United States Department of Agriculture
Forest Service

Grasshopper Restoration Project

Fuels Report

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for:
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Mt. Hood National Forest

08/26/2020 - DRAFT

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1.0 Introduction

This report is for the Fuels resource to inform the effects analysis for the Grasshopper project.

The Grasshopper Restoration project proposes treatments across a landscape that has both East Cascade and West Cascade characteristics. In the eastern portion of the planning area, a low-severity, “fire adapted” fire regime (Agee 1993) shaped dry forest types dominated by ponderosa pine and Douglas-fir (Wright 2004). Towards the west and increasing in elevation, the planning area transitions to a stand replacing fire regime, made up of moist mixed conifer species. This report describes methods used to determine fuels treatments for both portions of the planning area, and the effects of those treatments and other activities proposed. All activities proposed by Alternative 1 (the “Proposed Action”) and Alternative 2 (the “Shelterwood Alternative”) are consistent with the Mt. Hood National Forest Land and Resource Management Plan which this report tiers to.

All proposed treatments are designed to build a healthy and resilient ecosystem. Healthy, thriving ecosystems are less vulnerable to extreme wildfires that can devastate watersheds, destroy wildlife habitat, and risk lives. Healthy ecosystems can adapt to climate change, invasive species, and insect infestations (USDA 2020c). A resilient ecosystem will allow for natural processes (fire, insects, etc.) to play their role in the system, while minimizing the potential of causing large scale mortality.

Activities proposed by both action alternatives support the forest health component of the purpose and need. In eastern units, proposed treatments would create resiliency through the return of fire to the fire-adapted ecosystem, which helps restore historical conditions. By restoring the fire adapted ecosystem, risks of uncharacteristic wildland fires are reduced and opportunities for safe engagement along Forest Service roads would be created. In western portions of the project area, proposed activities address the wildland fire risk component of the purpose and need by reducing the extent and severity of wildfires through creating defensible space and areas of safe engagement along Forest Service roads.

There is no intent to create conditions that remove fire from the landscape.

2.0 – Analysis Framework

This section of the report first describes the methods used for designing fuels treatments and then describes how effects of these treatments, and other proposed activities, were measured.

Fuel treatments were designed to mitigate the effects from a potential wildland fire, as well as establish conditions that are conducive of using low intensity prescribed fire where it is ecologically prudent.

Design of fuels treatments for the Grasshopper Restoration Project looked at principles of fire resistance for dry forests. In this context, resiliency is defined as a forest capable of maintaining substantial live basal area after being burned by a wildfire (Agee 2005). The four principles, reduce surface fuels, increase height to live crown, decrease crown density and retain large trees of resistant species are used as guides to develop forest fuels reduction treatments (Agee 2005).

While the principles were developed to address fuels concerns in dry forest types, the basis of design, to reduce crown fire initiation and potential for active crown fires, was used to develop treatments for creating a fuel break in the western portion of the Grasshopper planning area. Table 1 outlines the four principles of fire resistance.

Table 1. Principles of fire resistance

Principle	Effect	Advantage	Concerns
Reduce Surface Fuels	Reduces potential flame length	Control easier; less torching[1]	Surface disturbance less with fire than other techniques
Increase Height to Live Crown	Requires longer flame length to begin torching	Less torching	Opens understory; may allow surface wind to increase
Decrease Crown Density	Makes tree to tree crown fire less probable	Reduces crown fire potential	Surface wind may increase and surface fuels may be drier
Keep Large Trees of Resilient Species	Less mortality for same fire intensity	Generally restores historic structure	Less economical; may keep trees at risk of insect attack

Fuels treatments were planned using principles of fire safe forests: treat surface fuels, treat ladder fuels, thinning the crowns while leaving the large trees. These treatments acknowledge that forest structure and forest fuels do make a difference to a stand's survivability during a wildland fire, that even under severe fire weather, fuels conditions are relevant (Agee 2005).

Wildland firefighters are instructed during their basic training that forest fuels are part of the fire triangle as well as the wildland fire environment, and without fuel, there would be no fire (NWCG 2020). It is not only weather conditions, but also the removal of forest fuels that impede fire spread (Holsinger 2016). Using these concepts of removing forest fuels, treatments were strategically designed and placed, to limit fire spread, decrease fire behavior and fire severity, promote conditions for prescribed fire use and to provide safe engagements areas for wildland firefighters.

[1] Torching is the initiation of crown fire (Agee 2005).

Fuel treatment analysis considered forest service roads and their use for future prescribed fire and fire suppression response. Roads with potential use for fire and fuels were recommended to remain open, or minimally maintained, but accessible for firefighters. For more details about roads, please refer to the Transportation Report incorporated by reference and included on the project website.

2.1 - Resource Indicators and Measures

To determine proposed treatments, a review of the current Fire Regime Condition Class was conducted. In addition, expected fire behavior under current conditions was analyzed.

2.1.1 Resource Indicator 1: Fire Regime Condition Class (FRCC)

The Fire Regime Condition Class (FRCC) was used to develop proposed treatments for the fire adapted ecosystem found within the Grasshopper planning area. An analysis of the FRCC can guide the scope and scale of treatments that are needed to maintain, or that are needed prior to, returning the landscape to historic conditions. Areas which have a departure from historic conditions (FRCC 2 or FRCC 3), may require a moderate to high level of restoration treatment, either hand or mechanically treated, prior to putting fire back into the ecosystem (NWCG 2003). Areas with a moderate to high level of departure may require several successive treatments before the use of prescribed fire can occur. An example of this would be the need to masticate brush fuels, thin dense stands, complete pile burning and then use prescribed fire to establish a rotation of low intensity underburning. The risk of losing key ecosystem components during a wildland fire is high under FRCC 2 and FRCC 3 conditions. Similarly, the use of prescribed fire in these conditions, would have the same potential as a wildland fire. The ability to control and maintain a low intensity prescribed fire, without prior treatment, would pose risks to firefighters and impact the ability to hold a prescribed fire within containment lines.

2.1.2 Resource Indicator 2: Fire Behavior

Fire behavior is a critical component in analyzing the type and location of a proposed fuel treatment. Determining the expected fire behavior provides a snapshot of the conditions firefighters may encounter when they arrive on scene of a wildland fire. Modelling for fire behavior can provide insights to rates of fire spread, surface or crown fire, flame lengths, distance of spot fires and an approximate size of a fire.

Fuel models can be used to reference the expected fire behavior in the event of a wildland fire, or in any prescribed fire applications (Anderson 1982). Using fire behavior results, treatment options can be proposed to lessen wildland fire severity and intensity. Fuel models are discussed further in section 2.2 – Methodology.

2.2 - Methodology

Fuels treatments analysis was conducted using a computer based program, BehavePlus 6. The BehavePlus program is used to calculate expected fire behavior under a given set of conditions (weather, topography) and a fuel model(s).

A fuel model is a set of fuel bed inputs needed by a particular fire behavior or fire effects model (Scott 2005). The analysis for this project used the set of 40 standard fire behavior fuel models. The set of 40 fuel models was developed due to deficiencies in other models. The set of 40 provides better guidance on prescribed fire, wildland fire use, simulating the effects of fuel treatments on potential fire behavior, and simulating transition to crown fire using crown fire initiation models (Scott 2005).

Weather conditions were based upon the 90th percentile of weather data, collected for 20 years at the Wamic RAWS (station number 350913). The Wamic RAWS is less than 1 mile from the planning area. Fuel models were determined by the collection of stand data and site visits. Topography information was provided by collection of stand data.

Values used for modeling reference the very low dead fuel moisture scenarios outlined in the Standard Fire Behavior Fuel Models guide (Scott 2005). These scenarios correlate to the 90th percentile fuel moisture values represented by the Wamic RAWS.

Using 90th percentile weather and very low fuel moistures correlates well with increases in fire danger (USDA 2020a). As wildfire season progresses through the summer months, so does the fire danger. Modeling for conditions that represent peak fire season (High fire danger and above) provides better insight to expected fire behavior.

Expected fire behavior is used to determine the fire intensity. Additionally, fire behavior outputs can be used to determine the method of initial attack of a wildland fire. Fire behavior can dictate whether ground resources (fire engines and/or handcrews), heavy equipment (dozers) or aircraft is necessary for suppression of a wildland fire.

