United States Department of Agriculture
Forest Service

Zigzag Integrated Resource Project

Silviculture Specialist Report

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for:
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Executive Summary

This report shows that the proposed action, which includes thinning, group selections and regeneration harvest, to improve forest health, diversity and productivity, aquatic/riparian habitat enhancement and provide forest product complies with direction in the Mt. Hood National Forest Land and Resource Management Plan (hereafter referred to as the Forest Plan) (USDA 1990), as amended and the Record of Decision and Standards and Guidelines for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (hereafter referred to as the Northwest Forest Plan) (USDA 1994). Vegetation management actions are appropriate to move stands in the desired direction in terms of health, growth, productivity and the diversity of habitats in both the short and long term while minimizing effects to other resources. The proposed action was developed to be in full compliance with the National Forest Management Act [1] by meeting Forest Plan standards and guidelines for suitability of the land for timber management, opening size, and reforestation requirements. Cumulative effects would be expected to be unsubstantial. Exceptions to Forest Plan standards and guidelines are needed for FW-306 and 307.

Project Description

A Project Information Sheet was developed to briefly describe the project as well as the purpose and need for action and the proposed actions. The Project Information Sheet can be found here[2].

Methodology

An array of available information and tools were used in the analysis of vegetation treatments for Zigzag. These include the Aerial Insect & Disease Detection Survey data, local and forest-level GIS data, local knowledge, walkthroughs of stands, and collected common stand exam (CSE) data.

CSE data were uploaded into the US Forest Service Field Sampled Vegetation (FSVEG) database and prepared for the Forest Vegetation Simulator (FVS), a forest growth simulation model developed by the US Forest Service. It is an individual tree, distance-independent growth and yield model which can help to answer how vegetation could change in response to proposed management actions. Depending on region or location, different variants use different

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[1] https://www.fs.fed.us/emc/nfma/includes/NFMA1976.pdf

[2] https://www.fs.usda.gov/nfs/11558/www/nepa/112557_FSPLT3_5326056.pdf

assumptions for calculating growth and yield. For Zigzag, the Westside Cascades variant was used (Keyser 2008).

Existing Condition

The treatment units in the Zigzag planning area are made up of three general stand conditions – young plantations, plantations, and fire originated (Table 1).

Table 1 - Age Statistics for Units Proposed for Treatment

Age Condition	Mean Age	Youngest/Oldest	Acres	Percent of Area
Young Plantation	30	28/31	270	11%
Plantation	43	29/74	1104	44%
Fire Originated	82	51/117	1127	45%

The plantations are stands that were replanted following a regeneration harvest. Approximately 270 acres of the proposed treatment area are “young plantations” – plantations that are about 30 years old. Much of the young plantations were precommercially thinned around 2010 but brush, primarily rhododendron, is heavily competing with the planted trees. In many of the stands, western white pine was a component of the planted seedlings and now is experiencing disproportionate mortality due to white pine blister rust infections (*Cronartium ribicola*).

The “plantations” are plantations that are between 29 and 74 years old. Approximately 1,104 acres of plantations have reached a stage in their development where tree growth is slowing due to overcrowding. Many of these stands have some understory tree species component, but they are mainly shade-tolerant species such as western hemlock, Pacific silver fir and western redcedar. In addition, the project area contains about 1,127 acres of forested land that seeded in following a fire approximately 120 years ago. Many of these fire-originated stands also have a heavy component of shade-tolerant understory tree species, namely western hemlock and Pacific silver fir. Both the plantations and fire-originated stands are characterized by densely stocked trees that are now competing for resources such as soil nutrients, water, and sunlight.

A metric used to help indicate the degree of inter-tree competition within a stand is Curtis’ Relative Density (RD) (Curtis 1982). It is based on a stand’s basal area (BA) per unit area and quadratic mean diameter (QMD). Basal area is simply the cross-sectional area of a tree taken at 4.5 feet above ground level, and QMD is the diameter of a tree with average basal area. For a given constant QMD, RD would increase *with an increase* in BA. And for a given constant BA, RD would increase *with a decrease* in QMD. The implication is that higher values of RD would mean that there is a greater degree of competition in the stand. It is expected that with a RD above 50, i.e. above the upper thinning limit, a stand could begin to experience mortality and/or reduced diameter growth (Table 2). Appendix A provides stand-level attributes derived from FVS for stands proposed for treatment, including estimated RD derived from common stand exam data.

Table 2 - Relationships between Standards and Curtis' Relative Density

Standard	Curtis' RD
Maximum	100
Normal	70
Upper Thinning Limit	50
Lower Thinning Limit	35
Crown Closure	20

Diversity within these densely stocked forested stands is also lacking. The lack of structural diversity is evident in plantations as well as fire-originated stands. These stands contain trees of mostly the same age class and with a single canopy later. Plantations, in particular, typically lack species diversity as they were primarily planted with Douglas-fir. In addition, because these stands are densely stocked with trees, little light reaches the forest floor. This has resulted in lower levels of diversity of ground vegetation.

Where these plantations and some of the fire-originated stands occur in Riparian Reserves, the forest is not meeting the desired condition. Riparian Reserves are intended to protect the health of the aquatic system and its dependent species and are to be managed for late-successional forest consistent with the Aquatic Conservation Strategy Objectives. In these land allocations, there is a need to hasten the transition of these stands to a forest with mature characteristics, including a multi-layered canopy with large diameter trees, a well-developed understory, more than one age class, and sufficient quantities of snags and down woody debris.

Where these plantations and fire-originated stands occur in the Matrix land allocation, the forest is not meeting the desired condition. Within the Matrix, the desired condition is to have a mix of seral stages. There is a need to improve forest health within these stands by reducing competition, encouraging growth, and reducing fuels. There is also a need to increase diversity of forest conditions within the Matrix. Maintaining the health and diversity of forested stands in the Matrix is important, as some of the land allocations within the Matrix include timber production.

