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The Economics of Forest Health in Eastern Washington.

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Recent trends in the forest health conditions of eastern Washington are raising concern among policy makers, the public and forest landowners. Numerous studies and annual monitoring indicate that outbreaks of insects and disease coupled with increasing fire risk in unburned areas will continue and become increasingly severe. Various solutions to forest health problems have been proposed, but implementation requires a balance between desired biological outcomes and economic limitations to determine which treatments are most promising given the many constraints on landowners and managers. Analysis of potential treatment regimes for two common stand types was undertaken to determine likely forest health outcomes with and without incentives and education regarding forest health issues.

Eastern Washington forests are facing extreme pressure from stand replacing fire and insect and disease outbreaks (RTI Factsheet #31). 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 at the larger landscape level as well as increased the overall stocking and biomass levels in the forest. These past management practices create 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, 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.

There are a number of potential management strategies that can address forest health issues in eastern Washington. The success of any single treatment depends on the interplay between biological condition, management goals, and economic limitations. To evaluate treatment alternatives, the Landscape Management System (LMS), using the Forest Vegetation Simulator (FVS), was used to simulate alternative treatments for meeting forest health goals on two prevalent forest types: a ponderosa pine type in the Okanogan area and a mixed conifer type in northeastern Washington. The goal of the analysis was to assess the trade-offs 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 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 our 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. **Table 1** gives the basal area, risk ratings for fire and MPB, and economic values over a 90-year simulation period. 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**—a baseline assuming no disturbance.

Table 1: Predicted mortality risks and economic returns for a thinned ponderosa pine stand under four treatment scenarios

Pine Scenarios	Max NPV	Partial Retention	Overstory M	No Action
Average BA (ft^2)	32	42	68	161
BA range (across decades)	9 to 53	20 to 60	60 to 78	111 to 183
Average crowning index (mph)	63	61	98	48
Crowning index range (across decades)	40 to 106	41 to 88	60 to 134	41 to 63
NPV $ @ 5% interest	$3,586	$2,652	$1,109	(-)
Cash Flow (decades entered)	5 times	5 times	2 times	none
Beetle risk	ok	ok	barely	BAD
Fire risk	low	low	very low	moderate
Sustainable economics	yes	yes	NO	NO
Incentive needed ($/acre)	education only	$934	$2,477	$3,586
Annual Incentive (1st 20yrs)	0	$75/acre/yr	$199	$288+
Incentive to pile pulp logs	$300/acre	$300/acre	$300/acre	None

Because both Max NPV and Partial Retention emphasize initial overstory retention to facilitate regeneration, initial treatments can result in very similar residual stand conditions depending on leave tree characteristics. As a result, both treatment regimes can immediately move stands away from risky thresholds for fire, insects, and disease. Future treatments that facilitate the goals of each treatment regime do result in widely disparate stand conditions and therefore variation in resistance or resilience in the face of forest health conditions over time. These biological outcomes suggest that incentives for initial treatments to address forest health need to focus on immediate biological gains without requiring commitment to long term strategies that may not meet the financial obligations of landowners. **Table 1** indicates that the discounted financial returns/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. Overstory Maintenance treatments are designed to produce a widely spaced dominant pine stand akin to ‘old growth’ conditions. 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 thus susceptible to MPB attack and increasing fire risk. Incentives to facilitate any particular management strategy are shown as the difference between the maximum attainable value and the potential returns under alternative scenarios. While the costs of incentives are substantial, the possibility to amortize these incentive payments over a 20 year annual period would encourage a longer term management strategy to support forest health needs in eastern Washington.

Further economic gains can be obtained in the Partial Retention alternative relative to the Overstory Maintenance alternative with judicious use of tree selection criteria. While treatments such as controlling basal area to remain below the growth basal area (GBA) of the stand help to reduce stand stress (see factsheet #31 for a discussion on GBA), operations that remove some larger diameter trees can also effectively address forest health and economic considerations. In the example ponderosa pine stand, removing only trees <9” dbh results in no appreciable basal area reduction and hence no forest health benefit. Removing only trees < 12” dbh reduces basal area to 90 ft2/acre, a value that exceeds the MPB threshold for this site. Further reductions in basal area could occur by continuing to thin from below or by selectively removing a few larger diameter trees to increase the economic return to the landowner. Comparisons of a thin from below treatment that targets a basal area of 60 ft2/acre to a treatment that thins >20” dbh trees combined with a thin from below to the same target basal area results in the stand metrics and economic outcomes given in **Table 2**.