In conjunction with BehavePlus 6, the Forest Vegetation Simulator (FVS) fire and fuels extension was used to analyze some components of stand conditions. FVS data was used to determine canopy bulk density and crown base heights, both indicators of tree torching susceptibility and crown fire initiation.

Proposed fuel treatments were compared to existing conditions and the potential effects were analyzed. Analysis was made in regards to reducing ladder fuels, reducing surface fuels and increasing crown spacing, and the effects those treatments have on expected fire behavior.

Because the treatments were designed differently to meet the purpose and need for both the eastern and western portions of the planning area, the effects analysis is divided into two discussions. Section 3.0 discusses effects on the fire-adapted ecosystem of the more eastern portion of the planning area. Section 4.0 discusses effects pertaining to risks associated with wildland fire which drove the fuel treatment design for the more western portion.

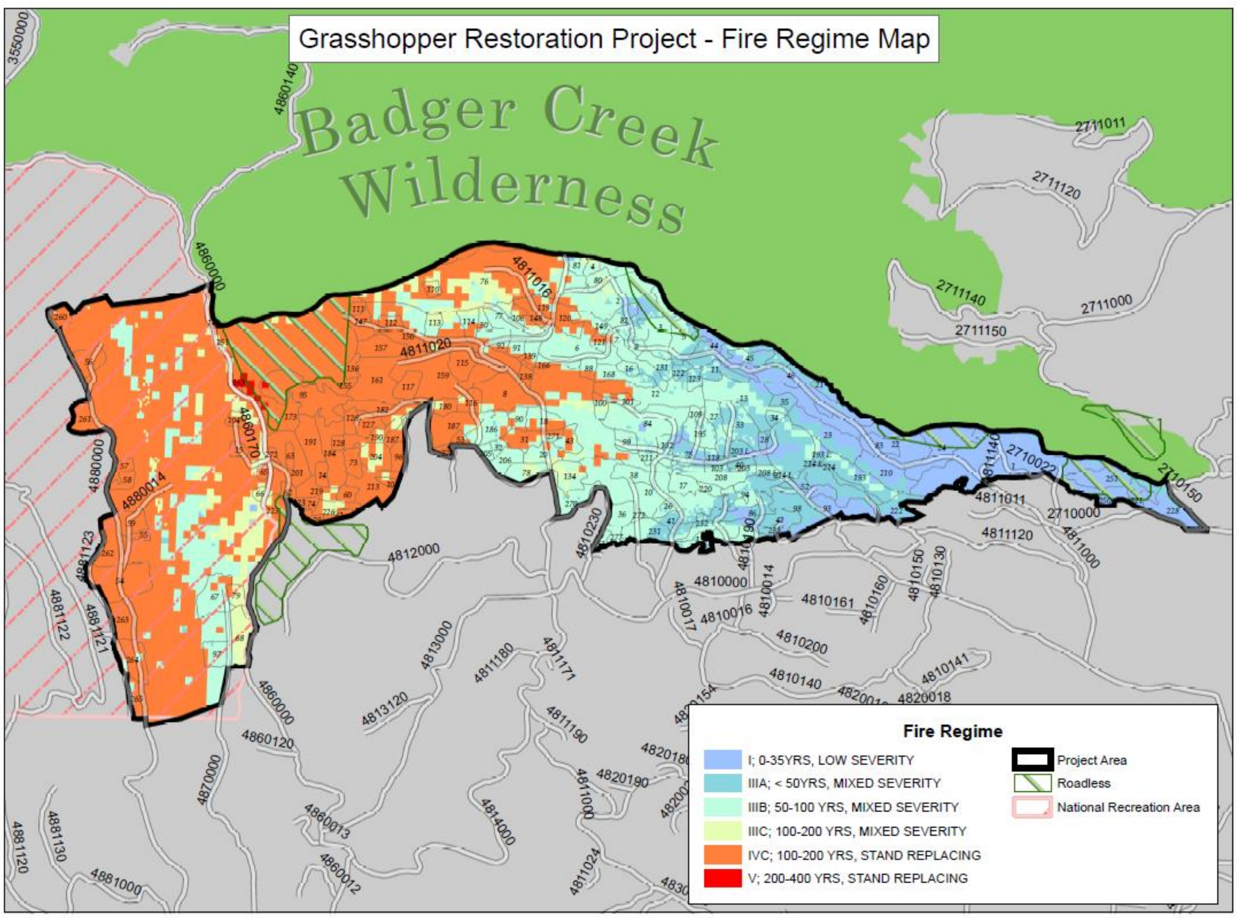
3.0 – Analysis of the Alternatives for Eastern Units and the Fire-Adapted Ecosystem

Proposed treatments were designed to return fire to the fire-adapted ecosystem which would help restore the area to historical conditions and create resiliency.

3.1 – Existing Condition - Eastern Units and the Fire-Adapted Ecosystem

Eastern Portion of the Planning Area

Figure 1. Fire Regime map of the Grasshopper Restoration Project



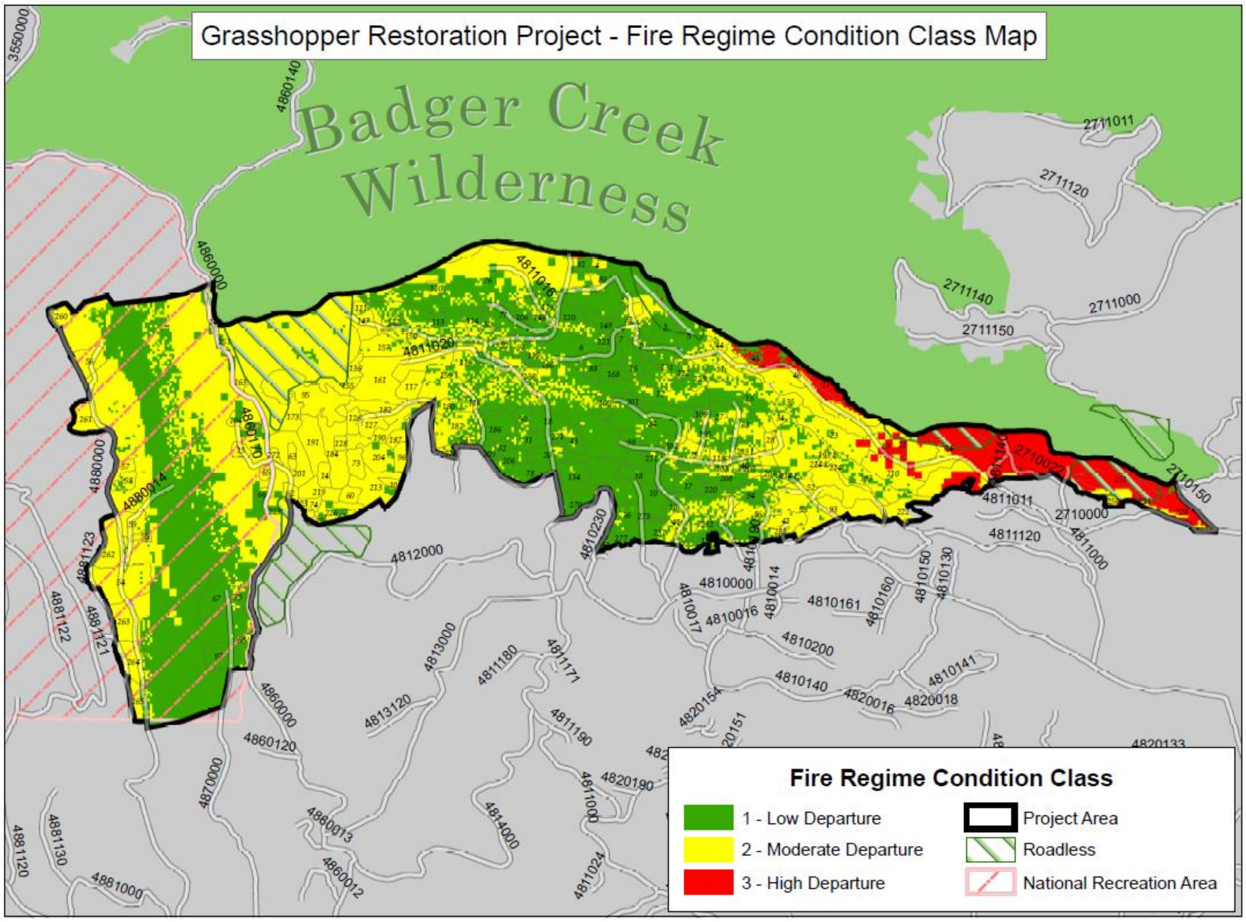
Wildfires are a natural part of the forested landscape, especially in the eastern slopes of the Cascade Range (Agee 1993). Historically, wildfires along the eastern front would burn frequently with low intensity as they moved across the landscape. Figure 1 shows the Grasshopper

Restoration Project Fire Regime map, detailing the fire regimes found within the Grasshopper planning area.

