Draft Case Study Reports
Hardwood Conversion Study
PSC 02-108

Submitted To:

Washington Department
of Natural Resources

Submitted By:

February 2008

Preface

As part of the ongoing riparian hardwood conversion study (PSC-02-108) in western Washington, seven sites were harvested and planted with conifer seedlings. An eighth site was harvested Summer 2007 and replanting activities are scheduled for Spring 2008. In the winter and spring of 2007, we re-visited these sites to collect post-harvest information. Objectives were to calculate and map harvesting in the riparian area zones, measure and describe site attributes, and survey riparian trees and other lesser vegetation after harvest. Questionnaire information and data has been received from landowner's describing harvest unit layout, harvest operations, and initial applied reforestation prescriptions. The questionnaires also provide volume harvested at sites and information to allocate costs for certain reforestation activities that have occurred to date.

This report provides individual preliminary draft case study reports for the seven sites. In these reports site attributes are described and pre- and post harvest stand and vegetation conditions are compared and reported. We describe harvest unit layout activities, the harvest operation, and regeneration activities performed to date. Harvest economics and costs allocated to reforestation activities that have been completed to date are also reported.

Harvesting at site 8 was completed in late summer 2007. This site will be incorporated into this report after initial reforestation efforts are completed by the landowner and after Duck Creek Associates has completed post-harvest surveys. Future reforestation activities (e.g., brush control, inter-planting, etc.) conducted by landowners will be tracked at all sites over the remainder of this study. Future field surveys are scheduled by Duck Creek Associates to monitor regeneration, stream recruitment, and fallen/windthrow trees. This information and data will be incorporated into case reports as it becomes available. Once the study term is completed at sites, final individual case study reports will be submitted.

Table of Contents

LIST OF FIGURES

List of Tables

SITE #5

SITE #8

SITE #11

SITE #12

SITE #13

SITE #14

SITE #15

SITE #23

1 Overview

1.1 Introduction

The natural riparian forests along streams in Western Washington exhibit a variety of species compositions which include mixed and pure hardwood and conifer forests. The natural balance of the riparian forests, however, has been altered by human activity. Indeed, many riparian stands in western Washington carry the legacy of past forest management practices, when riparian buffers were not required, or where conifer regeneration efforts were never implemented or soon abandoned because of high costs and low success. Instead of conifers regenerating naturally at these sites, fast growing hardwood and shrub species like red alder (*Alnus rubra*) and salmonberry (*Rubus spectabilis*) have become dominant, and, in some areas, continue to slow or prevent the re-establishment of conifers (Cole and Newton 1986, 1987, Hibbs and Giordano 1996). Red alder, however, also provide a variety of ecological benefits including decreased transition times of disturbed areas to a more natural state (Haeussler et al. 1995), the relatively rapid stabilization of slopes (Carlton 1988), nitrogen fixation and transport (e.g., Compton et al. 2003), increased primary productivity (e.g., Goldman 1961, Lavery et al. 2004, Piccolo and Wipfli 2002) and increases in macroinvertebrate and detritus export (Piccolo and Wipfli 2002).

The transition in riparian stand composition may be affecting both the quantity and quality of in-stream large wood (LW). Although there are important functional differences between conifers and hardwoods, both types of wood contribute LW to streams from riparian areas. Conifers, however, can attain larger sizes and, in general, resist decay better than hardwoods. As a result the LW contributed by conifers is typically more durable, more likely to form key pieces, and more likely to influence stream morphology for a longer period of time than the LW generated from red alder and other hardwoods (Andrus et al. 1988). Streams with low amounts of LW have fewer in-stream pools, lower quality fish spawning habitat, less diverse fish communities, and a lower survival rate of juvenile salmonids (Beechie and Sibley 1997).

Hardwood conversion has been portrayed as a win–win strategy both for landowners and for natural resource protection. Landowners may be able to realize financial gain from harvesting riparian hardwoods – particularly red alder (log prices for red alder are currently high and have been relatively stable for the past several years) – while over time establishing conifer dominance in riparian areas is expected to improve fish habitat more quickly than if riparian areas are left dominated by hardwoods. Additionally, although current law only allows a one-time entry, landowners might, in a future rotation, also be able to harvest some of these newly established conifers. Past experience, however, has shown that regenerating conifers in riparian areas can be difficult and expensive, and prone to failure if competing shrubs and browsing animals are not carefully monitored and controlled. Additionally, the short-term effects on water temperatures from harvesting trees near the stream as part of a hardwood conversion prescription are not well understood.

Using a case study experimental design and study plan, data were collected at eight (8) riparian hardwood harvests/conversions that were added to adjoining upslope harvest

units. To investigate the economic outcomes of harvesting hardwoods and reestablishing conifers in their place, participating landowners were involved in an operational forestry context. This report describes and quantifies the silvicultural prescriptions used to establish conifers in riparian areas, quantifies the financial costs and benefits of the hardwood conversion to the landowner, and quantifies and describes the stream temperature responses.

1.2 Background

Washington Forest Practices Rules (hereafter "rules") adopted in 2001 are based on pursuing three broad goals: 1) promoting a viable timber industry, 2) protecting water quality, and 3) restoring salmon habitat. The rules that guide harvesting of trees in riparian areas aim to put riparian stands along fish bearing streams on trajectories to develop into a desired future condition (DFC), which is defined in the rules as being structurally similar to a mature riparian conifer-dominated forest, as measured by basal area.

Along fish-bearing streams the rules delineate three parallel zones, which collectively form the riparian management zone (RMZ). Immediately adjacent to the stream is a 50 foot wide 'core' management zone (CMZ), where no trees can be harvested except when installing road crossings or logging corridors. Adjacent to the core zone is a variable width 'inner' management zone (IMZ), which extends from the edge of the core zone 10 to 100 feet, depending on the width of the stream and productivity of the site (Table 1). The amount of trees that can be harvested from the inner zone depends on whether the RMZ is dominated by conifers or hardwoods. Where conifers are dominant, the rules allow harvest of conifers from the inner zone as long as the retained conifers in the combined core and inner zones remain on a growth trajectory to reach a Desired Future Condition (DFC) by age 140 years – as defined by site class specific basal area targets. Where hardwoods are dominant, the rules allow for "conversion" harvests wherein hardwoods can be harvested (but not conifers >20" diameter at breast height [DBH], or more than 10% of conifers >8" DBH) from portions of the inner zone as long as the outcome of the harvest and reforestation is the conversion of the inner zone to conifer dominance and a trajectory to a DFC (i.e., mature riparian conifer forest). Extending from the inner zone is a variable width 'outer' zone, where trees can be harvested as long as a minimum number of trees (20 trees per acres [TPA]) are retained.

Table 1. Western Washington riparian management zone (RMZ) widths.

Site Class	RMZ width (in feet)	Core plus Inner Zone width [1]		Outer Zone width [2]	
		Stream Width (in feet)		Stream Width (in feet)	
		≤10	>10	≤10	>10
I	200	133	150	67	50
II	170	113	128	57	42
III	140	93	105	47	35
IV	110	73	83	37	27
V	90	60	68	30	22

[1] Measured from outer edge of bankfull width or CMZ.

[2] Measured from outer edge of Inner Zone.

To ensure protection of water quality, the hardwood conversion rules include qualifying elements that limit the amount of wood that can be harvested so that only portions of the inner zone may be cut. Many landowners believe that these restrictions do not allow for large enough canopy openings for successful, cost-effective conifer establishment and growth, especially for relatively shade-intolerant Douglas-fir.

During the negotiations of the forest practices rules, some participants advocated for less stringent hardwood conversion rules by arguing that the long-term benefits of establishing conifers closer to stream edges, measured by shade and potential LWD, offsets any short-term impacts to water quality, that overall there is a net gain for stream habitat measured by both water quality and fish productivity. Specifically, they argued that: 1) harvest of hardwood trees could be done closer to the stream, including being able to harvest some hardwoods from the core zones and more trees from the inner zone than the current rules allow, and 2) that timber could be cut along longer stream reaches than currently allowed without causing adverse impacts to water quality (e.g., water temperature). Uncertainty was also expressed over whether the economic benefits gained from harvesting hardwoods in RMZs as part of a hardwood conversion treatment would be a strong enough incentive for landowners to take on the responsibility of ensuring conifer regeneration in the harvested riparian areas, even with less stringent regulations.

When the hardwood conversion rules were adopted, the Washington State Forest Policy Committee directed CMER (Cooperative Monitoring, Evaluation and Research Committee) to conduct a study that would examine the silviculture, economic viability, and stream temperature impacts of hardwood conversions, with the understanding that the study could include harvest prescriptions that removed more hardwood trees from the core and inner zones than the current rules allow.

This study was launched in 2002, with the first harvests occurring in summer 2004. After analysis of the first post-harvest vegetation data collected in fall 2005, data collection methods were reviewed and altered because of concerns about between-plot variability and the ability to infer with confidence results about stand composition and structure to whole RMZs. In the meantime, the economic analysis and the stream temperature data collection methods were finalized. For a detailed description of the methods utilized for the case studies, please see the Riparian Hardwood Conversion (RHC) Study Plan (v. 10.0).

1.3 Study Objectives

The purpose of this study is to:

1. Monitor, describe and quantify the regeneration of conifers in riparian management zones and describe the silviculture used to insure regeneration success.
2. Quantify the costs of successfully regenerating conifers in riparian zones and the net financial gain (or loss) of adding riparian hardwood conversions to adjacent upslope harvest units.
3. Describe and quantify stream temperature responses to harvesting dominant hardwood trees from the riparian management zone.

1.4 Site Selection

In the early stages of the study design – prepared for and approved by the Washington Department of Natural Resources (DNR) pursuant to Personal Services Contract 02-108 – a list of attributes was developed to help determine the suitability of landowner-recommended sites for conversion from hardwood dominance to conifer dominance (discussed below; also see Table 1 in the RHC Study Plan, version 10.0). The original plan was to use these criteria in the site selection process to identify and select the 'best' 15 to 20 sites for inclusion in the study. However, site selection proved to be more difficult than anticipated and given that landowners' harvest schedules largely controlled the initial implementation of the study, a total of 8 sites were selected. Sites selected for this project were in riparian forests in western Washington that, although currently dominated by red alder and/or other hardwoods, also support conifers. The criteria used to select study sites included: 1) riparian forests dominated by hardwoods, 2) evidence of historic presence of conifers (especially presence of stumps and/or snags) or indications that conifers would succeed on the site, and 3) landowner willingness to participate in the study and share information about their sites and silvicultural practices.

Harvest and regeneration prescriptions were left to the discretion of landowners with the following requirements; no harvest within 25' feet of the edge of bank-full or CMZ; retain conifers in the core and inner zones; and conifer must be successfully regenerated (i.e. adequately stocked and free-to-grow) and be on track to dominate the converted RMZ, regardless of cost.

1.5 Methods

Information in this report was pooled from a variety of sources. Landowner profiles were pulled from the company's website while climate information was pulled from National Weather Service and NOAA National Climate Data Center climate stations (available on the web). Landowners provided much of the information in a questionnaire designed by Duck Creek Associates and the Riparian Scientific Advisory Group (RSAG) and distributed to the landowner post-harvest. Reforestation and harvest economics data were compiled by Duck Creek Associates using information provided by landowners in the questionnaires. Stumpage values were calculated using Washington Department of Revenue (WDOR) Stumpage Value Determination Tables. However, WDOR logging cost adjustment methods were modified to allow for prorated adjustments by logging method. Duck Creek Associates conducted pre-harvest vegetation surveys at sites using the procedures outlined in the WDNR Hardwood Conversion Procedures Manual and a post-harvest survey at sites following the procedures outlined in the Post Harvest 100% and Stump Procedures Manual (Version 1.2).[1] Duck Creek Associates conducted

[1] Pre-harvest vegetation surveys, and initial post harvest surveys, done at 4 sites, were conducted using a transect plot design. After review of the variability in the initial post harvest transect data, the Riparian Scientific Advisory Group (RSAG) decided to discontinue its use for collecting post-harvest vegetation data. In place of the transect survey post-harvest, a 100% RMZ survey was used to collect large tree data (> 5" DBH) on all trees including stumps, snags, and fallen/windthrow trees, and a 1/50th acre circular plot design to collect regeneration and lesser vegetation data in the planted RMZ. Although the two methods are not directly comparable, the pre-harvest survey data offers insights into the small tree composition, and lesser vegetative composition and percent cover. Furthermore, post-harvest 100% data can be used to reconstruct the pre-harvest condition for large trees, while circular plot data can be compared through time to assess changes in lesser vegetation composition and percent cover, and seedling growth and survival post harvest.

regeneration surveys following the procedures outlined in the Post Harvest Regeneration Survey Procedures Manual (Version 1.3) and collected GPS data during the various on-site surveys. Various site attributes, derived from GIS data layers, were downloaded from both WDNR and USDA spatial data clearinghouses.

RMZ stand metrics were compiled using Forest Projection and Planning System (FPS) version 6.62 software. GPS data was compiled and analyzed using ArcGIS 9.2 while stream attribute and lesser vegetation data were compiled and summarized using both Microsoft Excel and Access 2003.

1.6 Key Findings (combination of case studies and site[s])

For final compiled report.

- Harvest patterns in the RMZ were not uniform between sites but varied according to site-specific conditions, often resulting in buffers wider than 25' from stream edge or CMZ. The conditions listed below were significant factors that influenced the amount cut in RMZ;
    - Sensitive features (potentially unstable slopes, inner gorge areas, side-hill seeps, etc.)
    - The amount of conifer retained in RMZ, and conifer in outer zone can be a barrier to cutting hardwoods nearer the stream
    - Up-slope trees left uncut to prevent damage to retained buffer trees
    - Other retention tree requirements (WRT, GRT, outer zone riparian leave trees, etc.) often left "clumped" adjacent to RMZ
- Harvests in the RMZs (7 sites) resulted in 17% to 67% of area in RMZ cut at sites and resulted in an average 27% (12% to 44%) reduction in cubic foot volume.
- Findings indicate that at 6 of the 7 sites analyzed so far, timber harvesting in the RMZ resulted in less revenue generated per acre cut than the adjoining upland - RMZ values averaged 64% (46% to 116%) of the upland value.

2 Site Reports

What follows is a series of case study reports for each hardwood conversion site. Site reports include a general description, an activities timeline, pre- and post-harvest vegetation descriptions, applied harvest and regeneration prescriptions, details on harvest regeneration economics and key findings.

2.1 Site #5 (FPA/N # 2905299)

2.1.1 Site Identification and Description

2.1.1.1 Landowner Profile

Longview Fibre Company (hereafter, Longfibre), founded in Longview, Washington in 1927 and purchased in April 2007 by Canadian-owned Brookfield Asset Management, is a real estate investment trust (REIT) engaged in the ownership and management of more than half a million acres of softwood timberlands located predominantly in western Washington and Oregon. Longfibre has seven manufacturing plants, office locations in dozens of US cities, employs nearly 2,500 people, and manufactures a variety of products that include lumber and specialty papers and containers.

2.1.1.2 Factors Leading to Hardwood Conversion

Longfibre, where feasible, would like to incorporate hardwood conversions into their management decisions and identified two primary factors responsible for incorporation of hardwood conversions: 1) the potential financial benefit and 2) the potential to increase operable conifer acres. Longfibre participated in this study for the aforementioned reasons and – as they identified in the questionnaire – because they were asked to participate.

2.1.1.3 Location

This hardwood conversion study site ("CMER Research Site #5) is located in Longfibre's SW Washington Tree Farm, Cowlitz County, in a portion of Section 17, Township 8 North, Range 1 West, Willamette Meridian.

2.1.1.4 Topography and Climate

The study site varies in elevation from 525 to 760 feet and receives, on average, 48.02 inches of precipitation per year. Most of the precipitation falls from November through March in the form of rain with average snowfall of 5.38 inches and a mean air temperature of 52.0°F. Climate data comes from the National Weather Service's Cooperative Station Network, Longview station[2] (454769) located in Longview, Washington. Values are reported as annual mean monthly data from 1971-2000.

2.1.1.5 Stream Description

The hardwood conversion study stream segment is classified by the DNR as a Type III water. The stream was not surveyed for fish presence at the time of FPA permitting.

[2] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

However, no known fish use exists. The in-unit stream segment length is approximately 1,800 feet, stream bankfull width averages 7.6 feet, and the stream gradient averages 16.6%.

2.1.1.6 Unit Description

Situated northwest of Kelso Washington, near Mt. Brynion, the harvest area consisted of three cutting blocks or units, laid out from east to west, totaling approximately 68 acres (according to Longfibre). The hardwood conversion study stream segment divided the western and middle cutting blocks while another stream segment, not part of this study, divided the middle and eastern cutting blocks. Figure 1 displays a map of the harvest area.

2.1.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 170 feet with a "management RMZ" (core plus inner zone) width of 113 feet (Table 2). Of this, 50 feet represented the core zone and 63 feet represented the inner zone (Figure 1). The management RMZ that fell within the study reach covered 8.4 acres (Figure 1). An estimated 1.6 acres of the management RMZ was harvested, resulting in a retention buffer that covered 6.8 acres (Figure 1). The western (right) bank of the study reach was mostly a full retention buffer, similar to the no inner zone management option, where almost all of the trees within the management RMZ were retained. The eastern (left) bank was a variable width buffer but all trees within 25 feet of bankfull width were retained. Cutting outside of the 25-foot no cut zone on the eastern (left) bank resulted in a variable width buffer that ranged from 25 to in excess of 113 feet in width. Steep slopes were excluded from harvest in the RMZ as a measure to maintain slope stability and help prevent cut trees and slash from entering the stream during harvest operations. In other areas of this RMZ, trees were left outside of the 25-foot no cut zone to meet in-unit and outer zone riparian wildlife leave tree requirements. At this site, slopes within the RMZ range from 20 to 80 percent and average 39 percent. Figure 1 displays the location of the study reach, within the harvest area and the resulting buffer configuration.

Table 2. Site #5 riparian management zone (RMZ) widths.

Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
II	170'	≤ 10'	113'

2.1.1.8 Soil Description

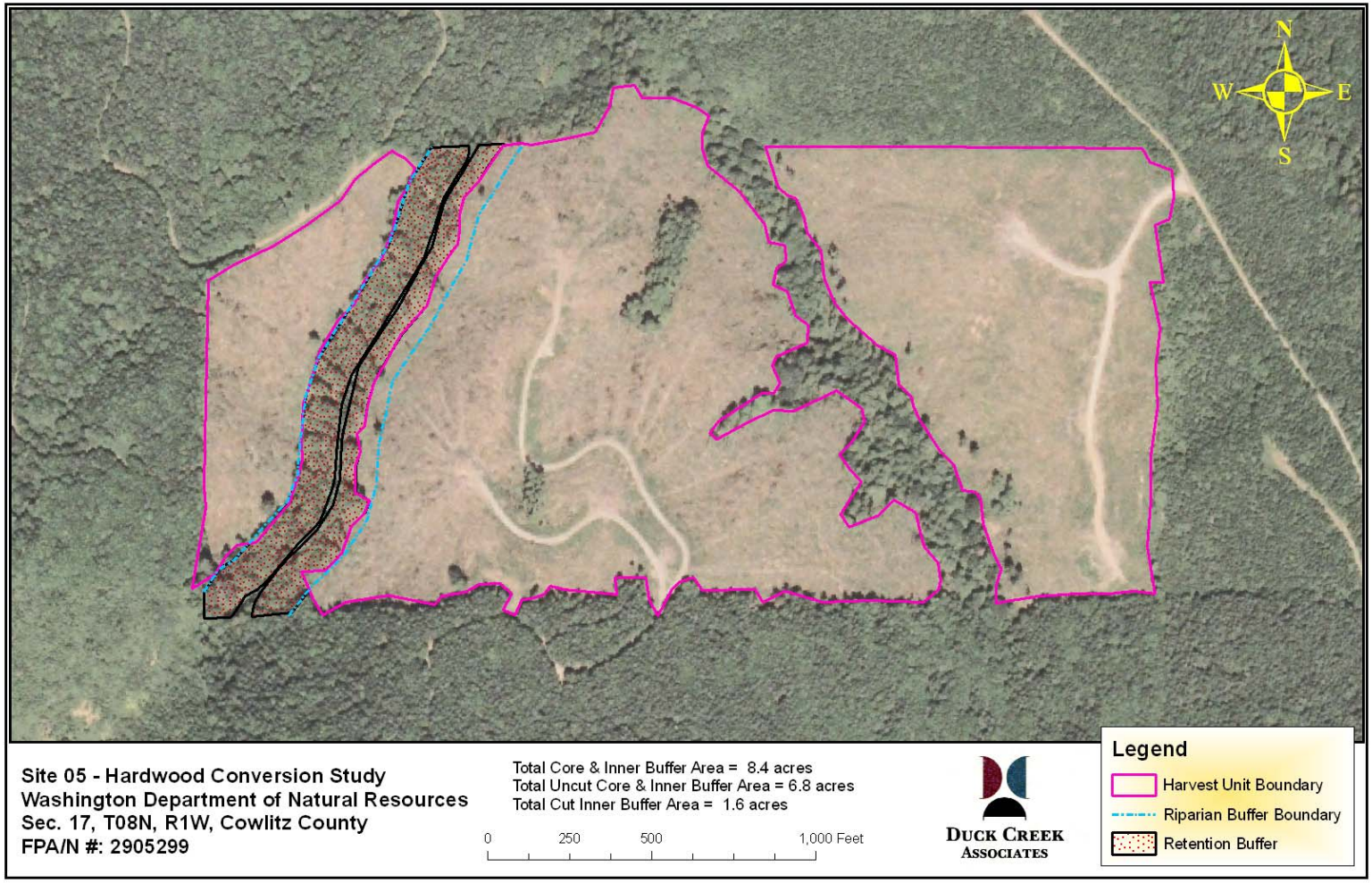
Soils in the research segment are derived from foothill basalt and are typically from the Hazeldell gravelly silty loam (30-65% slopes) soil series. The generalized site productivity class, as defined by official Forest Practices maps, is Site Class II.

2.1.2 Duck Creek Associates Activities Timeline

During the Spring of 2002, Duck Creek Associates conducted an initial site review and selected the site for inclusion in the study. In October 2002, Duck Creek Associates conducted a pre-harvest vegetation survey at the site. In fall 2003, Duck Creek

Associates collected various stream metric information at the site and in February 2007 conducted a post-harvest vegetation survey at the site. Additionally, during the February 2007 post-harvest vegetation survey, Duck Creek Associates conducted a regeneration survey and a GPS mapping survey of the treatment RMZ. In May 2007, the landowner returned the questionnaire. In August 2007, Duck Creek Associates digitized and/or analyzed the GIS data and compiled this report. RMZ stand metrics (e.g., species distribution, trees per acre, volume, etc.) were calculated from the February 2007 post-harvest 100% and regeneration surveys.

Figure 1. Site #5 Map.



2.1.3 Pre-harvest Vegetation

2.1.3.1 Pre-harvest Upslope Stand Table/Description

The upslope (i.e., non-RMZ) stand table/description is not available for this site. For an approximation of the species distribution in the upland refer to Table 5 in the Combined Harvest Volume in Section (2.1.5) of this report.

2.1.3.2 Pre-harvest RMZ Stand Table/Description

Red alder was the dominant species in the RMZ pre-harvest. Red alder accounted for 80% of the live tree basal area and 81% of the gross cubic foot volume, as shown in Table 3. These statistics were compiled using post-harvest 100% survey data, which included stump cruise data, collected by Duck Creek Associates in February 2007, to reconstruct the pre-harvest condition. It is important to note that this survey occurred one growing season after harvest and that no adjustments have been made to account for growth occurring in standing live trees since the time of harvest.

Table 3. Pre-Harvest RMZ Stand Table Summary

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Red alder	1.6	8.4	0.7	41.7	1.4	-	3.9	-
	Douglas fir	0.1	7.0	0.0	34.9	0.0	-	0.0	-
Snag Totals		**1.8**		**0.7**		**1.4**	**-**	**3.9**	**-**
Live	Red alder	90.1	13.0	87.5	90.5	2,703.0	2,510.0	11,458.8	10,642.7
	Douglas fir	12.6	11.8	11.5	81.6	366.3	341.7	1,602.4	1,494.8
	Western redcedar	5.2	13.1	6.6	55.4	167.5	154.9	629.4	580.8
	Black cottonwood	0.2	26.0	0.9	137.0	40.0	36.0	207.1	185.8
	Bigleaf maple	2.7	9.8	1.7	65.4	41.0	35.9	167.1	146.0
	Western hemlock	0.7	15.0	1.2	72.0	38.3	32.4	165.9	139.2
	Other hardwoods	0.1	9.0	0.1	65.0	1.1	1.0	3.5	3.4
Live Totals		**111.6**		**109.4**		**3,357.1**	**3,111.9**	**14,234.1**	**13,192.5**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet

2.1.3.3 Pre-harvest RMZ Vegetation Description

Table 4 displays major vegetation species in the RMZ pre-harvest, by percent cover and average height. This data was compiled using pre-harvest vegetation transect survey data collected in Fall 2002 (see section 1.5 Methods footnote 1).

Table 4. Pre-harvest RMZ vegetation.

