Timber product output implications of a national program of mechanical fuel treatments applied on government timberland in the Western States of U.S.

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ABSTRACT This study reports the results from a five-year fuel treatment simulation for the western United States. The state level simulation model of interrelated timber markets was used to evaluate the timber product outputs of a projected large-scale fuel reduction program on public timberland[2] in the western U.S. 84 million acres, or 66 percent of total timberland, is publicly managed; of this 78 million acres are managed by the federal agencies. Using assumptions of 1) an annual "subsidy" (payments for treatments) of $1.5 billion, 2) the treatment costs, 3) the priority ranking by forest type, 4) fire risk level, and 5) the wildland-urban interface (WUI) status, the simulation shows that Lodgepole pine, ponderosa pine and fir-spruce are projected to be major forest types treated in the West. Idaho, Montana, Oregon, Colorado are the states projected to have the largest treatment areas on public timberland. About 59% of the potential volume[3] removals are sawtimber [4] for all the public timberland treated. Twenty percent of the total biomass[5] is projected to come from trees less than 5-inches in diameter at breast height (dbh), and another 20% of the biomass is expected from trees 20-inches (dbh) and above.

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[2] Timberland is forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. Areas qualifying as timberland have the capability of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.

[3] Net volume of wood in the central stem of sample tree 5.0 inches diameter or larger, from a 1-foot stump to a minimum 4-inch top diameter outside bark.

[4] Based on the definition of Forest Inventory and Analysis (FIA), sawtimber trees are dbh 9-inch and above for softwood and 11-inch and above for hardwood.

[5] Total gross biomass ovendry weight for live trees. The total above ground biomass of a sample tree 1.0 inch diameter or larger, including all tops and limbs (but excluding foliage).

KEY WORDS: Timber product, fuel treatment, timberland, biomass, modeling

Introduction

Land managers and the public have become aware that the conditions of some forests in the United States are subject to more intense wildfire behavior, and the magnitude of the problem requires the development of strategic planning tools to estimate the fuel conditions at a spectrum of scales and evaluate alternate treatment scenarios (Shepperd, Abt, Barbour, Fight, etc). As combined efforts, a project was launched for a national study of the economic impacts of biomass removals to mitigate wildfire damages on federal, state and private lands under the support of Joint Fire Science Program. As a part of the study, this sub-report demonstrates the potential timber product output from the simulated fuel reduction treatment based on certain economic assumptions. It displays the diameter distributions of potentially treated biomass by state, forest type and the major tree species.

The Data

The basic data was from the Forest Inventory and Analysis (FIA) program managed by the US Forest Service. The most recent periodic inventory[6] data for each State were assembled in the 2002 RPA database (Forest and Rangeland Renewable Resource Planning Act). The FIA inventory plots selected for analysis were assigned fire risk levels based on the calculated torching index (TI) and crowning index (CI) using FTE[7]-. There

[6] Periodic inventory survey is a old forest inventory survey system which was conducted every five to ten year for each State.

[7] FTE, the Fuel Treatment Evaluator, is a web-based tool that can be used to explore the impact of alternative thinning intensities for any forest area in the United States (Shepperd, Abt, Barbour, Fight, etc)

are three fire risk levels, high, medium and low[8]. A plot was not treated if: TI and CI were at least 25, or CI was at least 40, or the plot was all hardwood, or the algorithm was unable to determine crown bulk density and canopy base height for the plot, which are necessary to compute TI & CI.

Each plot was also assigned a status of with in the wildland-urban interface (WUI) or not within the WUI. Plots in the WUI have increased potential for loss of private property during wildfire events (Abt and Prestemon, 2006). The definition of WUI used here includes both interface and intermix, nonWUI includes all other FIA plots[9]. Estimates of removals for each state and forest type were made using the EBR model described elsewhere in this report using assumptions listed below.

Method and Assumptions

This study involves two major steps. First, the forest inventory data was assembled and summarized to the format of the model of interrelated timber markets in the U.S. west (Abt and Prestemon, 2006) by state, forest type, fire risk level, and WUI status. The model maximizes the area treated, given different priorities regarding forest type, fire risk level and WUI status given a set of economic constraints including treatment cost and the budget available. The output of the model is state-based, therefore, the second step of this study is to disaggregate the state treatment information to fine scale level. Each individual treatable plot in the RPA

[8] if both TI <25 and CI < 25, then fire risk is high, if TI=25 and CI<25 then fire risk is medium, if TI<25, 25=<CI<40 then fire risk is low.

