United States Department of Agriculture
Forest Service

Forest Vegetation Report

Colville National Forest Plan Revision
Draft Environmental Impact Statement

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Table of Contents

List of Tables

List of Figures

Introduction

This report analyzes the issues of old forest management and timber production as it relates to six different alternatives for the revised forest plan on the Colville National Forest. The classification of vegetation on the forest is described, and the historical range of variation is compared to the current condition. Recent timber harvest levels, as well as projected future levels are described for each alternative. The projected vegetation condition after 100 years is modeled and compared to the historical range of variation for each alternative.

Old Forest Management and Timber Production

The amount of late forest structure across the Colville National Forest has been influenced by fire, land management practices, high levels of bark beetles and defoliating insects, climate variability, and fire suppression. With fire suppression, late seral, shade-tolerant species have increased in proportion to shade-intolerant early seral species. As a consequence, stand structures have changed from relatively open single or two storied stands dominated by large individuals of fire resistant species, to denser, smaller stemmed, multi-layered stands with a high proportion of fire sensitive, late seral species. (Everett et al. 1994, Williams et al. 1995, Hessburg and Agee 2003)

For the Colville National Forest, current late forest structure levels reflect the fire history of the forest. During the period from the 1910s into the 1930s, a number of large scale fires occurred across portions of the landscape (Catlin et al. 2005). Significant numbers of large and old trees were killed in these fires and harvested afterwards. Approaching 100 years after some of these initial fires, forest structure across the landscape has slowly been transitioning into a mid-seral, closed canopy situation. Also, portions of the Colville had unsuccessful homestead activity and the lands once cleared for homestead development are slowly growing into mid-seral, closed canopy stands.

Partially as a result of the past fire history for the Colville, recent (since 1970) fire influenced areas have been minimal. In addition, the Colville has had high success in containing fire starts which has been a priority due to the high levels of adjacent development and wildland urban interface.

Management approaches to promote and retain late forest structure and its effect on timber production were raised and brought forward as an issue within the planning process. To evaluate the effects of different land management alternatives, levels of late forest structure were modeled and estimated after a 100 year period and were compared to the historical range of variability (HRV) values. Late forest structure is but one component of dynamic forest landscapes. Success in providing late forest structure through time requires having stands across the landscape in a variety of developmental stages, from seedlings and saplings, to young forest, and closed-canopy mid-seral forest. Domination of landscapes by late structure forests can lead to a lack of early successional stand stages that are important for a variety of species, as well as providing areas for future late forest structure (Swanson et al. 2010, Swanson 2012).

Timber production on the Colville averaged 35 MMBF (million board feet) per year from 2000-2009, while the average from 2010-2015 was 45.9 MMBF per year (Table 1). Economic, ecological, legal, and social factors affect how much timber production occurs on the National Forest.

Table 1. Timber production on the Colville, 2000-2015. MMBF = Million Board Feet

Fiscal Year	MMBF	Fiscal Year	MMBF
2000	51.1	2010	48.2
2001	23.9	2011	40
2002	22.4	2012	35.9
2003	30.6	2013	46.6
2004	27.6	2014	46.8
2005	18	2015*	57.7
2006	37.4	Total	275.2
2007	34.6	**Avg/Year**	**45.9**
2008	60.9		
2009	43.6		
Total	350.1		
Avg/Year	**35.01**		

*2015 is estimated.

To evaluate the effects between the different land management alternatives, projected timber production output was modeled and compared using current budget levels, as well as an unconstrained budget.

Relevant Laws, Regulations and Policy that Apply

- Multiple-Use Sustained Yield Act of 1960 (16 U.S.C. 528-531).
- National Environmental Policy Act of 1969 (16 U.S.C. 4321 et seq.).
- National Forest Management Act of 1976 (16 U.S.C. 1600-1614, 472a).
- 1982 Planning Rule.

Affected Environment

Background

The Colville National Forest is considered to be part of the Northern Rocky Mountains, with the Kettle River Range on the west half of the forest, and the Selkirk Mountains defining the eastern half. The Cascade mountain range lies to the west of the area and has a significant influence on precipitation patterns and rain shadow effects that influence vegetation.

Vegetation on the Colville National Forest is highly complex and varied as a result of a wide diversity of soil parent materials, highly diverse topography, interaction of continental and maritime climatic patterns, significant and persistent disturbance processes that include fire, insects, and disease, and strong influences by larger scale climatic events including the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) (Heyerdahl et al. 2008).

Climate patterns for the Colville are influenced by a transition between an intense rain shadow effect in the west formed by the Cascades, and the inland expression of maritime climate in the east caused by the convergence and uplifting of moist air masses over the Rockies. The result is a considerable west-east variation in precipitation across the forest. This variation can be seen expressed in vegetation from open, dry Douglas-fir types along the Okanogan-Ferry County line on the western boundary of the Forest, to more moist redcedar-hemlock vegetation types near the Idaho border on the eastern boundary of the Forest (Williams et al. 1995).

Soil parent material is highly varied and originates from sedimentary, igneous, and metamorphic processes. The entire area has been influenced by glaciation and has been covered by major continental ice sheet advances in the past, as evidenced by rounded off hills and glacial deposits of varying depths. Volcanic influences are also frequently evident with columnar basalt layers and volcanic ash, including deposits from the large Mt. Mazama eruption, as well as more recent deposits from the Mt. St. Helens eruption in 1980 (Quigley 1996).

Methods

Vegetation Composition

Vegetation composition for the planning area was classified based on plant association groups (PAGs), which are groups of plant associations with similar moisture and temperature regimes. The PAG data was produced in 2012 and covers the entire Colville National Forest. Forested PAGs were then assigned to a Landfire biophysical setting (BpS), and a subsequent common name vegetation type. Landfire biophysical settings represent vegetation that may have been dominant on the land before European settlement and are based on an approximation of the historical disturbance regime (LANDFIRE 2007). These biophysical settings provide a good description of general vegetation characteristics, along with historical disturbance regimes, successional pathways, and basic spatial information. They also provide a link between the vegetation analysis presented here and the fire/fuels analysis. See table 4 below, and appendix A for PAG and BpS information.

Forest Structure

Current forest structure information comes from the Landscape Ecology, Modeling, Mapping, and Analysis (LEMMA) Gradient Nearest Neighbor (GNN) data. The GNN data is a consistently interpreted vegetation data set based on an imputation processes utilizing a 2012 Landsat image (GNN 2012). Forest Inventory and Monitoring (FIA) plots, Continuous Vegetation Survey (CVS) plots, ecology plots, and other established vegetation plots were utilized as source data in the imputation process. Table 2 shows how structure types were defined.

Forest tree structure has a great influence on how stands develop, which species are able to grow and reproduce, and has been identified as an important factor in assessing fire behavior as well as providing various wildlife habitats. Forest structural stages are a product of successional processes and include both natural and human influenced disturbance. There are several major disturbance processes that influence forest structural stage development including fire, insects and diseases, windthrow, climate variations such as droughts, landslides and avalanches, and human induced influences such as livestock grazing and timber harvest.

Table 2. Structure class definitions based on canopy cover and diameter

Structure	Definition
Early	Trees less than 10" dbh or canopy cover < 10%
Mid Open	Trees 10-20" dbh, canopy cover ≥ 10% and < 40%
Mid Closed	Trees 10-20" dbh, canopy cover ≥ 40%
Late Open	Trees ≥ 20" dbh, canopy cover ≥ 10% and < 40%
Late Closed	Trees ≥ 20" dbh, canopy cover ≥ 40%

Tree structure is classified into five general groups based on diameter and canopy cover as shown in table 2. Haugo et al. (2015) used a similar approach to defining structure classes, and the GNN data (2012) lends itself well to easily analyzing forest structure at multiple scales using these definitions. The diameter is based on the quadratic mean diameter in inches of trees whose heights are in the top 25% of all tree heights in the stand. This generally means that the diameters of the larger co-dominant trees in a stand are used to define the structure class.

Historical Range of Variability (HRV)

Historical range of variability (HRV) analysis was used to evaluate forest structure. The historical range of variability refers to the dynamic behavior and functioning of ecosystems before dramatic changes occurred with European settlement, generally considered to be the mid-1800s for this area (Aplet and Keeton 1999). The historical range of variability provides a framework to determine changes to ecosystem attributes that have occurred between historical and current conditions and recognizes that ecosystems experience a range of conditions across which processes are resilient and self-sustaining (Figure 1). When allowed to move beyond the limits of the range of variability, ecosystems move into a state of disequilibrium or disorganization (Kaufmann et al. 1994, Holling and Meffe 1996, Egan and Howell 2001).

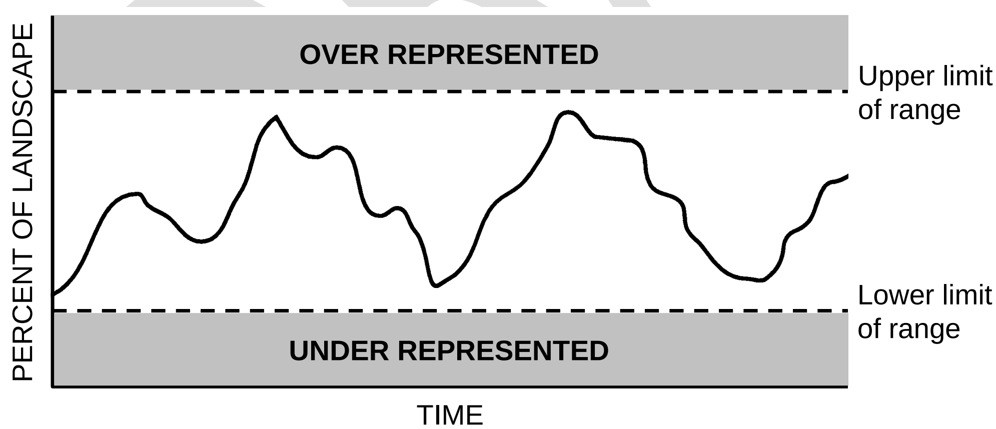

Figure 1. The historical range of variability (HRV) concept illustrated above was used to evaluate whether forest structure is functioning properly in a temporal context (Morgan et al. 1994, Swanson et al. 1994, Aplet and Keeton 1999). Note that conditions occurring above the upper limit of the range are considered to be over-represented; conditions below the lower limit of the range are considered to be under-represented (both representation zones are shown in gray).

Vegetation modeling

A state and transition model, ST-Sim (2014), was used to simulate forest dynamics and development of forest structure through time. This model provided forest structure for each vegetation type, as well as potential timber production outputs. The model was run for 300 years for each vegetation type and average values from years 101-300 were used to develop HRV ranges. The model showed how different potential management areas and actions affect forest structure and forest products through time. Table 3 shows the three actions that were modeled to occur annually, along with estimated acres for each action by vegetation type and alternative. These acres are based on budget assumptions and the requirement to have non-declining timber output over time. Additional details of how these actions were modeled can be found in appendix B.

Table 3. Average annual treatment acres modeled by vegetation type and alternative.

Vegetation Type	Treatment Type	NA	PA/P	R	B/O
Douglas-fir dry	Mechanical Fuels Treatment	615	3074	615	1229
	Prescribed Fire	2153	2153	2153	2153
	Timber Harvest	500	2500	500	1000
Northern Rocky Mountain Mixed Conifer	Mechanical Fuels Treatment	481	1925	0	963
	Prescribed Fire	1686	1686	1686	1686
	Timber Harvest	388	1550	0	775
Western redcedar/western hemlock	Mechanical Fuels Treatment	0	0	0	309
	Prescribed Fire	0	0	0	0
	Timber Harvest	0	0	0	0
Subalpine Fir/Lodgepole pine	Mechanical Fuels Treatment	0	0	0	0
	Prescribed Fire	1040	1040	1040	1040
	Timber Harvest	1900	950	475	475

Three management categories were created to model vegetation across the forest through time, with each plan management area assigned to a category. These management categories are wilderness/other, harvest, and production. The wilderness/other category consists of congressionally designated areas or areas proposed for wilderness designation where active vegetation management is limited to the use of fire. The harvest category includes those areas where scheduled timber harvest is not planned, and where there would only be incidental timber harvest for specific resource benefit to meet management objectives. The production category includes areas where scheduled timber harvest would be planned, and where a full suite of active management could occur, including harvest, prescribed fire, and mechanical fuels treatment. See appendix C for a full listing of management areas and categories.

State and transition models are only an approximation of complex forest dynamics (Peterson et al. 2011). However, they can provide useful information on how forest structure changes through time, and what types of outputs can be expected. The individual state and transition models for each vegetation type used for this effort were originally developed under the Integrated Landscape Assessment Project (ILAP 2013) and then modified based on local knowledge and experience (see Appendix B for details).

Current Conditions

Vegetation Composition

The Colville is composed primarily of vegetation in the dry Douglas-fir type, characterized by ponderosa pine and Douglas-fir plant associations across the lower elevations of the forest. On the eastern, wetter half of the forest, mixed conifer stands dominate at higher elevations and more northerly aspects, with western hemlock plant associations and a variety of tree species such as western redcedar, western larch, and western white pine. On the western, drier side of the forest, similar elevations and aspects produce stands of lodgepole pine and subalpine fir, frequently found with western larch and Douglas-fir. The wettest portions of the forest support stands of western redcedar and western hemlock. Table 4 shows how plant association groups were categorized into Landfire biophysical settings and vegetation types. Figure 2 clearly shows the majority of acres occurring in the Douglas-fir dry vegetation type, followed by the Northern Rocky Mountain mixed conifer type. See appendix A for descriptions of Landfire types, and common names for plant association groups.

Table 4. Vegetation types, Landfire biophysical settings, plant association groups, and approximate total acres.

Vegetation Type	Landfire Biophysical Setting Number and Name	Plant Association Groups*	Acres
Douglas-fir dry	1010451 - Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest – Ponderosa Pine – Douglas-fir	PP/AGSP-PUTR dry shrub-grass DF-PP/AGSP-PUTR-FEID-ARUV DF/CARU-SPBE-PAMY-ARUV-SYOR DF/SYAL-PHMA DF/VACA-VAME-VAMY	486045
Northern Rocky Mountain Mixed Conifer	1010471 - Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	WH/GASH-XETE-VAME-HODI-ARNE WH/GASH-BENE-RHMA-PAMY-CLUN WH/ACCI-GASH-BENE-ACTR-POMU	308365
Western redcedar / Western hemlock	1010471 - Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (95%) 1010472 - Northern Rocky Mountain Mesic Montane Mixed Conifer Forest - Cedar Groves (5%)	WH/POMU-TIUN-OXOR-ARNU3 WH/OPHO-ATFI-LYAM WH/MEFE-XETE-RUPE	95820
Subalpine fir / Lodgepole pine	1010452 - Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest – Larch	PIAL/VASC-LUHI-CARU SAF/CARU-PAMY SAF/VASC-VACA-VAME-LIBOL SAF/RHAL-XETE-ARLA-POPU	173699

Vegetation Type	Landfire Biophysical Setting Number and Name	Plant Association Groups*	Acres
Spruce / Subalpine fir	1010560 - Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland (90%) / 1011610 - Northern Rocky Mountain Conifer Swamp (10%)	SAF/TRCA3-ATFI-GYDR-STAM-riparian	20,240

*See Appendix A for plant acronym definitions.

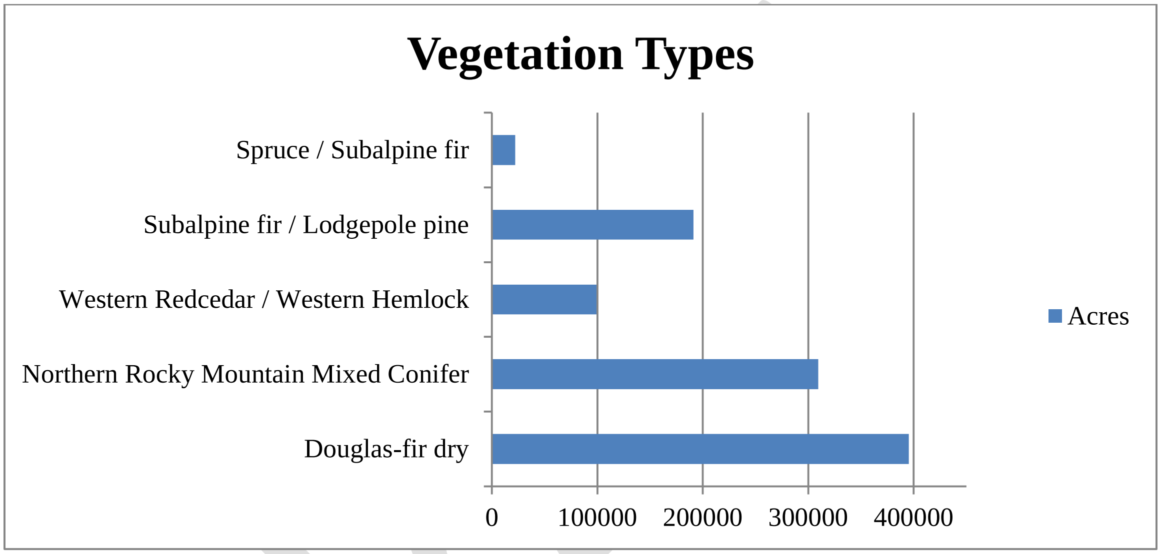

Figure 2. Approximate current total acres for each vegetation type

Forest Structure

Table 5 shows total current acres in each structure class and vegetation type, along with total percentages. The majority of the forest is in the mid closed structure class (57%), with lesser amounts in the early (19%) and late closed (15%) classes.

Table 5. Approximate total current acres in each structure class and vegetation type

	Early	Mid Open	Mid Closed	Late Open	Late Closed	Total (Acres)	Total (%)
Douglas-fir dry	58325	34023	277046	24302	92349	486045	44%
Northern rocky mountains mixed conifer	58589	12335	200437	3084	33920	308365	28%
Spruce / Subalpine fir	4250	0	12144	0	3846	20240	2%

	Early	Mid Open	Mid Closed	Late Open	Late Closed	Total (Acres)	Total (%)
Subalpine fir / Lodgepole pine	57321	6948	85113	3474	22581	191052	17%
Western hemlock / Western redcedar	33537	0	49826	0	12457	95820	9%
Total (Acres)	212023	53306	624566	30860	151116	1101522	
Total (%)	19%	5%	57%	3%	15%		

Table 6 shows percentage of each structure class within each vegetation type. Subsequent analyses of structure classes by vegetation type will only use percentages.

Table 6. Current structure class percentage by vegetation type

	Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	12	7	57	5	19
Northern rocky mountains mixed conifer	19	4	65	1	11
Spruce / Subalpine fir	21	0	60	0	19
Subalpine fir / Lodgepole pine	33	4	49	2	13
Western hemlock / Western redcedar	35	0	52	0	13

The historical range of variability (HRV) was developed for forest structures across the different vegetation types. Table 7 compares current structure conditions for each vegetation type to HRV.

Table 7. Historical Range of Variability (HRV) percentages by vegetation type for each structure class compared to current conditions.

		Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Current %	12	7	57	5	19
	Historical %	6-16	2-8	4-13	38-78	1-32
Northern Rocky Mountain mixed conifer	Current %	19	4	65	1	11
	Historical %	9-25	1-3	18-30	4-6	44-60
Spruce / Subalpine fir	Current %	21	0	60	0	19
	Historical %	4-24	0	7-27	0	55-83
Subalpine fir / Lodgepole pine	Current %	33	4	49	2	13
	Historical %	45-65	0	33-53	0	3
Western hemlock / Western redcedar	Current %	35	0	52	0	13
	Historical %	14-46	0	13-41	0	29-57

Black shading indicates values below HRV, while gray shading indicates values above HRV.

For all vegetation types except subalpine fir/lodgepole pine, there is an abundance of mid structural stage and a lack of late stages. This reflects the effects of fire exclusion, as well as the widespread stand-replacing fires of the early 1900s. The majority of forest stands are in a mid closed structure condition, showing smaller tree sizes than would be expected historically, and for the dry type, more canopy cover.

The subalpine fir / lodgepole pine type shows an abundance of late closed stage and a lack of early stage, which is consistent with fire exclusion and the ecology of lodgepole pine dominated stands. Given the effects of mountain pine beetle and a stand-replacing fire regime, there historically would be little late structure in this type, and the majority would be in early and mid structure classes. Current conditions show that more of this type has transitioned into the late closed stage, likely due to the lack of disturbance required to move these stands back to an early stage. Current conditions in both the mid open and late open shows a small percentage, whereas historically these would not have existed. This again is likely due to fire exclusion and active pine beetle activity causing mortality and reducing canopy cover. This could also reflect recent management in lodgepole pine stands, where canopy cover has been temporarily reduced.

Insects and Disease

Levels of insect and disease related mortality across eastern Washington have been widely publicized over the past several years. In most cases the scale of recent insect outbreaks are unprecedented (WA DNR 2014-2). Fire suppression, grazing, and harvesting have been identified as the principle factors resulting in increased stocking levels, increased levels of mid and late seral species, and homogenization of spatial patterns. Widespread fires in the 1920s and 1930s also created large areas of even-aged forests. All of these factors contribute to uncharacteristic conditions that support larger scale and more persistent insect outbreaks (Hessburg et al. 1994). Insect and disease affected acres have consistently exceeded fire affected acres for the Colville National Forest. Figure 3 shows total insect and disease acres since 1980, while figure 4 shows fire acres since 1970.

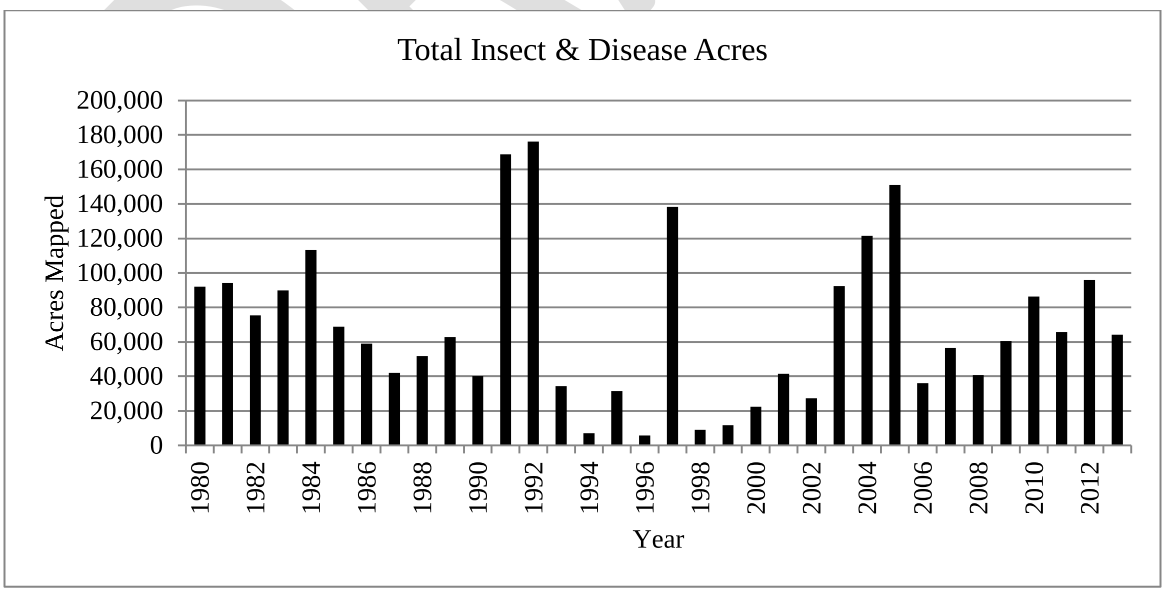

Figure 3. Total insect and disease activity 1980-2013.

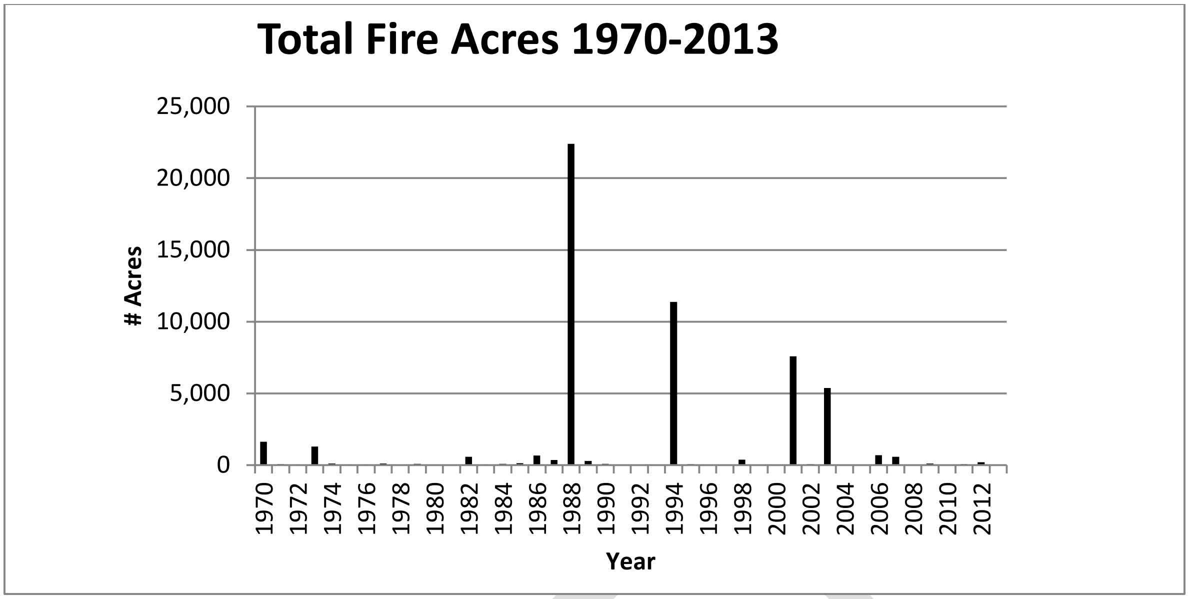

Figure 4. Total fire acres on the Colville National Forest 1970-2012

A recent report from the Washington Department of Natural Resources (WA DNR 2014-2) notes that the acres of trees killed or damaged by insects and diseases is 150 percent greater than in the 1990s, 200 percent greater than in the 1980s, and 175 percent greater than in the 1970s.

The National Insect and Disease Risk Map (NIDRM) predicts continued high levels of insect and disease related mortality over the 15 year period between 2013-2027, with particularly high levels occurring in northeast Washington and on the Colville National Forest (figure 4). Over 42% (449,430 acres) of the Colville National Forest are identified as experiencing greater than 25% basal area loss between 2013 and 2027 due to insects and diseases based on the NIDRM. The majority of this risk comes from mountain pine beetle, western pine beetle, Douglas-fir beetle, and root diseases. Basal area is the cross sectional area of a tree stem including the bark measured at 4.5 feet off the ground and is used as a measure of tree density.

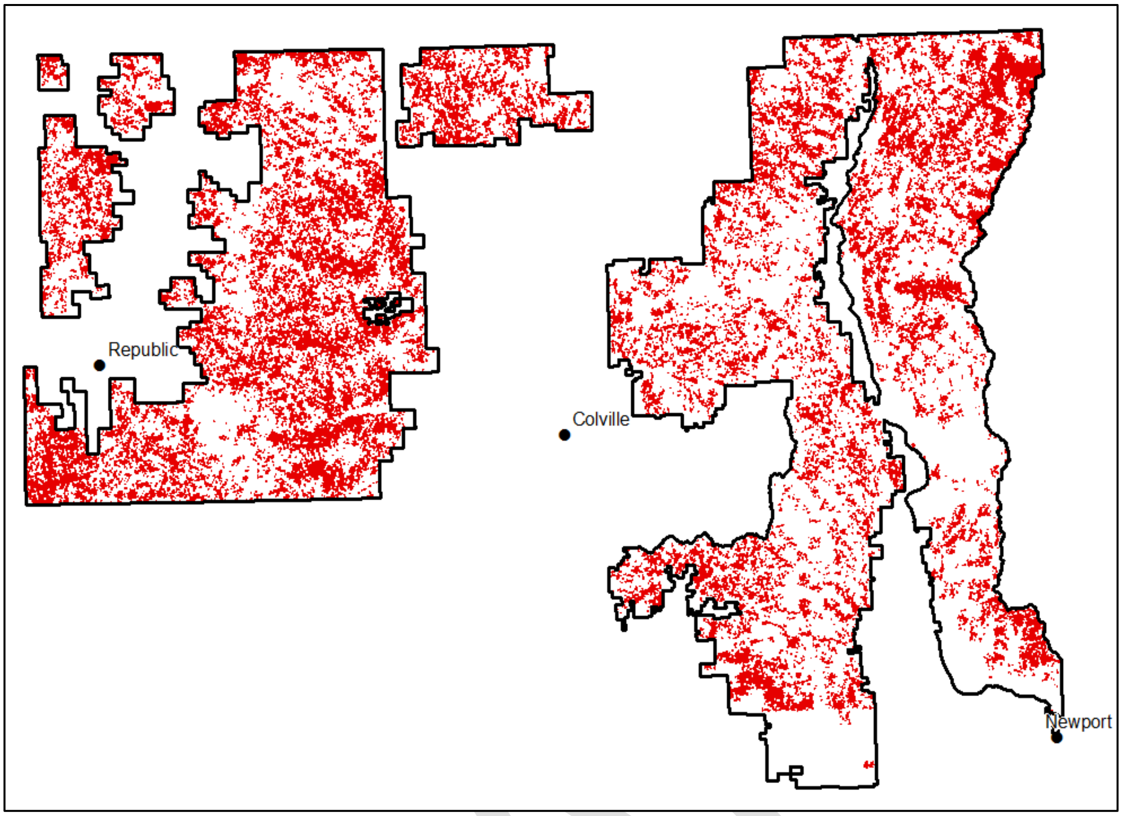

Figure 5. National Insect and Disease Risk Map for the Colville National Forest. Red areas show where more than 25% of the total live basal area is at risk of loss within the next 15 years.

In 2012, a forest health hazard warning was issued by the state of Washington for portions of eastern Washington, including the western portion of the Colville National Forest within Ferry County. This represented the first time this state authority was ever used since its inception. This designation was focused on western spruce budworm and pine beetles, and was based on recent insect damage, projected future damage, and potential for on-the-ground action to address the damage (WA DNR 2014-1).

Recent insect and disease flights have noted increases in Douglas-fir beetle, fir engraver, pine bark beetles, and western spruce budworm. All of these increases can be attributed to the increasing amounts of Douglas-fir and older lodgepole pine across the landscape, as evidenced by most of these vegetation types being in a mid-closed or late-closed structure type. Higher tree densities, as well as an increase in mid-to-late successional species such as Douglas-fir and western redcedar, have contributed to conditions that are favorable to insect outbreaks (Ferrell 1986, Gibson 2009, Schmitz 1996). Multi layered tree canopies dominated by Douglas-fir and grand fir facilitate western spruce budworm outbreaks (Blackford 2004). The non-native disease white pine blister rust is also contributing to tree stress, resulting in increased vulnerability to mountain pine beetle mortality in western white pine and whitebark pine (Bockino and Tinker 2012).

Figures 5 and 6 below show the yearly status since 1980 for western spruce budworm and mountain pine beetle and are derived from the annual flights.