Species	% Cover	Height (ft.)
Vine maple	61.8	21.4
Western swordfern	34.6	3.1
Salmonberry	17.3	6.3
Oregon oxalis	13.9	≤1.0

2.1.4 Applied Harvest Prescription

2.1.4.1 Site Layout and Road Construction/Maintenance Description

This site consisted of three harvest units or cutting blocks, two of which bordered the study reach. Due to the steepness of the terrain, Longfibre left additional trees along the left (East) bank buffer to help keep materials out of the creek during harvest. A total of 2,300 feet of new roads were allocated to the unit, no roads were reconstructed, and there were no additional road construction activities attributed directly to the hardwood conversion. A total of twelve (12) person hours were required to lay out the study RMZ.

2.1.4.2 Schedule of Activities

The FPA application for this site was approved in April 2004. Harvesting was initiated in August of 2005 and completed in January of 2006. Upland site preparation (i.e., aerial herbicide application; discussed in greater detail further below) was conducted in September 2006 while no RMZ site preparation was performed. Upland and riparian plantings occurred in February 2007 with animal damage deterrents installed simultaneously (described in more detail below).

2.1.4.3 Yarding/Logging Description

Three logging methods were employed with an estimated 75% of the unit harvested by skyline, 15% by high lead, and 10% by shovel. There were no special activities or equipment required during harvesting operations.

2.1.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 1,025.8 MBF (net Scribner scale) of sawlog material, as displayed in Table 5, and approximately 2,998 tons of chipwood material. The reported combined upland and RMZ area was 68 acres.

Table 5. Combined upland and RMZ net harvest volume (68 acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF[1]/acre)	Percent of Total
Red alder	799.7	11.76	78.0
Douglas fir	186.8	2.75	18.2
Western hemlock	17.5	0.26	1.7
Western redcedar	17.4	0.26	1.7
Grand fir	2.4	0.04	0.2
Black cottonwood	1.4	0.02	0.1
Bigleaf maple	0.6	<0.01	0.1
Totals	**1,025.8**	**15.09**	**100.0**

[1] Thousand board feet

2.1.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced 17.3 MBF (net Scribner scale) of sawlog material, as displayed in Table 6**,** and approximately 11 tons of chipwood material. The estimated harvest area in the RMZ is 1.6 acres.

Table 6. RMZ net harvest volume (1.6 acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF[1]/acre)	Percent of total
Red alder	11.0	6.88	63.6
Douglas fir	5.8	3.63	33.3
Western redcedar	0.3	0.19	1.9
Bigleaf maple	0.1	0.06	0.4
Western hemlock	0.1	0.06	0.8
Totals	**17.3**	**10.82**	**100.0**

[1] Thousand board feet

2.1.6 Key Harvest Operation Findings and Challenges

In the questionnaire, Longfibre mentioned that laying out this study buffer took much less time than laying out the alternative no inner zone management option (WAC 222-030-021,(1), (ii), (A), because there was little conifer to account for in the inner zone.

In the questionnaire, Longfibre identified the steepness of the slopes surrounding the RMZ as the main challenge associated with the hardwood conversion. The steep slopes made harvesting difficult due to the extra efforts necessary to keep logs and slash from rolling towards the stream and they had to leave additional trees to help keep material from entering the stream.

2.1.7 Harvest Economics

The estimated stumpage value for the harvest occurring in the RMZ was $6,377. The indicated Forest Excise tax amount was $319. Using 1.6 acres as the area of harvest in the RMZ, Table 7 displays the calculated stumpage value for the RMZ on a per acre basis. The indicated stumpage value for the harvest in the upland is $347,525. The indicated Forest Excise tax amount was $17,376. Based on an indicated area of 66.4 acres for the upland, Table 7 displays the calculated stumpage value for the upland on a per acre basis. The estimated gross stumpage value of the harvest for the entire 68 acre unit was $353,902. The indicated Forest Excise tax amount was $17,695. Table 7 displays the calculated stumpage value for the combined upland and RMZ harvest on a per acre basis.

Table 7. Harvest stumpage values in dollars per acre.

	RMZ		Upland		Combined (RMZ/Upland)	
Cost/Revenue	**Acres**	**$/Acre**	**Acres**	**$/Acre**	**Acres**	**$/Acre**
Stumpage Value	1.6	3,985.62	66.4	5,233.81	68.0	5,204.44
Harvest Taxes		(199.38)		(261.69)		(260.22)
Net Stumpage Value		**3,786.24**		**4,972.12**		**4,944.22**

2.1.8 Regeneration Prescription

2.1.8.1 Site Preparation and Brush Control

2.1.8.1.1 Upland

No mechanical or manual upslope site preparation activities were conducted prior to planting. Herbicides, however, were applied to control brush. The chemical herbicide treatment included aerial application of three chemicals (Chopper, Oust Extra, Razor Pro) on September 8th, 2006. Chopper and Oust Extra were applied at a rate of 8 and 3 ounces per acre, respectively, while Razor Pro was applied at a rate of 3 quarts per acre. According to the landowner the reported total cost of application was $3,909.32; includes contractor labor, equipment and materials.

2.1.8.1.2 RMZ

There were no mechanical, manual or chemical RMZ site preparation or brush control treatments.

2.1.8.2 Planting Schedule/Description

2.1.8.2.1 Upland and RMZ Combined

Three native species of seedlings were planted post-harvest on February 8th, 2007: Douglas-fir (*Psuedotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*). Douglas-fir plug-1 planting stock was planted at a target density of 464 trees per acre (TPA) while western hemlock and western redcedar plug-15 planting stock was planted at 9.75 and 7.5 TPA, respectively within the unit as a whole, however shade tolerant western hemlock and western redcedar were reserved primarily

for planting in riparian areas. All seedlings were planted to specifications using a hand shovel at one tree per hole. Table 8 displays the planting stock list provided by the landowner for the upland and RMZ combined. According to the landowner, a total of 38,520 trees were planted at a total cost (includes seed, nursery and contract labor costs) of $26,235.

Table 8. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA)
2/18/2007	Douglas fir	Native	Ht-106/P-1	2,340	29.25
"	Douglas fir	Native	Ht-97/P-1	34,800	435
"	Western Hemlock	Native	M-979/P-15	780	9.75
"	Western redcedar	Native	M-981/P-15	600	7.5

2.1.8.3 Animal Control Strategies/ Descriptions

2.1.8.3.1 Upland and RMZ Combined

Paper seedling caps and Vexar® tubes were installed on some of the seedlings during planting (February 8th, 2007) as deer and elk browse deterrents. The paper seedling budcaps were installed on the Douglas-fir at a target density of 435 TPA (i.e., not all the Douglas-fir seedlings received budcaps) while the Vexar® tubes were installed on the western redcedar. None of the western hemlock seedlings received animal control devices. According to the landowner a total of 35,400 trees were capped and netted at a total cost (includes material and contract labor costs) of $4,602.

2.1.8.4 Key Reforestation Findings and Challenges

In the questionnaire, Longfibre identified brush control in the RMZ as difficult because their primary tool for control is aerial application of herbicides, which is not allowed in the RMZ.

2.1.9 Regeneration Economics

Table 9 displays the indicated regeneration costs, to date, on a per acre basis for the upland and RMZ. The upland and RMZ acreage basis for site preparation used is 66.4 and 1.6 acres, respectively.

Table 9. Upland and RMZ Regeneration Costs.

	Upland		RMZ	
Activity	Date	Cost per acre	Date	Cost per acre
Site preparation	09/2006	$58.88	-	$0.00
Planting	02/2007	$327.94	02/2007	$327.94
Animal control	02/2007	$57.53	02/2007	$57.53
Total (For Final Report)				

Costs reported by landowner in the questionnaire (dated May 8, 2007) included materials, labor, and equipment for application and planting. Company administration costs were not included.

2.1.10 Post-harvest Vegetation

2.1.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting, as is indicated in Table 10 under the "Cutting" group, accounted for a 20% reduction in the number of trees per acre, a 17% reduction in basal area per acre, and 17% reduction in gross cubic foot volume per acre. Compared to the pre-harvest condition, disturbance, as is indicated in Table 10 under the "Fallen/Windthrow" group, accounted for an 8% reduction in trees per acre, a 7% reduction in basal area per acre, and a 6% reduction in gross cubic foot volume per acre.

Table 10. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	12.9	12.6	11.8	89.4	360.7	342.7	1,529.4	1,452.9
	Douglas fir	7.6	11.1	5.8	80.0	173.6	164.9	729.4	692.9
	Western redcedar	1.4	9.5	0.9	43.9	16.6	15.8	52.9	50.3
	Western hemlock	0.2	14.1	0.3	61.8	6.7	6.4	22.4	21.2
	Bigleaf maple	0.2	9.8	0.1	72.7	3.0	2.9	12.9	12.3
Cutting Totals		**22.5**		**18.9**		**560.7**	**532.7**	**2,347.1**	**2,229.7**
Fallen/ Windthrow	Red alder	8.1	11.8	6.5	88.3	192.5	182.9	828.2	786.8
	Douglas fir	0.9	9.4	0.5	70.2	10.3	9.8	43.5	41.4
	Western redcedar	0.2	7.0	0.1	36.5	0.8	0.8	3.5	3.4
	Bigleaf maple	0.2	8.5	0.1	62.4	1.8	1.7	7.1	6.7
	Western hemlock	0.1	9.0	0.1	53.1	1.0	0.9	3.5	3.4
Fallen/Windthrow Totals		**9.6**		**7.2**		**206.3**	**196.0**	**885.9**	**841.6**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.1.10.2 Post-harvest RMZ Stand Table/ Description

Compared with the pre-harvest condition, live tree basal area was reduced by 24% and there was a 23% reduction in live tree gross cubic foot volume. As is displayed in Table 11, red alder remains the dominant species post-harvest, accounting for 83% of the basal area and gross cubic foot volume.

Table 11. Post-harvest Stand Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Red alder	2.5	8.3	1.0	41.3	2.0	-	5.0	-
Snag Totals		**2.5**		**1.0**	**41.3**	**2.0**	**-**	**5.0**	**-**
Live	Red alder	68.2	13.2	68.9	91.2	2,144.9	1,991.4	9,074.1	8,426.0
	Douglas fir	4.1	13.7	5.3	86.2	182.4	170.0	834.1	776.9
	Western redcedar	3.5	14.9	5.6	61.2	151.0	139.5	575.3	530.2
	Black cottonwood	0.2	26.0	0.9	137.0	40.0	36.0	207.1	185.8
	Bigleaf maple	2.2	9.9	1.4	64.9	36.2	31.5	147.1	127.7
	Western hemlock	0.4	17.7	0.8	85.1	30.5	25.8	140.0	117.0
	Other hardwood	0.1	9.0	0.1	65.0	1.1	1.0	3.5	3.4
Live Totals		**78.8**		**83.0**		**2,586.1**	**2,395.1**	**10,981.2**	**10,166.9**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.1.10.3 RMZ Regeneration Survey Data

Table 12 displays a summary of compiled data from the regeneration survey conducted in the RMZ in February 2007 following initial planting. Two follow-up surveys are scheduled, one in Spring 2009 and another in Spring 2011, to track regeneration in the RMZ at this site.

Table 12. Initial Post-Harvest RMZ Regeneration Survey Summary

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2006	Douglas-fir	Planted	479.4	0.0	0.0	1.7	95
	Western redcedar	Planted	55.9	0.0	0.0	1.0	95
	Totals		**535.3**	**0.0**	**0.0**	**1.6**	
	Red alder	Live (natural)	97.1	0.0	0.0	2.6	80
	Douglas-fir	Live (natural)	2.9	3.1	0.2	20.0	19
	Totals		**100.0**	**0.1**	**0.2**	**3.1**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acres weighted average
[2] In square feet
[3] In feet

2.1.10.4 RMZ Shrub and Site Condition Description

Table 13 displays major vegetation species observed and site condition factors that could impact planting in the planted portion of the RMZ. This data was compiled from data collected in conjunction with the regeneration survey in the RMZ following planting in February 2007.

Table 13. Initial Post-harvest RMZ Vegetation Survey Results

Growth Year	Species	% Cover	Height (ft.)
2006	Western sword fern	30.3	2.4
	Miner's lettuce	8.5	1.0
	Slash	*7.1*	*2.7*
	Vine maple	5.6	9.8
	Salmonberry	3.2	4.0
	Oregon Oxalis	0.6	1.0

2.1.11 Economic Analysis (for final compiled report)

In the final report this section will bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site

Example

Table 14. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	$4,972.12	
Regeneration Costs		
Administration Costs		
Net Income		

Example

Table 15. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	$3,786.24	
Regeneration Costs		
Administration Costs		
Net Income		

2.1.12 Discussion and Key Findings (for final compiled report)

1. Summary of regeneration strategy, and evaluation of its success or failure at this site
2. Lesson(s) learned from hardwood conversion
3. Relevant/interesting results not presented earlier in document

2.2 Site #8 (FPA/N #)

Harvest and planting information is not yet available for this site. Facts, figures, and data will be incorporated as it becomes available after initial planting and post harvest surveys are completed. The headings and tables provided below are listed only as placeholders for keeping the Tables of Contents/Figures/Tables organized.

2.2.1 Site Identification and Description

2.2.1.1 Landowner Profile

2.2.1.2 Factors Leading to Hardwood Conversion

2.2.1.3 Location

2.2.1.4 Topography and Climate

2.2.1.5 Stream Description

2.2.1.6 Unit Description

2.2.1.7 RMZ Description

Table 16. Site #8 riparian management zone (RMZ) widths.

RMZ width (in feet)			Management RMZ area (acres)	
	Management			
Regulatory	Core	Inner	Retention	Harvested

[1] Measured from outer edge of bankfull width or outer edge of Core Management Zone (CMZ) of water.
[2] Measured from outer edge of Inner Management Zone (IMZ).

2.2.1.8 Soil Description

2.2.2 Duck Creek Associates Activities Timeline

Figure 2. Site #8 Map.

2.2.3 Pre-harvest Vegetation

2.2.3.1 Pre-harvest Upslope Stand Table/Description

2.2.3.2 Pre-harvest RMZ Stand Table/Description

Table 1. Pre-Harvest RMZ Stand Table Summary

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag									
Snag Totals									
Live									
Live Totals									

[1] DBH = diameter (in inches) at breast height
[2] In square feet
[3] In feet

2.2.3.3 Pre-harvest RMZ Vegetation Description

Table 2. Pre-harvest RMZ Vegetation

Species	% Cover	Height (ft.)

2.2.4 Applied Harvest Prescription

2.2.4.1 Site Lay-out and Road Construction/Maintenance Description

2.2.4.2 Schedule of Activities

2.2.4.3 Yarding/Logging Description

2.2.5 Combined Harvest Volume (Upland and RMZ)

Table 17. Combined upland and RMZ net harvest volume.

Species	Net Volume Harvested (MBF[1])	Per Acre Harvest (MBF[1])	Percent of Total
Totals			

[1] Thousand board feet

2.2.5.1 RMZ Harvest Volume

Table 18. RMZ Net Harvest Volume.

Species	Net Volume Harvested (MBF)	Percent of total
Totals		

2.2.5.2 Key Harvest Operation Findings and Challenges

2.2.6 Harvest Economics

Table 19. Harvest stumpage values in dollars per acre.

	RMZ		Upland		Combined (RMZ/Upland)	
Cost/Revenue	**Acres**	**$/Acre**	**Acres**	**$/Acre**	**Acres**	**$/Acre**
Stumpage Value						
Harvest Taxes						
Net Stumpage Value						

2.2.7 Regeneration Prescription

2.2.7.1 Site Preparation and Brush Control

2.2.7.1.1 Upland

2.2.7.1.2 RMZ

2.2.7.2 Planting Schedule/Description

2.2.7.2.1 Upland and RMZ Combined

Table 20. Planting Stock List for Upland and RMZ Combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA)

2.2.7.3 Animal Control Strategies/Descriptions

2.2.7.3.1 Upland and RMZ Combined

2.2.7.4 Key Reforestation Findings and Challenges

2.2.8 Regeneration Economics

Table 21. Upland and RMZ Regeneration Costs.

	Upland		RMZ	
Activity	Date	Cost per acre	Date	Cost per acre
Total (For Final Report)				

2.2.9 Post-harvest Vegetation

2.2.9.1 RMZ Stand Depletion

Table 22. Total and percentage (of remaining standing trees; in parentheses) RMZ Stand Depletions, by year, for Cutting and Fallen/Windthrow.

Group	Year	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
							Gross	Net	Gross	Net
Cutting										
Cutting Totals										
Fallen/ Windthrow										
Fallen/Windthrow Totals										

[1] DBH = diameter (in inches) at breast height
[2] In square feet
[3] In feet

2.2.9.2 Post-harvest RMZ Stand Table/Description

2.2.9.3 RMZ Regeneration Survey Data

Table 23. Initial Post-Harvest RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown

[1] DBH = diameter (in inches) at breast height
[2] In square feet
[3] In feet

2.2.9.4 RMZ Shrub and Site Condition Description

Table 24. Initial Post-harvest RMZ Vegetation Survey Results.

Growth Year	Species	% Cover	Height (ft.)

Table 25. Total and percentage (of remaining standing trees; in parentheses) Post-harvest Stand Summary, by year.

							Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Year	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag										
Snag Totals										
Live										
Live Totals										

[1] DBH = diameter (in inches) at breast height
[2] In square feet
[3] In feet

2.2.10 Economic Analysis (for final compiled report)

Example

Table 26. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value		
Regeneration Costs		
Administration Costs		
Net Income		

Example

Table 27. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value		
Regeneration Costs		
Administration Costs		
Net Income		

2.2.11 Discussion and Key Findings (for final compiled report)

4. Summary of regeneration strategy, and evaluation of its success or failure at this site
5. Lesson(s) learned from hardwood conversion
6. Relevant/interesting results not presented earlier in document

2.3 Site #11 (FPA/N # 2606709)

2.3.1 Site Identification and Description

2.3.1.1 Landowner Profile

Merrill and Ring (hereafter, M&R), founded in 1888 and headquartered in Port Angeles, Washington, is a privately held timber and land management company engaged in natural resource management. The company, comprised of seven partner ownership entities including Ring Family LP – which holds this site – together holds 75,000 timberland acres in western Washington, British Columbia and New Zealand. M&R has several office locations in western Washington and one in New Zealand.

2.3.1.2 Factors Leading to Hardwood Conversion

M&R has been conducting hardwood conversion operations for 13+ years and identified two primary factors responsible for incorporation of hardwood conversions: 1) the potential financial benefit and 2) land stewardship and management goals. M&R participated in this study for the aforementioned reasons and – as they identified in the questionnaire – because they were asked to and felt that "it was the right thing to do."

2.3.1.3 Location

This hardwood conversion study site ("CMER Research Site #11) is located in M&R's western Washington Pysht Tree Farm, Clallam County, in a portion of Section 5, Township 31 North, Range 11 West, Willamette Meridian.

2.3.1.4 Topography and Climate

The study site varies in elevation from 200 to 480 feet and receives, on average, 95.11 inches of precipitation per year. Most of the precipitation falls from November through February in the form of rain with average snowfall of 19.2 inches and a mean air temperature of 49.0°F. Climate data comes from the National Weather Service's Cooperative Station Network, Sappho 8 E station[3] (457319) located in Sappho, Washington. Values are reported as annual mean monthly data from 1971-2000.

2.3.1.5 Stream Description

The hardwood conversion study stream segment is located along Reed Creek and is classified by the DNR as a Type III water. The stream was not surveyed for fish presence at the time of FPA permitting. However, fish are known to use the stream during portions of the year. The in-unit stream segment length is approximately 2,200 feet, stream bankfull width averages 13.9 feet, and the stream gradient averages 0.8%.

2.3.1.6 Unit Description

Situated in the Pysht River Tree Farm, the harvest unit, located northeast of Sappho, Washington, consisted of one cutting block (or unit) that ran along the south side of Reed Creek, was laid out from east to west, and totaled approximately 8.5 acres (according to M&R). Figure 3 displays a map of the harvest area.

[3] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

2.3.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 140 feet with a "management RMZ" (core plus inner zone) width of 105 feet, of which, 50 feet represented the core zone and 55 feet represented the inner zone (Table 28). The management RMZ that fell within the study reach covered 5.5 acres. An estimated 3.6 acres of the management RMZ was harvested, resulting in a retention buffer that covered 1.9 acres. The entire length of the study reach was a 25 foot no cut buffer. Conifer in the core and inner zone, and trees needed to meet outer zone leave tree requirements, out to site potential tree height (140'), were also retained in the RMZ. At this site, the slopes within the RMZ were relatively gentle, ranging from flat to 10%, with an average slope of less than 2%. Figure 3 displays the location of the study reach within the harvest area and the resulting buffer configuration.

Table 28. Site #11 riparian management zone (RMZ) widths.

Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
III	140'	>10'	105'

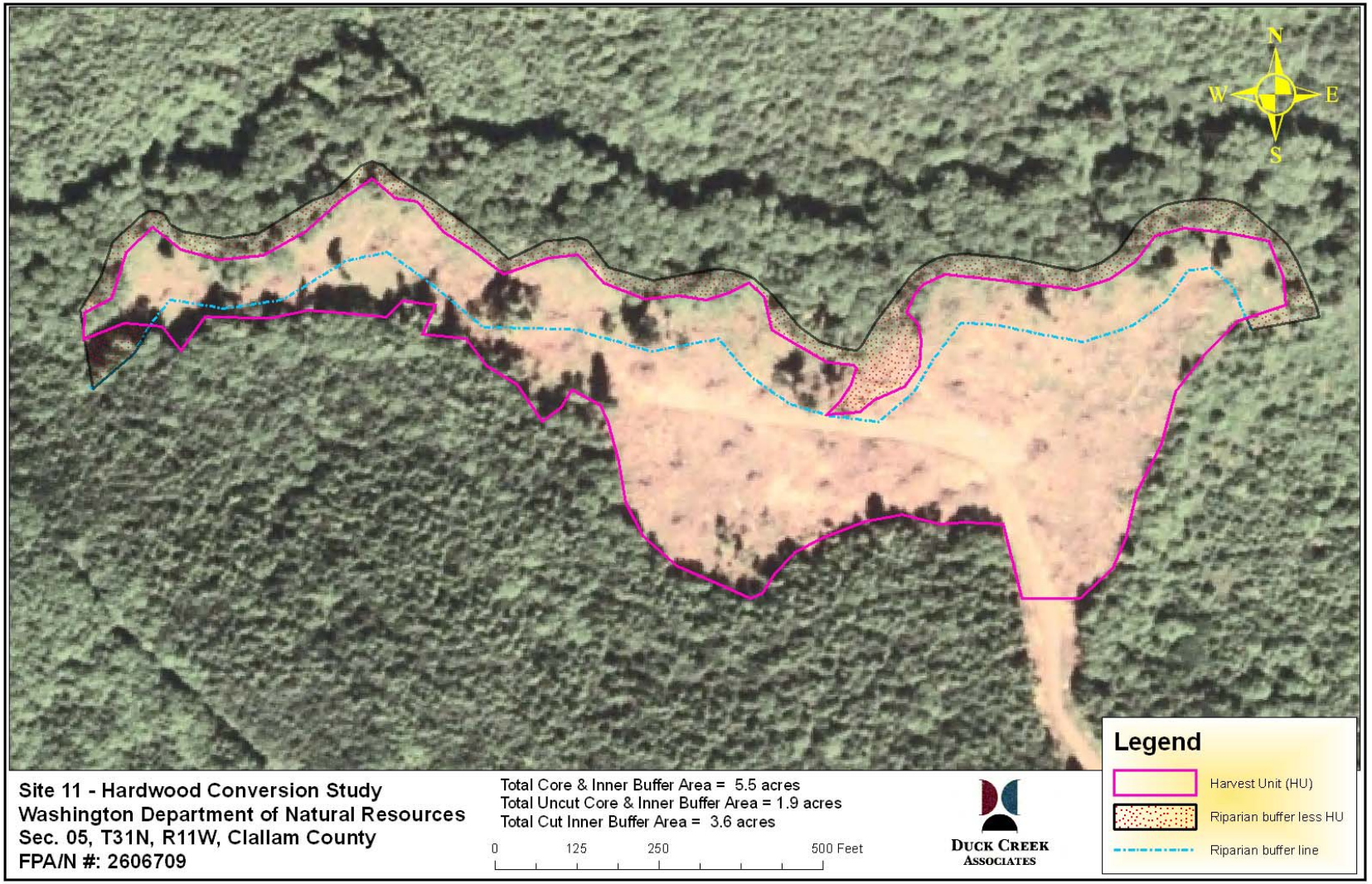
2.3.1.8 Soil Description

Soils in the research segment are derived from foothill basalt and are typically from the Andic Cryaquepts-Rock outcrop complex soil series. The generalized site productivity class, as defined by official Forest Practices maps, is Site Class III.

2.3.2 Duck Creek Associates Activities Timeline

During the Summer of 2002, Duck Creek Associates conducted an initial site review and recommended that it be selected for inclusion in the study by RSAG. In September 2003, Duck Creek Associates conducted a pre-harvest vegetation survey at the site and collected various stream metrics information. In May 2006, Duck Creek Associates conducted the initial regeneration survey. In February 2007, Duck Creek Associates conducted the 100% vegetation survey and a GPS mapping survey of the treatment RMZ. In August 2007, the landowner returned the questionnaire. In August 2007, Duck Creek Associates digitized and/or analyzed the GIS data and in December 2007, compiled this report. RMZ stand metrics (e.g., species distribution, trees per acre, volume, etc.) were calculated from the February 2007 post-harvest 100% and regeneration surveys. In October 2007 Duck Creek Associates conducted the first of two follow-up regeneration survey re-visits.