[9] The definitions for what constitutes interface and intermix can be found on the web: http://silvis.forest.wisc.edu/lobrary/WUIDefinitions2.asp

database is revisited to determine if it is treated based on the information of the state model output and the basic assumptions.

We assumed that the annual allowable "subsidy" (payments for treatments) was $1.5 billion for 5 years. We only simulated treatments on public timberland (Federal and non-federal) in the western U.S. The selection of plots to treat was made based on a ranking of treatment priority by forest type (table1) and the WUI spending requirements. Spending in WUI was set at 50% of the annual budget to reflect direction in the Healthy Forest Restoration Act of 2003.Lodgepole and fir-spruce will be treated with a thin-from-below treatment which results in smaller size tree removals. All other forest types were treated with a stand density index-based treatment biased toward taking larger trees.

Scenario one: (1) Treat the forest type based on rank, that is, treat the rank 1 (forest type) first, , then rank 2, and so on; (2) spend 50% of the budget on WUI following the type priority unless there are no WUI left for treating, (3) the next 50% of the budget on the NON-WUI following type priorities

Scenario two: (1) Treat 50% of rank 1 type, 30% of rank 2 type, and 20% of rank 3 forest type for each year based on the treated acres if the treatment happens, after finishing the treatment for the first three rank types, the other types just follow the rank order. (2) spend 50% of the budget on WUI acres following the type priority, and spread the budget to each type, that is, 50% of this 50% budget goes to Rank 1, 30% of this 50% budget goes to Rank 2, 20% of this 50% budget goes to Rank 3, unless there are no WUI acres left for treating, (3) the next 50% of the budget on the NON-WUI following type priorities

Both scenarios are simulated for five years with annual budget of 1.5 billion U.S. dollars. All the counties west of the Cascade Crest in Washington and counties in Oregon west of the Cascade Crest and north of the Dougla/Linn county line are excluded from fuel treatment. These counties are excluded because it is neither the policy of the states, nor the federal government (Golden Personnel Communication) to give them a high priority for fire hazard reduction treatments.

The ranking of forest types for fuel treatment is listed in table 1 for each state.

Table 1. Major forest type rankings for fuel treatment priority in western states
(Rank 1 to 10 from high to low priority, based on expert opinion)

Forest Type	AZ	CA	CO	ID	MT	NM	NV	OR	SD	UT	WA	WY
Ponderosa pine	1	1	1	1	1	1	1	1	1	1	1	1
Lodgepole pine		2	2	3	3		2	3		2	3	2
Douglas-fir	2	5	3	6	6	2	3	7		3	7	4
Fir - spruce	3	3		7	7	3	4	4	4	4	5	5
Larch			4	2	2			2			2	
Western white pine		4		5	4		5	5			4	
Aspen - birch				4	5				3			3
White-red-jack pine									2			
Pinyon - juniper	4	6	5	9	9	4	6	6	6	5	6	6

The Analysis

Twelve west states are included in this study, they are Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, South Dakota, Utah, Washington and Wyoming. There are total 127 million acres of timberland for all ownership in these twelve western states of the U.S, in which 84 million acres is public timberland including 78 million acres managed by the federal agencies. Plots meet the fire risk criteria are summarized as treatable acres. Table 2 shows the detailed timberland information for each state.

Table2. Treatable and treated timberland on Public timberland (1,000 Acres)

