APPLYING MANAGEMENT MODELING TO ASSESS THE FEASIBILITY OF ACCELERATING LANDSCAPE RESTORATION ON FEDERAL FORESTS IN EASTERN OREGON

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Abstract—The state of Oregon recently invested in exploring options for increasing the extent of forest restoration activity. This initiative aims to reduce the incidence, effects, and expense of catastrophic fire events and restore economic stability to rural communities by enhancing the supply of raw materials for wood processing facilities and wood-based, renewable energy producers, particularly in the comparatively xeric, eastern two-thirds of the State. Collaborating with PNW-FIA and Portland State University, the Oregon Department of Forestry evaluated current levels of fire hazard as embodied in multiple metrics, assessed the effectiveness of a broad suite of fuel treatment-focused silvicultural prescriptions in achieving resilient forest stands, assessed the wood production potential of landscape restoration, and assessed treatment longevity for northeast Oregon, especially on federal forests. We developed a four-decade simulation, using BioSum 5 (dynamic), with 1,365 forested FIA plots in the northeastern corner of the state and 32 multi-decade sequences of silvicultural prescriptions applied, via FVS-FFE, to all plots where applicable. We estimated treatment costs using the R-based OpCost model, and treatment effectiveness based on multiple stand metrics selected to represent different dimensions of forest resilience, including crown fire potential, predicted mortality and fire intensity. The policy-relevant findings and technical insights developed via this modeling effort are presented.

The Oregon Department of Forestry sought a better understanding of the potential for increased forest restoration activity in eastern Oregon, and the impacts of such efforts on fire hazard, stand resilience, and economic benefits to rural communities that have traditionally relied on economic activity generated by timber production. A combination of active management via appropriate thinning and prescribed fire, if applied across the forested landscape, offers the potential to increase the prevalence of open, resilient stands, and to decrease the incidence of catastrophic fires resulting from an abundance of overly dense forests. We applied a modeling framework to evaluate current fire hazard in the Blue Mountain region of eastern Oregon, and to understand the effectiveness of several kinds of commonly applied silvicultural treatments for fire hazard reduction. We estimated treatment costs, including both the on-site costs of harvest and surface fuel reduction and the costs of hauling harvested wood for milling and energy generation, and the potential revenue from sales of such wood.

STUDY AREA

In a previous study by the Federal Forest Advisory Committee, an economic assessment of increased restoration activity on Oregon's eastern National Forests was conducted with the intent of accelerating restoration on federal forestlands (Federal Forest Advisory Committee 2012). We analyzed the effectiveness and feasibility of alternative silvicultural prescriptions in the Blue Mountains region, where a mix of private and public land ownership exists among three of eastern Oregon's national forests.

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Stretching from east of Pendleton to the Snake River on the Oregon-Idaho border, the Blue Mountains comprise 21 percent of eastern Oregon's land area, containing over 2.8 million acres. (Campbell and others 2003). Many forests in the Blue Mountains are overstocked, resulting from an extended period of fire suppression and a history of harvests that primarily removed large trees.

FIA plots within the Blue Mountain region provide a representative sample of this forested landscape. We selected a subset of these plots to include only those containing forests classified as Doug fir, Grand Fir, Ponderosa Pine, or Lodgepole pine – the dominant forest types in this region (Fig.1). Plots on reserved lands were excluded from this analysis, leaving a total of 1,085 plots (full or partial), referenced hereafter