Desired Future Conditions

Desired Conditions (DFC) describes what a forest in a planning area should be like given the implementation of management direction. In Zigzag there are different existing stand conditions with their respective proposed actions to meet their DFC's.

Where these plantations and fire-originated stands occur in the Matrix allocation, the desired condition is to have live productive forest stands that can provide wood products now and in the future (Northwest Forest Plan on page 26 and Forest Plan on pages Four-3, Four-26 & Four-289).

Where these plantations and fire-originated stands occur in the Riparian Reserve allocation, the desired condition is to have a multi-layer canopy with large diameter trees, well-developed understory, more than one age class, and sufficient quantities of snags and down woody debris (Northwest Forest Plan on page C-32 and Forest Plan on page Four-67).

Environmental Consequences

Effects of No Action

If no action were taken, stands would continue on their current trajectory and current conditions would be maintained with little change to forest structure, competition, density, and ecological processes. Trees would continue to grow in height to capture available sunlight with little diameter growth. The stands would remain dense except for small canopy gaps caused by mortality of individual or small groups of trees. When openings do occur, the adjacent trees are at an increased risk of windthrow due to a high height to diameter ratio (Tappeiner 2007). Growth rates would decrease and mortality rates would increase due to high density levels.

Diversity within these densely-stocked forested stands would continue to be lacking for longer periods. Structural diversity would continue to be maintained as a single-canopy layer with only one age class. Due to closed canopies, shade tolerant species, such as western hemlock and Pacific silver fir, would be the most abundant regeneration present; however, due to the high tree density, much of this regeneration would not able to compete for resources. Herb and shrub cover would continue to be scarce.

Where currently present, dwarf mistletoe infection would continue to infect regenerating trees in the understory. Natural regeneration is generally of those species that are susceptible to dwarf mistletoe. These trees would continue to reduce in vigor, have decreased growth rates, and grow into poor, contorted forms with brooms. Any understory tree would continue to or become infected as dwarf mistletoe seeds continue to drop down from overstory trees. Existing rhododendron continues to reduce the establishment of grass, herb, forb and shrubs.

And with western hemlock continuing to die from dwarf mistletoe canopy cover would only decrease and would only allow additional dense rhododendron brush to establish.

Non-native white pine blister rust would continue to persist on infected trees in stands where they are located. Generally the infections start on branches and needles of the tree as passed on by alternate hosts (*Ribes spp.*) and travel to the stem of host trees. Once at the stem the infection girdles the tree over time and increases its likelihood of dying. These trees would no longer be able to become mature trees, and as they succumb to the effects of the disease their numbers become reduced which decreased species diversity in stands where they are located.

For those units within the Matrix land allocation, no forest products would be available for local economies.

Direct and Indirect Effects of Proposed Action

Improve Forest Health, Growth and Diversity: Variable-Density Thinning

A variable-density thinning approach would be implemented to treat these stands. Variable-density thinning could increase spatial heterogeneity in stand density and tree growth as well as heterogeneity in understory vegetation within stands (Harrington 2005). By inducing fine-scale variation in these otherwise homogeneous stands, variable-density thinning can promote biological and structural heterogeneity in the short term which can promote habitat while providing forest products.

"Skips" are areas skipped over during harvest operations and where snags, downed logs and any ground vegetation could be more protected. If snags are of operational concern they could be fallen to increase safety. "Gaps" are small openings created to encourage and enhance understory vegetation development. Gaps could also be used to encourage the development of a new cohort and age class of trees. The size and number of skips and gaps would depend on the land allocation in which they are located (Table 3).

Table 3 - Skips and Gaps for Northwest Forest Plan Land Allocations

Land Allocation	% Unit Area in Skips	Size Range of Skips	% Unit Area in Gaps	Size Range of Gaps
Riparian Reserve	Up to 5%	Minimum ¼ ac	0	0
Matrix	Up to 5%	Minimum ¼ ac	Up to 5%	Up to 2 ac

Outside of skips and gaps, the remainder of the stand would be thinned from below. Thinning from below, or low thinning, is the removal of trees from the lower crown classes to favor those in the upper crown classes. Diseased trees, such as those infected with dwarf mistletoe, would also be targeted to reduce their impact and spread in the unit.

In as much as 10% of the area outside of skips and gaps within the Matrix land allocation, heavy thins would occur. Approximately 25 to 70 trees per acre would be retained in these areas, further increasing structural diversity.

In areas that have insufficient quantities of snags and down woody debris, trees could either be girdled to artificially create snags, or felled and left in place to provide additional down woody debris.

In order to demonstrate the differences in effects between no action and the proposed action alternative, FVS was used to calculate silvicultural metrics for a representative plantation and representative fire-originated stand. Each stand's growth was set at time = 0 and projected for fifty years. Values are reported as projected in FVS, but these values should be used as a comparison between the proposed action and if no action were taken rather than as absolute numbers obtainable in the future. As shown in Table 4 and Table 5 below, in both stand conditions, FVS is predicting a greater increase in QMD in year 50 with treatment than without. A decrease in trees greater than 5" diameter at breast height (DBH) at year 50 with no action suggests that the unit may have succumbed to some level of competition mortality. With treatment, RD remained under the mortality threshold of 50 longer in the fire-originated stand than in the plantation. This is not to say that treatments would cause RD to remain under 50 for longer in only fire-originated stands. Each stand may have enough distinct differences because of age and site conditions that when projected over time and with different nuances to prescriptions for each unit the rate at which RD changes would be different.