State	Total Timberland [10]			Treatable Area			Treated in 5-year (Scen.1)		
	Fed	Non-Fed	Total	Fed	Non-Fed	Total	Fed	Non-Fed	Total
AZ	2,438.0	11.6	2,449.6	709.1	0	709.1	495.1	0	495.1
CA	10,130.4	168.0	10298.4	3588.7	41.5	3630.2	652.7	20.7	673.4
CO	8020.3	362.8	8383.1	2952.0	111.4	3063.4	796.7	34.4	831.1
ID	12596.4	1005.3	13601.7	4356.1	544.7	4900.8	1578.4	39.6	1618.0
MT	12505.6	721.9	13227.5	4578.5	364.7	4945.0	1133.2	94.5	1227.7
NM	2828.7	119.4	2948.1	1099.7	98.4	1198.0	493.9	80.6	574.5
NV	264.5	16.4	281.0	43.8	8.2	52.0	17.3	0	17.3
OR	14171.7	931.3	15103.0	2825.1	50.1	5350.9	1126.2	7.1	1133.3
SD	967.5	55.3	1022.8	224.0	0	224.0	189.9	0	189.9
UT	3585.7	219.0	3804.7	740.2	55.9	796.1	107.5	7.6	115.1
WA	6088.3	2275.9	8364.2	1143.9	304.2	3529.7	142.7	204.9	347.6
WY	4092.5	202.7	4295.2	1047.8	70.7	1118.5	324.9	36.6	361.5
Total	77689.7	6089.7	83779.4	23308.9	1649.8	24958.7	7058.4	525.9	7584.4

Most of the treatable acres (80%) are Non-WUI, and 93% of public timberland is managed by federal agencies. The majority of federal timberland is administered by the USDA Forest Service. Figure 1 illustrates the projected number of acres treated by forest type and WUI status base on the assumptions described in last section. Lodgepole pine, ponderosa pine and fir-spruce are projected to be major forest types treated in the West. Because of the small portion of plots defined as WUI in the database. There is no substantial difference for these two scenarios for the potential treated acres. Accordingly, we only concentrated on the analysis for scenario one in this report.

Figure 2 shows the distribution of diameter at the breast height (dbh) for each major forest type. The diameters of removed lodgepole pine and fir-spruce tend toward smaller

[10] Total timberland acres are summarized from RPA 2002 database.

size trees, while large portion of potential removals of ponderosa pine are from large size trees. This happens because the fuel treatment model removed lodgepole pine and fir-spruce using a thin-from-below prescription, and all others, including ponderosa pine, were treated with a stand density index (SDI[11]) based prescription which thins across diameters to create an uneven-aged stand.. A complication of this analysis is created because FIA does not record volume for trees less than 5 inches in diameter. Therefore, no volume removals are shown for trees under 5-in dbh.

In practice the number of these small trees killed by fire hazard reduction treatments is potentially quite large even if their aggregate volume is low. Their influence on fire behavior is also potentially very important (Peterson et., al. 2005). Idaho, Montana, Oregon, Colorado are the states projected to have the largest treatment areas for public timberland. Oregon, New Mexico, Arizona, and California are dominated by ponderosa pine treatment, while Montana, Colorado and Idaho are projected to treat more lodgepole pine. Idaho also has high potential removal of fir-spruce forest type (Figure 3). We only simulated potential fuel treatment for softwood forest types, so more than 97% of the potential product output is softwood tree species for both total volume and total biomass removals. The unclassified type treated in California is also a softwood type with multi-dominant softwood tree species that mostly include Douglas-fir, ponderosa pine and other softwood. The total biomass projected by diameter distribution for the major tree species treated on public timberland in western states are illustrated in Figure 4.

[11] SDI is stand density index which describes the empirical relationship between quadratic mean stand diameter and stem density.

The potential sawtimber product removals from all fuel treatments are shown in Figure 5. Again, the large portion of the projected removal from trees 25-inch and above is because of the treatment method used for this study (SDI for most forest types treated) and removal of those trees is required to meet the 25 MPH or greater CI threshold. If CI is not a priority then the diameter distributions and consequently the total volume removed would be quite different. We allowed removal of these larger trees because we were concerned with the effectiveness of the treatments not the policy of what trees will or will not be cut. About 59% of the potential volume removals are sawtimber [12] for all of the public timberland treated. Though, less than 13% of the volume treated is from non-federal timberland, 66% of the removals are going to be sawtimber, and only 58% of the treated volume from federal timberland are sawtimber size trees. Table 3 shows the potential product removals for each state.