Figure 3. Site #11 Map.



2.3.3 Pre-harvest Vegetation

2.3.3.1 Pre-harvest Combined Upslope and RMZ Stand Table/Description

Pre- harvest inventory stand statistics provided by the landowner (Table 29) provide a summary of the combined upland and RMZ pre-harvest. Red alder was the dominant species accounting for 57% of the basal area and 55% of the gross cubic foot volume. Western hemlock was a significant cohort species, accounting for 41% of the basal area and 42% of the gross cubic foot volume (Table 29).

Table 29. Site 11 Pre-harvest Combined Upslope and RMZ Stand Table Summary.

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Cubic Volume[3]/Acre		Board Feet/Acre	
					Gross	Net	Gross	Net
Live	Red alder	67	17.1	106	3,856	3,467	14,611	13,881
	Western Hemlock	68	14.3	76	2,930	2,639	12,551	11,896
	Sitka Spruce	4	15.7	5	242	221	1,048	995
Live Totals		**139**		**187**	**7,028**	**6,327**	**28,210**	**26,772**

[1] DBH = diameter (in inches) at breast height – quadratic mean diameter
[2] In square feet
[3] In feet

2.3.3.2 Pre-harvest RMZ Stand Table/Description

Red alder was the dominant species in the RMZ pre-harvest. Red alder accounted for 74% of the live tree basal area and gross cubic foot volume, as shown in Table 30. Pre-harvest statistics were re-constructed using the post-harvest 100% survey data – which included live trees, stumps, fallen/windthrown trees, and snags – collected by Duck Creek Associates in February 2007. It is important to note that this survey occurred almost two full growing seasons after harvest and that no adjustments have been made to account for growth occurring in standing live trees since the time of harvest.

Table 30. Pre-Harvest RMZ Stand Table Summary

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Red Alder	2.2	14.5	2.6	72.4	13.9	-	47.7	-
	Sitka Spruce	0.4	22.5	1.0	112.3	8.2	-	34.9	-
	Western Hemlock	0.5	12.7	0.6	63.2	4.2	-	16.3	-
Snag Totals		**3.1**		**4.3**		**26.4**	**-**	**98.9**	**-**
Live	Red alder	122.2	15.6	174.0	98.6	5,832.4	5,377.5	24,381.8	22,456.7
	Western Hemlock	29.3	13.2	34.4	68.4	1,098.3	1,003.6	4,621.8	4,195.8
	Sitka Spruce	17.6	14.8	26.9	75.0	957.3	902.1	4,287.3	4,036.2
	Douglas fir	0.7	10.2	0.4	72.9	10.5	9.7	41.8	38.5
Live Totals		**169.8**		**235.7**		**7,898.5**	**7,292.9**	**33,332.7**	**30,727.1**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.3.3.3 Pre-harvest RMZ Vegetation Description

Table 31 displays major vegetation species in the RMZ pre-harvest, by percent cover and average height. This data was compiled using pre-harvest vegetation *transect* survey data collected in September 2003 (see section 1.5 Methods footnote 1).

Table 31. Pre-harvest RMZ vegetation.

Species	%Cover	Height (Ft)
Western sword fern	44.6	3.9
Oregon oxalis	34.7	<1
Devil's club	30.7	6.9
Piggy-back plant	10.3	<1
Salmonberry	10.2	5.4
Lady fern	6.6	3.3
Red elderberry	5.3	12.6

2.3.4 Applied Harvest Prescription

2.3.4.1 Site Layout and Road Construction/Maintenance Description

This site consisted of one harvest unit (or cutting block) bordering the north side of the study reach. A total of 2,430 feet of new road was allocated to the unit, 1,340 feet of road was reconstructed, and there were no additional road construction activities attributed directly to the hardwood conversion. A total of sixteen (16) person hours were required to layout the harvest unit and an additional sixteen (16) person hours were allocated to permitting the harvest operation.

2.3.4.2 Schedule of Activities

The FPA application for this site was approved in May 2005. Harvesting was initiated in July of 2005 and completed that same month. Site preparation in both the upland and RMZ included shovel piling in July 2005, with the piles hand burned after the initial planting in October 2006. In October 2006, an herbicide ground spray brush control treatment was applied to the upland area (non-RMZ). The site was initially planted in February 2006 and both the upland and RMZ were interplanted in February 2007. Trapping for mountain beaver was done in November and December of 2005 and again in January of 2007 (described in more detail further below).

2.3.4.3 Yarding/Logging Description

One hundred percent (100%) of the unit was shovel logged and there were no special activities or equipment required during harvesting operations.

2.3.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 238 MBF (net Scribner scale) of sawlog material, as displayed in Table 32. The reported combined upland and RMZ area was 8.5 acres.

Table 32. Combined upland and RMZ net harvest volume (8.5 Acres)

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF[1]/Acre)	Percent of Total
Red alder	130	15.3	53.5
Western hemlock	105	12.4	43.2
Sitka spruce	8	0.9	3.3
Totals	**243**	**28.6**	**100.0**

[1] Thousand board feet

2.3.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced 60.4 MBF (net Scribner scale) of sawlog material, as displayed in Table 33. The estimated harvest area in the RMZ is 3.6 acres.

Table 33. RMZ net harvest volume (3.6 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF[1]/Acre)	Percent of total
Red alder	55.6	15.4	92.0
Western hemlock	3.5	1.0	5.8
Sitka spruce	1.3	0.4	2.1
Totals	**60.4**	**16.8**	**100.0**

[1] Thousand board feet

2.3.6 Key Harvest Operation Findings and Challenges

In the questionnaire, M&R mentioned that laying out this study buffer took about the same amount of time as laying out the no inner zone harvest option. They also mentioned that the time required to permit the harvest unit took extra time because of unanticipated changes in permit requirements after the initial plan was submitted.

2.3.7 Harvest Economics

The estimated stumpage value for the harvest occurring in the RMZ was $20,437. The indicated Forest Excise tax amount was $1,022. Using 3.6 acres as the area of harvest in the RMZ, Table 34 displays the calculated stumpage value for the RMZ on a per acre basis.

The indicated stumpage value for the harvest in the upland is $52,832. The indicated Forest Excise tax amount is $2,641. Based on an indicated area of 4.9 acres for the

upland, Table 34 displays the calculated stumpage value for the upland on a per acre basis.

The estimated gross stumpage value of the harvest for the entire 8.5 acre unit was $73,269. The indicated Forest Excise tax amount was $3,663. Table 34 displays the calculated stumpage value for the combined upland and RMZ harvest on a per acre basis

Table 34. Harvest stumpage values in dollars per acre.

Cost/Revenue	RMZ (3.6 Acres)	Upland (4.9 Acres)	Combined RMZ/Upland (8.5 Acres)
	$/Acre	$/Acre	$/Acre
Stumpage Value	5,676.94	10,782.04	8,619.88
Harvest Taxes	(283.89)	(538.97)	(430.94)
Net Stumpage Value	**5,393.05**	**10,243.07**	**8,188.94**

2.3.8 Regeneration Prescription

2.3.8.1 Site Preparation and Brush Control

2.3.8.1.1 Upland

Site preparation in the upland included shovel piling slash and brush in July 2005. Piles were hand burned in October 2006, after the initial planting. Following the initial planting, a ground spray herbicide brush control treatment was applied to the upland portion of the unit (non-RMZ) in October 2006, using a mix of Oust and Accord at a rate of 2 ½ ounces and 1 quart per acre, respectively.

2.3.8.1.2 RMZ

Site preparation in the RMZ included shovel piling and pile burning, following the same schedule as the upland. However, activities in the RMZ did not include the herbicide brush control treatment.

2.3.8.2 Planting Schedule/Description

2.3.8.2.1 Upland and RMZ Combined

Initial planting at this site occurred in February 2006. Species included Douglas-fir, western red cedar, western hemlock and Sitka spruce. The landowner reports a total of 5,000 trees planted (target density of 600 TPA), however totals by species were not listed. Douglas-fir and western hemlock were planted to specifications, one per hole, using a hand shovel. However, Sitka spruce and western red cedar were planted together in the same planting hole – one of each species per planting hole. The reported cost for the initial planting (including seed, nursery, and contract labor costs) was $360 per acre.

Inter-planting was done in February 2007. Species included Douglas-fir, western red cedar, western hemlock and Sitka spruce. The landowner reports a total of 1,600 trees were interplanted (target density of 600 TPA), however totals by species were not listed. Douglas-fir and western hemlock were planted to specifications, one per hole, using a hand shovel. However, Sitka spruce and Western red cedar were planted together in the

same planting hole – one of each species per planting hole. The reported cost for this inter-plant (including seed, nursery, and contract labor costs) was $180 per acre.

Table 35 displays the planting stock list figures provided by the landowner.

Table 35. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA)
02/2006	Douglas fir Western red cedar Western hemlock Sitka spruce	Native and Improved	P+1 and 1+1	5,000	600
02/2007	Douglas fir western red cedar Western hemlock Sitka spruce	Native and Improved	P+1 and 1+1	1,600	600

2.3.8.3 Animal Control Strategies/Descriptions

2.3.8.3.1 Upland and RMZ Combined

Animal control in both the upland and RMZ consisted of trapping for mountain beaver in November and December 2005, prior to the initial planting, and then again in January 2007, prior to inter-planting in February 2007.

2.3.8.4 Key Reforestation Findings and Challenges

When compared with current standard industry reforestation practices, M&R has taken a very aggressive approach in their reforestation efforts at this site.

The landowner used a practice of planting Sitka spruce and western redcedar together in the same planting hole. The idea behind this practice is based on deer and elk browse preference; the sharp needles on the Sitka spruce, a low preference browse species for deer and elk, deters browse of the Western redcedar, which is a highly desirable browse species. Once the western redcedar is large enough, considered free-to grow, the Sitka spruce stem is removed.

Additionally, in an attempt to increase future conifer stocking immediately adjacent to the stream, the landowner chose to under-plant the red alder-dominated retention buffer in the RMZ with shade-tolerant Sitka spruce, western hemlock, and western redcedar.

2.3.9 Regeneration Economics

Table 36. Upland and RMZ Regeneration Costs.

Activity	Description	Date	Upland Cost per acre	RMZ Cost per acre
Site Preparation	Piling	7/2005	$156.00	$156.00
	Pile Burning	10/2006	$74.81	$74.81
Animal Control	Trapping	11/2005	$55.00	$55.00

Activity	Description	Date	Upland Cost per acre	RMZ Cost per acre
	Trapping	1/2007	$47.11	$47.11
Planting		2/2006	$360.00	$360.00
Inter-planting		2/2007	$180.00	$180.00
Brush Control	Hand Spray	10/2006	$49.00	-
Totals (For Final)				

2.3.10 Post-harvest Vegetation

2.3.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting which targeted primarily hardwood species accounted for a 46% reduction in the number of trees per acre, a 39% reduction in basal area per acre, and 38% reduction in gross cubic foot volume per acre (as indicated in Table 37 under the "Cutting" group). Compared to the pre-harvest condition, disturbance (as indicated in Table 37 under the "Fallen/Windthrow" group) accounted for a 9% reduction in trees per acre, basal area per acre, and gross cubic foot volume per acre. It is important to note that conifer species accounted for 85% of the basal area and gross cubic foot volume in the "Fallen/Windthrow" group. This disparity resulted when one of the larger "clumped" conifer leave tree areas was heavily impacted by windthrow from storm events that occurred shortly after harvest.

Table 37. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	72.0	14.1	84.2	95.8	2,741.2	2,604.1	11,434.5	10,862.8
	Western hemlock	5.1	14.6	6.7	70.7	203.9	193.7	756.4	718.5
	Sitka spruce	2.5	11.8	2.2	65.5	65.4	62.2	254.5	241.8
Cutting Totals		**79.6**		**93.2**		**3,010.5**	**2,860.0**	**12,445.5**	**11,823.2**
Fallen/ Windthrow	Western hemlock	10.5	12.5	10.7	67.4	329.5	313.0	1,345.5	1,278.2
	Sitka spruce	3.6	17.3	7.4	84.4	271.0	257.4	1,209.1	1,148.6
	Red alder	2.2	15.8	3.2	98.2	108.8	103.3	447.3	424.9
	Douglas fir	0.2	12.0	0.1	81.3	3.8	3.6	14.5	13.8
Fallen/Windthrow Totals		**16.5**		**21.4**		**713.0**	**677.3**	**3,016.4**	**2,865.5**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.3.11 Post-harvest RMZ Stand Table/Description

For hardwood conversions, it would be expected that – when compared to pre-harvest conditions – conifer would contribute more to the large standing live tree component of the residual post-harvest stand since it was targeted for retention. However, at this site, the dominance of red alder in the residual riparian stand changed very little, even though it was the primary species targeted for removal. As discussed in the RMZ Stand Depletion section (above), the loss of retained conifer (windthrow) accounted for the disparity. Table 38 displays the residual post-harvest stand table.

Table 38. Post-harvest Stand Table Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Sitka spruce	1.3	20.4	3.8	101.9	37.3	-	191.6	-
	Red alder	2.0	14.0	2.2	69.9	10.7	-	34.2	-
	Western hemlock	1.3	11.4	1.1	57.0	7.1	-	26.7	-
	Douglas fir	0.2	7.0	0.0	34.9	0.1	-	0.0	-
Snag Totals		**4.7**		**7.1**		**55.1**	**-**	**252.5**	**-**
Live	Red alder	48.2	17.8	87.0	102.9	3,000.4	2,766.0	12,447.3	11,455.8
	Western hemlock	12.9	13.4	16.5	68.7	552.0	497.5	2,452.7	2,190.8
	Sitka spruce	10.5	14.2	14.5	73.4	513.8	483.3	2,290.9	2,151.7
	Douglas fir	0.4	11.0	0.3	76.0	6.8	6.2	27.3	25.1
Live Totals		**72.0**		**118.2**		**4,073.0**	**3,753.0**	**17,218.2**	**15,823.3**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.3.12 RMZ Regeneration Survey Data

When considering the planted Sitka spruce and western redcedar statistics displayed in Table 39 and Table 40 it is important to note that these species were planted together; one of each species per planting hole. Table 39 displays regeneration statistics from the survey conducted in May 2006 (2005 growth year). Table 40 displays regeneration statistics from the re-visit survey conducted in October 2007.

Table 39. Initial Post- Harvest RMZ Regeneration Survey Summary

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2005	Sitka spruce	Planted	241.3	0.0	0.0	1.4	92%
	Western redcedar		240.4	0.0	0.0	1.4	87%
	Western hemlock		130.8	0.0	0.0	1.9	91%
	Douglas fir		23.1	0.0	0.0	1.3	87%
	Total Planted		**635.6**	**0.0**	**0.0**	**1.5**	

Western hemlock	Dead/Dying	10.6	0.0	0.0	2.0	21%
Western redcedar		8.7	0.0	0.0	1.4	53%
Sitka spruce		3.8	0.0	0.0	1.4	40%
Douglas fir		2.9	0.0	0.0	1.2	25%
Total Dead/Dying		**26.0**	**0.0**	**0.0**	**1.6**	**26.0**
Western hemlock	Natural	9.6	1.7	0.4	14.4	59%
Sitka spruce		2.9	1.8	0.1	10.6	66%
Total Natural		**12.5**	**1.7**	**0.5**	**13.5**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

Table 40. Second RMZ Regeneration Survey Summary

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2007	Western redcedar	Planted	315.4	0.0	0.0	2.1	85%
	Sitka spruce		314.4	0.1	0.0	2.8	85%
	Western hemlock		143.3	0.3	0.1	3.1	86%
	Douglas fir		19.2	0.0	0.0	2.4	83%
	Total Planted		**792.3**	**0.1**	**0.1**	**2.5**	
	Sitka Spruce	Dead/Dying	9.6	0.0	0.0	1.2	0%
	Western redcedar		9.6	0.0	0.0	1.0	0%
	Western hemlock		1.0	0.0	0.0	1.0	0%
	Douglas fir		1.0	0.0	0.0	1.0	0%
	Total Dead/Dying		**21.2**	**0.0**	**0.0**	**1.1**	
	Red alder	Natural	603.8	0.2	0.1	2.9	79%
	Western hemlock		16.9	0.6	0.3	5.6	80%
	Big-leaf maple		9.6	0.5	0.0	2.0	88%
	Other Hardwoods		3.8	0.1	0.0	3.9	88%
	Sitka Spruce		2.9	0.5	0.0	5.2	62%
	Western redcedar		1.0	0.0	0.0	1.3	88%
	Total Natural		**638.0**	**0.2**	**0.4**	**2.9**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.3.13 RMZ Vegetation and Planting Site Condition Description

Table 41 displays the occurrence of the major vegetation species observed at the time of the initial regeneration survey (May 2006).

Table 41. Initial Post-harvest RMZ Vegetation Summary.

Growth Year	Species	% Cover	Height (ft.)
2005	Oregon oxalis	12.5	<1
	Western swordfern	10.6	2.8
	Devils club	5.7	7.0

Table 42 displays the occurrence of major vegetation species and site conditions observed at the time of the second regeneration survey conducted in October 2007. Compared with the May 2006 survey, it is important to note that the increased presence of competing grasses/sedges and brush species may have an impact on seedling growth and survival.

Table 42. Second Post-harvest RMZ Vegetation Summary

Growth Year	Species	% Cover	Height (ft.)
2007	Oregon oxalis	33.4	<1
	Grasses/Sedges	20.7	2.8
	Western swordfern	14.7	4.0
	Salmonberry	11.9	6.4
	Stinging needle	9.6	3.2
	Windthrow cover	7.4	6.1
	Devils club	6.9	8.9
	Piggy-back plant	6.3	<1

2.3.14 Economic Analysis (for final compiled report)

1. Bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site
2. Summarize cost and revenues assumptions

Example

Table 43. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	10,782.04	
Regeneration		
Administration		
Net Income		

Example

Table 44. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	5,393.05	
Regeneration		
Administration		
Net Income		

Assumptions:

2.3.15 Discussion and Key Findings (for final compiled report)

1. Summary of regeneration strategy, and evaluation of its success or failure at this site
2. Lesson(s) learned from hardwood conversion
3. Relevant/interesting results not presented earlier in document

2.4 Site #12 (FPA/N # 2606454)

2.4.1 Site Identification and Description

2.4.1.1 Landowner Profile

Merrill and Ring (hereafter, M&R), founded in 1888 and headquartered in Port Angeles, Washington, is a privately held timber and land management company engaged in natural resource management. The company, comprised of seven partner ownership entities including JLCC, LLC – which holds ownership of this site – together holds 75,000 timberland acres in western Washington, British Columbia and New Zealand. M&R has several office locations in western Washington and one in New Zealand.

2.4.1.2 Factors Leading to Hardwood Conversion

M&R has been conducting hardwood conversion operations for 13+ years, plans for them on a site-specific basis, and identified two primary factors responsible for incorporation of hardwood conversions: 1) the potential financial benefit and 2) land stewardship and management goals. However, they also noted that no one factor has a dominant influence over the other. M&R participated in this study for the aforementioned reasons and – as they identified in the questionnaire – because they were asked to and felt that "it was the right thing to do."

2.4.1.3 Location

This hardwood conversion study site ("CMER Research Site #12) is located in Washington State's Clallam County, Northeast of the town of Sappho in a portion of Sections 20 and 29, Township 31 North, Range 11 West, Willamette Meridian.

2.4.1.4 Topography and Climate

Elevation in the harvest unit ranges from 219 to 320 feet and receives, on average, 95.11 inches of precipitation per year. Most of the precipitation falls from November through February in the form of rain with average snowfall of 19.2 inches and a mean air temperature of 49.0°F. Climate data comes from the National Weather Service's Cooperative Station Network, Sappho 8 E station[4] (457319) located in Sappho, Washington. Values are reported as annual mean monthly data from 1971-2000.

2.4.1.5 Stream Description

The South Fork Pysht, along the study unit, is classified by the DNR as Type 3 water . Fish have been observed or are known to use the South Fork Pysht. The in-unit stream research segment length is approximately 3,500 feet, stream bankfull width averages 34.5 feet, and the stream gradient averages 1.2%.

2.4.1.6 Unit Description

The harvest area consisted of four cutting blocks (harvest units) totaling approximately 15 acres (according to M&R). The hardwood conversion study stream segment ran along

[4] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

the northern edge of three of the harvest units and along the southwestern edge of one unit.

Figure 4 displays a map of the harvest area.

2.4.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 140 feet while the "management RMZ" width was 105 feet (Table 92), of which, 50 feet represented the core zone and 55 feet represented the inner zone (

Figure 4). The management RMZ that fell within the study reach covered 9.1 acres (

Figure 4). An estimated 3.4 acres of the management RMZ was harvested, resulting in a retention buffer that covered 5.7 acres (

Figure 4). The 25 foot no cut buffer was applied were possible at this site, but large areas were excluded outside of 25 feet for the following reasons. Conifer in the core and inner zone, and trees needed to meet outer zone leave tree requirements, out to site potential tree height (140'), were also retained in the RMZ. Additionally, steep inner gorge areas required buffers well in excess of the prescription. Fixed buffers were marked with flagging and leave trees were identified by species. At this site, the steepest slopes within the Harvest Unit were 50%.

Figure 4 displays the location of the study reach within the harvest area and the resulting buffer configuration.

Table 45. Site #12 riparian management zone (RMZ) widths.

Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
III	140'	>10'	105'

2.4.1.8 Soil Description

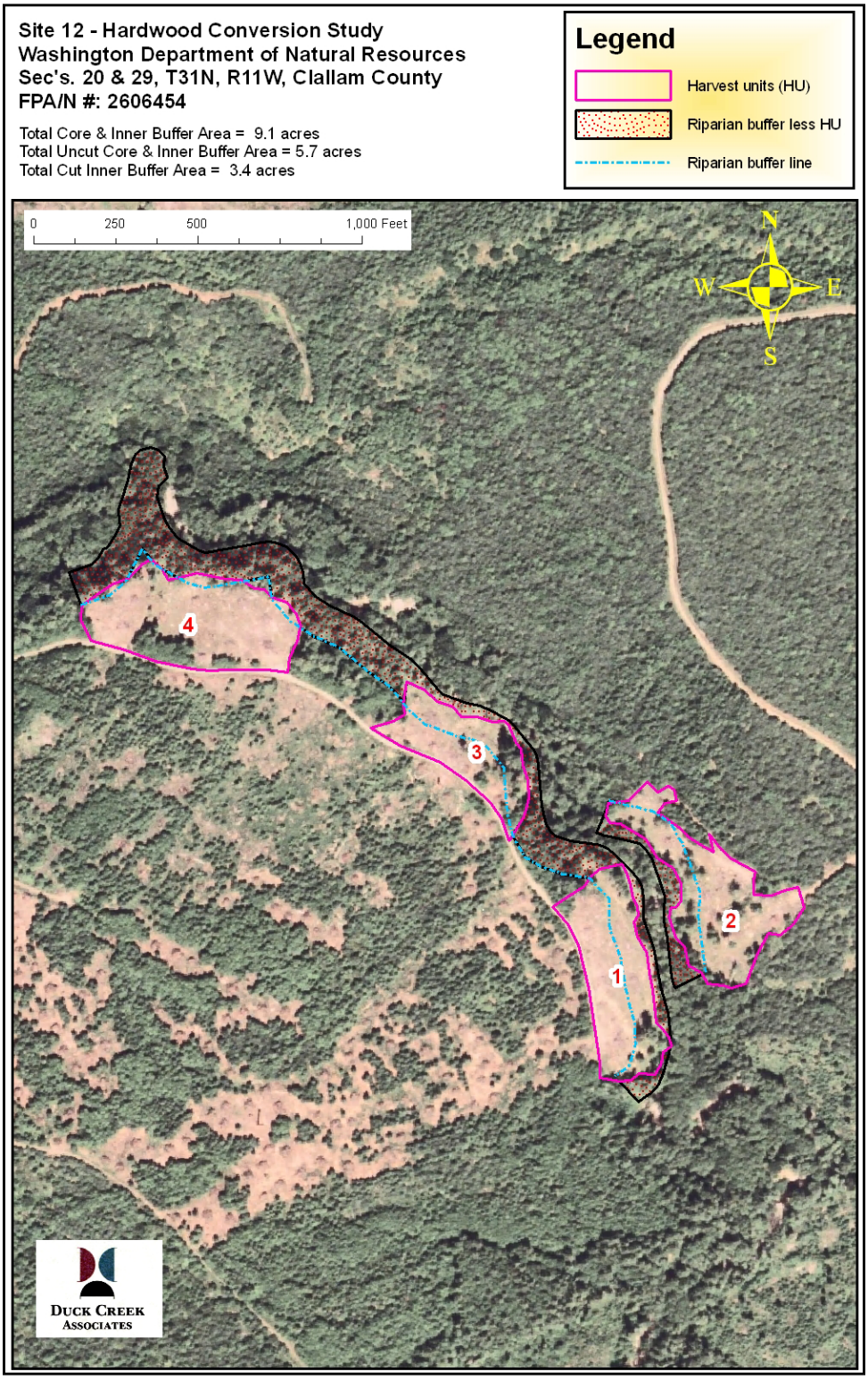
There are two primary soil types located in the research segment. The Palix soils are well-drained and located on hillslopes and hills. Slopes are typically in the 65-90% range and the parent material consists of colluvium and residuum derived from sandstone. The Klahowya soils are moderately well drained and also located on hillslopes and hills. Slopes are typically in the 5 to 35% range and parent material also consists of colluvium and residuum derived from sandstone. Soil descriptions come from the Natural Resources Conservation Service's Soil Data Mart website[5]. The generalized site productivity class at this site, as defined by official Forest Practices maps, is Site Class III.