Table 4 - Calculated metrics to compare alternatives in a plantation outside of skips and gaps (See Appendix A for data definitions)

	Age	Basal Area (BA) > 5"	Trees Per Acre (TPA) > 5"	QMD> 5"	RD> 5"	Canopy Cover (CC) > 5"
Pre-treatment Year 0	42	226	298	11.8	66	85
No Treatment Year 50	92	458	288	17.1	111	94
Post Treatment Year 50	92	238	85	22.6	50	64

Table 5 - Calculated metrics to compare alternatives in a fire-originated stand outside of skips and gaps (See Appendix A for data definitions)

	Age	BA> 5"	TPA > 5"	QMD> 5"	RD> 5"	CC> 5"
Pre-treatment Year 0	85	274	287	13.2	75	80

	Age	BA> 5”	TPA > 5”	QMD> 5”	RD> 5”	CC> 5”
No Treatment Year 50	135	342	210	17.3	82	80
Post Treatment Year 50	135	181	43	27.7	34	41

In general, thinning tends to improve the overall vigor, growth, health and architecture of trees. Thinning can directly affect productivity and forest health by maintaining growth rates of young stands. Thinning would redistribute growth potential to fewer trees, while maximizing the site’s potential, leaving a stand with a desired structure and composition (Oliver 1996).

Thinning provides growing space, which gives the trees with the best competitive advantage the opportunity to take advantage of this growing space for the longest practical time, fully utilizing the ability of the trees to expand their crowns into the growing room provided by the removal of neighboring trees (Oliver 1996). Trees with larger crowns have greater stem taper, that is, the base of the tree is relatively large compared with trees that have small short crowns. Thinning increases a tree’s resistance to the wind (windfirmness) by maintaining a larger crown and increasing stem taper. Trees with more taper are less likely to suffer stem breakage or wind damage. In general, thinning increases both stem and root strength. Thinning can also improve the resistance of some trees to some pathogens by manipulating the structure and species composition of a stand.

In units 190-198, thinning would reduce the overstory canopy to enhance huckleberry growth and production. Reducing the overstory was found to be positively associated with big huckleberry (*Vaccinium membranaceum*) berry production (Minore 1984) and taking measures to minimize mechanical damage and plant/rhizome damage, such as using designated skid trails, would be utilized. Additional brushing could also be done to help give competitive advantage to them.

Improve Forest Health, Growth and Diversity: Group Selection

A group selection approach would occur in units 62, 63, 64, 65 and 68, where in as much as 25 percent of the unit outside of the riparian protection buffers, two acre gaps would be created. The majority of the unit would still continue on its current trajectory with little change to forest structure, competition, density, and ecological processes. However, in one or multiple gaps, new age classes would be created to diversify age classes and encourage and enhance understory vegetation development. These gaps would also be monitored for natural conifer tree seedling regeneration and could, with additional site preparation, such as brushing, be planted with other tree species, thereby increasing species diversity across the landscape.

Improve Forest Health, Growth and Diversity: Regeneration Harvest, Site Preparation and Planting

A regeneration harvest (shelterwood with reserve silvicultural system) would be used in unit 129 to reduce the spread of dwarf mistletoe (*Arceuthobium tsugense*), a parasite that depends entirely on its host for food. Major hosts include western hemlock, Pacific silver fir, noble fir, and mountain hemlock. The disease is spread when its seeds are shot as much as 50 feet from fruits, spreading to understory host trees (Shaw 2009). The host experiences growth loss, distortion, topkill, and predisposition to attack by bark beetles (Goheen 2006). Stand exam data shows that the stand is primarily comprised of Pacific silver fir, Douglas-fir, and western hemlock. Western hemlock and Pacific silver fir are the primary species in the understory.

Fifteen percent of the trees in the unit would be retained for structural diversity and could also provide a seed source for natural regeneration. Most of these retention areas would be in patches ranging in size from 0.5 to 2.5 acres. Some individual trees and small patches less than 0.5 acre would also be retained.

As part of site preparation for regeneration, grapple piling and burning of slash, is proposed to reduce short-term competition to give an advantage to planted seedlings or natural regeneration. Some brushwork by hand or mechanically may also be involved to reduce competition to seedlings. The unit would then be planted with as much as 300 trees per acre and monitored so that minimum stocking level (125 trees per acre) would be achieved within five years after the harvest. If monitoring suggests the minimum stocking level may not be achieved, then additional fill-in planting may need to be done. The species primarily planted would be dwarf mistletoe non-host species such as Douglas-fir, western larch and western white pine. It is likely that dwarf mistletoe host species would naturally seed in from the retention areas as well as from natural sources outside of the stand and hence add to the species diversity. This stand is within the matrix land allocation and the planted trees would provide an opportunity in the future to develop the stand into a productive forest providing wood products.

Improve Forest Health, Growth and Long-Term Productivity: Sapling Thinning and Brush Release and Western White Pine Restoration

In the young plantations, precommercial thinning and brush release, white pine treatment, or a combination of both would be implemented.

Precommercial thinning and brush release maintains and improves growth of conifer trees by reducing tree densities and competition. By increasing growing space, young trees would have more availability to resources, such as light, water, and nutrients. A lop-and-scatter slash treatment would be used, spreading activity created slash across the forest floor and allowing for decomposition and nutrient cycling. In some units, activity created slash could be hand piled and burned.

On approximately 225 acres of young plantations, pruning of western white pine branches would occur to enhance their resiliency to white pine blister rust and to encourage young trees to survive to maturity. To be successful, pruning should not take more than 50 percent of the total tree height, and pruning should be done on trees with cankers more than 4 inches from the bole of the tree (Schnepf 2006). Otherwise the trees would not positively respond and would still likely succumb to the disease. If pruning is successful, the treated western white pine would continue to survive and become part of the overstory. They are moderately shade intolerant and some of the trees could become co-dominant or dominant trees in the overstory. Retaining western white pine for a longer period in the stands would maintain and add to the overall biological diversity. Inter-planting of blister rust resistant western white pine seedlings could also occur in stands where it is determined that infection rates have exceeded pruning effectiveness. Site preparation activities would be performed by hand. Some brushwork by hand may also be involved to reduce competition to seedlings. The planting would be monitored for survival as well as potential infection of blister rust.