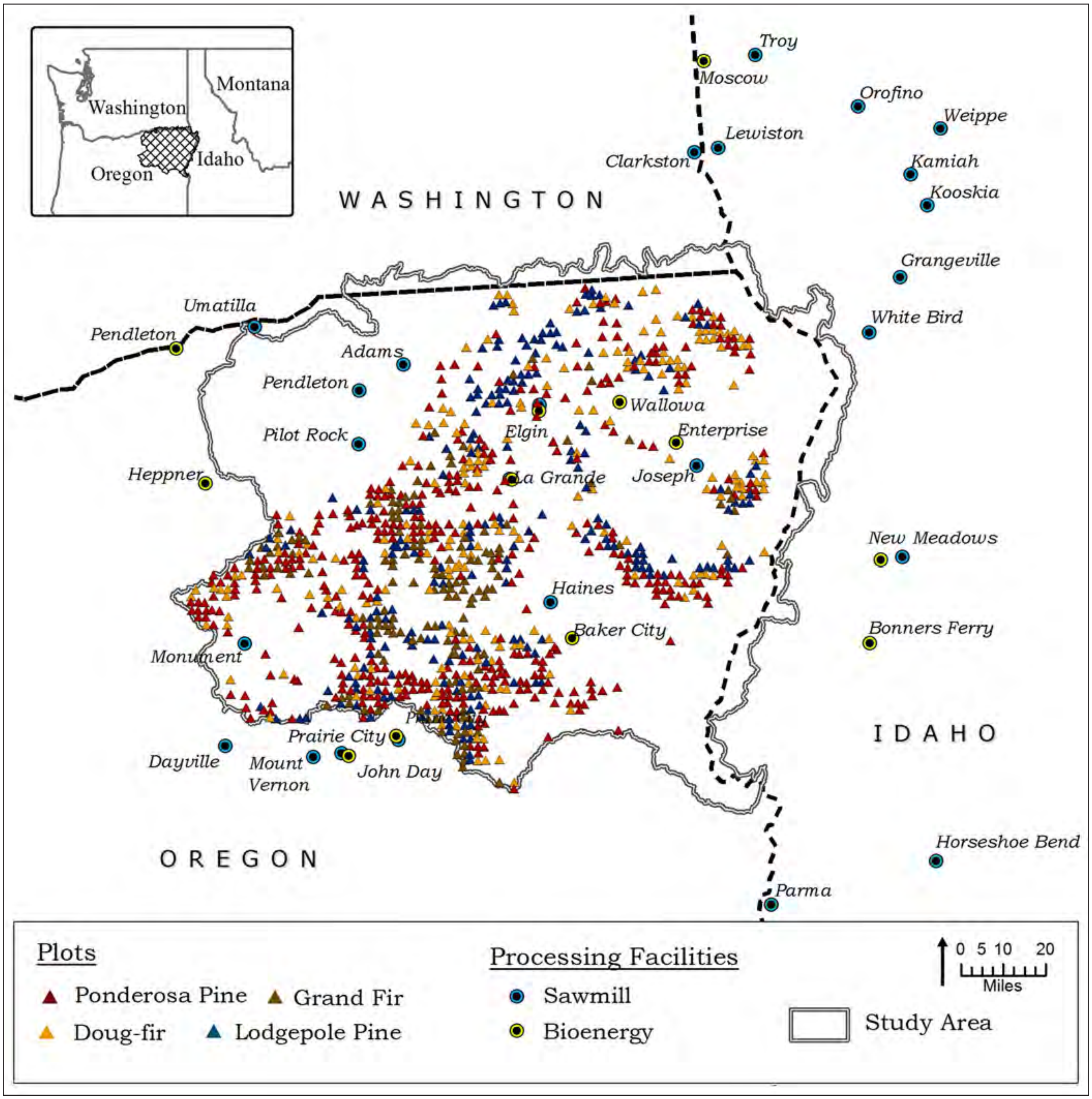

Figure1—Location of FIA plots and processing facilities within the Blue Mountain study area.

as stands, that represent 2.19 million forested acres. Most stands are located on national forest system land (NFS), with nearly all of the remainder on private land (Table 1). Due to the limited sample size of stands on state and other federal lands, we only discuss results for NFS and private lands.

