Discussion Paper 9 (DP9): Eastside Forest Management Treatment Alternatives, Objectives and Forest Type/Owner Stratification

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Introduction

Eastern Washington forests are facing extreme pressure from stand replacing fire and insect and disease outbreaks as indicated in the discussion on forest health. The historic management approach over the last 100 years has favored continuous forest cover and 'uneven-aged' management strategies combined with fire suppression. In all but the driest forests, this management strategy has produced multi-layered stands of shade-tolerant species on sites previously dominated by single storied seral species. Fire suppression has homogenized stand structure and species distributions across the landscape as well as increased the overall stocking and biomass levels in the forest. These past practices have exacerbated climate trends by creating conditions suitable for extensive insect and disease epidemics and high fire risk. Against this backdrop of legacies from past management, it is necessary to overlay a complex pattern of land ownership with a wide array of management goals, and challenges in meeting those goals because of the lack of infrastructure for removing excess fuel accumulations and small diameter wood from the forest. A representative stratification of treatments across the landscape must include both a wide variation in forest types, owner objectives, regulatory requirements and operational challenges.

Alternative Management Strategies

For the timber supply analysis we include one management alternative developed to reflect current practices for each owner group (the base case) and a series of management scenarios developed to investigate potential alternative management intensities and forest health treatments dependent upon owner type. The primary management objective for many private forestland owners is sustainable economic returns from harvest activities. Private forest managers periodically remove merchantable trees while retaining those trees, often in the understory, with the potential of growth towards future merchantability. In situations where the understory growth potential becomes inadequate to support the next re-entry, a regeneration harvest using clearcut, shelterwood or seed tree methods along with planting of seral species is initiated. Variation on these treatment options have been customized for each owner type based upon merchantability of the standing inventory and the need for density control to improve forest health. A general threshold for merchantability is met with a standing volume of 6000 BF per acre with some limits on minimum diameter and height (Williamson, 2006). Statutory green tree retention of a minimum of 4 TPA >10" DBH after harvest is required (WAC 222, 2001). Once merchantability criteria are met, threshold assessments test understory and pole sapling layers to determine if they are sufficient for an overstory removal with some culturing of residual understory.

Because of the tight complementarities of economic, social, and biological systems in Eastern Washington, effective alternative strategies must address all criteria simultaneously. Thus treating forests to increase their resilience to insects and disease requires an approach that addresses economic and social criteria as well. The diversity of ownerships and situations suggests that approaches will vary across ownerships. For example, private forest land owners have the option to aggressively salvage affected trees and reduce the rate of insect spread by preferentially harvesting at-risk stands and those with active beetle populations. They also have much greater latitude in determining which trees to take and which to leave. Public land owners have a much more challenging task in addressing the risks and impacts from insects and disease because of the work necessary to perform required impact analysis and to obtain agreement among critical stakeholders. Using different types of alternative strategies for different situations and owner groups result in a wide range of biological solutions that may be economically justified.

Alternative strategies to maximize private landowner's economic goals by increasing management intensity are possible, but the positive effect requires substantial increases in intensity in areas that have not historically been high timber producing regions. Maximizing volume through increased management intensities may not necessarily produce a greater net present value (NPV) as the higher volume and value tends to be generated later in the simulation period and the investment in planting and stand tending occurs early on in the simulation period. While long-term forest productivity, forest health restoration, and community stability in the historically poorer regions of the state could benefit from increased management intensity on private lands, economic criteria suggests that increased investment in forestry for private landowners is not likely without incentives (Oneil, 2005).

Alternative strategies on state lands focus on integrating forest health concerns with habitat objectives. There is potential for increased volume removal as much of the acreage is overstocked relative to its historic carrying capacity and experiencing high mortality, but a spatial analysis of the treatments was not undertaken. According to a presentation to the Forest Health Working Group in August 2004, the DNR's

Southeast Region is poised to take on the dual issues of habitat conservation and forest health using an approach that moves forest condition to a more historic cover type. Simulations of the impact of harvest activities targeted at removing grand fir and Douglas-fir understories from ponderosa pine and dry Douglas-fir forest types characterize the alternate strategy in that region. This approach is estimated to increase available timber volumes from the DNR Southeast Region in the near term, while being responsive to forest health and habitat concerns (Shelton, 2004).

Management alternatives for the National Forests center on managing fire hazard on all dry forests and moist Douglas-fir and grand fir forests, as well as managing insect risk on lodgepole pine forests. Treating all National Forest acres within the first three habitat types roughly corresponds to thinning in low and mixed severity fire regime locations with a concentration on the Wildland Urban Interface (WUI) in the first decades. With the inclusion of treating lodgepole pine types the alternative also manages the escalating impact of mountain pine beetle in lodgepole pine forests. In order to maintain the benefit of thinning treatments with respect to fire safety, additional treatments are required on a 30-40 year return interval. Depending on the growth of regeneration and the overstory, the second and subsequent entries typically do not yield much merchantable volume and thus are categorized as fire safe treatments. These treatments do not contribute merchantable volume toward timber supply, or generate net carbon benefits with respect to the products stream, but will ameliorate fire risk and its resulting carbon release. The alternative regime assumes that continued management to reduce fire and insect risks would occur despite lack of financial incentive after the first treatment. These treatments, while not justified by market values, have been demonstrated to produce many benefits above and beyond their cost including avoided fire fighting costs, reduced acres burned, increased carbon stored, biomass removed and other non-market values. A brief summary of the magnitude of potential avoided costs and non-market values is included in Discussion Paper 10 (DP10-E) on eastside avoidable costs. Single acre simulation examples of the various strategies used in the analysis are outlined in the following section.

Single Acre Simulation Examples of Alternative Strategies to Address Forest Health

Treatment alternatives were simulated on two of the more prevalent forest types: a ponderosa pine type in the Okanogan area and a mixed conifer type in Northeastern Washington. The analysis identified break points between economic return and reducing stand susceptibility to insects, disease, and fire. For each alternative, we report on the likelihood of risk reduction, economic outcomes, and the subsequent level of additional cost or incentive that might be needed to encourage landowners to adopt a specific treatment. Given the array of management goals across the ownerships of Eastern Washington, there is no best single management alternative. Analyzing alternatives provides a useful comparison of trade-offs, costs, and expected outcomes for meeting forest health goals.

In the ponderosa pine forest type, the stand used for analysis was a fully stocked merchantable ponderosa pine stand that is currently experiencing mountain pine beetle (MPB) mortality because of excessive density and basal area relative to site carrying capacity. On this very dry site, the ponderosa pine is regenerating (albeit poorly) under its own shade, which allows for treatment approaches that would not be as successful on wetter sites. Periodic stand entries were simulated using four different treatment regimes: (1) **Max NPV**—maximizes net present value of cash flows through removal of merchantable volume to the limits permitted by state forest practices laws; (2) **Partial Retention**—partial cutting from below to a target basal area; (3) **Overstory Maintenance**—treatments to move the stand toward ‘old growth’ conditions with a few large trees/acre including understory removal; and (4) **No Action**—assuming no disturbance (note that with high fire hazard the stand would likely burn early in the period).

Figure DP9.1 demonstrates the diversity of stand conditions present after the first entry and 40 years forward in the simulation for the three treatment types that have active management undertaken. While the short term results look very similar, in the long term Figure DP9.1 demonstrates the variability across the landscape that might occur with the application of these three treatment types, the most notable being the elimination of understory recruitment in a true overstory maintenance treatment. Both Max NPV and Partial Retention emphasize initial overstory retention to facilitate regeneration and result in very similar residual stand conditions depending on leave tree characteristics. Both treatment regimes can immediately move stands away from high hazard thresholds for fire, insects, and disease, regardless of differences in the long-term management goal. These two alternatives would likely be acceptable choices for an array of private landowners that might have various degrees of interest in maintaining large diameter trees for their long-term habitat attributes.