Areas in the eastern part of the Grasshopper Restoration project are characterized as a fire adapted ecosystem, consisting of Fire Regimes I and III. National level fire regimes have been refined and adapted for the forests of Oregon and Washington. Using regionally adapted fire regimes, the Grasshopper Project sets forth proposals to restore lands identified as Fire Regime I and IIIA (Evers 2002, Rice 2006). These are the lands that historically had frequent, low severity fires shaping the landscape. Fire regimes IIIB and IIIC are considered fire adapted, with longer fire return intervals and higher levels of mixed severity fire found on the landscape. Most lands classified as Fire Regime IIIB or IIIC are in the historic range of normal. Fire Regime IIIB and IIIC lands would be treated to maintain conditions and allow for the potential use of prescribed fire.

In this fire-adapted landscape, the exclusion of fire and past forest management actions have resulted in a departure from the natural fire regime. To determine the level of departure, a comparison of current fire regime attributes (vegetation characteristics, fuel composition, fire frequency, severity and pattern) to the tendency of the natural, or historical, fire regime attributes is made. The Fire Regime Condition Class, or FRCC, provides a classification of the amount of departure from the natural regime (NWCG 2003). Attributes of a fire adapted landscape that is departed from historic conditions include an abundance of ladder fuels, an increased density of trees, brush and shrubs, as well as an accumulation of dead and down surface fuels. All these attributes lead to an increase in the vertical and horizontal continuity of fuels. Refer to the Grasshopper Restoration Project Fire Regime Condition Class map (Figure 2) for the delineation of the FRCC in the Grasshopper planning area. This version of the FRCC map is different from the FRCC map provided during public scoping, as it was determined during internal scoping and the analysis process that stratum FRCC was the best method for analyzing fire regime condition class at this scale.

Figure 2. Fire Regime Condition Class map of the Grasshopper Restoration Project



The intent of proposed fuels treatments in the fire adapted ecosystem of the eastern, dry mixed conifer portion of the planning area is to begin the process of restoring historic forest structure and composition. Restoration treatments are focused in Fire Regimes I and IIIA, where the intent is to put fire back onto the landscape.

The majority of the Fire Regimes I and IIIA found in the eastern portion of the Grasshopper Restoration Project area are operating outside their historic range of conditions and are vulnerable to uncharacteristic wildfire effects. The fire regime condition class provides a good indication of this departure. Current conditions found within the fire adapted ecosystem include a moderate to high increase in tree densities, increase in shade tolerant tree species and an increase in surface fuel loadings. These forest conditions in dry eastside environments lead to a general deterioration of the integrity of forest ecosystems and a higher probability of an uncharacteristically large, high-severity, stand-replacing fire (McCaskill 2018).

Surface fuels, which are comprised of litter, needles, moss, rotten and sound logs, woody debris and slash, allow a fire to transition from the ground to the overstory tree crowns. Surface fuel loadings (measured in tons per acre) have increased as a result of missed disturbances. The fuels have accumulated to loadings above what would be considered normal in historical context. As fuel loadings increased, so has the horizontal continuity. With no breaks in the continuity of fuels, fires have the ability to spread across the landscape quicker and with higher flame lengths. This increases the potential of a wildland fire transitioning into a crown fire.

Additionally, missed disturbance events have led to an increase in tree densities and higher components of brush and shrubs. These conditions are identified in the White River Watershed analysis, stating that fire exclusion and failure to manage the understory had allowed for dense conifer regeneration to establish and grow in the eastside zone (USDA 1995). Higher levels of trees and brush in the understory lead to an increase in ladder fuels. Ladder fuels provide vertical continuity in the spread of fires. As fires move through the continuous surface fuels, with higher flame lengths and higher spread rates, the brush and trees provide a transition for surface fires to potentially become crown fires.

3.1.1 - Resource Indicator – Fire Regime Condition Class

Analyzing the Fire Regime Condition Class provides a look at the vegetation characteristics, fuel composition, frequency and severity of fire of a given area. Table 2 shows the approximate amount of acres in the planning area classified as a fire adapted ecosystem and the percentage of those acres in each FRCC. The table below shows the departure of Fire Regime I (>90%) and Fire Regime IIIA (>70%) into condition classes 2 or 3.

Table 2. Percent of Fire Regime in corresponding Fire Regime Condition Class

Fire Regime	Acres	FRCC 1 (Acres)	FRCC 1 (%)	FRCC 2 (Acres)	FRCC 2 (%)	FRCC 3 (Acres)	FRCC 3 (%)
I – (0-35 years, low severity)	863	27	3%	453	52%	383	45%
IIIA – (<50 years, mixed severity)	752	212	28%	470	63%	70	9%
IIIB – (50-100 years, mixed severity)	1,981	1684	85%	292	14%	5	<1%
IIIC – (100-200 years, mixed severity)	493	300	61%	191	39%	2	<1%

It is important to note the cause of departure is not limited to fire exclusion, e.g. disease infestation may change the departure, so too could timber harvest, grazing, etc.

3.1.2 - Resource Indicator – Fire Behavior

A comparison of fuel models can provide depth, and further insight, to the departure of stand conditions found in the Grasshopper Project’s fire adapted ecosystem. Current conditions can be expressed by five of the 40 representative fuel models, as shown in Table 3.

Table 3. Current Fuel Models in the Fire Adapted Ecosystem of Grasshopper

Fuel Model	Fuel Model Description	Approximate Acres	% Fire Adapted Ecosystem
TU 4	Fuelbed is short conifer trees with grass or moss understory. Spread rate moderate; flame length moderate.	1,022	25%
TU 5	Fuelbed is high load conifer litter with shrub understory. Spread rate moderate; flame length moderate.	1,227	30%
TL 4	Moderate load, includes small diameter downed logs. Spread rate low; flame length low.	613	15%
TL 8	Moderate load and compactness may include small amount of herbaceous load. Spread rate moderate; flame length low.	409	10%
TL 9	Very high load, fluffy. Spread rate moderate; flame length moderate.	818	20%

Desired fuel models for Fire Regime I and IIIA include TL 4 and TL 8. Low severity fires can be expected in these fuel models. Fire Regime IIIB and IIIC are a part of the fire adapted ecosystem, however, these two classifications include higher levels of a mixed severity fire disturbance. All 5 of the current fuel models would remain represented in Fire Regime IIIB and IIIC to maintain the attributes associated with mixed severity fire.

Within the fire adapted ecosystem of Grasshopper, conditions exist that could lead to an increase in intensity and severity during a wildland fire or prescribed fire incident (USDA 1995). Fire behavior potential can provide information on the expected fire intensity during these incidents. The severity of a fire depends on the fire intensity and the degree to which ecosystem properties are fire resistant. Additionally, fire severity can be defined by the amount of overstory plant mortality. Overstory mortality below 30% is considered low, mortality above 70% is considered high and anything in between would be considered moderate (Agee 2007a). Low severity fire is further characterized by minimal, short-term ecosystem effects. Soils are not heated and overstory vegetation is rarely affected. The result of a low severity fire is reducing fuel loadings and top kill of understory vegetation (Agee 2007b). Table 4 represents expected fire behavior under current conditions.

