	3
	4	9	1
	5	11	2
	6	6	2
	7	6	3
	8	10	2
	9	6	2
	10	7	2

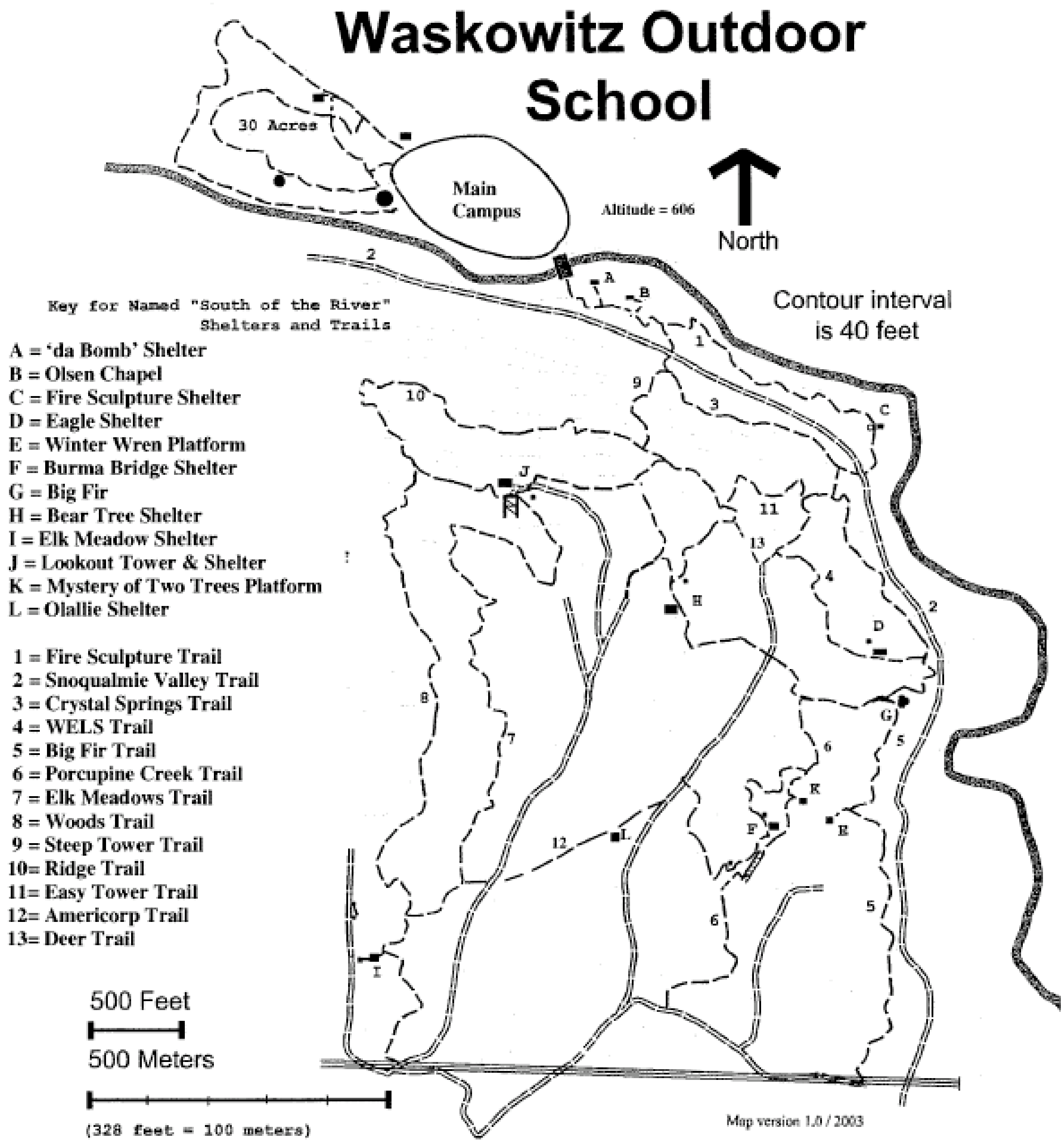
Decay Class Data-Plot 1- Autumn 2007			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	7	2
	2	5	2
	3	11	2
	4	6	4
	5	15	3
	6	11	3
	7	6	2
	8	8	2
	9	8	3
	10	6	2
	11	5	2
	12	18	2
	13	7	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	5	2
	2	9	2
	3	10	4
	4	8	2
	5	12	3
	6	10	2
	7		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	28	3
	2	6	4
	3	7	4
	4	5	2
	5	31	5
	6	8	2
	7		
	8		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	7	2
	2	13	4
	3	9	2
	4	7	1
	5	8	2
	6	5	2
	7	6	2
	8	9	2
	9	5	2
	10		