Table DP9.1 gives the range of basal area, density, hazard ratings for fire and MPB, and economic values over a 90-year simulation period for all simulations including the No Action alternative. For the Max NPV and Partial Retention Scenario the residual basal area (BA) after treatment is capped at 60 while overstory maintenance continues to increase over time even as the understory is removed to keep the fire risk down. Tree density values assume regeneration in managed scenarios, but assume negligible regeneration in the No Action scenario because the overstory does and would continue to eliminate the potential for natural regeneration in the absence of mortality from bark beetles or fire. The bark beetle risk increases when BA exceeds carrying capacity, as it does in the Overstory Maintenance scenario in latter years and the No Action alternative throughout the simulation. Crowning index is the predicted wind speed at which a ground fire would move into the crown resulting in tree mortality (>50mph low risk, 25 to 50mph moderate risk, <25mph high risk). Thus low crowning indices indicate that low wind speeds are all that is required to cause tree mortality and the risk of crown fire becomes higher. All treatments reduce the risk of crown fires, but even without treatment the lack of viable understory and high live crowns in this particular stand preclude high fire risk under normal fire conditions in the No Action scenario. Only in cases of running crown fire would the high crown density in the No Action alternative produce significant changes in fire risk relative to the managed scenarios assuming that canopy base height is low enough to initiate a crown fire (Graham et al, 1999).

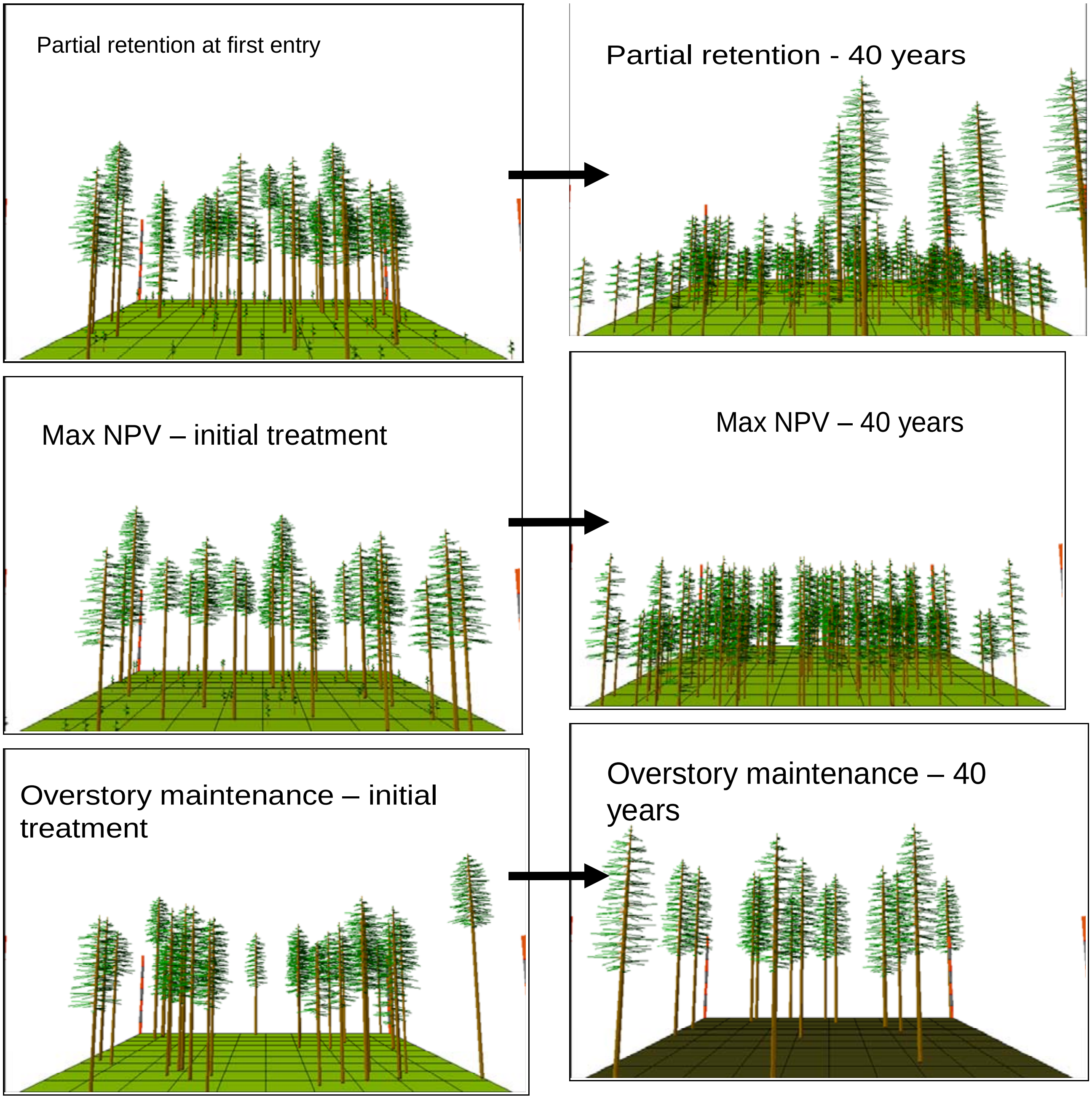


Figure DP9.1: Three management options for dry forests showing initial stand conditions and 40 years forward in the simulation

Table DP9.1: Forest Health risks and economic returns for dry forests under four treatment scenarios

Ponderosa Pine Scenarios	Max NPV	Partial Retention	Overstory Maintenance	No Action
BA range (across decades)	9 to 53	20 to 60	60 to 78	111 to 183
BA ave. (sq.ft.)	32	28	68	161
Crowning index range (across decades)	40 to 106	41 to 88	60 to 134	41 to 63
Crowning index average (mph)	63	61	98	48
TPA range (across decades)	25 to 475	83 to 335	15 to 281	61 to 147
TPA ave.	164	157	96	105
NPV $@5%	$3,586	$2,652	$1,109	(-)
Cash Flow (decades entered)	5 times	5 times	2 times	none
Beetle risk	Low	Low	Marginal	High
Fire risk	Low	Low	Very low	Moderate
Sustainable econ	Yes	Yes	No	No

Table DP9.1 indicates that the discounted financial returns per acre for the three treatments in ponderosa pine are positive, primarily because the stand has a significant merchantable component. Reduced returns from the Partial Retention treatments are a result of retaining some large diameter overstory trees that would otherwise have been removed in the Max NPV alternative. In contrast to the first two alternatives, Overstory Maintenance treatments are designed to produce a widely spaced dominant pine overstory. Reduced returns from these treatments are a function of lost revenue beyond the second entry coupled with continuing financial obligations for understory removal, either mechanically or by burning, to ensure that the stand does not become overstocked and multi-layered and thus susceptible to MPB attack and increasing fire risk. The overstory maintenance approach is not considered viable for private landowners, but may meet the non-market goals of public and Tribal landowners.

The mixed conifer stand case study examines the potential treatment outcomes from a commonly occurring situation where a stand has been repeatedly harvested over the past century using selective overstory removal techniques. In the case study, the stand is composed of grand fir, western red cedar and Douglas-fir that are growing slowly on a dry Douglas fir habitat type that does not support rapid growth of these species. The stand is currently not merchantable, but within 30-40 years, a large component of the intermediate cohort would become merchantable.

Periodic stand entries were simulated using four different treatment regimes: (1) **Max NPV**—removal of merchantable volume at regular cutting cycles; (2) **OS with Retention**—overstory conversion to a seral species mix with retention of dominant Douglas fir to provide structural diversity; (3) **OS without Retention**—no retention of dominants (required wildlife trees in adjacent riparian zones are retained); and (4) **No Action**—assumes no disturbances. Figure DP9.2 demonstrates the diversity of stand conditions present after the first entry for the three treatment scenarios with active management. While the 'No Action' alternative assumes no stand altering disturbance for the rest of the period, the risk of loss from root rot, budworm and fire are all high suggesting that stand conditions will likely be altered by a disturbance.

