New Proposal

TITLE: BARK BEETLE OUTBREAKS IN PONDEROSA PINE AND DOUGLAS-FIR FORESTS: IMPLICATIONS FOR FUELS, FIRE, AND MANAGEMENT UNDER DIFFERENT CLIMATE SCENARIOS
INT-F-09-01
LOCATION: National Forests in South Dakota and Wyoming
DURATION: 2 year project **FUNDING SOURCE**: Fire Plan EM
PROJECT LEADER: Carolyn Sieg, USFS RMRS, Flagstaff, 928-556-2151, csieg@fs.fed.us
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PROJECT OBJECTIVES:
1. Quantify fuels in forest stands experiencing a) high levels of bark beetle-caused ponderosa pine and Douglas-fir mortality, b) high tree mortality followed by vegetation treatments (restoration, sanitation, salvage, fuels reduction), and c) no tree mortality.
2. Model fire behavior in these stands under different climate, management, and restoration scenarios.

JUSTIFICATION:
Previous studies in other geographic locations and with other bark beetle-host systems have demonstrated that bark beetle outbreaks can affect fire behavior attributes (predicted flame length, fire rate of spread, torching) due to increased fuel loading, higher wind speeds and quicker drying of fuel (reviewed by Jenkins et al. 2008). These findings can have profound implications for managing dead trees resulting from extensive bark beetle outbreaks and restoration of damaged ecosystems.

Linkage to FHM Detection Monitoring: FHM aerial detection surveys (ADS) found more than 150,000 acres of ponderosa pine impacted by mountain pine beetle in the Black Hills between 2002-2008. Douglas-fir beetle outbreaks have been detected by ADS in both the Shoshone NF 120,000 acres and Bighorn NF 10,000 acres over the same time period. Previously FHM-funded studies conducted by our team documented the effects of wildland fires contributing to Douglas-fir beetle outbreaks in Wyoming (McMillin and Allen 2003). These events have had profound political, social, and ecological importance throughout the Black Hills and Wyoming and dramatic impacts on public perceptions of forest health. As a result of these landscape level impacts and the pervasive occurrence of high density overstocked stands, agencies and communities throughout the West are implementing various vegetation treatments to decrease standing and surface fuels. However, it remains unclear how these treatments are affecting fire behavior following a bark beetle outbreak.

Significance in terms of geographic scale: Landscape-level bark beetle outbreaks have occurred throughout the Western US during recent years in response to dense forest conditions, drought, and fire (Fettig et al. 2007). Climate change has also been implicated as a primary factor contributing to the extent and magnitude of these outbreaks (Carroll et al. 2004). Results from our study will extend our knowledge of how these outbreaks and subsequent vegetation treatments influence fire behavior in ponderosa pine and Douglas-fir forests of the western US.

Biological impact and/or political importance of the issue related to fire: Wildland fires, bark beetle outbreaks, and forest management are politically charged issues throughout the West. With the extent of bark beetle outbreaks and post-outbreak vegetation treatments being implemented throughout the West, we need to improve our knowledge of how these outbreaks and treatments are influencing fuel loading, fire behavior, and other aspects of forests. For example, if vegetation treatments (restoration, sanitation, salvage) reduce short- and long-term stand fire risk, we need to state that. Conversely, if they do not, we need to know why not. Furthermore, treatments may be having other important biological impacts on

forest ecosystem function, such as changes in nutrient cycling, non-native invasive plant spread, and coarse woody debris.

Feasibility of the project being successfully completed within 1-3 years: Numerous outbreaks and subsequent vegetation treatments have occurred over the last decade in both forest types in South Dakota and Wyoming (Harris 2005). Using ADS data and information on vegetation treatments provided by silviculturists and foresters on the Black Hills, Shoshone, and Bighorn National Forests, we have already determined locations for study. Our team has experience in documenting the effects of bark beetle outbreaks, collecting and analyzing fuel loading, and modeling fire risk in a variety of forest types in a timely manner (McMillin and Allen 2003, Hoffman et al. 2007, Hoffman et al., in prep).

Priority Issues addressed from Request for Proposals: The proposed study will address four of the 5 Priority Issues listed: Climate change; Fire risk and fuel loading; Ecological impacts of fires; Restoration of ecosystems. Bark beetle outbreaks are affecting fire risk and fuel loading. We will quantify how these effects can be modified by post-outbreak vegetation (including restoration) treatments under varying climate scenarios.

BACKGROUND:
Increased surface fuels as a result of outbreaks can affect fire behavior; however, studies examining these relationships have been limited to mid- to high-elevation forest types (Douglas-fir, lodgepole pine, spruce-fir) (reviewed by Jenkins et al. 2008). Similar work is essential in lower elevational forest types, such as ponderosa pine, that are widespread throughout the West (Jenkins et al. 2008). The proposed research will increase our ability to assess risk (i.e., when and where post-outbreak treatments are needed to reduce fire hazard) and management planning (i.e., providing carbon for societal and ecosystem health and sustainability) in an uncertain future.

