

2012 Annual Report to Joint Fire Science Program

Project Title: Management options for reducing short and long-term fire risk in mountain pine beetle-infested forests

JFSP Project Number: 09-1-06-16

Project Location: Fraser Experimental Forest, Medicine Bow-Routt and Arapaho-Roosevelt National Forests and Colorado State Forest

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Description of Project:

We assessed the consequences of salvage logging on tree regeneration, species composition and fuel loads in lodgepole pine forests that experienced > 70% overstory mortality from mountain pine beetles. These findings were then used to predict changes in potential fire behavior as dead stands deteriorate and new stands develop in the century following the outbreak. The objective of this research was to better inform management decisions based on the short and long-term consequences of operational scale forest management following mountain pine beetle on future forest development and potential fire behavior.

Summary of Findings:

Stand Development in Harvested and Untreated Beetle-killed Stands

Seedling colonization in both untreated and salvage logged beetle killed stands is abundant. Three-quarters of all new seedlings colonizing harvested areas were lodgepole pine; there were 10-times more new pine seedlings in the cut areas compared to untreated stands. Aspen sprouts were 7-fold more abundant in harvest units compared to untreated stands. In untreated areas subalpine fir accounted for 70% of all new seedlings.

Stand development projections based on these field measurements suggest abundant sprouting in the first four decades after beetle infestation will increase the presence of aspen in untreated and harvested stands. In harvested areas lodgepole pine will once again become the dominant species as aspen declines. In untreated stands subalpine fir and lodgepole pine are projected to be the dominant species a century after the beetle infestation. Pre-outbreak stand conditions are expected to recover after 75 and 90 years in untreated and harvested stands, respectively. Due to an increased presence of subalpine fir in untreated stands, canopy bulk density is expected to reach pre-infestation levels 3 to 4 decades sooner than in harvested areas.

Fuel Dynamics in Harvested and Untreated Beetle-killed Stands

Salvage logging increased the total mass of woody surface fuels 2.7 times compared to untreated stands following salvage logging. Harvesting increased the mass of fine (*i.e.*, < 7.6 cm diameter) and sound, coarse (≥ 7.6 cm diameter) fuels 3.3 and 3.5-fold compared to untreated stands, respectively. The observed increases in fine surface fuels are expected to be transient however, declining within three decades as a result of decomposition and low input from the developing canopy.

Standing dead trees are projected to deteriorate and fall within the first three decades following beetle attack, adding branches and boles as surface fuels. Coarse wood mass is expected to increase 5.5-fold above pre-infestation levels as dead trees topple in untreated stands. Tree boles are expected to decompose slowly, keeping coarse fuel loads high in untreated stands for more than a century following the outbreak.

Potential Fire Behavior in Untreated and Harvested Beetle-killed Stands

Salvage logging in beetle-infested Colorado forests is expected to impact future fires by favoring regeneration of pine and aspen over subalpine fir, a species with a dense crown and branches that extend to the ground. Abundant subalpine fir in untreated, beetle-killed stands will act as ladder fuels that allow fires burning on the surface to spread into the forest overstory. Initial measurements indicated harvest treatments increased woody surface fuels compared to untreated stands, but potential fire behavior did not differ between treatments due to the sparse overstory canopy. Elevated coarse fuel loads will increase the potential for larger and more severe wildfires by increasing soil heating, the production of airborne burning material and hindering fire suppression. We expect harvesting will substantially alter potential fire behavior in beetle-killed forests, though salvage operations will treat only a small fraction of infested Colorado forests.

The difference in tree species composition and the higher fuel loads in untreated, beetle-killed stands create the potential for more extreme fire behavior compared to harvested areas. Following the loss of foliage in dead trees (*i.e.*, gray-stage), a lack of canopy fuels will result in similar fire behavior in untreated and harvested areas. However, as the forest overstory develops, abundant subalpine fir will increase the canopy bulk density and lower canopy base height of untreated stands. These crown conditions allow torching at lower wind speeds and increase active crown fire potential during extreme weather. As a result, passive crown fires (*i.e.*, fires that ignite individual tree crowns, but do not spread between canopies) are expected to occur in untreated stands under average weather conditions (*i.e.*, 50th percentile weather); in contrast, under similar weather conditions surface fires are expected in harvested areas.

Implications

Our findings suggest that salvage logging in beetle-killed, gray-stage, lodgepole pine stands will dampen the behavior and severity of potential future wildfires. Harvesting favored establishment of lodgepole pine seedlings and aspen sprouts and decreased the dominance of subalpine fir in recovering stands (lowering crown bulk density 25%). These differences in species composition and stand structure translate to lower risk of active crown fire and higher amounts of post-fire survival as treated stands mature. Harvesting also reduced coarse fuel loads by >50% compared

to untreated stands. In the event of a post-infestation wildfire the removal of coarse fuels would reduce the duration and magnitude of soil heating associated with combustion of heavy fuels that is known to damage plant root systems and soil biota, to increase soil losses and to delay post-fire ecosystem recovery.

Full details of findings can be found in Collins et al. 2012 and associated science delivery products (Appendix 1).