METHODS

We used the Forest Inventory and Analysis (FIA) BIOSUM 5 analysis framework to assess the effectiveness, costs, and potential revenue resulting from implementing 32 generic fuel treatment-driven silvicultural sequences that reflect management prescriptions common in this region. Over the past decade, the PNW FIA Program developed BIOSUM (Fried et al. 2004) for bioregional inventory-oriented management simulation. BIOSUM integrates FIA data, wood processing facility locations, and GIS representations of transportation infrastructure with a workflow management system that:

1. Organizes data flow to and from multiple computer programs that are components of the analysis framework.
2. Audits inputs and outputs.
3. Evaluates alternative landscape-scale silvicultural treatments in terms of user-defined indicators of effectiveness and management objectives.

BIOSUM 5 integrates the following specific components:

1. Systematic forest inventory (FIA) data.
2. A dynamic forest stand model (FVS) for summarizing current conditions and predicting potential stand conditions at decadal intervals under various management alternatives (Dixon 2002).
3. An R-based treatment cost model (Bell and Keefe 2014).
4. A haul cost estimation model.
5. User-guided effectiveness heuristics for selecting the best silvicultural sequence of decadal treatment activities for each stand.

Table 1—Area of forest and number of stands modeled by owner group and forest type.

Owner	Forest Type	Area (1000 acres)	Area (percent of total)	Stands
National Forest	Douglas fir	316	14.4	200
	ponderosa pine	585	26.7	368
	grand fir	327	14.9	208
	lodgepole pine	231	10.5	160
	total	1459	66.6	936
Other Federal	Douglas fir	7	0.3	3
	ponderosa pine	22	1.0	4
	total	29	1.3	7
State and Local	Douglas fir	7	0.3	1
	ponderosa pine	16	0.7	3
	grand fir	2	0.1	2
	total	25	0.8	6
Private	Douglas fir	143	6.5	28
	lodgepole pine	379	17.3	78
	grand fir	113	5.1	19
	lodgepole pine	43	2.0	11
	total	679	31.0	136
Total		2192	100	1085

We devised 32 silvicultural sequences in consultation with specialists from the Oregon Department of Forestry, representing the full spectrum of treatments commonly implemented on federal lands in the study area.

To evaluate current levels of fire hazard and to assess the effectiveness of the selected silvicultural sequences in reducing fire hazard over time, we relied on four descriptors of stand-level fire hazard at a point in time (Jain and others 2012). These thresholds, which when exceeded indicate hazard, are: probability of torching (Ptorch) >20 percent, Torching Index (TI) <20 mph, Surface Flame Length (SFL) >4 feet, and Mortality Volume as a Percent (of pre-treatment stand volume) (MVP) >30 percent. A stand's hazard score, at a point in time such as before, or after, initiating a treatment activity at the beginning, or at any decadal interval within, a silviculural sequence, is calculated as the number of descriptors for which the threshold is exceeded. Thus, hazard score has a maximum value of 4, which occurs when all descriptor thresholds are exceeded. We defined effective treatments as those that reduce initial hazard score when assessed one year post treatment. The costs and revenues from wood production determined the economic feasibility of each silvicultural sequence.

When applied to a given stand, any one of the 32 silvicultral sequences may result in treatment activity occurring as often as every decade. Treatments were designed to follow one of two styles: thin from below or thin across diameter classes, and had residual basal area targets of 25 to 135 ft^2/acre. Many of the silvicultural sequences included reduction of surface fuels following thinning, via prescribed fire or lopping and scattering all harvested wood below merchantable size. Silvicultural sequences simulated harvest via either cut-to-length or whole tree logging systems.

RESULTS

Current Conditions

None of the 2.19 million forested acres represented by the FIA plot data are currently rated resilient with respect to all aspects of fire hazard considered in this study. All stands have at least one hazard element—the hazard indicator for MVP was present in all but 1 percent of the represented acres—and 32 percent have all four (Table 2). More than half, 66 percent, of the represented acres have a hazard score of 3 or greater.

Table 2—Area and area fraction (percent) of forest, before any simulated treatment activities, rated hazardous (+) or not hazardous (-) by combination of hazard descriptors. A "+" indicates as follows, for each hazard descriptor: Probability of Torching (PTorch) > 20 percent, Torching Index (TI) <20 mph, Surface Flame Length (SFL) >4 feet, and Mortality Volume Percent (MVP) > 30 percent.