Table 4. Expected fire behavior found in the Fire Adapted Ecosystem

Fire Behavior Output	TU 4 Fuel Model	TU 5 Fuel Model	TL 4 Fuel Model	TL 8 Fuel Model	TL 9 Fuel Model
Rates of Spread (ch/hr)	7.4	6.8	1.8	4.5	5.4
Flame Length (ft)	4.8	6.9	1.3	3.1	4.1
Scorch Height (ft)	36	62	3	18	28
Mortality (%)	84	80	12	12	20

Fuel models TU 4 and TU 5 comprise over 50% of the fire adapted landscape found in the Grasshopper project area. In current conditions, increased flame lengths and high mortality rates in the overstory trees can be expected.

3.2 - Environmental Consequences - Eastern Units and the Fire-Adapted Ecosystem

The effects analysis for the fire adapted ecosystem has been evaluated for the No Action, Proposed Action and for the Shelterwood Alternative.

3.2.1 – Effects of No Action

No treatments would occur, resulting in the majority (currently 85%) of Fire Regimes I and IIIA remaining outside historic conditions, or in Fire Regime Condition Class 2 or 3. The areas that are within historic conditions (15%) would begin to move towards FRCC 2, and would be at risk for losing key ecosystem components in the event of a wildfire. In the absence of treatments, or disturbance event, Fire Regimes IIIB and IIIC move towards FRCC 2. No action continues a critical trend in the disturbance process; the risks of insects, disease and stand replacing fire remain outside the range of natural (USDA 1995).

Fuel models not associated with low severity fire remain, and the potential exists for an increase in fire behavior and loss of key ecosystem functions. Brush and shrubs continue to be a part of the understory, contributing to the increased fire behavior potential.

Surface fuel loadings remain high, with potential to increase due to continued full fire suppression direction. In the absence of fire, or treatment, understory vegetation remains, increasing the ladder fuels (vertical component) leading to increased fire behavior and mortality of overstory trees.

The use of fire as a tool for restoration would continue to be a challenge for fire managers. Planned prescribed fires would be complex, requiring a large organization to ignite, patrol and monitor the controlled burn. A large organization, with extended patrol and monitoring can increase the cost of the prescribed fire, resulting in the burns becoming cost prohibitive. In the absence of treatment, the use of prescribed fire could have a detrimental effect on the landscape, resulting in high mortality of overstory trees or an increased risk of escape.

3.2.2 - Effects of Proposed Action

3.2.2.1 Fire Regime Condition Class

Overall, the fire regime condition class would start moving towards historic conditions. Through the completion of treatments, vegetation characteristics and fuel composition would start returning to natural levels. The fire adapted ecosystem would begin to build resiliency to future disturbances.

Mechanical and hand treatments would start the process of reducing the 85% of Fire Regimes I and IIA currently in FRCC 2 or FRCC 3 to Fire Regime Condition Class 1. Proposed treatments would prepare the landscape for the use of prescribed fire. After treatments and prescribed burning, these areas would be functioning within the natural range, and the risk to key ecosystem components, such as soils and water quality would be low. Prescribed fires are designed to be less severe and would be expected to have less effect on water quality and soils (Neary 2005). For more details about effects to soils and water quality, please refer to the Soils Report and Hydrology Report which are incorporated by reference and included on the project website.

Restoring the fire adapted ecosystem would create a buffer along the southeast boundary of the Badger Creek Wilderness area. Returning these lands to the natural fire regime would create opportunity for the future use of naturally ignited wildland fires in the wilderness area. By treating the fuels and establishing a prescribed fire rotation along the boundary, the risk and consequences of a wildland fire escaping from the wilderness and impacting communities and other values at risk would be reduced.

3.2.2.2 Fire Behavior

Through successive treatments, utilizing the principles of fire resistance, which include thinning (decrease crown density, leave large trees), mastication (increase crown base height), pruning (increase crown base height), hand and mechanical piling of fuels (reduce surface fuels), pile burning and use of prescribed fire (reduce surface fuels), a transition in observed fuel models would occur. At the completion of all treatments, Fuel Models TL 4 and TL 8 would comprise 70-75% of the fire adapted landscape in the planning area, compared to 25% under current conditions. As Table 4 shows, Fuel Models TL 4 and TL 8 have predicated mortality rates under 30% and scorch heights under 20 feet, both traits of a low severity fire. Project design and values to other resources account for maintaining a diversity of all fuel models. Other fuel models would primarily be found in the Late Successional Reserves and Riparian Reserves of the fire adapted ecosystem. Maintaining 25-30% of the area in other fuels models would provide potential for mixed severity fire to occur on the landscape during a prescribed fire or wildland fire.

Proposed activities would reduce the surface fuel loadings to 10-15 tons per acre, thin understory vegetation, prune lower limbs of trees, masticate brush and shrubs. Such treatments would have a direct effect on reducing the horizontal and vertical continuity of fuels. Rearrangement and reduction of surface fuels would break up horizontal continuity, creating barriers to surface fire spread. The proposed treatments would break up the vertical continuity by removing excessive ladder fuels and increasing the canopy base height to over 10’. Dead and downed wood would be removed, but project design criteria have been developed for wildlife and soil considerations. For more details about effects to wildlife and soils, please refer to the Wildlife Report and Soils Report which are incorporated by reference and included on the project website.

Proposed treatments would reduce canopy cover to an average of 48%. The use of variable density thinning (VDT) from below would be used to create openings in the canopy. Variable density thinning has been used to create a forest structure with a density of large trees and species composition similar to that found prior to logging and long-term fire exclusion (Knapp 2017). Thinning from below can mimic the non-regeneration function of a low severity fire; killing of smaller trees and keeping the understory open. A silvicultural treatment that thins from below would remove the smaller trees, promoting diameter growth, while retaining the larger, more resilient trees (Weatherspoon 1996a, Knapp 2017, McCaskill 2018). Thinning, along with fuels reduction treatments, were recently shown to recover tree biomass within 13 years of harvest. The recovered tree biomass was stored in fewer, larger trees (Clyatt 2017).

Upon completion of hand and mechanical treatments, this area would be in a condition conducive of prescribed fire use. Research has consistently shown that thinning treatments and thinning with burning treatments in a ponderosa pine forest can restore low severity fire due to changes in forest structure (Fulé 2012). Knapp (2017) also concluded that a variable density thinning followed by burning produced the best outcome in terms of structure most similar to those once created by frequent fire, which combined with low surface fuel loads, provides the greatest protection from future high-severity wildfire. Additionally, thinning before burning increases the minimum distances between overstory trees, reducing the fire stress placed upon individual trees by providing for more heat dissipation during prescribed fire (McCaskill 2018).

As a standalone treatment, lower intensity prescribed fire is shown to be insufficient to restore structure to long-unburned forests (Sackett 1996; North 2007; Collins 2011; Knapp 2017). Lack of substantial overstory change can be attributed to trees too large to easily kill with prescribed burns or burns of insufficient intensity. Burning under benign fire weather conditions, typical of a spring or late fall burn, tend to produce less ecological change than a wildfire occurring during the dry summer season, when fuels are drier and temperatures are hotter (Knapp 2017). In the absence of mechanical treatments, prescribed fires would need to be of a moderate intensity or higher to produce the change required for restoration. Implementing a prescribed fire of higher intensity is substantially more challenging due to an increase in fire behavior, increased risk of escape, increase in duration of the event and the amount of resources, specifically, a larger organizational need to conduct the burn.

Fuels reduction and thinning treatments have generated concerns with the potential to affect the microclimate (increased winds and drier fuels) post treatment. Concerns are related to the potential of increased fire behavior in the treated stands, negating the benefit of the fuels reduction treatment. Studies show that the increase in rate of spread and flame length predicted from the slight increases in the wind speed is inconsequential and unlikely to pose a problem for suppression efforts (Bigelow 2012, Van Wagtendonk 1996). Conversely, if understory wind speeds are only slightly elevated, they may assist prescribed burning because light winds can help prevent crown scorch by dissipating heat more quickly (Waldrop 2012). The combination of mechanical treatments followed by prescribed burning has proven to be the most effective at reducing potential fire behavior and effects (Vaillant 2009).

Prescribed burning and pile burning would have the potential to provide an ignition source for a wildfire, but control and management[2] of the burn would minimize the risk. Prescribed fire would produce smoke and have potential to affect air quality around the local communities. Project design criteria have been developed to utilize best burn practices to minimize smoke production and increase burn efficiency (OAR 2019).