Forest Products

One of the direct effects of improving forest health, growth and diversity and creating early-seral habitat is the forest product output. With the use of FVS, an estimate of timber volume of trees greater than 5 inch DBH was made for removals in thinnings, gaps, heavy thins, group selections and the regeneration harvest unit. Approximately 25.0 million board feet (mmbf) of viable commercial timber products would be available after treatment.

Cumulative Effects

The effects of thinning or regeneration harvest on stand growth and productivity are generally experienced or expressed within the stands; therefore the analysis area for cumulative effects would be the unit boundaries. The time scale for cumulative effects analysis is quite long: some impacts from 30 to 60 years ago when stands were clearcut or burned remain today, and alterations made during harvest have the potential to benefit health and growth many years into the future. The existing condition and the changes projected above include past actions as they have affected growth including previous logging, site preparation, planting, precommercial thinning and recreational activities.

One ongoing and foreseeable action is the Tamarack Loop Fish Log Project (USDA 2016). The project would remove up to 1,000 live whole trees along portions of Forest Road 2656 and associated spur roads for stream and floodplain restoration projects for up to 10 years. Trees would be removed by pulling trees 10-20 inches DBH out of the ground whole with a tracked excavator that remains on the road. There is some spatial and temporal overlap between proposed treatment units within the Zigzag project and the Tamarack Loop Fish Log project. Timing of the fish log removal in relation to the treatments proposed in the Zigzag project could result in different effects. If the fish logs are removed prior to thinning, tree density in the stand would be high and the pushing over of trees would increase the risk of damage to the residual trees. Wounds could decrease a tree's vigor, weakening it and making it more susceptible to disease infections and/or insect attacks. Damage to the root systems of residual trees could occur when trees are pulled from the ground. Root systems in forest stands are often intertwined, not spatially distinct like tree crowns (Oliver 1996). This root system damage could further compromise the tree's vigor and wind-firmness. Variable-density thinning treatments would then reduce stand densities to prescribed levels, targeting trees in the smaller diameter classes and those exhibiting loss of vigor. Species diversity could also be decreased within the stand if a particular species is determined to be more effective for restoration purposes and is targeted when selecting individual trees for fish log acquisition.

Another foreseeable future project occurring inside the units that can overlap in time and space and therefore have cumulative effects is managing noxious weeds and invasive plants to prevent their spread. Openings and reductions in canopy cover could create conditions conducive to the growth and spread of noxious weeds and invasive plants. Management of these could be by pulling, cutting and burning, or herbicide use. The management of noxious weeds and invasive plants can add or compound to the proposed action by (1) reducing competition thereby giving competitive advantage to forage species, and (2) reduce competition to and potentially eliminate the need for release of seedlings proposed to be planted in reforestation operations.

Because the impact on growth, productivity and diversity is generally a beneficial one, and the actions discussed in this section are relatively small scale in the project area as a whole, the cumulative effects would be expected to be unsubstantial.

Management of Competing and Unwanted Vegetation

This analysis is guided by the 1988 Record of Decision and Mediated Agreement for the "Managing Competing and Unwanted Vegetation" Final Environmental Impact Statement (referred to as VEG EIS). The purpose of this analysis is to provide information to decision makers and interested publics about proposed treatments and how they might affect unwanted vegetation. Appropriate design criteria would be identified and incorporated into any vegetation management project work to minimize potential adverse impacts to the environment, project workers, and public. Herbicide use to treat invasive plants is no longer applicable but the direction in the 1988 documents is still applicable to unwanted native vegetation, brush control and fuel treatments. Fuels treatments in thinning projects are exempt.

Site Analysis for Site Preparation

Site-specific vegetation management objectives have been developed. The following list of objectives will be used to identify the “damage thresholds” for vegetation management, vegetation management strategies and the feasible treatment methods.

Site-Specific Objectives:

1. Meet the recommended stocking levels within five years after harvesting.
2. Meet standards for minimizing soil erosion and soil degradation.
3. Maintain adequate levels of downed woody debris and snags.

Nature and Role of Associated Vegetation

Currently, these are the following stand conditions where site preparation, reforestation, or brushing are proposed:

1. Approximately 13 acres are proposed for a regeneration harvest to reduce spread of dwarf mistletoe in Matrix Land Allocation (B-2 LRMP). Post-harvest site preparation for reforestation would include grapple piling and burning of slash to reduce short-term competition to give an advantage to planted seedlings or natural regeneration. Some brushwork by hand or mechanically may also be involved to reduce competition to seedlings. Tree species to plant could include Douglas-fir, western larch, and western white pine.
2. Approximately 126 acres in stands approximately less than 30 years of age are proposed for an assortment of noncommercial treatments, which could include brushing of rhododendron to release overtopped seedlings. Slash would be lopped-and-scattered to spread activity fuels across forest floor for quicker decomposition and nutrient cycling.

Damage Thresholds

Post-treatment/pre-planting "damage thresholds" have been identified for this site based upon operational experience and the site-specific management objectives. If slash or live vegetation exceeds the following levels prior to planting, treatment would be needed.

Damage thresholds:

- Greater than 20% cover of live vegetation.
- Less than 350 well-distributed planting spots per acre.

- Greater than 15 tons/acre of slash in the 0-3" size class (could exceed 15 tons per acre if the arrangement of the fuels do not present a fire hazard).

Harvest units are expected to need treatment of both live vegetation and slash so that management objectives can be attained. Past experience in this area shows that if trees are established immediately after site preparation, no release treatments from competing brush are required to meet the stand growth objectives. This past experience includes professional expertise of local silviculturists and monitoring data from plantation survival exams and precommercial thinning exams from adjacent plantations.