Ptorch	TI	SFL	MVP	Area (1000 acres)	Area (percent of total)
+	+	+	+	711	32.4
+	+	-	+	437	19.9
-	+	-	+	410	18.7
-	+	+	+	252	11.5
-	-	-	+	171	7.8
+	-	-	+	157	7.2
+	-	+	+	28	1.3
+	-	+	-	10	0.4
+	+	+	-	10	0.4
-	-	+	+	7	0.3
-	-	-	-	0	0

Treatment Effectiveness

In our simulations, over 35 percent of stands, representing 775,000 acres, were effectively treated at first entry, i.e., their hazard score was reduced when evaluated one year post-treatment, by one or more of the 32 silvicultural sequences. For most stands, BIOSUM selected sequences composed of thin-from-below style treatments as the most effective, and more frequently selected those with lower residual basal area targets. Of the 775,000 treatable acres, 52 percent achieved a post-treatment hazard score of zero and 42 percent, a hazard score of one; 17 percent remained fully resilient (hazard score=0) at the end of 40 years (Fig.2).

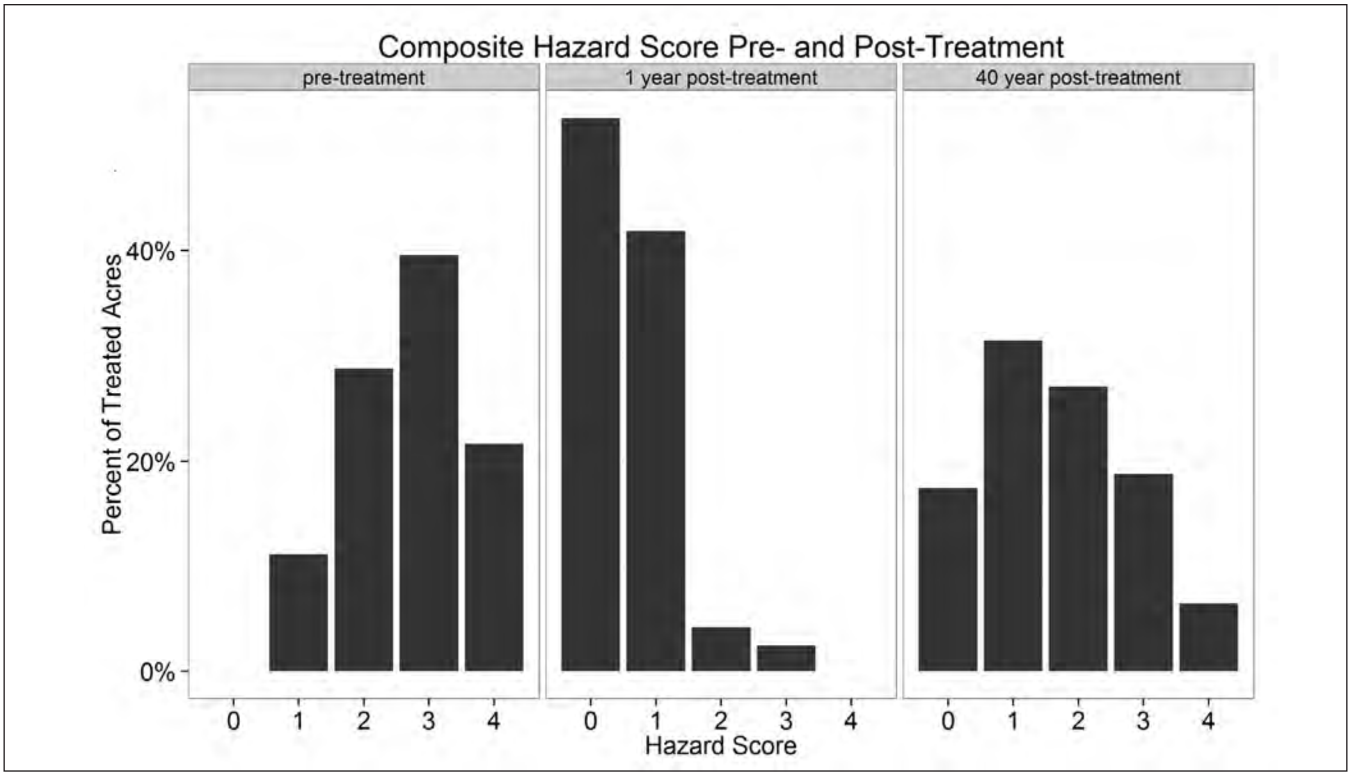

Figure 2— Distribution of area by hazard score for stands amenable to effective treatment (1) before treatment, (2) one year after treatment, and (3) 40 years after treatment.

Costs and Revenues

On most (85 percent) of the treatable acres, treatment costs could be fully financed by sales of merchantable wood and bioenergy feedstock. Private lands had the highest average dollar per acre net revenue, netting over five times more revenue per acre than National Forest land (Table 3). In all cases, the collection, transport, and sale of wood for bioenergy (collectable harvest residues such as sub-merchantable trees and the tops and limbs of merchantable trees) increased the overall maximum net revenue compared to on-site disposal of such residues in an air-curtain destructor.

Wood products obtained during harvest would notably increase the flow of wood to eastern Oregon processing facilities. By directing woody materials to a facility based on proximity to harvest site, centrally located facilities with bioenergy capabilities—Elgin, Prairie City, and Haines—would see a potential increase in merchantable wood exceeding 300 million cubic feet a year (Table 4). The increased yield of