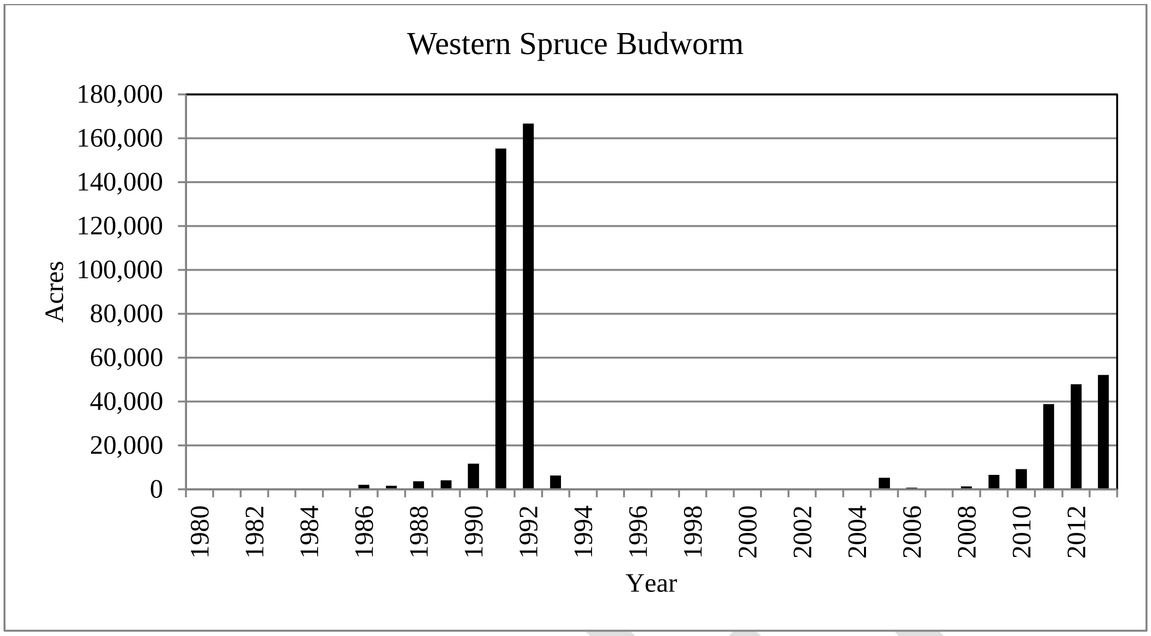

Figure 6. Western spruce budworm activity, 1980-2013

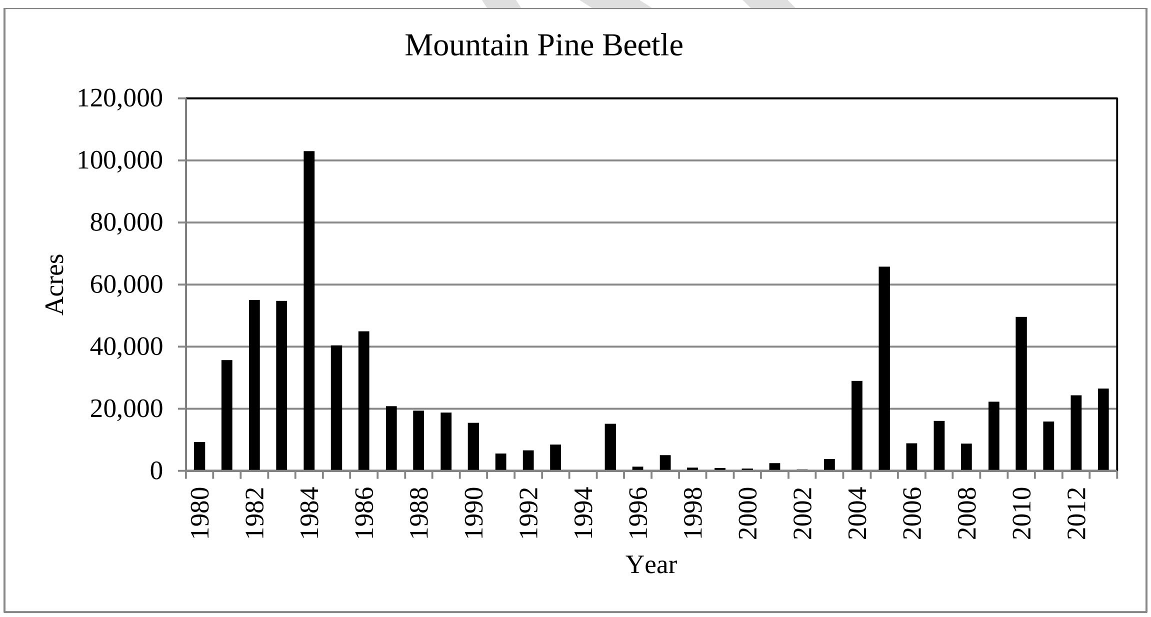

Figure 7. Mountain pine beetle activity 1980-2013.

After four years of defoliation by spruce budworm, bark beetle activity has been increasing – primarily Douglas-fir bark beetle and fir engraver. Defoliators (e.g. western spruce budworm) do not kill trees directly, however continued defoliation over a number of years impacts tree defense capabilities and results in vulnerability to mortality from bark beetles. As trees are defoliated and die, ground fuel beds increase leading to a potential for higher fire severity. Mountain pine beetle attacks can have the potential of changing crown fire rates within lodgepole tree canopies (Page et al. 2012).

Infestation of mountain pine beetle in lodgepole pine has been somewhat persistent since 1980 but shows an increase in acres after 2000. Some of the increase may be due to climate change impacts where mountain pine beetles at higher elevations are completing life cycles in one year instead of two years and more larvae are surviving warmer winters. (Williams and Liebhold 2002, Mitton and Ferrenberg 2012, Rosenberger et al. 2012)

The interaction of increased tree densities, increased insect levels of both defoliators and bark beetles, increased fuel levels, and climate change impacts, such as water stress, are all influencing the levels of current late forest structures and will continue to influence future late forest structure development.

Need for Change

The forest has identified six different needs that require action, three of which are directly addressed in this report. The first is the need to manage forest vegetation conditions to be more resilient to disturbances. As noted previously, HRV is a means to assess changes that have occurred and provide a reference condition within which ecosystems are resilient and responsive to disturbances. By developing HRV ranges within each vegetation type, and then assessing how well each alternative moves vegetation towards these ranges, it is possible to determine how forest management affects resiliency.

The second need related to forest vegetation is to address climate change implications and adaptations. This is highly related to the first need, and forests that are resilient to disturbances should implicitly be well adapted to possible effects from climate change. Moving forest vegetation towards HRV will result in more resilient vegetation conditions, and therefore will result in forests better adapted to climate change. Additionally, some alternatives (proposed action and P) provide additional flexibility in responding to climate change impacts by having broad management areas that allow a variety of management options to address unforeseen impacts.

The third need related to forest vegetation is social and economic conditions. This report specifically addresses timber production levels between the alternatives and provides estimates of outputs needed to move forest vegetation towards desired conditions.

Old Forest Management and Timber Production

In the revision of the Forest Plan, three broad-scale concerns drove the need to consider how we address late forest structure management and timber production. These are:

- The recent history of high levels of disturbance resulting from insect and disease activity that would likely continue into the future.
- The interaction between disturbances and climate change that elevates the importance of restoring landscape resiliency.

- Social and economic concerns surrounding timber production levels and promotion of late forest structure.

The recent and projected insect and disease related mortality show a need to move the forest structure across the landscape towards HRV.

Haugo et al. (2015) analyzed restoration needs across Oregon and Washington and found that one of the areas with the highest level of need for restoration was Northeast Washington, including the Colville National Forest. A need for both disturbance and succession related change was shown. Several other recent studies have shown the need for active restoration across western forests (Brown et al. 2004, Hessburg et al. 2005, Franklin et al. 2008). Methods for restoration are project specific, but generally include modification of forest structure and species composition to move individual stands and larger landscapes towards HRV (Jain 2005).

Environmental Consequences

Methodology

The current conditions, trends toward desired conditions, and legal and planning rule requirements are the three areas that are analyzed in this report.

The 1982 Planning Rule has certain requirements for calculation of timber outputs. ST-Sim was used to help calculate the Allowable Sale Quantity (ASQ) and Long Term Sustained Yield (LTSY). The measure will be board foot volume.

Assumptions

- State and transition models are useful, but far from an exact representation of ecological processes. ST-Sim models were calibrated using local knowledge and by using the Forest Vegetation Simulator (FVS) (Keyser 2008, Moeur and Vandendriesche 2009, Robinson and Beukema 2012). See Appendix B for full details of modeling assumptions for each alternative.
- GNN is a consistently interpreted data set that covers the entire forest. Accuracy of the classification is reasonable for forest wide analysis down to the scale of a 12th field HUC.
- Late forest structure management under the No Action alternative (maintaining the current Old Growth Management Areas) and R alternative would primarily be passive, where structural changes would be the result of successional process, insect and disease interactions, and fire that escapes initial attack. Some treatments may occur to reduce fire risk by fuels reduction or manipulation of structure and species composition to increase tree vigor to maintain old structure for a longer period of time. Also, fuels reduction would take place in areas that fall within WUI areas.
- Alternatives that propose continuation of Eastside Screens should result in similar, but more spatially static, late closed forest structure levels when compared to the landscape approach. However, late open structure is difficult to create and maintain under Eastside Screens due to the limit of cutting trees over 21” dbh. Eastside Screens requires evaluation of the current condition and a comparison against the historical range of variability (HRV). If the landscape is below HRV, then there are limitations on cutting trees ≥21” dbh. If the landscape is above HRV, then large trees could be cut to achieve specific objectives. The Eastside Screens

emphasize maintaining connectivity between late forest structure areas but does not give specific guidance on planning for late forest structure replacement.

- Late forest structure management under the B and O alternatives that have Restoration Zones would have active management with the emphasis of retaining levels of late forest structure which are at or approach the maximum HRV values.
- Late forest structure management under the R alternative, a large scale reserve approach, would have minimal active management with the emphasis of retaining levels of late forest structure which are at or approach the maximum HRV values.
- General Forest land in the No Action alternative and non-reserve areas within B, O, and R alternatives would be managed for timber production using the shelterwood with reserves regeneration method. Retaining Eastside Screens would make two-aged management difficult because of the 21” diameter cap, and in reality would result in uneven-aged stands within the non-reserve land, with further promotion of closed canopy, mid and late seral stands.
- The Proposed Action and P alternative would promote structural and landscape complexity. The overarching emphasis would be moving the landscape towards HRV by modifying structure to increase resilience and adaptability. Forest lands in the general and focused restoration areas would be managed using variable density thinning, free selection, and other silvicultural treatments tailored to meet both landscape and site specific objectives (Franklin et al. 2007, Graham et al. 2007, Aukema and Carey 2008, Puettmann et al. 2009, Franklin and Johnson 2012, DeRose and Long 2014).

Incomplete and Unavailable Information

Climate Change

While it is possible to reflect potential climate change influences with state and transition models, the results here would not show any potential climate change influences due to the unknown factors of how much change, where the change would influence system dynamics, and how fast the change could occur. Climate science currently does not have forest-scale predictions and probabilities needed for state and transition modeling. Furthermore, there is no agreement between climate models on how vegetation would respond, with widely divergent predictions for dry forest types, which are the majority of forest types that are found on the Colville National Forest (Peterson et al. 2014).

Even given the uncertainty of how vegetation would respond to climate change, there is broad consensus that moving forests towards more resilient conditions should be a general goal of forest management (Millar et al. 2007, DeRose and Long 2014). Resilience has been defined as “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al. 2004). Moving forest structure across the landscape towards HRV is one way to increase resilience, and may be the best option currently available for managing lands where future climate is uncertain (Keane 2009).

Spatial and Temporal Context for Effects Analysis

The context for the effects analysis is through the modeled management areas and at a forest wide scale. ST-Sim was loaded with current conditions for each management area and then used to model each vegetation type by alternative. Outputs at 20, 50, and 100 years are used to evaluate effects. Emphasis and analysis is on modeled forest structure values at 100 years as compared to HRV values.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

The area for considering cumulative effects includes the lands within the Colville National Forest administrative boundary.

Socio-economic choices can have the potential to influence cumulative effects. In the recent past, there have been some significant shifts in ownership of lands previously managed for industrial forestry objectives or large ranches being sold with possible conversion to other uses. Management objectives of the new owners, mostly unknown at this time, could influence a number of dynamics such as water quality and quantity, habitat connectivity, and fire management.

The cumulative environmental effects of the proposed management under all alternatives are to move a portion of the vegetation toward desired conditions. These efforts would contribute to overall landscape restoration goals and increase the resilience and adaptability of forest vegetation.

Summary of Effects Common to All Alternatives

Under the current fire suppression model that does not utilize or limits use of natural ignitions to achieve desired conditions, late forest structure would accumulate within wilderness and other areas, where vegetation management is limited to the use of fire, until stand density related mortality occurs or fires escape initial control efforts. Early successional habitats would likely be lacking under this scenario until a disturbance occurs resulting in an excess of early structure type. For late forest structure, the result could tend to be more of a boom and bust cycle with long periods of time required for early structure to grow into late forest structure.

In the Proposed Action, P, R, O, and B alternatives, there are various amounts of acres recommended for wilderness. All of these areas fit into the wilderness/other category described in the modeling where the use of fire is the only tool to achieve desired conditions. It is uncertain how the fire tool would be used to achieve desired conditions. Currently, natural ignitions are usually suppressed, including in designated wilderness areas, although this plan allows more flexibility in using natural fire as a tool.

Both the proposed action and P alternatives were modeled using variable density thinning (VDT) as the primary tool for actively managing forests and moving them towards HRV. Alternatives R, B, and O were modeled using shelterwood with reserves as the primary tool. Appendix B contains details of what types of harvest activities occur under each alternative, and how they were modeled.

Late forest structure levels

Tables 8, 9, and 10 show modeled forest structure conditions for all alternatives and vegetation types compared to HRV for 20, 50, and 100 years out, respectively. Results indicate that late open forest structure in the Douglas-fir dry type would be within HRV in one hundred years for all scenarios, while late closed forest structure would be well within HRV for the proposed action and P alternatives, and just barely within or above HRV for all other alternatives. Results past 100 years indicate that all alternatives maintain the late open structure in Douglas-fir dry within HRV (Figure 8), although the proposed action and P alternatives create and maintain more than the other alternatives. For late closed structure in Douglas-fir dry (figure 9), the proposed action and P alternatives maintain the structure type at the midpoint of HRV, while the other alternatives are either at or over the upper limit of HRV. For the late closed structure in the Northern Rocky Mountain mixed conifer type (figure 10), no alternatives maintain this structure within HRV past 100 years. As seen in Figure 10, there is a small window of time when late closed is within HRV, however it quickly exceeds the upper limit. The growth within this vegetation type exceeds the effects from the assumed treatments (Table 3), hence most of this vegetation type eventually ends up in the late closed structure type.

Alternative O has the most structure classes (12) within HRV at 100 years, while the B alternative has eleven. The proposed action, P, and R alternatives have eight structure classes within HRV, and the No Action has the least with four structure types within HRV. It is important to note that the amounts of each structure type vary with time, and choosing a different point in time would result in alternatives having a different number of structure types within HRV. For instance, the O alternative is within HRV at 100 years for late closed in Douglas-fir dry, but at 110 years it is above HRV. Also, tables 8, 9, and 10 don't make an attempt to indicate how far above or below HRV a structure type may be. For instance, in the Northern Rocky Mountain mixed conifer type, late open structure is within HRV for the O alternative (5%) but not in the P alternative (7%), even though the P alternative is just one percent higher than the HRV range (4%-6%).

Figures 8, 9, and 10 graphically show how each alternative approaches HRV for late open and late closed in the Douglas-fir dry vegetation type, and for late closed in the Northern Rocky Mountain mixed conifer. Each of these graphs show the full 300 year long modeling timeline. Since most of the forest is covered with Douglas-fir dry and Northern Rocky Mountain mixed conifer vegetation types (nearly 70%), graphs for late structure in other vegetation types are not shown.

Table 8. Modeled forest structure levels at 20 years compared to HRV for all vegetation types and alternatives.

Early Structure at 20 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	-	@	@	@	@	@
Northern Rocky Mountain mixed conifer	@	-	-	-	@	@
Western hemlock / Western redcedar	@	-	-	-	@	@
Subalpine fir / Lodgepole pine	-	-	-	-	-	-
Spruce / Subalpine fir	@	@	@	@	@	@
Mid Open Structure at 20 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	+	+	@	+	+
Northern Rocky Mountain mixed conifer	-	+	+	@	+	+
Subalpine fir / Lodgepole pine	+	+	+	+	+	+
Mid Closed Structure at 20 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	+	+	+	+	+	+
Northern Rocky Mountain mixed conifer	+	+	+	+	+	+
Western hemlock / Western redcedar	+	+	+	+	+	+
Subalpine fir / Lodgepole pine	@	@	@	@	@	@
Spruce / Subalpine fir	+	+	+	+	+	+
Late Open Structure at 20 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	-	-	-	-	-	-
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Subalpine fir / Lodgepole pine	+	+	+	+	+	+
Late Closed Structure at 20 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Western hemlock / Western redcedar	-	-	-	-	-	-
Subalpine fir / Lodgepole pine	+	+	+	+	+	+
Spruce / Subalpine fir	-	-	-	-	-	-
Total Structure Classes Within HRV	**6**	**4**	**4**	**6**	**6**	**6**

Table 9. Modeled forest structure levels at 50 years compared to HRV for all vegetation types and alternatives.

Early Structure at 50 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	-	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Western hemlock / Western redcedar	-	-	-	-	@	@
Subalpine fir / Lodgepole pine	-	@	@	@	+	@
Spruce / Subalpine fir	-	-	-	-	-	-
Mid Open Structure at 50 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	+	+	@	@	+
Northern Rocky Mountain mixed conifer	-	+	+	@	+	+
Subalpine fir / Lodgepole pine	+	+	+	+	+	+
Mid Closed Structure at 50 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	+	+	+	+	+	+
Northern Rocky Mountain mixed conifer	+	+	+	+	+	+
Western hemlock / Western redcedar	+	+	+	+	+	+
Subalpine fir / Lodgepole pine	-	-	-	-	-	-
Spruce / Subalpine fir	+	+	+	+	+	+
Late Open Structure at 50 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	-	-	-	-	-	-
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Subalpine fir / Lodgepole pine	+	+	+	+	@	@
Late Closed Structure at 50 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Western hemlock / Western redcedar	@	@	@	@	@	@
Subalpine fir / Lodgepole pine	+	+	+	+	+	+
Spruce / Subalpine fir	-	-	-	-	-	-
Total Structure Classes Within HRV	**3**	**4**	**4**	**6**	**6**	**6**

Table 10. Modeled forest structure levels at 100 years compared to HRV for all vegetation types and alternatives.

Early Structure at 100 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	-	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Western hemlock / Western redcedar	-	-	-	-	-	-
Subalpine fir / Lodgepole pine	-	@	@	@	@	@
Spruce / Subalpine fir	-	-	-	-	-	-

Mid Open Structure at 100 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	@	@	@	@	@
Subalpine fir / Lodgepole pine	+	+	+	+	+	+

Mid Closed Structure at 100 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	-	-	-	-	-
Western hemlock / Western redcedar	-	-	-	-	@	@
Subalpine fir / Lodgepole pine	-	-	-	-	-	@
Spruce / Subalpine fir	@	@	@	@	@	@

Late Open Structure at 100 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	@	@	@	@	@	@
Northern Rocky Mountain mixed conifer	-	+	+	@	@	@
Subalpine fir / Lodgepole pine	+	+	+	+	@	@

Late Closed Structure at 100 Years	Above (+), Below (-), or Within (@) HRV					
	NA	PA	P	R	B	O
Douglas-fir dry	+	@	@	+	@	@
Northern Rocky Mountain mixed conifer	+	+	+	+	+	+
Western hemlock / Western redcedar	+	+	+	+	+	+
Subalpine fir / Lodgepole pine	+	+	+	+	+	+
Spruce / Subalpine fir	+	+	+	+	+	+
Total Structure Classes Within HRV	**4**	**8**	**8**	**8**	**11**	**12**

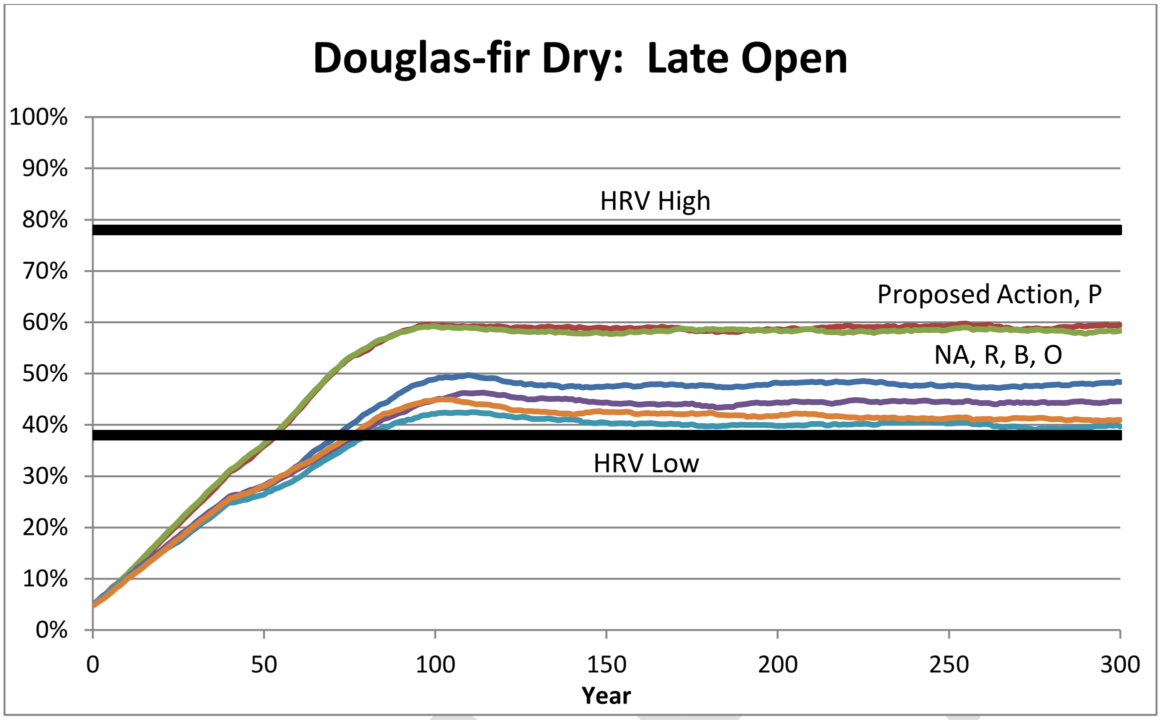

Figure 8. Modeled late open structure amounts for the Douglas-fir dry vegetation type for each alternative.

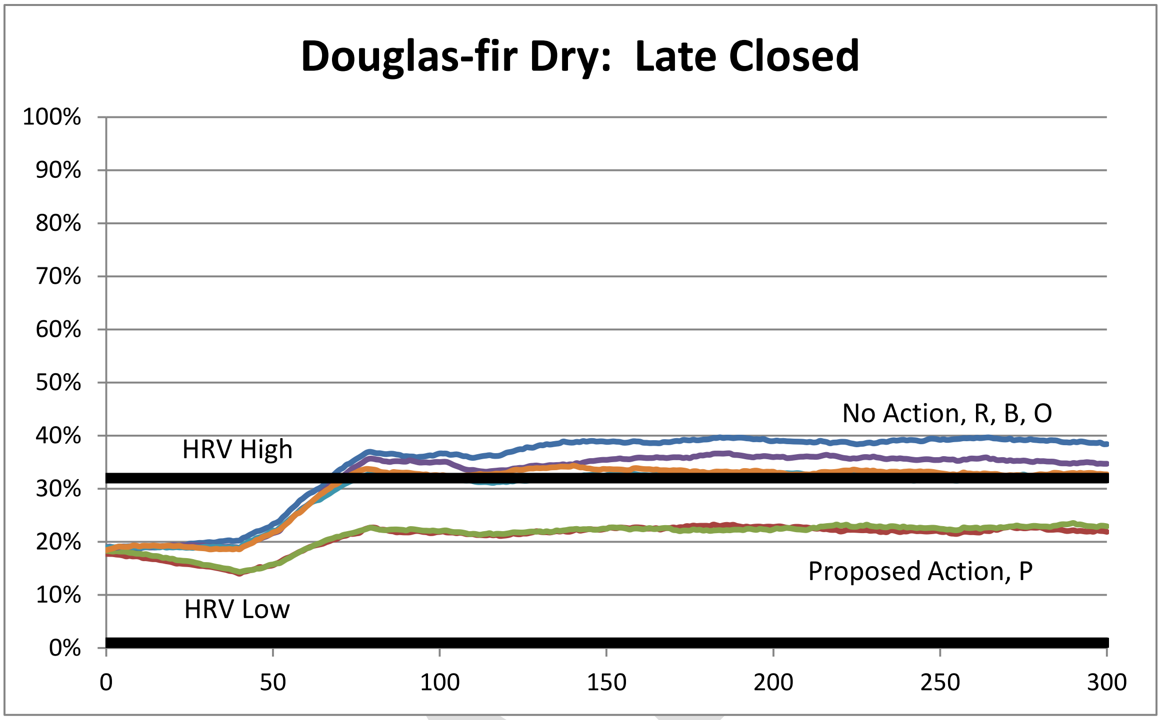

Figure 9. Modeled late closed structure amounts for the Douglas-fir dry vegetation type for each alternative.

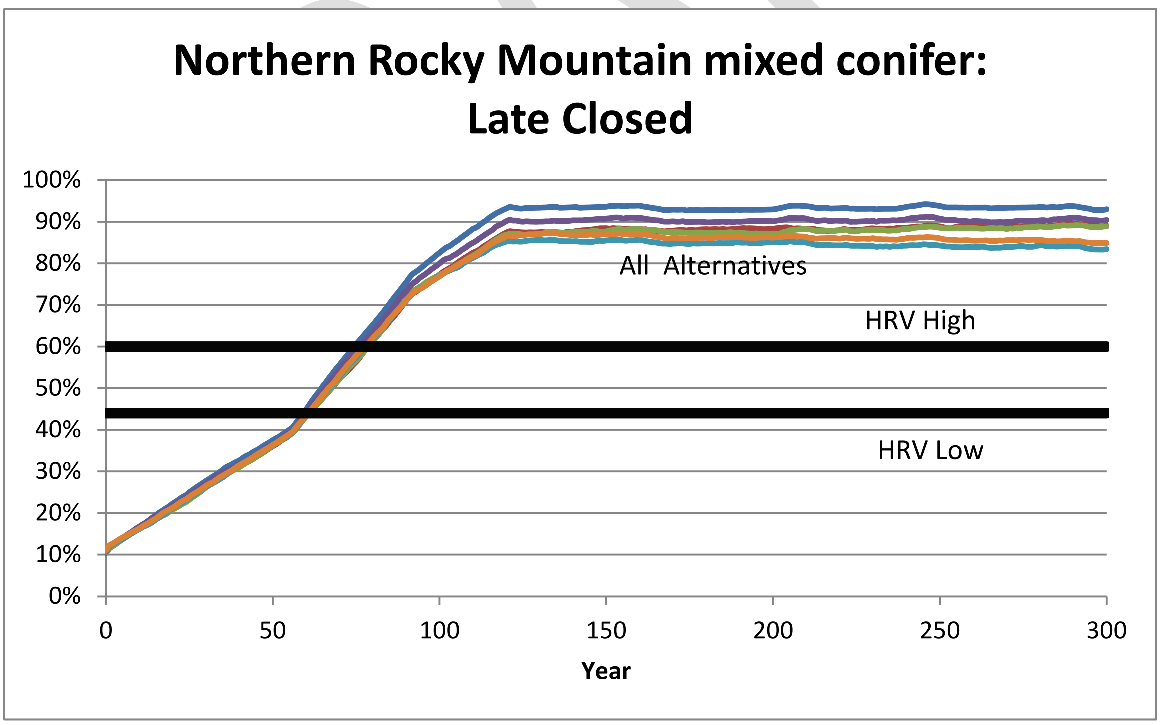

Figure 10. Modeled late closed structure amounts for the Northern Rocky Mountain mixed conifer vegetation type for each alternative

Timber production

There are several factors that influence timber production levels. The first are legal requirements as specified in the National Forest Management Act of 1976 (NFMA), the Multiple Use Sustained Yield Act of 1960 (MUSYA), and the 1982 Planning Rule under which this forest plan is being revised. The second is budget and workforce.

The MUSYA defines “sustained yield of the several products and services” as “the achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land”.

NFMA stipulates criteria for determining suitability of forest lands for timber production. It also specifies that timber harvest acres be split into two categories: lands suitable for timber production and other lands for harvest. Requirements to comply with MUSYA are also included as part of timber suitability determinations.

The 1982 Planning Rule summarizes NFMA requirements for determining lands suitable for timber production into four criteria: 1) Has not been withdrawn by Congress, the Secretary of Agriculture, or the Chief of the Forest Service, 2) Is forest land, 3) can be successfully regenerated in five years, and 4) harvest would not result in irreversible resource damage. Table 11 shows total suitable forest land by alternative as determined by this method. Appendix C contains full details of how these numbers were developed.

Table 11. Total acres of suitable forest land by alternative

	NA	PA	P	R	B	O
Total Suitable Forest Land	535,725	653,242	656,628	129,420	384,485	347,535

The 1982 Planning Rule also requires the calculation of Long Term Sustained Yield Capacity (LTSY) based on productivity and the calculation of Allowable Sale Quantity (ASQ) that is tied to lands that are suitable for timber production.

For the time horizon of this particular planning cycle, the next 20 years, no significant decline in timber productivity is assumed.

Current and anticipated budgets control workforce levels, sets priorities, and thereby constrains the number of acres that can be analyzed for conditions and management needs, areas that can be put into timber sales and administered, and other management needs. The modeling output from ST-Sim was used to develop the timber production limits by alternative. Each alternative was run for a 300 year period.

The long term sustained yield (LTSY) is the highest uniform wood yield that may be sustained given multiple-use objectives on lands managed for timber production. LTSY assumes that all suitable land for timber production is in the desired condition. LTSY was calculated assuming that the HRV midpoint for each structure class was the desired condition.

The allowable sale quantity (ASQ) reflects the quantity of timber that may be sold from lands suitable for timber production, within tree utilization standards, for the first decade of the plan given an unlimited budget. It is expressed as an annual average throughout the plan. It takes into account harvest from lands that are not in the desired condition, and therefore is slightly lower than the LTSY. Like the LTSY calculation, the desired condition was assumed to be the midpoint of HRV for each structure class. Since the desired condition requires more forest stands within a late structure condition, time is required for the trees to grow larger, and therefore ASQ is lower than LTSY.

The projected wood sale quantity (PWSQ) is the estimated quantity of timber and all other wood products that is expected to be sold from the plan area for the plan period. The PWSQ consists of the projected timber sale quantity as well as other woody material such as fuelwood, firewood, or biomass that is also expected to be available for sale. The PWSQ includes volume from timber harvest for any purpose based on expected harvests that would be consistent with the plan components. The PWSQ is also based on the planning unit's fiscal capability and organizational capacity. PWSQ is not a target nor a limitation on harvest, and is not an objective unless the responsible official chooses to make it an objective in the plan.

The projected timber sale quantity (PTSQ) is the estimated quantity of timber meeting applicable utilization standards that is expected to be sold during the plan period. As a subset of the projected wood sale quantity (PWSQ), the projected timber sale quantity includes volume from timber harvest for any purpose from all lands in the plan area based on expected harvests that would be consistent with the plan components. The PTSQ is also based on the planning unit's fiscal capability and organizational capacity. PTSQ is not a target nor a limitation on harvest, and is not an objective unless the responsible official chooses to make it an objective in the plan. Table 12 shows the long term sustained yield (LTSY), allowable sale quantity (ASQ), projected wood sale quantity (PWSQ), and projected timber sale quantity (PTSQ) for each alternative for the first decade. See Appendix C for details of how each number was calculated, as well as PWSQ and PTSQ numbers for the second decade.

Table 12. Average annual volumes (million board feet (mmbf)) by alternative for the first decade.

	NA	PA	P	R	B	O
LTSY	18.3	97.5	97.4	7.5	13.9	12.2
ASQ	18.3	67.6	67	7.5	13.9	12.2
PWSQ	40.6	62.1	61.8	14.3	37.4	37.5
PTSQ	26.9	48.4	48.1	9.3	23.7	23.8

The ASQ and LTSY values calculated for the No Action, R, B, and O alternatives are significantly lower than those for the Proposed Action and P alternatives because of the requirement of the 1982 Planning Rule to provide a non-declining flow of timber. Figure 11 shows an example of how non-declining flow was computed for the O alternative. The different lines represent different management intensities, with the 1x management intensity being the current assumed intensity of 5,000 acres per year each of timber harvest, mechanical fuels treatments, and prescribed burning. As can be seen, management intensities greater than 1/2x result in wildly fluctuating outputs which violate the non-declining flow requirement. The 1/2x management intensity results in an even and non-declining flow of timber, and thus this becomes the basis for the ASQ and LTSY. The No Action, R, and B alternatives all have similar non-declining flow graphs. Table 3 shows the results of how many actual acres are modeled to be treated to maintain a non-declining flow, and Appendix B contains further details of how ASQ and LTSY were computed.

Underlying the lower ASQ and LTSY values is the fact that the No Action, R, B, and O alternatives continue the direction of Eastside Screens. The diameter limits imposed by Eastside Screens essentially means that once a stand reaches late structure, there is very limited opportunity to do any harvest within that stand. Since the No Action, R, B, and O all continue the Eastside Screens, within a fairly short amount of time (approximately 50 years), more than half of the forest is within a late structure type. Figure 12 shows an example of this with alternative O, with the majority of the forest ending up in a late structure condition at around 50 years. Graphs for the No Action, R, and B alternatives look similar to Figure 12.