Decay Class Data- Plot 1- Spring 2008			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	6	2
	2	11	3
	3	15	3
	4	7	2
	5	5	2
	6	5	4
	7	7	2
	8	7	3
	9	5	2
	10	6	3
	11	10	3
	12	5	2
	13	16	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	5	3
	2	7	3
	3	9	3
	4	8	4
	5	6	3
	6	7	3
	7	9	2
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	12	2
	2	28	3
	3	6	4
	4	5	2
	5	7	4
	6	6	3
	7	30	4
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	10	4
	2	10	2
	3	14	4
	4	6	2
	5	9	3
	6	7	2
	7	5	2
	8	5	2
	9	6	2
	10	6	2

Decay Class Data- Plot 1- Autumn 2008			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	7	3
	2	11	3
	3	8	3
	4	7	2
	5	5	3
	6	6	3
	7	9	2
	8	5	2
	9	8	2
	10	13	3
	11	7	3
	12	6	3
	13		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	5	2
	2	12	3
	3	8	3
	4	5	2
	5	9	3
	6	6	4
	7	10	3
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	10	2
	2	12	3
	3	8	2
	4	5	3
	5	7	3
	6	6	2
	7		
	8		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	9	2
	2	11	2
	3	5	2
	4	7	2
	5	5	3
	6	7	2
	7	10	2
	8	6	3
	9		
	10		

Decay Class Data- Plot 1- Autumn 2010			
Line			
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to East	1	6	3
	2	10	3
	3	8	3
	4	6	3
	5	5	3
	6	5	4
	7	7	3
	8	5	3
	9	7	3
	10	11	3
	11	6	3
	12	5	3
	13	13	3
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to North	1	5	3
	2	10	3
	3	8	3
	4	6	3
	5	6	4
	6	5	3
	7	26	4
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to West	1	8	2
	2	26	3
	3	6	3
	4	5	3
	5	6	3
	6	5	3
	7	26	4
	8		
	Log Number	**Diameter (centimeters)**	**Decay Class**
Center to South	1	8	4
	2	10	3
	3	5	3
	4	12	4
	5	8	3
	6	6	3
	7	7	3
	8	5	3
	9	6	3
	10		

Appendix IV: Waskowitz property map



Appendix V: Procedural and informational handouts

Procedure for Establishing Permanent Research Plots at Waskowitz

Materials Required:

- Compasses –one for each pair of students
- Brightly colored flags on metal sticks or flagging tape- minimum of 17 flags or tape pieces for marking of the cardinal and sub cardinal directions
- Minimum of two measuring tapes marked in meters (not feet)-needs to be at least 25 meters long

Procedure:

1. Have a group leader take the students into approximate desired area for a permanent research plot. Hint: Look for area with high diversity of trees, stumps, understory vegetation, and varying soil conditions for the students to analyze and discuss.
2. Bring students into the center of the new plot area to explain what and why permanent plots are utilized at Waskowitz. Example: Permanent plots are used to study how a forest changes over time. In the cut area, we have an opportunity to watch succession from the beginning of a new stand as it progresses towards old growth.
3. Select two students to be the first to run out the line and mark the inner and outer circle borders for one of the cardinal directions. Hint: It proves easier to start with north and then go clockwise to the other cardinal and sub cardinal directions.
4. The two students should have one compass and stand directly in the center point of the circle. Mark this center point with a flag or flagging tape. The students choose who will be the walker and who will stay in the center point with the compass and be the guide. Give the walker two flags and the metered tape.