2.4.2 Duck Creek Associates Activities Timeline

During the Summer of 2002, Duck Creek Associates conducted an initial site review and recommended that it be selected for inclusion in the study by RSAG. In September 2003, Duck Creek Associates conducted the pre-harvest vegetation and stream metrics surveys and an initial regeneration survey in May 2006. In February 2007, Duck Creek Associates conducted a post-harvest 100% vegetation survey and a buffer configuration GPS survey of the treatment RMZ (and buffers). In August 2007, the landowner returned the questionnaire and resubmitted clarifications in January 2008. In August 2007, Duck Creek Associates digitized and/or analyzed the GIS data and compiled this report in February 2008.

[5] http://soildatamart.nrcs.usda.gov/

Figure 4. Site #12 Map.



2.4.3 Pre-harvest Vegetation

2.4.3.1 Pre-harvest Combined Upslope and RMZ Stand Table/Description

The pre-harvest stand statistics provided by the landowner describe pre-harvest species composition information from the combined upland and RMZ (Table 46). Red alder was the dominant species accounting for 49% of the basal areas and 51% of the gross cubit foot volume (Table 46).

Table 46. Pre-harvest Combined Upslope and RMZ Stand Table Summary.

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Cubic Volume[3]/Acre		Board Feet/Acre	
					Gross	Net	Gross	Net
Live	Red alder	67	17.1	106	3,856	3,467	14,611	13,881
	Douglas fir	68	14.3	76	2,930	2,639	12,551	11,896
	Western hemlock	16	18.0	28	590	530	5,100	4,600
	Sitka spruce	4	15.7	5	242	221	1,048	995
Live Totals		**155**		**215**	**7,618**	**6,857**	**33,310**	**31,372**

[1] DBH = diameter (in inches) at breast height – quadratic mean diameter
[2] In square feet
[3] In feet

2.4.3.2 Pre-harvest RMZ Stand Table/Description

In the pre-harvest RMZ, red alder was the dominant species accounting for 66% of the live trees per acre, 57% of the live tree basal area and 54% of the gross cubic foot volume (Table 47). Douglas fir was a significant secondary species accounting for 27% of the live tree basal areas and 34% of the gross cubic foot volume (Table 47). Western hemlock, Sitka spruce and Western redcedar were all minor contributors to species composition. Combined, however, conifer species accounted for 35% of the live tree basal area and 41% of the live tree gross cubic foot volume in the pre-harvest riparian stand (Table 47).

Table 47. Pre-Harvest RMZ Stand Table Summary.

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Red alder	3.5	11.7	2.9	58.3	8.0	-	25.7	-
	Douglas fir	1.3	8.7	0.6	43.7	1.4	-	4.4	-
	Big-leaf maple	0.3	10.7	0.2	53.2	0.5	-	1.1	-
	Western hemlock	0.1	7.0	0.0	34.9	0.0	-	0.0	-
Snag Totals		**5.3**		**3.7**		**9.9**	**-**	**31.2**	**-**
Live	Red alder	116.3	13.9	131.5	84.5	3,940.8	3,614.8	16,312.1	14,938.9
	Douglas fir	26.4	18.8	62.6	99.8	2,446.5	2,276.0	12,060.4	11,211.4
	Western hemlock	8.4	13.0	9.0	67.0	291.4	272.4	1,193.4	1,113.4
	Big-leaf maple	16.5	12.4	15.8	64.2	338.6	298.8	1,150.5	1,018.6
	Western red cedar	6.4	13.9	8.0	57.9	176.0	162.5	538.5	495.1
	Sitka spruce	1.6	12.4	1.6	54.0	43.5	40.9	150.5	141.4
	Black cottonwood	0.1	35.0	0.7	119.2	28.3	26.8	139.6	132.6
	Cascara buckthorn	0.1	6.2	0.0	44.8	0.0	0.0	0.0	0.0
Live Totals		**175.7**		**229.3**		**7,265.1**	**6,692.2**	**31,545.1**	**29,051.4**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.4.3.3 Pre-harvest RMZ Vegetation Description

Table 48 displays major vegetation species in the pre-harvest RMZ, by percent cover and average height. This data was compiled using pre-harvest vegetation *transect* survey data collected in September 2003 (see footnote 1 in section 1.5 – Methods).

Table 48. Pre-harvest RMZ vegetation.

Species	%Cover	Height (Ft)
Salmonberry	21.2	6.4
Oregon oxalis	19.1	<1
Western swordfern	17.6	3.7
Vine maple	13.0	12.9
Grass/Sedge	10.4	1.1
Piggy-back plant	8.1	<1

2.4.4 Applied Harvest Prescription

2.4.4.1 Site Lay-out and Road Construction/Maintenance Description

This site consisted of four contiguous harvest units (cutting blocks) of approximately 15 acres in size and bordering the southwest and northeast side of the South Fork Pysht River. Steep potentially unstable slopes were reserved from cutting and used, in part, as areas to meet in-unit and riparian leave tree retention requirements. Fixed buffers were

marked with flagging and leave trees were identified by species. A total of 150 feet of new road construction was allocated to the unit, but there were no additional road construction activities attributed directly to the hardwood conversion. A total of twenty-four (24) person hours were required to layout the units and sixteen (16) hours were allocated to permitting the harvest operation.

Of note at this site, is that in-stream large wood placement was incorporated with the work that was performed at this site by the landowner. Permitting was approved by the DNR with the condition that this work would be done in conjunction with this hardwood conversion study. Placement work was designed to take advantage of the machinery's proximity to the channel and was approved by the DNR, DOE, tribes, and WDFW. WDFW issued a Hydraulic Project Approval (HPA) for this project and the in-stream placement work at this site was funded by M&R. However other grants received from the Salmon Recovery Funding Board, the tribes, and others have contributed to other large wood placement on the South Fork of the Pysht River. When all large wood placement has been completed in the South Fork, a total of 4.3 river miles will have been improved with large wood additions.

2.4.4.2 Schedule of Activities

The Forest Practices Application for this site was approved in May 2005. Harvesting activities were initiated in July 2005 and were completed that same month. Site preparation included shovel piling in both the upland and RMZ in July 2005, and the piles were hand burned in November 2006. The RMZ and near-riparian zone was initially planted in February 2006 and inter-planted the following year in February 2007. Animal control treatments in the upland and RMZ included trapping for mountain beaver (after the initial planting) in April 2006 and again (prior to the inter-planting) in January 2007. In September 2006, a herbicide brush control treatment was done in the upland (non-RMZ) following the initial planting.

2.4.4.3 Yarding/Logging Description

Ground based equipment was used to log all harvest units. A combination of hand cutting and machine bunching was used in the cutting operation and trees were yarded using hydraulic shovel logging equipment. There were no special activities or equipment required during the harvest operation.

2.4.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 304 MBF (net scribner scale) of sawlog material (Table 49). The estimated area of the upland and RMZ combined is 15 acres.

Table 49. Combined upland and RMZ net harvest volume (15 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red alder	154.00	10.27	50.7%
Douglas fir	100.00	6.67	32.9%
Western hemlock	40.00	2.67	13.2%
Western redcedar	10.00	0.67	3.3%
Total	**304.00**	**20.27**	

[1] Thousand board feet

2.4.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced 50.4 MBF (net Scribner scale) of sawlog material (Table 50). The estimated harvest area in the RMZ is 3.4 acres (

Figure 4).

Table 50. RMZ net harvest volume (3.4 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red alder	49.11	14.44	97.4%
Douglas fir	0.39	0.11	0.8%
Western hemlock	0.04	0.01	0.1%
Big-leaf maple	0.73	0.21	1.4%
Western redcedar	0.17	0.05	0.3%
Totals	**50.43**	**14.83**	

[1] Thousand board feet

2.4.6 Key Harvest Operation Findings and Challenges

In the questionnaire, M&R noted that permitting this site took extra time because of the DNR's change in classification of the permit. Additionally, to take advantage of the proximity of logging machinery to the channel during the harvest of this unit, an in-stream large wood (LW) placement project was planned for and incorporated with the harvest work conducted at this site.

2.4.7 Harvest Economics

Harvesting in the RMZ regenerated an estimated stumpage value of $17,403 with an indicated timber excise tax liability of $870. When using 3.4 acres as the basis for the area of the RMZ, the indicated stumpage value on a per acre basis was $5,118.53 and the indicated excise tax was $255.88 per acre (Table 51).

The indicated stumpage value for the upland harvest was $98,547 with a timber excise tax liability of $4,928. When using 11.6 acres as the basis for the area of the upland, the indicated stumpage value on a per acre basis was $8,495.43 and the indicated excise tax was $424.83 per acre (Table 51).

The indicated stumpage value for the combined upland and RMZ harvest was $115,950 with a timber excise tax liability of $5,798. When using 15 acres as the basis for the area of the combined upland and RMZ, the indicated stumpage value on a per acre basis was $7,730.00 and the indicated excise tax was $386.53 per acre (Table 51).

Table 51. Harvest stumpage values in dollars per acre.

Cost/Revenue	RMZ (3.4 Acres)	Upland (11.6 Acres)	Combined RMZ/Upland (15 Acres)
	$/Acre	$/Acre	$/Acre
Stumpage Value	5,118.53	8,495.43	7,730.00
Harvest Taxes	(255.88)	(424.83)	(386.53)
Net Stumpage Value	**4,862.65**	**8,070.6**	**7,343.47**

2.4.8 Regeneration Prescription

2.4.8.1 Site Preparation and Brush Control

2.4.8.1.1 Upland

At this site, site preparation techniques consisted of shovel piling slash and brush (July 2005). Piles were hand burned in November 2006, after the initial planting. Following the initial planting, a ground spray herbicide treatment was applied to the upland (non-RMZ) in September 2006, using a mix of Oust and Accord at a rate of 2 ½ ounces and 1 quart per acre, respectively and a reported cost of $68.97 per acre.

2.4.8.1.2 RMZ

Site preparation in the RMZ included shovel piling and pile burning, on the same schedule as the upland, but did not include the herbicide brush control treatment.

2.4.8.2 Planting Schedule/Description

2.4.8.2.1 Upland and RMZ Combined

Initial planting occurred in February 2006 and Douglas fir, western red cedar, western hemlock and Sitka spruce were planted. M&R reported a total of 9,600 trees planted, however totals by species and stock type were not listed. Sitka spruce and western red cedar were planted together in the same planting hole; one of each species per planting hole. The reported cost for the initial planting was $407.94 per acre.

Inter-planting was done in February 2007. Douglas fir, western red cedar, western hemlock and Sitka spruce were planted. The landowner reports a total of 2,960 trees planted, however totals by species were not listed for this inter-plant. Sitka spruce and western red cedar were planted together in the same planting hole; one of each species per planting hole. The reported cost for this inter-plant was $135.67 per acre.

Table 52 displays the planting stock list figures provided by the landowner.

Table 52. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA)
February 2006	Douglas fir, western redcedar, western hemlock, Sitka spruce	Native and Improved	P+1 and 1+1	9,600	600
February 2007	Douglas, fir western redcedar, western hemlock, Sitka spruce	Native and Improved	P+1 and 1+1	2,960	600

[1] Trees Per Acre

2.4.8.3 Animal Control Strategies/Descriptions

2.4.8.3.1 Upland and RMZ Combined

Animal control in both the upland and RMZ consisted of trapping for mountain beaver in April 2006 (following the initial planting) at a reported cost of $67.47 per acre. Trapping was done again in January 2007 (prior to inter-planting in February of the same year) at a reported cost of $50.00 per acre.

2.4.8.4 Key Reforestation Findings and Challenges

When compared with typical industry reforestation practices, M&R has taken a very aggressive and directed approach in their reforestation efforts at this site.

The landowner used a practice of planting Sitka spruce and western redcedar together in the same planting hole. The theory behind this practice is based on deer and elk browse preference; the sharp needles on the Sitka Spruce, a low preference browse species of deer and elk, deters browse of the western redcedar, which is a highly desirable browse species. Once the western redcedar is large enough, considered free-to grow, the Sitka spruce stem is removed. The planted Sitka spruce seedling is effectively a surrogate animal damage control treatment.

Additionally, in an attempt to increase future conifer stocking immediately adjacent to the stream, the landowner chose to under-plant most areas dominated by red alder in the retention buffer of the RMZ with shade-tolerant Sitka spruce, western hemlock, and western redcedar.

2.4.9 Regeneration Economics

Table 53 summarizes reforestation costs at this site in the upland and RMZ.

Table 53. Upland and RMZ Regeneration Costs.

Activity	Type	Date	Upland Cost per acre	RMZ Cost per acre
Site Prep	Piling	7/2005	$156.00	$156.00
	Pile Burning	11/2006	$72.82	$72.82
Animal Control	Trapping	4/2006	$67.47	$67.47
	Trapping	1/2007	$50.00	$50.00
Plant		2/2006	$407.94	$407.94
Inter-plant		2/2007	$135.67	$135.67
Brush Control	Hand spray	9/2006	$68.97	-
Totals (For Final)				

2.4.10 Post-harvest Vegetation

2.4.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting (which primarily targeted hardwood species) accounted for a 29% reduction in the number of trees per acre, a 23% reduction in basal area per acre, and 21% reduction in gross cubic foot volume per acre (as displayed in Table 54 under the "Cutting" group). Compared to the pre-harvest conditions, disturbance accounted for a 9% reduction in trees per acre, an 8% reduction in basal area and gross cubic foot volume per acre (as displayed in Table 54 under the "Fallen/Windthrow" group).

Table 54. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	48.0	13.4	50.2	82.7	1,478.2	1,404.3	6,235.2	5,923.4
	Big-leaf maple	2.6	11.2	2.2	59.5	46.4	44.1	150.5	143.0
	Douglas fir	0.3	12.6	0.4	74.0	10.3	9.8	45.1	42.8
	Western redcedar	0.2	13.8	0.3	53.4	6.8	6.4	20.9	19.8
	Western hemlock	0.3	8.5	`	50.0	1.5	1.5	5.5	5.2
	Cascara	0.1	6.2	0.0	44.8	0.0	0.0	0.0	0.0
Cutting Totals		**51.6**		**53.1**		**1,543.3**	**1,466.1**	**6,457.1**	**6,134.3**
Fallen/ Windthrow	Red alder	11.4	14.0	13.1	84.9	392.5	372.9	1,601.1	1,521.0
	Douglas fir	1.1	13.8	1.3	84.1	38.5	36.5	163.7	155.5
	Black cottonwood	0.1	35.0	0.7	119.8	28.3	26.9	146.2	138.8
	Western hemlock	0.9	13.1	1.0	63.9	29.0	27.6	114.3	108.6
	Big-leaf maple	1.3	13.2	1.3	67.7	29.0	27.5	94.5	89.8
	Western redcedar	0.8	14.3	1.1	55.5	24.4	23.1	80.2	76.2
	Sitka spruce	0.1	24.0	0.3	80.9	11.0	10.4	41.8	39.7
Fallen/Windthrow Totals		**15.7**		**18.9**		**552.7**	**525.0**	**2,241.8**	**2,129.7**

[1] DBH = diameter (in inches) at breast height – trees per acre weighted average
[2] In square feet
[3] In feet – trees per acre weighted average

2.4.11 Post-harvest RMZ Stand Table/Description

As compared with pre-harvest conditions, in terms of species distribution, conifer species contribute more to the retained RMZ stand following harvest, which was expected since hardwoods were targeted for removal. Post harvest, conifer species account for 50% of the live tree basal area and 56% of the gross cubic foot volume per acre (versus 35% and 41%, respectively, in the pre-harvest stand). Table 55 displays the residual post-harvest stand table.

Table 55. Post-harvest Stand Table Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Red alder	6.7	12.2	6.0	60.9	17.9		59.3	
	Big-leaf maple	0.7	11.3	0.5	56.6	1.3		4.0	
	Douglas fir	1.3	8.0	0.5	39.9	0.8		2.4	
	Western hemlock	0.1	7.0	0.0	34.9	0.0		0.0	
Snag Totals		**8.8**		**7.0**		**20.1**	**0.0**	**65.7**	**0.0**
Live	Douglas fir	24.9	19.1	61.1	101.0	2,402.8	2,235.2	11,872.5	11,036.0
	Red alder	53.6	14.4	65.1	86.3	1,994.2	1,832.0	8,190.1	7,513.3
	Western hemlock	7.1	13.2	7.9	68.2	264.2	246.8	1,092.3	1,018.1
	Big-leaf maple	12.2	12.6	11.9	64.8	256.7	227.2	884.6	785.1
	Western redcedar	5.4	13.9	6.6	58.4	144.9	133.9	437.4	402.7
	Sitka spruce	1.5	11.6	1.3	52.1	32.5	30.5	108.8	102.0
Live Totals		**104.8**		**153.9**		**5,095.3**	**4,705.6**	**22,585.7**	**20,857.1**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.4.12 RMZ Regeneration Survey Data

When considering the planted Sitka spruce and western redcedar statistics (as displayed in Table 56), it is important to note that many of these species were planted together; one of each species per planting hole. Table 56 displays regeneration statistics from the initial regeneration survey conducted by Duck Creek in May 2006 (2005 Growth Year).

Table 56. Initial RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2005	Sitka spruce	Planted	304.4	0.0	0.0	1.4	92%
	Western redcedar		301.5	0.0	0.0	1.4	86%
	Western hemlock		167.6	0.0	0.0	2.0	92%
	Douglas fir		14.7	0.0	0.0	1.1	93%
	Total Planted		**788.2**	**0.0**	**0.0**	**1.5**	
	Western redcedar	Dead/dying	14.7	0.0	0.0	1.3	17%
	Sitka spruce		2.9	0.0	0.0	0.3	64%
	Western hemlock		1.5	0.0	0.0	2.0	68%

Total Dead/Dying		**19.1**	**0.0**	**0.0**	**1.2**	
Red alder	Natural	5.9	0.0	0.0	0.7	93%
Western hemlock		2.9	2.9	0.1	16.6	79%
Western redcedar		2.9	0.5	0.0	1.4	68%
Sitka spruce		1.5	4.2	0.1	19.0	75%
Total Natural		**13.2**	**1.2**	**0.3**	**6.4**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.4.13 RMZ Vegetation and Planting Site Condition Description

Table 57 displays the occurrence of the major vegetation species observed at the time of the initial regeneration survey (May 2006).

Table 57. Initial Post-harvest RMZ Vegetation Survey Summary.

Growth Year	Species	% Cover	Height (ft.)
2005	Grass/Sedge	15.4	1.1
	Salmonberry	13.5	3.9
	Western swordfern	10.8	3.2
	Oregon oxalis	6.9	<1
	Vine-maple	6.2	6.6
	Trailing blackberry	6.2	<1

2.4.14 Economic Analysis (for final compiled report)

1. Bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site
2. Summarize cost and revenues assumptions

Example

Table 58. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	8,070.60	
Regeneration		
Administration		
Net Income		

Example

Table 59. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments

Net Stumpage Value	4,862.65
Regeneration	
Administration	
Net Income	

Assumptions:

2.4.15 Discussion and Key Findings (for final compiled report)

1. Summary of regeneration strategy, and evaluation of its success or failure at this site
2. Lesson(s) learned from hardwood conversion
3. Relevant/interesting results not presented earlier in document

2.5 Site #13 (FPA/N # 2511948)

2.5.1 Site Identification and Description

2.5.1.1 Landowner Profile

The Weyerhaeuser Company, incorporated in 1900, is an international forest products company engaged in the ownership and management of private forests for the sustainable production of wood. Worldwide, Weyerhaeuser employs nearly 41,000 employees in 17 countries, mostly in the United States and Canada. In Washington State, they employ over 7,000 people and manage 1.11 million acres of timberland. Besides managing timberlands, Weyerhaeuser manufactures a variety of products that include wood and building materials, paper, cellulose fibers, and specialty papers and containers and provides a variety of services that includes wood product recycling, transportation and real estate transactions.

2.5.1.2 Factors Leading to Hardwood Conversion

Weyerhaeuser notes that riparian areas increase forest diversity within industrial tree farms, which fulfills one of their management goals. However, hardwood conversions are only considered by Weyerhaeuser when the financial benefits are evident. Additionally, they noted that alder sawlogs are a valuable commodity but alder fiber less so and the phototropic response of alder in riparian situations can reduce grade recovery and limit the financial utility of hardwood conversions. Therefore, they consider them on a case-by-case basis. Weyerhaeuser participated in this study because they "support the CMER process" and have participated in other studies.

2.5.1.3 Location

This hardwood conversion study site ("CMER Research Site #13) is located in Washington State's Pacific County, in a portion of Section 19, Township 15 North, Range 7 West, Willamette Meridian.

2.5.1.4 Topography and Climate

The study site varies in elevation from 260 to 660 feet and receives, on average, 53.14 inches of precipitation per year. Most of the precipitation falls from October through April in the form of rain with an average annual snowfall of 3.9 inches. Climate data comes from the National Weather Service's Cooperative Station Network, Doty 3 E station[6] (452220) located in Doty, Washington. Values are reported as annual mean monthly data from 1978-2007.

2.5.1.5 Stream Description

There are two Type 3 stream segments associated with this hardwood conversion study area, identified as stream segments A and B in the FPA-N submitted by the landowner. Stream segments A and B were surveyed for fish presence in May 2003 and cutthroat trout were found in segment A (see the fish survey forms [RAY-80-2003] associated with

[6] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

the FPA application/notification). No fish were found in stream segment B. The length of stream segments A and B is approximately 2,600 feet, stream bank-full width averages 5.9 feet, and the stream gradient averages 3.1%.

2.5.1.6 Unit Description

Situated north of Highway 6 between Raymond and Doty, Washington on the south flank of the Willapa Hills, the harvest area consisted of one cutting block (unit), laid out from east to west, totaling approximately 62 acres (according to Weyerhaeuser). The hardwood conversion study stream segment ran along the southern edge of the unit. Figure 5 displays a map of the harvest area.

2.5.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 170 feet while the "management RMZ" width was 113 feet for stream segment B (< 10 feet wide) and 128 feet for segment A (>10 feet wide; Table 60), of which, 50 feet represented the core zone and 63 to 78 feet represented the inner zone (Figure 5). The management RMZ that fell within the study reach covered 6.5 acres (Figure 5). An estimated 1.1 acres of the management RMZ was harvested, resulting in a retention buffer that covered 5.4 acres (Figure 5). Site specific conditions at this site resulted in a buffer width that was highly variable, ranging in with from 25 feet to in excess of 128 feet in width. All conifer in the core and inner zone were left uncut. Where possible, all hardwoods upslope of the 25-foot no cut buffer were harvested, however not all hardwoods could be felled because of sweep and heavy downhill lean which created the potential to damage trees in the retention buffer if felled. Additional conifers were retained, as needed, to meet outer zone leave tree requirements. At this site, slopes within the study RMZ averaged 51 percent and ranged from 10 to 110%. Figure 5 displays the location of the study reach within the harvest area and the resulting buffer configuration.

Table 60. Site #13 riparian management zone (RMZ) widths.