Table 3—Predicted average, per acre yields of merchantable and energy wood and associated value, costs, net revenue and landscape-wide net revenue, by owner group with application of the most effective treatment for acres where effective treatment is possible.

Owner	Area (1000)	Merch Yield tons/ac	Chip Yield tons/ac	Merch $/ac	Chip $/ac	Harvest Cost $/ac	Haul $/ac	Merch / Chip Net $/ac	Total Net $ (1000)
National Forest	618	31	14	3,238	299	2,719	286	531	328,633
Other Federal	6	18	14	1,587	309	1,583	332	-20	-109
State and Local	14	24	12	2,511	273	1,014	349	1,420	19,583
Private	146	28	14	2,910	303	1,149	251	1,813	265,254
All	196	25	13	2561	296	1616	305	936	613,361

energy wood harvested via thin-from-below treatments would also send over 3 million green tons of bioenergy feedstock to each of these three sites.

Table 4—Predicted mean annual quantities of merchantable wood and bioenergy feedstock that fuel treatment could make available to processing facilities in the Blue Mountains region.

Processing Facility	Merchantable wood	Bioenergy feedstock
	MCF(mil)/yr	gt (1000)/yr
Elgin	378	3,405
Prairie City	358	3,639
Haines	321	3,360
Joseph	194	2,040
La Grande	193	2,076
Monument	152	1,625
Pilot Rock	119	1,261
Adams	41	395
Dayville	19	205
Mount Vernon	15	146

DISCUSSION

Our analysis of forest inventory plot data suggests that forests in the Blue Mountain Region are at high risk of experiencing stand-replacing fire and that implementing a silvicultural sequence of restoration treatments aimed at fire hazard reduction would reduce hazard on over a third of the forested area. Results of the simulation analysis support the assertion that increased forest restoration can reduce fire hazard through the harvest and processing of merchantable and energy wood while generating revenue sufficient to offset the costs of implementing treatments in most forests in this study area. Naturally, these conclusions are contingent on the hazard criteria devised for this study, the assumptions and parameters relied upon to estimate harvest and haul costs, and the value of harvested wood. These findings support the assertion that increased forest restoration can reduce fire hazard and stimulate market development through the harvest and processing of merchantable and energy wood.

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