Strategies

Five strategies for controlling unwanted vegetation are identified in the FEIS and Exhibit A of the Mediated Agreement. These are prevention, early treatment, maintenance, correction and no action. The following analysis will focus on the prevention, correction and no action strategies (refer to Section II-72 through 11-74 in the Vegetation Management FEIS). The prevention strategy is a required element and the preferred strategy in the VEG EIS to consider and analyze.

No Action Strategy

"No Action" means that after harvest, planting would occur with no site preparation activity and slash and brush would be left unaltered on the site. It would be the appropriate strategy anytime there is evidence that the damage thresholds would not be exceeded. Within the Zigzag harvest unit, there is evidence that the no-action strategy would not meet management objectives and standards and guidelines because the damage thresholds would be exceeded.

Prevention Strategy

The prevention strategy would not involve direct treatment but would detect and ameliorate the conditions that cause or favor the presence of competing or unwanted vegetation before damage thresholds are reached. The removal of conifer encroachment would prevent openings from converting into forested stands.

Correction Strategies

Early corrective strategies through vegetation management actions would likely be necessary to reduce the amount of post-harvest live vegetation and slash to a point below the damage threshold. A post-harvest review would be conducted to make a final determination because there may be small areas where the no-action strategy is appropriate. Grapple piling and burning or other mechanized equipment similar to a slashbuster that is capable of masticating slash and brush may occur where the correction strategy is selected.

Mechanical Treatment and Burning - This method could use a track-mounted vehicle with a grapple-type device to pile a large portion of the slash. This method could also use a track-mounted vehicle with a masticating device to crush and/or chip slash and cut brush. Mechanized equipment using a masticating type device is a very effective corrective method on sites with more than 30% cover of larger vegetative plants such as dense western hemlock seedlings/saplings and rhododendron. Both of these treatments would remove the larger vegetation, but are not very effective on the smaller individual plants or species such as beargrass. In the case of mastication, the material would be left on site and as best as possible distributed evenly across the stand. Some raking and/or scalping would be required in order to plant tree species. The masticated material would act as mulch which could prevent rapid spread of rhododendron and give a competitive advantage to planted seedlings.

Both grapple piling and burning are very effective at reducing fire hazards on slopes less than 40%. More than 500 well-distributed planting spots per acre would be made available. Piles would be burned prior to planting. Piles can be burned in the fall when smoke dispersal conditions are favorable and pile burning has a relatively low level of safety concern for workers doing the burning and there is low risk of escaped fire situations. This method would cost approximately $300 per acre.

Design Criteria

In addition to the design criteria for the Zigzag project, the following general guidelines from the Vegetation Management FEIS (Chapter II) should be followed:

- Develop a silvicultural prescription, approved by a certified silviculturist with a site-specific diagnosis and treatment needs.
- Develop a site-specific prescribed burning plan approved by a line officer.
- A job hazard analysis would be developed and discussed by workers to reduce exposure to hazards such as use of power tools, fire and walking in difficult terrain.

Human Health Effects

The human health effects of mechanical treatments would be very low and would be limited to the operator who is inside a protected machine. Risks would increase as slopes increase. The risk to the general public would be very low.

Prescribed burning has the potential for both short and long-term effects to both workers and members of the public. There is the possibility of an escaped fire situation. Burning is only conducted during specific parameters of fuel moisture, humidity and wind speeds when the risk of catastrophic fire is low.

Alternatives

No Action

The No-Action Strategy for vegetation management would apply. Rhododendron brush would continue to thrive.

Proposed Action

A combination of prevention and correction strategies would be most effective. The preventative strategy would help maintain openings as foraging habitat. The corrective strategy would reduce both the amount of live vegetation presently on site and the expected level of fuel loading and/or fire hazard following harvesting. Successful completion of this treatment would prevent the need for the use of herbicide to control unwanted vegetation at a later date.

Project Monitoring

Post treatment monitoring would be conducted to determine the effectiveness of site preparation and survival rates for planted trees.

Consistency with Management Direction

The Zigzag project is consistent with the following standards and guidelines.

Northwest Forest Plan

Standards and Guidelines Pertinent to Regeneration Harvest

C-41–C-42: Patches of trees ranging from 0.5 acres to 2.5 acres would be retained across 10.5% of the unit, and individual trees and patches less than 0.5 acres would be retained in 4.5% of the unit. Total percentage of trees retained in this configuration would be 15% of the unit area.

Mt. Hood National Forest Land and Resource Management Plan

Standards and Guidelines Pertinent to All Treatments

FW-380, FW-381: Brush growth would be assessed to determine if it would outcompete natural and artificial reforestation and prevent acceptable stocking levels. Brush may be masticated, mowed, or lopped and scattered.

Standards and Guidelines Pertinent to Regeneration Harvest and/or Group Selection Treatments

FW-306, FW-307, FW-382: While FVS modeling suggests that in 2020 Unit 129 has not reached 95 percent of culmination of mean annual increment, it is proposed for regeneration harvest in order to reduce the spread of dwarf mistletoe in matrix land allocation and create an opportunity in the future to develop the stand into a productive forest providing wood products.

FW-331, FW-332, FW-346, FW-347, FW-358, FW-361: Group selection openings would be 2 acres and natural regeneration would be relied upon. In Unit 129, artificial reforestation with an approximate density of 200-300 trees per acre would occur. Natural and artificial regeneration would be monitored and fill-in planting could occur where needed.

Standards and Guidelines Pertinent to Variable-Density Thinning and Sapling Thinning Treatments

FW-365, FW-366: Precommercial thinning treatments would generally retain 200 to 300 trees per acre after thinning. Hardwood species would be retained for species diversity.