Stream Segment	Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
A	II	170'	>10'	128'
B	II	170'	≤10'	113'

2.5.1.8 Soil Description

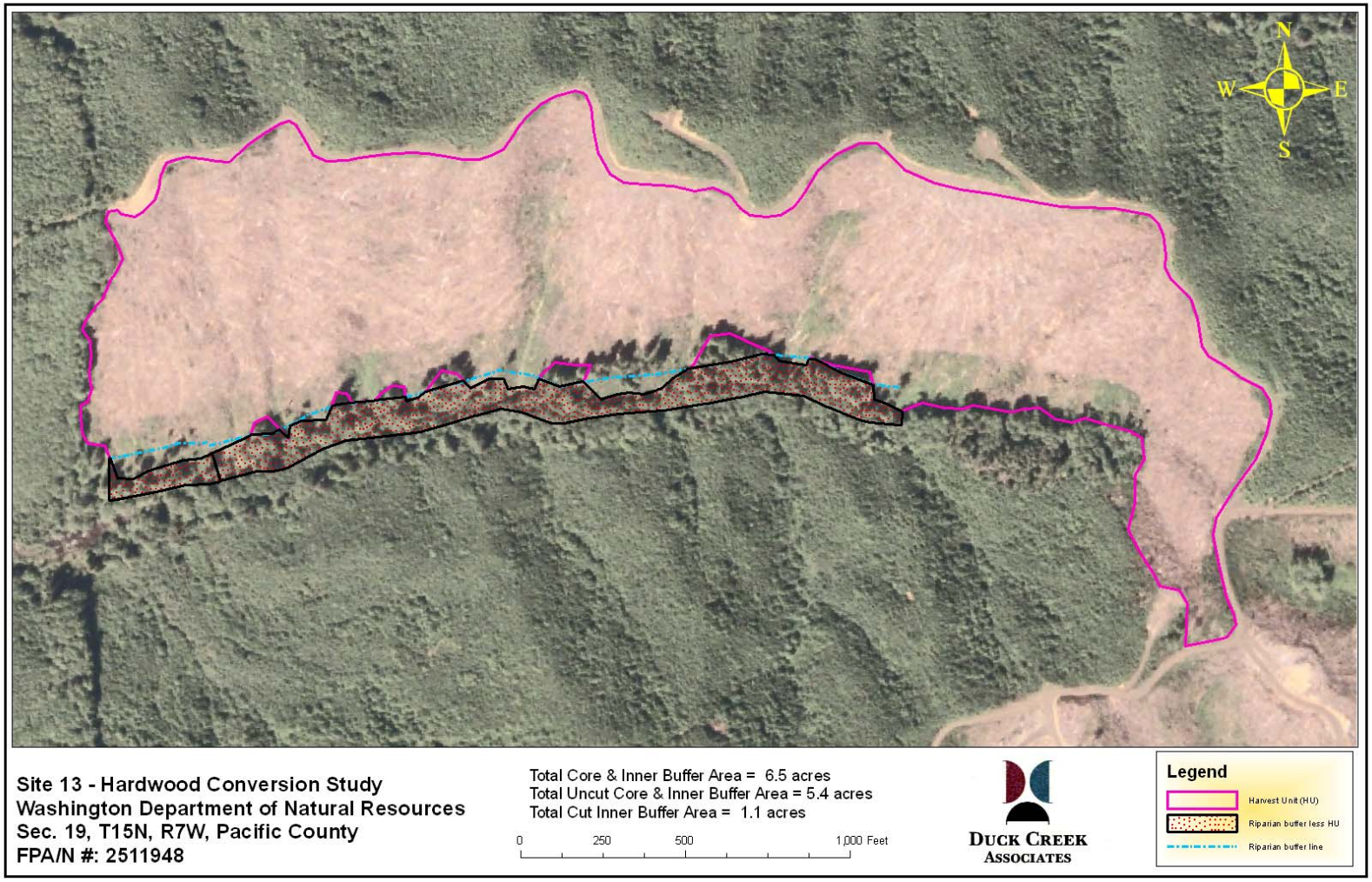
Soils in the research segment are deep and well-drained soils, slopes are typically in the 30-65% range (hills), the parent material consists of colluvium derived from sandstone, and are from the Zenker silt loam soil series[7]. Additionally, the far Eastern portion of the harvest unit contains deep well-drained soils from the Elochoman silt loam (30-65% slopes) soil series. Its parent material consists of residuum weathered from sandstone. The generalized site productivity class for this entire site, as defined by official Forest Practices maps, is Site Class II.

[7] http://www2.ftw.nrcs.usda.gov/osd/dat/Z/ZENKER.html

2.5.2 Duck Creek Associates Activities Timeline

During the Summer of 2002, Duck Creek Associates conducted an initial site review and recommended that it be selected for inclusion in the study by RSAG. In August 2003, Duck Creek Associates conducted a pre-harvest vegetation and stream metrics surveys. In May 2006, Duck Creek Associates conducted an initial regeneration survey with a follow-up regeneration survey conducted in March 2007. The 100% post-harvest RMZ survey was conducted in February 2007 and GPS buffer configuration mapping was conducted in March 2007. In April 2007, the landowner returned the questionnaire. In August 2007, Duck Creek Associates digitized and/or analyzed the GIS data and compiled this report in January 2008. Pre and post harvest RMZ large tree stand metrics (e.g., species distribution, trees Per Acre, volume, etc.) were calculated from the February 2007 post-harvest 100%.

Figure 5. Site #13 Map.



2.5.3 Pre-harvest Vegetation

2.5.3.1 Pre-harvest Combined Upslope and RMZ Stand Table/Description

According to pre-harvest inventory data provided by the landowner, displayed in Table 61, western hemlock was the dominant species accounting for a reported 52% of the basal area and 35% of the gross cubic foot volume. Red alder was significant cohort accounting for 31% of the basal area and 36% of the gross cubic foot volume (Table 61).

Table 61. Pre-harvest Combined Upslope and RMZ Stand Table Summary.

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Cubic Volume[3]/Acre		Board Feet/Acre	
					Gross	Net	Gross	Net
Live	Western hemlock	94	14	102	2,190	1,840	9,700	9,000
	Red alder	57	14	60	2,210	2,210	8,700	8,200
	Douglas fir	11	20	23	1,570	1,560	7,600	7,200
	Western red cedar	11	13	11	220	220	900	800
	Sitka spruce	-	-	-	40	40	200	100
Live Totals		**173**		**196**	**6,190**	**5,870**	**27,100**	**25,300**

[1] DBH = diameter (in inches) at breast height – quadratic mean diameter
[2] In square feet
[3] In feet

2.5.3.2 Pre-harvest RMZ Stand Table/Description

In the pre-harvest RMZ, red alder was the dominant species accounting for 53% of the live tree basal area and 47% of the live tree gross cubic foot volume (Table 62). Douglas fir, western red cedar, western hemlock, and Sitka spruce were all minor contributors to species composition. Combined, however, these conifer species accounted for 45% of the live tree basal area and 52% of the live tree gross cubic foot volume in the pre-harvest riparian stand (Table 62).

Table 62. Pre-Harvest RMZ Stand Table Summary

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Douglas fir	0.8	22.4	3.9	110.0	43.1	-	269.6	-
	Red alder	0.3	10.5	0.2	52.4	0.9	-	2.7	-
Snag Totals		**1.1**		**4.1**		**44.0**	**-**	**272.3**	**-**
Live	Red alder	82.3	12.6	78.6	77.9	2,090.7	1,923.6	7,909.2	7,270.4
	Douglas fir	8.8	17.9	18.4	100.0	688.3	646.7	3,229.2	3,033.2
	Western red cedar	17.2	13.5	25.7	56.3	701.0	622.0	2,924.6	2,555.2
	Western hemlock	8.0	16.8	15.0	91.1	582.0	529.0	2,644.6	2,385.7
	Sitka spruce	3.8	17.9	8.9	66.1	330.5	303.2	1,618.5	1,488.0
	Big-leaf maple	2.5	11.7	2.2	68.4	48.6	33.5	173.8	121.4

Other Hardwoods	0.3	10.5	0.2	69.9	5.7	5.5	23.1	21.9
Cascara	2.6	7.1	0.7	26.0	2.1	2.0	6.2	5.8
Live Totals	**125.5**		**149.6**		**4,448.9**	**4,065.4**	**18,529.2**	**16,881.6**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.5.3.3 Pre-harvest RMZ Vegetation Description

Table 63 displays major vegetation species in the pre-harvest RMZ, by percent cover and average height. This data was compiled using pre-harvest vegetation survey data collected in August 2003 (see footnote 1 in section 1.5 – Methods).

Table 63. Pre-harvest RMZ vegetation.

Species	%Cover	Height (Ft)
Salmonberry	25.6%	5.6
Western swordfern	24.7%	3.7
Oregon oxalis	24.7%	1.0
Vine maple	18.9%	19.1

2.5.4 Applied Harvest Prescription

2.5.4.1 Site Lay-out and Road Construction/Maintenance Description

This site consisted of one contiguous harvest unit (cutting block) of approximately 62 acres in size. The study reach was buffered with a 25-foot wide no-cut zone, measured from bank-full width, which was marked with paint and flagging. Conifers were retained in the core and inner zones, and additional conifers were left as needed to meet outer zone riparian leave tree and in-unit (WRT and GRT) requirements. All conifers retained outside of the 25-foot no-cut zone were marked individually with paint. There was no new road construction allocated to this site. According to information provided by the landowner, 8 person hours were required to permit the harvest operation and 24 person hours were required to conduct lay-out activities.

2.5.4.2 Schedule of Activities

The Forest Practices Application for this site was approved in March 2004. Harvesting activities were initiated on November 11, 2004 and were completed on March 4, 2005. The RMZ and near-riparian zone was initially planted in Spring 2005. In August 2005 an aerial herbicide site preparation treatment was applied to the upland (non-RMZ). In December 2005, mountain beaver were trapped in both the upland and RMZ. The initial planting of the upland occurred in March 2006. In April 2007, an aerial herbicide brush control treatment was applied to the upland (all described in more detail further below).

2.5.4.3 Yarding/Logging Description

The entire site was logged using high lead cable logging methods and no special activities or equipment were required during harvesting operations.

2.5.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 1,416.34 MBF (net Scribner scale) of sawlog material, as displayed in Table 64. The estimated area of the upland and RMZ combined is 62 acres.

Table 64. Combined upland and RMZ net harvest volume (62 Acres)

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Western hemlock	504.26	8.13	35.6
Red alder	459.43	7.41	32.4
Douglas fir	401.21	6.47	28.3
Western redcedar	42.66	0.69	3.0
Sitka spruce	8.35	0.13	0.6
Other hardwoods	0.43	0.02	0.0
Totals	**1,416.34**	**22.84**	**100**

[1] Thousand board feet

2.5.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced an estimated 11.36 MBF (net scribner scale) of sawlog material and approximately 11 tons of chipwood material (Table 65). The estimated harvest area in the RMZ is 1.1 acres (Figure 5).

Table 65. RMZ net harvest volume (1.1 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red Alder	11.36	10.33	100
Total	**11.36**	**10.33**	**100**

[1] Thousand board feet

2.5.6 Key Harvest Operation Findings and Challenges

In the questionnaire, Weyerhaeuser noted several conditions and challenges associated with this harvest operation. First, the phototropic response exhibited by alder on the steep south facing slopes of this unit aggravated sweep and lean in the alder. This made timber falling less productive and additional hardwoods were left in the RMZ in order to prevent potential damage to retention trees. The landowner also stated that residual

conifers retained in the RMZ made for obstacles that decreased yarding productivity and created additional safety hazards.

Additionally, Weyerhaeuser stated that, from a financial standpoint, this site was not a good hardwood conversion. Although yarding distances were short and deflection was good on this unit, these favorable yarding conditions were offset by the obstacles created by retained conifer, resulting in an overall reduction in productivity. Grade recovery was also poor in the alder at this site, because of the low form class and sweep of the riparian alder, and poorly stocked alder-dominated areas on the steep south facing upland slopes.

2.5.7 Harvest Economics

The estimated stumpage value for the RMZ harvest was $3,623. The indicated Forest Excise tax amount was $181. Using 1.1 acres as the area of harvest in the RMZ, Table 66 displays the per acre calculated stumpage value for the RMZ.

The indicated stumpage value for the upland harvest was $434,099. The indicated Forest Excise tax amount was $21,705. Using the indicated area of 60.9 acres in the upland, Table 66 displays the per acre calculated stumpage value for the upland.

The estimated gross stumpage value of the harvest for the entire 62 acre unit was $437,722. The indicated Forest Excise tax amount was $21,886. Using 62 acres as the area basis, Table 66 displays the per acre calculated stumpage value for the combined upland and RMZ harvests.

Table 66. Harvest stumpage values in dollars per acre.

Cost/Revenue	RMZ (1.1 Acres)	Upland (60.9 Acres)	Combined RMZ/Upland (62 Acres)
	$/Acre	$/Acre	$/Acre
Stumpage Value	3,293.64	7,128.06	7,060.03
Harvest Taxes	(164.55)	(356.40)	(352.67)
Net Stumpage Value	**3,129.09**	**6,771.66**	**6,707.36**

2.5.8 Regeneration Prescription

2.5.8.1 Site Preparation and Brush Control

2.5.8.1.1 Upland

No mechanical or manual upslope site preparation activities were conducted prior to planting. Herbicides, however, were applied as a site preparation treatment prior to planting the upland. This treatment included aerial application of three herbicides (Accord Concentrate, Chopper, and Oust Extra) in August 2005. Accord Concentrate was applied at a rate of 48 ounces per acre, Chopper at 8 ounces per acre, and Oust Extra at 4 ounces per acre. According to the questionnaire, the reported cost of this application was $69 per acre.

Following planting, an additional herbicide brush control treatment was applied in April 2007. This treatment included the aerial application of two herbicides (Accord

Concentrate and SFM 75 EG). Accord concentrate was applied at a rate of 16 ounces per acre and SFM 75 EG at 2 ounces per acre. According to the questionnaire, the reported cost of this application was $32 per acre.

2.5.8.1.2 RMZ

Prior to planting, there was no RMZ site preparation work. To date, there have been no brush control treatments either.

2.5.8.2 Planting Schedule/Description

2.5.8.2.1 Upland and RMZ Combined

The area immediately above the interface between the retention buffer and the harvested portion of the site was initially planted in the 1st quarter of 2005. This planting occurred mostly in the RMZ but likely also included some upland. The landowner does not have accurate records of this planting and no figures or costs were reported. Western hemlock, and possibly other shade tolerant conifer species, were planted. It is assumed that trees were planted at a density of 435 trees per acre (TPA).

In March 2006, the entire harvest unit was planted. This was the initial planting in the upland and it appears that RMZ inter-planting also occurred at this time. According to the landowner, genetically improved Douglas fir 1+1 stock was planted in the upland and RMZ at a target density of 435 TPA. The reported cost was $209 per acre, including planting stock and contractor labor. Table 67 displays the planting stock list provided by the landowner for the March 2006 planting.

Table 67. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA[1])
March 2006	Douglas fir	Improved	1+1	25,230	435

[1] Trees Per Acre

2.5.8.3 Animal Control Strategies/Descriptions

2.5.8.3.1 Upland and RMZ Combined

Animal control in both the upland and RMZ consisted of trapping for mountain beaver in December 2005 at a reported cost of $31 per acre.

2.5.8.4 Key Reforestation Findings and Challenges

At this site, Weyerhaeuser chose a strategy of planting the RMZ (and near-RMZ areas) with shade tolerant conifer species soon after harvesting was completed and one planting season prior to planting the upland. This was done because site preparation tool options are limited here (i.e., herbicides use is restricted). The hope is that the earlier planting would allow the seedlings an extra growing season to out-compete the untreated vegetation in the area.

The landowner expressed concerns about the difficulty of regenerating RMZ's. Because the options available for site preparation and brush control are limited here, they feel they

would have greater success if the application of chemical herbicides was allowed within the core zone.

2.5.9 Regeneration Economics

Table 68 summarizes reforestation costs at this site in the upland and RMZ.

Table 68. Upland and RMZ Regeneration Costs.

Activity	Date	Upland Cost per acre	RMZ Cost per acre
Planting	*1st Quarter 2005*	-	*$209.00*
Site Preparation (Aerial Spray)	8/2005	$69.00	-
Animal Control (Trapping)	12/2005	$31.00	$31.00
Planting	3/2006	$209.00	-
Inter-planting	*3/2006*	-	*$104.50*
Brush Control (Aerial Spray)	4/2007	$32.00	-
Totals (For Final)			

2.5.9.1 Regeneration Economics Cost Assumptions

Planting in the RMZ during the 1st quarter of 2005 is assumed to have cost the same as planting the upland in March 2006.

Inter-planting in the RMZ in March 2006 is assumed to have cost 50% of the initial upland planting cost.

2.5.10 Post-harvest Vegetation

2.5.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting accounted for a 19% reduction in the number of trees per acre, a 14% reduction in basal area per acre, and 13% reduction in gross cubic foot volume per acre (as is indicated by Table 69 under the "Cutting" group). Compared to the pre-harvest conditions, disturbance accounted for a 2% reduction in trees per acre, basal area per acre, and gross cubic foot volume per acre (as is indicated in Table 69 under the "Fallen/Windthrow" group).

Table 69. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	23.2	12.2	21.0	76.6	557.5	529.6	2,107.7	2,002.3
	Douglas fir	0.2	5.1	0.0	31.4	0.0	0.0	0.0	0.0
	Cascara	0.3	5.6	0.1	22.9	0.0	0.0	0.0	0.0
	Cutting Totals	**23.7**		**21.0**		**557.5**	**529.6**	**2,107.7**	**2,002.3**

Fallen/ Windthrow	Red alder	1.7	12.0	1.6	74.0	41.8	39.7	156.9	149.1
	Western hemlock	0.2	25.0	0.5	113.6	22.8	21.6	107.7	102.3
	Douglas fir	0.5	13.7	0.6	80.1	18.4	17.5	80.0	76.0
	Western redcedar	0.6	8.2	0.2	43.7	2.6	2.5	7.7	7.3
Fallen/Windthrow Totals		**2.9**		**2.9**		**85.6**	**81.3**	**352.3**	**334.7**

[1] DBH = diameter (in inches) at breast height – trees per acre weighted average
[2] In square feet
[3] In feet – trees per acre weighted average

2.5.11 Post-harvest RMZ Stand Table/Description

As compared with pre-harvest conditions, in terms of species distribution, conifer species contribute more to the retained RMZ stand following harvest, which was expected since hardwoods were targeted for removal. Post-harvest, conifer species account for 54% of the live tree basal area and 60% of the gross cubic foot volume per acre (versus 45% and 52%, respectively) in the pre-harvest stand. Table 70 displays the residual post-harvest stand table.

Table 70. Post-harvest Stand Table Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Douglas fir	0.9	19.7	3.9	96.6	43.2	-	269.6	-
	Red alder	1.5	12.9	1.7	64.4	8.1	-	32.4	-
	Big-leaf maple	0.2	6.0	0.0	29.9	0.1	-	0.0	-
	Snag Totals	**2.6**		**5.6**		**51.3**	**0.0**	**302.0**	**0.0**
Live	Red alder	56.2	12.7	54.6	78.5	1,473.0	1,353.5	5,609.2	5,148.8
	Douglas fir	8.0	18.6	17.7	103.6	669.9	629.4	3,149.2	2,958.4
	Western redcedar	16.6	13.7	25.4	56.8	698.4	619.5	2,916.9	2,547.9
	Western hemlock	7.8	16.7	14.5	90.6	559.2	507.8	2,536.9	2,285.9
	Sitka spruce	3.8	17.9	8.9	66.1	330.5	303.2	1,618.5	1,488.0
	Big-leaf maple	2.3	12.1	2.1	70.3	48.6	33.5	173.8	121.4
	Other hardwoods	0.3	10.5	0.2	69.9	5.7	5.5	23.1	21.9
	Cascara	2.3	7.3	0.7	26.4	2.1	2.0	6.2	5.8
	Live Totals	**97.4**		**124.2**		**3,787.4**	**3,454.3**	**16,033.8**	**14,578.1**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.5.12 RMZ Regeneration Survey Data

Table 71 displays a summary of compiled data from the initial regeneration survey conducted in the RMZ in May 2006 (following initial planting). Table 72 displays a summary of the second regeneration survey conducted in the RMZ in March 2007.

Table 71. Initial RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2005	Western Hemlock	Planted	211.5	0.0	0.0	2.5	93%
	Douglas fir		184.6	0.0	0.0	1.1	80%
	Western redcedar		3.8	0.0	0.0	1.6	93%
	Total Planted		**400.0**	**0.0**	**0.0**	**1.8**	
	Douglas fir	Dead/Dying	19.2	0.2	0.0	1.0	13%
	Total Dead/Dying		**19.2**	**0.2**	**0.0**	**1.0**	
	Cascara	Natural	915.4	0.2	0.9	4.1	39%
	Red alder		173.1	0.0	0.0	2.6	62%
	Western hemlock		7.7	0.0	0.0	2.0	75%
	Total Natural		**1096.2**	**0.1**	**0.9**	**3.8**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

Table 72. Second RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2006	Western Hemlock	Planted	176.9	0.2	0.1	2.8	87%
	Douglas fir		130.8	0.0	0.0	1.5	71%
	Western redcedar		3.8	0.0	0.0	2.3	59%
	Total Planted		**311.5**	**0.1**	**0.1**	**2.3**	
	Cascara	Natural	753.8	0.4	0.9	3.8	55%
	Red alder		84.6	0.1	0.0	3.6	62%
	Western hemlock		7.7	0.0	0.0	3.0	55%
	Total Natural		**846.2**	**0.4**	**0.9**	**3.7**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.5.13 RMZ Vegetation and Planting Site Condition Description

Table 73 displays the occurrence of the major vegetation species observed at the time of the initial regeneration survey conducted in May 2005. Table 73 also displays the occurrence of the major vegetation species observed at the time of the second regeneration survey conducted in March 2007. It is important to note that the large increase in % cover Western swordfern and especially increases in % cover and height of salmonberry may have a negative impact on seedling growth and survival.

Table 73. Initial (2005) and Secondary (2006) Post-harvest RMZ Vegetation Survey Summary.

Growth Year	Species	% Cover	Height (ft.)
2005	Grass/Sedges	15.4	1.1
	Salmonberry	13.5	3.9
	Western swordfern	10.8	3.2
	Oregon oxalis	6.9	<1
	Vine maple	6.2	6.6
	Trailing blackberry	6.2	<1
2006	Western swordfern	31.9	2.3
	Salmonberry	31.2	5.2
	Trailing blackberry	11.5	1.1
	Vine maple	7.3	12.1

2.5.14 Economic Analysis (for final compiled report)

1. Bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site
2. Summarize cost and revenues assumptions

Example

Table 74. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	6,771.66	
Regeneration		
Administration		
Net Income		

Example

Table 75. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	3,129.09	
Regeneration		
Administration		
Net Income		

Assumptions:

2.5.15 Discussion and Key Findings (for final compiled report)

1. Summary of regeneration strategy, and evaluation of its success or failure at this site
2. Lesson(s) learned from hardwood conversion
3. Relevant/interesting results not presented earlier in document

2.6 Site #14 (FPA/N # 2511930)

2.6.1 Site Identification and Description

2.6.1.1 Landowner Profile

The Weyerhaeuser Company, incorporated in 1900, is an international forest products company engaged in the ownership and management of private forests for the sustainable production of wood. Worldwide, Weyerhaeuser employs nearly 41,000 employees in 17 countries, mostly in the United States and Canada. In Washington State, they employ over 7,000 people and manage 1.11 million acres of timberland. Besides managing timberlands, Weyerhaeuser manufactures a variety of products that include wood and building materials, paper, cellulose fibers, and specialty papers and containers and provides a variety of services that includes wood product recycling, transportation and real estate transactions.

2.6.1.2 Factors Leading to Hardwood Conversion

Weyerhaeuser notes that riparian areas increase forest diversity within industrial tree farms, which fulfills one of their management goals. However, hardwood conversions are only considered by Weyerhaeuser when the financial benefits are evident. Additionally, they noted that alder sawlogs are a valuable commodity but alder fiber less so and the phototropic response of alder in riparian situations can reduce grade recovery and limit the financial utility of hardwood conversions. Therefore, they consider them on a case-by-case basis. Weyerhaeuser participated in this study because they "support the CMER process" and have participated in other studies.

2.6.1.3 Location

This hardwood conversion study site ("CMER Research Site #14) is located in Washington State's Pacific County, in a portion of Section 03, Township 14 North, Range 8 West, Willamette Meridian.

2.6.1.4 Topography and Climate

Elevation in the harvest unit ranges from 235 to 530 feet (235-410 feet in the research area) and receives, on average, 83.14 inches of precipitation per year. Most of the precipitation falls from October through April in the form of rain with an average annual snowfall of 0.7 inches. Climate data comes from the National Weather Service's Cooperative Station Network, Raymond 2 S station[8] (456914) located in Raymond, Washington. Values are reported as annual mean monthly data from 1980-2007.

2.6.1.5 Stream Description

The stream segment associated with this hardwood conversion study site is classified by the DNR as a Type 3 water. A stream typing and electrofish survey conducted by the landowner found fish usage in the study reach. Additionally, fish presence was also observed in a small tributary that bisects the study RMZ buffer at approximately the mid-

[8] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

point. The main study stream segment is approximately 1,150 feet, stream bankfull width averages 10.9 feet, and the stream gradient averages 1.0%.

2.6.1.6 Unit Description

Situated about 4 miles northeast of Raymond, Washington on the northwest flank of the Willapa Hills, the harvest area consisted of one cutting block (unit), laid out from north to south, totaling approximately 51 acres (according to Weyerhaeuser). The hardwood conversion study stream segment ran along the norther edge of the unit. Figure 6 displays a map of the harvest area.

2.6.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 170 feet while the "management RMZ" width was 128 feet (Table 76), of which, 50 feet represented the core zone and 78 feet represented the inner zone (Figure 6). The management RMZ that fell within the study reach covered 3.3 acres (Figure 6). An estimated 2.2 acres of the management RMZ was harvested, resulting in a retention buffer that covered 1.2 acres (Figure 6). At this site, the no-cut RMZ buffer was 25 feet in width. All conifer in the core and inner zones were left uncut, where it was possible to protect the retention trees in the retained 25-foot no-cut area, hardwoods upland from the 25 foot were harvested, and additional conifers were left as needed to meet outer zone requirements. At this site, slopes within the study RMZ averaged 23% and ranged from 5 to 85%. Figure 6 displays the location of the study reach within the harvest area and the resulting buffer configuration.

Table 76. Site #14 riparian management zone (RMZ) widths.

Stream Segment	Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
3	II	170'	>10'	128'

2.6.1.8 Soil Description

Soils in the research segment are deep and well-drained. Slopes are typically in the 8-30% range and the parent material consists of colluvium derived from sandstone and siltstone and are from the Lytell silt loam soil series[9]. The generalized site productivity class, as defined by official Forest Practices maps, is Site Class II.