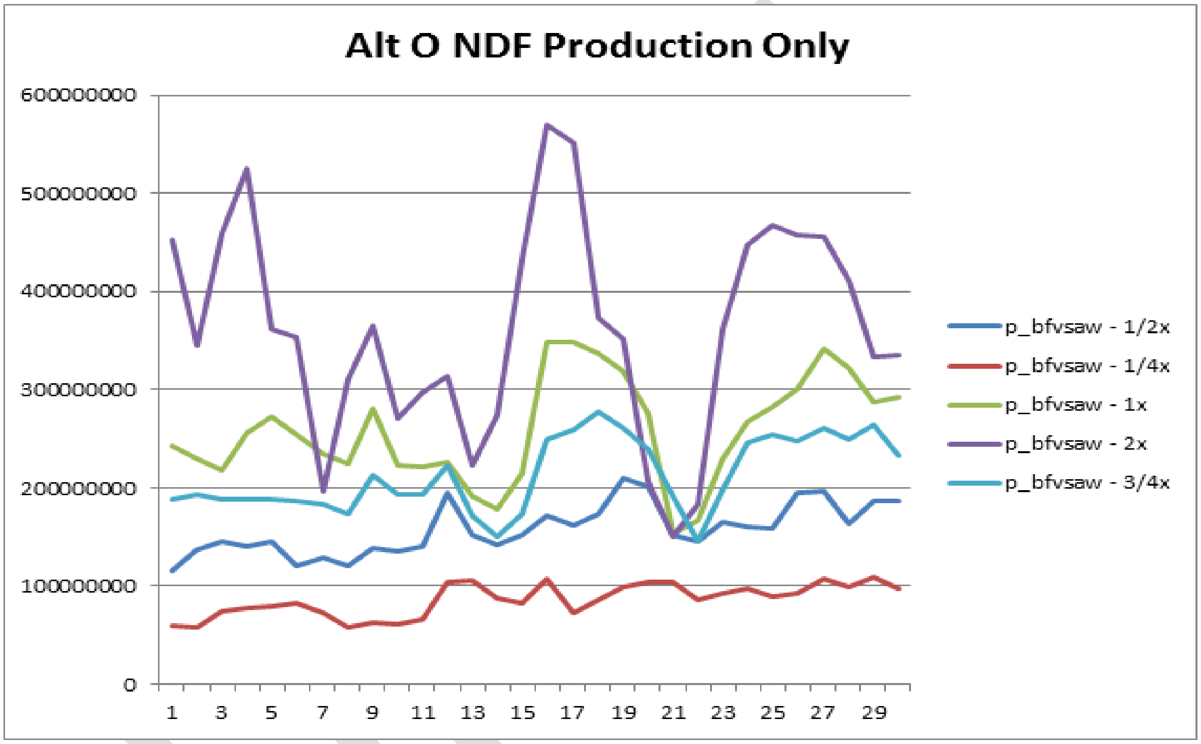

Figure 11. Non-declining flow for the O alternative. The 1/2x management intensity is where non-declining flow is achieved.

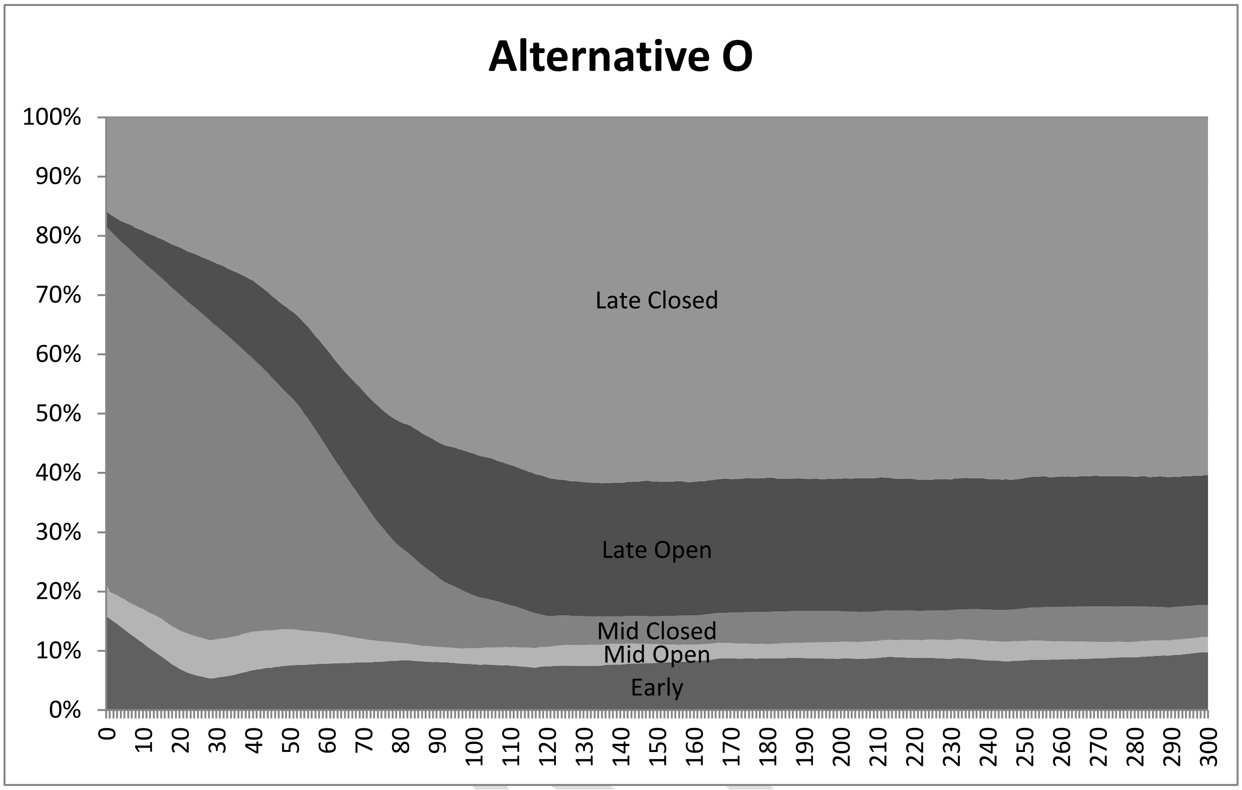

Figure 12. Structure amounts in Alternative O over the 300 year modeling period.

Alternative NA – No Action

The no action alternative follows the current Colville Forest Plan as amended. The current management direction of having individual, defined old forest management areas within a matrix of general forest with emphasis on timber production using two-aged regeneration methods would continue. This alternative continues the use of Eastside Screens which includes conducting a HRV analysis, and generally not cutting trees ≥ 21 inches in diameter.

Summary of Effects

Old Forest Management and Timber Production

The no action alternative retains the Eastside Screens that were intended to be interim direction until the forest plan was revised. Eastside Screens restricts cutting of 21 inch diameter and larger trees in many situations requiring justification for cutting, even when site specific objectives may warrant removal. Retaining all trees ≥ 21 inch diameter can result in situations where tree vigor is reduced to a point where density related mortality factors could cause significant mortality resulting in loss of late forest structure.

The Eastside Screens process requires assessment of current conditions and comparison to pre-settlement HRV. When conditions are below HRV, the Eastside Screens prohibit the removal of ≥21” diameter trees. When conditions are above HRV, there are more opportunities to remove large trees based on specific criteria and for specific objectives. Desired future conditions reflect

HRV, thus following the Eastside Screen process should move the forest towards late structure levels as listed in the HRV tables. The main difference between the no action and proposed action is the fixed locations of late forest structure reserves in the no action, with no opportunity to maintain or enhance it if there is little or no actual late forest structure within the reserve, whereas the proposed action's landscape approach supports planning for replacement in a dynamic landscape. Additionally, the diameter limit imposed by Eastside Screens creates a situation where certain structure types are generally difficult to create and maintain, such as early or late open. Once trees within a stand grow larger than 21" dbh, the number of management options is restricted to essentially fire, and there is little opportunity to reduce densities and create early structure or maintain open structure types.

Managing late closed forest structure at or near the maximum end of the HRV range has a number of risks. Higher stocking results in stand density levels that are within the zone of competition induced mortality, where trees are experiencing increased levels of mortality from high levels of competition for resources such as light and water. The risk of mortality from bark beetles and other insects is greatly increased, and stand structure can change from a late closed structure back to early structure. Within the old forest management areas, some natural processes, such as succession, are allowed to function, but others, such as wildfire, are not.

An emphasis on late forest structure can result in reduced amounts of other forest structural states such as early successional stages. Inadequate representation of early successional structure is a frequent issue across the forested landscape (Swanson et al. 2010).

Modeling Results

Modeling results (Table 13) indicate that in the Douglas-fir dry vegetation type, the current excess of mid closed structure class moves into the late open and late closed structure classes. At 100 years, the majority of this vegetation type is in the late open structure type (49%) and late closed structure type (37%), with the remainder in mid closed (7%) and early (5%). Mid open, mid closed, and late open are all within HRV.

In the Northern Rocky Mountains mixed conifer type, the majority of structure is within the late closed class (83%), followed by mid closed (14%) and only 4% in the early class. Late closed is the only structure class within HRV at 100 years, although as figure 9 shows, this is a temporary situation and shortly after 100 years there is an excess of late closed.

Nearly all of the western hemlock / western redcedar type is in the late closed structure class (96%). Only 3% is in mid closed and 1% in early. No structure class is within HRV in this vegetation type.

For subalpine fir / lodgepole pine, the majority is in the early structure class (52%), with the remainder in mid closed (45%) and only 3% in late closed. All structure classes are within HRV in this vegetation type.

In the spruce / subalpine fir type, results show that there would be a lack of early structure type (only 3%), although there would be an abundance of late closed type (62%). The remainder is in the mid closed type (35%). Only the mid closed structure class is within HRV for this vegetation type.

Table 13. Modeling results for the No Action alternative.

		Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Historical	6-16	2-8	4-13	38-78	1-32
	Current	12	7	57	5	19
	20 Years	5	8	53	15	19
	50 Years	5	8	36	28	23
	100 Years	5	2	7	49	37
Northern rocky mountains mixed conifer	Historical	9-25	1-3	18-30	4-6	44-60
	Current	19	4	65	1	11
	20 Years	7	0	70	0	22
	50 Years	3	0	60	0	38
	100 Years	4	0	14	0	83
Western hemlock / Western redcedar	Historical	4-24	0	7-27	0	55-83
	Current	21	0	60	0	19
	20 Years	1	0	65	0	34
	50 Years	0	0	35	0	65
	100 Years	0	0	0	0	100
Subalpine fir / Lodgepole pine	Historical	45-65	0	33-53	0	3
	Current	33	4	49	2	13
	20 Years	27	18	41	2	12
	50 Years	41	24	23	1	10
	100 Years	38	21	26	5	11
Spruce / Subalpine fir	Historical	14-46	0	13-41	0	29-57
	Current	35	0	52	0	13
	20 Years	15	0	69	0	16
	50 Years	7	0	70	0	24
	100 Years	4	0	34	0	63

Alternative PA – Proposed Action

The proposed action (PA) was released to the public on June 30, 2012, and implements a landscape approach utilizing active management to move forest structure towards HRV. The main difference between the Proposed Action and the P alternative are the number of acres recommended for wilderness. This alternative replaces Eastside Screens with a series of desired HRV conditions and removes the restriction of cutting trees ≥ 21 inches in diameter.

Summary of Effects

The landscape approach to forest structure management in this alternative proposes to use HRV as the desired future condition. All future actions that affect forest vegetation would be assessed and compared to HRV, with the goal of moving the overall landscape towards HRV. Restoring forest structure would result in also moving species composition, process, and spatial pattern towards more resilient conditions, with a higher likelihood of sustaining desired levels of late forest structure across the landscape.

Restoring landscape heterogeneity through forest structure results in a high flexibility to adjust to climate change influence and provides reduced risk of fire to adjacent communities.

Old Forest Management and Timber Production

The Proposed Action does not include the Eastside Screens, and does not limit the cutting of trees 21 inches in diameter and larger. The proposed action alternative, with its landscape approach, has desired conditions for levels of late forest structure that are to be met at a landscape scale. Large trees can be cut when the landscape is in excess of late forest structure, or, when site specific objectives call for removal, as long as post treatment conditions still meet desired conditions. The diameter limit imposed by Eastside Screens creates a situation where HRV cannot be met for certain structure types, such as early or open, because there is not a means to create and/or maintain these types. Once trees within a stand grow larger than 21” dbh, the number of management options is essentially restricted to fire, and there is little opportunity to reduce densities and create early structure or maintain open structure types. The ability to actively manage stands that grow into larger diameter classes means that the Proposed Action is better able to create and maintain structure types, such as early and late open, than alternatives that maintain the Eastside Screens. This is especially true in the Douglas-fir dry type that makes up the majority of the forest, where late forest levels are closer to the midpoints of the HRV range.

Modeling Results

Modeling results (Table 14) indicate that in the Douglas-fir dry vegetation type, late open structure would occupy the most area (59%), followed by late closed (22%). All structure types are within HRV for this vegetation type.

In the Northern Rocky Mountains mixed conifer type, the majority of structure would be in the late closed class (77%), followed by mid closed (12%). Mid open is the only structure type within HRV in this vegetation type, while both late open and late closed are above HRV, and early and mid closed are below HRV.

For western hemlock / western redcedar, 100% is within the late closed structure class. No structure class is within HRV for this vegetation type, largely because no active management is assumed to occur within this type.

For subalpine fir / lodgepole pine, the majority is within the early structure class (56%), followed by mid closed (22%) and mid open (11%). Early is the only structure classes within HRV in this vegetation type.

In the spruce / subalpine fir type, results show that there would be a lack of early structure type (3%), although there would be an abundance of late closed type (65%). The remainder is in the mid closed class (32%). Both early and late closed are outside of HRV in this vegetation type.

Table 14. Modeling results for the proposed action alternative

Forest type		Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Historical	6-16	2-8	4-13	38-78	1-32
	Current	12	7	57	5	19
	20 Years	7	14	45	17	16
	50 Years	8	18	22	36	16
	100 Years	8	6	4	59	22
Northern rocky mountains mixed conifer	Historical	9-25	1-3	18-30	4-6	44-60
	Current	19	4	65	1	11
	20 Years	7	7	64	1	21
	50 Years	2	6	53	2	36
	100 Years	2	1	12	7	77
Western hemlock / Western redcedar	Historical	4-24	0	7-27	0	55-83
	Current	21	0	60	0	19
	20 Years	1	0	65	0	34
	50 Years	0	0	34	0	66
	100 Years	0	0	0	0	100
Subalpine fir / Lodgepole pine	Historical	45-65	0	33-53	0	3
	Current	33	4	49	2	13
	20 Years	37	9	41	1	12
	50 Years	57	12	21	1	9
	100 Years	56	11	22	3	9
Spruce / Subalpine fir	Historical	14-46	0	13-41	0	29-57
	Current	35	0	52	0	13
	20 Years	14	0	69	0	18
	50 Years	6	0	68	0	26
	100 Years	3	0	32	0	65

Alternative P

The P alternative implements a landscape approach to managing forest structures by utilizing active management to improve adaptability and resilience and move the landscape towards HRV. The main difference between the Proposed Action and the P alternative is the number of acres recommended for Recommended Wilderness (RW). The alternative replaces Eastside Screens with a series of desired conditions and removes the restriction of cutting trees greater than 21 inches in diameter.

Summary of Effects

The landscape approach to forest structure management in this alternative proposes to use HRV as the desired future condition. All future actions that affect forest vegetation would be assessed and compared to HRV, with the goal of moving the overall landscape towards HRV. Restoring forest structure would result in also moving species composition, process, and spatial pattern towards more resilient conditions, with a higher likelihood of sustaining appropriate levels of late forest structure across the landscape.

Restoring landscape heterogeneity through forest structure results in a high flexibility to adjust to climate change influence and provides reduced risk of fire to adjacent communities.

Old Forest Management and Timber Production

Alternative P does not include the Eastside Screens, and does not limit the cutting of trees 21 inches in diameter and larger. Alternative P, with its landscape approach, has desired conditions for levels of late forest structure that are to be met at a landscape scale. Large trees can be cut when the landscape is in excess of late forest structure, or, when site specific objectives call for removal, as long as post treatment conditions still meet desired conditions. The diameter limit imposed by Eastside Screens creates a situation where HRV cannot be met for certain structure types, such as early or open, because there is not a means to create and/or maintain these types. Once trees within a stand grow larger than 21” dbh, the number of management options is essentially restricted to fire, and there is little opportunity to reduce densities and create early structure or maintain open structure types. The ability to actively manage stands that grow into larger diameter classes means that the P alternative is better able to create and maintain structure types, such as early and late open, than alternatives that maintain the Eastside Screens. This is especially true in the Douglas-fir dry type that makes up the majority of the forest, where late forest levels are closer to the midpoints of the HRV range.

Modeling Results

Modeling results (Table 15) indicate that in the Douglas-fir dry vegetation type, all structure types are within HRV.

In the Northern Rocky Mountains mixed conifer type, the majority of structure is within the late closed class (77%) and mid closed (12%). Mid open (1%) is the only structure type within HRV, although late open (7%) is just one percent higher than HRV. There is a lack of early (2%) and mid closed (12%).

For western hemlock / western redcedar, all of the structure is within the late closed type (100%). No structure class is within HRV in this vegetation type, largely because no active management is assumed to occur within this type.

For subalpine fir / lodgepole pine, the early structure class dominates (57%), with lesser amounts in mid closed (12%) and late closed (9%). Early is the only structure type within HRV.

In the spruce / subalpine fir type, results show that there would be a lack of early structure class (3%), although there would be an abundance of late closed class (63%). Only mid closed (33%) is within HRV in this vegetation type, with early being below HRV and late closed being above HRV.

Table 15. Modeling results for the P alternative

		Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Historical	6-16	2-8	4-13	38-78	1-32
	Current	12	7	57	5	19
	20 Years	6	14	45	18	17
	50 Years	9	18	21	36	16
	100 Years	8	6	5	59	22
Northern rocky mountains mixed conifer	Historical	9-25	1-3	18-30	4-6	44-60
	Current	19	4	65	1	11
	20 Years	7	7	63	1	21
	50 Years	2	6	54	2	36
	100 Years	2	1	12	7	77
Western hemlock / Western redcedar	Historical	4-24	0	7-27	0	55-83
	Current	21	0	60	0	19
	20 Years	1	0	63	0	35
	50 Years	0	0	34	0	66
	100 Years	0	0	0	0	100
Subalpine fir / Lodgepole pine	Historical	45-65	0	33-53	0	3
	Current	33	4	49	2	13
	20 Years	35	10	41	1	12
	50 Years	57	13	20	1	9
	100 Years	57	11	21	2	9
Spruce / Subalpine fir	Historical	14-46	0	13-41	0	29-57
	Current	35	0	52	0	13
	20 Years	14	0	66	0	21
	50 Years	8	0	65	0	27
	100 Years	3	0	33	0	63

Alternative R

The R alternative implements an expanded late forest structure reserve network, recommends high levels of RW, and retains a production oriented general forest utilizing two-aged management practices. The late forest structure reserve network is based on northern goshawk occupied territories, elevational criteria, and currently identified late forest structures based on GNN data. Late forest structure reserves have little active management. This alternative continues the use of Eastside Screens which includes not cutting trees greater than 21 inches in diameter.

Summary of Effects

Old Forest Management and Timber Production

The R alternative retains the Eastside Screens that were intended to be interim direction until the forest plan was revised. Eastside Screens restricts cutting of 21 inch diameter and larger trees in many situations, even when site specific objectives may warrant removal. Retaining all trees greater than 21 inch diameter can result in situations where tree vigor is reduced to a point where density related mortality factors could cause significant mortality resulting in loss of late forest structure.

The Eastside Screens process requires assessment of current conditions and comparison to pre-settlement HRV. When conditions are below HRV, there are narrow criteria for removing large, $\geq$21” diameter trees trees. When conditions are above HRV, there are more opportunities to remove large trees based on specific criteria and for specific objectives. Desired future conditions reflect HRV, thus following the Eastside Screen process should move the forest towards late structure levels as listed in the HRV tables. The main difference between the R alternative and the proposed action is the fixed locations of late forest structure reserves in the R alternative, with little opportunity to maintain or enhance it if there is no actual late forest structure within the reserve, whereas the proposed action’s landscape approach supports planning for replacement in a dynamic landscape. Additionally, the diameter limit imposed by Eastside Screens creates a situation where certain structure types are difficult to create and maintain, such as early or late open. Once trees within a stand grow larger than 21” dbh, the number of management options is restricted to essentially fire, and there is little opportunity to reduce densities and create early structure or maintain open structure types.

Managing late closed forest structure at or near the maximum end of the HRV range has a number of risks. Higher stocking results in stand density levels that are within the zone of competition induced mortality, where trees are experiencing increased levels of mortality from high levels of competition for resources such as light and water. The risk of mortality from bark beetles and other insects is greatly increased, and stand structure can change from a late closed structure back to early structure. Within the late forest structure management areas, some natural processes, such as succession, are allowed to function, but others, such as wildfire, are not.

An emphasis on late forest structure can result in reduced amounts of other forest structural states such as early successional stages. Inadequate representation of early successional structure is a frequent issue across the forested landscape (Swanson et al. 2010).

The use of a reserve system for late forest structure and the remainder for timber production results in less likelihood of having resilient forests in the long term. Late forest structure presence on the landscape is likely to be cyclical, with long time periods required to move from early to late structure. There is also limited flexibility to respond to climate change or other landscape scale changes.

Within timber production areas, reduced late forest structures are likely as an emphasis on two-aged management tends to cut trees at or near the culmination of mean annual increment, which is around 80 years, before reaching late forest structure.

Modeling Results

Modeling results (Table 16) indicate that in the Douglas-fir dry vegetation type, most structure would be within the late open class (45%), followed by late closed (35%). All structure types except for late closed are within HRV. While the proposed action and P alternatives maintain both late open and late closed around the midpoint of the HRV range, this alternative results in an amount of late open closer to the lower HRV limit, while having an overabundance of late closed.

In the Northern Rocky Mountains mixed conifer type, late closed contains the most area (80%), with mid closed (13%) taking up most of the remainder. Mid open (1%) and late open (4%) are the only structure types within HRV, and there is a lack of early (3%).

For western hemlock / western redcedar, all structure is within the late closed class (100%). No structure class is within HRV for this vegetation type.

For subalpine fir / lodgepole pine, the early structure class is dominant (59%), followed by mid closed (27%) and late closed (7%). Early is the only type within HRV at 100 years for this vegetation type.

In the spruce / subalpine fir type, results show that there would be a lack of early structure class (3%), although there would be an abundance of late closed class (63%). The mid closed class (34%) is within HRV for this vegetation type, while both early and late closed are outside of HRV.

Table 16. Modeling results for the R alternative

Forest type	Period	Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Historical	6-16	2-8	4-13	38-78	1-32
	Current	12	7	57	5	19
	20 Years	6	7	52	16	19
	50 Years	8	7	35	28	22
	100 Years	8	3	8	45	35
Northern rocky mountains mixed conifer	Historical	9-25	1-3	18-30	4-6	44-60
	Current	19	4	65	1	11
	20 Years	7	3	67	1	22
	50 Years	2	3	56	2	37
	100 Years	3	1	13	4	80
Western hemlock / Western redcedar	Historical	4-24	0	7-27	0	55-83
	Current	21	0	60	0	19
	20 Years	2	0	65	0	34
	50 Years	0	0	36	0	64
	100 Years	0	0	0	0	100
Subalpine fir / Lodgepole pine	Historical	45-65	0	33-53	0	3
	Current	33	4	49	2	13
	20 Years	37	5	45	1	12
	50 Years	59	6	25	1	9
	100 Years	59	5	27	2	7
Spruce / Subalpine fir	Historical	14-46	0	13-41	0	29-57
	Current	35	0	52	0	13
	20 Years	15	0	68	0	17
	50 Years	7	0	69	0	24
	100 Years	3	0	34	0	63

Alternative B

The B Alternative emphasizes two management areas that focus on forest vegetation; the Restoration MA**,** which emphasizes late forest structure**,** and the Active MA**,** which emphasizes a two-aged approach to timber production by using the shelterwood with reserves regeneration method. Input from the Northeast Washington Forestry Coalition’s alternative on vegetation, road, aquatic management and wilderness recommendations are included in this alternative. Proposed management not provided in the coalition’s alternative comes from the proposed action. This alternative also responds to those advocating for increased wilderness and to public concerns that the amount and location of summer and winter motorized use may impact aquatic, riparian and wildlife habitats. This alternative continues the use of Eastside Screens which includes not cutting trees ≥ 21 inches in diameter.

Summary of Effects

Old Forest Management and Timber Production

The B alternative retains the Eastside Screens that were intended to be interim direction until the forest plan was revised. Eastside Screens restricts cutting of 21 inch diameter and larger trees in many situations, even when site specific objectives may warrant removal. Retaining all trees ≥ 21 inch diameter can result in situations where tree vigor is reduced to a point where density related mortality factors could cause significant mortality resulting in loss of late forest structure.

The Eastside Screens process requires assessment of current conditions and comparison to pre-settlement HRV. When conditions are below HRV, there are narrow criteria for removing large, ≥21” diameter trees trees. When conditions are above HRV, there are more opportunities to remove large trees based on specific criteria and for specific objectives. Desired future conditions reflect HRV, thus following the Eastside Screen process should move the forest towards late structure levels as listed in the HRV tables. The main difference between the B alternative and the proposed action is the fixed locations of late forest structure reserves in the B alternative, with little opportunity to maintain or enhance it if there is no actual late forest structure within the reserve, whereas the proposed action’s landscape approach supports planning for replacement in a dynamic landscape. Additionally, the diameter limit imposed by Eastside Screens creates a situation where certain structure types are difficult to create and maintain, such as early or late open. Once trees within a stand grow larger than 21” dbh, the number of management options is restricted to essentially fire, and there is little opportunity to reduce densities and create early structure or maintain open structure types.

Managing late closed forest structure at or near the maximum end of the HRV range has a number of risks. Higher stocking results in stand density levels that are within the zone of competition induced mortality, where trees are experiencing increased levels of mortality from high levels of competition for resources such as light and water. The risk of mortality from bark beetles and other insects is greatly increased, and stand structure can change from a late closed structure back to early structure. Within the late forest structure management areas, some natural processes, such as succession, are allowed to function, but others, such as wildfire, are not.

An emphasis on late forest structure can result in reduced amounts of other forest structural states such as early successional stages. Inadequate representation of early successional structure is a frequent issue across the forested landscape (Swanson et al. 2010).

The use of a reserve system for late forest structure and the remainder for timber production results in less likelihood of having resilient forests in the long term. Late forest structure presence on the landscape is likely to be cyclical, with long time periods required to move from early to late structure. There is also limited flexibility to respond to climate change or other landscape scale changes.

Within timber production areas, reduced late forest structures are likely as an emphasis on two-aged management tends to cut trees at or near the culmination of mean annual increment, which is around 80 years, before reaching late forest structure.

Modeling Results

Modeling results (Table 17) indicate that in the Douglas-fir dry vegetation type, most of the structure is within the late open class (42%), followed by late closed (32%), early (12%), mid closed (10%), and mid open (4%). All structure classes are within HRV for this vegetation type. While the proposed action and P alternatives maintain both late open and late closed around the midpoint of the HRV range, this alternative results in an amount of late open closer to the lower HRV limit, while having an amount of late closed that is at the upper HRV limit.

In the Northern Rocky Mountains mixed conifer type, late closed occupies the most area (77%), while mid closed (10%) and early (8%) make up nearly all of the rest. Mid open and late open are the only structure types within HRV for this vegetation type, while there is an overabundance of late closed and a lack of early and mid closed.

For western hemlock / western redcedar, most structure is within the late closed class (90%), while mid closed (8%) and early (2%) make up the rest. Mid closed is the only structure class within HRV, while both early and late closed are outside of HRV.

For subalpine fir / lodgepole pine, the vast majority of area is within the early structure class (62%), while mid closed (30%) and late closed (6%) make up the remainder. Only the early type is within HRV for this vegetation type, with both mid closed and late closed outside of HRV.

In the spruce / subalpine fir type, results show that there would be a lack of early structure type (3%), although there would be an abundance of late closed type (64%). Mid closed (32%) is within HRV, while both early and late closed are outside of HRV.

Table 17. Modeling results for the B alternative

Forest type		Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Historical	6-16	2-8	4-13	38-78	1-32
	Current	12	7	57	5	19
	20 Years	7	9	49	15	19
	50 Years	11	8	32	26	22
	100 Years	12	4	10	42	32
Northern rocky mountains mixed conifer	Historical	9-25	1-3	18-30	4-6	44-60
	Current	19	4	65	1	11
	20 Years	9	4	64	1	21
	50 Years	7	4	51	2	36
	100 Years	8	1	10	4	77
Western hemlock / Western redcedar	Historical	4-24	0	7-27	0	55-83
	Current	21	0	60	0	19
	20 Years	4	0	61	0	35
	50 Years	6	0	30	0	63
	100 Years	2	0	8	0	90
Subalpine fir / Lodgepole pine	Historical	45-65	0	33-53	0	3
	Current	33	4	49	2	13
	20 Years	40	2	45	1	12
	50 Years	66	3	22	0	8
	100 Years	62	1	30	0	6
Spruce / Subalpine fir	Historical	14-46	0	13-41	0	29-57
	Current	35	0	52	0	13
	20 Years	15	0	68	0	16
	50 Years	8	0	68	0	25
	100 Years	3	0	32	0	64

Alternative O

The O alternative proposes two management areas to address vegetation management: the Restoration MA to move forest structure to within the historical range of variability, and the Responsible MA that emphasizes two-aged management for timber production by using the shelterwood with reserves regeneration method. The total percentage of the Forest allocated to vegetation management is similar to the B Alternative, though the O Alternative has a greater percentage in the Restoration MA than the B Alternative. The Forest Service fully developed this alternative using the Proposed Action to fill in the gaps not addressed in the collaborative process. This alternative continues the use of Eastside Screens which includes not cutting trees ≥ 21 inches in diameter.

Summary of Effects

Old Forest Management and Timber Production

The O alternative retains the Eastside Screens that were intended to be interim direction until the forest plan was revised. Eastside Screens restricts cutting of 21 inch diameter and larger trees in many situations, even when site specific objectives may warrant removal. Retaining all trees greater than 21 inch diameter can result in situations where tree vigor is reduced to a point where density related mortality factors could cause significant mortality resulting in loss of late forest structure.

The Eastside Screens process requires assessment of current conditions and comparison to pre-settlement HRV. When conditions are below HRV, there are narrow criteria for removing large, ≥21” diameter trees. When conditions are above HRV, there are more opportunities to remove large trees based on specific criteria and for specific objectives. Desired future conditions reflect HRV, thus following the Eastside Screen process should move the forest towards late structure levels as listed in the HRV tables. The main difference between the O alternative and the proposed action is the fixed locations of late forest structure reserves in the O alternative, with little opportunity to maintain or enhance it if there is no actual late forest structure within the reserve, whereas the proposed action’s landscape approach supports planning for replacement in a dynamic landscape. Additionally, the diameter limit imposed by Eastside Screens creates a situation where certain structure types are difficult to create and maintain, such as early or late open. Once trees within a stand grow larger than 21” dbh, the number of management options is restricted to essentially fire, and there is little opportunity to reduce densities and create early structure or maintain open structure types.

Managing late closed forest structure at or near the maximum end of the HRV range has a number of risks. Higher stocking results in stand density levels that are within the zone of competition induced mortality, where trees are experiencing increased levels of mortality from high levels of competition for resources such as light and water. The risk of mortality from bark beetles and other insects is greatly increased, and stand structure can change from a late closed structure back to early structure. Within the late forest structure management areas, some natural processes, such as succession, are allowed to function, but others, such as wildfire, are not.

An emphasis on late forest structure can result in reduced amounts of other forest structural states such as early successional stages. Inadequate representation of early successional structure is a frequent issue across the forested landscape (Swanson et al. 2010).

The use of a reserve system for late forest structure and the remainder for timber production results in less likelihood of having resilient forests in the long term. Late forest structure presence on the landscape is likely to be cyclical, with long time periods required to move from early to late structure. There is also limited flexibility to respond to climate change or other landscape scale changes.

Within timber production areas, reduced late forest structures are likely as an emphasis on two-aged management tends to cut trees at or near the culmination of mean annual increment, which is around 80 years, before reaching late forest structure.

Modeling Results

Modeling results (Table 18) indicate that in the Douglas-fir dry vegetation type, most of the structure would be within a late open class (45%) and late closed (32%). All structure classes are within HRV for this vegetation type. While the proposed action and P alternatives maintain both late open and late closed around the midpoint of the HRV range, this alternative results in an amount of late open closer to the lower HRV limit, while having an amount of late closed that is at the upper HRV limit.