Table 3.Potential product output from fuel treatment on public timberland by States

(Thousand tons)

State	Total Removal	Sawtimber Removal	Sawtimber Percent
AZ	2765	1667	60
CA.	6597	5286	80
CO	3108	621	20
ID	11431	6560	57
MT	4300	1869	43
NM	3174	1972	62
NV	39	24	60
OR	5473	4046	74
SD	824	392	48
UT	376	122	32
WA	3947	2600	66
WY	1070	332	31
Total	43104	25491	59

Figure 6, figure 7 and figure 8 are maps display the location of potential fuel treatment for treated acres, total volume removed and potential total biomass treated respectively, based the study assumptions. The grids in the maps are hexagons with about 160,000 acres in area for each. The map is also overlaid with

[12] Based on the definition of Forest Inventory and Analysis (FIA), sawtimber trees are dbh 9-inch and above for softwood and 11-inch and above for hardwood.

FIA survey units[13] along with state boundary. Most westside counties in Oregon and Washington are not planned to be treated, while most of the public timberland in South Dakota is located in the western part of that state. The potential treatment for acres, volume and biomass are significant in Idaho, Montana, Oregon and Colorado. Though a smaller portion of area is projected for treatment in California, New Mexico and Arizona, the potential volume and biomass removed is relatively large as shown in the maps, this happens because of the structure of the forest types and the method used for treating the different forest types.

Conclusion

The potential product output from fuel treatment on public timberland depends on the treated forest types in each state. In average, more than half volume treated will be sawtimber. 20% of the total biomass are trees less than 5-inch, and another 20% of the biomass is expected from trees 20-inch and above. Lodgepole pine, ponderosa pine and fir-spruce are projected to be major forest types treated in the West. Idaho, Montana, Oregon and Colorado will be the major western states for fuel treatment regarding the acres to be potentially treated on public timberland. This study demonstrates the tool or process for fuel reduction treatment analysis, and may provide useful information on potential product output from assumed treatments to policy makers for planning activity.

References

Abt, Karen L.; Miles, Jeffrey P. Prestemon. 2006. Timber markets and fuel treatments in the Western U.S. Natural Resource Modeling. Volume 19, Number 1. 31 p.

[13] Contiguous counties are grouped to survey units for sampling for each state in FIA survey. Each state has 1 to 10 survey units.

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Smith, B.W.; Miles, Patrick D.; Vissage, J.S.; Pugh, Scott A. 2004. Forest resources of the United States, 2002. Gen. Tech. Rep. NC-241. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 137 p.

Figure 1.Treated Acres on Public timberland in 5-years (1000 acres) for the West States