2.6.2 Duck Creek Associates Activities Timeline

During the Summer of 2002, Duck Creek Associates conducted an initial site review and recommended that it be selected for inclusion in the study by RSAG. In August 2003, Duck Creek Associates conducted the pre-harvest vegetation and stream metrics surveys. In May 2006, Duck Creek Associates conducted an initial regeneration survey with a follow-up regeneration survey conducted in March 2007. The 100% RMZ survey was conducted in February 2007 and the buffer configuration was GPS mapped in March

[9] http://www2.ftw.nrcs.usda.gov/osd/dat/L/LYTELL.html

2007. In April 2007, the landowner returned the questionnaire. In August 2007, Duck Creek Associates digitized and/or analyzed the GPS/GIS data.

Figure 6. Site #14 Map.

2.6.3 Pre-harvest Vegetation

2.6.3.1 Pre-harvest Combined Upslope and RMZ Stand Table/Description

The pre-harvest stand statistics are based on harvest cut-out statistics provided by the landowner, displayed in Table 77, and give an approximation of the pre-harvest species composition (volume metrics) for the combined upland and RMZ. Western hemlock was the dominant species accounting for 60% of the gross cubit foot volume while red alder was co-dominant, accounting for 23% of the gross cubic foot volume (Table 77).

Table 77. Pre-harvest Combined Upslope and RMZ Stand Table Summary.

Group	Species	Cubic Volume[1]/Acre		Board Feet/Acre	
		Gross	Net	Gross	Net
Live	Western hemlock	5,060	5,030	20,500	19,600
	Red alder	1,890	1,890	7,700	7,300
	Sitka spruce	760	750	4,100	3,700
	Western redcedar	110	110	600	500
	Douglas fir	570	560	2,700	2,600
Live Totals		**8,390**	**8,340**	**35,600**	**33,700**

[1] In feet

2.6.3.2 Pre-harvest RMZ Stand Table/Description

In the pre-harvest RMZ, red alder was the dominant species accounting for 79% of the live tree basal area and 72% of the live tree gross cubic foot volume (Table 78). Douglas fir, western red cedar, western hemlock, and Sitka spruce were all minor contributors to species composition. Combined, however, these conifer species accounted for 21% of the live tree basal area and 27% of the live tree gross cubic foot volume in the pre-harvest riparian stand (Table 78).

Table 78. Pre-Harvest RMZ Stand Table Summary

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Red alder	1.5	9.4	0.7	46.9	4.3		13.1	
Snag Totals		**1.5**		**0.7**		**4.3**		**13.1**	
Live	Red alder	108.5	13.8	127.1	85.4	3876.0	3526.6	15927.3	14485.3
	Sitka spruce	4.5	29.5	27.0	106.6	1215.2	1106.6	6557.6	5963.0
	Western hemlock	0.9	23.7	3.1	116.2	117.0	103.9	539.4	479.4
	Western redcedar	0.3	35.0	2.0	105.0	65.1	60.4	263.6	244.0
	Douglas fir	0.9	15.0	1.5	104.1	51.4	48.8	227.3	215.9
	Big-leaf maple	2.1	9.9	1.2	78.0	30.2	28.7	127.3	120.9
Live Totals		117.3		161.8	595.2	5354.9	4874.9	23642.4	21508.5

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet

[3] In feet – Trees Per Acre weighted average

2.6.3.3 Pre-harvest RMZ Vegetation Description

Table 79 displays major vegetation species in the pre-harvest RMZ, by percent cover and average height. This data was compiled using pre-harvest vegetation survey data collected in August 2003 (see footnote 1 in section 1.5 – Methods).

Table 79. Pre-harvest RMZ vegetation.

Species	%Cover	Height (Ft)
Salmonberry	49.2%	6.4
Oregon oxalis	36.6%	<1
Piggy-back plant	12.4%	<1
Moss	11.0%	<1
Vine maple	7.9%	11.2

2.6.4 Applied Harvest Prescription

2.6.4.1 Site Lay-out and Road Construction/Maintenance Description

This site consisted of one contiguous harvest unit (cutting block) of approximately 51 acres in size. The study reach was buffered with a 25-foot wide no-cut zone, measured from bank-full width, which was marked with paint and flagging. Conifers were retained in the core and inner zones, and additional conifers were left as needed to meet outer zone riparian leave tree requirements. All conifers retained outside of the 25-foot no-cut zone were marked individually with paint. A total of 2,355 feet of new road was constructed and 180 feet of road reconstruction were allocated to this harvest operation. According to information provided by the landowner, 8 person hours were required to permit the harvest operation and 24 person hours were required to conduct lay-out activities.

2.6.4.2 Schedule of Activities

The Forest Practices Application for this site was approved in March 2004. Harvesting activities were initiated on September 14, 2004 and were completed on January 5, 2005. The RMZ and near-riparian zone was initially planted in Spring 2005. In August 2005, an aerial herbicide site preparation treatment was applied to the upland (non-RMZ). In December 2005, mountain beaver were trapped in both the upland and RMZ. The initial planting of the upland occurred in March 2006. In April 2007, an aerial herbicide brush control treatment was applied to the upland (all described in more detail further below).

2.6.4.3 Yarding/Logging Description

Both highlead and shovel logging methods were used to harvest this unit. The landowner estimates that roughly 50% of the unit was logged by highlead with the other 50% by shovel. The study RMZ was yarded entirely using shovel logging equipment.

2.6.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 1,716.19 MBF (net scribner scale) of sawlog material (Table 80). The estimated area of the upland and RMZ combined is 51 acres.

Table 80. Combined upland and RMZ net harvest volume (51 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Western hemlock	997.87	19.57	58.1%
Red alder	370.89	7.27	21.6%
Sitka spruce	190.17	3.73	11.1%
Douglas fir	130.77	2.56	7.6%
Western redcedar	25.67	0.50	1.5%
Other hardwoods	0.82	0.02	<1%
Total	**1,716.19**	**33.65**	

[1] Thousand board feet

2.6.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced an estimated 29.9 MBF (net scribner scale) of sawlog material and approximately 14 tons of chipwood material (Table 81). The estimated harvest area in the RMZ is 1.1 acres (Figure 6).

Table 81. RMZ net harvest volume (1.1 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red alder	22.96	10.44	76.8%
Sitka spruce	6.37	2.90	21.3%
Western hemlock	0.48	0.22	1.6%
Douglas fir	0.10	0.05	0.3%
Total	**29.90**	**13.59**	

[1] Thousand board feet

2.6.6 Key Harvest Operation Findings and Challenges

In the questionnaire, Weyerhaeuser noted that this site was an excellent candidate for hardwood conversion due to good road access, productive logging, and good alder grade recovery.

2.6.7 Harvest Economics

The estimated stumpage value for the RMZ harvest was $9,644. The indicated Forest Excise tax amount was $482. Using 2.2 acres as the area of harvest in the RMZ, Table 82 displays the per acre calculated stumpage value for the RMZ.

The indicated stumpage value for the upland harvest was $439,558. The indicated Forest Excise tax amount was $21,978. Using the indicated area of 48.8 acres in the upland, Table 82 displays the per acre calculated stumpage value for the upland.

The estimated gross stumpage value of the harvest for the entire 51 acre unit was $449,202. The indicated Forest Excise tax amount was $22,460. Using 51 acres as the area basis, Table 82 displays the per acre calculated stumpage value for the combined upland and RMZ harvests.

Table 82. Harvest stumpage values in dollars per acre.

Cost/Revenue	RMZ (2.2Acres)	Upland (48.8Acres)	Combined RMZ/Upland (51 Acres)
	$/Acre	$/Acre	$/Acre
Stumpage Value	4,383.64	9,007.33	8,807.88
Harvest Taxes	(219.09)	(450.37)	(440.39)
Net Stumpage Value	**4,164.55**	**8,556.96**	**8,367.49**

2.6.8 Regeneration Prescription

2.6.8.1 Site Preparation and Brush Control

2.6.8.1.1 Upland

No mechanical or manual upslope site preparation activities were conducted prior to planting. Herbicides, however, were applied as a site preparation treatment prior to planting the upland. This treatment included aerial application of three herbicides (Accord Concentrate and Oust Extra) in August 2005. Accord Concentrate was applied at a rate of 60 ounces per acre, Oust Extra at 4 ounces per acre. According to the questionnaire, the reported cost of this application was $61 per acre.

Following planting, an additional herbicide brush control treatment was applied in April 2007. This treatment included the aerial application of two herbicides (Accord Concentrate and SFM 75 EG). Accord concentrate was applied at a rate of 24 ounces per acre and SFM 75 EG at 2 ounces per acre. According to the questionnaire, the reported cost of this application was $33 per acre.

2.6.8.1.2 RMZ

Prior to planting, there was no RMZ site preparation work. To date, there have been no brush control treatments either.

2.6.8.2 Planting Schedule/Description

2.6.8.2.1 Upland and RMZ Combined

The area immediately above the interface between the retention buffer and the harvested portion of the site was initially planted in the 1st quarter of 2005. This planting occurred mostly in the RMZ but likely also included some upland. The landowner does not have accurate records of this planting and no figures or costs were reported. Western hemlock, and possibly other shade tolerant conifer species, were planted. It is assumed that trees were planted at a density of 435 trees per acre (TPA).

In March 2006, the entire harvest unit was planted. This was the initial planting in the upland and it appears that RMZ inter-planting also occurred at this time. According to the landowner, genetically improved Douglas fir 1+1 stock was planted in the upland and RMZ at a target density of 435 TPA. During this planting, an additional 1,000 native western hemlock seedlings were allocated for planting in the RMZ. The reported cost was $209 per acre, including planting stock and contractor labor. Table 83 displays the planting stock list provided by the landowner for the March 2006 planting.

Table 83. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA[1])
March 2006	Douglas fir	Improved	1+1	25,230	435
	Western hemlock	Native	Plug	1,000	

[1] Trees Per Acre

2.6.8.3 Animal Control Strategies/Descriptions

2.6.8.3.1 Upland and RMZ Combined

Animal control in both the upland and RMZ consisted of trapping for mountain beaver in December 2005 at a reported cost of $31 per acre.

2.6.8.4 Key Reforestation Findings and Challenges

At this site, Weyerhaeuser chose a strategy of planting the RMZ (and near-RMZ areas) with shade tolerant conifer species soon after harvesting was completed and one planting season prior to planting the upland. This was done because site preparation tool options are limited here (i.e., herbicides use is restricted). The hope is that the earlier planting would allow the seedlings an extra growing season to out-compete the untreated vegetation in the area.

The landowner expressed concerns about the difficulty of regenerating RMZ's. Because the options available for site preparation and brush control are limited here, they feel they would have greater success if the application of chemical herbicides was allowed within the core zone.

2.6.9 Regeneration Economics

Table 84 summarizes reforestation costs at this site in the upland and RMZ.

Table 84. Upland and RMZ Regeneration Costs.

Activity	Date	Upland Cost per acre	RMZ Cost per acre
Planting	*1st Quarter 2005*	-	*$209.00*
Site Preparation (Aerial Spray)	8/2005	$61.00	-
Animal Control (Trapping)	12/2005	$31.00	$31.00
Planting	3/2006	$209.00	-
Inter-planting	*3/2006*	-	*$104.50*
Brush Control (Aerial Spray)	4/2007	$33.00	-
Totals (For Final)			

2.6.9.1 Regeneration Economics Cost Assumptions

Planting in the RMZ during the 1st quarter of 2005 is assumed to have cost the same as planting the upland in March 2006.

Inter-planting in the RMZ in March 2006 is assumed to have cost 50% of the initial upland planting cost.

2.6.10 Post-harvest Vegetation

2.6.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting accounted for a 47% reduction in the number of trees per acre, a 44% reduction in basal area per acre, and a 45% reduction in gross cubic foot volume per acre (as is indicated in Table 85 under the "Cutting" group). Compared to the pre-harvest conditions, disturbance accounted for a 4% reduction in trees per acre, a 2% reduction in basal area and gross cubic foot volume per acre (as is indicated in Table 85 under the "Fallen/Windthrow" group).

Table 85. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	50.9	14.0	61.3	85.3	1,907.3	1,811.9	7,900.0	7,505.0
	Sitka spruce	1.2	28.0	7.9	96.2	362.1	344.0	2,030.3	1,928.8
	Western hemlock	0.6	18.6	1.1	111.7	40.6	38.6	160.6	152.6
	Big-leaf maple	2.1	9.9	1.2	78.0	30.2	28.7	127.3	120.9
	Douglas fir	0.6	9.4	0.3	98.5	8.8	8.4	30.3	28.8
	Cutting Totals	**55.5**		**71.9**	**469.9**	**2,349.0**	**2,231.6**	**10,248.5**	**9,736.1**
Fallen/ Windthrow	Red alder	4.8	10.9	3.5	80.7	93.9	89.2	372.7	354.1
	Sitka spruce	0.3	26.0	1.1	106.0	43.3	41.1	187.9	178.5
Fallen/Windthrow Totals		**5.2**		**4.6**	**186.7**	**137.2**	**130.3**	**560.6**	**532.6**

[1] DBH = diameter (in inches) at breast height – trees per acre weighted average
[2] In square feet
[3] In feet – trees per acre weighted average

2.6.11 Post-harvest RMZ Stand Table/Description

As compared with pre-harvest conditions, in terms of species distribution, conifer species contribute more to the retained RMZ stand following harvest, which was expected since hardwoods were targeted for removal. Post-harvest, conifer species account for 27% of the live tree basal area and 35% of the gross cubic foot volume per acre (versus 21% and 27%, respectively) in the pre-harvest stand. Table 86 displays the residual post-harvest stand table.

Table 86. Post-harvest Stand Table Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Red alder	2.1	9.4	1.0	47.0	6.0		18.3	
	Snag Totals	**2.1**	**9.4**	**1.0**	**47.0**	**6.0**		**18.3**	
Live	Red alder	52.1	13.9	62.0	86.0	1,881.7	1,708.4	7,609.1	6,895.0
	Sitka spruce	3.0	30.5	18.0	110.8	809.8	734.0	4,339.4	3,929.9
	Western hemlock	0.3	34.0	1.9	125.0	76.4	67.5	378.8	335.6
	Western redcedar	0.3	35.0	2.0	105.0	65.1	60.4	263.6	244.0
	Douglas fir	0.3	26.0	1.1	115.2	42.6	40.4	197.0	187.1
	Live Totals	**56.1**		**85.1**	**541.9**	**2,875.6**	**2,610.6**	**12,787.9**	**11,591.5**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.6.12 RMZ Regeneration Survey Data

Table 87 displays a summary of compiled data from the initial regeneration survey conducted in the RMZ in May 2006 (following initial planting). Table 88 displays a summary of the second regeneration survey conducted in the RMZ in March 2007.

Table 87. Initial RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2005	Douglas fir	Planted	220.0	0.0	0.0	1.2	87%
	Western hemlock		80.0	0.0	0.0	2.5	91%
	Sitka spruce		2.5	0.0	0.0	1.6	93%
	Total Planted		**302.5**	**0.0**	**0.0**	**1.6**	
	Douglas fir	Dead/Dying	22.5	0.0	0.0	1.2	42%
	Total Dead/Dying		**22.5**	**0.0**	**0.0**	**1.2**	
	Cascara	Natural	170.0	0.0	0.0	3.1	36%
	Sitka spruce		5.0	0.0	0.0	2.6	87%
	Western hemlock		2.5	0.0	0.0	3.9	29%
	Total Natural		**177.5**	**0.0**	**0.0**	**3.1**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

Table 88. Second RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2006	Douglas fir	Planted	187.5	0.0	0.0	1.5	86%
	Western hemlock		75.0	0.2	0.0	3.2	81%
	Sitka spruce		5.0	0.0	0.0	2.1	56%
	Total Planted		**267.5**	**0.1**	**0.0**	**2.0**	
	Douglas fir	Dead/Dying	2.5	0.0	0.0	1.0	19%
	Total Dead/Dying		**2.5**	**0.0**	**0.0**	**1.0**	
	Cascara	Natural	157.5	0.3	0.2	3.3	72%
	Red alder		20.0	0.0	0.0	3.0	68%
	Western hemlock		7.5	0.3	0.0	3.1	82%
	Total Natural		**185.0**	**0.3**	**0.3**	**3.3**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.6.13 RMZ Vegetation and Planting Site Condition Description

Table 89 displays the occurrence of the major vegetation species observed at the time of the initial regeneration survey (May 2005) and second regeneration survey (March 2007). It is important to note that the large increase in % cover of salmonberry may have a negative impact on seedling growth and survival.

Table 89. Initial (2005) and Secondary (2006) Post-harvest RMZ Vegetation Survey Summary.

Growth Year	Species	% Cover	Height (ft.)
2005	Salmonberry	22.5	3.6
	Oregon oxalis	13.5	<1
	Grasses/Sedges	7.0	<1
2006	Salmonberry	32.5	3.4
	Grasses/Sedges	12.0	<1

2.6.14 Economic Analysis (for final compiled report)

1. Bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site
2. Summarize cost and revenues assumptions

Example

Table 90. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	8,556.96	
Regeneration		
Administration		
Net Income		

Example

Table 91. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	4,164.55	
Regeneration		
Administration		
Net Income		

Assumptions:

2.6.15 Discussion and Key Findings (for final compiled report)

1. Summary of regeneration strategy, and evaluation of its success or failure at this site
2. Lesson(s) learned from hardwood conversion
3. Relevant/interesting results not presented earlier in document

2.7 Site #15 (FPA/N # 2910059)

2.7.1 Site Identification and Description

2.7.1.1 Landowner Profile

The Weyerhaeuser Company, incorporated in 1900, is an international forest products company engaged in the ownership and management of private forests for the sustainable production of wood. Worldwide, Weyerhaeuser employs nearly 41,000 employees in 17 countries, mostly in the United States and Canada. In Washington State, they employ over 7,000 people and manage 1.11 million acres of timberland. Besides managing timberlands, Weyerhaeuser manufactures a variety of products that include wood and building materials, paper, cellulose fibers, and specialty papers and containers and provides a variety of services that includes wood product recycling, transportation and real estate transactions.

2.7.1.2 Factors Leading to Hardwood Conversion

Weyerhaeuser notes that riparian areas increase forest diversity within industrial tree farms, which fulfills one of their management goals. However, hardwood conversions are only considered by Weyerhaeuser when the financial benefits are evident. Additionally, they noted that alder sawlogs are a valuable commodity but alder fiber less so and the phototropic response of alder in riparian situations can reduce grade recovery and limit the financial utility of hardwood conversions. Therefore, they consider them on a case-by-case basis. Weyerhaeuser participated in this study because they "support the CMER process" and have participated in other studies. Additionally, they noted that hardwood conversion at this site was financially lucrative due to good sawlog recovery and few logging obstacles.

2.7.1.3 Location

This hardwood conversion study site ("CMER Research Site #15) is located in Washington State's Pacific County, East-Southeast of the town of Raymond in a portion of Section 36, Township 14 North, Range 8 West, Willamette Meridian.

2.7.1.4 Topography and Climate

Elevation in the harvest unit ranges from 62 to 375 feet and receives, on average, 83.14 inches of precipitation per year. Most of the precipitation falls from October through April in the form of rain with an average annual snowfall of 0.7 inches. Climate data comes from the National Weather Service's Cooperative Station Network, Raymond 2 S station[10] (456914) located in Raymond, Washington. Values are reported as annual mean monthly data from 1980-2007.

2.7.1.5 Stream Description

There is one Type III stream segment associated with this hardwood conversion study area. Fish have been observed or are known to use this stream segment. The in-unit

[10] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

stream research segment length is approximately 2,100 feet, stream bankfull width averages 17.97 feet, and the stream gradient averages 0.3%.

2.7.1.6 Unit Description

Situated about 4 miles northeast of Raymond, Washington on the southwest flank of the Willapa Hills, the harvest area consisted of one cutting block (unit) totaling approximately 33 acres (according to Weyerhaeuser). The hardwood conversion study stream segment ran along the southern edge of the unit. Figure 7 displays a map of the harvest area.

2.7.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 170 feet while the "management RMZ" width was 128 feet (Table 92), of which, 50 feet represented the core zone and 78 feet represented the inner zone (Figure 7). The management RMZ that fell within the study reach covered 6.3 acres (Figure 7). An estimated 2.4 acres of the management RMZ was harvested, resulting in a retention buffer that covered 3.9 acres (Figure 7). At this site, the no-cut RMZ buffer was 25 feet in width. All conifer in the core and inner zones were left uncut, where possible, hardwoods upland from the 25 foot RMZ were harvested, and additional conifers were left as needed to meet outer zone requirements. Additional trees were left as wildlife reserve trees and green recruitment trees. Slopes within the study RMZ averaged 22% and ranged from 2 to 50%. Figure 7 displays the location of the study reach within the harvest area and the resulting buffer configuration.

Table 92. Site #15 riparian management zone (RMZ) widths.

Stream Segment	Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
A	II	170'	>10'	128'

2.7.1.8 Soil Description

Soils in the unit are deep and well-drained. Slopes are typically in the 8-30% range and the parent material consists of colluvium derived from sandstone and siltstone and are from the Lytell silt loam soil series[11]. Additionally, the apex of the harvest unit contains soils from the Arta silt loam series where slopes are typically in the 3-15% range, the parent material consists of alluvium derived from sandstone and siltstone, and the soils are typically deep and moderately well drained. The generalized site productivity class at this site, as defined by official Forest Practices maps, is Site Class II.

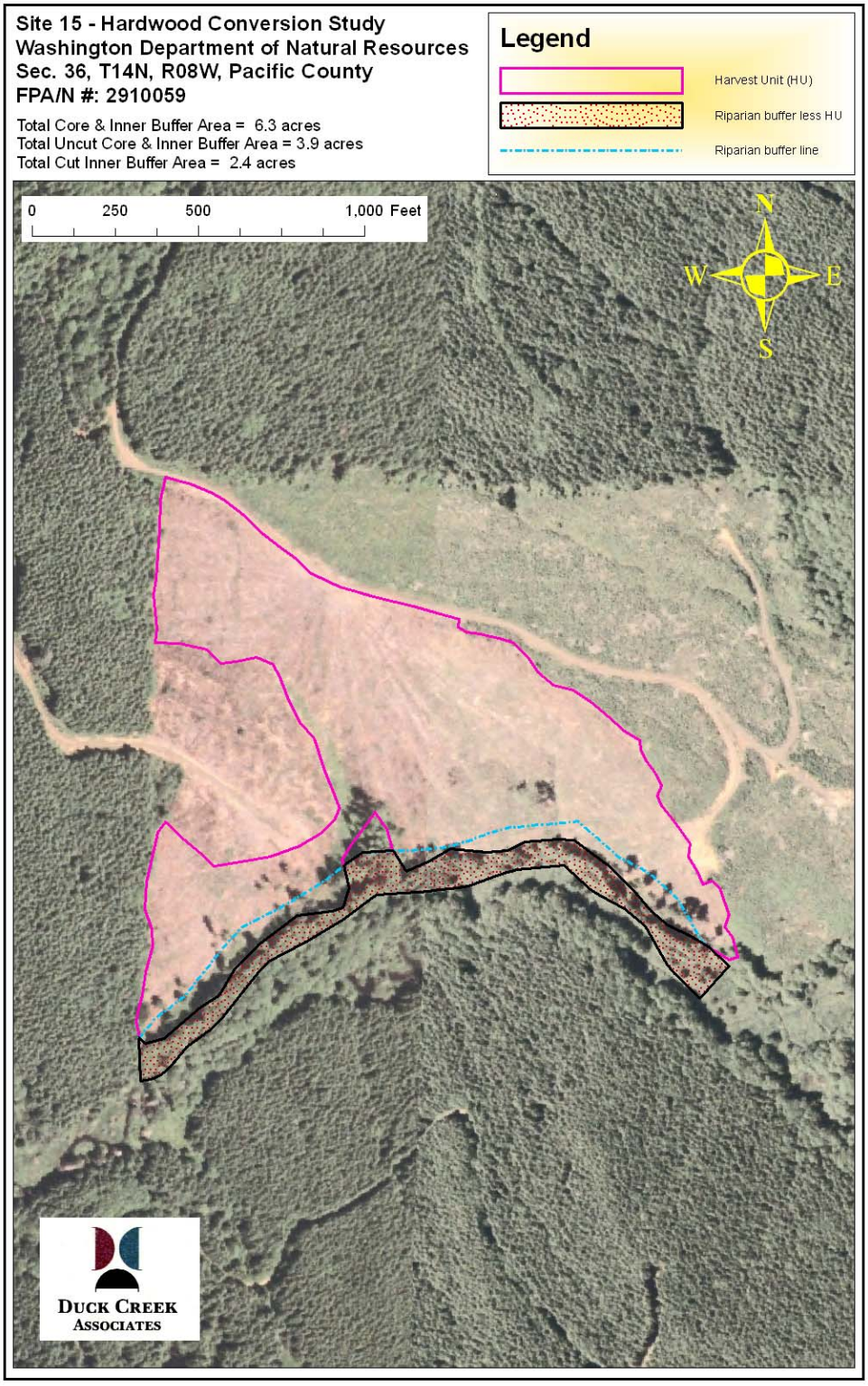
2.7.2 Duck Creek Associates Activities Timeline

During the Summer of 2002, Duck Creek Associates conducted an initial site review and recommended that it be selected for inclusion in the study by RSAG. In August 2003, Duck Creek Associates conducted the pre-harvest vegetation and stream metrics surveys. In May 2006, Duck Creek Associates conducted an initial regeneration survey with a

[11] http://www2.ftw.nrcs.usda.gov/osd/dat/L/LYTELL.html

follow-up regeneration survey conducted in March 2007. The post harvest 100% RMZ survey was conducted in February 2007 and the RMZ buffer configuration was GPS mapped in March 2007. In April 2007, the landowner returned the questionnaire. In August 2007, Duck Creek Associates digitized and/or analyzed the GIS data and compiled this report in January 2008.