3.2.3 - Effects of Shelterwood Alternative

3.2.3.1 Fire Regime Condition Class

Proposed treatments of the Shelterwood alternative option would have the same effects on the fire regime condition class. Proposed shelterwood treatments are outside the fire adapted ecosystem and would not effect changes to the FRCC.

3.2.3.2 Fire Behavior

Proposed treatments associated with the Shelterwood alternative would have the potential to indirectly reduce fire behavior in the eastern portion of the planning area. The shelterwood alternative would provide for increased canopy openings, reducing the potential for crown fire initiation and sustainability, providing opportunities for safe firefighter engagement and increasing success of initial attack resources. Reduced crown fire potential may indirectly lead to less stand replacing fire impacting the drier, eastern portion of the planning area.

See section 4.2.3. Shelterwood Alternative for further analysis of this alternative.

3.2.4 - Cumulative Effects

Cumulative effects are impacts on the environment that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions.

Previous projects analyzed for cumulative effects include the Rock Creek Sapling Thin and Underburn project from 2012 and the Rocky Restoration project from 2018. These projects were looked at due to their proximity to the Grasshopper Project planning area and the similarities in proposed treatments for fuels reduction. Rocky Restoration is adjacent to, and directly south of the Grasshopper planning area. Rock Creek Sapling Thin and Underburn is south and east of Grasshopper by 4 miles. Both Rocky Restoration and the Rock Creek Sapling Thin project are in implementation and are being considered in cumulative effects.

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[2] Prescribed burning would occur under a Prescribed Fire Management Plan, in accordance with Forest Service Manual direction; FSM 5142.6

All three projects propose treatments that would restore fire adapted landscapes with intent to return fire to the ecosystem. An increase in prescribed fire use would affect air quality, with the potential to impact the communities of Wamic, Pine Hollow and Tygh Valley. Cumulative effects of smoke and quantity of smoke is governed by the Oregon Department of Forestry through their Smoke Management Rules. The proximity of these projects to one another would not increase the amount of smoke impacting residents on a daily basis. Daily smoke production is governed by the State of Oregon and limits are set each day for the amount of acres allowed to be ignited. Any form of prescribed burning would follow the Oregon Department of Forestry smoke management rules (OAR 2019). Please see the Air Quality report for more information.

3.2.5 - Degree to Which the Purpose and Need is Met – Proposed Action

One objective of the Grasshopper Restoration project was to enhance and restore forest diversity, structure, and species composition. Treatments designed to restore the fire adapted ecosystem directly achieve this objective through the proposed action. Treatment types have been designed based upon the four principles of fuels reduction with the intent of returning fire to the ecosystem. It may take one or more uses of prescribed fire before the landscape has fully returned to its historic condition, but the benefits of restoration treatments would be seen after each successful entry.

Another intent of the project is to maintain a road network that provides for public and firefighter safety in the event of a wildfire. Restoration activities in the eastern part of the planning area directly achieve this goal. Restoring the fire adapted landscape would lessen fire behavior along Forest Service Road 4811 by modifying fuel profiles to a more open understory, with minimal surface fuels. Under the proposed action, the landscape begins to transition towards FRCC 1 and the fuel models come into alignment with characteristics of low intensity fire. This creates a fire environment where firefighters can use direct attack actions on wildland fires and can safely provide egress to evacuating publics.

3.2.6 - Degree to Which the Purpose and Need Met – Shelterwood Alternative

The shelterwood alternative does not propose shelterwood treatments in the fire-adapted ecosystem. As a result, within the fire-adapted ecosystem, direct effects would be the same for both Alternative 1 and Alternative 2. Treatment activities would continue to meet the purpose and need as outlined above (3.2.5)

3.3 - Consistency with Management Direction- Eastern Units and the Fire-Adapted Ecosystem

The proposed action and the shelterwood alternative are consistent with the Mt Hood Forest Plan, as amended, including all standards and guides for forest protection and air quality.

Treatments in the proposed action and shelterwood alternative are consistent with the Roadless Area Conservation Rule (RACR) §294.13. The applicable exception situation is 294.13(b)1(ii): To maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period. Please refer to section 3.14 of the EA for more information.

3.4 – Summary of Effects - Eastern Units and the Fire-Adapted Ecosystem

Table 5 compares the effects of no action to the proposed action and the shelterwood alternative. No action would result in a higher likelihood of a high severity fire while fuels reduction treatments are shown to be effective at reducing burn severity within a large wildfire (Dodge 2019). In regards to restoring the fire adapted ecosystem, both the proposed action and the shelterwood alternative have the same effect.

Table 5. Summary Comparison: Eastern Units and the Fire-Adapted Ecosystem

Resource Element	Indicator or Measure	No Action	Proposed Action	Shelterwood Alternative
Fire Resistance	Fire Regime Condition Class	85% of Fire Regime I and IIIA remain in FRCC 2 or 3 and at risk for uncharacteristic wildfire effects. In the absence of disturbance or treatment, FRCC 1 conditions transition towards FRCC 2. Overtime, all areas of the fire adapted ecosystem would be outside historic conditions and at risk for loss of key ecosystem components. Higher likelihood of an uncharacteristic high severity fire.	A variety of treatments occur. Surface fuels are reduced to 10-15 tons per acre and understory vegetation is thinned removing ladder fuels. Variable density thinning from below reduces canopy cover to 48%, removing smaller trees while retaining the larger more resilient trees. The use of prescribed fire is incorporated into fire management planning and the fire adapted landscape begins to transitions back towards FRCC 1, operating within historic range of normal. Fuels reduction would reduce burn severity within a large fire.	Shelterwood alternative would have the same effect as the proposed action.

Resource Element	Indicator or Measure	No Action	Proposed Action	Shelterwood Alternative
Fire Resistance	Fire Behavior	High loads of brush and shrubs create conditions leading to increased fire behavior and uncharacteristic wildfire effects. Fuel models not indicative of low severity fire dominate the fire adapted ecosystem. Increased fire spread, flame lengths and overstory mortality are possible during wildland or prescribed fire events. Higher likelihood of an uncharacteristic high severity fire.	Treatments would remove brush, shrubs and thin overstocked stands to modifying fuel profiles. Fuel models indicative of low severity fire (TL 4and TL 8) comprise the 75% of the fire adapted landscape. 25% remains in other fuel models to account for mixed severity disturbances. Flame lengths are low, spread rates are slow and low mortality in overstory trees can be expected. Restoration treatments would reduce fire behavior along FSR 4811, supporting a road network that allows for public and firefighter safety.	Shelterwood alternative has the potential to provide an indirect effect of reducing fire behavior. By further reducing crown fire potential along the 4860 road, initial attack success is increased, reducing the potential of stand replacing fire impacting the eastern planning area

4.0 –Analysis of the Alternatives for Western Units and Wildland Fire Risks

Proposed treatments are designed to create a resilient ecosystem, allowing for natural processes to play their role in the ecosystem, while minimizing the extent and severity of wildfires.

4.1 - Existing Condition - Western Units and Wildland Fire Risks

Western Portion of the Planning Area

Not all lands in the Grasshopper planning area are characterized as a fire adapted ecosystem. To the west, the landscape increases in elevation and transitions to a mixed conifer forest, depicted by a stand replacing fire regime. These are categorized as Fire Regime IVC and VA (Evers 2002). Fires burn with high severity and have a long return interval. A return interval of 100-200 years is considered in the range of normal for disturbance events.

Wildfires starting in the higher elevations and moving east, pushed by predominately west winds, are a concern to the communities adjacent to National Forest System lands. A stand replacing fire originating in the Badger-Tygh subwatershed has the potential to detrimentally affect ownerships east of the Forest boundary, under worst case scenarios a fire beginning in Badger Creek could threaten the communities of Wamic, Pine Hollow and Tygh Valley (USDA 1995). This scenario developed in 1973, when the Rocky wildfire started in an area just south of the Grasshopper planning area. The Rocky wildfire burned over 7500 acres of National Forest and private lands, threatening those communities. In 2005, Wasco County, Oregon created a Community Wildfire Protection Plan (CWPP). This plan identified the Pine Hollow Wildland Urban Interface (WUI) as the area with the highest hazard risk rating of those analyzed in the CWPP (Hulbert 2005). The eastern portion of the Grasshopper planning area extends into the Pine Hollow WUI.