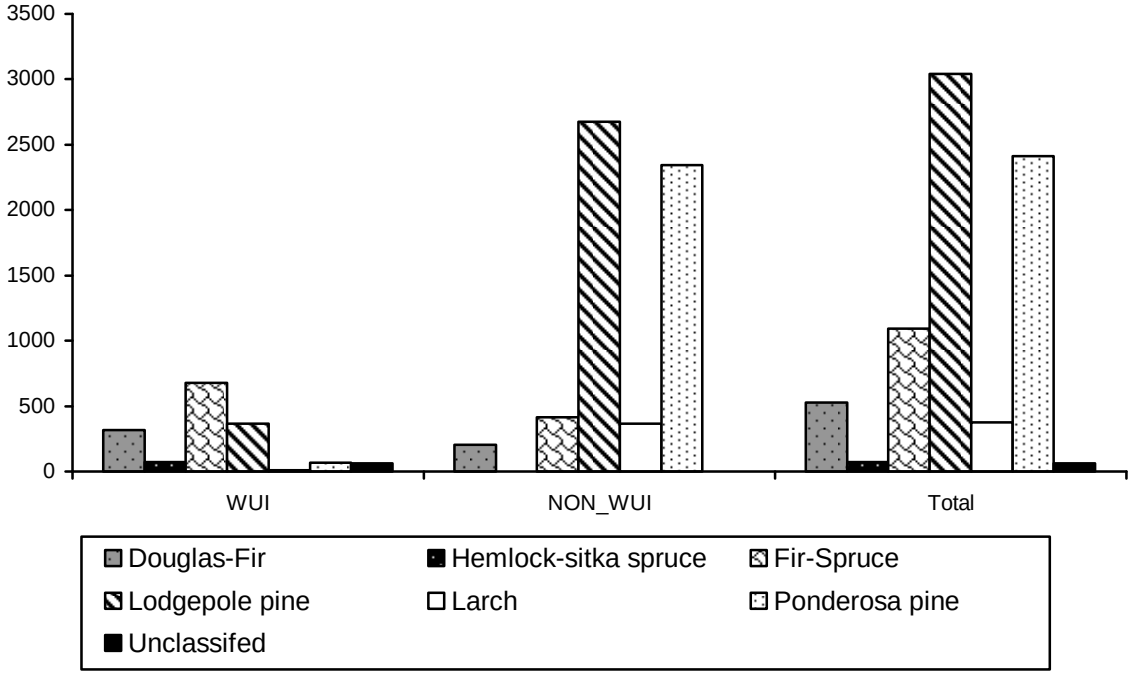

Figure 2. DBH distribution of treatment Total Volume Removal on public timberland by major forest types in Western States

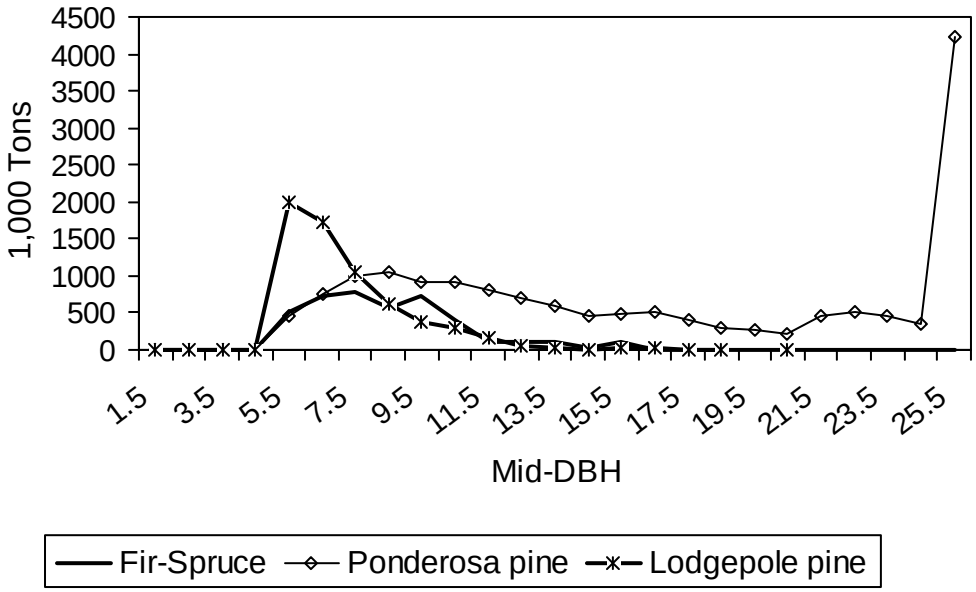

Figure 3. Potential treatment acres by forest type and state on public timberland