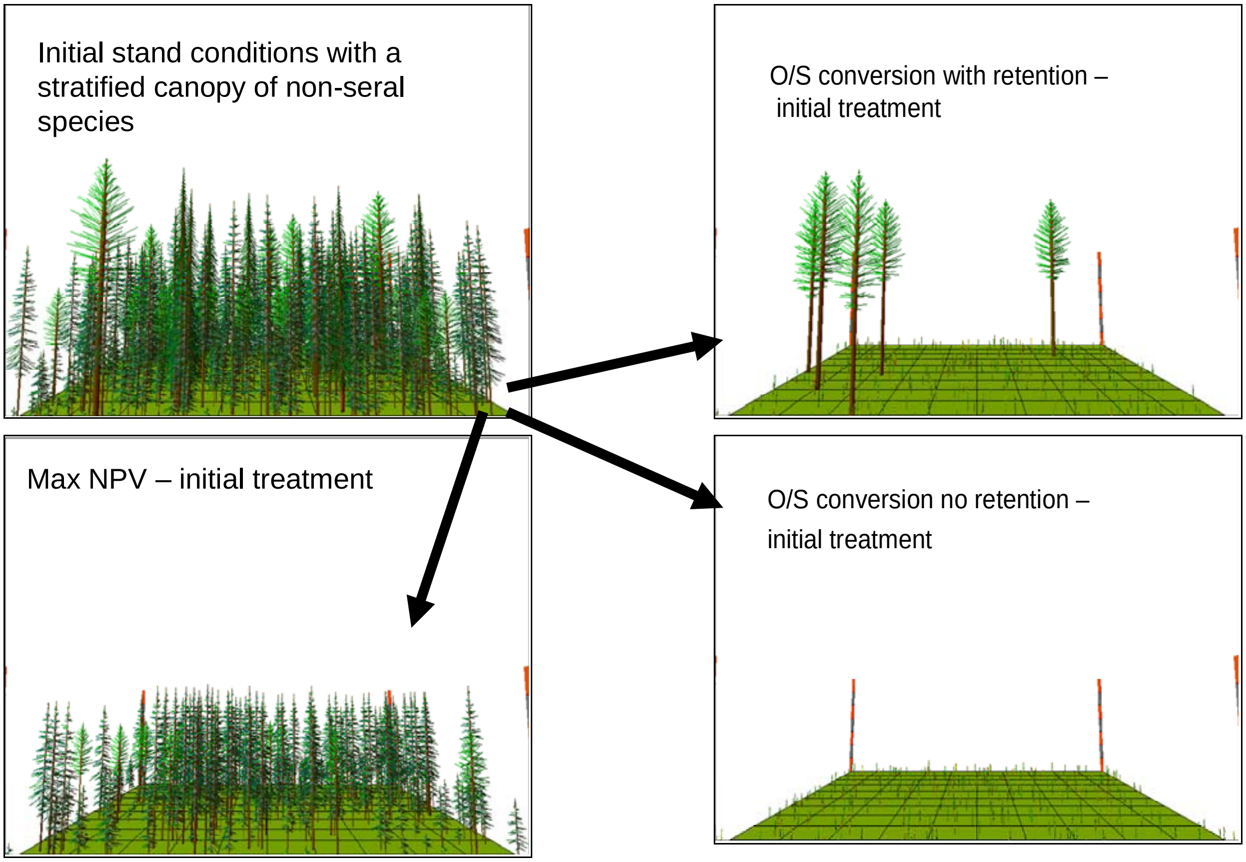


Figure DP9.2: Three management options for moist forests showing treatment outcomes

Table DP9.2 gives the stand metrics, hazard ratings for fire, insects and disease, and economic values over a 90-year simulation period for all the treatment options. This simulation demonstrates that the timing of treatments to address forest health is critical. In this case the simulation indicates that the investment required for overstory conversion to forests with reduced fire and root rot risk must be amortized over a minimum of 40 years prior to any returns. A status quo treatment regime of continuing overstory removal maximizes economic gain while doing little to alleviate risks associated with fire, insects, and disease.

While return per acre in the species conversion scenarios continues to improve through the simulation period, discounting at 5% negates the gains in later years as compared to the Max NPV case. Thus the economic trade-offs may dissuade conversion to species and stand structures that can avert forest health problems unless small diameter timber becomes more valuable, resulting in earlier merchantability of the current inventory. However, the incentive required to motivate overstory conversion is not great in cases where forest health risks are of utmost importance.

Simulation results reported in Table DP9.2 suggest that retaining even a few large trees into the next forest stand in the 'with Retention' case impacts both immediate timber value and subsequent growth of understory trees resulting in a 44% loss in economic return over the 90 year period relative to the 'without Retention' case. This loss in value is consistent with the fact that the few large diameter trees in the stand would be left at the first entry which is an immediate loss of revenue, coupled with the fact that overstory trees substantially reduce the growth and yield of subsequent seral regeneration in the simulation.

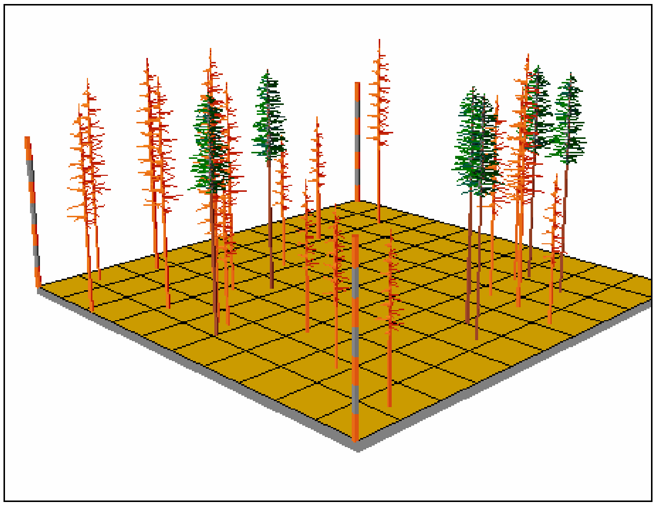
Table DP9.2: Forest Health risks and economic returns for mixed conifer forests under four treatment scenarios

Mixed Conifer Scenarios	Max NPV	OS convert with Retention	OS convert without Retention	No Action
BA range (across decades)	2 to 39	15 to 53	0 to 48	111 to 257
BA ave. (sq.ft.)	23	37	29	264
Crowning index range (across decades)	18 to 125	38 to 160	0 to 110	10 to 18
Crowning index average (mph)	54	76	51	13
TPA range (across decades)	72 to 515	5 to 400	0 to 388	137 to 52[illegible]
TPA ave.	250	197	198	315
NPV $@5%	$2,814	$1,213	$2,164	(-)
Cash Flow (decades entered)	5 times	4 times	4 times	none
Root rot risk	Marginal	Better	OK	High
Budworm risk	3 bad decades	OK	OK	High
Fire risk	Low	Very low (just)	Low (just)	High
Sustainable cash flow	Yes	Yes	Yes	No

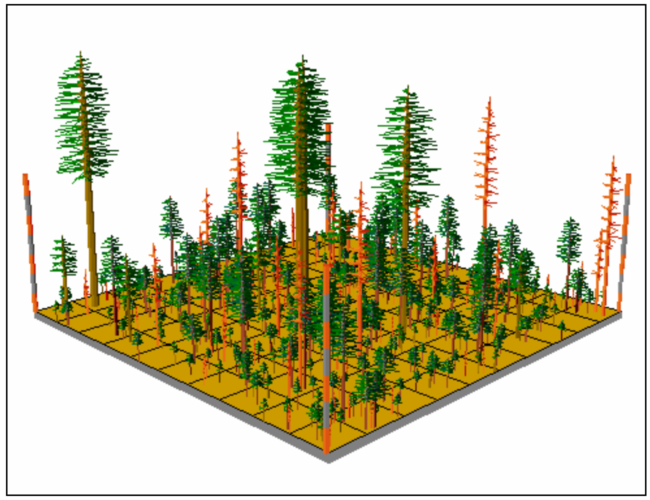
Reducing forest health risks is accomplished in all three mixed conifer scenarios where active management is pursued. Delaying the transition from a multi-layered stand to an even aged stand composed of seral species is responsible for the reduced forest health benefits of the Max NPV case with respect to root rot and budworm risk. Fire risk varies substantially through time as managed stands transition from regeneration through sapling, pole, and mature phases, whereas it remains high throughout the simulation for the No Action scenario. Table DP9.2 indicates that all stands have periods when they are at high risk of crown fire, but that the managed stands do not stay in the high risk category as indicated by the average crowning index over the 100 year simulation period. Likewise, all stands have periods of higher and lower density and basal area as indicated by the ranges and average values given in Table DP9.2. The simulation did not invoke reduced growth and mortality from root rot or initiate a fire under any scenario, thus the No Action alternative does not reflect the impacts or probabilities associated with maintaining a stand in a high risk condition for an extended period of time.