Figure 7. Site #15 Map.



2.7.3 Pre-harvest Vegetation

2.7.3.1 Pre-harvest Combined Upslope and RMZ Stand Table/Description

The pre-harvest stand statistics are based on harvest cut-out statistics provided by the landowner and give an approximation of the pre-harvest species composition (volume metrics) for the combined upland and RMZ (Table 93). Red alder was the dominant species accounting for 97% of the gross cubic foot volume while Douglas fir accounted for roughly 3% of the gross cubic foot volume (Table 93).

Table 93. Pre-harvest Combined Upslope and RMZ Stand Table Summary.

Group	Species	Cubic Volume[3]/Acre		Board Feet/Acre	
		Gross	Net	Gross	Net
Live	Red Alder	3,982	3,980	16,368	15,614
	Douglas fir	120	120	689	664
	Other Hardwoods	9	9	29	29
	Western redcedar	5	5	22	22
	Sitka spruce	4	4	22	17
	Western hemlock	3	3	3	12
Totals		**4,123**	**4,121**	**17,142**	**16,359**

[1] In feet

2.7.3.2 Pre-harvest RMZ Stand Table/Description

In the pre-harvest RMZ, red alder was the dominant species accounting for 89% of the live tree basal area and 86% of the live tree gross cubic foot volume (Table 94). Douglas fir, western hemlock, and Sitka spruce were all minor contributors to species composition. Combined, however, these conifer species accounted for 11% of the live tree basal area and 14% of the live tree gross cubic foot volume in the pre-harvest riparian stand (Table 94).

Table 94. Pre-Harvest RMZ Stand Table Summary.

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Red Alder	0.3	7.0	0.1	34.9	0.2		0.0	
Snag Totals		**0.3**	**7.0**	**0.1**	**34.9**	**0.2**		**0.0**	
Live	Red alder	123.0	13.4	135.1	82.8	3947.4	3604.0	16196.8	14769.4
	Douglas fir	3.8	26.0	15.4	122.8	633.2	593.7	3206.3	3005.1
	Sitka Spruce	1.0	10.8	0.7	43.5	12.1	11.5	31.7	30.2
	Western hemlock	0.3	12.5	0.3	52.0	6.8	6.5	22.2	21.1
	Cascara	0.2	6.0	0.0	49.9	0.0	0.0	0.0	0.0
Live Totals		**128.3**		**151.5**		**4599.5**	**4215.7**	**19457.1**	**17825.8**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet

[3] In feet – Trees Per Acre weighted average

2.7.3.3 Pre-harvest RMZ Vegetation Description

Table 95 displays major vegetation species in the pre-harvest RMZ, by percent cover and average height. This data was compiled using pre-harvest vegetation survey data collected in August 2003 (see footnote 1 in section 1.5 – Methods).

Table 95. Pre-harvest RMZ vegetation.

Species	%Cover	Height (Ft)
Grasses/Sedges	27.9%	1.5
Western swordfern	27.4%	3.9
Trailing blackberry	14.3%	<1
Vine maple	7.9%	13.4
Salmonberry	6.1%	4.0
Oregon oxalis	5.5%	<1

2.7.4 Applied Harvest Prescription

2.7.4.1 Site Lay-out and Road Construction/Maintenance Description

This site consisted of one contiguous harvest unit (cutting block) of approximately 33 acres in size. The study reach was buffered with a 25-foot wide no-cut zone, measured from bank-full width, which was marked with paint and flagging. Conifers were retained in the core and inner zones, and additional conifers were left as needed to meet outer zone riparian leave tree requirements. All conifers retained outside of the 25-foot no-cut zone were marked individually with paint. There was no new road construction or reconstruction allocated to this harvest operation as road construction and betterment work done in adjoining harvest areas a few years prior to this operation accommodated the harvesting needs at this site. According to information provided by the landowner, 8 person hours were required to permit the harvest operation and 12 person hours were required to conduct lay-out activities.

2.7.4.2 Schedule of Activities

The Forest Practices Application for this site was approved in August 2004. Harvesting activities were initiated on October 20, 2004 and were completed on March 3, 2005. The RMZ and near-riparian zone was initially planted in Spring 2005. In August 2005, an aerial herbicide site preparation treatment was applied to the upland (non-RMZ). In December 2005, mountain beaver were trapped in both the upland and RMZ. The initial planting of the upland occurred in February 2006.

2.7.4.3 Yarding/Logging Description

The entire unit (100%) was logged with a highlead cable system.

2.7.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 539.86 MBF (net scribner scale) of sawlog material (Table 96). The estimated area of the upland and RMZ combined is 33 acres.

Table 96. Combined upland and RMZ net harvest volume (33 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red alder	515.27	15.61	95.4%
Douglas fir	21.92	0.66	4.1%
Other Hardwoods	0.97	0.03	0.2%
Western redcedar	0.72	0.02	0.1%
Sitka spruce	0.57	0.02	0.1%
Western hemlock	0.40	0.01	0.1%
Total	**539.86**	**16.36**	

[1] Thousand board feet

2.7.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced an estimated 24.7 MBF (net scribner scale) of sawlog material and approximately 16 tons of chipwood material (Table 97). The estimated harvest area in the RMZ is 2.4 acres (Figure 7).

Table 97. RMZ net harvest volume (2.4 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red alder	22.33	10.14	98.7%
Douglas fir	0.33	0.14	1.3%
Total	**24.66**	**10.28**	

[1] Thousand board feet

2.7.6 Key Harvest Operation Findings and Challenges

In the questionnaire, Weyerhaeuser noted that this site was an excellent candidate for hardwood conversion due to productive logging and good alder grade recovery. Additionally, there were few residual conifers in the RMZ which made this unit easier to lay-out (i.e., there were fewer conifers outside the 25-foot no-touch zone to individually mark) and there were few conifer "obstacles" to log around.

2.7.7 Harvest Economics

The estimated stumpage value for the RMZ harvest was $8,416. The indicated Forest Excise tax amount was $421. Using 2.4 acres as the area of harvest in the RMZ, Table 98 displays the per acre calculated stumpage value for the RMZ.

The indicated stumpage value for the upland harvest was $168,092. The indicated Forest Excise tax amount was $8,404. Using the indicated area of 30.6 acres in the upland, Table 98 displays the per acre calculated stumpage value for the upland.

The estimated gross stumpage value of the harvest for the entire 33 acre unit was $176,508. The indicated Forest Excise tax amount was $8,825. Using 33 acres as the area basis, Table 98 displays the per acre calculated stumpage value for the combined upland and RMZ harvests.

Table 98. Harvest stumpage values in dollars per acre.

Cost/Revenue	RMZ (2.4Acres)	Upland (30.6 Acres)	Combined RMZ/Upland (33 Acres)
	$/Acre	$/Acre	$/Acre
Stumpage Value	3,506.67	5,493.20	5,348.73
Harvest Taxes	(175.42)	(274.64)	(267.42)
Net Stumpage Value	**3,331.25**	**5,218.56**	**5,08131**

2.7.8 Regeneration Prescription

2.7.8.1 Site Preparation and Brush Control

2.7.8.1.1 Upland

At this site, site preparation techniques consisted of a ground spray herbicide treatment. This treatment included the application of three herbicides (Accord Concentrate. Chopper, and Oust Extra) applied with backpack sprayer in August 2005. Accord Concentrate was applied at a rate of 48 ounces per acre, Chopper at 8 ounces per acre, while Oust Extra was applied at a rate of 4 ounces per acre. According to the landowner, the reported cost of this application was $104 per acre.

2.7.8.1.2 RMZ

Prior to planting, there was no RMZ site preparation work. To date, there have been no brush control treatments either.

2.7.8.2 Planting Schedule/Description

2.7.8.2.1 Upland and RMZ Combined

The area immediately above the interface between the retention buffer and the harvested portion of the site was initially planted in the 1st quarter of 2005. This planting occurred mostly in the RMZ but likely also included some upland. The landowner does not have accurate records of this planting and no figures or costs were reported. Western hemlock, and possibly other shade tolerant conifer species, were planted and it is assumed that trees were planted at a density of 435 trees per acre (TPA).

In February 2006, the entire harvest unit was planted. This was the initial planting in the upland and it appears that RMZ inter-planting also occurred at this time. According to the landowner, genetically improved Douglas fir 1+1 stock was planted in the upland and RMZ at a target density of 435 TPA. The reported cost was $209 per acre, including

planting stock and contractor labor. Table 99 displays the planting stock list provided by the landowner for the February 2006 planting.

Table 99. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA[1])
February 2006	Douglas fir	Improved	1+1	14,000	435

[1] Trees Per Acre

2.7.8.3 Animal Control Strategies/Descriptions

2.7.8.3.1 Upland and RMZ Combined

Animal control in both the upland and RMZ consisted of trapping for mountain beaver in December 2005 at a reported cost of $27 per acre.

2.7.8.4 Key Reforestation Findings and Challenges

At this site, Weyerhaeuser chose a strategy of planting the RMZ (and near-RMZ areas) with shade tolerant conifer species soon after harvesting was completed and one planting season prior to planting the upland. This was done because site preparation tool options are limited here (i.e., herbicides use is restricted). The hope is that the earlier planting would allow the seedlings an extra growing season to out-compete the untreated vegetation in the area.

Additionally, the landowner expressed concerns about the difficulty of regenerating RMZ's. Because the options available for site preparation and brush control are limited here, they feel they would have greater success if the application of chemical herbicides was allowed within the core zone.

2.7.9 Regeneration Economics

Table 100 summarizes reforestation costs at this site in the upland and RMZ.

Table 100. Upland and RMZ Regeneration Costs.

Activity	Date	Upland Cost per acre	RMZ Cost per acre
Planting	*1st Quarter 2005*	-	*$209.00*
Site Preparation (Ground Spray)	8/2005	$104.00	-
Animal Control (Trapping)	12/2005	$27.00	$27.00
Planting	2/2006	$209.00	-
Inter-planting	*2/2006*	-	*$104.50*
Totals (For Final)			

2.7.9.1 Regeneration Economics Cost Assumptions

Planting in the RMZ during the 1st quarter of 2005 is assumed to have cost the same as planting the upland in February 2006.

Inter-planting in the RMZ in February 2006 is assumed to have cost 50% of the initial upland planting cost.

2.7.10 Post-harvest Vegetation

2.7.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting accounted for a 39% reduction in the number of trees per acre, a 28% reduction in basal area per acre, and 24% reduction in gross cubic foot volume per acre (as is indicated by Table 101 under the "Cutting" group). Compared to the pre-harvest conditions, disturbance accounted for a 4% reduction in trees per acre, a 2% reduction in basal area and gross cubic foot volume per acre (as is indicated by Table 101 under the "Fallen/Windthrow" group).

Table 101. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	50.0	11.8	41.6	78.4	1,103.2	1,048.1	4,396.8	4,177.0
	Douglas fir	0.2	20.8	0.4	112.5	13.2	12.6	55.6	52.8
	Cutting Totals	**50.2**		**42.0**	**190.9**	**1,116.4**	**1,060.6**	**4,452.4**	**4,229.8**
Fallen/ Windthrow	Red alder	1.6	14.0	1.9	84.8	54.2	51.5	217.5	206.6
	Sitka spruce	0.2	11.0	0.1	58.1	2.0	1.9	4.8	4.5
Fallen/Windthrow Totals		**1.7**		**2.0**	**142.9**	**56.2**	**53.4**	**222.2**	**211.1**

[1] DBH = diameter (in inches) at breast height – trees per acre weighted average
[2] In square feet
[3] In feet – trees per acre weighted average

2.7.11 Post-harvest RMZ Stand Table/Description

As compared with pre-harvest conditions, in terms of species distribution, conifer species contribute more to the retained RMZ stand following harvest, which was expected since hardwoods were targeted for removal. Post-harvest, however, red alder still remains the dominant species, by far. Post harvest, conifer species account for 15% of the live tree basal area and 19% of the gross cubic foot volume per acre (versus 11% and 14%, respectively) in the pre-harvest stand. Table 102 displays the residual post-harvest stand table.

Table 102. Post-harvest Stand Table Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Red alder	1.6	9.3	0.9	46.4	3.0		8.4	
	Snag Totals	**1.6**	**9.3**	**0.9**	**46.4**	**3.0**		**8.4**	
Live	Red alder	70.2	14.6	90.8	86.2	2,780.7	2,533.5	11,506.3	10,466.9
	Douglas fir	3.7	26.2	15.0	123.2	619.9	581.3	3,150.8	2,953.0
	Sitka spruce	0.8	10.8	0.6	40.6	10.1	9.6	27.0	25.6
	Western hemlock	0.3	12.5	0.3	52.0	6.8	6.5	22.2	21.1
	Cascara	0.2	6.0	0.0	49.9	0.0	0.0	0.0	0.0
	Live Totals	**75.1**		**106.7**		**3,417.5**	**3,130.9**	**14,706.3**	**13,466.6**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.7.12 RMZ Regeneration Survey Data

Table 103 displays a summary of compiled data from the initial regeneration survey conducted in the RMZ in May 2006 (following initial planting). Table 104 displays a summary of the second regeneration survey conducted in the RMZ in March 2007.

Table 103. Initial RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2005	Western hemlock	Planted	139.5	0.0	0.0	2.3	87%
	Douglas fir		136.8	0.0	0.0	1.2	80%
	Total Planted		**276.3**	**0.0**	**0.0**	**1.7**	
	Douglas fir	Dead/Dying	13.2	0.0	0.0	0.9	13%
	Total Dead/Dying		**13.2**	**0.0**	**0.0**	**0.9**	
	Cascara	Natural	23.7	1.1	0.4	9.0	40%
	Western hemlock		2.6	0.0	0.0	1.0	59%
	Total Natural		**26.3**	**1.0**	**0.4**	**8.2**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

Table 104. Second RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2006	Western hemlock	Planted	134.2	0.1	0.0	2.7	85%
	Douglas fir		126.3	0.0	0.0	1.4	83%
	Total Planted		**260.5**	**0.1**	**0.0**	**2.1**	

Western hemlock	Dead/Dying	5.3	0.0	0.0	1.8	0%
Total Dead/Dying		**5.3**	**0.0**	**0.0**	**1.8**	
Cascara	Natural	13.2	1.4	0.2	12.6	58%
Western hemlock		7.9	0.0	0.0	1.4	69%
Sitka spruce		2.6	0.0	0.0	1.3	88%
Total Natural		**23.7**	**0.8**	**0.2**	**7.6**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.7.13 RMZ Vegetation and Planting Site Condition Description

Table 105 displays the occurrence of the major vegetation species observed at the time of the initial regeneration survey (May 2005) and second regeneration survey (March 2007).

Table 105. Initial (2005) and Secondary (2006) Post-harvest RMZ Vegetation Survey Summary.

Growth Year	Species	% Cover	Height (ft.)
2005	Western swordfern	25.8	4.4
	Grasses/Sedges	23.4	1.4
2006	Western swordfern	32.9	2.5
	Grasses/Sedges	27.4	1.3
	Trailing blackberry	11.6	1.4

2.7.14 Economic Analysis (for final compiled report)

3. Bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site
4. Summarize cost and revenues assumptions

Example

Table 106. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	5,218.56	
Regeneration		
Administration		
Net Income		

Example

Table 107. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	3,331.25	
Regeneration		

Administration

Net Income

Assumptions:

2.7.15 Discussion and Key Findings (for final compiled report)

4. Summary of regeneration strategy, and evaluation of its success or failure at this site
5. Lesson(s) learned from hardwood conversion
6. Relevant/interesting results not presented earlier in document

2.8 Site #23 (FPA/N # 2606200)

2.8.1 Site Identification and Description

2.8.1.1 Landowner Profile

With forestry offices in Washington State and Oregon but headquartered in Poulsbo, Washington, Pope Resources (and its subsidiaries) is a publicly traded Master Limited Partnership that has a 150 year heritage as a land and timber owner in the Pacific Northwest. Today, Pope Resources has three primary business segments (fee timber, timberland management and consulting, and real estate), manages over 1.5 million acres of investment-grade timberland, and assets include 115,000 acres of productive timberland and nearly 3,000 acres of development property, most of which is within a 50-mile radius of Seattle.

2.8.1.2 Factors Leading to Hardwood Conversion

Pope Resources notes that they consider riparian hardwood conversion options when harvesting units near streams. However, Pope Resources noted that when they initially designed this hardwood conversion, they had no idea if the financial benefit would outweigh the extra work associated with the conversion option. At this site, they believe that the financial benefit will be worth the extra effort and fits with their management and stewardship goals. However, they also note that future hardwood conversions with be reviewed on a case-by-case basis. Pope Resources participated in this study because they had an interest in establishing conifer in the RMZ and they were interested in collecting data from their own property.

2.8.1.3 Location

This hardwood conversion study site ("CMER Research Site #23) is located on the Toandos Peninsula in Washington State's Jefferson County, East-Northeast of the town of Quilcene in a portions of Sections 12 and 13, Township 27 North, Range 01 West, Willamette Meridian.

2.8.1.4 Topography and Climate

Elevation in the harvest unit ranges from 121 to 377 feet and receives, on average, 55.24 inches of precipitation per year. Most of the precipitation falls from November through March in the form of rain with an average annual snowfall of 7.4 inches. Climate data comes from the National Weather Service's Cooperative Station Network, Quilcene 2 SW station[12] (456846) located in Quilcene, Washington. Values are reported as annual mean monthly data from 1948-2007.

2.8.1.5 Stream Description

Numerous (18) stream segments were associated with this harvest. However, only one stream segment (Thorndyke Creek segment 1) is associated with this hardwood conversion study. The Thorndyke Creek stream segment is classified by the DNR as

[12] National Weather Service station accessed online at http://www.wrcc.dri.edu/summary/Climsmwa.html.

Type 3 water and fish were found in it. Forest practices protocols were used for determination of stream typing physicals while fish presence/absence was determined using an electrofisher. Work was completed April 2nd through the 11th, 1999. The in-unit stream study segment length is approximately 3,100 feet, stream bankfull width averages 21.4 feet, and the stream gradient averages 1.5%.

2.8.1.6 Unit Description

Situated east-northeast of Quilcene, Washington, the harvest area consisted of several cutting blocks (units) totaling approximately 70 acres (according to Pope Resources). The hardwood conversion study stream segment ran from north to south, dissecting several of the harvest units. Figure 8 displays a map of the harvest area.

2.8.1.7 RMZ Description

The regulatory RMZ width for the study stream segment was 90 feet while the "management RMZ" width was 68 feet (Table 108), of which, 50 feet represented the core zone and 18 feet represented the inner zone (Figure 8). This site is unique in that not all conversion RMZs were included in survey efforts as part of this study. The survey efforts at this site included only what is delineated as Thorndyke Creek Stream Segment 1, as identified in the FPA-N, which has an estimated study reach management RMZ that covered 9.1 acres[13]. (Figure 8). Within the 9.1 acre study segment, an estimated 2.6 acres was harvested, resulting in an estimated retention buffer that covered 6.5 acres (Figure 8). At this site, the no-cut RMZ buffer was 25 feet in width. Conifer in the core and inner zones were retained, and where possible, all hardwoods upland from the 25 foot RMZ were harvested, and additional conifers were left as needed to meet outer zone requirements. The landowner also noted that small wetland areas adjacent streams were buffered in excess of 25 feet. Slopes within the study RMZ averaged 8% and ranged from flat to 45%. Figure 8 displays the location of the study reach within the harvest area and the resulting buffer configuration.

Table 108. Site #23 riparian management zone (RMZ) widths.

Stream Segment	Site Class	RMZ width	Stream Width	Management RMZ Width (Core plus Inner zone)
Thorndyke Creek Segment 1	V	90'	>10'	68'

2.8.1.8 Soil Description

Soils in the research segment are varied and include Belfast silty clay loam (wet variant; Bm), Mukilteo peat (moderately shallow variant; Mu), and Alderwood gravelly, sandy loam (0-15% slopes; Alc). The Belfast soil variant is typically found on floodplains with slopes of 1 to 2 percent, is typically poorly drained, and parent material consists of alluvium. The Mukilteo soil variant is typically found on depressions with slopes of 0 to 1 percent, is not flooded but are frequently ponded, typically very poorly drained, and organic matter in the surface horizon is about 30%. The Alderwood soil variant is found

[13] Based on information provided in the FPA-N, we estimate that the total combined Core and Inner Zone area, for all converted stream segments, was approximately 29.2 acres, of which an estimated 10.0 acres was cut.

on terraces, is not flooded or ponded, parent material consists of basal till with a component of volcanic ash in the upper part, and is moderately well drained. Soil descriptions come from the Natural Resources Conservation Service's Soil Data Mart website[14]. The generalized site productivity class at this site, as defined by official Forest Practices maps, is Site Class V.

2.8.2 Duck Creek Associates Activities Timeline

During the Summer of 2002, RSAG staff members conducted an initial site review and recommended that it be selected for inclusion in the study. In September 2003, Duck Creek Associates conducted the pre-harvest vegetation and stream metrics surveys. In May 2006 the initial regeneration survey was conducted in the study RMZ. In May 2007 the post harvest 100% RMZ survey was completed, the second follow-up regeneration survey was conducted, and the buffer configuration was GPS mapped. In August 2007, the landowner returned the questionnaire. In September 2007, Duck Creek Associates digitized and/or analyzed the GIS data.

[14] http://soildatamart.nrcs.usda.gov/

Figure 8. Site #23 North Map.