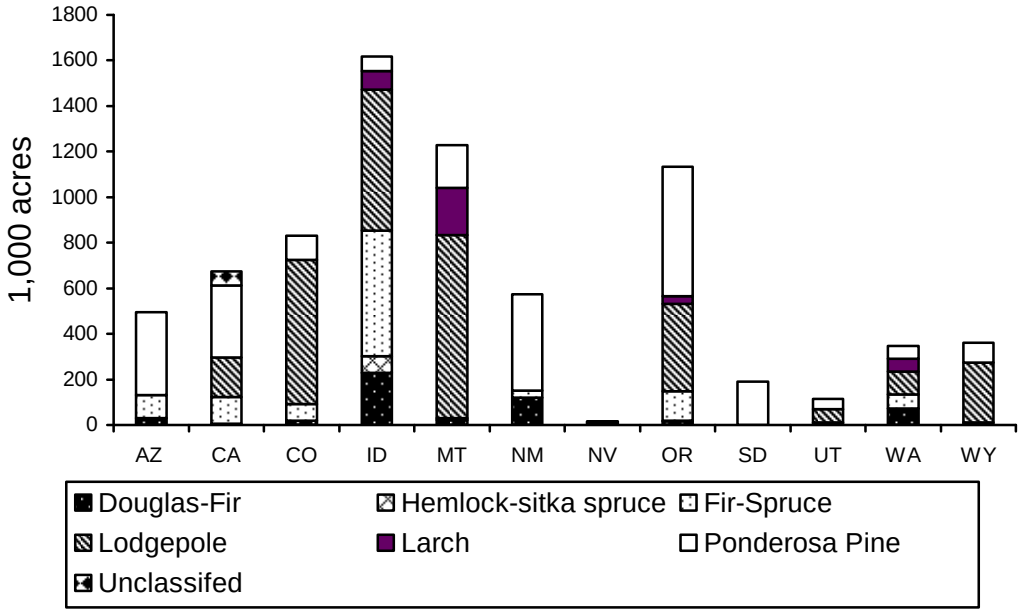

Figure 4. Diameter distribution of projected biomass removals by major tree species on public timberland in western states.

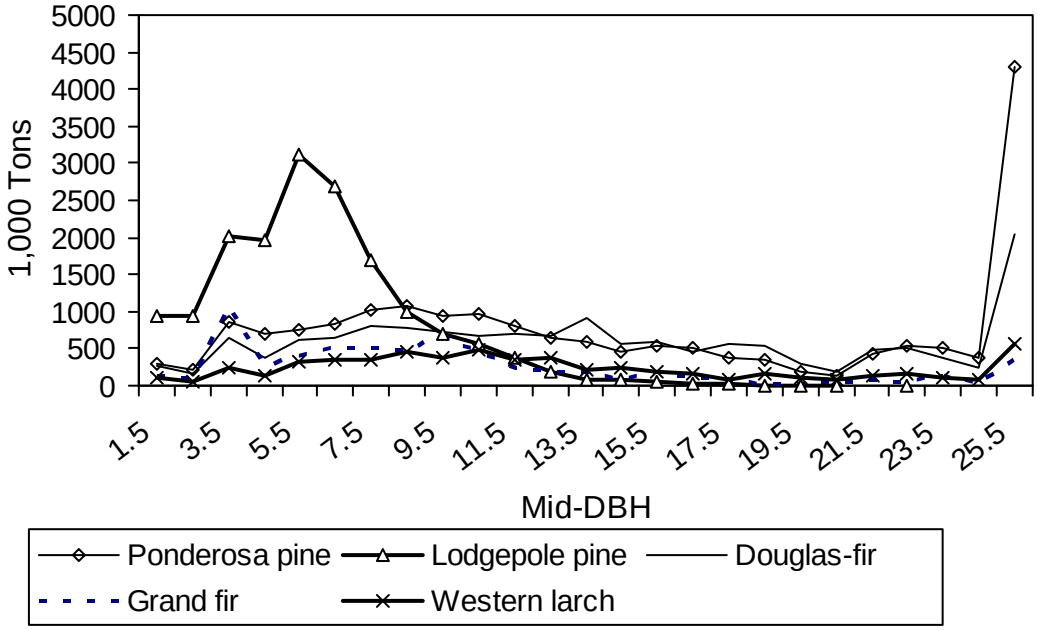

Figure 5. DBH distribution of volume and biomass removals on Public timberland for the Western States