5. The designated walker will take the meter tape in hand, as the guide determines the line to be walked in the desired direction. Note: The guide should be holding the compass with hand out and at eye level, finding a landmark such as a tree, shrub or stump that the walker can aim for.
6. As the guide holds onto the end of the metered tape, he or she will call out to the walker as they proceed making sure the line is as perfectly straight as possible. The guide must make sure that the line is straight and that it goes through obstacles not around them. Guide should feel free to tell the walker to go right or move a little left to stay exactly in the straight line.
7. When the walker reaches 10 meters, they will stop and insert the first flag into the ground, which will form the inner circle when all directions have been completed. They will then proceed in the straight line until they reach 17.8 meters, which is where the second and final flag is inserted into the ground creating the border for the tenth of a hectare plot. Have the guide release the end of the metered tape and the walker reels it back in as they come back to the center of the circle.
8. Start again in the center of the plot with two new students and have them repeat steps 3-7. Select two new students for running out the line in each of the four cardinal and four sub cardinal directions.
9. Once all of the flags have been stuck in the ground, have one student stand at each of the sixteen flags in the plot. This will visually reveal the size of a circular tenth of a hectare plot. There will be an inner circle (where the flags at 10 meters where inserted), which will later be used to do understory vegetation plots.
10. Have the students discuss what is in their plot. Ask what tree and understory species are present. What might they have expected to find that is missing? How do they think this plot will change over time?

Coarse Woody Debris Decay Class Guidelines

Decay Class 1- (Least decayed)- Logs that are entire, usually cylindrical in shape (i.e. looking like a tree lying down), may be freshly fallen down but not always (some trees take much longer to decay while others will start to rot while still standing). The log may or may not have bark. The log has less than 5% imperfections such as splits, holes, exposing rot, ect. No fungal fruiting bodies. It remains hard, sound wood.

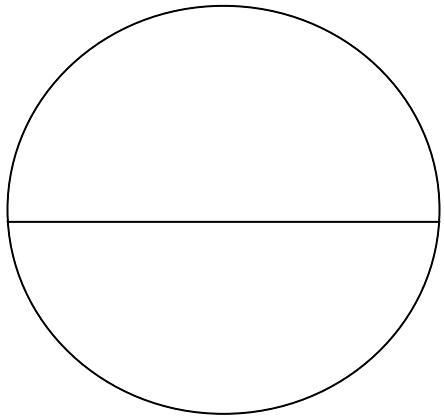
Decay Class 2- Twigs and small branches have fallen off. Wood is still hard but presence of splits, cracks, wounds, and decayed ends increases. Bark is loosened or missing. Fruiting bodies may be present (sometimes found on logs which would otherwise be classified as Class 1 logs). The overall rot of the surface area remains under 10% and the log retains much of its original shape.

Decay Class 3- Beginning to loose its “tree-like” appearance, often with large sections of exterior wood missing. Logs containing splits, cracks, ect. Exposing rot to an overall surface of 11-20%. Exterior may be moderately soft. No bark retained.

Decay Class 4- Losing much of its “tree-like” appearance often with large sections of exterior wood missing. Exposed rot to 21-50% of log surface area. Exterior may be moderately soft.

Decay Class 5- (most decayed)- Rotting wood roughly in the shape of a log, often only solid wood present along sides of log, often embedded partially in the soil. Wood is well decayed and it is possible to squeeze it by fingers. More than 50% of the surface area consisting of rot. Usually soft and wet.

Tree Diameter at Breast Height



D = C/π
π =3.14
C= 2πr

Cross-section of a tree trunk

C= Circumference of the tree trunk at breast height
D= Diameter of the tree
R= radius of the tree- it is half of the diameter

Calculating Diameter at Breast Height- D = C/ π

- Measure the circumference of the tree trunk at breast height using diameter tape
- Record that number and divide it by 3.14
- The value given will be the diameter of the tree at breast height

Another View of the Red Alder Cut

Recently, Waskowitz Outdoor School was faced with a decision regarding what should be done with the aging red alder stand many students and teachers had grown to know and love. Red Alder trees are unique in that after fifty years of age they typically develop heart rot, creating a serious blow down hazard as well as making the sale of the decaying wood near to impossible. A choice had to be made before the majority of the alder trees became thoroughly decayed. The aging trees had to be removed, but the words “clear cut” at Waskowitz conjured up images of a barren wasteland of stumps where nothing is spared. This picture of a traditional clear cut did not synchronize with the goals and mission of our school, which works to promote knowledge of healthy forest practices.