METHODS:
We will install fixed radius plots with similar pre-mortality stand and site conditions, but varying levels of tree mortality, time since mortality, and post-mortality treatments. Canopy and surface fuels will be quantified using standardized methodology (Brown 1974, Fulé et al. 2001). We will model predicted fire behavior across the treatments and over a range of climatic scenarios using the NEXUS Fire Behavior and Hazard Assessment system (Scott and Reinhardt 1999). This system estimates fire intensity, spread, flame length, wind speeds required for fires to transition from surface to crown fires, and the proportion of various fire types (such as surface or crown). NEXUS, which links separate models of surface and crown fire behavior to assess crown fire potential of a given stand, relies on Rothermel's (1991) equations to predict fire rate of spread and Byram's (1959) equation to predict fire line intensity. These are the most commonly used equations in the United States for estimating fire behavior attributes (Pastor et al. 2003). We successfully used this approach to assess bark beetle outbreaks (Hoffman et al., in prep) and dwarf mistletoe (Hoffman et al. 2007) effects on fuel loading in ponderosa and piñon pine stands in Arizona.

Products: Primary products will be technical reports and peer-reviewed manuscripts. Transfer of information to land managers through local and regional meetings, and via web-based media products.

Schedule of Activities:
Year 1. Collect plot data on fuel loading from ponderosa pine forests in the Black Hills, South Dakota and Wyoming. Run fire behavior models. Complete progress report and summarize findings in a poster at the FHM Working Group meeting.
Year 2. Collect plot data on fuel loading from Douglas-fir forests in Wyoming. Run fire behavior models. Complete final report, technical reports, and peer-reviewed manuscripts.

Citations:

Brown, J.K. 1974. Handbook for inventorying downed woody material. Gen.Tech. Rep. INT-16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 20 p.
Byram, G.M. 1959. Combustion of Forest Fuels. Pp. 61-89 in Forest Fire; Control and Use. McGraw-Hill, NY.
Carroll, A., et al. 2004. 2004. Effects of climate change on range expansion by the mountain pine beetle in British Columbia. In: T.L. Shore, J.E. Brooks, J.E. Stone, eds. Mountain Pine Beetle Symposium: challenges and Solutions. Canadian Forest Service, Victoria, BC. Inf. Rep. BC-X-399. pp. 223−232.
Fettig, C.J., K.D. Klepzig, R.F. Billings, A.S. Munson, T.E. Nebeker, J.F. Negrón, and J.T. Nowak. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. For. Ecol. Manage. 238: 24-53.
Fulé, P.Z., A.E.M. Waltz, W.W. Covington and T.A. Heinlein. 2001. Measuring forest restoration effectiveness in reducing hazardous fuels. J. For. 99: 24-28.
Harris, J.L., comp. 2005. Forest Insect and Disease Conditions in the Rocky Mountain Region, 2004. USDA For. Serv., Rocky Mountain Region, Renewable Resources. R2-05-09. 31 p
Hoffman, C., R. Mathiasen and C.H. Sieg. 2007. Dwarf mistletoe effects on fuel loadings in ponderosa pine forests in northern Arizona. Can. J. For. Res. 37: 662-670.
Hoffman, C., J.D. McMillin, C.H. Hull Sieg and P.Z. Fulé. Influence of bark beetle caused mortality on fuel loadings and crown fire hazard in southwestern ponderosa pine stands. In preparation.
Jenkins, M.J., E. Hebertson, W. Page and C.A. Jorgensen. 2008. Bark beetles, fuels, fires and implications for forest management in the Intermountain West. For. Ecol. Manage. 254: 16-34.
McMillin, J.D. and K.K. Allen. 2003. Effects of Douglas-fir beetle (Coleoptera: Scolytidae) on forest overstory and understory conditions in the Rocky Mountains. WNAN 63: 498–506.
Pastor, E., E. Planas and J. Arnaldos. 2003. Mathematical models and calculation systems for the study of wildland fire behavior. Prog. Energy Combust. 29: 139-153.
Rothermel, R.C. 1991. Predicting behavior and size of crown fires in the Northern Rocky Mountains. USDA For. Serv. Res. Pap. INT-143.
Scott, J.H. and E.D. Reinhardt. 1999. NEXUS fire behavior and hazard assessment system. Software program available from Systems for Environmental Management, Missoula, MT.

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR 1				
Administration	Salary	24,000*	20,000	FHP, RMRS, U of ID
	Overhead			
	Travel	6,000*	1,500	FHP Base
Procurements	Contracting			
	Equipment			
	Supplies	2,000		
Total, Year 1		32,000	21,500	
	Item	**Requested FHM EM Funding**	**Other-Source Funding**	**Source**
YEAR 2				
Administration	Salary	25,000*	20,000	FHP, RMRS, U of ID
	Overhead			
	Travel	7,000*	1,500	FHP Base
Procurements	Contracting			
	Equipment			
	Supplies	2,000		
Total, Year 2		34,000	21,500	

Budget explanation

*Costs for hiring two GS-4/5 seasonal biological technicians and their travel expenses to collect plot data, enter data, and run fire behavior models.