Deliverables and Accomplishments

Deliverable	Accomplishment	Date
FMO/Silviculture & MPB Managers Field Tour	"Managing Post-Beetle Outbreak Forests, Fuels and Fire"	Aug-12
Presentations	Rhoades, C.C., K. Elder, R.M. Hubbard, B.J. Collins, M.A. Battaglia, P. Fornwalt. Initial responses to Colorado's bark beetle outbreak. <i>Oral presentation</i> Bark Beetle Cooperative, Breckenridge, CO.	Apr-11
	Rhoades, C.C. <i>Oral presentation</i> Blue River Watershed Council, Dillon, CO.	Jun-11
	B.J. Collins, M.A. Battaglia, C.C. Rhoades, R.M. Hubbard. Future stand development and potential fire behavior following mountain pine beetle and harvesting in Colorado lodgepole pine stands. <i>Poster presentation</i> Ecological Society of America, Annual Meeting, Austin, TX.	Aug-11
	Rhoades, C.C., R.M. Hubbard, K. Elder, D. Pierson, B.J. Collins. Soil nitrogen and carbon responses to salvage harvesting alternatives in pine beetle-infested, Colorado forests. <i>Oral presentation</i> Soil Science Society of America, Annual Meeting, San Antonio, TX.	Oct-11
	Elder, K., C.C. Rhoades, R.M. Hubbard. Effects of mountain pine beetle and forest management on water quantity, quality and forest recovery-North Platte and Upper Colorado river basins. <i>Oral presentation</i> North Platte Basin Round Table, Walden, CO.	Oct-11
	Rhoades, C.C., K. Elder, R.M. Hubbard. Ecosystem responses to mountain pine beetle & management in Colorado forests. <i>Oral presentation</i> Western Water Assessment, Water and Bark Beetle Workshop, Salt Lake City, UT.	Dec-11

	Rhoades, C.C., M.A. Battaglia, B.J. Collins, R.M. Hubbard. Salvage logging reduces fire risks after bark beetle outbreaks in lodgepole pine forests. <i>Oral presentation</i> Future Forests Webinar, Fort Collins, CO.	Jan-12
	Collins, B.J., C.C. Rhoades, R.M. Hubbard, P.J. Fornwalt, M.A. Battaglia, K. Elder. Ecosystem changes after mountain pine beetle and salvage logging in Colorado subalpine forests. <i>Poster presentation</i> . Rocky Mountain National Park Research Conference, Estes Park, CO	Mar-12
	Collins, B.J., C.C. Rhoades, R.M. Hubbard, K. Elder, M.A. Battaglia, P.J. Fornwalt. Ecosystem changes following pine beetle and salvage logging in Colorado subalpine forests. <i>Invited oral presentation</i> , Northern Front Range Mountain Pine Beetle Working Group Meeting, Longmont, CO	Mar-12
	Rhoades, C.C., B.J. Collins*, R.M. Hubbard, K. Elder, M.A. Battaglia, P.J. Fornwalt. Ecosystem changes after pine beetle and salvage logging in Colorado subalpine forests. <i>Invited oral presentation</i> , 20 th High Altitude Revegetation Workshop, Fort Collins, CO (*presenter)	Mar-12
	Rhoades, C.C., B.J. Collins*, R.M. Hubbard, K. Elder, M.A. Battaglia, P.J. Fornwalt. Ecosystem changes after pine beetle and salvage logging in Colorado subalpine forest. <i>Invited oral presentation</i> , Front Range Fuels Treatment Partnership Implementers' Meeting, Lakewood, CO (*presenter)	Mar-12
Peer-Review Publication	Collins B.J., Rhoades, C.C., Battaglia, M.A., Hubbard, R.M. 2012. The effects of bark beetle outbreaks on forest development, fuel loads and potential fire behavior in salvage logged and untreated lodgepole pine forests. <i>Forest Ecology and Management</i> . 284: 260-268.	Sept-12
Technical / Science Delivery Products	Bark Beetles and Fire: Two Forces of Nature Transforming Western Forests. Joint Fire Sciences Program, <i>Fire Science Digest</i> Volume 12, 16 pp.	Feb-12
	Collins B.J., Rhoades, C.C., Battaglia, M.A., Hubbard, R.M. 2012. Effects of salvage logging on fire risks after bark beetle outbreaks in Colorado	Sept-12

	<p>lodgepole pine forests. <i>Fire Management Today</i> 72(3): 18-22.</p> <p>From Death Comes Life: Recovery and Revolution in the Wake of Epidemic Outbreaks of Mountain Pine Beetle. US Forest Service, Rocky Mountain Research Station, <i>Science You Can Use Bulletin</i> 1(1), 8 pp.</p> <p>From Death Comes Life: Recovery and Revolution in the Wake of Epidemic Outbreaks of Mountain Pine Beetle. US Forest Service, Rocky Mountain Research Station, <i>Science You Can Use Bulletin</i> 1(1), 8 pp.</p>	<p>Oct-12</p>
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Appendix 1 Products

- 1) Collins B.J., Rhoades, C.C., Battaglia, M.A., Hubbard, R.M. 2012. The effects of bark beetle outbreaks on forest development, fuel loads and potential fire behavior in salvage logged and untreated lodgepole pine forests. *Forest Ecology and Management* 284: 260-268.
- 2) Collins B.J., Rhoades, C.C., Battaglia, M.A., Hubbard, R.M. 2012. Effects of salvage logging on fire risks after bark beetle outbreaks in Colorado lodgepole pine forests. *Fire Management Today* 72(3): 18-22.
- 3) "From Death Comes Life: Recovery and Revolution in the Wake of Epidemic Outbreaks of Mountain Pine Beetle." US Forest Service, Rocky Mountain Research Station, *Science You Can Use Bulletin* 1(1), 8 pp.
- 4) "Managing Post-Beetle Outbreak Forests, Fuels and Fire." 21 August 2012, FMO/Silviculture & MPB Managers Field Tour Handouts.