FW-372: Through the use of variability-density thinning and reducing Curtis' Relative Density, an assortment of wildlife needs would be provided.

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Appendix A: Stand Attribute Table

Not all stands have data described in Data Dictionary because they were either (1) not collected or (2) for reasons described in Data Dictionary.

Data Dictionary for Tables

Unit = Unit Number
Acres: Area of unit analyzed, measured in acres
Stand Origin: Description of stand's origin, to the best of knowledge
CSE Age: Age of stand from Common Stand Exam Data
The following information is reported as calculated in FVS
RD 2020: Curtis' relative density of all trees greater than 5 inches DBH at year 2020
RD 50 YR: Year in which RD is estimated to reach 50, if not already in 2020
95% CMAI 2020 = "Y" for "yes" or "N" for "no" if unit has met or exceeded 95% of CMAI at year 2020. Culmination of mean annual increment is a metric to estimate the age at which average rate of annual tree growth, measured in cubic feet, stops increasing and begins to decline.
YR CMAI = year in which unit meets CMAI

TPA: Trees per acre
TPA>5: Trees per acre for all trees greater than 5 inches DBH
QMD: Quadratic mean diameter, or the DBH of a tree of average per-tree basal area, of all trees, measured in inches
QMD>5: Quadratic mean diameter, or the DBH of a tree of average per-tree basal area, of all trees greater than 5 inches DBH, measured in inches
BA>5: Basal area for all trees greater than 5 inches DBH, measured in square feet per acre
Avg HT: Average height of all trees, measured in feet
HT>5: Average height of all trees greater than 5 inches DBH, measured in feet
CC>5: Canopy cover for all trees greater than 5 inches DBH, reported as a percentage
H:D Ratio: Ratio of average height of all trees greater than 5 inches DBH (in inches) to QMD of all trees greater than 5 inches DBH (in inches). Generally, a value of 80 or greater indicates an increased susceptibility to windthrow
Proposal = general proposal for unit

Table 6 - Stand Attributes for VDT, Group Selection & Regeneration Units

Unit	Acres	Origin	CSE Age	RD 2020	RD 50 YR	95% CMAI 2020	YR CMAI	TPA	TPA >5"	QMD >5"	BA >5"	HT >5"	CC	H:D Ratio	Proposal
2	11.1	fire	91	109		Y	2019	617	367	14.4	414	85	90	71	Variable Density Thinning
4	32.2	fire	88	70		N	2119	591	279	12.8	249	85	77	80	Variable Density Thinning
6	29.2	fire	85	75		Y	2019	899	287	13.2	274	78	80	71	Variable Density Thinning
7	11.7	fire	92	58		N	2129	460	167	16.0	232	101	74	77	Variable Density Thinning
8	9.5	fire	85	62		N	2119	754	318	10.8	202	65	75	73	Variable Density Thinning
12	15.3	plantation	42	78		Y	2019	730	342	12.0	270	73	80	73	Variable Density Thinning
13	33.8	plantation	42	55		Y	2079	573	216	12.9	197	83	69	78	Variable Density Thinning
14	8	plantation	51	78		N	2079	614	370	11.4	264	65	89	69	Variable Density Thinning
16	19	fire	91	51		N	2109	1532	147	15.9	202	85	66	65	Variable Density Thinning
18	28.6	fire	96	57		N	2089	715	158	16.4	232	100	58	74	Variable Density Thinning
20	7.2	fire	94	54		N	2089	1124	110	20.1	242	119	64	71	Variable Density Thinning
24	12.5	fire	85	63		N	2099	562	175	16.4	256	87	74	64	Variable Density Thinning
26	11	fire	91	64		Y	2039	3642	112	22.2	301	125	67	67	Variable Density Thinning
28	19.8	fire	91	91		N	2049	508	317	14.1	341	78	82	68	Variable Density Thinning
31	4.9	fire	107	68		N	2079	1388	271	12.8	242	63	87	60	Variable Density Thinning
32	27.6	plantation	49	48	2023	N	2079	224	143	15.6	191	76	71	59	Variable Density Thinning
33	10.4	fire	90	65		Y	2029	1926	185	16.0	260	84	89	63	Variable Density Thinning
34	14.8	fire	85	71		N	2089	3426	185	17.1	295	100	83	70	Variable Density Thinning
38	51.4	plantation	48	56		N	2099	735	260	11.6	191	78	78	81	Variable Density Thinning
40	4.4	plantation	45	66		Y	2019	555	311	11.5	223	79	81	84	Variable Density Thinning
41	5.3	plantation	34	45	2026	N	2119	484	239	10.5	144	45	54	52	Variable Density Thinning
42	38.2	plantation	42	66		N	2069	675	298	11.8	226	69	85	71	Variable Density Thinning