Table 2: Stand attributes after treatment to address forest health issues

	Treatment Regime		
Stand Metrics and $/acre	Thin to Basal area of 60 (from below)	Thin to Basal area of 60	Differences between treatments
TPA >6" dbh	**32**	**45**	**13**
DBHq > 6" dbh	**18.6**	**15.6**	**-3**
Height of tallest 40 trees (ft)	**71**	**81**	**10**
BA > 6" dbh	**60**	**60**	**0**
Net Return After Tax ($/acre)	**$1,527**	**$2,303**	**($776)**

The differences in stand metrics between the two treatments are relatively minor. However, the differences in economic outcomes are significant. There is nearly a $800/acre difference between treatments. This differential implies that where financial considerations are important, landowners may not choose to leave all the largest trees while producing the attributes of a healthy forest. The economic differentials also indicate that almost half the value differential in net present values between Partial Retention and Overstory Maintenance can be attributable to tree selection criteria within the first two treatment periods. As tree selection criteria also drives long term forest health benefits, maintaining more of the larger diameter trees within these systems may require incentives to address immediate economic needs.

The economic viability of forest health restoration efforts needs to consider the timing of stand treatments relative to the stage of stand development. In our ponderosa pine example, economic viability is largely determined by the current state of the forest, as discounting favors returns early in the simulation period. In the mixed conifer stand example, the stand has been repeatedly harvested over the past century using overstory removal techniques. The resulting stand is composed of grand-fir, cedar and Douglas-fir that are growing slowly because site conditions are not conducive to rapid growth of these species. The stand is currently barely merchantable, but within 40 years, a large component of the intermediate cohort would become merchantable. **Table 3** gives the stand metrics, risk ratings for fire, insects and disease, and economic values over a 90-year simulation period. 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. The timing of forest health treatments in these cases is critical, as after the first entry, the investment required for overstory conversion to forests with reduced fire and root rot risk has to be amortized over a minimum of 40 years prior to any returns. In this case, a status quo treatment regime of continuing overstory removal maximizes NPV while doing little to alleviate risks associated with fire, insects, and disease.

Table 3: Predicted mortality risks and economic returns for a mixed conifer stand under four treatment scenarios

Mixed Conifer Scenarios	Max NPV	OS convert with Retention	OS convert without Retention	No Action
BA ave. (sq.ft.)	23	37	29	264
BA range (across decades)	2 to 39	15 to 53	0 to 48	111 to 357
Crowning index average (mph)	54	76	51	13
Crowning index range (across decades)	18 to 125	38 to 160	0 to 110	10 to 18
TPA ave.	47	45	40	229
TPA range (across decades)	72 to 316	0 to 216	5 to 205	153 to 539
NPV $@5%	$2,814	$1,213	$2,164	(-)
Cash Flow (entries)	5 times	4 times	4 times	none
Root rot risk	marginal	better	ok	BAD
Budworm risk	3/10 bad decades	ok	ok	BAD
Fire risk	barely low	very low	barely low	HIGH
Sustainable cash flow	yes	yes	yes	NO
Incentive needed ($ up front)	education only	$1501/acre	$650	$2,814
Incentive if annual for 20yrs	0	$120/acre/yr	$52	$226
Incentive to pile pulp logs	$300/acre	$300/acre	$300/acre	None

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. **Table 3** also illustrates the economic effect of retaining a minor number of large trees into the next forest stand. Not only is the initial value lost, but subsequent growth impacts reduce the value of understory trees resulting in an additional 33% loss in economic return over the 90 year period. In developing incentives, the additional costs of retaining large diameter structural elements in a species conversion scenario should be quantified. With this cost accounting, a value can be assigned to the structural elements that provide for key non-market values using implicit market methods. This example illustrates that incentives in mixed conifer forests must be targeted to those stands that are at a developmental stage that makes them well suited for conversion to species that meet forest health criteria, whether it be addressing fire, insect, or disease risks. Criteria for choosing stands for forest health conversion incentives would include stands that have at a minimum: few viable trees in the intermediate, pole, and sapling categories; stagnated understory layers; and limited ability to respond to overstory removal. Additional criteria might include some component of seral, fire, or disease resistant species in the overstory, though retention of even a minor overstory component retards the growth of understory species and hence reduces economic returns in the long run.

Strategies to address forest health challenges can be developed by considering site parameters and the multiple metrics that describe stand dynamics. Forest health goals can best be met with a flexible approach that permits landowners to harvest sufficient numbers of larger trees to ensure economic viability while maintaining basal area targets and stand structures that promote forest health. Modest incentive packages could be developed to target landowners who would benefit the most by reducing forest health risk and have costs that will likely be much smaller than the public benefits of reducing fire, insect, and disease risk. Similar analysis for a wider variety of stand types at different stages of development will be required to determine optimal strategies to achieve forest health objectives across the wide range of conditions that exist within the eastside landscape.

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