In the Northern Rocky Mountains mixed conifer type, late closed structure occupies the most area (77%), followed by mid closed (11%), early (6%), late open (5%) and mid open (2%). Mid open and late open are within HRV, while there is an overabundance of late closed and a lack of early and mid closed.

For western hemlock / western redcedar, the bulk of structure is within the late closed class (90%), with mid closed (8%) and early (2%) occupying the rest. Only mid closed is within HRV for this vegetation type, while both early and late closed are outside of HRV.

For subalpine fir / lodgepole pine, 55% is within the early structure class, while 37% is within mid closed and 6% in late closed. Early and mid closed are within HRV for this vegetation type, while there is an overabundance of late closed.

In the spruce / subalpine fir type, results show that there would be a lack of early structure type (3%), although there would be an abundance of late closed type (67%). Mid closed (30%) is the only structure class that is within HRV, while both late closed and early are outside of HRV.

Table 18. Modeling results for the O alternative

Forest type		Early %	Mid Open %	Mid Closed %	Late Open %	Late Closed %
Douglas-fir dry	Historical	6-16	2-8	4-13	38-78	1-32
	Current	12	7	57	5	19
	20 Years	6	10	50	15	19
	50 Years	9	9	32	28	22
	100 Years	11	4	8	45	32
Northern rocky mountains mixed conifer	Historical	9-25	1-3	18-30	4-6	44-60
	Current	19	4	65	1	11
	20 Years	9	5	64	1	21
	50 Years	5	4	52	2	36
	100 Years	6	2	11	5	77
Western hemlock / Western redcedar	Historical	4-24	0	7-27	0	55-83
	Current	21	0	60	0	19
	20 Years	4	0	62	0	35
	50 Years	6	0	31	0	63
	100 Years	2	0	8	0	90
Subalpine fir / Lodgepole pine	Historical	45-65	0	33-53	0	3
	Current	33	4	49	2	13
	20 Years	38	2	47	1	12
	50 Years	62	2	28	0	8
	100 Years	55	1	37	0	6
Spruce / Subalpine fir	Historical	14-46	0	13-41	0	29-57
	Current	35	0	52	0	13
	20 Years	14	0	68	0	19
	50 Years	7	0	67	0	26
	100 Years	3	0	30	0	67

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Appendices

A – PAG and Biophysical Setting Information

B – State and transition modeling information

C – Timber Suitability

D – Harvest Volumes, LTSY, ASQ, and TSPQ Calculations

E – Seed Orchard Management

United States Department of Agriculture
Forest Service

Forest Vegetation Report - Appendices

Colville National Forest Plan Revision

Draft Environmental Impact Statement

Prepared by:

Jonathan Day, Forest Silviculturist
Colville National Forest

October 19, 2015

Appendix A – Plant association groups and Landfire biophysical environment descriptions.

Table 1 – Crosswalk of plant association, code, plant association group, PAG code, Landfire biophysical setting number, and vegetation type (model). See tables 2 and 3 below for common names of plant associations and plant association groups.

Plant Association	*Code*	*Plant Association Group (PAG)*	*PAG Code*	*Landfire BpS*	*Vegetation Type (Model)*
ABLA2/CARU	CEG311	PIAL/VASC-LUHI-CARU	2501	1010451	Subalpine Fir/Lodgepole pine
ABLA2/CLUN	CEF421	SAF/VASC-VACA-VAME-LIBOL	2503	1010452	Subalpine Fir/Lodgepole pine
ABLA2/COCA	CEF423	SAF/TRCA3-ATFI-GYDR-STAM-riparian	2507	1010560 (90%) / 1011610 (10%)	Spruce/Subalpine fir
ABLA2/LIBOL	CEF211	SAF/VASC-VACA-VAME-LIBOL	2503	1010452	Subalpine Fir/Lodgepole pine
ABLA2/RHAL	CES211	SAF/RHAL-XETE-ARLA-POPU	2505	1010452	Subalpine Fir/Lodgepole pine
ABLA2/RHAL-XETE	CES210	SAF/RHAL-XETE-ARLA-POPU	2505	1010452	Subalpine Fir/Lodgepole pine
ABLA2/TRCA3	CEF422	SAF/TRCA3-ATFI-GYDR-STAM-riparian	2507	1010560 (90%) / 1011610 (10%)	Spruce/Subalpine fir
ABLA2/VACA	CES422	SAF/VASC-VACA-VAME-LIBOL	2503	1010452	Subalpine Fir/Lodgepole pine
ABLA2/VAME	CES313	SAF/VASC-VACA-VAME-LIBOL	2503	1010452	Subalpine Fir/Lodgepole pine
ABLA2/VASC	CES412	SAF/CARU-PAMY	2502	1010452	Subalpine Fir/Lodgepole pine
ABLA2/XETE	CEF111	SAF/RHAL-XETE-ARLA-POPU	2505	1010452	Subalpine Fir/Lodgepole pine
PIEN/EQUIS	CEM211	SAF/TRCA3-ATFI-GYDR-STAM-riparian	2507	1010560 (90%) / 1011610 (10%)	Spruce/Subalpine fir
PIPO-PSME/AGIN	-	PP/AGSP-PUTR dry shrub-grass	1001	1010451	Douglas-fir dry
PIPO-PSME/AGSP	CDG311	PP/AGSP-PUTR dry shrub-grass	1001	1010451	Douglas-fir dry
PSME/CARU	CDG131	DF/CARU-SPBE-PAMY-ARUV-SYOR	1403	1010451	Douglas-fir dry

Appendix A – Plant association groups and Landfire biophysical environment descriptions.

Plant Association	*Code*	*Plant Association Group (PAG)*	*PAG Code*	*Landfire BpS*	*Vegetation Type (Model)*
PSME/PHMA	CDS715	DF/SYAL-PHMA	1404	1010451	Douglas-fir dry
PSME/PHMA-LIBOL	CDS716	DF/SYAL-PHMA	1404	1010451	Douglas-fir dry
PSME/SYAL	CDS633	DF/SYAL-PHMA	1404	1010451	Douglas-fir dry
PSME/SYOR	CDS632	DF-PP/AGSP-PUTR-FEID-ARUV	1401	1010451	Douglas-fir dry
PSME/VACA	CDS813	DF/VACA-VAME-VAMY	1405	1010451	Douglas-fir dry
PSME/VAME	CDS814	DF/VACA-VAME-VAMY	1405	1010451	Douglas-fir dry
THPL/ARNU3	CCF222	WH/POMU-TIUN-OXOR-ARNU3	1907	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock
THPL/CLUN	CCF221	WH/GASH-XETE-VAME-HODI-ARNE	1901	1010471	Northern Rocky Mountain Mixed conifer
THPL/OPHO	CCS211	WH/POMU-TIUN-OXOR-ARNU3	1907	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock
THPL/VAME	CCS311	WH/GASH-XETE-VAME-HODI-ARNE	1901	1010471	Northern Rocky Mountain Mixed conifer
TSHE/ARNU3	CHF312	WH/POMU-TIUN-OXOR-ARNU3	1907	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock
TSHE/CLUN	CHF311	WH/GASH-XETE-VAME-HODI-ARNE	1901	1010471	Northern Rocky Mountain Mixed conifer
TSHE/GYDR	CHF422	WH/POMU-TIUN-OXOR-ARNU3	1907	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock
TSHE/MEFE	CHS711	WH/MEFE-XETE-RUPE	1912	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock
TSHE/RUPE	CHS411	WH/POMU-TIUN-OXOR-ARNU3	1907	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock
TSHE/XETE	CHF521	WH/MEFE-XETE-RUPE	1912	1010472 (5%) / 1010471 (95%)	Western redcedar/western hemlock

Table 2 – Plant association group codes and common names

Plant Association Group Code	Description
PIAL/VASC-LUHI-CARU	whitebark pine / grouse huckleberry-smooth woodrush-pinegrass
SAF/CARU-PAMY	subalpine fir / pinegrass-pachistima
SAF/VASC-VACA-VAME-LIBOL	subalpine fir / grouse huckleberry-dwarf huckleberry-big huckleberry-twinflower
SAF/RHAL-XETE-ARLA-POPU	subalpine fir / Cascade azalea-beargrass-broadleaf arnica
SAF/TRCA3-ATFI-GYDR-STAM-riparian	subalpine fir / false bugbane-ladyfern-oak fern-claspleaf twisted stalk
PP/AGSP-PUTR dry shrub-grass	ponderosa pine / bluebunch wheatgrass-bitterbrush
DF-PP/AGSP-PUTR-FEID-ARUV	Douglas-fir-ponderosa pine / bluebunch wheatgrass-bitterbrush-Idaho fescue-bearberry
DF/CARU-SPBE-PAMY-ARUV-SYOR	Douglas-fir / pinegrass-shiny leaf spirea-pachistima-bearberry-mountain snowberry
DF/SYAL-PHMA	Douglas-fir / common snowberry-ninebark
DF/VACA-VAME-VAMY	Douglas-fir / dwarf huckleberry-big huckleberry-low huckleberry
WH/GASH-XETE-VAME-HODI-ARNE	western hemlock / salal-beargrass-big huckleberry-ocean spray-pinemat manzanita
WH/GASH-BENE-RHMA-PAMY-CLUN	western hemlock / salal-Oregon grape-Pacific rhododendron-pachistima-queencup beadlily
WH/ACCI-GASH-BENE-ACTR-POMU	western hemlock / vine maple-salal-Oregon grape-sweet after death-swordfern
WH/POMU-TIUN-OXOR-ARNU3	western hemlock / swordfern-foamflower-oxalis-glossyleaf manzanita
WH/OPHO-ATFI-LYAM	western hemlock / devil’s club-ladyfern-skunkcabbage
WH/MEFE-XETE-RUPE	western hemlock / rusty menzeisia-beargrass-five leaved ramble

Table 3 – Plant association codes and common names

Plant Association	*Common Name*
ABLA2/CARU	Subalpine fir / pinegrass
ABLA2/CLUN	Subalpine fir / queencup beadlily
ABLA2/COCA	Subalpine fir / bunchberry dogwood
ABLA2/LIBOL	Subalpine fir / twinflower
ABLA2/RHAL	Subalpine fir / Cascades azalea
ABLA2/RHAL-XETE	Subalpine fir / Cascades azalea – beargrass
ABLA2/TRCA3	Subalpine fir / false bugbane
ABLA2/VACA	Subalpine fir / dwarf huckleberry
ABLA2/VAME	Subalpine fir / big huckleberry
ABLA2/VASC	Subalpine fir / grouse huckleberry

Appendix A – Plant association groups and Landfire biophysical environment descriptions.

Plant Association	*Common Name*
ABLA2/XETE	Subalpine fir / beargrass
PIEN/EQUIS	Engelmann spruce / horsetail
PIPO-PSME/AGIN	Ponderosa pine – Douglas-fir / beardless bluebunch wheatgrass
PIPO-PSME/AGSP	Ponderosa pine – Douglas-fir / bluebunch wheatgrass
PSME/CARU	Douglas-fir / pinegrass
PSME/PHMA	Douglas-fir / ninebark
PSME/PHMA-LIBOL	Douglas-fir / ninebark – twinflower
PSME/SYAL	Douglas-fir / snowberry
PSME/SYOR	Douglas-fir / mountain snowberry
PSME/VACA	Douglas-fir / dwarf huckleberry
PSME/VAME	Douglas-fir / big huckleberry
THPL/ARNU3	Western redcedar / wild sarsaparilla
THPL/CLUN	Western redcedar / queencup beadlily
THPL/OPHO	Western redcedar / devil's club
THPL/VAME	Western redcedar / big huckleberry
TSHE/ARNU3	Western hemlock / wild sarsaparilla
TSHE/CLUN	Western hemlock / queencup beadlily
TSHE/GYDR	Western hemlock / oak fern
TSHE/MEFE	Western hemlock / rusty menziesia
TSHE/RUPE	Western hemlock / five-leaved bramble
TSHE/XETE	Western hemlock / beargrass

Vegetation Modeling Assumptions for the Colville Forest Planning Effort

Prepared by Maximillian Wahlberg, Regional Analyst

Background:

The following documentation represents model parameters and assumptions used in the modeling of Forest Plan Alternatives in the Colville National Forest revision effort. This document specifically refers to the model runs and results provided to Colville Interdisciplinary Team (IDT) members in February 2015.

Software

State and transition simulation modeling (STSM) was conducted using the St-Sim module of SyncroSim, version 2.3.8. For a full description of St-Sim the reader is referred to ApexRMS and online documentation at http://wiki.syncrosim.com/index.php?title=Main_Page.

Model origins

The models used in this effort were adapted from models received from Mark Loewen (NEWz Vegetation Specialist, now retired). These base models were evaluated for potential flaws (with fixes applied as necessary) and reworked through a workshop process. Model workshops were conducted in Wenatchee, WA with key specialists' involvement in July of 2014. Further refinement of the models was done based on feedback received from Colville NF specialists in August of 2014. Final modifications were made in consultation with Jonathan Day, Colville Plan Revision Vegetation Specialist between August and November of 2014.

Stratifications

The model space is stratified by two primary components, 1) Potential Vegetation Type, and 2) Modeling Zone.

Model Types

The Potential Vegetation Type is derived from plant association group (PAG) crosswalks combining like PAGs into functional groupings based on similar vegetation potential and disturbance response.

Table 1 - Model Types

Model Type	***Code***	***Total Modeled Acres***
Douglas-Fir Dry	FDD	395,250
Northern Rocky Mountain Mixed Conifer	FCM	309,500
Spruce/Subalpine Fir	FCD_LPWL	23,506
Subalpine Fir/Lodgepole pine	FCD_DFmx	189,794
Western Redcedar/Western Hemlock	FRN	99,200

Geospatial representation of the PAGs comes from the 2012 Henderson PAG layer. Table 2 includes a crosswalk between PAGs and Model Types.

Table 2 - Plant Association Group to Forest Plan Model Type Crosswalk

PAG NAME	MAP CODE	PVG	FOREST PLAN MODEL
PIAL/VASC-LUHI-CARU	2501	Cold	Subalpine Fir/Lodgepole pine (fcd)
SAF/CARU-PAMY	2502	Cold	Subalpine Fir/Lodgepole pine (fcd)
SAF/VASC-VACA-VAME-LIBOL	2503	Cold	Subalpine Fir/Lodgepole pine (fcd)
SAF/RHAL-XETE-ARLA-POPU	2505	Cold	Subalpine Fir/Lodgepole pine (fcd)
SAF/TRCA3-ATFI-GYDR-STAM-riparian	2507	Cold	Spruce/Subalpine fir (fcd?)
PP/AGSP-PUTR dry shrub-grass	1001	Dry	Douglas-fir dry (fdd)
DF-PP/AGSP-PUTR-FEID-ARUV	1401	Dry	Douglas-fir dry (fdd)
DF/CARU-SPBE-PAMY-ARUV-SYOR	1403	Dry	Douglas-fir dry (fdd)
DF/SYAL-PHMA	1404	Dry	Douglas-fir dry (fdd)
DF/VACA-VAME-VAMY	1405	Dry	Douglas-fir dry (fdd)
WH/GASH-XETE-VAME-HODI-ARNE	1901	Mesic	Northern Rocky Mountain Mixed Conifer (fcm)
WH/GASH-BENE-RHMA-PAMY-CLUN	1903	Mesic	Northern Rocky Mountain Mixed Conifer (fcm)
WH/ACCI-GASH-BENE-ACTR-POMU	1906	Mesic	Northern Rocky Mountain Mixed Conifer (fcm)
WH/POMU-TIUN-OXOR-ARNU3	1907	Mesic	Western redcedar/western hemlock (frn)
WH/OPHO-ATFI-LYAM	1910	Mesic	Western redcedar/western hemlock (frn)
WH/MEFE-XETE-RUPE	1912	Mesic	Western redcedar/western hemlock (frn)
Northern Artemesia-Agropyron steppe	501	Non-Forest	
Non-Forest Dry	1071	Non-Forest	
Non-Forest Dry	1471	Non-Forest	
Non-Forest Dry	1971	Non-Forest	
Non-Forest Dry	2571	Non-Forest	
Dry Continental PKL	3201	Non-Forest	
Alpine	3301	Non-Forest	
DF-ES/riparian	1409	Riparian	

Model zones

The second strata applied to this modeling effort are "Model Zones". Four primary model zones were created to capture different management emphasis on lands with different designations under each alternative[1]. These model zones allow a certain number of model "cells" to receive different transitions and probabilities than other model cells of the same state. In this way, model cells that reflect designated Wilderness, for example, can be programed to receive fire transitions but not mechanical treatments. In the St-Sim database, these areas are referred to as "Planning Zones". A list of the model zones is contained in Table 3.

[1] While the models themselves are not run spatially (the outcome in a given model cell is not informed by the outcomes of "adjacent" cells), model initial conditions are set based on acres of each model state in each model zone based on GIS queries.

Table 3 - Model Zones

Planning Zone	***ST-Sim Description***
Reserve	Reserve lands
Restoration	Whole Landscape Approach and Restoration Zones
TimbProd	Active Timber Production Zones
WildOther	Wilderness, RW and other

Model zones are based on and tier to categories developed by Jon Day, Planning Team Vegetation Specialist as part of the timber suitability analysis.

Parameters

Alternatives

Individual model runs were completed for each vegetation/model type[2], and for each alternative. Transitions for each alternative were developed and refined through a workshop process and based on local expertise and the interdisciplinary team's understanding of the alternatives. A full description of the model assumptions for each alternative can be found in the section Model Assumptions by Alternative.

Non-spatial

All models are run as non-spatial models. However, existing (initial) conditions are populated based on spatial analysis of model state distribution across modeling zones. See the Modeling Zoned and Existing Conditions sections for a detailed description of the spatial data that feeds the initial conditions in these model runs.

Existing conditions

Source

Existing conditions were calculated using the following data sources:
2012 Gradient Nearest Neighbor (GNN) Structure Data produced by the Landscape Ecology, Modeling, Mapping and Analysis group (LEMMA). GNN structure data can be obtained from the following link: *http://lemma.forestry.oregonstate.edu/data/structure-maps*

- 2012 Plant Association Group (PAG) map developed and updated by Jan Henderson. A description of this product can be found in the document: "FINAL REPORT for CONTRACT AG-05H7-P-10-0029 - Revise and update the PAG map and model for the Okanogan, Wenatchee and Colville National Forests.
- Model Zones (discussed above)

To develop datasets for imputation into the St-Sim modeling database, both datasets were classified into model groupings. The PAG data were classified and cross walked into model vegetation types as displayed in Table 2. GNN data were classified into structural groupings

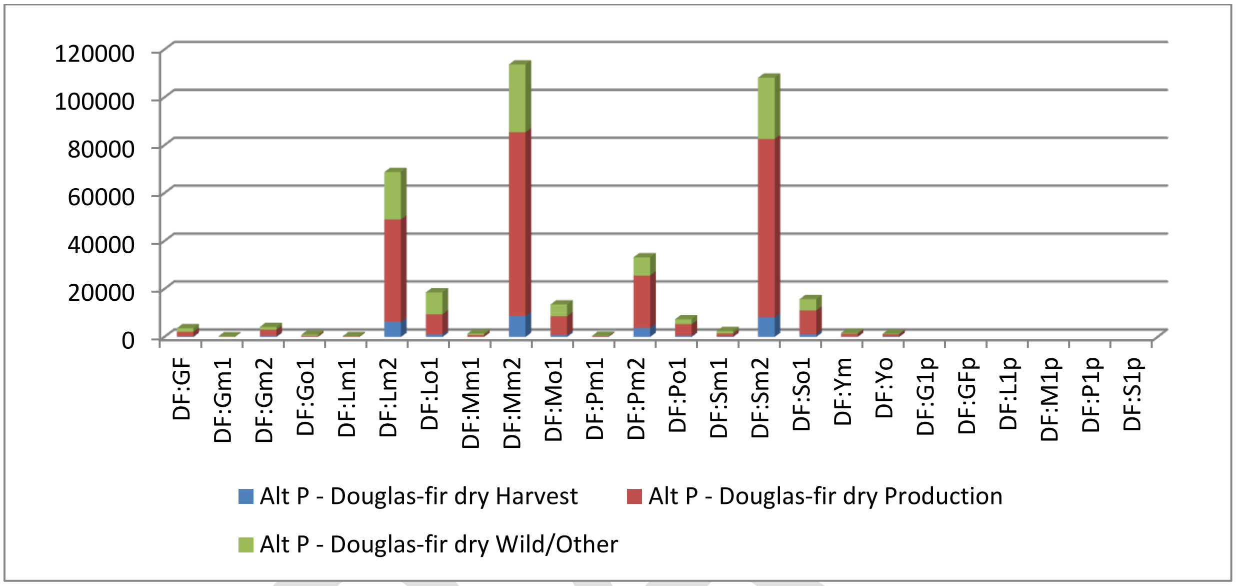
[2] The one exception to this was the FCD model, which was run as one model, but represents two different model types (Spruce/Subalpine Fir & Subalpine Fir/Lodgepole Pine). However, there are no transition pathways between the two model types contained in this model, therefore they essentially function as separate models run concurrently. This was done to expedite modeling as the base models contained linkages between these two model types that were removed as a result of model workshops based on local understanding of the ecology inherent to these systems.

based on canopy cover, size class and storiedness. These structural groupings represent the structural components of the model states[3] in each state and transition simulation model.

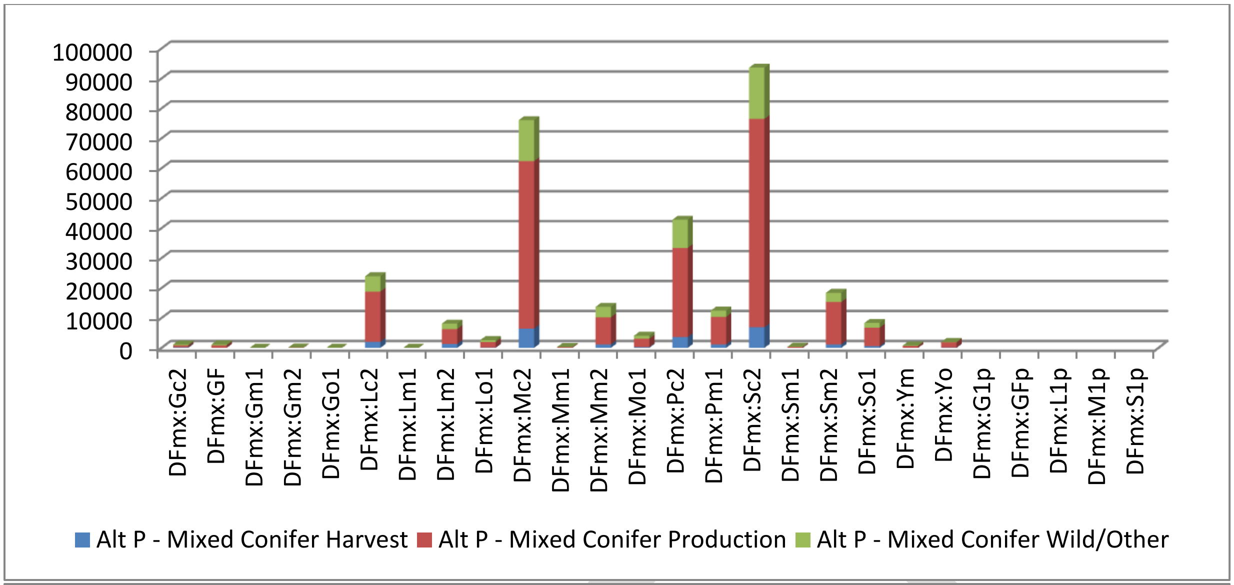
Values

Full existing condition values by model state and model zone are included in the St-SIM database. The following summaries show existing conditions by model state and model zone in graphical format.

Alternative P



[3] The model states are not synonymous with the Colville Structure Groupings used for final reporting in the Vegetation Specialist's Report. These structural groupings represent a finer delineation of structural characteristics (e.g. storiedness) than the Colville Structural Groupings. A crosswalk between modeled structure states and the Colville Structure Groupings can be found in Appendix 2.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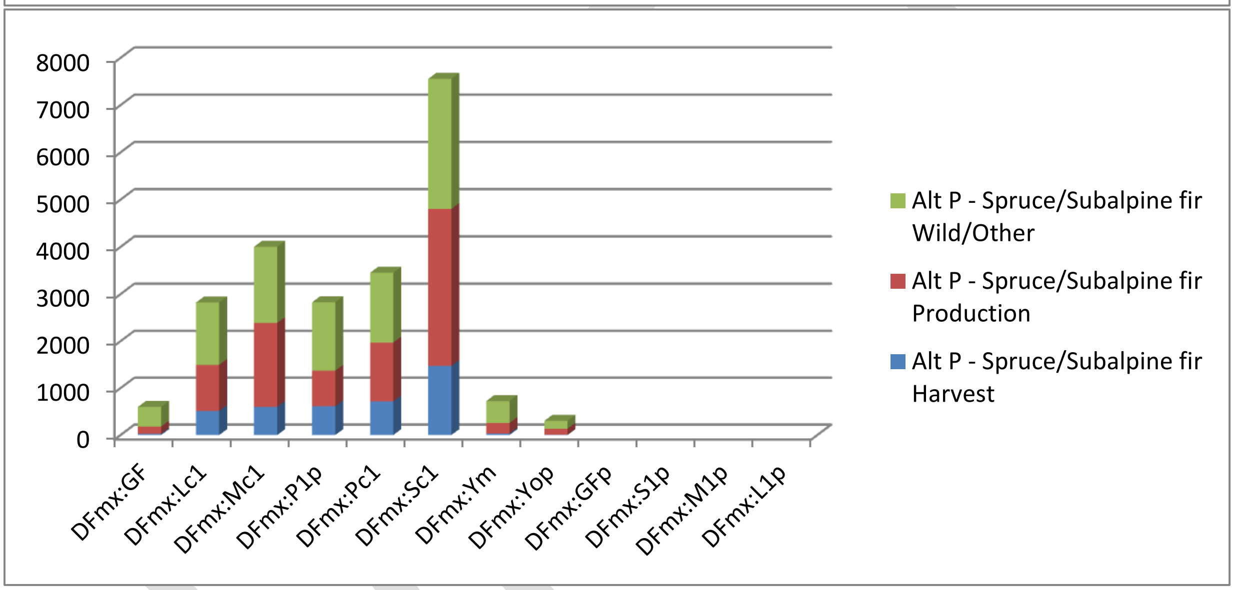
Alt P - Mixed Conifer Harvest
Alt P - Mixed Conifer Production
Alt P - Mixed Conifer Wild/Other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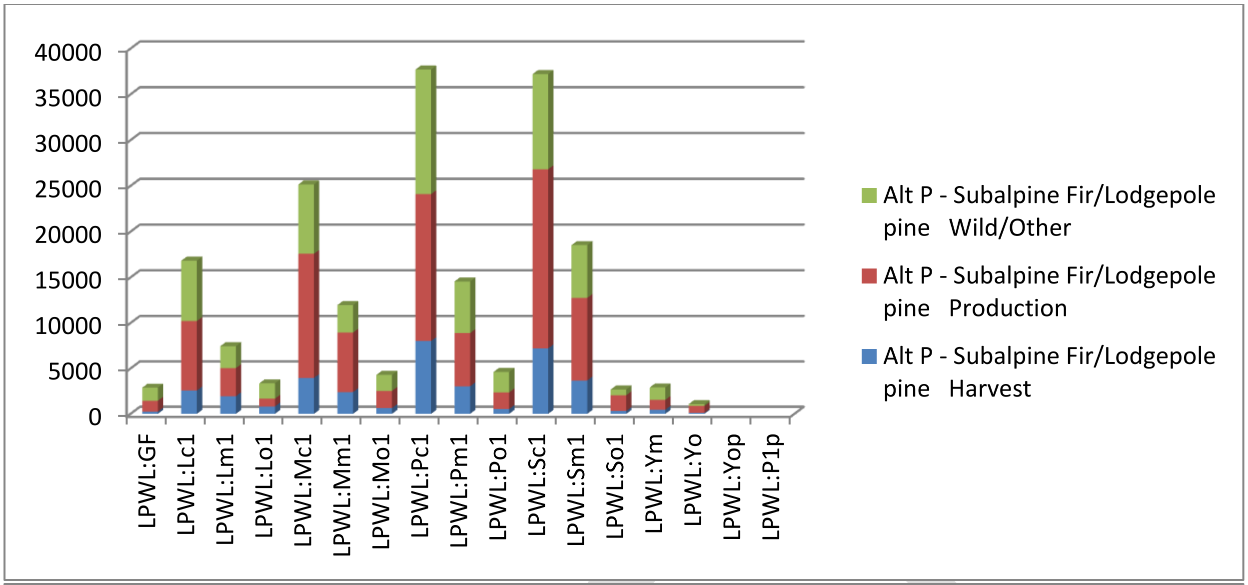
Alt P - Spruce/Subalpine fir Production
Alt P - Spruce/Subalpine fir Harvest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LPWL:Pm1
LPWL:Po1
LPWL:Sc1
LPWL:Sm1
LPWL:So1
LPWL:Ym
LPWL:Yo
LPWL:Yop
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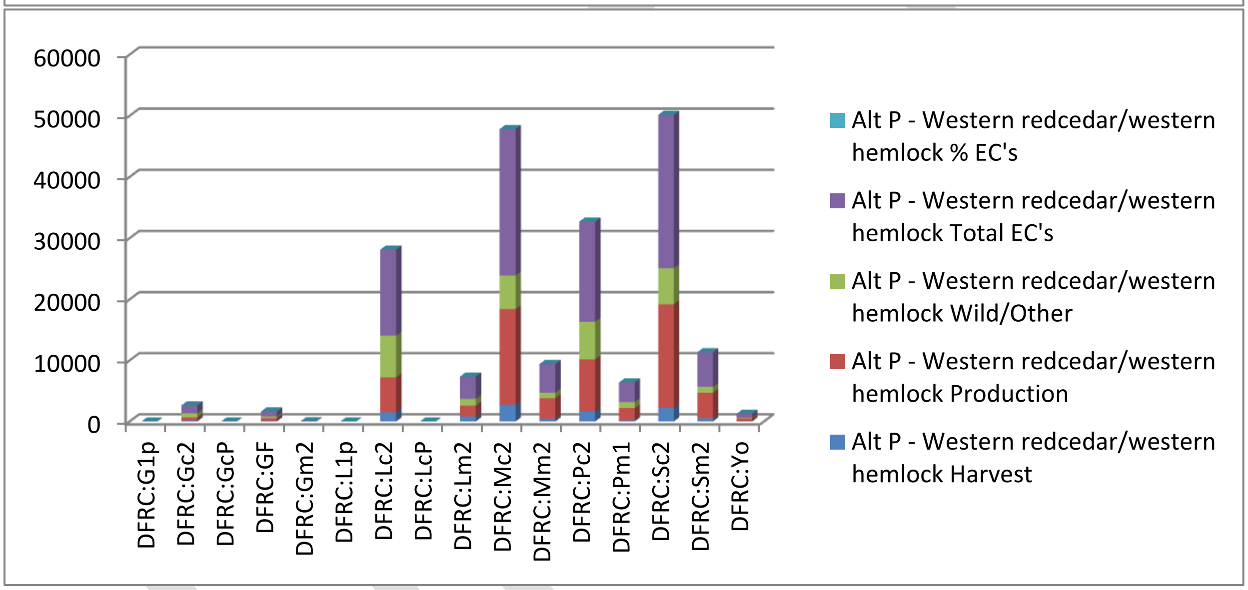
Alt P - Subalpine Fir/Lodgepole pine Wild/Other
Alt P - Subalpine Fir/Lodgepole pine Production
Alt P - Subalpine Fir/Lodgepole pine Harvest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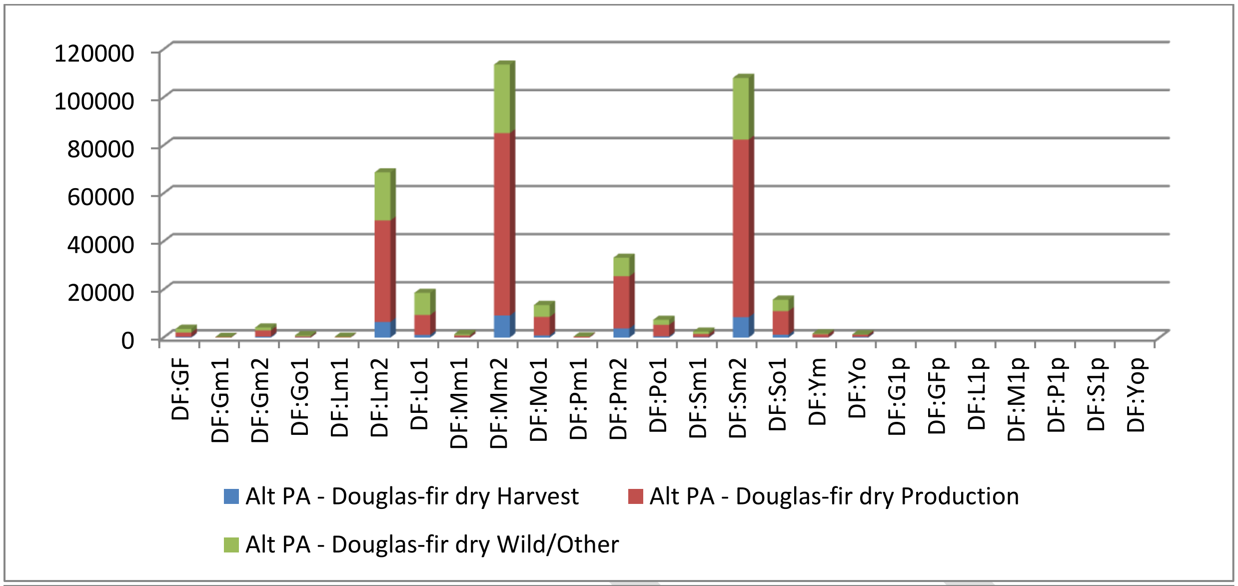
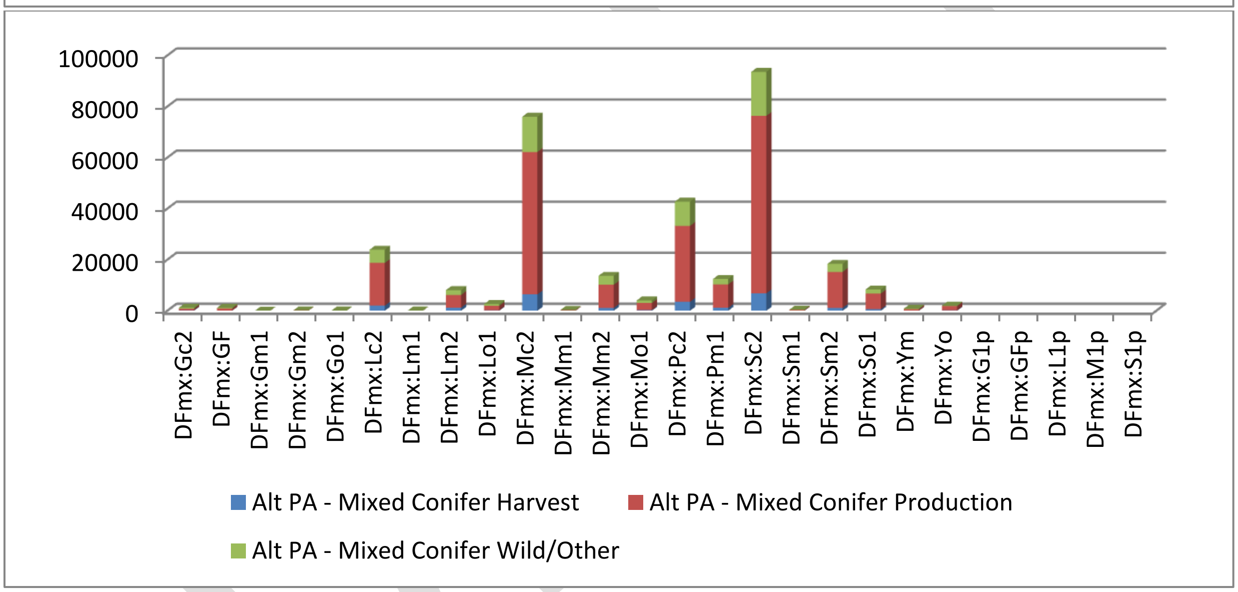
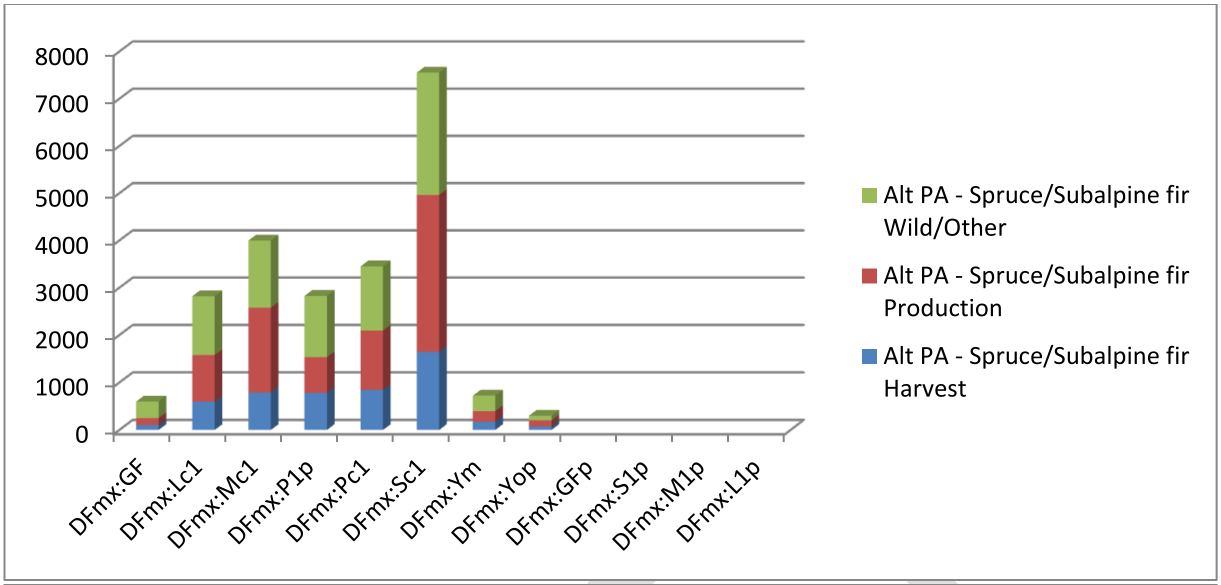
DFRC:Lm2
DFRC:Mc2
DFRC:Mm2
DFRC:Pc2
DFRC:Pm1
DFRC:Sc2
DFRC:Sm2
DFRC:Yo
Alt P - Western redcedar/western hemlock % EC's
Alt P - Western redcedar/western hemlock Total EC's
Alt P - Western redcedar/western hemlock Wild/Other
Alt P - Western redcedar/western hemlock Production
Alt P - Western redcedar/western hemlock Harvest