Developing Treatment Scenarios from Management Alternatives

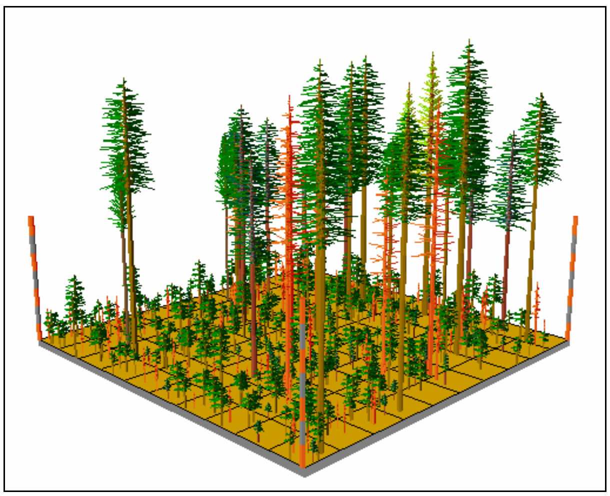
The single acre examples provide a framework for developing scenarios, but the outcomes from any particular treatment are driven by stand history and current inventory regardless of treatment applied. The interaction of regeneration potential, dominant tree species, habitat type, stand history, and treatment produces significant variability in outcomes. Figure DP9.3 provides two examples where an identical treatment sequence was applied to two different inventory plots from the FIA data. In both cases, the residual forest condition is substantially different under the same treatment which illustrates the difficulty in stratifying eastside forests by treatment regime alone. To address the variability in eastside systems an overarching stratification framework was developed. This stratification framework integrates ecological parameters that drive forest growth and fire risk with ownership pattern. By stratifying on both ecological and ownership parameters simultaneously, much, but not all, of variance in the application of treatments is reduced which generates some stability in results emerging from any particular management alternative.



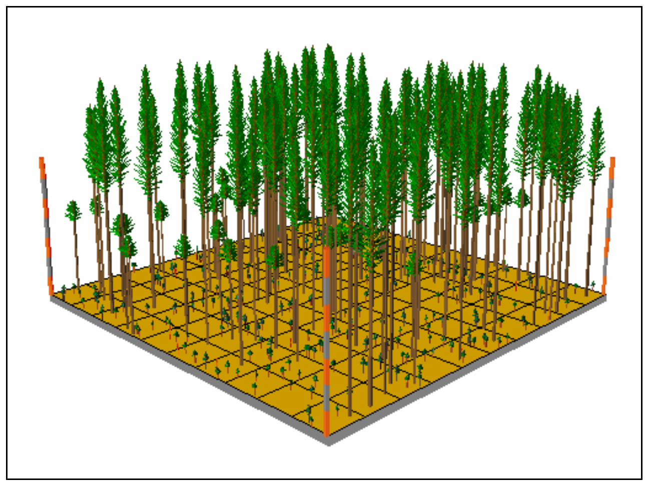
10-35 thin to 5 from above by dbh



10-35 thin to 5 from above by dbh



12-40 thin to 25 proportionally by dbh



12-40 thin to 25 proportionally by dbh

Figure DP9.3: Identical treatments produce different outcomes as a function of starting inventory

Stratification

Stratifying the complexity and diversity of the Eastside into a relatively small number of uniform groups and treatment regimes as part of the timber supply analysis requires a number of simplifying assumptions and approaches. An overarching assumption relies on grouping forests according to an elevation gradient and moisture regime that captures many of their productivity and species composition differences. Initial constraints are also driven by calibration of growth models for the region. There are three regional variants of the Forest Vegetation Simulator (FVS) growth and yield model covering the Intermountain Region: the North Idaho (NI) variant representing northeastern Washington, the East Cascades (EC) variant representing harvest estimates along the east cascades of Washington and the Blue Mountains (BM) variant representing forests in southeastern Washington. Growth and yield in forests in areas covered by these variants were simulated using a range of treatments. Harvest volume targets were averaged across the three variants to generate a weighted average for each owner category. The estimates of forest yield, economic activity, standing inventory, residual stand characteristics, carbon impact, and fire risk were weighted to reflect the amount of forest cover, ownership patterns, treatment regime, and anticipated harvest rates in these geographic regions.

Stratification of forest types, ownerships and management intensities: Initial stratification grouped forest inventory plots according to an elevation gradient and moisture regime that captures many of the productivity and species composition differences in these forests. These groupings are commonly used for wide scale fire risk assessments as well as uniform treatment regime assessments. The groupings also capture a great deal of the variability in ownership pattern and the resulting management intensities on these ownerships. These broad groupings are identified as **dry forests**, including ponderosa pine, dry Douglas-fir and dry grand fir habitat types, **moist forests**, with most of the mixed conifer forest types including moist Douglas-fir, grand fir, and cedar-hemlock habitat types, at mid elevations, and **cold forests**, which include subalpine fir, spruce, larch, and lodgepole pine forests at high elevations. The high elevation forests are predominantly under federal wilderness or national forest designation. The stratification scheme is illustrated in Figure DP9.4. The percentage of the land base in each ownership and forest type bin varies regionally and by FVS variant. The estimated acreage available by owner group, forest group, leading species, and the percentage of productive timber lands is given in Table DP9.3. The interaction of regeneration potential, dominant tree species, habitat type, stand history, and treatment produces the kinds of variability in outcome displayed in Figure DP9.3.