Unit	Acres	Origin	CSE Age	RD 2020	RD 50 YR	95% CMAI 2020	YR CMAI	TPA	TPA >5"	QMD >5"	BA >5"	HT >5"	CC	H:D Ratio	Proposal
43	21.9	fire	72	71		Y	2019	816	329	11.6	241	72	86	76	Variable Density Thinning
44	56	plantation	43	45	2025	N	2119	537	156	14.1	169	70	72	61	Variable Density Thinning
46	2.4	plantation	42	61		N	2069	369	224	13.5	223	78	83	70	Variable Density Thinning
48	21.9	plantation	39	68		N	2059	750	259	13.2	247	75	78	65	Variable Density Thinning
55	25.4	plantation	46	80		N	2109	1398	403	11.0	264	52	91	58	Variable Density Thinning
56	27.4	plantation	43	63		N	2049	957	238	13.3	229	86	67	79	Variable Density Thinning
58	17.7	plantation	40	78		Y	2019	1739	240	15.2	302	110	73	88	Variable Density Thinning
60	23.7	plantation	45	33	2046	N	2109	876	88	16.8	135	79	61	57	Variable Density Thinning
61	52.4	plantation	36	63		N	2089	647	329	10.7	205	48	86	55	Variable Density Thinning
62	96	fire	91	71		Y	2079	781	235	14.5	270	89	76	74	Group Selection
63	17	fire	102	62		N	2099	1804	165	16.8	255	103	72	74	Group Selection
64	72.2	fire	94	86		Y	2019	759	195	18.7	372	112	79	72	Group Selection
65	10.4	fire	90	81		Y	2019	522	201	17.7	341	121	79	82	Group Selection
68	58	fire	79	55		N	2129	550	163	15.6	216	84	74	65	Group Selection
69	38.6	plantation	44	65		N	2069	612	352	10.5	212	55	86	64	Variable Density Thinning
71	35.7	plantation	40	89		N	2049	743	589	9.1	268	54	93	71	Variable Density Thinning
73	14.4	plantation	29	97		Y	2020	694	694	8.7	284	60	85	84	Variable Density Thinning
74	10.3	plantation	38	52		N	2109	595	204	13.1	189	77	79	71	Variable Density Thinning
80	16.8	plantation	57	83		Y	2019	399	227	16.4	335	106	81	78	Variable Density Thinning
82	25.5	plantation	49	40	2037	N	2089	336	115	16.0	162	96	52	72	Variable Density Thinning
86	6.6	fire	93	51		Y	2019	203	106	19.9	228	116	70	70	Variable Density Thinning
88	16	fire	85	59		N	2089	391	132	18.9	255	101	77	65	Variable Density Thinning
92	2.1	plantation	36	67		N	2059	398	204	15.4	264	80	89	63	Variable Density Thinning
96	10	plantation	34	88		N	2059	806	466	10.6	286	62	88	71	Variable Density Thinning
102	10.1	fire	77	85		N	2099	500	382	11.8	291	65	91	67	Variable Density Thinning

Unit	Acres	Origin	CSE Age	RD 2020	RD 50 YR	95% CMAI 2020	YR CMAI	TPA	TPA >5"	QMD >5"	BA >5"	HT >5"	CC	H:D Ratio	Proposal
104	12.5	plantation	49	59		N	2079	689	278	11.5	199	63	82	67	Variable Density Thinning
106	5.3	plantation	74	71		N	2089	1367	375	10.6	232	61	83	69	Variable Density Thinning
108	16	fire	80	85		N	2059	1067	433	10.9	283	68	88	75	Variable Density Thinning
110	17.2	plantation	39	60		N	2059	860	255	12.3	211	74	75	73	Variable Density Thinning
112	13.2	plantation	72	75		N	2099	1982	553	8.5	219	54	87	76	Variable Density Thinning
114	15.4	fire	67	79		N	2129	1100	404	10.9	260	60	87	66	Variable Density Thinning
116	17.2	plantation	56	56		N	2139	1355	242	12.2	196	58	86	58	Variable Density Thinning
117	10.5	fire	60	60		N	2109	2957	216	13.7	222	80	76	71	Variable Density Thinning
118	29.5	plantation	44	57		N	2089	380	206	13.7	211	71	78	63	Variable Density Thinning
119	44.2	fire	86	141		N	2049	1938	772	10.4	456	59	97	69	Variable Density Thinning
120	33.5	plantation	46	58		N	2089	1635	333	10.1	184	64	79	78	Variable Density Thinning
121	3	fire	74	45	2027	N	2109	1659	217	11.4	153	68	75	73	Variable Density Thinning
122	22	plantation	41	47	2024	N	2059	781	180	13.2	171	64	68	59	Variable Density Thinning
124	48.9	plantation	35	52		N	2109	852	247	11.4	175	62	70	65	Variable Density Thinning
126	8.2	plantation	30	68		N	2049	1412	507	8.5	199	55	77	79	Variable Density Thinning
128	14	plantation	54	50		N	2139	1387	220	12.0	173	63	75	63	Variable Density Thinning
129	13.2	fire	117	60		N	2139	2237	279	11.5	202	62	77	65	Regeneration Harvest, Site Preparation & Planting
130	57	fire	86	81		N	2089	1000	409	11.0	270	63	89	69	Variable Density Thinning
132	7.8	fire	92	86		Y	2019	738	233	16.6	351	90	80	66	Variable Density Thinning
134	21.3	plantation	43	52		N	2099	493	230	12.1	182	61	70	61	Variable Density Thinning
136	19	plantation	42	46	2024	N	2109	589	180	13.1	168	72	64	67	Variable Density Thinning
138	3.8	plantation	32	48	2022	N	2089	1541	230	11.3	160	65	62	71	Variable Density Thinning
139	4.1	plantation	40	65		N	2069	1320	436	9.1	196	47	90	64	Variable Density Thinning
140	14.1	plantation	44	68		N	2059	649	342	10.9	223	75	75	83	Variable Density Thinning