Alternative PA



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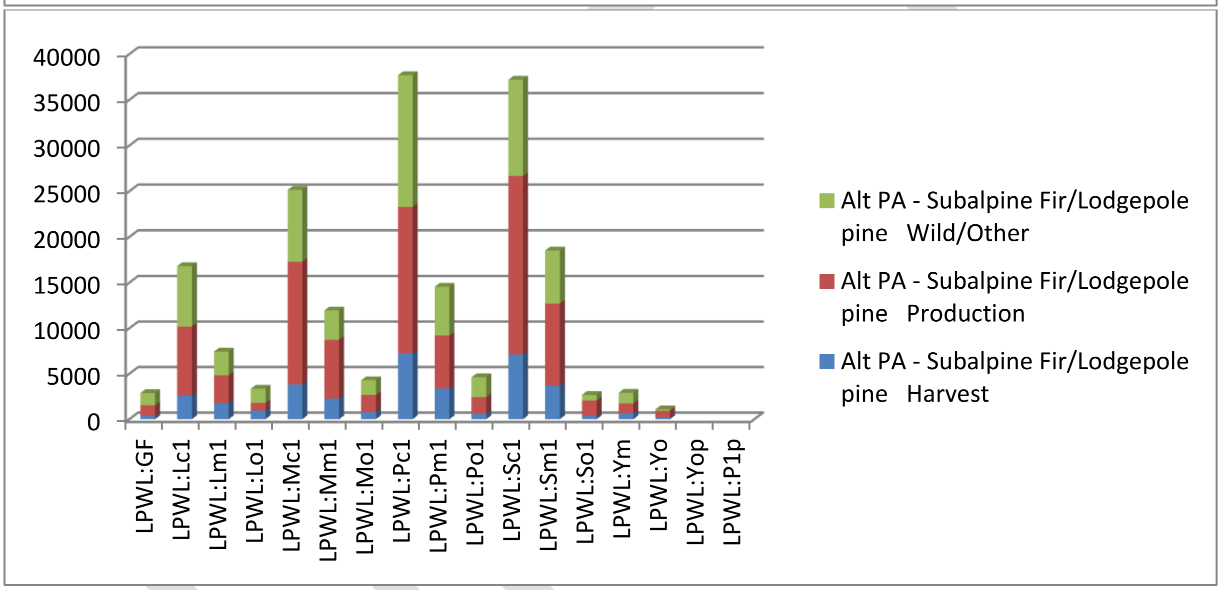
Alt PA - Spruce/Subalpine fir Production
Alt PA - Spruce/Subalpine fir Harvest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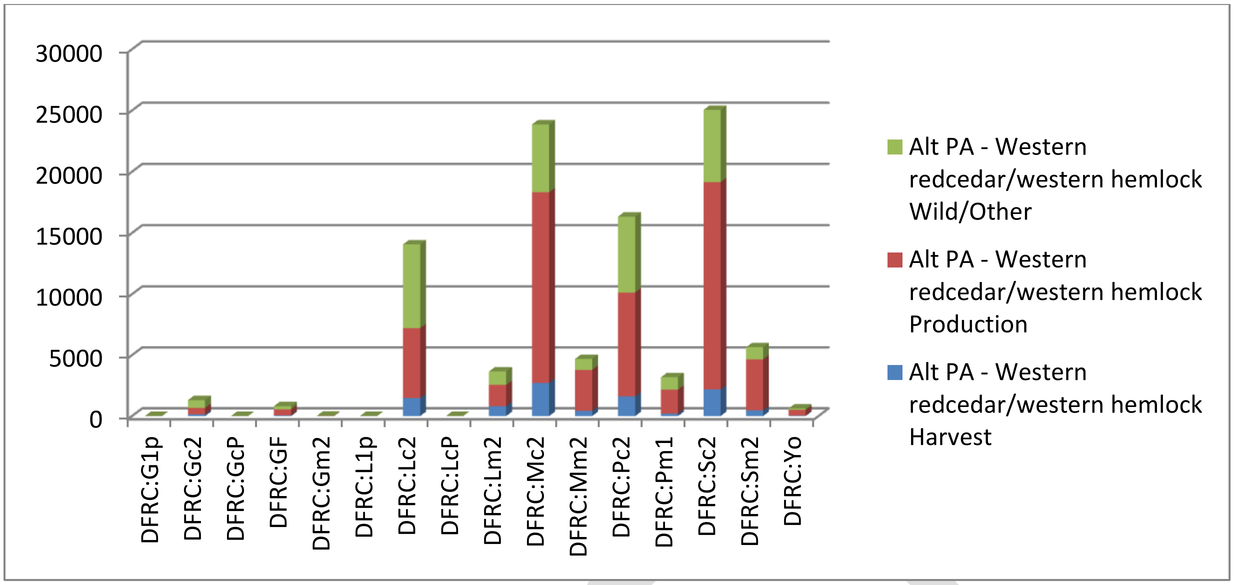
Alt PA - Subalpine Fir/Lodgepole pine Harvest



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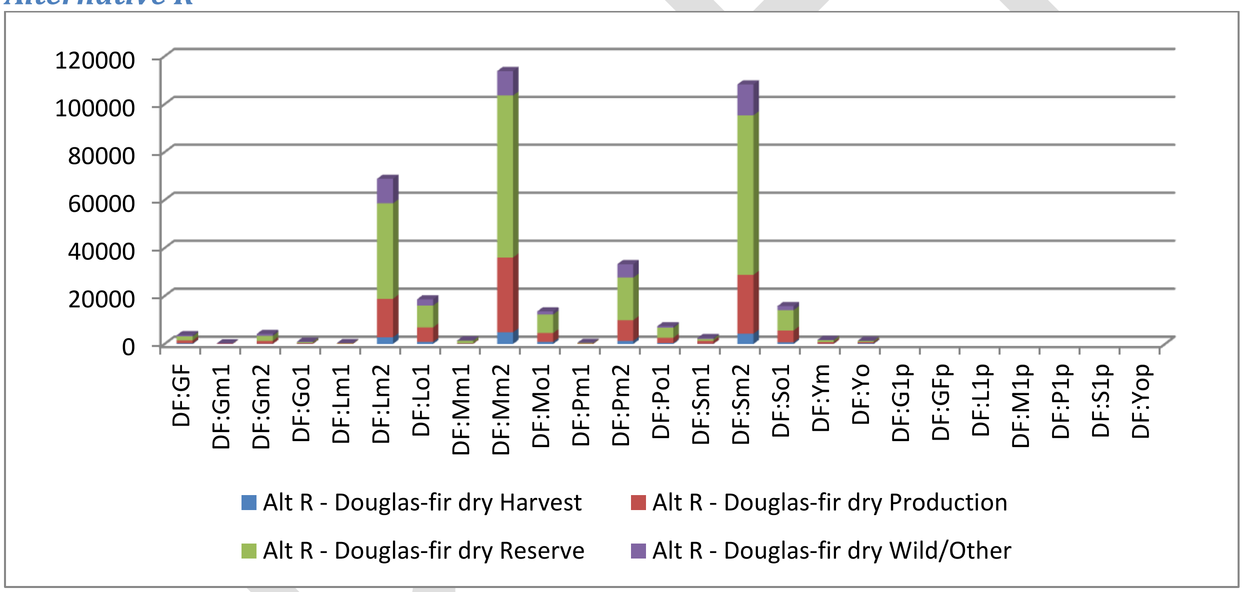

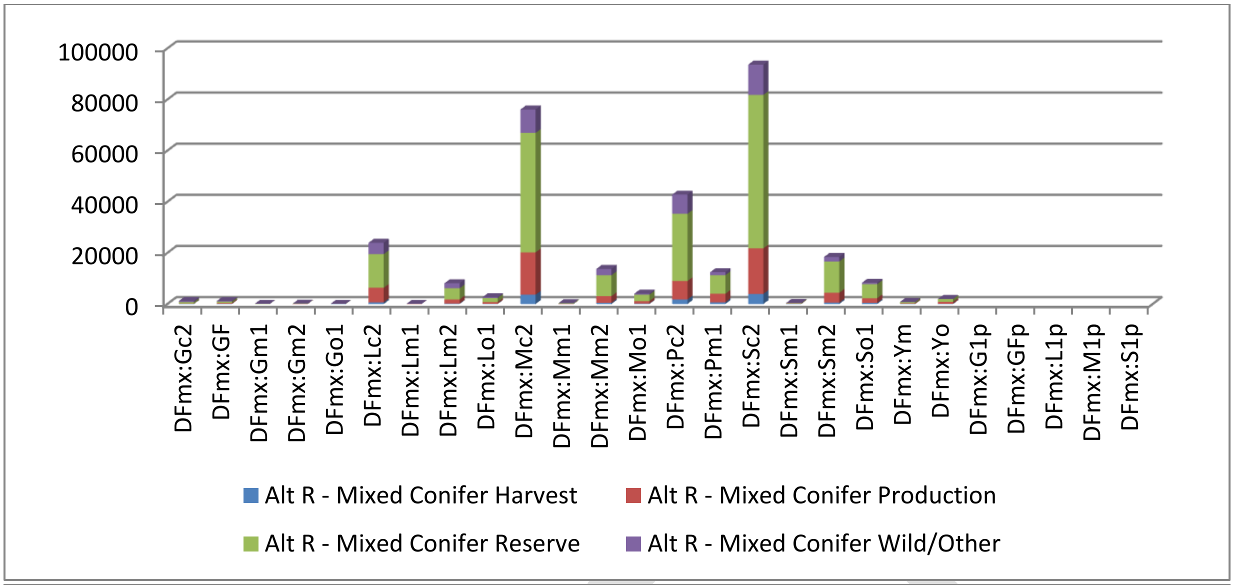
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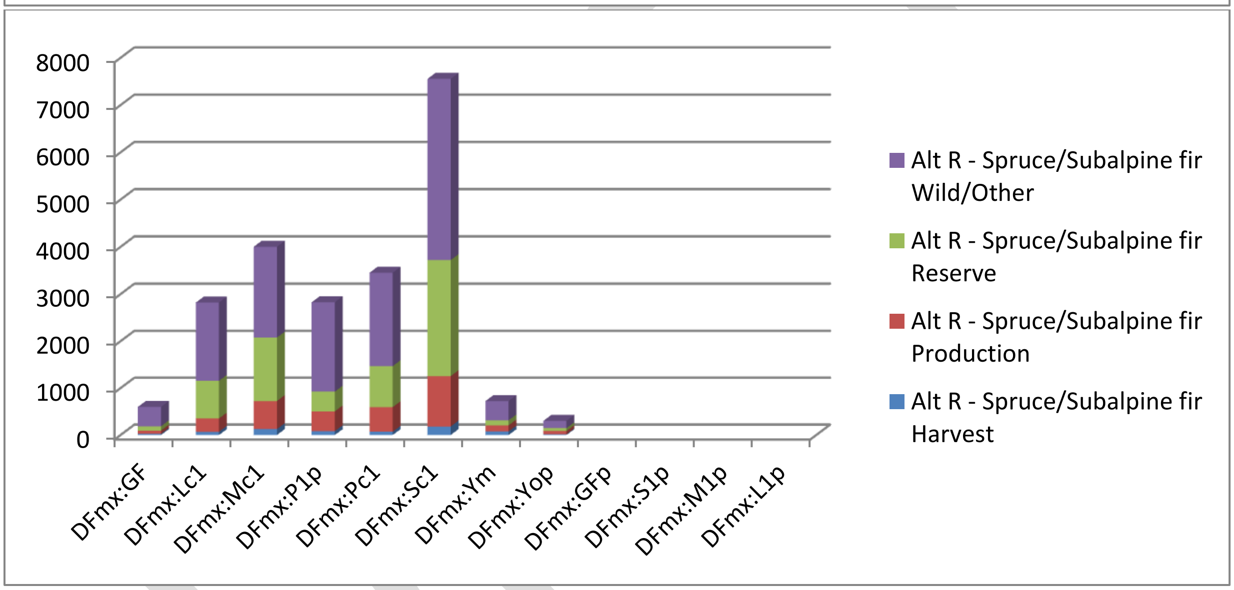
Alt R - Mixed Conifer Production
Alt R - Mixed Conifer Reserve
Alt R - Mixed Conifer Wild/Other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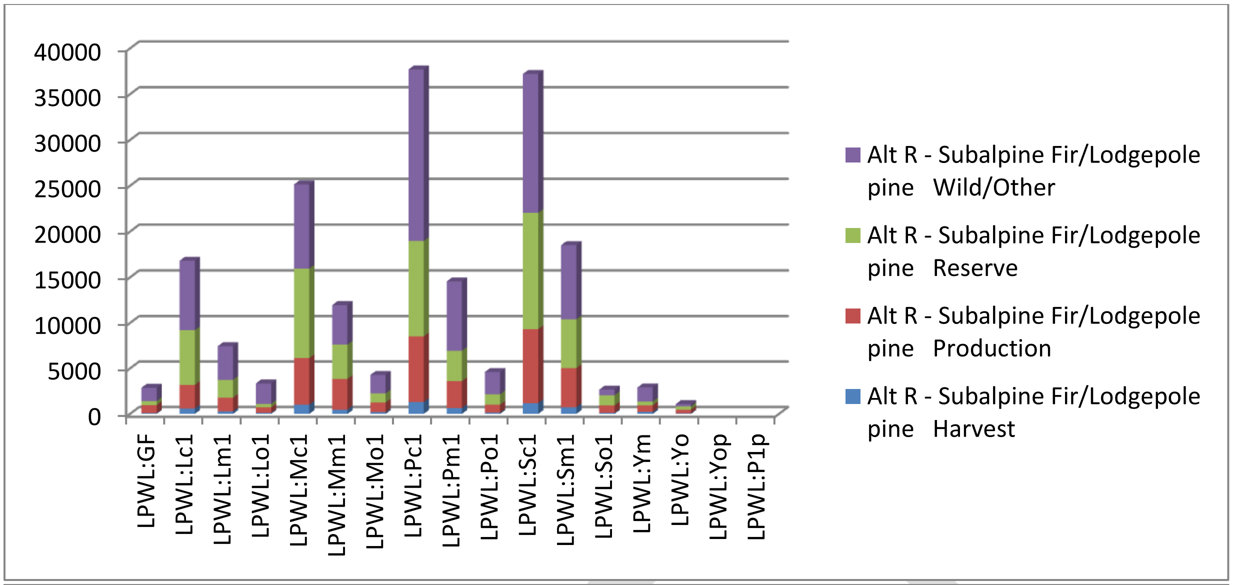
Alt R - Spruce/Subalpine fir Harvest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Alt R - Subalpine Fir/Lodgepole pine Wild/Other
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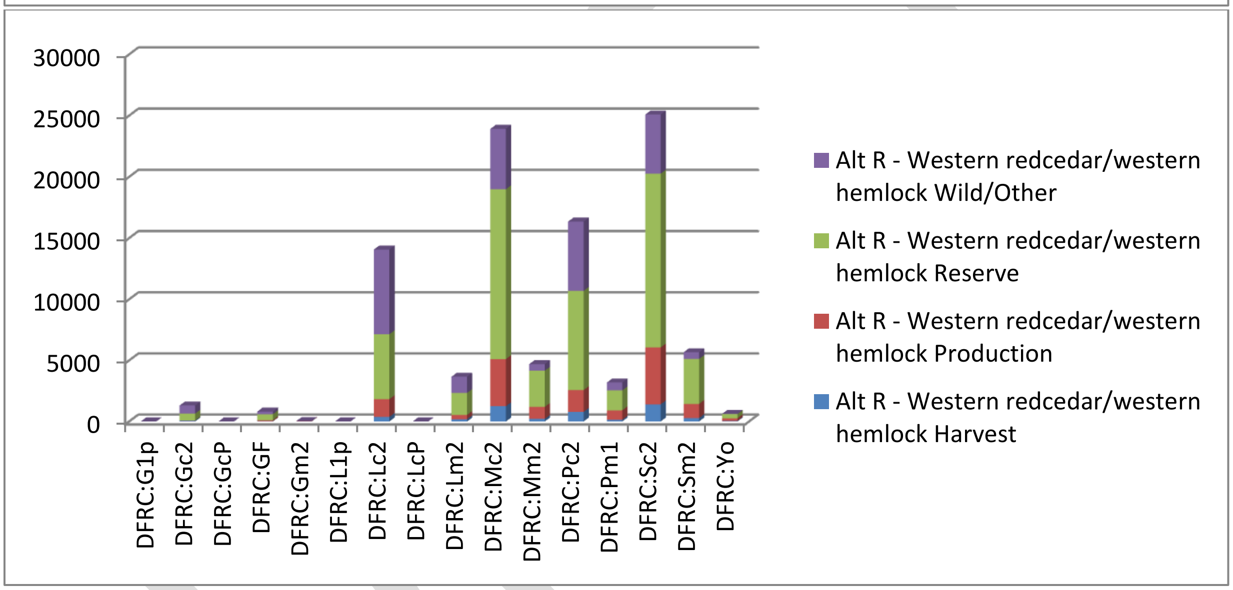
Alt R - Subalpine Fir/Lodgepole pine Harvest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DFRC:Sc2
DFRC:Sm2
DFRC:Yo
Alt R - Western redcedar/western hemlock Wild/Other
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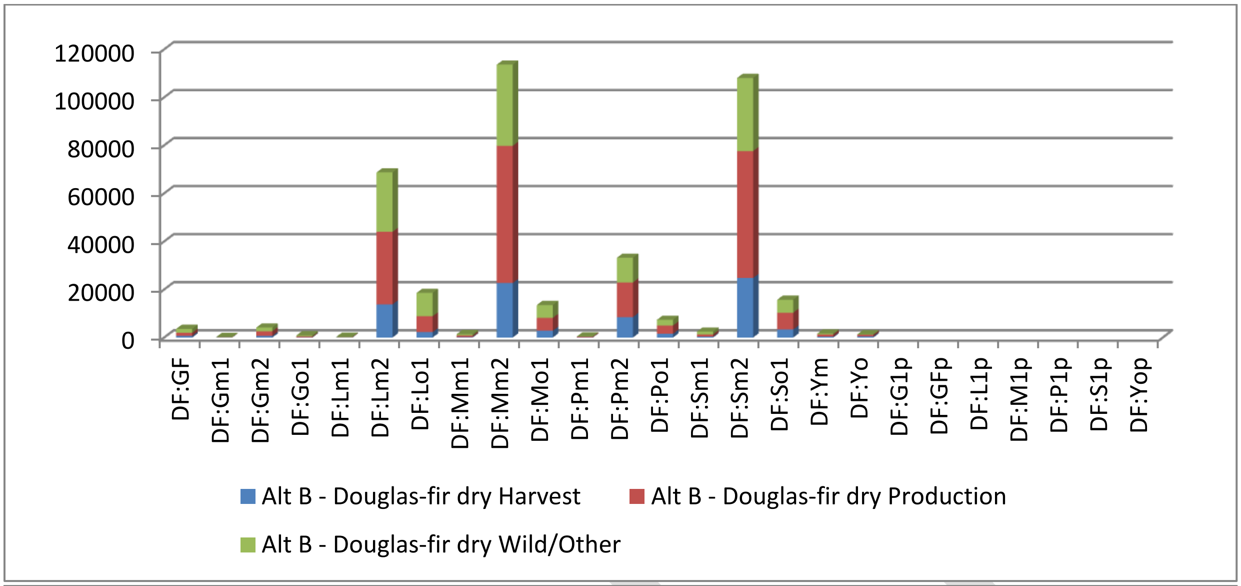
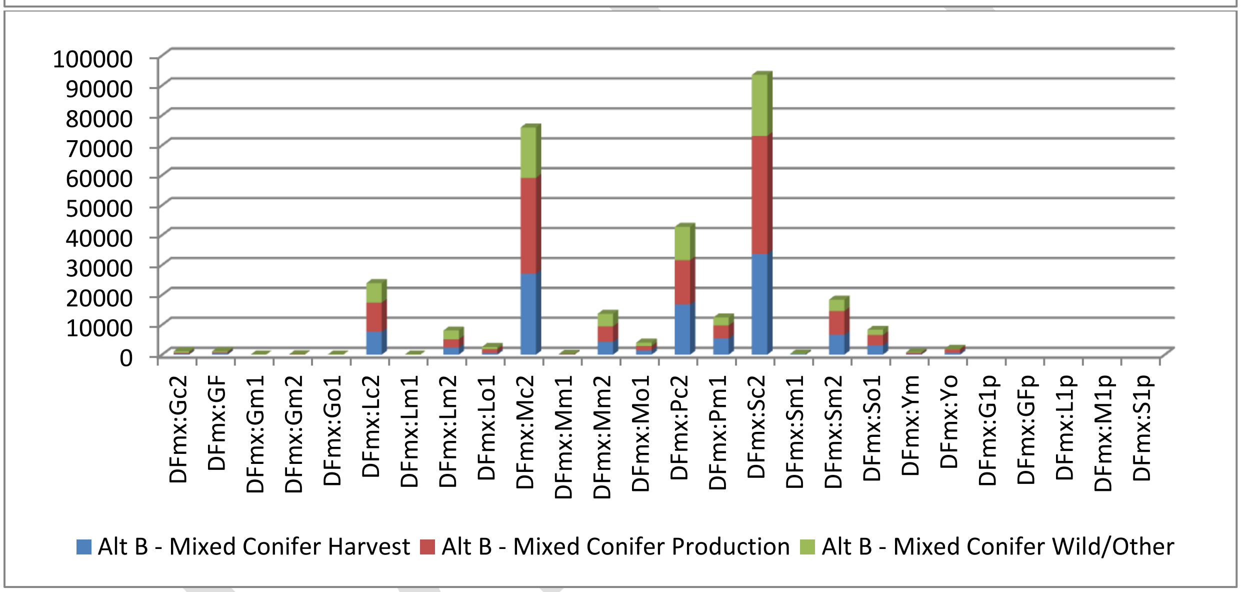
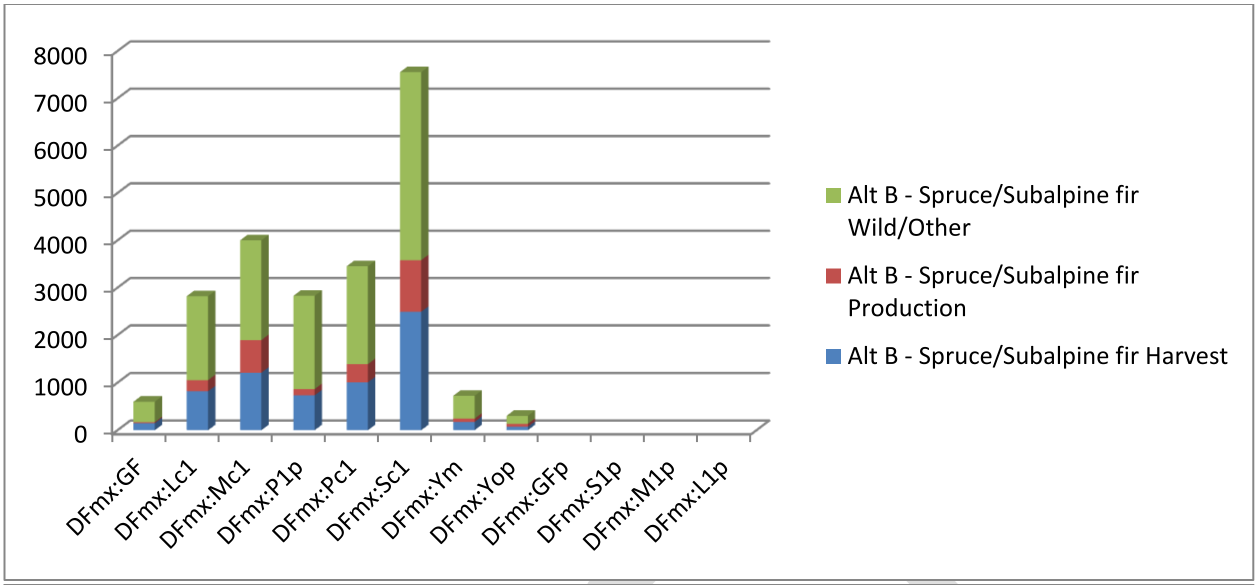
Alt R - Western redcedar/western hemlock Harvest