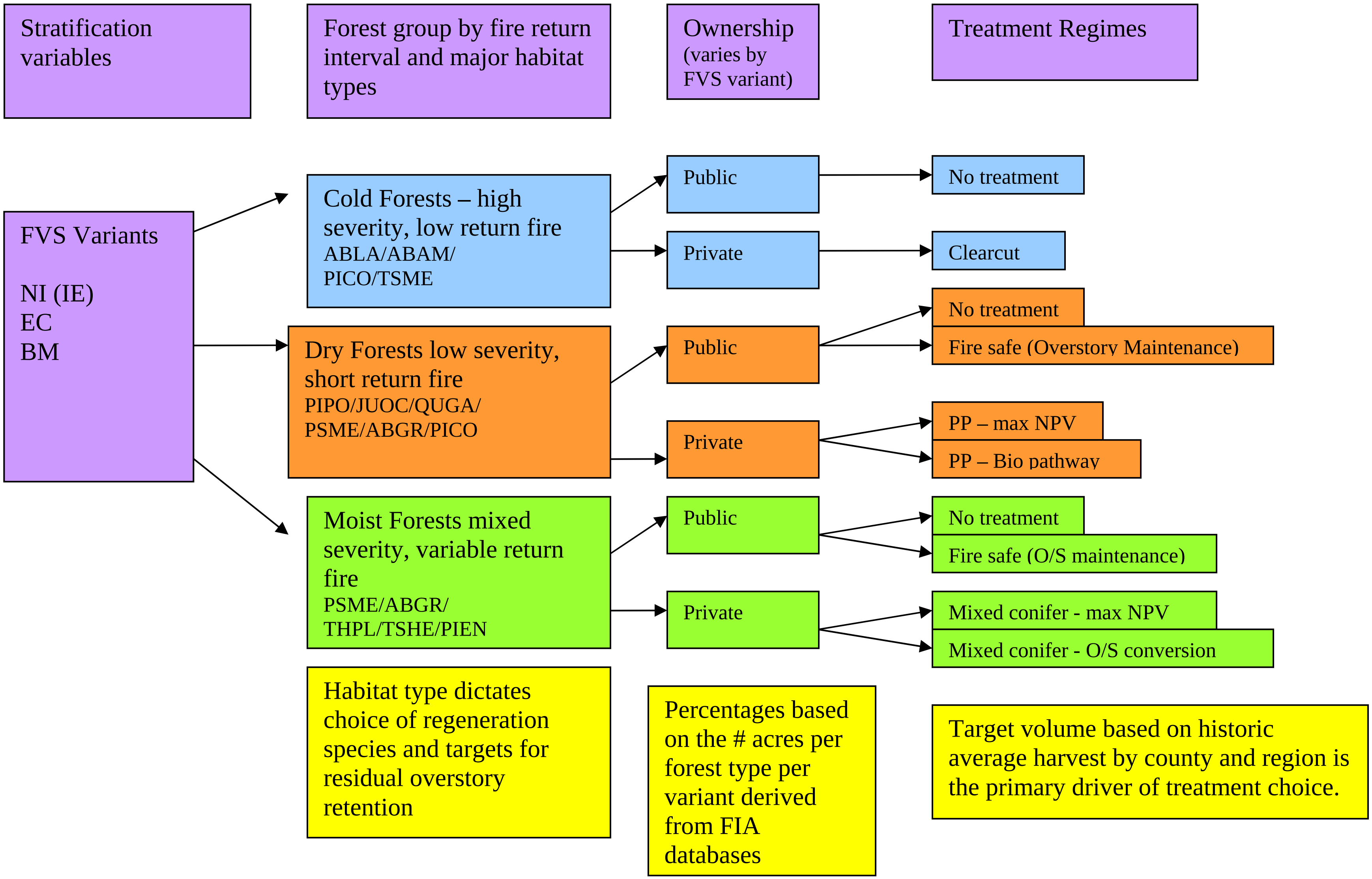


Figure DP9.4: Stratification variables for eastern Washington

Table DP9.3: Forest types, owner groups, and plant association groups

Treatment type	Dry		Moist		Cold	
Plant Association Group by owner type	**Acres**	**% of productive timberlands**	**Acres**	**% of productive timberlands**	**Acres**	**% of productive timberlands**
Private						
Noble Fir					19,165	0.3
Hemlock					49,982	0.7
Lodgepole pine					37,580	0.5
Douglas-fir	492,096	7.0	899,125	12.7		
Ponderosa pine	798,155	11.3				
Grand fir	341,047	4.8	466,935	6.6		
Englemann Spruce			57,121	0.8		
Total Private	1,631,298	23.1	1,423,181	20.1	106,728	1.5
State						
Noble Fir					12,224	0.2
Hemlock					12,315	0.2
Douglas-fir	239,139	3.4				
Ponderosa pine	122,557	1.7				
Englemann Spruce			48,895	0.7		
Grand fir			195,991	2.8		
Total State	361,695	5.1	244,886	3.5	24,539	0.3
National Forest						
Noble Fir					125,837	1.8
Englemann Spruce			227,091	3.2	444,045	6.3
Hemlock					233,655	3.3
Mountain Hemlock					117,158	1.7
Ponderosa pine	33,193	0.5				
Douglas-fir	628,166	8.9	642,265	9.1		
Grand fir			615,637	8.7		
Western red cedar			210,487	3.0		
Total National Forest	661,359	9.4	1,695,480	24.0	920,695	13.0
Grand Total	2,654,353	37.5	3,363,547	47.6	1,051,962	14.9

Each of the broad stratification categories includes two or more treatment regimes for both public and private owner groups. Low intensity treatment regimes, such as a Bio-pathway in ponderosa pine (Figure DP9.4) to maintain an overstory component, might be used by small private owners or government entities that are focused on establishing habitat conditions or addressing forest health issues. Moderate intensity treatment regimes, such as the MaxNPV or OS conversion (Figure DP9.4), cover the dominant harvest and thinning regimes for private industrial and some non-industrial owners whose emphasis is on timber revenue maximization. The treatment options by owner category are presented in detail at the end of the stratification summary. The stratification scheme identifies the range of treatments that occur by owner type and forest type.

The analysis includes two general cases, one reflecting current management conditions, called the base case, and the other reflecting an increase in management intensity in areas where increased intensity could be supported. For the base case the number of acres treated per year and shifts in the level of management intensity toward higher volume removal were driven by overarching yield targets that were based on historic average harvests by region. For the alternate case, treatment regimes were varied by owner group to reflect a range of potential actions that were designed to meet specific fire risk reduction or habitat restoration goals. Under the alternate case there were an increased number of acres treated and more acres treated at a higher management intensity as well as an increased number of federal acres treated to reduce fire risk and insect and disease outbreaks. The alternate treatments influence estimates of available timber, economic returns to the state, and habitat, as well as estimates of carbon sequestration potential and fire risk.

Data attributes: Data from FIA plots covering Eastern Washington National Forests, private, state, and tribal lands were used to represent the stands in the region. The data was limited to conifer dominated plots on unreserved lands that have a capability of growing more than 20 ft^2/acre/year as this productivity rate is typically used in FIA summaries to designate the split between productive and non-productive forest types. Elimination of plots that supported non-commercial species cover further reduced the sample used in the analysis. Two analyses were conducted with the FIA data, one that simulated data aggregated by habitat type for all owner groups and a second that simulated all FIA plots in select private ownership categories. The detailed analysis of private ownerships was used to identify core issues related to commercially available timber supply and regional infrastructure declines. The relative stability of DNR and USFS harvests in the face of substantial policy and market changes meant that timber supply could be estimated from historic trends with predictions for future growth without detailed analysis.

In the first analysis data from the FIA plots were stratified by habitat type for each owner group. Because simulated growth rates in the FVS variants are highly sensitive to habitat type, median stands by habitat type were chosen to reflect average forest conditions for the dominant habitat types for each owner group. Dominant habitat types were those that covered more than 5% of the land base in each region and owner group. The segregation by habitat type gave a total of 57 “stands” that were modeled in 30 unique habitat type/ownership bins across the 3 variants.

Statistical analysis of the stands found on each habitat type/ownership bin produced a very high variance in basal area, quadratic mean diameter, SDI, and trees/acre. As an example, Figure DP9.5 provides a plot of the QMD distribution for the habitat groups in the East Cascades variant on public lands.

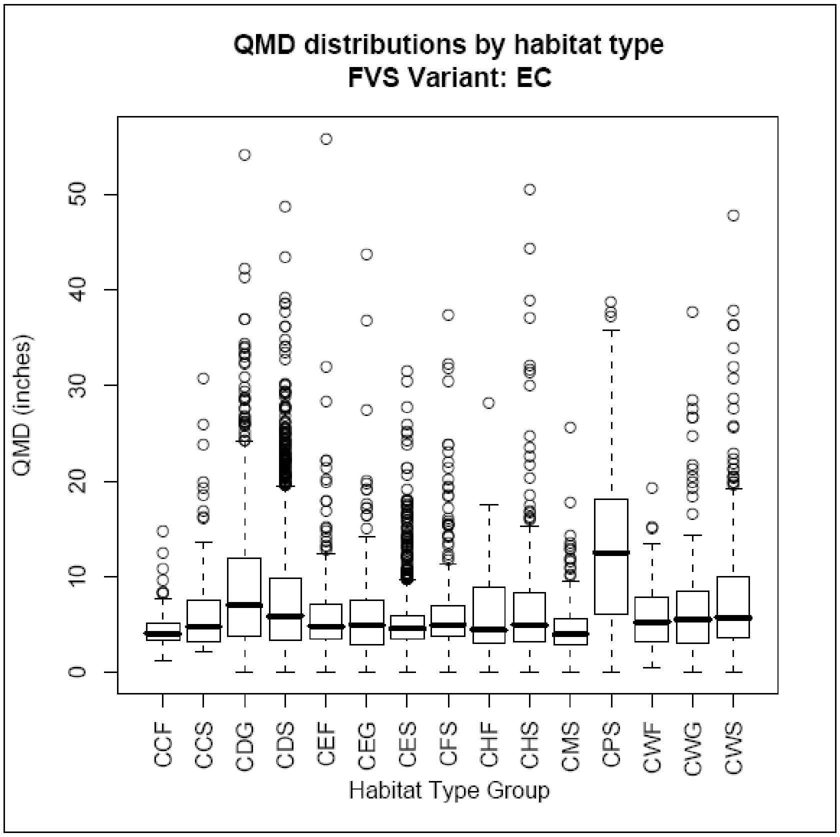


Figure DP9.5: Size distributions by habitat type

In order to adequately represent landscape variability while accommodating known model limitations, a representative "stand" was chosen that was closest to the median value in basal area (BA), trees/acre (TPA) and quadratic mean diameter (QMD) for each habitat type. Those median values were calculated on a subplot basis as is shown in the example in Figure DP9.6 for the CDS (see plant association codes in appendix for a listing of the various codes used throughout this paper) habitat type group in the East Cascades variant. In this example the median trees/acre and QMD values were 400 and 5.9" respectively whereas the average trees/acre and QMD values of all collated plots were 601 and 4.9" respectively. While these differences are not dramatic, they do represent potential sources of error in the growth simulation process. Minimizing that error through adopting a consistent statistical approach that most closely represents the most commonly occurring stand conditions for a given habitat type was deemed integral for quality control.