This area of the Grasshopper project is considered part of the crest zone in the White River Watershed Analysis.

Stand replacing fire is described as a fire that is lethal to most of the dominant above ground vegetation and substantially changes the vegetation structure. Stand replacement may occur through crown fires or high severity surface fires or ground fires. This type of disturbance is characterized by major changes in wildlife or fish habitat, as well as ecologic function (USDA 1995).

Three major disturbance types (fire, insect and disease) interact to create large openings and elaborate vegetative mosaics in this area. When a stand replacing fire event occurred, several hundred to several thousand acres would burn. Following a large scale disturbance, brush fields would cover the area for 10-20 years, then conifers would begin to dominate. In 20-50 years, fuel loadings would be sufficient to allow a re-burn in the footprint of the disturbance (USDA 1995).

A review of the Grasshopper Fire Regime Condition Class map (Figure 2) shows this area in FRCC 1 or FRCC 2. Table 6 shows the current percent of each condition class in Fire Regime IVC and Fire Regime VA.

Table 6. Percent of Fire Regime in corresponding Fire Regime Condition Class

Fire Regime	Acres	FRCC 1 (Acres)	FRCC 1 (%)	FRCC 2 (Acres)	FRCC 2 (%)	FRCC 3 (Acres)	FRCC 3 (%)
IVC – (100-200 years, stand replacing)	3692	1128	31%	2564	69%	0	NA
VA – (200-400 years, stand replacing)	18	0	NA	18	100%	0	NA

While there is a large percentage (70%) of the stand replacing fire regimes in FRCC 2, overall this area of the Grasshopper project is operating in the range of normal. However, conditions can be found in these areas that are reflective of the departure from normal and are notably the increase in downed woody material, or surface fuels. This was also highlighted as a critical trend in the disturbance processes for the crest zone of the White River Watershed Analysis. It was noted that while most or all the natural disturbance processes appear to be operating with the range of natural conditions, if the current policy of fire exclusion continued, unnatural levels of fuel buildup may occur, even in the crest zone (USDA 1995).

Conditions exist (excessive ladder fuels, continuous surface fuels and continuity in overstory trees) for stand replacing wildland fires to occur in, and around, the mixed conifer of the Grasshopper planning area. Crown fires, or a high severity surface fire can be expected in this area during periods of high to extreme fire danger. However, limited opportunities exist for firefighters to perform direct, or indirect, attack on an emerging wildland fire that occurs in these fuels. When conditions (topography, weather and fuels) align, firefighting resources may not be able to safely engage in fire suppression efforts, or to facilitate evacuations of forest users, no matter the fire danger.

Stand replacing fire is infrequent and an ignition is difficult to predict. Despite the infrequency of these fires, a need to provide suppression options and areas of engagement still exists. Current Forest policy dictates a suppression response to all wildfires (USDA 1990). As noted in the White River Watershed Analysis (USDA 1995), there is a concern for fires originating to the west and fanned by strong west winds during intense thermal lows. There is a need to create fuel breaks along ridge tops and roads, knowing that their design is not intended to stop fire, but allow suppression resources a higher probability of success in attacking a wildland fire. Effectiveness is also dependent on the psychology of firefighters regarding their safety; as such, narrow or unmaintained fuel breaks are less likely to be entered than wider, well-maintained ones (Agee 2000).

Proposed fuels treatments in the more western portion of the planning area, characterized by higher elevation mixed conifer, are designed to provide for public and firefighter safety in the event of a wildfire, as well as reduce wildfire threats to communities and resources. This area includes a National Recreation Area, areas accessing Wilderness, and Inventoried Roadless Areas, all values that members of the public would consider socially unacceptable to lose (USDA 1995).

Given current conditions, the continued suppression of wildfires exacerbate the overly dense stands and excessive fuels. To mitigate wildfire losses, some form of active management needs to occur in conjunction with suppression efforts (Weatherspoon 1996a).

4.1.1 - Resource Indicator – Fire Behavior

A comparison of fuel models that comprise the stand replacing fire regimes can provide insight into expected fire behavior in the event of a wildland fire. Fuel models were selected to account for existing levels of fine woody debris and coarse woody debris (USDA 2020b), and their impacts to fire behavior. In addition to increased levels of downed woody material, areas of vegetation with an abundance of ladder fuels and dense tree canopies exist. Excessive amounts of ladder fuels, and tree species type, have resulted in low canopy base heights (<2’) in this area. Current canopy bulk density values are high enough to sustain an active crown fire (Peterson 2003). The following fuel models were used to analyze the stand replacing fire regimes of the Grasshopper project:

- **TU 5**: Heavy timber litter with shrubs and small trees in the understory. Spread rates are moderate and flame lengths are moderate.
- **TL 3**: Moderate levels of timber litter, with a light amount of downed wood. Spread rates are low and flame lengths are low.
- **TL 4**: Moderate levels of timber litter and downed wood. Small logs contribute to fire spread. Spread rate low, flame lengths generally low.
- **TL 5**: High levels of timber litter and downed wood. Mortality contributes to increased levels of downed wood. Spread rates low, flame lengths generally low.

Overall, the majority of this part of the planning area has moderate to heavy amounts of downed wood. Additionally, understory vegetation contributes to fire behavior, so the TU 5 fuel model was analyzed. Figure 3 is representative of a TL 5 and TU 5 condition.

Figure 3. High levels of downed wood with small trees in understory.

To determine fire behavior under current conditions, modeling used a singular input (one fuel model), or in this scenario, used a blend of two fuel models. Calculated outputs can provide fire managers, and firefighters, with an insight into expected fire behavior. Relevant information includes rates of spread (chains per hour), flame lengths, transition to crown fire and potential fire growth. Table 7 shows modeled fire behavior of current conditions in the stand replacing fire regimes.

Table 7. Fire Behavior outputs; 90th percentile fuel moistures; 10 mph winds.

Fire Behavior Output	TU 5	TL 3	TL 4	TL 5	TL 5/TU 5
Rate of Spread (ch/hr)	7.7	1.7	2.4	3.7	6.3
Flame Length (feet)	7.1	1.1	1.4	2.1	7.1
Transition to Crown Fire	Yes	No	No	No	Yes
Spotting Distance (miles)	0.3	0.2	0.2	0.2	0.3
Estimated Size (acres) – 2 hours	11.1	0.5	1.1	2.7	7.6

Firefighters responding to reported wildfires in these types of fuels can expect higher flame lengths, increased rates of spread, single and group tree torching and short to long range spotting. These types of fire behavior conditions are considered normal for this part of the planning area, however, they pose challenges during initial attack efforts.

Table 8 shows the relationship of fire flame lengths to suppression resources and corresponding capabilities to hold and control a wildland fire (Andrews 2011).

Table 8. Relationship of surface fire flame length to suppression interpretations.

Flame Length (feet)	Interpretation
< 4	Fires can generally be attacked at the head of flanks by persons using hand tools. Hand line should hold the fire.
4 – 8	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 – 11	Fires may present serious control problems: torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
> 11	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Under current conditions, there are limited opportunities for fire suppression resources to safely engage an established wildland fire. Continuity of fuels, vertically and horizontally, support large fire growth, as depicted in Table 7. Within 2 hours, areas with a continuous understory component can have a fire size upwards of 12 acres. Two hours is a reasonable expectation for a response time of an initial attack resource arriving at this location. Combined with expected flame lengths above 4 feet, initial attack resources would need to be supplemented with aircraft or heavy equipment. Few areas along Forest Service Road 4860 and 4811 exist where suppression efforts could slow, or limit fire growth.

4.2 - Environmental Consequences - Western Units and Wildland Fire Risks

The effects analysis has been evaluated for the No Action, Proposed Action and for the Shelterwood Alternative.

Analysis took into consideration the placement of thinning treatments and fuels reduction treatments to reduce the extent and severity of wildland fires.

4.2.1 – Effects of No Action

No treatments would occur and the stand replacing fire regimes would continue to be in the range of normal. Natural processes will continue, adding to the dead and downed fuel loading and existing understory vegetation. Wildland fires would be able to spread through surface fuels and transition into the canopy. This can result in high rates of spread, spotting, torching and crown fire potential, all indicators of extreme fire behavior.