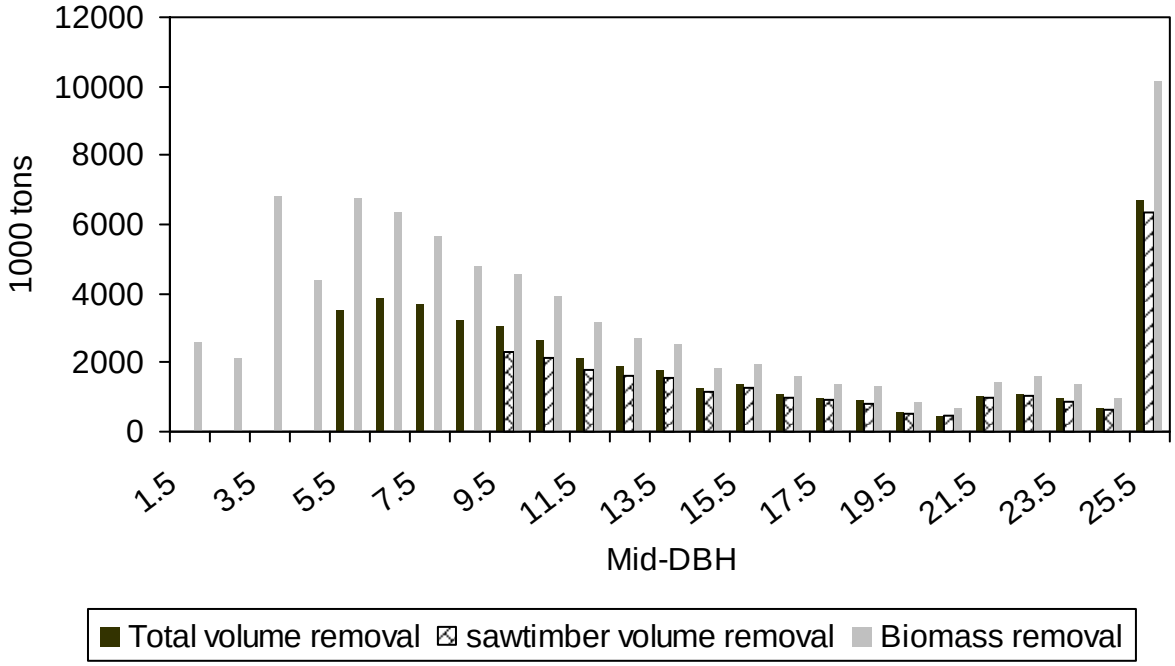

Figure 6. Total Projected Treated Area on Public Timberland per 160,000 Acres

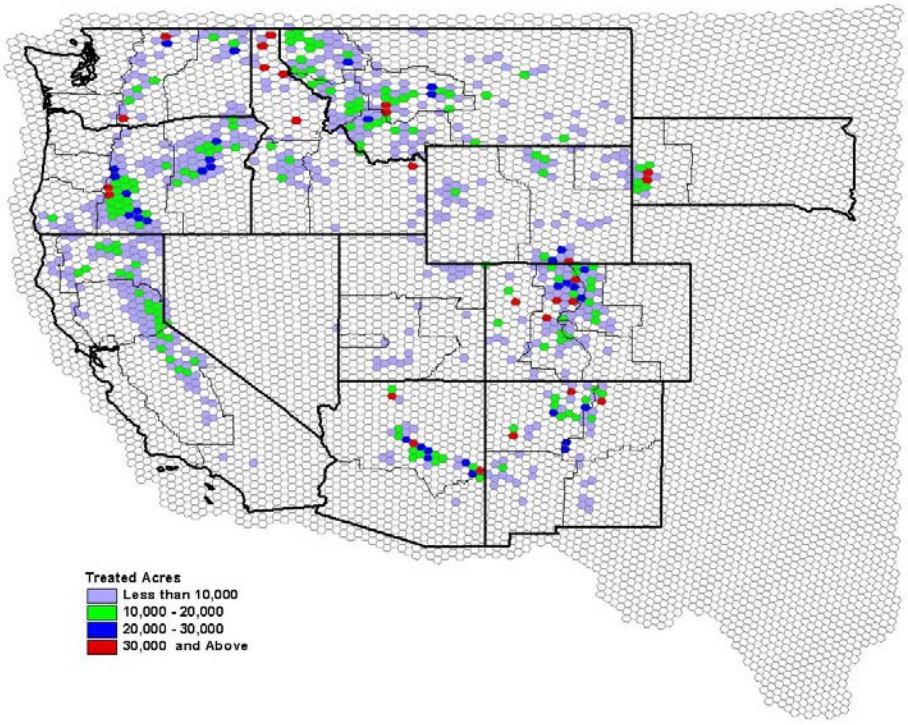