A cursory examination of Figure DP9.6 suggests that stands are following a classic self-thinning and differentiation trajectory with older stands having larger QMD and smaller TPA values. Further statistical analysis failed to confirm that either QMD increases with age or TPA declines with age. Figure DP9.7 is an example of TPA - AGE relationships for all plots on National Forest lands in Eastern Washington which demonstrates the lack of these anticipated age related trends.

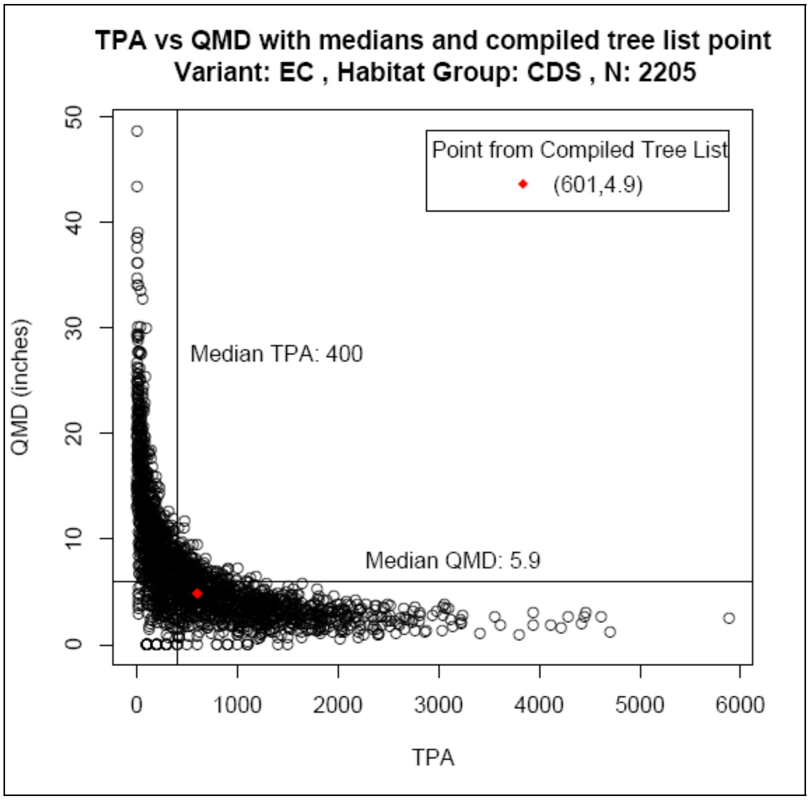


Figure DP9.6: TPA vs QMD in an East Cascades Douglas-fir habitat type

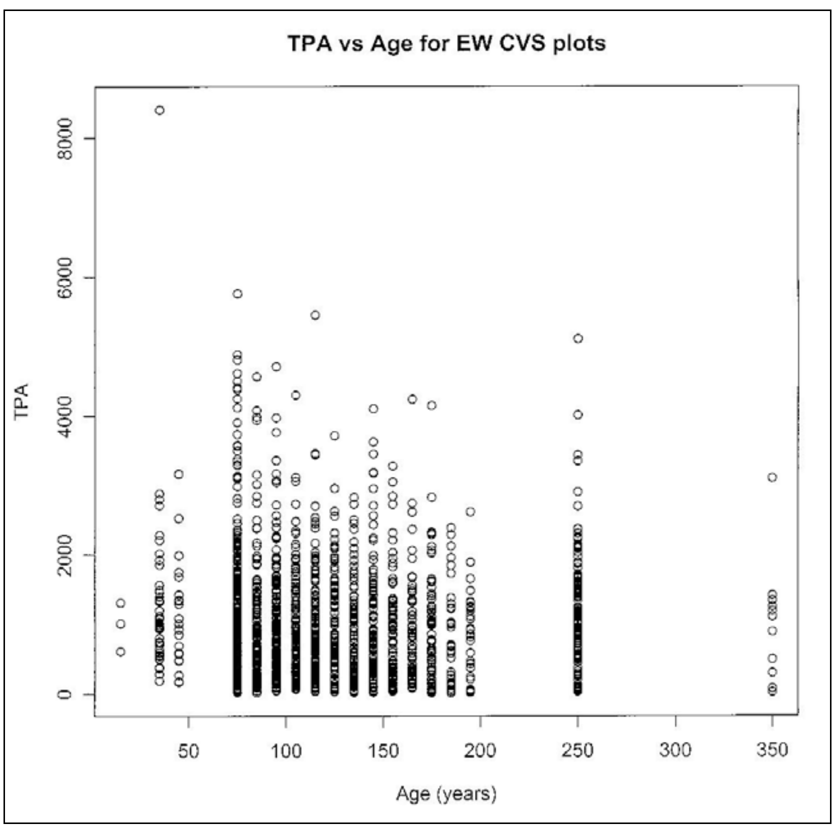
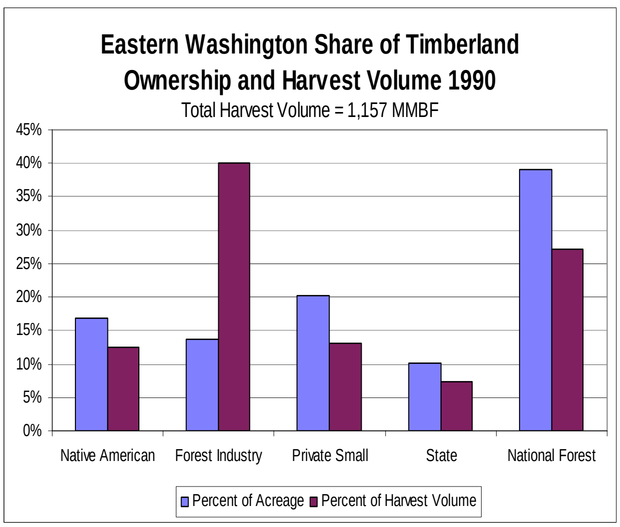


Figure DP9.7: TPA vs Age for Federal Forests in Eastern Washington

Graphical analysis of FIA inventory plots highlighted the high variability in stand attributes, structure, age, and habitat type in eastern Washington. Categorizing this variability into representative stands using habitat type as the selection criterion helped to reduce the variability in stand response to treatment regimes, but did not eliminate it. Treatment scenarios that represent likely management activities were tailored to individual plots to generate yield estimates.

Summary of full plot analysis: To explore correlations between known infrastructure declines and available timber volume, a second analysis was conducted using only those FIA plots for the private and tribal forests. Tribal analysis was further informed by the generous provision of forests plans and inventory data from the Confederated Tribes of the Colville Reservation, the Spokane Tribe, and the Yakama Nation. These ownerships were chosen for several reasons. First, they account for more than 80% of the harvest volume in Eastern Washington. Second, the historical trends suggest that Washington State Department of Natural Resources (DNR) harvest levels have consistently accounted for a small but stable percentage of total harvest (about 7%) that does not appear to vary significantly in response to market conditions or regulatory changes suggesting that potentially available timber is not the dominant predictor of timber supply that may be available on this ownership. Third, significant declines in harvest volume on federal lands and the uncertainty of future management forecasts prompted an assumption that potential contribution of federal timber to regional supply would remain constant at current low levels.