When conditions align, a wildland fire can be expected to exceed initial attack actions and become a large fire (NWCC 2020). Limited opportunities remain for fire suppression resources to limit fire spread, or reduce the extent of, a large fire. When a stand replacing fire occurs, it would pose a risk to firefighters and the public, as well as impacting local communities, recreation and wilderness areas. With limited natural barriers, and no created barriers, the potential for a wildland fire to spread from the west to the east, as noted by the White River Watershed analysis (USDA 1995) remains.

Not all wildfire ignitions will become stand replacing, high severity fires in this area. During periods of average fire conditions, or low to moderate fire danger, low rates of spread with lower flame lengths can be expected in all fuel model types. Initial attack suppression efforts would have a high probability of success during average fire conditions.

4.2.2 - Effects of Proposed Action

Proposed treatments would create a fuel break between an area with natural resource values and public safety concerns. Proposed actions would treat approximately 2,050 acres of the 3,700 acres of the stand replacing fire regime in the planning area to reduce the risks associated with high severity wildfires. The proposed action would thin from below with a variable density and intermediate thinning, creating a patchwork of treatments, with variability in spatial arrangement. The proposed action would be expected to create some overlap in treatment locations. In areas where no overlap occurs, a wildland fire could burn unchecked through corridors between treatment blocks (Finney 2001).

Through successive treatments, utilizing the principles of fire resistance, which include thinning (decrease crown density), pruning (increase height to live crown), hand and mechanical piling of fuels and pile burning (reduce surface fuels), a transition in observed fuel models would begin. At the completion of treatments, vegetation and fuel characteristics represented by fuel models TL 3 and TL 4 would be the dominant fuel models found throughout the treated stands of the stand replacing fire regime, primarily concentrated along Forest Service Roads 4860 and 4811. These fuel models are characterized by lesser fire behavior. Proposed action treatments would reduce vegetation and characteristics that are attributed to TU5 and TL5 fuel models.

Heavier surface fuels, with a shrub and tree understory and dense canopy cover would remain; however, these conditions would primarily be located within the National Recreation Area and Inventoried Roadless areas and away from FSR 4860 and FSR 4811. This would maintain the integrity of the stand replacing fire regime, with parts of the planning area still at risk for high severity fire. Leaving some untreated areas at the landscape scale and providing for within-stand spatial heterogeneity of residual trees and shrubs are important components. Proposed treatments would help meet the goals of reducing ecosystem loss due to stand replacement fire while restoring forest habitats.

Proposed activities would reduce the surface fuel loadings to 20-25 tons per acre, thin understory vegetation, prune lower limbs of trees and increase crown spacing through intermediate and variable density thinning (VDT) from below. The proposed actions would modify fuel profiles from TU5 and TL5 fuel models, to fuel profiles associated with TL3 and TL4 fuel models. This would occur by reducing or rearranging surface fuels and removing excessive ladder fuels. Such treatments would have a direct effect on reducing the horizontal and vertical continuity of fuels. Treatments would reduce the fine woody debris that lead to fire starts, spread and higher fireline intensity (Rothermel 1983, Raymond 2005, NWCG 2007). With modification of fuel profiles, reduced rates of spread, lower flame lengths and decreased spotting distances can be expected as indicated in Table 7. Downed woody material would be removed, but project design criteria have been developed for wildlife and soil considerations.

Proposed action vegetation treatments would reduce canopy cover from approximately 62% to an average of 48%. This would be achieved through a variable density thinning from below. Canopy continuity would be moderately to largely decreased, however, single and group tree torching with passive crown fire remains possible. Canopy base heights would be increased and canopy bulk densities would be decreased leading to an overall reduction in crown fire initiation, development and spread (Peterson 2003, Graham 1999).

Opening the canopy would increase sunlight reaching the forest floor and would increase the surface wind speeds. These factors are a concern in their potential to alter fire behavior by increased drying of surface fuels and increased rates of spread. An increase in the overall fire hazard could be expected following a thinning if activity generated fuels and natural fuels are not reduced concurrently with the thinning. Where thinning is followed by sufficient treatment of surface fuels (reducing loading and continuity), the overall reduction in expected fire behavior and fire severity outweigh the changes in fire weather factors attributed to increased wind speed and decreased fuel moistures (Weatherspoon 1996a, Van Wagtendonk 1996, Graham 1999, Bigelow 2012). Proposed treatments would indirectly reduce future fine woody debris recruitment that leads to fire spread. Stands opened by harvesting reduces tree densities, resulting in fewer branches accumulating on the forest floor. Additionally, increased sunlight exposure and precipitation through-fall to the forest floor in open stands increases surface fuel decomposition rates (Clyatt 2017).

Without future maintenance, proposed actions designed to reduce fire severity and extent would lose their effectiveness over time. This issue has been raised by collaborative groups and members of the public. Specific concerns brought forward include new vegetation growth and the impacts to fire behavior. The White River Watershed Analysis (USDA 1995) references the development of brush fields after a large scale disturbance. Similar ingrowth of brush could be expected upon completion of the proposed actions. Timing of maintenance needs is unknown, however the watershed analysis references fuel loadings would be susceptible to a re-burn in 20-50 years after a disturbance (USDA 1995). Although the degree of manipulation and the maintenance schedule may vary, it is understood that maintenance is essential for traditional fuel breaks (Agee 2000, Peterson 2003). Future needs that arise would be analyzed for at that time. Although the degree of manipulation and the maintenance schedule may vary, maintenance is essential for area treatments, as much as it is for traditional fuel breaks (Agee 2000, Peterson 2003).

Prescribed burning and pile burning would have the potential to provide an ignition source for a wildfire, but control and management[3] of the burn would minimize the risk. Prescribed fire would produce smoke and have potential to affect air quality around the local communities. Project design criteria have been developed to utilize best burn practices to minimize smoke production and increase burn efficiency (OAR 2019). For more details please see the Air Quality Report which is incorporated by reference and included on the project website.

Not all wildfire ignitions will become stand replacing, high severity fires in this area. In periods of low to moderate fire danger, or average fire conditions, low rates of spread with lower flame lengths can be expected, with higher success of initial attack suppression efforts.

4.2.3 – Effects of Shelterwood Alternative

The effects of the shelterwood alternative would establish a more robust fuel break along FSR 4860 when compared to the proposed action. The scoping process revealed that no fuels reduction treatments can occur on the west side of FSR 4860 because they are inside of the National Recreation Area. The National Recreation Area only permits fuels treatments if they are to reduce effects of uncharacteristic wildfire. However, if a wildfire were to occur in these areas it would not be considered uncharacteristic. Therefore, the units were dropped from

[3] Prescribed burning would occur under a Prescribed Fire Management Plan, in accordance with Forest Service Manual direction; FSM 5142.6

consideration. The shelterwood alternative was created to account for the loss of treating both sides of FSR 4860 by increasing treatment overlap. The shelterwood alternative would create a linear break treatment in combination with a patchwork of treatments to the east. This combination would create overlap in treatment units. Modeling shows slower spreads rates in treated units and in the fuels between the overlapping regions of the treatments where fire would be forced to flank (Finney 2001). Additionally, shelterwood treatments build upon the fire resistance principles of the proposed action by further reducing fuels and by further decreasing crown density.

Along Forest Service Road (FSR) 4860, approximately 2.0 miles would be treated using a shelterwood harvest to further reduce fire severity and extent. Proposed shelterwood treatments would replace variable density thinning from below treatments in select units on the east side of FSR 4860. Along the 2.0 mile stretch, encompassing units 151, 163, 173, 184, 191, 201, 219, 223, 226 and 272, proposed shelterwood treatments on approximately 284 acres would reduce canopy cover from an average of 85% (in these units) to 35%. This would create more space between tree crowns and provide more depth to the break in overstory continuity. Additionally, units proposed for shelterwood treatment would further reduce surface fuels to 15-20 tons per acre. All other fuels reduction treatments would be the same as in the proposed action alternative.