Figure 7. Total Projected Volume Removals on PublicTimberland

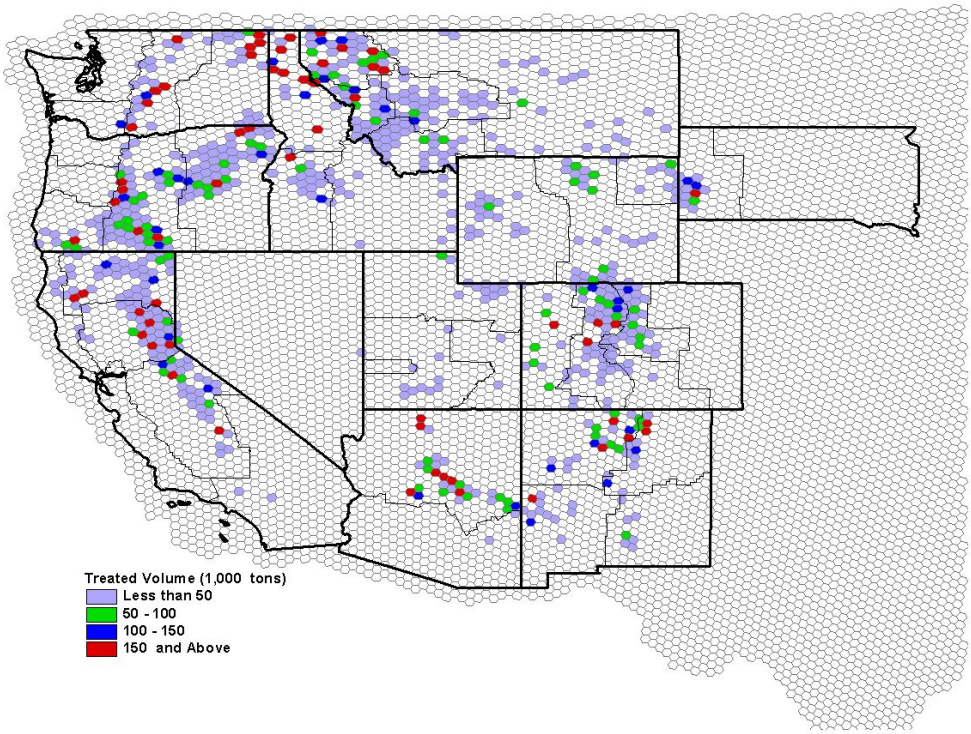
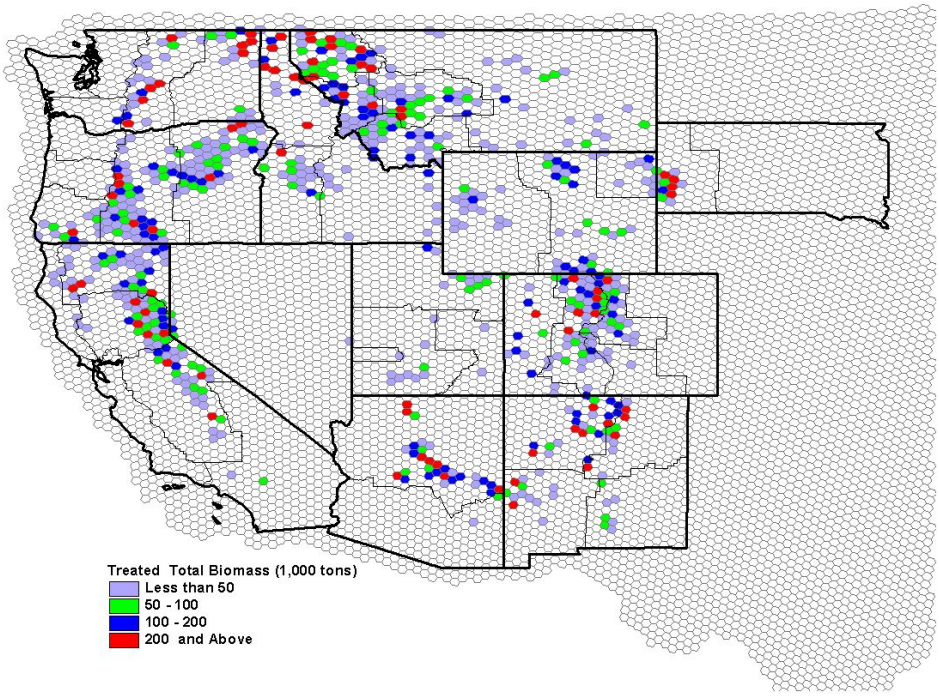
Figure 8. Total Projected Biomass Removals in Public Timberland