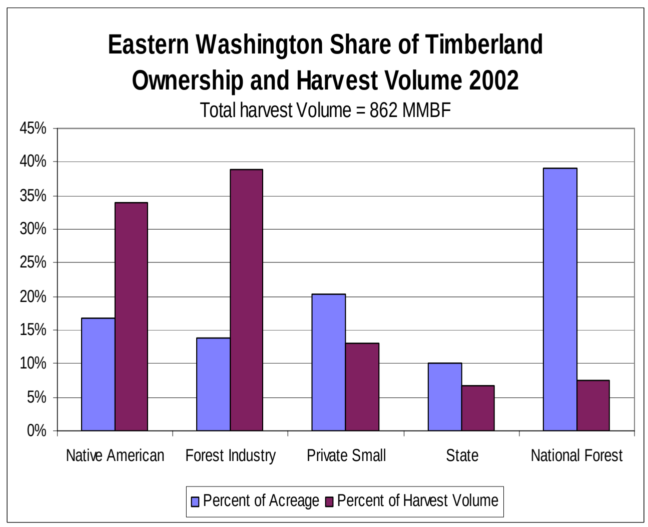


Figure DP9.8: Ownership and Harvest share change from 1990 to 2002.

Table DP9.4: Harvest Volumes for Eastern Washington by Ownership Type 1990 and 2002.

Year	**Ownership Type –** *Volumes in Million Board Feet*					
	Native American	**Forest Industry**	**Private Small**	**State**	**National Forest**	**Total**
1990	144.7	462.7	152.5	84.2	313.3	1,157.4
2002	292.3	334.6	112.8	58.7	64.0	862.4

For the full plot analysis private and tribal Eastern Washington forests were stratified by forest as follows: The East Cascades counties were aggregated into 4 distinct units reflecting their proximity to the National Forests of the FVS EC variant. The forests are the Gifford Pinchot (GP), Okanogan (OKA), Tonasket (TON) and Wenatchee (WEN). The Tonasket is Ferry County for the purposes of this analysis. As growth parameters vary somewhat by forest, the initial stratification was intended to control for that variable. The southeast counties are grouped into the FVS BM variant and the NE counties (Spokane, Stevens, Pend Oreille) were grouped in the FVS NI variant. Acreage per plot was determined using the 1991 FIA data, with each plot representing 'x' acres (varies by plot). Plots were stratified by owner group (industrial and other private) and by county. The acres represented by each plot were summed for each of the units according to the county proximity to the National Forests. The total acreage for each region is given in Table DP9.5. The acreage accounts for FIA estimates of coniferous leading forests that produce more than 20 bf/acre/year within the other private and industrial ownership categories (1991 data) for the counties within each region and NF unit.

Table DP9.5: Private acreage by region used for full plot analysis

private and tribal forests acres by region		
Region	NF code	private acres*
Yakima	603	616,585
Okanogan	608	401,165
Tonasket	699	518,782
Wenatchee	617	305,931
Southeast	614	146,329
Northeast	621	1,201,555

Defining the Base Case

For the aggregated assessment, stands were allocated an area value based on the percentage of that cover type in that ownership in each variant. Thus for all variants, the total area in each simulation equals 100 or 100% of the land base in commercially operable forest. Stand areas ranged from 0.3 to 30.6 acres or 0.3% to 30.6% of that total. The largest percentage of land is in the Douglas-fir dominated forest types held in private ownership across all variants, with Douglas-fir, and white or grand fir dominated lands on National Forests ranking 2nd and 3rd in percentage cover. The representative stands associated with large acreage values were partitioned into smaller units in order to approximate even flow harvest and allocation between the management intensities. For the full plot assessment, acreage associated with each plot was taken from the FIA database.

Estimates of base case even flow harvest rates were taken from the Washington State Department of Natural Resources timber harvest summary statistics (DNR, 2007). This publication provided the average harvest rate over the past 30 years by ownership and county which permits calculation of harvest rates by FVS variant and ownership bins. These average harvest rates were then allocated among the habitat type/ownership bins based on the percentage of land area occupied by each bin. This allocation scheme assumes that across all ownerships they are 'harvesting the profile' of habitat types. Treatment intensity (low and medium) were allocated based on the percentage of harvest by owner group in the 1999 harvest year with state, forest industry and large private ownerships grouped as medium intensity and small private and tribal lands grouped under low intensity management regimes. National Forest harvests were treated in an entirely separate category that did not use 30 year average harvest rates because of declining harvests off this land ownership. Calculating the averages by ownership and variant gives the values and allocations in Table DP9.6. Private forests comprise the aggregate of industrial, small owner, and tribal ownerships.

Table DP9.6: Target harvest volume by region and owner group for eastside forests.

30 year average harvest rate with *NF at (1994-2003 rate)						
Owner group	Private		State		National Forest*	
FVS Variant	Average MBF/yr	Percent by Variant	Average MBF/yr	Percent by Variant	Average MBF/yr	Percent by Variant
North Idaho/Inland Empire variant	299,887	44.0%	26,927	22.4%	43,254	55.5%
East Cascades variant	365,317	53.6%	53,217	73.1%	27,511	35.3%
Blue Mountains variant	16,357	2.4%	1,363	4.5%	7,170	9.2%
Totals	681,562	100.0%	81,507	100.0%	71,326	100.0%

Cross validating these harvest volumes with median stand volumes and areas by stand type illustrates some issues that had to be addressed in the management scenarios. For example, the 763 MMBF/yr harvested under state and private ownerships is coming from an unadjusted acreage of 3,792,328 giving a harvest rate of 200 BF/acre/year. Adjusting the acreage downward to account for non-productive forests and reserved areas determines that the commercially available land base is approximately 3,429,460 acres. Applying the target harvest rate to the growing cycle period of the simulation model gives a harvest rate of 2.22 MBF/acre/decade. Not all stands were capable of producing 2MBF/acre at the first decade and the proposed harvest regimes typically produced much higher MBF/acre values, after which a second entry was not slated for 20-40 years. An iterative process of allocating harvests between habitat types and ownerships to minimize the differentials between even flow harvest volume estimates while meeting general management scenario outcomes ensued. Alternative strategies involved reallocating acres between management intensities while maintaining treatment regimes as they were initially developed.

For the National Forests, the harvest rate of 71,326 MBF/yr over 3,277,533 acres gives a harvest rate of 20 BF/acre/yr or 200 BF/acre/decade or 1/10th the harvest rate of state and private forests. The harvest was allocated over a subset of plots that represent stands in the dry and moist forests which might be treated under current policy directives. The total available acreage on National Forests was estimated at 1,915,919 acres for an estimated 26 BF/acre/yr or 260 BF/acre/decade which is approximately equal to the gross growth/acre on National Forest lands (FIA 2006).

In both analyses, treatment scenarios were developed that met criteria for total volume removed per stand and across the region, residual and harvested tree characteristics, and allocation of volume removal by owner group and habitat type.

For the base case, the scenarios met these specific conditions:

- Harvest volumes per decade were allocated to owner groups based on historic harvest rates.
- Treatment regimes varied by owner group to reflect probably harvest patterns and entries
- Harvest rates were allocated across all habitat types (analysis 1) and plots (analysis 2) according to the percentage of the harvestable land base they occupy.
- Riparian zones were treated as reserves and netted from the total acreage as a percentage per county weighted by habitat type.

Treatment thresholds: Treatments were applied consistently across habitat types but the timing of entry was not consistent in order to account for differential growth rates and ensure that merchantable volume was available at the time of harvest re-entry. The timing of treatments considered minimum values for top height, volume and the number of trees > 10”dbh. The decision tree for harvest entry used treatment threshold tests measured the number of trees >60 feet tall and > 10” dbh and the total standing volume. Higher volume stands were entered first. For each entry, sufficient overstory to meet statutory green tree retention targets was maintained by ensuring that a minimum of 4 TPA >10" DBH were retained at every entry.