Alternative B



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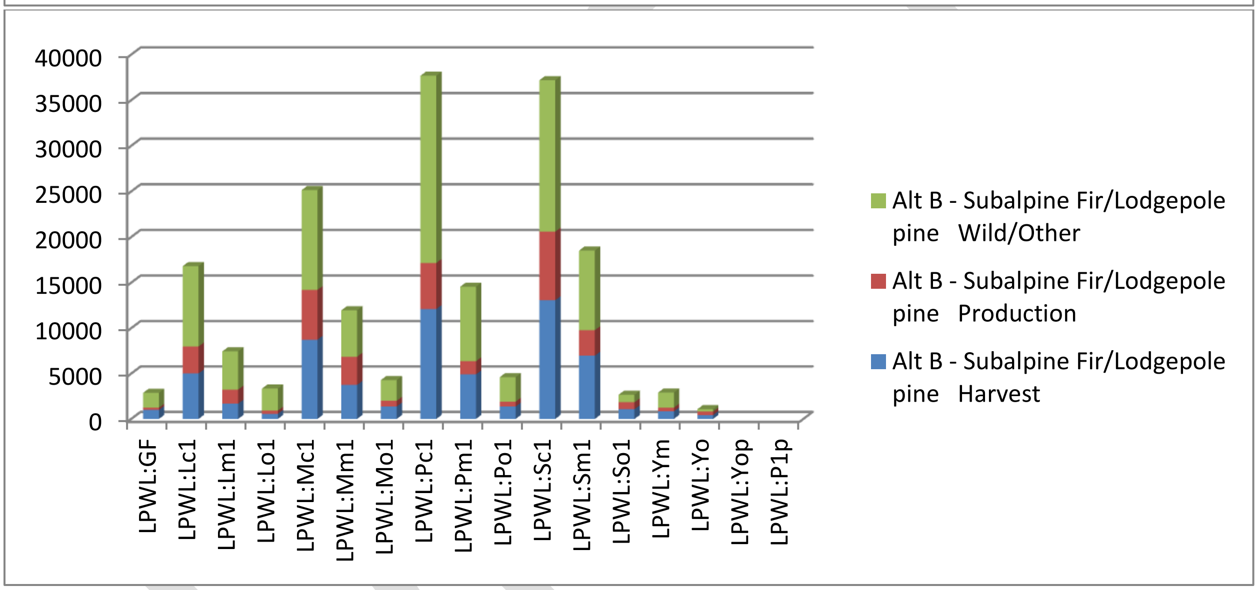
Alt B - Spruce/Subalpine fir Wild/Other
Alt B - Spruce/Subalpine fir Production
Alt B - Spruce/Subalpine fir Harvest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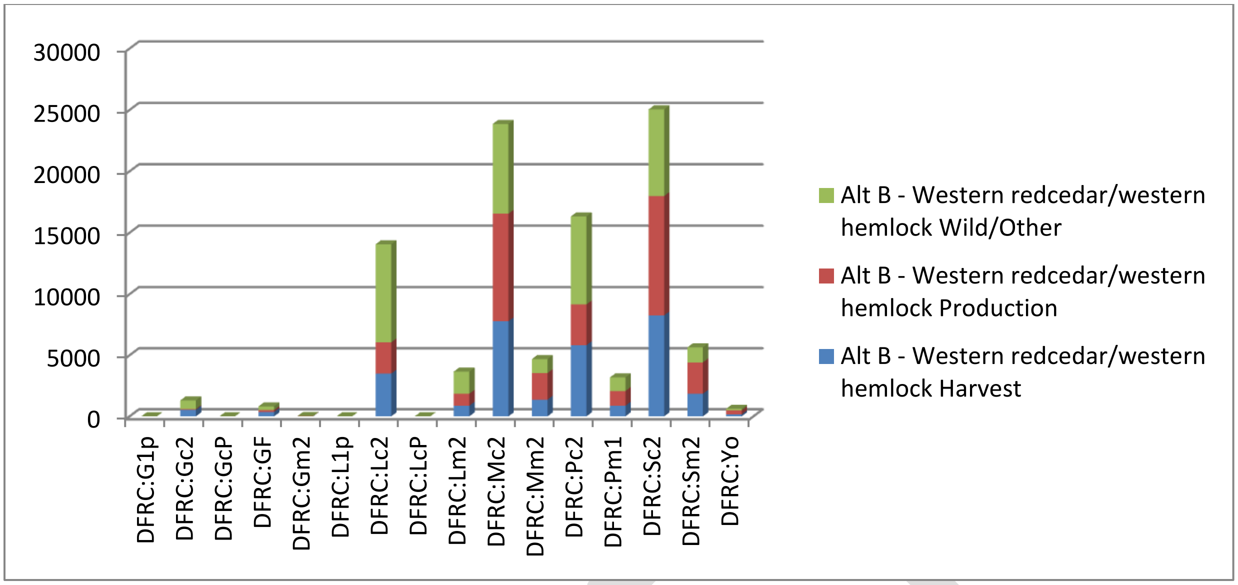
Alt B - Subalpine Fir/Lodgepole pine Wild/Other
Alt B - Subalpine Fir/Lodgepole pine Production
Alt B - Subalpine Fir/Lodgepole pine Harvest



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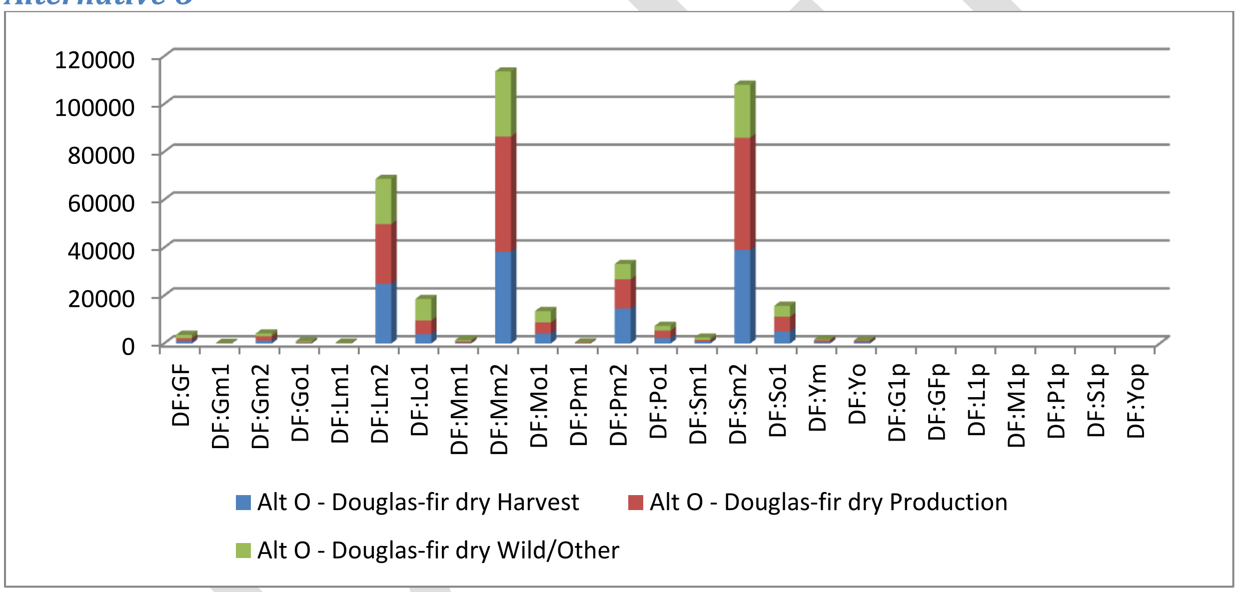

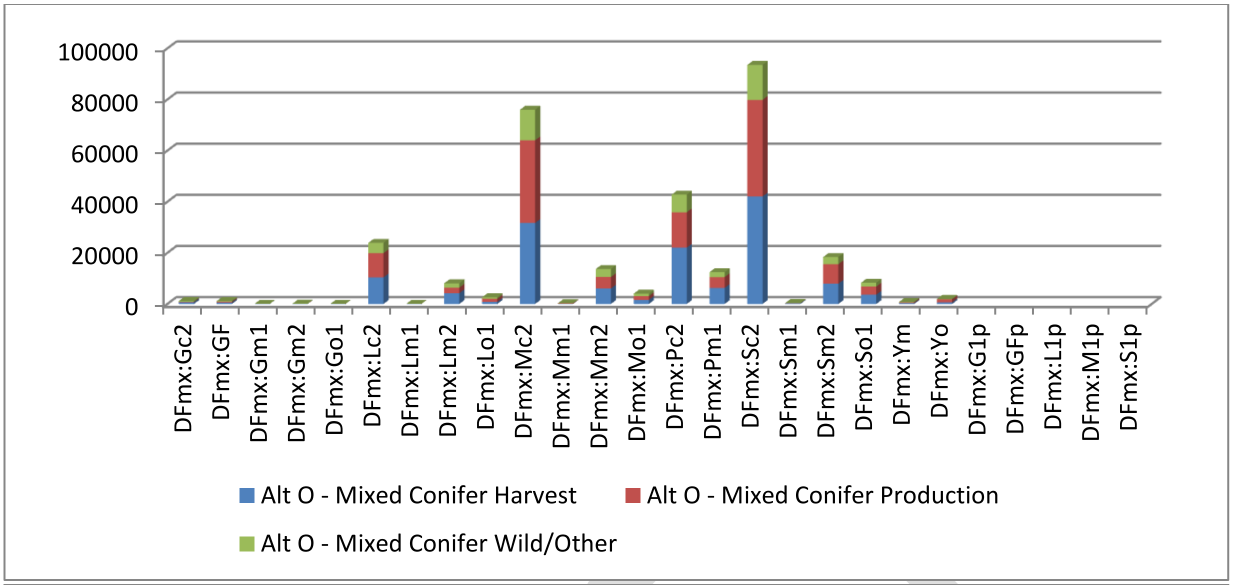
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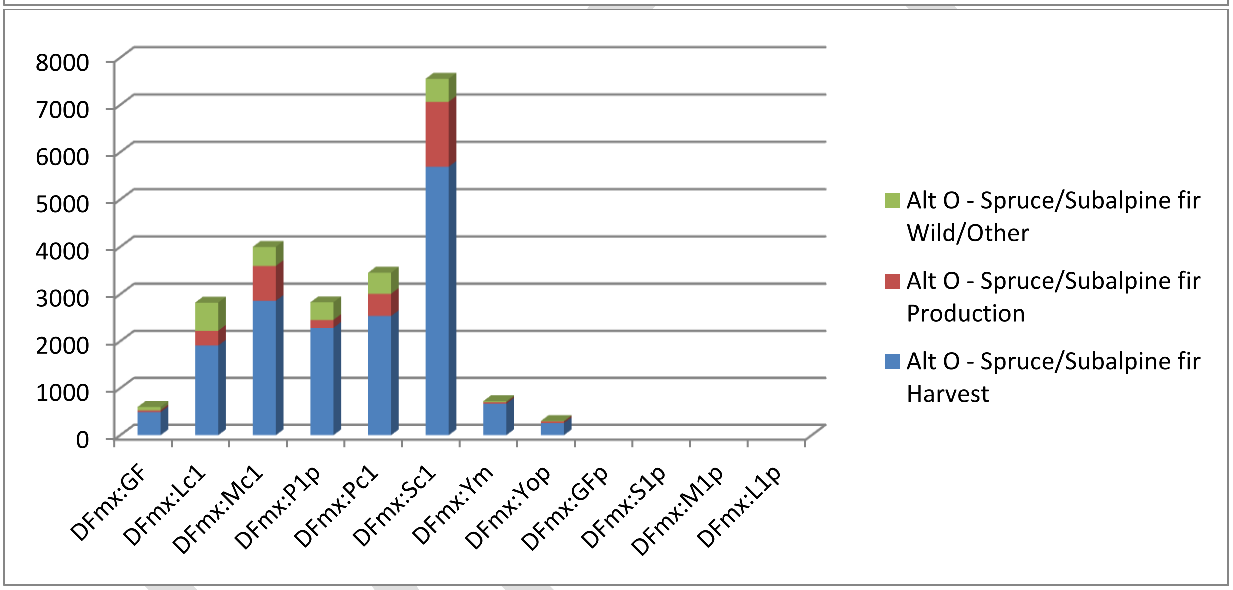
Alt O - Mixed Conifer Harvest
Alt O - Mixed Conifer Production
Alt O - Mixed Conifer Wild/Other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Alt O - Spruce/Subalpine fir Wild/Other
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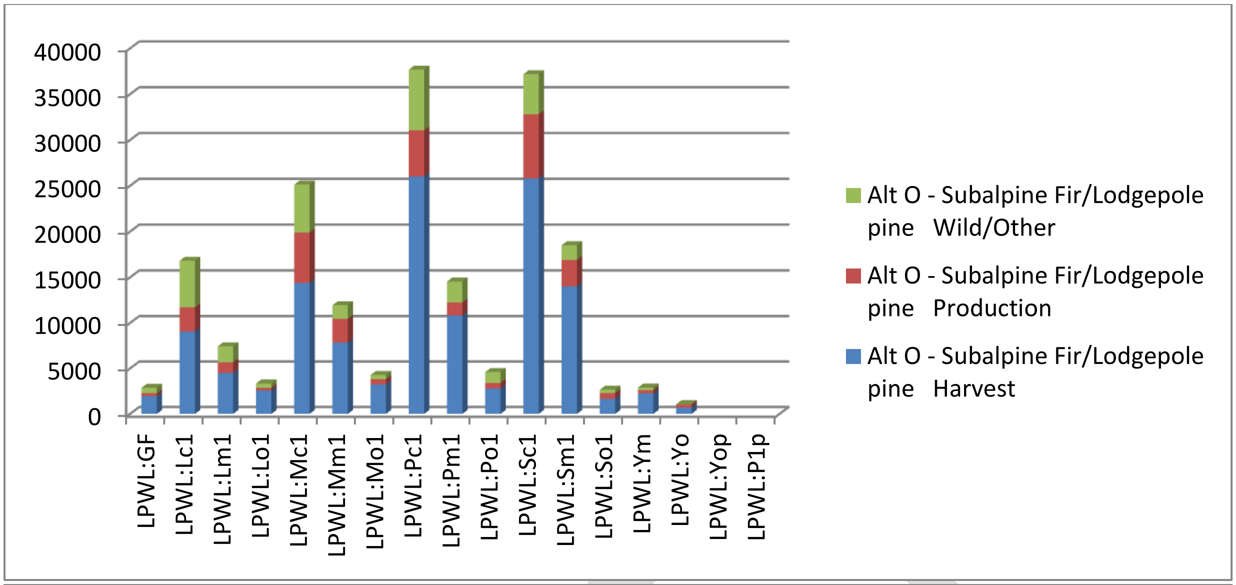
Alt O - Spruce/Subalpine fir Harvest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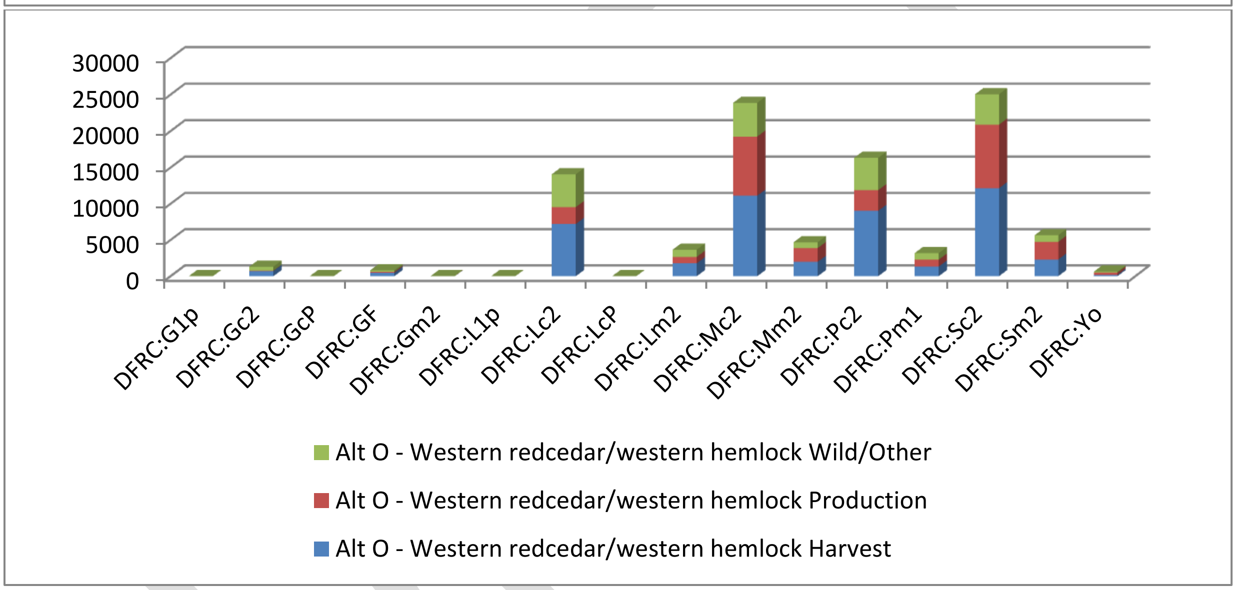
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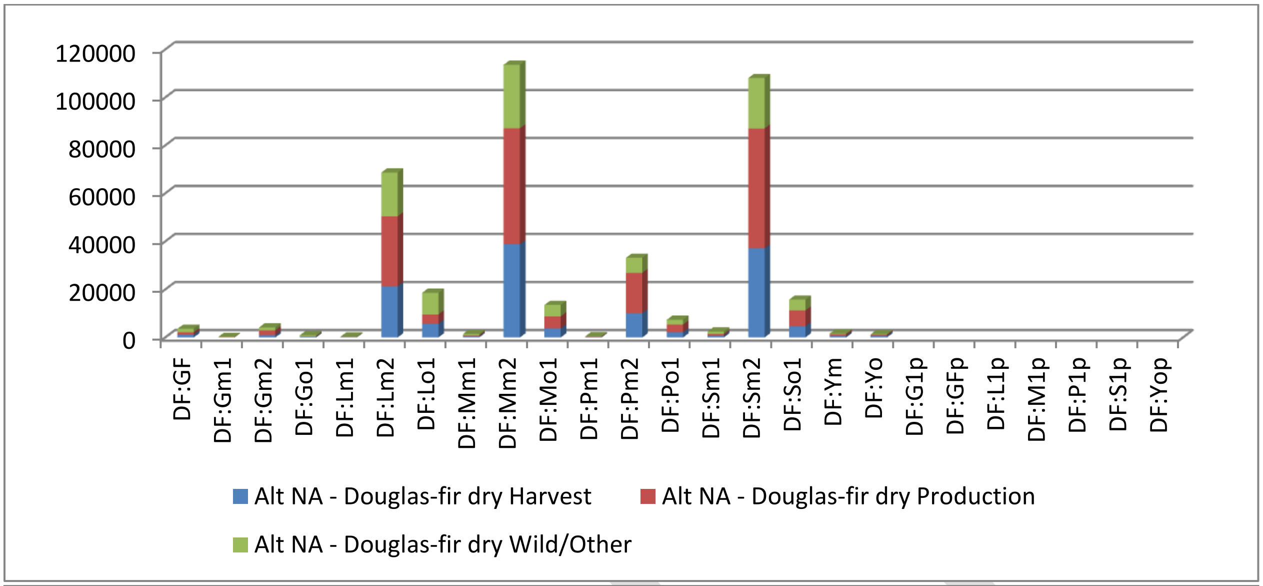
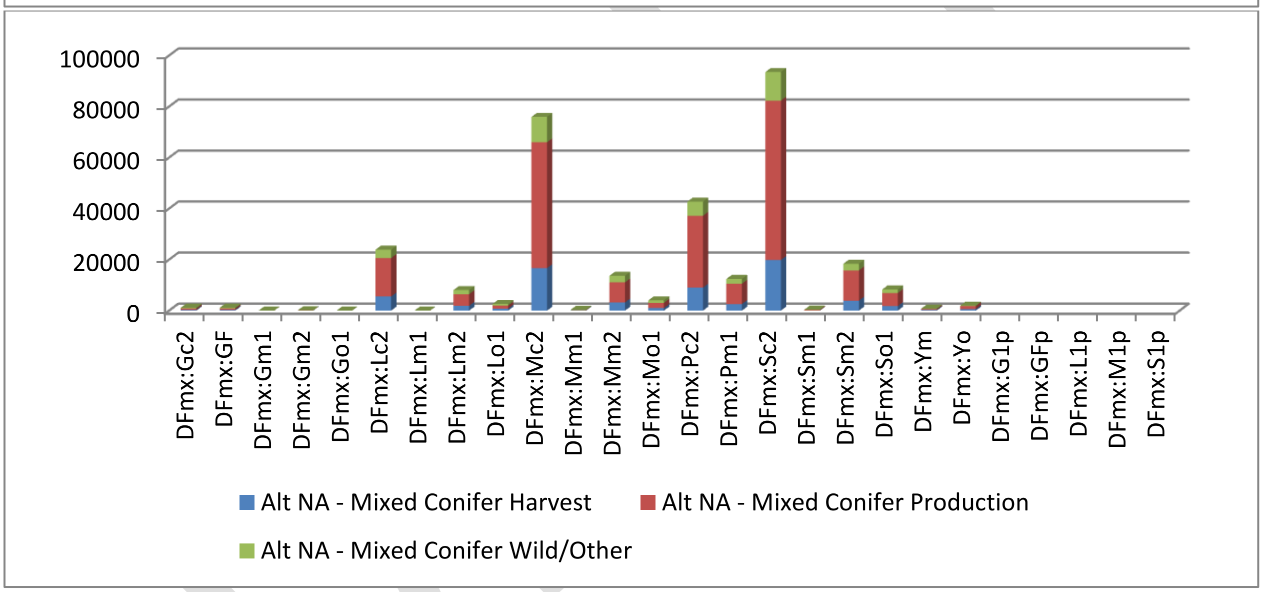
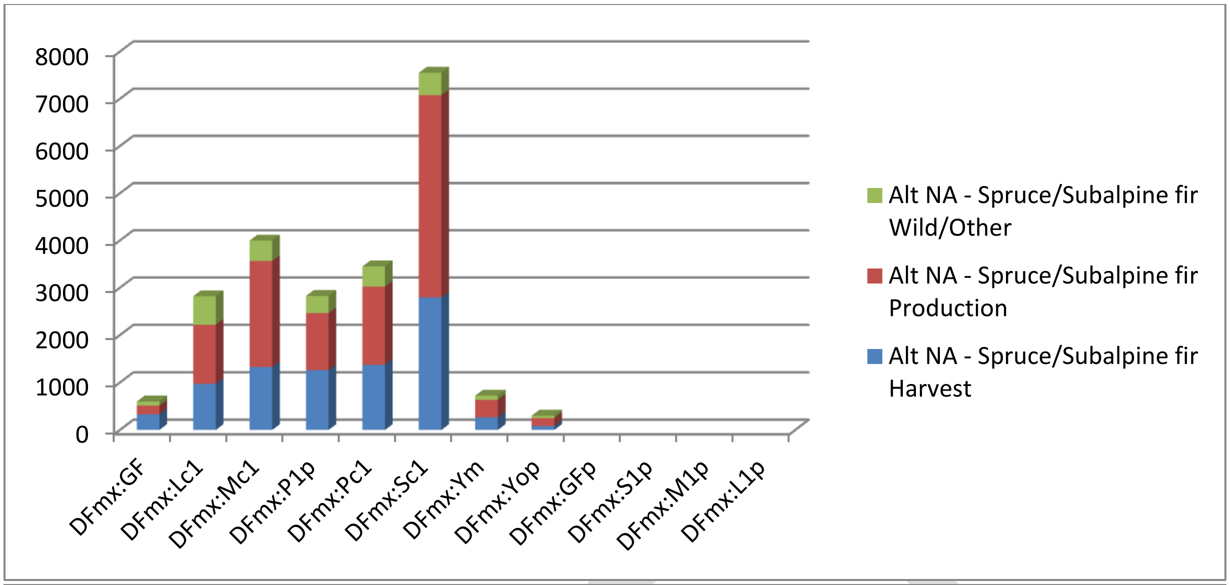
Alt O - Western redcedar/western hemlock Production
Alt O - Western redcedar/western hemlock Harvest

No Action Alternative



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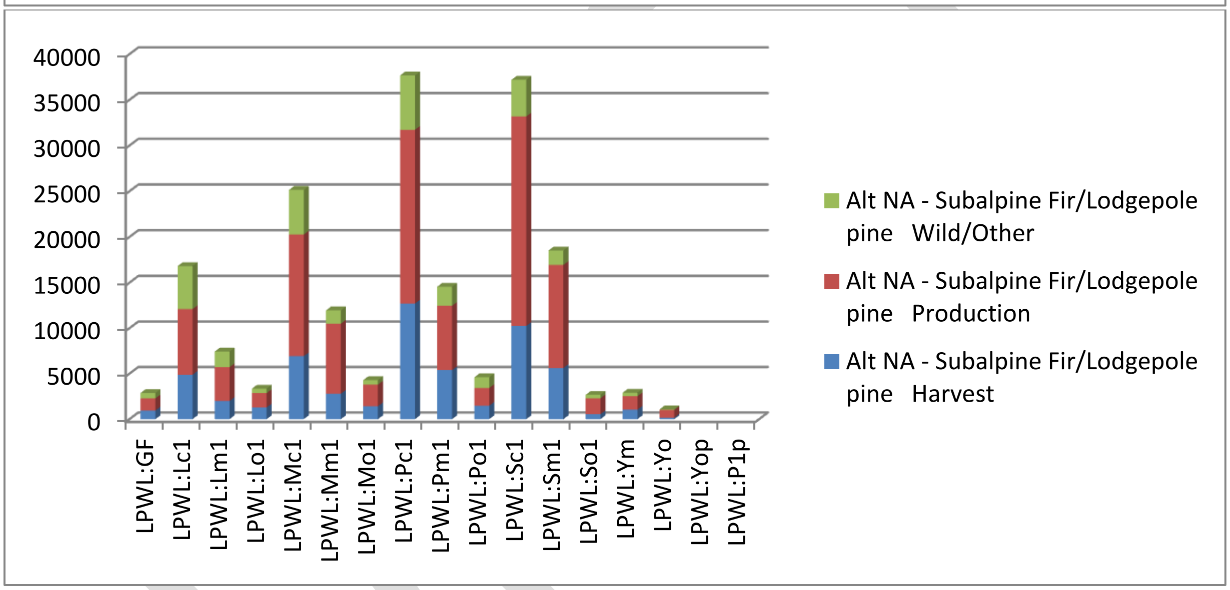
Alt NA - Spruce/Subalpine fir Production
Alt NA - Spruce/Subalpine fir Harvest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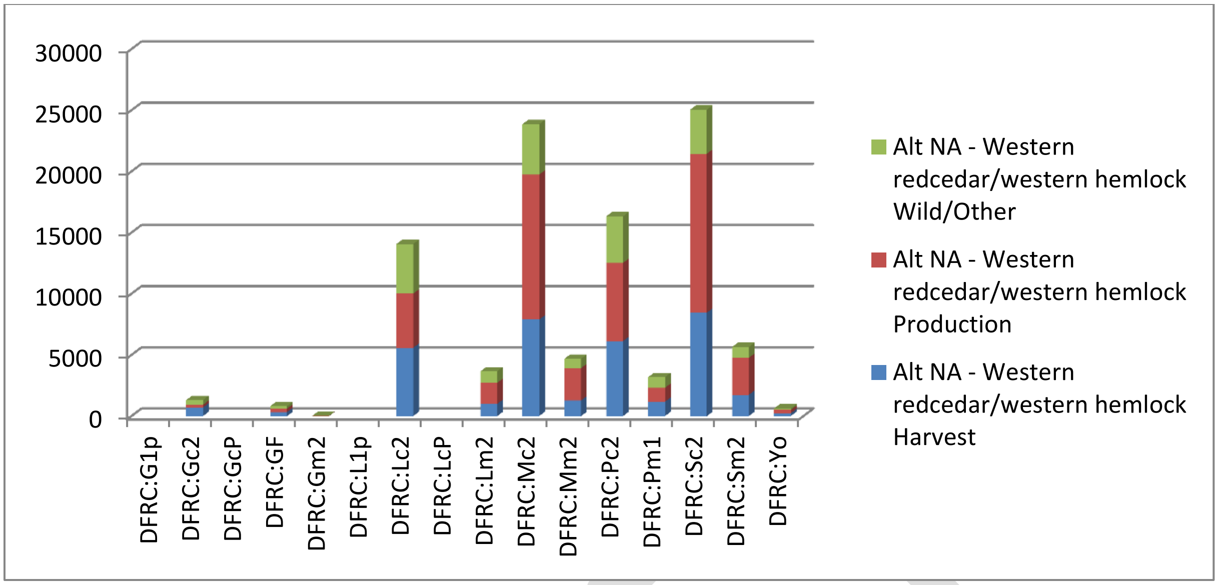


Attributes

Two types of attributes were developed and tracked into the St-Sim model database. State Attributes are used to link model states with a given attribute and track relative abundance over time. State attributes are used in this effort to track wildlife habitat and structure groups. Transition Attributes are used to track values associated with given model transitions, and are used in this effort to track timber volume removed through mechanical treatments.

Wildlife Habitat

Attribute tables were developed and loaded into the St-Sim model database containing crosswalks between model states and wildlife habitat for specific species. This facilitates the tracking of trend in attributes such as wildlife habitat through a model run. For wildlife attributes, the unit of measure that is tracked is acreage.

Model Type	Model State	Primary Black Backed Woodpecker	Secondary Black Backed Woodpecker	Goshawk	Primary Lewis's Woodpecker	Secondary Lewis's Woodpecker	American Marten	Pileated Woodpecker	White-headed Woodpecker
Douglas-fir dry	DF:G1p		X						
	DF:GFp	X			X				
	DF:Gm1			X				X	
	DF:Gm2			X				X	

Model Type	Model State	Primary Black Backed Woodpecker	Secondary Black Backed Woodpecker	Goshawk	Primary Lewis's Woodpecker	Secondary Lewis's Woodpecker	American Marten	Pileated Woodpecker	White-headed Woodpecker
	DF:Go1					X			X
	DF:L1p		X						
	DF:Lm1		X	X					
	DF:Lm2		X	X				X	
	DF:Lo1					X			X
	DF:M1p		X						
	DF:Mm1		X	X					
	DF:Mm2		X	X					
Northern Rocky Mountain Mixed Conifer	DFmx:G1p		X						
	DFmx:Gc2		X	X			X	X	
	DFmx:GFp	X							
	DFmx:Gm1		X	X			X	X	
	DFmx:Gm2		X	X			X	X	
	DFmx:L1p		X						
	DFmx:Lc2		X	X			X	X	
	DFmx:Lm1		X	X			X	X	
	DFmx:Lm2		X	X			X	X	
	DFmx:M1p		X						
	DFmx:Mc2		X	X			X		
	DFmx:Mm1		X	X					
	DFmx:Mm2		X	X					
Spruce/ Subalpine fir	DFmx:GFp	X							
	DFmx:L1p		X						
	DFmx:Lc1		X	X			X	X	
	DFmx:M1p		X						
	DFmx:Mc1		X	X			X		
Subalpine Fir/Lodgep ole pine	LPWL:GFp	X							
	LPWL:L1p		X						
	LPWL:Lc1		X	X			X	X	
	LPWL:Lm1		X	X			X	X	

Model Type	Model State	Primary Black Backed Woodpecker	Secondary Black Backed Woodpecker	Goshawk	Primary Lewis's Woodpecker	Secondary Lewis's Woodpecker	American Marten	Pileated Woodpecker	White-headed Woodpecker
	LPWL:M1p		X						
	LPWL:Mc1		X	X			X		
	LPWL:Mm1		X	X					
Western redcedar/western hemlock	DFRC:G1p		X						
	DFRC:Gc2		X	X			X	X	
	DFRC:Gm2		X	X			X	X	
	DFRC:L1p		X						
	DFRC:Lc2		X	X			X	X	
	DFRC:LcP		X						
	DFRC:Lm2		X	X					
	DFRC:Mc2		X	X					
	DFRC:Mm2		X						

Timber volumes

Timber volumes are tracked in the modeling process based on transition attributes. For each transition type pertaining to mechanical harvest, a harvest volume coefficient is developed based on the model state that the harvest occurs in. To develop harvest coefficients it was first necessary to designate standing timber for each model state. Initial standing volume values were developed based on Zhou and Hemstrom 2010[4] and were inherited with the original models developed for the NEWz co-planning effort. As part of the Colville model development process, some model states did not have standing volume estimates. In these cases, the most similar ancillary model state for which data was available was chosen to approximate standing volume. However, if the most similar ancillary model state was determined to not be a close approximation for the missing value, proportional values were assigned using proportional calculations tied to relative canopy closure and associated states for which data were available. Volume removals were calculated by determining the difference in standing volume for a given state before a transition and after a transition. Some modeled transitions (e.g. Variable Density Thinning) have multiple destination states; in these cases, volume removals were calculated using proportional coefficients identical to those applied in the model destination probabilities.

[4] Zhou, Xiaoping; Hemstrom, Miles A. 2010. Gen. Tech. Rep. PNW-GTR-819. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 31 p
Available online at: http://www.fs.fed.us/pnw/pubs/pnw_gtr819.pdf

In this way, one volume removal value is assigned for each starting model state / harvest type for a given volume attribute.

The volume estimates are provided below and represent volume removals *per acre*.