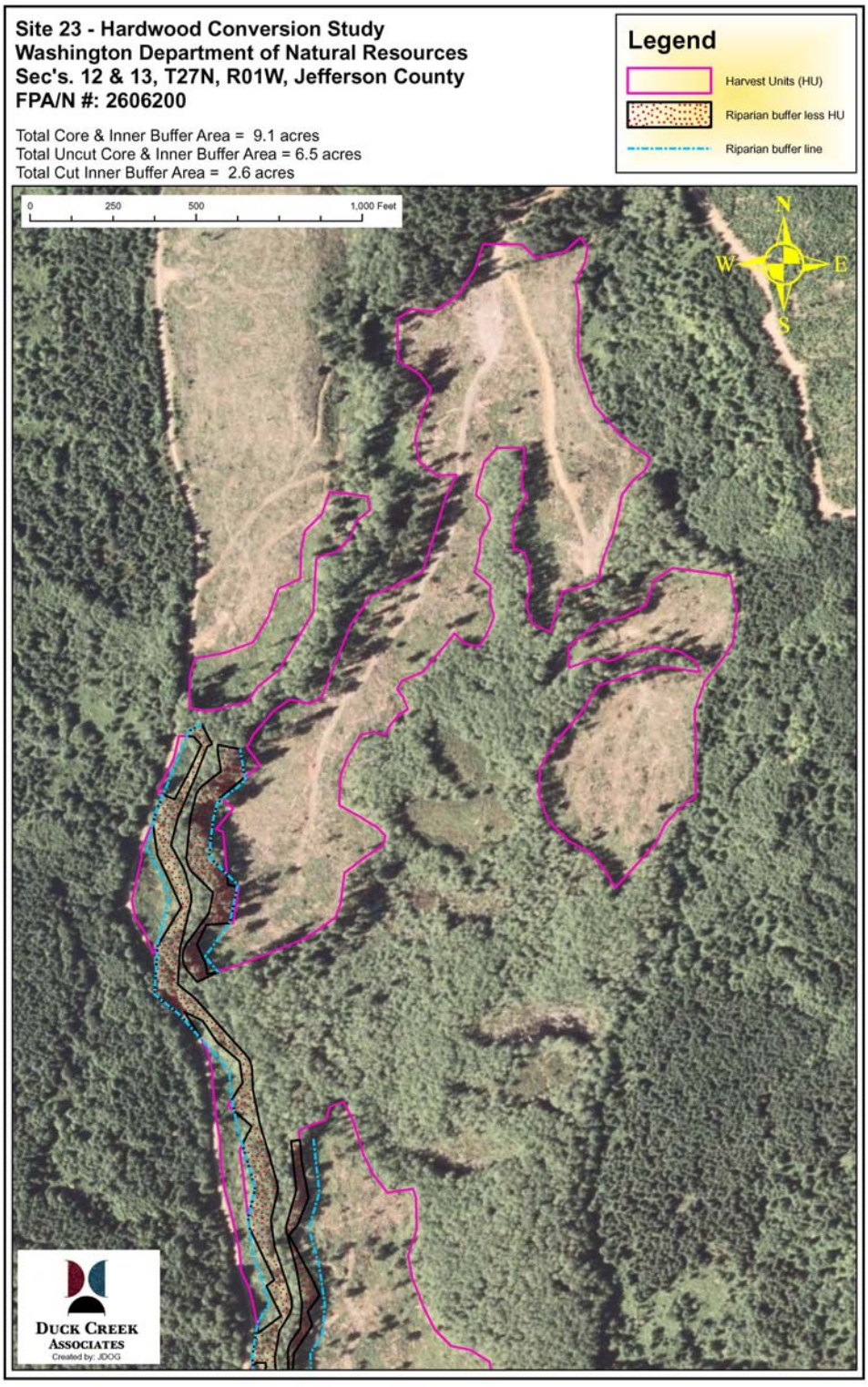
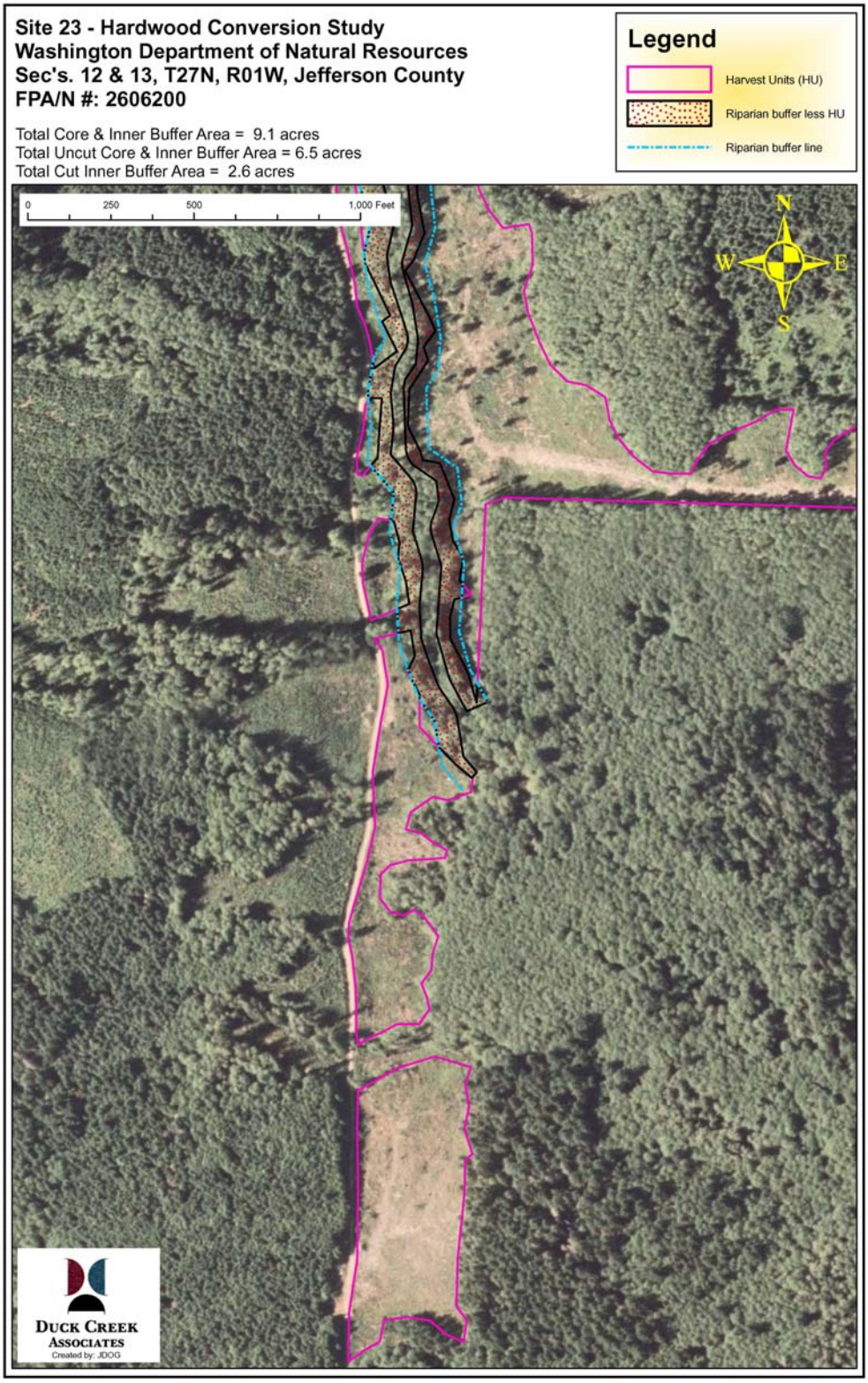


Figure 9. Site #23 South Map.



2.8.3 Pre-harvest Vegetation

2.8.3.1 Pre-harvest Combined Upslope and RMZ Stand Table/Description

The pre-harvest stand statistics were not available for the upland at this site. Total harvest volume statistics provided for the combined upland and RMZ, however, provide an approximation of the species distribution found at this operation pre-harvest (see Table 111 in the Combined Harvest Volume section of this report).

2.8.3.2 Pre-harvest RMZ Stand Table/Description

In the pre-harvest RMZ, red alder was the dominant species accounting for 83% of the live tree basal area and live tree gross cubic foot volume (Table 109). Douglas fir, western hemlock, Western redcedar, Western hemlock, Sitka spruce and grand fir were all minor contributors to species composition. Combined, however, these conifer species accounted for 11% of the live tree basal area and 12% of the live tree gross cubic foot volume in the pre-harvest riparian stand (Table 109).

Table 109. Pre-Harvest RMZ Stand Table Summary.

Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Cubic Volume[3]/Acre		Board Feet/Acre	
						Gross	Net	Gross	Net
Snag	Western redcedar	0.1	59.0	2.1	294.4	19.5		118.9	
	Douglas fir	0.2	54.0	3.5	269.5	31.5		61.9	
	Red alder	2.7	11.7	2.3	58.5	6.6		21.1	
	Big-leaf maple	0.2	6.5	0.1	32.4	0.1		0.0	
Snag Totals		**3.3**		**7.9**		**57.7**		**202.0**	
Live	Red alder	124.7	15.0	166.1	91.4	5,338.6	4,943.6	22,280.2	20,600.3
	Douglas fir	2.3	17.8	6.2	91.3	269.3	255.1	1481.3	1402.8
	Big-leaf maple	8.1	14.0	10.5	73.7	284.5	260.8	1092.3	998.4
	Western redcedar	2.9	19.9	8.2	68.1	240.8	226.7	976.9	920.9
	Western hemlock	4.8	13.1	5.4	66.5	169.6	160.3	684.6	647.7
	Sitka spruce	1.1	18.5	2.8	70.0	101.2	95.7	465.9	440.8
	Grand fir	0.1	21.0	0.3	99.9	9.3	8.8	37.4	35.5
	Cascara	0.1	13.0	0.1	91.7	3.3	3.1	13.2	12.0
Live Totals		**144.2**		**199.5**		**6,416.6**	**5,954.1**	**27,031.9**	**25,058.5**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.8.3.3 Pre-harvest RMZ Vegetation Description

Table 110 displays major vegetation species in the pre-harvest RMZ, by percent cover and average height. This data was compiled using pre-harvest vegetation survey data collected in August 2003 (see footnote 1 in section 1.5 – Methods).

Table 110. Pre-harvest RMZ vegetation.

Species	%Cover	Height (Ft)
Salmonberry	42.4%	5.8
Western swordfern	38.9%	4.0
Vine maple	14.9%	14.2

2.8.4 Applied Harvest Prescription

2.8.4.1 Site Lay-out and Road Construction/Maintenance Description

This site consisted of numerous harvest units (cutting blocks) totaling approximately 62.7 acres in size[15]. The study reach was buffered with a 25-foot wide no-cut zone, measured from bank-full width, which was marked using tags and flagging. Conifers were retained in the core and inner zones, and additional conifers were left as needed to meet outer zone riparian leave tree requirements. Conifers retained outside of the 25-foot no-cut zone were marked individually with flagging, if scattered, or with tags and flagging, if in well-defined clumps. A total of 1,950 feet of new road construction was allocated to this harvest operation. According to information provided by the landowner, 32 person hours were required to permit the harvest operation and 80 person hours were required to conduct lay-out activities. The large harvest unit perimeter at this site, including RMZ and forested wetland classification and delineation, was identified as a significant factor in the time required to lay-out this site. In particular, the thick brush and undergrowth found along the streams at this site necessitated additional on-the-ground marking (more frequently spaced) so that harvest operators could easily follow unit boundary and retention tree delineations.

2.8.4.2 Schedule of Activities

The Forest Practices Application for this site was approved in August 2004. Harvesting activities were initiated on August 20, 2004 and were completed on October 8, 2005. The RMZ and near-riparian zone was initially planted in January 2005. According to information provided by the landowner, no costs were allocated directly to site preparation prior to planting and there were no brush or animal control treatments.

2.8.4.3 Yarding/Logging Description

The entire unit (100%) was logged using ground-based equipment (tractor and shovel) and was mostly machine-felled.

2.8.5 Combined Harvest Volume (Upland and RMZ)

Harvesting at this site produced a total of 1,259.6 MBF (net scribner scale) of sawlog material and approximately 3,391 tons of chipwood material (Table 111). The area of the combined upland and RMZ used to report per acre volumes is 62.7 acres[15].

[15] 62.7 acres is based on Duck Creek Associates' GIS analysis. 70.2 acres was reported by the landowner.

Table 111. Combined upland and RMZ net harvest volume (62.7 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Douglas fir	615.32	9.81	48.8%
Red alder	584.72	9.33	46.4%
Western hemlock	31.78	0.51	2.5%
Western redcedar	24.03	0.38	1.9%
Big-leaf maple	3.12	0.05	0.2%
Silver fir	0.64	0.01	0.1%
Total	**1,259.61**	**20.09**	

[1] Thousand board feet

2.8.5.1 RMZ Harvest Volume

Harvesting in the RMZ produced an estimated 66.9 MBF (net scribner scale) of sawlog material and approximately 40 tons of chipwood material (Table 112). The estimated harvest area in the RMZ is 2.6 acres (Figure 8).

Table 112. RMZ net harvest volume (2.6 Acres).

Species	Net Volume Harvested (MBF[1])	Net Volume Harvested (MBF/Acre)	Percent of Total
Red alder	63.31	24.35	94.7%
Big-leaf maple	1.58	0.61	2.4%
Western hemlock	1.45	0.56	2.2%
Douglas fir	0.38	0.15	0.6%
Western redcedar	0.16	0.06	0.2%
Total	**66.88**	**25.72**	

[1] Thousand board feet

2.8.6 Key Harvest Operation Findings and Challenges

In the questionnaire, Pope Resources noted that the large amount of harvest unit perimeter to delineate and mark, along with the brushy conditions found at this site, added to the time required to lay out the units. Additionally, Pope Resources did not anticipate the large number of site meetings with state regulatory officials for permitting.

2.8.7 Harvest Economics

The estimated stumpage value for the RMZ harvest was $23,230. The indicated Forest Excise tax amount was $1,162. Using 2.6 acres as the area of harvest in the RMZ, Table 113 displays the per acre calculated stumpage value for the RMZ.

The indicated stumpage value for the upland harvest was $463,154. The indicated Forest Excise tax amount was $23,157. Using the indicated area of 60.1 acres in the upland, Table 113 displays the per acre calculated stumpage value for the upland.

The estimated gross stumpage value of the entire harvest unit (upland and RMZ) was $486,384. The indicated Forest Excise tax amount was $24,319. Using 62.7 acres as the area basis, Table 113 displays the per acre calculated stumpage value for the combined upland and RMZ harvests.

Table 113. Harvest stumpage values in dollars per acre.

Cost/Revenue	RMZ (2.6 Acres)	Upland (60.1 Acres)	Combined RMZ/Upland (62.7 Acres)
	$/Acre	$/Acre	$/Acre
Stumpage Value	8,934.62	7,706.39	7,757.32
Harvest Taxes	(446.92)	(385.31)	(387.86)
Net Stumpage Value	**8,487.70**	**7,321.08**	**7,369.46**

2.8.7.1 Harvest Economic Assumptions/Limitations

The upland harvest economic figures reported above include volume, values, and area for RMZ that are outside the study reach RMZ. The typical method used to reconcile a condition like is to expand volume and values from similar stands that have been sampled, into like un-sampled stands. The non-study RMZs, however, are unlike the study RMZ or the combined upland/RMZ. If the sampled RMZ were used to expand volume and values into the un-sampled RMZ, the effect would be a decreased upland value. Based on photo interpretation, and our knowledge of the site, however, the non-study RMZ areas appear to have more retained conifer. This condition leads use to believe that per acre volumes and values would be less in the non-study RMZ compared to the study RMZ. If these observations are true, this would have the effect of reducing overall RMZ volumes and values and result in greater per acre volume and value in the upland. The formula used to determine the reported upland value was [Combined RMZ/upland value] – [RMZ value] = [Upland value] but has limitations for the reasons stated above.

2.8.8 Regeneration Prescription

2.8.8.1 Site Preparation and Brush Control

According to Pope Resources, there were no costs allocated (or activities reported) to site preparation or brush control activities to date at this site.

2.8.8.2 Planting Schedule/Description

2.8.8.2.1 Upland and RMZ Combined

This site was initially planted in January 2005. According to Pope Resources, a total of 26,720 seedlings were planted at a target density of 435 trees per acre. Douglas fir comprised the majority of the planted species. However, Sitka spruce, Western redcedar,

and grand fir were planted and were allocated primarily to the RMZ. The reported planting cost for Douglas fir seedlings was $0.60 per tree and $0.65 per tree fro Sitka spruce, Western redcedar, and grand fir (these figures include cost of seedlings, contract planting, and planting contract administration. Table 114 displays the planting stock list provided by the landowner for the January 2005 planting.

Table 114. Planting stock list for upland and RMZ combined.

Planting Date	Species	Seed source	Stock type	Total Trees	Target density (TPA)
January 2005	Douglas fir	Native	P + 1	20,180	
	Sitka spruce	Native	P + 1	3,180	435
	Western redcedar	Native	P + 1	2,280	(for all)
	Grand fir	Native	P + 1	1,080	

[1] Trees Per Acre

2.8.8.3 Animal Control Strategies/Descriptions

2.8.8.3.1 Upland and RMZ Combined

Animal control in both the upland and RMZ included the use of mesh tubing to protect some seedlings (mostly Western redcedar) from deer and elk browse. The added costs for these devices was incorporated in the per seedling costs reported by the landowner. However, exact application specifications and quantities were not reported.

2.8.8.4 Key Reforestation Findings and Challenges

At this site, Pope Resources chose a strategy of planting all areas (upland and RMZ) as soon after harvesting as possible. This was done because they felt that site preparation treatment options were limited here (i.e., herbicide use is restricted). Planting as soon as possible after harvest offers seedlings the additional growing season(s) to compete with and hopefully out-perform the untreated vegetation in the area. Shade tolerant species were favored for planting in the RMZ while Douglas-fir was prioritized for planting in the upland.

2.8.9 Regeneration Economics

Table 115 summarizes reforestation costs at this site in the upland and RMZ. Planting costs reported by Pope Resources for the initial January 2005 planting includes planting stock, contract labor, and contract compliance./management.

Table 115. Upland and RMZ Regeneration Costs.

		Upland	RMZ
Activity	Date	Cost per acre	Cost per acre
Planting	*January 2005*	*$259.29*	*$269.45*
Totals (For Final)			

2.8.9.1 Regeneration Economics Cost Assumptions

To address the difference in total conversion RMZ acres versus study RMZ acres and a lack of accurate record keeping for species count allocations for upland versus RMZ, we had to make several assumptions. In the initial planting, we assumed that the average planting density achieved was 426 trees per acre in both upland and RMZ [26,720 total reported trees planted divided by 62.7 acres]. We also assumed that, in RMZ, Douglas fir was planted at a density of 149 TPA [35 percent of species mix planted, as the 2006 RMZ regeneration survey indicates], with shade tolerant species [Sitka spruce, Western redcedar, and Western hemlock] making up the balance in RMZs [277 TPA]. We also assumed that there were 10.0 acres of RMZ altogether, and that any remaining balance of shade tolerant species, not accounted for in RMZs using the above assumptions, were planted elsewhere in the upland portion of the unit.

2.8.10 Post-harvest Vegetation

2.8.10.1 RMZ Stand Depletion

Cutting and disturbance resulting from logging activities (e.g., breakage, tipping, etc.) and natural causes (e.g., wind and weather damage, channel migration, etc.) contributed to RMZ stand depletion. Compared to pre-harvest conditions, cutting accounted for a 30% reduction in the number of trees per acre and basal area per acre and a 32% reduction in gross cubic foot volume per acre (as displayed in Table 116 under the "Cutting" group). Compared to the pre-harvest conditions, disturbance accounted for a 3% reduction in trees per acre, and a 2% reduction in basal area and gross cubic foot volume per acre (as displayed in Table 116 under the "Fallen/Windthrow" group).

Table 116. RMZ Stand Depletions for Cutting and Fallen/Windthrow.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Cutting	Red alder	41.5	15.4	58.1	92.1	1,898.1	1,803.2	7,849.5	7,457.0
	Bigleaf maple	2.0	12.5	2.3	68.8	63.5	60.3	250.5	238.0
	Western hemlock	0.4	21.2	1.1	99.3	40.9	38.9	172.5	163.9
	Douglas fir	0.3	13.3	0.4	86.8	10.5	10.0	44.0	41.8
	Grand fir	0.1	21.0	0.3	99.9	9.3	8.8	37.4	35.5
	Western redcedar	0.4	12.6	0.4	54.5	7.5	7.1	18.7	17.7
Cutting Totals		**44.8**		**62.5**		**2,029.7**	**1,928.2**	**8,372.5**	**7,953.9**
Fallen/ Windthrow	Red alder	3.3	11.9	2.8	83.1	82.0	77.9	338.5	321.5
	Western hemlock	0.5	14.8	0.8	75.6	25.8	24.5	105.5	100.2
	Bigleaf maple	0.1	18.0	0.2	79.9	5.2	5.0	18.7	17.7
	Western redcedar	0.2	9.5	0.1	44.0	1.6	1.5	5.5	5.2
	Sitka spruce	0.1	9.0	0.0	48.3	0.9	0.8	3.3	3.1
	Douglas fir	0.1	8.0	0.0	52.6	0.6	0.5	2.2	2.1
Fallen/Windthrow Totals		**4.4**		**3.9**		**116.1**	**110.3**	**473.6**	**449.9**

[1] DBH = diameter (in inches) at breast height – trees per acre weighted average
[2] In square feet
[3] In feet – trees per acre weighted average

2.8.11 Post-harvest RMZ Stand Table/Description

As compared with pre-harvest conditions, in terms of species distribution, conifer species contribute more to the retained RMZ stand following harvest, which was expected since hardwoods were targeted for removal. Post-harvest, however, red alder still remains the dominant species, by far. Post harvest, conifer species account for 15% of the live tree basal area and 17% of the gross cubic foot volume per acre (versus 11% and 12%, respectively) in the pre-harvest stand. Table 117 displays the residual post-harvest stand table.

Table 117. Post-harvest Stand Table Summary.

2006 Growth Year						Cubic Volume[3]/Acre		Board Feet/Acre	
Group	Species	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Gross	Net	Gross	Net
Snag	Douglas fir	0.2	54.0	3.5	269.5	31.5		203.5	
	Western redcedar	0.1	59.0	2.1	294.4	19.5		127.7	
	Red alder	6.6	12.9	6.5	64.2	20.1		68.3	
	Bigleaf maple	0.2	6.5	0.1	32.4	0.1		0.0	
Snag Totals		**7.1**		**12.2**		**71.2**		**399.5**	
Live	Red alder	76.0	15.0	100.9	91.6	3,225.0	2,921.1	13,400.0	12,124.0
	Douglas fir	1.9	19.1	5.8	94.4	258.2	240.7	1,435.2	1,334.8
	Western redcedar	2.2	22.4	7.6	73.2	232.5	213.5	957.1	878.5
	Bigleaf maple	6.0	14.4	8.1	75.2	215.9	186.9	824.2	708.0
	Sitka spruce	1.0	19.6	2.7	72.4	100.3	92.1	462.6	422.2
	Western hemlock	3.8	11.9	3.5	61.5	102.9	95.4	406.6	377.4
	Cascara	0.1	13.0	0.1	91.7	3.3	2.1	13.2	7.6
Live Totals		**91.1**		**128.8**		**4,138.1**	**3,751.8**	**17,498.9**	**15,852.6**

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.8.12 RMZ Regeneration Survey Data

Table 118 displays a summary of compiled data from the initial regeneration survey conducted in the RMZ in May 2006 (following initial planting; 2005 growth year). Table 119 displays a summary of the second regeneration survey conducted in the RMZ in May 2007 (2006 growth year).

Table 118. Initial RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2005	Sitka spruce	Planted	83.8	0.0	0.0	1.5	93%
	Douglas fir		70.6	0.0	0.0	1.4	91%
	Western redcedar		33.8	0.0	0.0	1.8	70%
	Grand fir		11.8	0.0	0.0	1.3	87%
	Total Planted		**200.0**	**0.0**	**0.0**	**1.5**	
	Bigleaf maple	Natural	44.1	0.0	0.0	3.9	50%
	Red alder		22.1	0.0	0.0	3.9	93%
	Western hemlock		2.9	1.4	0.0	4.9	93%
	Cascara		1.5	0.0	0.0	0.7	75%
	Douglas fir		1.5	2.8	0.1	18.0	63%
	Total Natural		**72.1**	**0.1**	**0.1**	**4.2**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

Table 119. Second RMZ Regeneration Survey Summary.

Growth Year	Species	Group	Trees/ Acre	Average DBH[1]	Basal Area[2]/Acre	Height[3]	Percent live crown
2006	Sitka spruce	Planted	82.4	0.1	0.0	2.5	87%
	Douglas fir		67.6	0.0	0.0	2.5	83%
	Western redcedar		29.4	0.0	0.0	2.1	64%
	Grand fir		11.8	0.0	0.0	2.6	90%
	Total Planted		**191.2**	**0.0**	**0.0**	**2.5**	
	Western redcedar	Dead/Dying	1.5	0.0	0.0	2.3	0%
	Total Dead/Dying		**1.5**	**0.0**	**0.0**	**2.3**	
	Bigleaf maple	Natural	100.0	0.9	0.5	8.9	87%
	Cascara		10.3	0.0	0.0	1.4	67%
	Western hemlock		2.9	0.8	0.0	5.4	68%
	Douglas fir		1.5	2.7	0.1	21.0	39%
	Total Natural		**114.7**	**0.9**	**0.6**	**8.3**	

[1] DBH = diameter (in inches) at breast height – Trees Per Acre weighted average
[2] In square feet
[3] In feet – Trees Per Acre weighted average

2.8.13 RMZ Vegetation and Planting Site Condition Description

Table 120 displays the occurrence of the major vegetation species observed at the time of the initial regeneration survey conducted in May 2006 (2005 growth year) and second regeneration survey conducted in May 2007 (2006 growth year). It is important to note

that the large increase in % cover and height of salmonberry, a major competing shrub, may have a negative impact on seedling growth and survival.

Table 120. Initial (2005) and Secondary (2006) Post-harvest RMZ Vegetation Survey Summary.

Growth Year	Species	% Cover	Height (ft.)
2005	Salmonberry	33.1	4.4
	Western swordfern	16.5	3.8
	Bleeding heart	15.7	1.0
2006	Salmonberry	64.7	5.6
	Western swordfern	13.7	3.7
	Bleeding heart	8.7	1.8
	Stinging nettle	5.4	4.8

2.8.14 Economic Analysis (for final compiled report)

1. Bring together all cost and revenue components and summarize the financial benefit of adding a riparian harvest at this site
2. Summarize cost and revenues assumptions

Example

Table 121. Upland Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	7,321.08	
Regeneration		
Administration		
Net Income		

Example

Table 122. RMZ Harvest Conversion Return Analysis

Cost/Revenue Component	$/Acre	Preliminary Comments
Net Stumpage Value	8,487.70	
Regeneration		
Administration		
Net Income		

2.8.14.1 Assumptions

1) See Harvest Economics section regarding reported net stumpage value for upland.
2) See Regeneration Economics section regarding reported RMZ and Upland regeneration costs.

2.8.15 Discussion and Key Findings (for final compiled report)

1. Summary of regeneration strategy, and evaluation of its success or failure at this site
2. Lesson(s) learned from hardwood conversion
3. Relevant/interesting results not presented earlier in document

3 LITERATURE CITED

Carlton, GC. 1988. *The Structure and Dynamics of Red Alder Communities in the Central Coast Range of Western Oregon*. MS thesis, Oregon State University, Corvallis.

Compton, JE, MR Church, ST Larned, and WE Hogsett. 2003. Nitrogen export from forested watershed in the Oregon Coast Range: the role of N2-fixing red alder. Ecosystems 6: 773-785.

Deal, R., Mark Wipfli, Adelaide Johnson, Toni De Santo, Paul Hennon and Thomas Hanley (2001). Does red alder enhance wildlife, aquatic, and fisheries resources in young-growth western hemlock-Sitka spruce forests of southeast Alaska? Beyond 2001: a silvicultural odyssey to sustaining terrestrial and aquatic ecosystems. Proceedings of the 2001 National Silviculture Workshop, Hood River, Oregon, USDA Forest Service.

Goldman, CR. 1961. The Contribution of Alder Trees (Alnus tenuifolia) to Primary Productivity of Castle Lake, California. Ecology 42:282-288.

Lavery, JM, PG Comeau, and CE Prescott. 2004. The influence of red alder patches on light, litterfall, and soil nutrient sin adjacent conifer stands. Canadian Journal of Forest Research 34: 56 – 64.

Piccolo, JJ and MS Wipfli. 2002. Does Red Alder (Alnus Rubra) in upland riparian forests elevate macroinvertebrates and detritus export from headwater streams to downstream habitats in southeastern Alaska? Canada J. Aqua. Sci. 59:503-513.