FSR 4860 is a linear feature along these 2.0 miles. There are no sharp bends in the road and the elevation remains fairly constant. Placed along a ridgetop and a road, this treatment would provide for greater potential of being an operational control line during a wildland fire. Suppression efforts have an increased likeliness to impede fire spread when they are focused along roads, as they provide access for firefighters and the interactive effect of topography, as often times roads are located on ridgetops. Similarly the ability of fuels treatments to impede fire spread may be enhanced when coupled with suppression efforts (Holsinger 2016). Proposing these units for shelterwood treatments would reduce canopy cover to a lower extent than the proposed action, while maximizing the road and ridgetop location. These factors combine to create a more effective fuel break between areas with public safety concerns and areas with resource values (Weatherspoon 1996b). In addition, at the landscape scale, a well-designed fuel break along FSR 4860 builds upon fuels reduction work completed through the Rocky Restoration Project, adjacent too, and south of the Grasshopper planning area.

Direct effects from proposed shelterwood treatments would further lower canopy bulk density and further increase canopy base heights compared to a VDT from below treatment. This would require higher flame lengths and higher winds to initiate tree torching in the shelterwood treated area. Shelterwood treated units would be more protected from a crown fire that originated from an adjoining stand. Shelterwood methods and all of their variations would have the potential to reduce the severity and intensity of wildfires. Open stands with low crown bulk densities would not likely support a crown fire when the regeneration was short (Graham 1999).

To maximize fuel treatment effectiveness, the surface fuels would be reduced to 15-20 tons per acre in the units proposed for shelterwood treatment. The combination of further reducing surface fuels, and less natural recruitment after a shelterwood, provide for sustained effectiveness of the fuels reduction treatment. A higher reduction in 1 hour fuels, which is a component of fine woody debris, would be expected in the shelterwood treated units. A 23 year study show shelterwood treated areas, in conjunction with fuels reduction, had up to 87% less accumulation of 1 hour fuels compared to the untreated areas (Clyatt, 2017). The conventional thinning had up to 62% less accumulation. Shelterwood treatments show a potential of 25% less accumulation of 1 hour fuels, a primary component of fire spread.

An indirect effect of shelterwood treatments would be the increase in ladder fuel development reducing canopy base height. A shelterwood treatment is designed to promote regeneration. If the regeneration is not pre-commercially thinned, the subsequent development of ladder fuels would increase potential for crown fire behavior (Graham 1999). The shelterwood alternative may require maintenance earlier compared to the proposed action alternative.

Areas not proposed for shelterwood treatments would have the same effects as described in the proposed action alternative. Similarly, indirect effects identified under the proposed action (Section 4.2.2) would be the same under the shelterwood alternative.

4.2.4 - Cumulative Effects

Cumulative effects are impacts on the environment that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions.

Previous projects analyzed for cumulative effects include the Rock Creek Sapling Thin and Underburn project from 2012 and the Rocky Restoration project from 2018. These projects were looked at due to their proximity to the Grasshopper Project planning area and the similarities in proposed treatments for fuels reduction. Rocky Restoration is adjacent to, and directly south of the Grasshopper planning area. Rock Creek Sapling Thin and Underburn is south and east of Grasshopper by 4 miles. Both Rocky Restoration and the Rock Creek Sapling Thin project are in implementation and are being considered in cumulative effects.

All three projects propose treatments that would restore fire adapted landscapes with intent to return fire to the ecosystem. An increase in prescribed fire use would affect air quality, with the potential to impact the communities of Wamic, Pine Hollow and Tygh Valley. Cumulative effects of smoke and quantity of smoke is governed by the Oregon Department of Forestry through their Smoke Management Rules. The proximity of these projects to one another would not increase the amount of smoke impacting residents on a daily basis. Daily smoke production is governed by the State of Oregon and limits are set each day for the amount of acres allowed to be ignited. Any form of prescribed burning would follow the Oregon Department of Forestry smoke management rules (OAR 2019). For more details please see the Air Quality Report which is incorporated by reference and included on the project website.

4.2.5 - Degree to Which the Purpose and Need is Met

In the shelterwood alternative, canopy cover would be decreased more when compared to the proposed action. This would provide more depth to areas of engagement for firefighters and provide less overstory continuity for crown fire sustainability and initiation. In addition, tons per acre would be reduced more within the shelterwood units. Table 9 compares the proposed action and the alternatives and their relation to the purpose and need.

Table 9. Summary comparison of how the alternatives address the purpose and need.

Purpose and Need	Indicator/Measure	Existing Condition	Proposed Action	Shelterwood Alternative
Reduce risk high intensity wildfire	Fire Behavior – Reduce surface fuels	> 25 tons/acre	20-25 tons/acre	15-25 tons/acre
Reduce risk high intensity wildfire	Fire Behavior – Increase crown base height	< 2’	> 20’	> 20’
Roads - Firefighter and Public Safety	Defensible space – Canopy Cover	61%	48%	35%

4.3 - Consistency with Management Direction - Western Units and Wildland Fire Risks

The proposed action and the shelterwood alternative are consistent with the Mt Hood Forest Plan, as amended, including all standards and guides for forest protection and air quality.

4.4 – Summary of Effects - Western Units and Wildland Fire Risks

Table 10 compares the effects of no action to the proposed action and the shelterwood alternative. This summary is in regards to reducing wildland fire threats in the western units. The proposed action and shelterwood alternative show that a management scheme which includes fuel treatments in combination with other land management scenarios is critical for successfully reducing the size and intensity of wildfires (Van Wagtendonk 1996).

Additionally, the conclusion that there will always be a role for well-designed fuel break systems which provide options for managing entire landscapes, including wildfire buffers, anchor points for prescribed natural fire and management-ignited fire, and protection of special features (Omi 1996) especially applies for this project and in this location. Approximately 2.0 miles of road, in a north to south line, would be treated to reduce the extent of stand replacing wildfires that typically move in a west to east direction. As noted by Finney (2001), it is clear that the greatest reduction in fire size and severity occurs when fuel treatment units limit fire spread in the heading direction.

Table 10. Summary Comparison – Western Units and Wildland Fire Risks

Resource Element	Indicator or Measure	No Action	Proposed Action	Shelterwood Alternative
Fire Resistance	Fire Behavior	Conditions remain for large, stand replacing fire events. A fire originating from the west has the potential to move east and impact communities and other values at risk. In times of drought and/or higher fire danger, initial attack actions would be challenging with limited options for safe engagement. Initial attack actions would be successful in normal weather conditions.	2,050 acres would be treated to reduce risks associated with stand replacing fire. Canopy cover is reduced to 48% to lessen crown fire risk and initiation. Surface fuels are treated to reduce flame lengths. Canopy base heights are increased to reduce risk of trees torching and initiating crown fire. Proposed treatments would create areas along FSR 4860 and FSR 4811 for firefighters to engage and initiate suppression actions. Surface winds and fuel moistures may increase due to proposed treatments. Overall reduction in expected fire behavior and fire severity outweigh any changes in fire weather factors due to thinning. Maintenance actions would be required to sustain the effectiveness of the fuels reduction treatments.	All proposed actions would carry over into the shelterwood alternative except for 284 acres proposed for shelterwood treatment in place of a variable density thinning from below. Shelterwood treatment would occur on the eastside of FSR 4860. Treatments would reduce canopy cover to 35%, further reducing crown fire initiation and susceptibility compared to the proposed action. Increase in overlap of treatment units. Shelterwood treated units have the potential to require maintenance in few years compared to proposed action. Regeneration would need to be monitored and pre-commercially thinned to maintain effectiveness of fuels reduction treatments.

5.0 – Summary of Alternatives

Compared to taking no action, both the proposed action and the shelterwood alternative would reduce forest fuel loadings, increase crown to height ratios, decrease crown density and retain large trees of resilient species. Both action alternatives would reduce the risks of uncharacteristic wildland fires in the fire adapted ecosystem and would reduce the extent and severity of wildland fires originating from the west, moving upslope and to the east. Proposed treatments in both action alternatives would create defensible space and areas of safe engagement for fire suppression personnel along Forest Service roads.

The shelterwood alternative would provide for a more robust fuel break along FSR 4860 by a further reduction in surface fuel loadings and canopy cover. The shelterwood alternative would create conditions along FSR 4860 less conducive to crown fire initiation and susceptibility, providing an increase in defensible space for fire suppression personnel when compared to the proposed action.

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