Model Type	Treatment Code	Model State	cfsawvol	bfvsaw
Douglas-fir dry	VDT	DF:Gm1	319	1,065
	VDT_2	DF:Gm1	319	1,065
	VDT	DF:Gm2	1,041	5,975
	VDT_2	DF:Gm2	1,041	5,975
	VDT	DF:Lm1	2,764	17,438
	VDT	DF:Lm2	2,346	12,555
	NAharv	DF:Mm1	1,760	9,032
	RegHar	DF:Mm1	4,351	22,071
	VDT	DF:Mm1	3,293	16,859
	NAharv	DF:Mm2	838	4,129
	RegHar	DF:Mm2	2,507	12,265
	VDT	DF:Mm2	1,634	8,034
	RegHar	DF:Mo1	830	4,005
	PH.poles	DF:Pm1	499	2,440
	PH.poles	DF:Pm2	249	1,220
	NAharv	DF:Sm1	555	2,369
	VDT	DF:Sm1	1,154	5,064
	NAharv	DF:Sm2	272	1,159
	VDT	DF:Sm2	645	2,885

Model Type	Treatment Code	Model State	cfsawvol	bfvsaw
Northern Rocky Mountain Mixed Conifer	VDT	DFmx:Gc2	1,004	5,887
	VDT_2	DFmx:Gc2	1,004	5,887
	VDT	DFmx:Lc2	1,167	5,689
	VDT_2	DFmx:Lc2	1,167	5,689
	NAharv	DFmx:Mc2	1,141	5,296
	VDT	DFmx:Mc2	2,415	11,860
	NAharv	DFmx:Mm2	4,810	23,621
	NAharv	DFmx:Sc2	1,141	5,296
	RegHar	DFmx:Sc2	3,381	15,628
	VDT	DFmx:Sc2	2,355	10,909
	RegHar	DFmx:Sm1	2,240	10,332
	NAharv	DFmx:Sm2	1,098	5,035
	RegHar	DFmx:Sm2	1,098	5,035
	RegHar	DFmx:So1	551	2,527

Model Type	Treatment Code	Model State	cfsawvol	bfvsaw
Western redcedar/western hemlock	RegHar	DFRC:Mc2	2,933	15,610
	RegHar	DFRC:Mm2	2,933	15,610
	VDT	DFRC:Sc2	721	3,442

Model Type	Treatment Code	Model State	cfsawvol	bfvsaw
Subalpine Fir/Lodgepole pine	RegHar	LPWL:Mc1	3,606	17,346
	RegHar2	LPWL:Mc1	3,426	16,476
	RegHar	LPWL:Mm1	3,606	17,346
	RegHar	LPWL:Sc1	2,809	13,087
	RegHar2	LPWL:Sc1	2,668	12,431
	RegHar	LPWL:Sm1	2,809	13,087

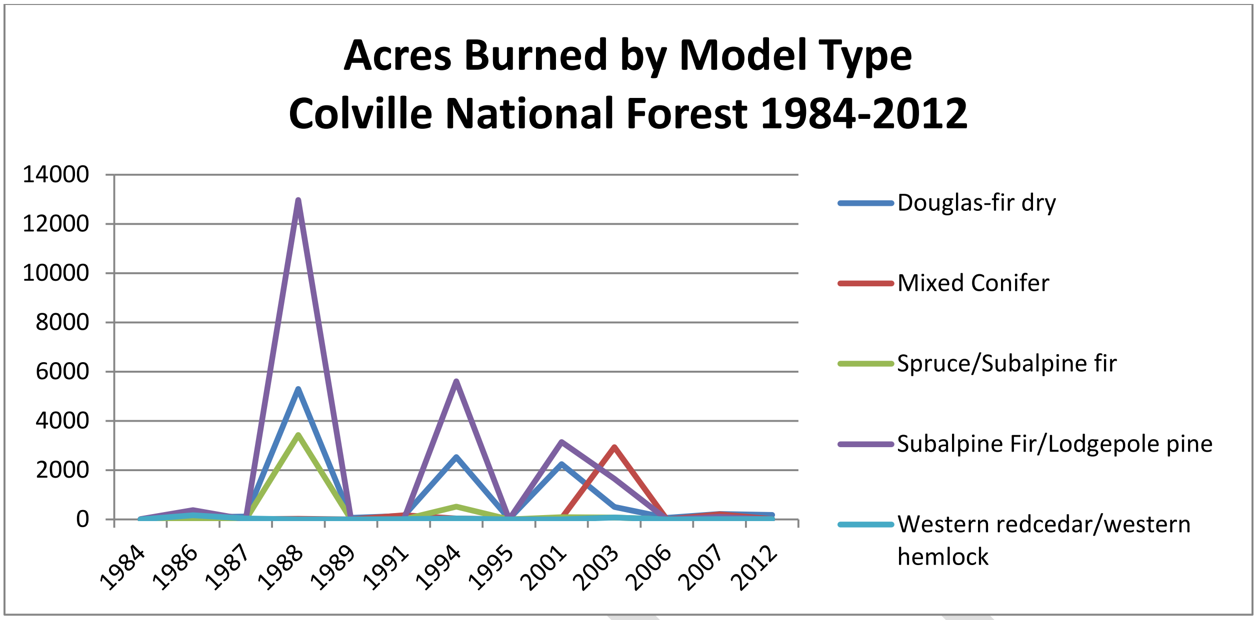
Modeled Alternatives

Model Coefficients Common to All Alternatives

While management prescriptions vary from one alternative to another, natural growth rates, wildfire probability and insect and disease probabilities generally do not.

Wildfire

Wildfire coefficients were developed based on fire history for the Colville national forest. Fire history polygons were intersected with the PAG derived model types layer to calculate acres burned by model type by year. To assign burn severity, the ILAP derived burn severity (based on MTBS data) were queried to determine percentage of burned are by severity class for each model type. These model type specific proportions were then applied to total burned acres to determine area burned by burn severity. The period of 1985-2012 was used to reflect the contemporary period for fire occurrence on the Colville and develop wildfire probability coefficients.



The following table displays the annual wildfire probability coefficients applied to each model type by burn severity.

	Douglas-fir dry	***Mixed Conifer***	***Spruce/Subalpine fir***	***Subalpine Fir/Lodgepole pine***	***Western redcedar/western hemlock***
1985-2012 avg. annual acres burned	408	122	147	851	11
Total Acres / PAG	616,503	394,482	21,040	183,765	125,207
Calc Total Fire Prob:	0.0007	0.0003	0.0070	0.0046	0.0001
Calc Total MFRI (in years)	1,513	3,235	143	216	11,222
Annual Probability (Non Lethal - WFNL)	0.000351	0.000128	0.002214	0.001466	0.000037
Annual Probability (Mixed Severity - WFMS)	0.000173	0.000070	0.001521	0.001007	0.000020
Annual Probability (Stand Replacing - WFSR)	0.000137	0.000110	0.003260	0.002159	0.000032

Insect and Disease

Insect and disease coefficients were developed by intersecting Aerial Detection Survey GIS with PAG / Model Types. For polygons with multiple agents in the same year, only the primary agent was used to calculate a coefficient. Aerial detection data from 1985-2012 was used to develop contemporary I&D rates and coefficients. These resulting summary values are contained in Table 4. Full data used to create the values, as well as aerial detection survey values going back to 1970 are included in the project spreadsheet 1970_2012_InD_Colville_Coeffifient.xlsx.

Table 4 - Modeled Insect and Disease Values

Model Type	***Transition Type***	***Prob. Coefficient***	***Eq. Return Interval (yrs)***
Subalpine Fir / Lodgepole	MPB	0.0250	40
Spruce / Subalpine Fir	SAFMort	0.0002	4,043
Spruce / Subalpine Fir	SPB	0.0004	2,561
Northern Rocky Mountain Mixed Conifer	DFB	0.0053	189
Northern Rocky Mountain Mixed Conifer	FE	0.0076	131
Northern Rocky Mountain Mixed Conifer	RDBT	0.0100	100
Northern Rocky Mountain Mixed Conifer	SBWobk	0.0022	451
Northern Rocky Mountain Mixed Conifer	SPB	0.0001	12,194
Douglas-Fir Dry	DFB	0.0060	167
Douglas-Fir Dry	FE	0.0061	163
Douglas-Fir Dry	MPB	0.0091	109
Douglas-Fir Dry	RDBT	0.0100	100
Douglas-Fir Dry	SBW	0.0225	45
Western Redcedar/Western Hemlock	DFB	0.0048	210
Western Redcedar/Western Hemlock	RDBT	0.0200	50

Stochastic Variation

Transition multipliers (in the form of Monte Carlo Multipliers or MCMs) are used in the model to create stochasticity. The MCMs vary the probability of certain natural transitions (fire and other natural mortality) to better reflect the variance in these disturbance agents. In this way, some model "years" have higher probability of stand replacing fire than other years for example. All MCM values are contained in the ST-Sim database. Figure 1 displays the probability multipliers for stand replacing fire for years 1-300 of the model run.

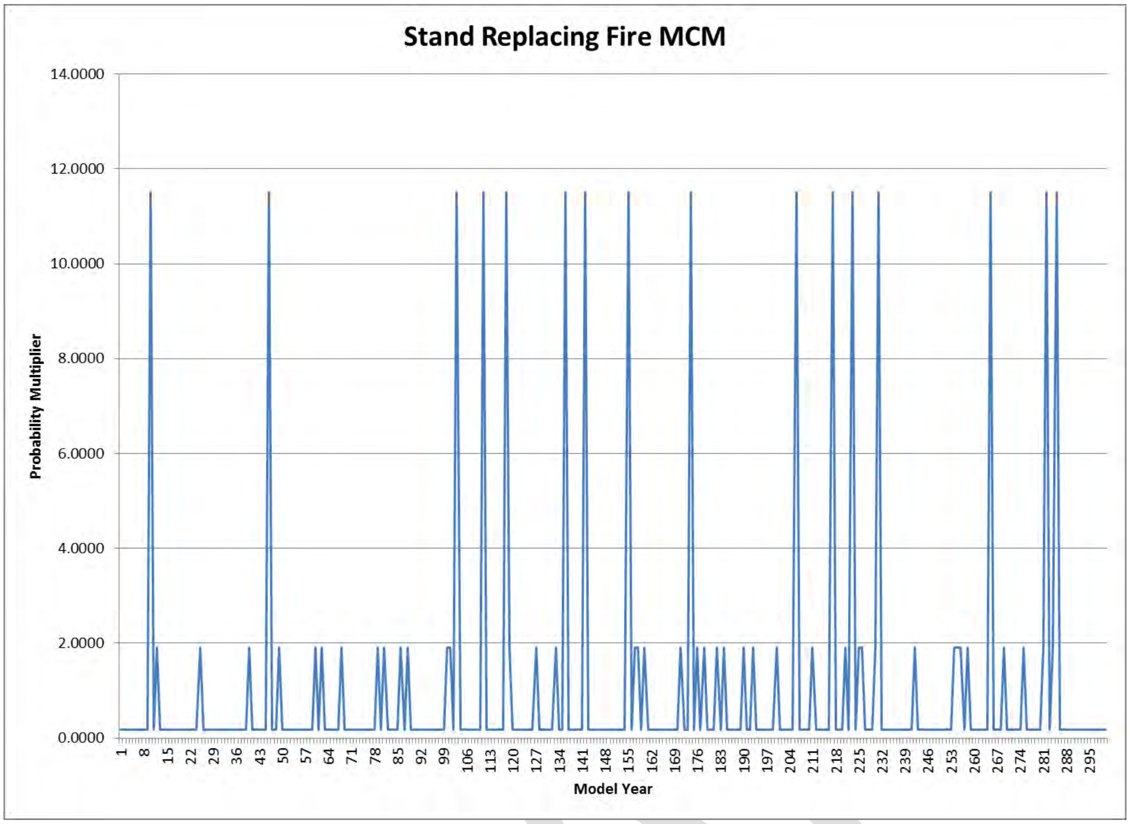


Figure 1 - Stochastic Variation Example: MCM values for Stand Replacing Fire

Model Assumptions by Alternative

Alternative PA & P

Note: the following descriptions for modeled assumptions are combined for the P and PA alternatives. This is *not* intended to imply that the two are identical. Rather, the *types* of prescriptions applied in the models are identical for the P and PA alternatives. However, the *locations* of treatments vary between the two alternatives based on suited land designations.

Douglas-Fir Dry

Restoration Zone[5]

Variable Density Thinning (VDT) is prescribed in Small, Medium, and Large model states with closed canopies (>40% CC). Once desired conditions are attained (~60 years) VDT is applied in Giant states. Variable density thinning results in proportional transitions to destination states as follows:

[5] The "restoration zone" in the P and PA alternatives include both Suitable and Non-Suitable timber lands. To account for treatment and harvest volumes on suitable lands separately, the model is programmed to include a "timber production" zone. However, this timber production zone simply represents the suitable timber lands, and receives the exact same treatments and probabilities as the unsuitable restoration zone lands *that are outside the wilderness/other category.* As a result, raw model outputs for the P and PA alternatives show values for timber production zones, which is not to imply that there is a primary timber emphasis for these areas or that they would receive different treatments.

- 75% transitions to an open canopied (10-39% canopy cover) system of the same size class with an increased model age of 5 years (to account for increased overall age of unharvested trees)
- 10% remains in the closed canopy state and does not transition to another state
- 15% reverts to the Grass/Forb state with less than 10% total tree canopy cover

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5" DBH) classes and open canopied classes of all sizes.

- PCT results in transitions to or maintains states with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Northern Rocky Mountain Mixed Conifer

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small & Medium model states with closed canopies (>60% CC). Once desired conditions are attained (~60 years) VDT is applied in Large & Giant states. Variable density thinning results in proportional transitions to destination states that mimic the effects of mixed severity fire[6] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Prescribed Fire is applied to mimic natural mixed severity fire occurring in closed canopied (>60% CC) states with multiple stories that are small-giant in size. Prescribed

[6] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.

mixed severity fire results in proportional transitions to destination states that mimic the effects of mixed severity fire[7] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

No Prescribed Fire is not applied in this model zone[8].

Spruce/Subalpine Fir

No activity is modeled in this vegetation type. Wildfire and insect/disease agents; all alternatives are the same for all model zones.

Subalpine Fir/Lodgepole pine

Restoration Zone

Shelterwood harvest [RegHar] is prescribed in small and medium sized states with closed canopies (>60% CC) beginning at 80 years of age. Resulting transitions are proportional as follows:

- 90% reverts to the Grass/Forb state with less than 10% total tree canopy cover
- 10% transitions to an open canopied state of the same size class

Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

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[7] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.

[8] This is not to imply that natural fire is excluded from this model zone, but Rx fire is not included for this model zone.

Western Redcedar/Western Hemlock

Reserve Zone
No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Restoration Zone
No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Timber Production Zone
No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Wild / Other Zone
No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Alternative R

Douglas-Fir Dry

Reserve Zone
Pre-Commercial Thinning (PCT) is prescribed in Seed/Sap (>40% CC) states maintaining the state class.
Partial Harvest of Poles (PH.Poles) is prescribed in Pole size states with closed canopies (>40% CC) with transitions to open canopied pole states (10-40% CC).
Partial Harvest of small closed canopied states (>40% CC) with transitions similar to those prescribed for partial harvest in the No Action alternative[9]:

- 30% transitions to an open canopied state of the same size class
- 20% transitions to an open canopied state of medium size class (to reflect retention of larger trees)
- 50% maintains closed canopy of the same state class (>40%)

Partial Harvest of medium closed canopied states (>40% CC) with transitions similar to those prescribed for partial harvest in the No Action alternative[10]:

- 50% transitions to an open canopied state of the same size class
- 50% maintains closed canopy of the same state class (>40%)

Prescribed Fire (non-lethal) is applied to open canopied model states of Seed/Sap, Pole, and Small size classes to maintain open canopies and prevent canopy infill (GROWCAN).

[9] Because the referenced transition mechanics are identical here to the No Action harvest in this type, the model database uses the nomenclature (NAharv) to represent this transition.
[10] Because the referenced transition mechanics are identical here to the No Action harvest in this type, the model database uses the nomenclature (NAharv) to represent this transition.

Restoration Zone

(The following are the same as the restoration zone assumptions for the PA and P alternatives)

Variable Density Thinning (VDT) is prescribed in Small and Medium model states with closed canopies (>40% CC). Variable density thinning results in proportional transitions to destination states as follows:

- 75% transitions to an open canopied (10-39% canopy cover) system of the same size class with an increased model age of 5 years (to account for increased overall age of unharvested trees)
- 10% remains in the closed canopy state and does not transition to another state
- 15% reverts to the Grass/Forb state with less than 10% total tree canopy cover

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5” DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Timber Production Zone

Shelterwood Harvest is prescribed at 120 years of age (modeled as regeneration harvest [RegHar]) medium size class only[11]. Retention of ~15 trees per acre is assumed to transition to the Grass/Forb state with <10% residual tree cover.

Salvage is prescribed for states burned with stand replacing fire, transitioning from Grass/Forb with standing dead to Grass/Forb state

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5” DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

No Prescribed Fire is not applied in this model zone.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

[11] Previous modeling included RegHar for the R alternative in the Timber Production Zone for states larger than medium. This was changed to reflect IDT wishes communicated on 1/30/2015.

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Northern Rocky Mountain Mixed Conifer

Reserve Zone

No Mechanical prescriptions are modeled in this model zone.

Prescribed Fire is applied to mimic natural mixed severity fire occurring in closed canopied (>60% CC) states with multiple stories that are small-giant in size. Prescribed mixed severity fire results in proportional transitions to destination states that mimic the effects of mixed severity fire[12] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small & Medium model states with closed canopies (>60% CC). Variable density thinning results in proportional transitions to destination states that mimic the effects of mixed severity fire[13] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Prescribed Fire is applied to mimic natural mixed severity fire occurring in closed canopied (>60% CC) states with multiple stories that are small-giant in size. Prescribed mixed severity fire results in proportional transitions to destination states that mimic the effects of mixed severity fire as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class

[12] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.

- 6% remains in the closed canopied state and does not transition to another state

Timber Production Zone

Variable Density Thinning (VDT) is prescribed in Small & Medium model states with closed canopies (>60% CC). Variable density thinning results in proportional transitions to destination states that mimic the effects of mixed severity fire as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Prescribed Fire is applied to mimic natural mixed severity fire occurring in closed canopied (>60% CC) states with multiple stories that are small-giant in size. Prescribed mixed severity fire results in proportional transitions to destination states that mimic the effects of mixed severity fire[14] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Spruce/Subalpine Fir

No activity is modeled in this vegetation type. Wildfire and insect/disease agents; all alternatives are the same for all model zones.

Subalpine Fir/Lodgepole pine

Reserve Zone

No Mechanical prescriptions are modeled in this model zone.
Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those

with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Restoration Zone

Shelterwood harvest is prescribed in small and medium sized states with closed canopies (>60% CC) beginning at 80 years of age. Resulting transitions are proportional as follows:

- 90% reverts to the Grass/Forb state with less than 10% total tree canopy cover
- 10% transitions to an open canopied state of the same size class

Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Timber Production Zone

Shelterwood harvest is prescribed in small and medium sized states with closed canopies (>60% CC) beginning at 80 years of age. Resulting transitions are proportional as follows:

- 90% reverts to the Grass/Forb state with less than 10% total tree canopy cover
- 10% transitions to an open canopied state of the same size class

Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Western Redcedar/Western Hemlock

Reserve Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Restoration Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Timber Production Zone

No Mechanical prescriptions are modeled in this model zone.

No Prescribed Fire is not applied in this model zone

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Alternative B

Douglas-Fir Dry

Timber Production Zone

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5" DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

- **Shelterwood Harvest** is prescribed at ~120 years of age (modeled as regeneration harvest [RegHar]) medium size class only[15]). Retention of ~15 trees per acre is assumed to transition to the Grass/Forb state with <10% residual tree cover.
- **Salvage** is prescribed for states burned with stand replacing fire, transitioning from Grass/Forb with standing dead to Grass/Forb state
  No Prescribed Fire is not applied in this model zone

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small and Medium[16] model states with closed canopies (>40% CC). Variable density thinning results in proportional transitions to destination states as follows:

- 75% transitions to an open canopied (10-39% canopy cover) system of the same size class with an increased model age of 5 years (to account for increased overall age of unharvested trees)
- 10% remains in the closed canopy state and does not transition to another state
- 15% reverts to the Grass/Forb state with less than 10% total tree canopy cover

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5" DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

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[15] This reflects models as re-run and delivered in February 2015. This change was made after the November 2014 model runs to deal with constraints in this alternative relative to "Eastside Screens".

[16] VDT in the large state was removed to reflect *no mechanical* harvest in large or giant dominated stands to deal with constraints in this alternative relative to "Eastside Screens".

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Northern Rocky Mountain Mixed Conifer

Timber Production Zone

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5” DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Regeneration Harvest with Reserves [RegHar] is prescribed at ~80 years (small size class) with transition to the Grass/Forb state (<10% tree CC).
No Prescribed Fire is not applied in this model zone

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small & Medium model states with closed canopies (>60% CC). Variable density thinning results in proportional transitions to destination states that mimic the effects of mixed severity fire[17] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Prescribed Fire is applied to mimic natural mixed severity fire occurring in closed canopied (>60% CC) states with multiple stories that are small-giant in size. Prescribed mixed severity fire results in proportional transitions to destination states that mimic the effects of mixed severity fire[18] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class

[17] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.
[18] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.

- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

No Prescribed Fire is applied in this model zone

Spruce/Subalpine Fir

No activity is modeled in this vegetation type. Wildfire and insect/disease agents; all alternatives are the same for all model zones.

Subalpine Fir/Lodgepole pine

Timber Production Zone

Regeneration Harvest with Reserves is prescribed at 80-120 years (small & medium size class) with transition to the Grass/Forb state (<10% tree CC).
No Prescribed Fire is applied in this model zone

Restoration Zone

Shelterwood harvest is prescribed in small and medium sized states with closed canopies (>60% CC) beginning at 80 years of age. Resulting transitions are proportional as follows:

- 90% reverts to the Grass/Forb state with less than 10% total tree canopy cover
- 10% transitions to an open canopied state of the same size class

No Prescribed Fire is applied in this model zone

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Western Redcedar/Western Hemlock

Timber Production Zone

Partial Harvest (PH.small) is prescribed in small states with mid-canopy closure (40-60% CC) maintaining the state class and preventing canopy infill (GROWCAN).
Regeneration Harvest with Reserves is prescribed at ~80 years (medium size class) with transition to the Grass/Forb state (<10% tree CC).

No Prescribed Fire is not applied in this model zone.

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small model states with closed canopies (>60% CC). Variable density thinning results in proportional transitions to destination states as follows:

- 72% transitions to a mid-canopied state
- 14% remains in a closed canopied state
- 14% reverts to a grass/forb state

No Prescribed Fire is not applied in this model zone

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Reserve Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone

Alternative O

Douglas-Fir Dry

Timber Production Zone

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5" DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

- **Shelterwood Harvest** is prescribed at ~120 years of age (modeled as regeneration harvest [RegHar]) medium size class only[19]). Retention of ~15 trees per acre is assumed to transition to the Grass/Forb state with <10% residual tree cover.
- **Salvage** is prescribed for states burned with stand replacing fire, transitioning from Grass/Forb with standing dead to Grass/Forb state
  No Prescribed Fire is not applied in this model zone

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small and Medium[20] model states with closed canopies (>40% CC). Variable density thinning results in proportional transitions to destination states as follows:

[19] This reflects models as re-run and delivered in February 2015. This change was made after the November 2014 model runs to deal with constraints in this alternative relative to "Eastside Screens".

- 75% transitions to an open canopied (10-39% canopy cover) system of the same size class with an increased model age of 5 years (to account for increased overall age of unharvested trees)
- 10% remains in the closed canopy state and does not transition to another state
- 15% reverts to the Grass/Forb state with less than 10% total tree canopy cover

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5" DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Partial Harvest of Poles (PH.Poles) is prescribed in pole states with canopy cover >40%.

- Partial Harvest of Poles results in transitions to pole stands with open canopies (10-39% canopy cover)

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Northern Rocky Mountain Mixed Conifer

Timber Production Zone

Pre-commercial thinning (PCT) is prescribed for Seed/Sap (<5" DBH) classes with canopy cover > 40%.

- PCT results in transitions to Seed/Sap stands with open canopies (10-39% canopy cover)

Regeneration Harvest with Reserves is prescribed at ~80 years (small size class) with transition to the Grass/Forb state (<10% tree CC).

No Prescribed Fire is not applied in this model zone

Restoration Zone

Variable Density Thinning (VDT) is prescribed in Small & Medium model states with closed canopies (>60% CC). Variable density thinning results in proportional transitions to destination states that mimic the effects of mixed severity fire[21] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class

[20] VDT in the large state was removed to reflect *no mechanical* harvest in large or giant dominated stands to deal with constraints in this alternative relative to "Eastside Screens".

[21] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.

- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Prescribed Fire is applied to mimic natural mixed severity fire occurring in closed canopied (>60% CC) states with multiple stories that are small-giant in size. Prescribed mixed severity fire results in proportional transitions to destination states that mimic the effects of mixed severity fire[22] as follows:

- 58% transitions to an open canopied (10-39% canopy cover) system of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) multi-storied state of the same size class
- 21% transitions to a mid-canopied (40-60% canopy cover) single-storied state of the same size class
- 6% remains in the closed canopied state and does not transition to another state

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.

No Prescribed Fire is applied in this model zone

Spruce/Subalpine Fir

No activity is modeled in this vegetation type. Wildfire and insect/disease agents; all alternatives are the same for all model zones.

Subalpine Fir/Lodgepole pine

Timber Production Zone

Regeneration Harvest with Reserves is prescribed at 80-120 years (small & medium size class) with transition to the Grass/Forb state (<10% tree CC).
No Prescribed Fire is applied in this model zone

Restoration Zone

Shelterwood harvest is prescribed in small and medium sized states with closed canopies (>60% CC) beginning at 80 years of age. Resulting transitions are proportional as follows:

- 90% reverts to the Grass/Forb state with less than 10% total tree canopy cover
- 10% transitions to an open canopied state of the same size class

No Prescribed Fire is applied in this model zone

[22] Fire transition proportions were derived from equal probability cover-severity tables. Cover-Severity proportions are provided in Appendix 1.

Wild / Other Zone
No Mechanical prescriptions are modeled in this model zone.
Prescribed Stand Replacing Fire is applied at 80-100 years of age in small size class and larger states with a transition to a Grass/Forb state with less than 10% canopy cover retaining residual fuel loading. It is also applied to Seed/Sap and Pole states (only those with residual fuels from previous burns) and transitions to a Grass/Forb state with less than 10% canopy cover from trees.

Western Redcedar/Western Hemlock

Timber Production Zone
Partial Harvest (PH.small) is prescribed in small states with mid-canopy closure (40-60% CC) maintaining the state class and preventing canopy infill (GROWCAN).
Regeneration Harvest with Reserves is prescribed at ~80 years (medium size class) with transition to the Grass/Forb state (<10% tree CC).
No Prescribed Fire is not applied in this model zone.

Restoration Zone
Variable Density Thinning (VDT) is prescribed in Small model states with closed canopies (>60% CC). Variable density thinning results in proportional transitions to destination states as follows:

- 72% transitions to a mid-canopied state
- 14% remains in a closed canopied state
- 14% reverts to a grass/forb state

No Prescribed Fire is not applied in this model zone

Wild / Other Zone
No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

No Action Alternative

Douglas-Fir Dry

Restoration Zone[23]
No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Timber Production Zone
Pre-Commercial Thinning (PCT) is prescribed in Seed/Sap (>40% CC) states maintaining the state class.
Partial Harvest of small closed canopied states (>40% CC) with transitions similar to those prescribed for partial harvest in the No Action alternative:

- 30% transitions to an open canopied state of the same size class

[23] While the term restoration zone is used here, this term is not used in the NA or current plan. This represents acres in the "harvest" category of the suitability analysis for the NA alternative. The terminology of Restoration Zone is used here only because it corresponds to the terminology used in the model database.

- 20% transitions to an open canopied state of medium size class (to reflect retention of larger trees)
- 50% maintains closed canopy of the same state class (>40%)

Partial Harvest of medium closed canopied states (>40% CC) with transitions similar to those prescribed for partial harvest in the No Action alternative:

- 50% transitions to an open canopied state of the same size class
- 50% maintains closed canopy of the same state class (>40%)

Prescribed Fire is applied to open canopied states only (10-39% canopy cover). Rx fire maintains open canopied states and prevents canopy infill (GROWCAN) transitions to closed states.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Northern Rocky Mountain Mixed Conifer

Restoration Zone[24]

No Mechanical prescriptions are modeled in this model zone.
Prescribed Fire is applied to small, medium, and large sized states with closed canopies. Resulting transitions are proportional as follows:

- 75% transitions to mid-closed canopy states with multiple-storied structure of the same size class.
- 25% transitions to mid-closed canopy states with single storied structure of the same size class.

Timber Production Zone

Thinning Harvest [NaHarv] is prescribed in small and medium sized, closed canopied systems with transitions to mid-canopied states of the same size class.
Regeneration Harvest [RegHar] is prescribed in small and medium sized, mid-canopied systems with transitions to the Grass/Forb state.
Prescribed Fire is applied to small, medium, and large sized states with closed canopies. Resulting transitions are proportional as follows:

- 75% transitions to mid-closed canopy states with multiple-storied structure of the same size class.
- 25% transitions to mid-closed canopy states with single storied structure of the same size class.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

[24] While the term restoration zone is used here, this term is not used in the NA or current plan. This represents acres in the "harvest" category of the suitability analysis for the NA alternative. The terminology of Restoration Zone is used here only because it corresponds to the terminology used in the model database.

Spruce/Subalpine Fir

No activity is modeled in this vegetation type. Wildfire and insect/disease agents; all alternatives are the same for all model zones.

Subalpine Fir/Lodgepole pine

Restoration Zone[25]

Regeneration Harvest is prescribed in small and medium sized states with closed canopies with transitions to the Grass/Forb state.
No Prescribed Fire is not applied in this model zone.

Timber Production Zone

Regeneration Harvest is prescribed in small and medium sized states with closed canopies with transitions to the Grass/Forb state.
No Prescribed Fire is not applied in this model zone.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Western Redcedar/Western Hemlock

Restoration Zone[26]

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Timber Production Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Wild / Other Zone

No Mechanical prescriptions are modeled in this model zone.
No Prescribed Fire is not applied in this model zone.

Constrained Model Runs

In order to better represent expected landscape trajectories, a set of model runs were developed using constraints based on budget assumptions. The assumed budget is based on existing performance reflecting recent budgets on the Colville National Forest. While it is recognized that budgets can and do fluctuate, this is intended to give a good approximation of what could be accomplished under current budgets. Further, it is acknowledged that particularly in the realm of

[25] While the term restoration zone is used here, this term is not used in the NA or current plan. This represents acres in the "harvest" category of the suitability analysis for the NA alternative. The terminology of Restoration Zone is used here only because it corresponds to the terminology used in the model database.

[26] While the term restoration zone is used here, this term is not used in the NA or current plan. This represents acres in the "harvest" category of the suitability analysis for the NA alternative. The terminology of Restoration Zone is used here only because it corresponds to the terminology used in the model database.

prescribed fire, budget is not the only constraint; rather it is on equal footing with regulatory limitations and forest capacity. In other words, it is possible that an increased budget alone might not lead to an increase in prescribed fire treatments if regulatory constraints and forest capacity remain unchanged. Budget assumptions are translated into the model as acres of treatment per year. Cost per acre of treatment, by treatment type is not factored into this analysis.

Budget assumptions

The original budget constrained runs used the following acre targets by model type. These values are based on an assumed 5,000 acre of total treatment per year for each of the three categories (Timber Management, Prescribed Fire, and Mechanical Fuels Treatment. The specific acres applied generally represent the approximate proportion of the landscape represented by each model type with some adjustments for resource objectives.

Budget constrained treatment acres for the each alternative are displayed in Table 5. For the B, O, R, and NA alternatives, the modeled values for constrained runs reflect further constraints associated with Non-Declining Flow for timber management transitions. See the section of this document on Timber Scheduling for a full description of the Allowable Sale Quantity, Long Term Sustained Yield, and Non-Declining Flow calculation process.

Table 5 - Budget Constrained Treatment Values

Model Type	Transition Group	Alt P/PA Target Area (Acres)	Alt B/O Target Area (Acres)	Alt NA Target Area (Acres)	Alt R Target Area (Acres)
Subalpine Fir/Lodgepole pine	5kFuelsMech	0	0	0	0
	5kRxFire	1040	1040	1040	1040
	5kTimber	950	475	1900	475
Northern Rocky Mountain Mixed Conifer	5kFuelsMech	1925	963	481	0
	5kRxFire	1686	1686	1686	1686
	5kTimber	1550	775	388	0
Douglas-fir dry	5kFuelsMech	3074	1229	615	615
	5kRxFire	2153	2153	2153	2153
	5kTimber	2500	1000	500	500
Western redcedar/western hemlock	5kFuelsMech	0	309	0	0
	5kRxFire	0	0	0	0

For those alternatives where non-declining flow restricted number of acres treated for timber management below the 5,000 acre current values, transition targets were reduced/increased (within the 5,000ac cap).

Acres and probabilities

To approximate the above discussed budget constraints, model transitions were grouped into three categories: 1) Timber Management, 2) Prescribed Fire, and 3) Fuels Mechanical. Transition area targets where then assigned to each model type and transition group based on the values provided in Table 5 above. The model then adjusts probabilities on the fly to approximate the entered amount of treatment by treatment group in a given year.

Unconstrained

The original model runs produced in Nov. of 2014 included unconstrained model runs. These model runs allowed for much higher amounts of treatment acres in an attempt to see what an unlimited management budget could achieve under the management prescriptions for each alternative. However, these model runs were not consistent with the concept of non-declining flow for timber volume, and did not meet Long Term Sustained Yield (LTSY) objectives. Therefore they are not currently included in the modeling package. Instead, the LTSY and Allowable Sale Quantity (ASQ) runs now approximate the maximum harvest levels of an unlimited budget and associated resource impacts. See the Timber Scheduling section of this document for a description of the process used to model LTSY and ASQ.