The need for this cut presented a unique opportunity to put into action new forestry techniques that would actually speed up succession by nearly one hundred years. The alder may have taken another fifty years to completely die out and be replaced by more shade tolerant conifers from the understory. By removing the alder now and planting a diverse mix of conifer seedlings, we help not only to speed the process up, but we also help to assure that the new stand coming up is made of several species, not a monocrop like traditional clear cut replanting. The students also benefited from identifying and planting the seedlings themselves. They were instructed on the different shade tolerances and water preferences of the western hemlock, Douglas-fir, and western redcedar seedlings while planting within the cut.

We are very proud of the techniques used in the alder cut to promote the acceleration of succession to a healthy, highly diverse forest with structural heterogeneity. This is not accomplished with traditional clear cut methods where every tree and snag is cut and the understory vegetation is destroyed. To avoid loss of the entire understory species as well as valuable wildlife snags a method called **variable retention** was used in our cut. Retention refers to leaving standing green trees of variable size and species. These trees provide shade, soil stability as well as serve as a seed source within the cut. In addition to trees, snags (standing dead trees) are also retained and have proven valuable to many wildlife species such as cavity nesting birds.

The pattern in which the trees are retained also proves important. We could choose an arbitrary percentage of trees to retain, such as leaving fifteen percent of the trees dispersed throughout the cut. Or we could retain that same fifteen percent in an island formation. These two methods are known as dispersed and aggregated retention. Both methods serve different purposes and have different disadvantages described below.

Dispersed retention: A percentage of the trees in the stand are left standing after a clear cut. The trees are left evenly dispersed across the stand.
Advantages: The roots of the live trees will stabilize the soil and reduce erosion. Good for holding soil on slopes. Mycorrhizal fungi that aid in nutrient absorption can stay alive on these roots and aid the growth of the new seedlings. These dispersed trees can provide a corridor for wildlife such as birds that may be preyed upon if forced to cross over long open distances over a clear cut.
Disadvantages: The understory vegetation is still exposed to the elements such as wind and strong light and will die off. The dispersed trees do not provide all the benefits of a real

forest. Animals dependent on shade or understory species will not find what they require. If the trees retained were suppressed trees, not ready to deal with high light and wind stress, they may simply be blow over within a few years.

Aggregated retention: Again a percentage of the entire cut area is left standing. This percentage is aggregated creating a type of forest island within a cut. This aggregate not only retains all the trees and snags in the given area but also keeps the entire understory intact. **Advantages:** The aggregate provides a safe island of intact forest for wildlife. Within the aggregate there is shade, understory plants and protection from the elements. Preserving an island containing understory species will later serve as a seed source out into the cut. In large cuts this can be very important because the nearest edge containing understory species may be far away and take years for the seeds to disperse and travel back into the center of the cut. **Disadvantages:** Outside of the aggregate is a clear cut. The soil is not stabilized outside of the aggregate. Erosion is still heavy outside the island. The soil also is exposed to heat outside the island, which leads to death of the mycorrhizal fungi. The new seedlings will have a harder time establishing and growing without the retention of mycorrhiza dispersed throughout the cut. If the aggregate is too small, then light and wind penetration around the edges can lead to death of the understory as well as wind throw of the retained trees.

An Integrated Approach for Waskowitz

To maximize the benefits of both methods and reduce the possible drawbacks, these new methods were integrated to produce a cut that would minimize loss of biodiversity while accelerating the return of a mixed conifer forest and its benefits. The retention of legacy trees, fallen logs and snags, allows us to simulate characteristics found in old growth forests. The cut used a combination of aggregates surrounded by dispersed trees and retained trees around riparian areas. Although mostly comprised of alder, the stand also contained several conifer species and bigleaf maple. These species were left to serve as legacy trees providing shade, seeds, and soil benefits for the stand.

The goal for the future of this forest is to allow it to proceed in succession towards old growth. The legacy structures, such as snags and fallen logs, will combine over time with this diverse newly planted cohort; pushing the forest to attain its goal sooner than if the alder stand was left to die out on its own. Structurally diverse in age, species, and patterns, old growth provides vital wildlife habitat and endless educational opportunities. The students at Waskowitz will actively participate in the replanting, data collection and analysis of this changing stand.