Harvest of large diameter trees was the default approach for moderate intensity treatment regimes. The harvest volume removed and remaining varied as a function of starting inventory. The stand structure that remained post-harvest dictated treatment options on the pole/sapling and understory. The residual stand was evaluated for species mix relative to site potential and habitat type, stocking levels, Height: DBH ratios and release potential. If the growth potential for the residual stand was poor, it was removed and a regeneration treatment was applied.

Regeneration: Eastside forestry field personnel indicate that they rely on some natural regeneration from overstory trees, but also fill plant with seral species in the range of 250-350 TPA. Their seral species mix almost always contains ponderosa pine and often contains larch, white pine, and sometimes Douglas-fir. As well as fill planting with these species, simulations add a 'natural regeneration' component to the stand depending on the level and intensity of treatments applied. This natural regeneration component varies by habitat type and reflects the overstory component of the stand. The assumptions made about regeneration rates, species composition, and logging damage to residual understory are based on average understory values found in the current FIA inventory.

Summary of Stratification by owner and forest type: Specific assumptions associated with the treatment regimes by ownership classes within the three forest types in the stratification scheme are highlighted below.

Large Private and Industrial Treatment Regime

Dry Forests: The treatment regime is a shelterwood thin from below to re-establish the next crop retaining 25-40 TPA first entry, but with no required retention of the dominant cohort except for statutory requirements for green tree retention.

Moist Forests: The treatment regime is a periodic entry to remove merchantable volume, with only minimal stand improvements and promotion of non-seral understory. Alternative strategies in moist forests also depend on regular stand entries with aggressive focus on re-establishment and stand improvement with more fill planting and stand tending.

High Elevation Forests and Wet forests (includes LPP): The treatment regime is a No Retention even-aged strategy that leaves a minimum of 4 TPA>10"DBH following regeneration harvest to meet statutory requirements for green tree retention.

Tribal Treatment Regime

Dry Forests: The treatment regime is an uneven-aged individual tree and group selection favoring retention of Ponderosa pine and western larch. Post harvest basal area targets range from 40-80 square feet per acre depending upon stand conditions with insect and mistletoe damaged trees prioritized for removal.

Moist Forests**:** The treatment regime is a periodic entry to remove merchantable volume, favoring retention and under-planting of Ponderosa pine and western larch. Post harvest basal area targets range from 60-100 square feet per acre depending upon stand conditions with insect and mistletoe damaged trees prioritized for removal.

High Elevation Forests and Wet forests (includes LPP): The treatment regime is a No Retention even-aged strategy that leaves a minimum of 4 -12 TPA>10"DBH following regeneration harvest for green tree retention.

Small Private Treatment Regime

Dry Forests: The treatment regime is a shelterwood thin from below to re-establish the next crop, with some retention of the dominant cohort for non-timber values.

Moist Forests: The treatment regime is a periodic entry to remove merchantable volume, with only minimal stand improvements and promotion of non-seral understory.

High Elevation Forests and Wet forests: The treatment regime is a No Retention even-aged strategy that leaves a minimum of 4 TPA>10"DBH following regeneration harvest to meet statutory requirements for green tree retention.

State Lands Treatment Regime

Harvests on state forests assume similar treatment regimes as those for private forests with the following exceptions. In retaining dominant and co-dominant leave trees as part of a statutory requirement, a seed tree system, or as a shelterwood, the largest trees in the stand are retained rather than leaving the smaller trees of the required size class. Additionally, more trees are left in dominant and co-dominant size classes for a given treatment regime.

National Forests Treatment Regime

National forests alternate case management intensity applies restoration strategies to reduce fire and insect risk. These national forest harvest strategies are applied to plots located in dry and moist forests that roughly correspond to areas within the Wildland Urban Interface (WUI). Treatment regimes for National Forests assume that thinning from below is standard with trees removed up to a diameter limit of 12" dbh. After that limit is reached, on pine stands at risk for mountain pine beetle outbreak, a further removal to a basal area of 60 square feet/acre is also applied. No planting is assumed, but natural regeneration is included in the simulations with species compositions based on forest type, overstory species composition, and habitat type. The base case is taken as a percentage of the alternate where the volume removed is equivalent to a target volume based on current (1994-2003) harvest trends as indicated in Table 5. For the base case, the volume removed is not increased over recent experience to be consistent with budget constraints, regardless of the number of potentially treatable sites that are available on national forest land.

Alternate Case – Public Lands: For National Forests, the alternate case maintained the same treatment regimes, but increased the number of acres that were treated per year. For state forests, there were three different approaches taken because of limitations identified in the base case analysis. For stands grown in the FVS BM variant simulations, there was no opportunity to increase management intensity because of lack of yield potential. In the FVS EC variant simulations, the same treatment regimes were maintained but increased the number of acres were treated. In the FVS NI variant simulations, both an increase in management intensity and an increase in the number of acres treated were identified as possible options under the alternate case.

Alternate Case – Private Lands: For the state and private timbershed level assessment, simulations suggested that there was little opportunity to increase management intensity and that a fall down was imminent in both timbershed 6 (East Cascades) and 7 (Inland Empire). The more detailed regional analyses of private lands identified two regions where increases in management intensity were not possible because of the combination of changes in commercially available acres and liquidation of mature forests in the 1990's in response to changes in market opportunities.

Increases in standing volume in four of the six regions under the base case identified locations where potential opportunities for increased management intensity could occur, but they would require an immediate and substantial investment in forest management and milling infrastructure to realize. With recent and very notable declines in infrastructure and the transfer of industrial lands into TIMO's, REIT's and small private ownerships, there is little to suggest that increased management intensity of private lands is a likely alternative given the low rate of return from these lands under current market conditions. Exceptions are private and tribal forests in the Northeast and Yakima regions as long as adequate milling infrastructure and markets still exist. Base case simulations also indicated that more volume could be removed from these forests without an unsustainable decline in standing inventory. As with the comparison between the MaxNPV and O/S conversion strategies identified in Table DP9.2, despite an overall increase in acres treated and volume removed, the substantial investment required meant that alternate strategies produced an $180-240 decline in cashflow/harvested acre over baseline values. While forest health is definitely a concern, restoration forestry using the approaches we identified in Figures DP9.2 and DP9.3 requires incentives per acre that we estimated at $900-1600/acre (Table DP9.2 & 3). As NPV under current treatment regimes averages only $978/acre, opting for restoration forestry activities on private lands could not be justified economically in most cases.

Developing ways to increase the value of Eastside private forest lands to ensure their sustainable management is identified as both a key issue emerging from the study and an opportunity to be realized. We have identified several pathways where by accounting for the value associated with carbon sequestration (Discussion Paper 10), biofuel potential (Discussion Paper 12), and avoided costs (Discussion Paper 11) could justify the investment and incentives needed to increase management intensity on these forests. Provision of regulatory relief (Discussion Paper 13) is also identified as a necessary ingredient in maintaining economic viability of Eastside private forests and regional milling capacity. The integration of all of these opportunities to increase economic return may be necessary to address sustainability under current conditions and to provide a business environment that is capable of taking on the more daunting challenges associated with adapting to climate change and the impacts it has on our forest resource base.

References

DNR, 2007, Washington State Department of Natural Resources Timber Harvest Reports, http://www.dnr.wa.gov/htdocs/obe/obehome4.htm

FIA, 2006, USFS Pacific Northwest Forest Inventory and Analysis Branch, http://www.fs.fed.us/pnw/fia/

Oneil, E., 2005, The Economics of Forest Health in Eastern Washington, Factsheet #35, Rural Technology Initiative, College of Forest Resources, University of Washington, Seattle WA, http://www.ruraltech.org/pubs/fact_sheets/fs035/index.asp

Shelton, G., 2004, Washington State Department of Natural Resources Southeast Region, presentation to the Forest Health Strategy Working Group, August 18, 2004, Seattle WA.

WAC 222, 2001, Washington Administrative Code Chapter 222-30, 2001, Timber harvesting Section 222-30-11 Wildlife reserve tree management.

Williamson, M, 2006, personal communication with general manager of Williamson Consulting, a forestry consulting firm in Colville WA.