Unit	Acres	Origin	CSE Age	RD 2020	RD 50 YR	95% CMAI 2020	YR CMAI	TPA	TPA >5"	QMD >5"	BA >5"	HT >5"	CC	H:D Ratio	Proposal
141	11.2	plantation	43	51		N	2059	1032	163	14.8	196	84	65	69	Variable Density Thinning
142	3.6	plantation	43	54		N	2089	1281	325	9.8	169	57	87	71	Variable Density Thinning
143	11.3	plantation	43	104		N	2049	867	663	9.4	320	61	96	79	Variable Density Thinning
144	23.7	plantation	41	68		N	2059	736	324	11.4	230	68	76	72	Variable Density Thinning
146	17.6	plantation	39	48	2023	N	2079	808	249	10.7	157	66	60	75	Variable Density Thinning
148	5.5	plantation	31	56		N	2069	1585	279	11.0	184	64	69	71	Variable Density Thinning
150	15.9	plantation	44	50		N	2079	667	191	13.2	182	72	70	67	Variable Density Thinning
154	22.6	plantation	43	55		N	2089	2183	264	11.3	183	63	74	68	Variable Density Thinning
156	17.2	plantation	40	49	2022	N	2069	914	174	13.8	182	70	73	62	Variable Density Thinning
160	16	plantation	41	47	2023	N	2089	1414	186	13.0	171	56	75	52	Variable Density Thinning
162	7.3	plantation	39	57		N	2069	431	211	13.5	208	73	72	66	Variable Density Thinning
164	25.7	plantation	46	52		N	2089	810	280	10.5	169	55	85	64	Variable Density Thinning
165	9.2	fire	91	80		N	2109	1473	481	9.8	252	48	88	57	Variable Density Thinning
168	139.7	fire	56	72		N	2059	407	232	14.8	275	76	80	62	Variable Density Thinning
170	44.8	plantation	56	66		N	2079	1528	249	13.3	242	66	81	60	Variable Density Thinning
172	16.1	plantation	37	51		N	2069	841	216	12.3	178	63	68	63	Variable Density Thinning
174	17.7	plantation	37	66		N	2069	932	316	11.3	220	61	88	66	Variable Density Thinning
175	7.4	fire	79	72		N	2079	1039	335	11.5	243	61	88	60	Variable Density Thinning
176	3.5	fire	71	82		N	2079	2016	560	9.0	245	57	92	76	Variable Density Thinning
178	9.1	fire	84	93		N	2089	1697	497	10.5	300	56	92	64	Variable Density Thinning
180	121.2	fire	100	74		N	2129	1754	360	11.2	247	57	86	61	Variable Density Thinning
181	31	fire	76	53		N	2129	2180	268	10.9	175	56	89	62	Variable Density Thinning
182	16.4	fire	71	68		Y	2018	410	177	17.1	281	84	68	59	Variable Density Thinning
184	20.6	fire	56	52		N	2149	468	215	12.6	186	72	73	68	Variable Density Thinning
185	6.6	fire	65	51		N	2139	1958	195	13.2	186	61	83	56	Variable Density Thinning

Unit	Acres	Origin	CSE Age	RD 2020	RD 50 YR	95% CMAI 2020	YR CMAI	TPA	TPA >5"	QMD >5"	BA >5"	HT >5"	CC	H:D Ratio	Proposal
186	7	fire	61	56		N	2159	3463	277	11.1	185	64	82	70	Variable Density Thinning
190	13.7	fire	56	43	2029	N	2169	3981	261	9.8	136	56	67	69	Variable Density Thinning (Huckleberry Enhancement)
192	3.8	fire	51	40	2045	N	2129	1923	268	9.1	122	53	55	71	Variable Density Thinning (Huckleberry Enhancement)
194	11.1	fire	74	52		N	2169	2488	316	9.7	162	43	74	54	Variable Density Thinning (Huckleberry Enhancement)
196	7	fire	86	64		N	2119	2997	209	14.6	243	62	81	51	Variable Density Thinning (Huckleberry Enhancement)
198	22.7	fire	66	30	2091	N	2249	5724	121	12.8	108	65	35	62	Variable Density Thinning (Huckleberry Enhancement)

Table 7 - Stand Attributes for Sapling Thin & Western White Pine Restoration Units

Unit	Acres	Origin	CSE Age	TPA	TPA >5"	QMD	Avg HT	Proposal
300	2.2	young plantation	31	932	266	4.3	17	Sapling Thin & Brush Release
302	3.2	young plantation	31	645	199	6.1	23	Sapling Thin & Brush Release Western White Pine Restoration
304	19.7	young plantation	28	1264	67	2.7	13	Sapling Thin & Brush Release Western White Pine Restoration
306	12.9	young plantation	31	933	100	4.3	9	Sapling Thin & Brush Release Western White Pine Restoration
308	23.8	young plantation	28	2268	272	5.3	13	Sapling Thin & Brush Release
312	6.5	young plantation	29					Sapling Thin & Brush Release

Unit	Acres	Origin	CSE Age	TPA	TPA >5"	QMD	Avg HT	Proposal
314	11.2	young plantation	29	1065	33	2.2	10	Sapling Thin & Brush Release
316	15	young plantation	31	1735	245	7.9	8	Sapling Thin & Brush Release Western White Pine Restoration
318	10.5	young plantation	30	1770	125	2.0	8	Western White Pine Restoration
320	6.6	young plantation	30	1229	229	2.7	11	Western White Pine Restoration
322	7.2	young plantation	30	599	226	5.0	19	Western White Pine Restoration
324	11.2	young plantation	30	1498	100	2.5	8	Western White Pine Restoration
326	6.6	young plantation		1524	175	3.3	8	Western White Pine Restoration
328	30.6	young plantation	31	1199	150	3.2	8	Western White Pine Restoration
330	28.3	young plantation	31	866	100	3.2	10	Western White Pine Restoration
332	5.2	young plantation	31					Western White Pine Restoration
334	11.1	young plantation	31	898	266	4.5	15	Western White Pine Restoration
338	14.9	young plantation	31	766	100	3.1	9	Sapling Thin & Brush Release Western White Pine Restoration
340	13.8	young plantation	30	1730	167	2.5	11	Western White Pine Restoration
342	4.3	young plantation		1158	140	2.9	8	Western White Pine Restoration

Unit	Acres	Origin	CSE Age	TPA	TPA >5"	QMD	Avg HT	Proposal
344	9.3	young plantation	29	1563	33	1.4	4	Sapling Thin & Brush Release Western White Pine Restoration
346	7.6	young plantation	29	2650	128	3.5	6	Sapling Thin & Brush Release Western White Pine Restoration
348	7.9	young plantation	30	1098	100	2.4	8	Western White Pine Restoration