Timber Scheduling

To meet NFMA and 1982 planning rule requirements, model runs were completed to calculate Long Term Sustained Yield, Allowable Sale Quantity, and planned sale quantities reported as Planned Wood Sale Quantity & Planned Timber Sale Quantity. Model runs were developed to be consistent with R6 Timber Calculations Guidance[27].

Calculation of Long Term Sustained Yield

The calculation of Long Term Sustained Yield (LTSY) assumes that the forest has already achieved desired conditions on the landscape, and computes the maximum volume that can be sustained in perpetuity while maintaining those desired conditions. To facilitate these runs, the model was first populated with initial conditions that reflect desired conditions. Because the stated desired conditions are based on the simplified Colville Structural Groupings[28], and not model states, values for initial conditions by model states were derived using outputs from the Natural Range of Variation model runs.

With initial conditions set, model runs were conducted with successively higher (and lower) transition targets (acres) for mechanical treatments (timber and fuels). Models were run with existing intensity (1x) as well as ¼, ½, ¾, 2x, 2.5x, 3x, 4x, 8x, 16x, and 32x management intensities. The outputs from each run were then compared to determine the maximum intensity of management possible for each model type that both conformed to the principle of non-declining flow and best approximated the maintenance of desired conditions.

Table 6 displays the selected LTSY intensity for each model type by alternative. As evidenced by this table, LTSY could not be calculated for alternatives B, O, R, or NA. This is because no intensity of management under the prescriptions developed for these alternatives led to a non-declining flow of timber or maintained desired conditions.

[27] The March 2011 document, “Determining Lands Suitable for Timber Production, and Long-Term Sustained Yield, Allowable Sale Quantity and Harvest Volume Estimates for Forest Plan Revisions Under Provisions of the 1982 Rule – Pacific Northwest Region” contains a full description of regional guidance on preforming timber calculations.

[28] See appendix 2 for a crosswalk between Colville Structural Groupings and Model States.

Table 6 - LTSY management intensities relative to current management intensity

	LTSY Maximum Management Intensity by Alternative					
Vegetation Type:	**PA**	**P**	**B**	**O**	**R**	**NA**
FDD	3x	3x	*	*	*	*
FCM	2.5x	2.5x	*	*	*	*
FCD	1x	1x	*	*	*	*
FRN	0x	0x	*	*	*	*

The selected LTSY management intensities resulted in the LTSY volumes presented in Table 8.

Calculation of the Allowable Sale Quantity

The calculation of Allowable Sale Quantity (ASQ) follows the same general process as the LTSY calculation with the key distinction that model runs use initial conditions reflecting current conditions on the forest (see the Existing Conditions section of this document for a full description of how these values were calculated). ASQ model runs were conducted with successively higher (and lower) transition targets (acres) for mechanical treatments (timber and fuels). Models were run with existing intensity (1x) as well as ¼, ½, ¾, 2x, 2.5x, 3x, 4x, 8x, 16x, and 32x management intensities. The outputs from each run were then compared to determine the maximum intensity of management possible for each model type that conformed to the principle of non-declining flow while moving towards desired conditions.

Calculation of Non-Declining Flow

A true ASQ value could not be calculated for the B, O, R or NA alternative because no intensity of management under the prescriptions developed for these alternatives led to desired conditions. However, non-declining flow rates were developed for these alternatives and are reported in Table 7.

Table 7- Non-Declining Flow management intensities relative to current management intensity

	Non-Declining Flow Maximum Management Intensity by Alternative					
Vegetation Type:	**PA**	**P**	**B**	**O**	**R**	**NA**
Douglas-fir dry	2x	2x	1/2*	1/2*	<1/4*	<1/4*
Northern Rocky Mountain Mixed Conifer	2x	2x	1/2*	1/2*	0x	<1/4*
Subalpine Fir/Lodgepole pine	1x	1x	1/2*	1/2*	1/2x	2x
Western redcedar/western hemlock	0x	0x	1/2*	1/2*	0x	0x

Calculation of the Planned Sale Quantities

Planned sale quantities were developed using the budget constrained transition targets for mechanical treatments. Modeled volumes for both Planned Wood Sale Quantity (PWSQ) and Planned Timber Sale Quantity (PTSQ) are included in Table 8. Values below do not reflect additional contributions to PWSQ from other non-chargeable volume including fuelwood.

Table 8- Modeled Timber Volumes by Alternative

		Alternative					
Value		**PA**	**P**	**B**	**O**	**R**	**NA**
LTSY	*MMBF*	97.5	97.4	*	*	*	*
	CCF	191,094	186,418	*	*	*	*
ASQ	*MMBF*	67.6	67	*	*	*	*
	CCF	139,416	138,041	*	*	*	*
NDF	*MMBF*	67.6	67	13.9	12.2	7.5	18.3
	CCF	139,416	138,041	29,132	26,525	15,576	38,397
PWSQ	*MMBF*	*62.07*	*61.77*	*37.37*	*37.47*	*14.26*	*40.57*
	CCF	*125,866*	*125,379*	*75,843*	*77,067*	*28,849*	*82,758*
PTSQ	*MMBF*	40.8	41.2	13.9	12.2	7.5	18.3
	CCF	83,992	84,902	29,132	26,525	15,576	38,397

* LTSY and ASQ cannot be calculated for these alternatives as the associated management prescriptions do not represent non-declining flow nor do they move toward or sustain the stated desired conditions.

Appendix 1 – Cover Severity Tables

Non-Lethal in OPEN		
POST-FIRE CONDITION		
CANOPY COVER CLASS	COUNT	%
CANOPY COVER CLASS	COUNT	%
1 (non-forested; <10% tree cover)	48	6.4
2 (open; 10-39.9% tree cover)	702	93.6
3 (closed; 40%+)	0	0.0

Non-Lethal in mid-canopy		
POST-FIRE CONDITION		
1 (non-forested; <10% tree cover)	0	0.0
2 (open; 10-39.9% tree cover)	157	31.4
3 (closed; 40%+)	343	68.6

Mixed Severity in OPEN		
POST-FIRE CONDITION		
	COUNT	%
1 (non-forested; <10% tree cover)	610	40.7
2 (open; 10-39.9% tree cover)	890	59.3
3 (closed; 40%+)	0	0.0

Mixed Severity in mid-canopy		
POST-FIRE CONDITION		
1 (non-forested; <10% tree cover)	418	80.4
2 (open; 10-39.9% tree cover)	102	19.6
3 (mid-closed; 40-60%)	0	0.0

Stand replacing in OPEN		
POST-FIRE CONDITION		
1 (non-forested; <10% tree cover)	780	1.0
2 (open; 10-39.9% tree cover)	0	0.0
3 (mid-closed; 40-60%)	0	0.0

Stand Replacing in mid-canopy **POST-FIRE CONDITION**		
1 (non-forested; <10% tree cover)	418	80.4
2 (open; 10-29.9% tree cover)	102	19.6
3 (mid-closed; 40-60%)	0	0.0

Stand Replacing in closed Canopy (>60%) **POST-FIRE CONDITION**	COUNT	%
1 (non-forested; <10% tree cover)	544	51.0
2 (open; 10-29.9% tree cover)	522	49.0
3 (mid-closed; 40-60%)	0	0.0

Appendix 2 – Colville Structure Groupings Crosswalk

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
Douglas-fir dry	DF:Yo	seed/sap <5"	Open 10-40%		A - Early
	DF:Po1	pole 5-10"	Open 10-40%	Single	
	DF:Ym	seed/sap <5"	Mid CC 40-60%		
	DF:Pm2	pole 5-10"	Mid CC 40-60%	Multi	
	DF:Pm1	pole 5-10"	Mid CC 40-60%	Single	
	DF:G1p	GFB (w/ snags)	<10%		
	DF:L1p	GFB (w/ snags)	<10%		
	DF:M1p	GFB (w/ snags)	<10%		
	DF:P1p	GFB (w/ snags)	<10%		
	DF:S1p	GFB (w/ snags)	<10%		
	DF:Yop	GFB (w/ snags)	<10%		
	DF:GF	GFB	<10%		
	DF:So1	small 10-15"	Open 10-40%	Single	B - Mid Open
	DF:Mo1	medium 15-20"	Open 10-40%	Single	
	DF:Sm2	small 10-15"	Mid CC 40-60%	Multi	C - Mid Closed
	DF:Sm1	small 10-15"	Mid CC 40-60%	Single	
	DF:Mm2	medium 15-20"	Mid CC 40-60%	Multi	
	DF:Mm1	medium 15-20"	Mid CC 40-60%	Single	
	DF:Lo1	large 20-30"	Open 10-40%	Single	D - Late Open
	DF:Go1	giant >30"	Open 10-40%	Single	
	DF:Lm2	large 20-30"	Mid CC 40-60%	Multi	E - Late Closed
	DF:Lm1	large 20-30"	Mid CC 40-60%	Single	
	DF:Gm2	giant >30"	Mid CC 40-60%	Multi	
	DF:Gm1	giant >30"	Mid CC 40-60%	Single	

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
Northern Rocky Mountain Mixed Conifer	DFmx:Yo	seed/sap <5"	Open 10-40%		A - Early
	DFmx:Pm1	pole 5-10"	Mid CC 40-60%	Single	
	DFmx:Pc2	pole 5-10"	Closed >60%	Multi	
	DFmx:S1p	GFB (w/ snags)	<10%		
	DFmx:M1p	GFB (w/ snags)	<10%		
	DFmx:L1p	GFB (w/ snags)	<10%		
	DFmx:G1p	GFB (w/ snags)	<10%		
	DFmx:So1	small 10-15”	Open 10-40%	Single	B - Mid Open
	DFmx:Mo1	medium 15-20"	Open 10-40%	Single	
	DFmx:Sm2	small 10-15”	Mid CC 40-60%	Multi	C - Mid Closed

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
	DFmx:Sm1	small 10-15”	Mid CC 40-60%	Single	
	DFmx:Mm2	medium 15-20"	Mid CC 40-60%	Multi	
	DFmx:Mm1	medium 15-20"	Mid CC 40-60%	Single	
	DFmx:Sc2	small 10-15”	Closed >60%	Multi	
	DFmx:Mc2	medium 15-20"	Closed >60%	Multi	
	DFmx:Lo1	large 20-30"	Open 10-40%	Single	D - Late Open
	DFmx:Go1	giant >30"	Open 10-40%	Single	
	DFmx:Lm2	large 20-30"	Mid CC 40-60%	Multi	E - Late Closed
	DFmx:Lm1	large 20-30"	Mid CC 40-60%	Single	
	DFmx:Gm2	giant >30"	Mid CC 40-60%	Multi	
	DFmx:Gm1	giant >30"	Mid CC 40-60%	Single	
	DFmx:Lc2	large 20-30"	Closed >60%	Multi	
	DFmx:Gc2	giant >30"	Closed >60%	Multi	

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
Spruce/Subalpine fir	DFmx:GFp	seed/sap <5"	Open 10-40%		A - Early
	DFmx:Ym	seed/sap <5"	Mid CC 40-60%		
	DFmx:Pc1	pole 5-10"	Closed >60%		
	DFmx:Yop	GFB (w/ snags)	<10%		
	DFmx:P1p	GFB (w/ snags)	<10%		
	DFmx:S1p	GFB (w/ snags)	<10%		
	DFmx:M1p	GFB (w/ snags)	<10%		
	DFmx:L1p	GFB (w/ snags)	<10%		
	DFmx:Sc1	small 10-15”	Closed >60%		C - Mid Closed
	DFmx:Mc1	medium 15-20"	Closed >60%		
	DFmx:Lc1	large 20-30"	Closed >60%		E - Late Closed

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
Subalpine Fir/Lodgepole pine	LPWL:Yo	seed/sap <5"	Open 10-40%		A - Early
	LPWL:GFp	seed/sap <5"	Open 10-40%		
	LPWL:Ym	seed/sap <5"	Mid CC 40-60%		
	LPWL:Pc1	pole 5-10"	Closed >60%		
	LPWL:Yop	GFB (w/ snags)	<10%		
	LPWL:P1p	GFB (w/ snags)	<10%		
	LPWL:S1p	GFB (w/ snags)	<10%		
	LPWL:M1p	GFB (w/ snags)	<10%		
	LPWL:L1p	GFB (w/ snags)	<10%		
	LPWL:Sm1	small 10-15”	Mid CC 40-60%		C - Mid Closed

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
	LPWL:Sc1	small 10-15”	Closed >60%		
	LPWL:Mc1	medium 15-20"	Closed >60%		
	LPWL:Lc1	large 20-30"	Closed >60%		E - Late Closed

Model Type	Model State Code	Size Class	Cover Class	Storiedness	Colville Grouping
Western redcedar/western hemlock	DFRC:Yo	seed/sap <5"	Open 10-40%		A - Early
	DFRC:LcP	seed/sap <5"	Open 10-40%		
	DFRC:GcP	seed/sap <5"	Open 10-40%		
	DFRC:Pm1	pole 5-10"	Mid CC 40-60%	Single	
	DFRC:G1p	GFB (w/ snags)	<10%		
	DFRC:L1p	GFB (w/ snags)	<10%		
	DFRC:GF	GFB	<10%		
	DFRC:Sm2	small 10-15”	Mid CC 40-60%	Multi	C - Mid Closed
	DFRC:Mm2	medium 15-20"	Mid CC 40-60%	Multi	
	DFRC:Sc2	small 10-15”	Closed >60%	Multi	
	DFRC:Mc2	medium 15-20"	Closed >60%	Multi	
	DFRC:Lm2	large 20-30"	Mid CC 40-60%	Multi	E - Late Closed
	DFRC:Gm2	giant >30"	Mid CC 40-60%	Multi	
	DFRC:Lc2	large 20-30"	Closed >60%	Multi	
	DFRC:Gc2	giant >30"	Closed >60%	Multi	

Appendix C – Timber Suitability

Table 1 – Modeling categories and management areas

Modeling Category	Management Area	Alternative(s)
Wilderness/Other	Wilderness	All
	Research Natural Areas	All
	PARW	PA, P, R, B, O
	Non-forest	All
	Irreversible Resource Damage	All
	Reforestation Difficulties	All
	Soils: Timber Harvest unsuitable	All
Harvest	Backcountry Motorized	PA, P, R, B, O
	Backcountry Non-motorized	PA, P, R, B, O
	Caribou Habitat	No Action
	Downhill skiing	No Action
	Old growth management area	No Action
	Potential Wilderness Area	PA, P, R, B, O
	Recreation	No Action
	Recreation/Wildlife	No Action
	Old Forest Emphasis	R
	Restoration Area	B, O
	Scenic Byways	PA, P, R, B, O
	Scenic/winter range	No Action
	Semi-Primitive Non-motorized	No Action
	Semi-Primitive Motorized	No Action
	Winter range	No Action
Production	Focused and General Restoration	PA, P, R
	Responsible Management	O
	Active Management	B
	Wood/forage	No Action
	Scenic/Timber	No Action

The soil survey geographic data (SSURGO) dataset was used to derive acres for non-forest, irreversible resource damage, reforestation difficulties, and unsuitable soils for harvest.

- Lithic soils (depth <50cm) and hydric soils (75%+ of map unit) determined areas unsuitable due to reforestation difficulties.
- Slopes greater than 80% determined unsuitable due to irreversible resource damage.
- Mollisols (grassland soils) determined unsuitable, and correspond to non-forest areas.

The acres for each category are:

Lithic soils – 184,659 acres
Hydric soils – 5,236 acres
Slopes greater than 80% - 0 acres
Mollisols – 64,416 acres

Table 2 - Suitability determination by alternative

Lead #	Description	No Action	Proposed Action	B	O	P	R
1	Nonforest Land	64,416	64,416	64,416	64,416	64,416	64,416
2	Forest land	1,037,943	1,037,943	1,037,943	1,037,943	1,037,943	1,037,943
3	Lands Withdrawn	36,157	36,157	36,157	36,157	36,157	36,157
4	Lands not capable of producing industrial wood	12,979	12,979	12,979	12,979	12,979	12,979
5A	Lands physically unsuited (irreversible resource damage)	0	0	0	0	0	0
5B	Lands physically unsuited (restocking difficulty)	130,057	130,057	130,057	130,057	130,057	130,057
6	Forest land inadequate information	0	0	0	0	0	0
7	***Tentatively Suitable Timber Lands***	858,750	858,750	858,750	858,750	858,750	858,750
All above are common to all alternatives.							
All below are by alternative							
8A	Minimum management requirements	0	0	0	0	0	0
8B	Multiple Use Objectives	323,025	205,508	474,265	511,215	202,122	729,330
8C	Cost efficiency	0	0	0	0	0	0
9	Unsuitable Forest Land (lines 1+3+4+5+6+8)	502,218	384,701	653,458	690,408	381,315	908,523
10	***Total Suitable Forest Land (line 2 - line 9)***	***535,725***	***653,242***	***384,485***	***347,535***	***656,628***	***129,420***

Appendix D – Harvest Volumes, LTSY, ASQ, PWSQ, and PTSQ Calculations

The 1982 planning rule requires calculation of the long term sustained yield and allowable sale quantity. Tables 1 (MMBF) and 2 (CCF) show these calculated values for each alternative.

The long term sustained yield (LTSY) is the highest uniform wood yield that may be sustained given multiple-use objectives on lands managed for timber production. LTSY assumes that all suitable land for timber production is within the desired condition.

The allowable sale quantity (ASQ) reflects the maximum theoretical annual timber yield for the life of the plan, which in this case was modeled as 20 years. It takes into account harvest from lands that are not yet within the desired condition, and therefore is slightly lower than the LTSY.

The projected wood sale quantity (PWSQ) is the estimated quantity of timber and all other wood products that is expected to be sold from the plan area for the plan period. The PWSQ consists of the projected timber sale quantity as well as other woody material such as fuelwood, firewood, or biomass that is also expected to be available for sale. The PWSQ includes volume from timber harvest for any purpose based on expected harvests that would be consistent with the plan components. The PWSQ is also based on the planning unit's fiscal capability and organizational capacity. PWSQ is not a target nor a limitation on harvest, and is not an objective unless the responsible official chooses to make it an objective in the plan. PWSQ for the No Action alternative was derived by averaging the total wood sale program quantity from 2010-2014.

The projected timber sale quantity (PTSQ) is the estimated quantity of timber meeting applicable utilization standards that is expected to be sold during the plan period. As a subset of the projected wood sale quantity (PWSQ), the projected timber sale quantity includes volume from timber harvest for any purpose from all lands in the plan area based on expected harvests that would be consistent with the plan components. The PTSQ is also based on the planning unit's fiscal capability and organizational capacity. PTSQ is not a target nor a limitation on harvest, and is not an objective unless the responsible official chooses to make it an objective in the plan.

Table 3 shows predicted PWSQ product type volume outputs. Table 4 shows total volume sold from 1988-2014 for reference purposes.

Table 1 – Modeled average annual volume outputs by alternative for LTSY, ASQ, PWSQ, and PTSQ (million board feet (MMBF)).

		NA	PA	P	R	B	O
	LTSY	18.3	97.5	97.4	7.5	13.9	12.2
	ASQ	18.3	67.6	67	7.5	13.9	12.2
Decade 1	PWSQ	40.6	62.1	61.8	14.3	37.4	37.5
	PTSQ	26.9	48.4	48.1	9.3	23.7	23.8
Decade 2	PWSQ	41.5	67.3	66.1	14.7	37.8	38.3
	PTSQ	27.8	53.6	52.4	9.7	24.1	24.6

Table 2 – Modeled average annual volume outputs by alternative for LTSY, ASQ, PWSQ, and PTSQ (hundred cubic feet (CCF)).

		NA	PA	P	R	B	O
	LTSY	38397	191094	186418	15576	29132	26525
	ASQ	38397	139416	138041	15576	29132	26525
Decade 1	PWSQ	82758	125866	125379	28849	75843	77067
	PTSQ	56466	99574	99087	19310	49551	50775
Decade 2	PWSQ	84751	136013	133519	29600	76552	78634
	PTSQ	58459	109721	107227	20061	50260	52342

Table 3 – Projected wood sale quantity (PWSQ) product volumes

Product Type	Measure	NA	PA	P	R	B	O
Harvest-Softwood Sawtimber	CCF	56,466	99,574	99,087	19,310	49,551	50,775
Harvest-Softwood Pulp	CCF	0	0	0	0	0	0
Harvest-Hardwood Sawtimber	CCF	0	0	0	0	0	0
Harvest-Hardwood Pulp	CCF	0	0	0	0	0	0
Poles	CCF	13	13	13	0	13	13
Posts	CCF	0	0	0	0	0	0
Fuelwood	CCF	8,914	8,914	8,914	3,231	8,914	8,914
Non-Saw	CCF	3,410	3,410	3,410	1,231	3,410	3,410
Grn Bio Cv	CCF	13,955	13,955	13,955	5,077	13,955	13,955
Total	CCF	82,758	125,866	125,379	28,849	75,843	77,067
	MMBF	40.57	62.07	61.77	14.26	37.37	37.47

Table 4 – Volume sold 1988-2014

Fiscal Year	MMBF	
1988	123.6	
1989	134	
1990	109.3	
1991	79.6	
1992	22	
1993	29.2	(eastside screens begins)
1994	52.5	
1995	18.2	
1996	48.7	
1997	36.2	
1998	28.1	
1999	35.4	
2000	51.1	
2001	23.9	
2002	22.4	
2003	30.6	
2004	27.6	
2005	18	
2006	37.4	
2007	34.6	
2008	60.9	
2009	43.6	
2010	48.2	
2011	40	
2012	35.9	
2013	46.6	
2014	46.8	
2015	57.7*	(estimated)

Calculation of LTSY and ASQ for Alternative R of the Colville National Forest Plan Revision Effort

Introduction:

To fulfill the requirements of the National Forest Management Act (NFMA) and 1982 Planning Rule, alternatives were analyzed to calculate key metrics of timber output. Specifically, analysis was conducted to determine Long Term Sustained Yield (LTSY) and Allowable Sale Quantity (ASQ) for each alternative. Through this analysis, it was determined that LTSY and ASQ cannot be calculated for the R, B, O, and NA alternatives as currently interpreted. This document provides a summary of the analysis performed, the assumptions used, and conclusions drawn for these alternatives, and describes the calculation of non-declining flow associated with these alternatives. While this document is specifically intended to describe the Forest Service developed R alternative, the same principles apply to the B, O, and NA alternatives.

Background:

To better understand the calculation of LTSY and ASQ, it is important to first understand the constraints and assumptions for these calculations. The considerations and assumptions in this analysis conform to the Pacific Northwest regional guidance on determining LTSY and ASQ provided via transmittal letter to the Colville National Forest on April 14th, 2011.

1) Timber Suitable Lands only
    a. The calculation of timber volumes that represent the LTSY and ASQ relate to designated as suitable for timber production. Harvest can and likely would occur on lands not designated suitable for timber production where other resource objectives are the driving factors in determining vegetation management; however, the referenced volume estimates are intended to reflect scheduled harvest for timber production. These scheduled harvests would be in areas designated as suitable for timber production. Because LTSY and ASQ relate only to lands suitable for timber production, this document focuses only on the model zone "TimberProd" (Active Timber Production modeling zone).
2) Consistency with Multiple Use Objectives and associated Plan Components
    a. Timber volumes are calculated based on consistency with multiple use objectives and associated plan components. For the purposes of this planning effort, all alternatives share the same forest wide desired conditions for vegetation structural stages. Specifically, this desired condition is to manage vegetative systems at or towards their natural range of variation. In other words, management is intended to create and/or maintain representative proportions of the landscape in key structural stages (Early, Mid-Open, Mid-Closed, Late-Open, & Late-Closed), commensurate with proportions that would have existed under natural disturbance regimes prior to Euro-American settlement. Because late and old forest structure is a key issue developed in this planning effort, special emphasis is placed on

describing its condition and trends in the plan set of documents. For the purposes of this analysis, timber calculations are made using the assumption that harvest volumes at the LTSY level should create or maintain the desired conditions on the landscape.

3) Principle of Non-Declining Flow
    a. The National Forest Management Act (NFMA 1976) requires that the Department limits "sale of timber from each national forest to a quantity equal to or less than a quantity which can be removed from such forest annually in perpetuity on a sustained-yield basis" unless certain key criteria are met in determining and developing a departure. The principle of non-declining even flow is intended to provide a steady and predictable supply of timber products from NFS lands that does not decline over time. It is further intended to ensure consistent long-term flow of timber products. Furthermore, non-declining flow is considered on a decadal basis; a given year may exceed the annual volume, provided that the decadal average of any given year is equal to or less than the following decade.
4) Eastside Screens
    a. The R, B, O, and NA alternatives all continue Eastside Screens direction. Specifically, the Colville interpretation of Screens language that essentially prohibits harvest in stands dominated by trees 21" and larger (diameter at breast height DBH). While provisions exist within screen direction for limited harvest of large trees when specific criteria are met, the Colville Planning Team interprets these specific criteria to be sufficiently restrictive to prevent harvest of large tree dominated stands in any meaningful quantity. To comply with this interpretation of the alternatives continuing Eastside Screens provisions, calculations of LTSY and ASQ assumed that harvest would generally *not* occur in stands dominated by large trees.

Process:

For a full description of the modeling process and timber scheduling calculations see the "Timber Scheduling" section of the document ***Vegetation Modeling Assumptions for the Colville Forest Planning Effort.*** A synopsis of harvest methods for the R alternative in the timber production zone is provided below:

Harvest scheduled for the R alternative:

In the Dry Douglas-fir vegetation type, shelterwood harvests are scheduled in the timber production zone targeting the medium size class of trees.

In the Northern Rocky Mountain Mixed Conifer vegetation type, a variable density thinning harvest is scheduled targeting small and medium size class stands.

In the Subalpine Fir / Lodgepole pine vegetation type, shelterwood harvests are scheduled in the timber production zone targeting small and medium size class stands.

Discussion:
In interpreting the results of the modeling for ASQ, it is important to keep in mind the existing conditions on the ground currently, especially as they relate to the application of Eastside Screens. Current conditions indicate that a majority of lands suitable for timber production are in the small to medium size class, as illustrated in Figure 1. While this represents a sizable potential harvest base, scheduling excess harvest in the short term to target this size class would lead to a decrease in available volume in the future while waiting for regrowth from these shelterwoods. Conversely, harvesting more conservative acreage leads to natural growth of some of the currently medium sized stands into the large size class. Once a stand matures into the large size class, it becomes unavailable for timber harvest due to the size cap interpretation from Eastside Screens. In this way, it is difficult to provide for both a sustained harvest level *and* prevent maturation of stands into a size-class that is not harvestable under the specified constraints. As a result, non-declining flow volume is limited to that which can be sustained in the long term.

Calculations for non-declining even flow for each alternative have been developed. These values represent the long term volume that can be produced consistently over time without a decline in future outputs, while adhering to the constraints of Eastside Screens as interpreted for each alternative.

The calculation of LTSY assumes that the forest is already within its desired conditions, and looks at how much volume can be produced in perpetuity while maintaining those desired conditions.

The 1982 Planning Rule does contain provisions for developing a departure schedule which departs from the base sale schedule by harvesting excess volume in the short term to better meet multiple use objectives. However, a departure schedule can only be used when doing so would "lead to better attaining the overall objectives of multiple-use management".

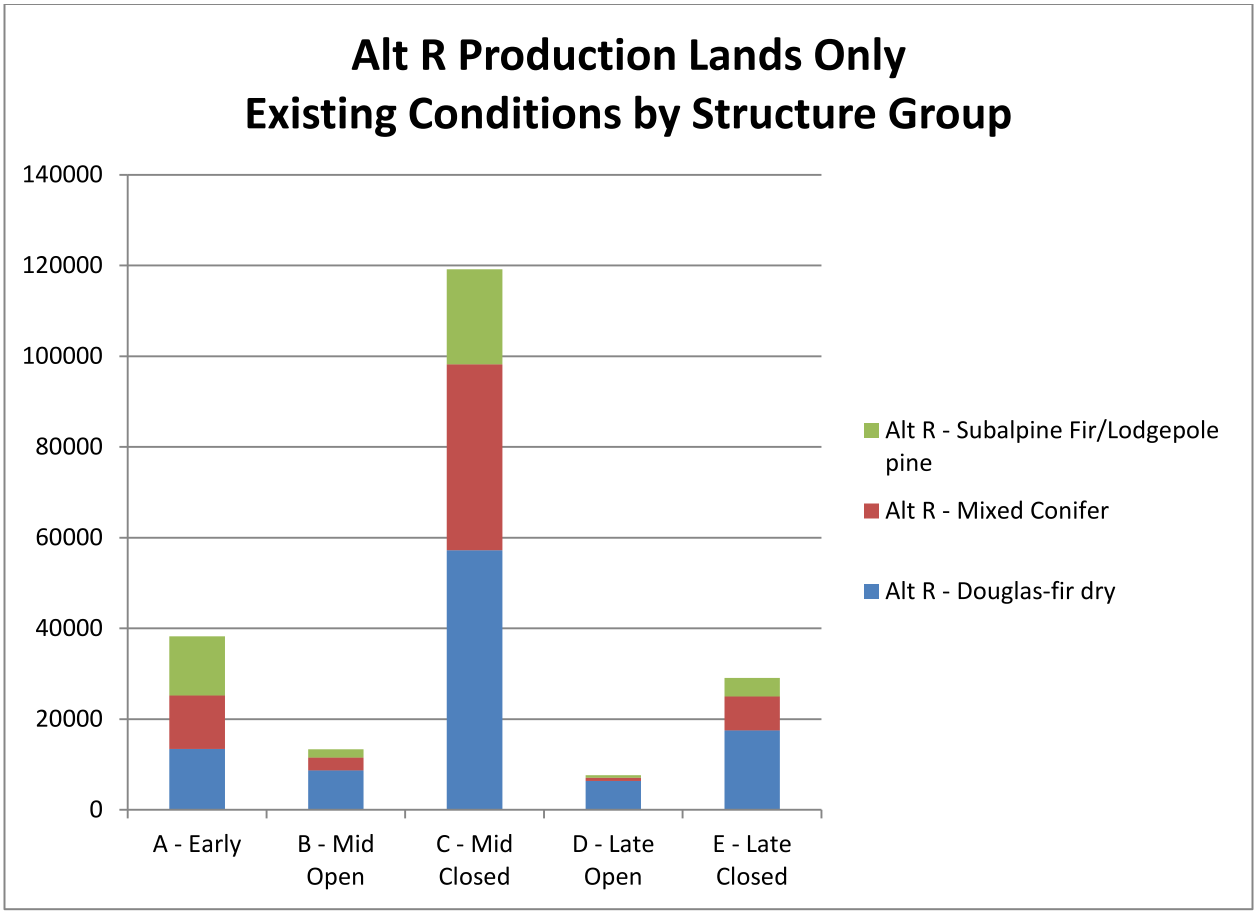
Alt R Production Lands Only
Existing Conditions by Structure Group
140000
120000
100000
80000
60000
40000
20000
0
A - Early
B - Mid Open
C - Mid Closed
D - Late Open
E - Late Closed
Alt R - Subalpine Fir/Lodgepole pine
Alt R - Mixed Conifer
Alt R - Douglas-fir dry

Figure 1

Appendix E - Seed Orchards Management as Administrative Sites

All seed orchards on the Colville National Forest have been designated administrative sites to facilitate their management for maximizing the production of cones and seeds on all trees on all tree species within the seed orchards. The seed orchards are listed in the INFRA database for the Colville National Forest and include all the trees within the seed orchard, the eight foot tall fence surrounding the trees, all buildings within the orchard, the RAWS weather stations, the roads within the orchards, and a 300 to 600 feet buffer zone surrounding the orchards to be managed as a pollen dilution zone for the tree species in the orchard and as a fire protection zone. The seed orchards and the buffer zones surrounding the orchards are to be managed to protect all trees, structures, fences and gates in the orchards from insects, diseases, wildfire, blowdown, invasive species, noxious weeds, and animals. They are also to be managed to keep all trees within the orchards growing rapidly & in vigorous health to produce cones. Treatments can include but are not limited to: soil fertilization, cone stimulation and fertilization through pollen management, supplemental watering, thinning, pruning, invasive species and noxious weed control, gopher and rodent control, insect and disease control, wildfire suppression, and hazardous tree removal. All management activities would be conducted utilizing current direction for administrative sites in the Forest Plan, Regional direction and guidelines, existing laws and regulations, and safety laws and regulations. The seed orchards would continue to be protected from mining and mineral exploration and extraction by continuing to be withdrawn from these activities through the Bureau of Land Management's Locatable Mineral Entry Withdrawal process. This withdrawal would be renewed every 20 years.