TITLE: Evaluating the resiliency of ponderosa pine forests to bark beetle infestations a decade following fuel reduction treatments

LOCATION: California

DATE: 30 September 2010

DURATION: Year 1 of 2-yr project **FUNDING SOURCE:** Fire

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PROJECT OBJECTIVES: The effectiveness of fuel reduction and forest restoration treatments to increase the resiliency of ponderosa pine forests to wildfire is well established, but may have unintended effects. Our objective is to evaluate the resiliency of different structures, created by application of fuel reduction and forest restoration treatments in ponderosa pine forests, to bark beetle infestations.

JUSTIFICATION:

a. **Linkage:** Data from FHP-aerial surveys and related ground surveys, FHM-funded monitoring surveys and FIA surveys have reported significant tree mortality attributed to bark beetle outbreaks in ponderosa pine forests during recent years.

b. **Significance:** This work has implications to the management of ponderosa pine throughout its range.

c. **Biological Impact:** Bark beetle attacks modify stand structure and composition by causing tree mortality. Excessive tree mortality may impact timber production, fuel conditions, water quality and quantity, fish and wildlife populations, recreation, grazing capacity, real estate values, biodiversity, carbon storage, and cultural resources. Delayed bark beetle-caused tree mortality following fuel reduction projects may interfere with management objectives by increasing surface fuels and creating the need for additional treatments.

d. **Scientific Basis/Feasibility:** We have a strong track record of providing deliverables in a timely manner, including those originating from work previously funded by FHM-EM; and in association with work at Blacks Mountain Experimental Forest (BMEF) and Goosenest Adaptive Management Area (GAMA) (BMEF: Fettig et al. 2008, Can. J. For. Res. 38: 924-935, Fettig and McKelvey 2010, Fire Ecol. 6: 26-42; GAMA: Fettig et al. 2010, For. Sci. 56: 60-73) where we propose to conduct this work.

e. **Priority Issues:** This project will evaluate levels of tree mortality a decade after the application of fuel reduction and forest restoration treatments, and determine the resiliency of these structures to bark beetle infestations during a period of time largely dominated by drought, elevated growing season temperatures, and elevated bark beetle "pressure". To that end, climate change is expected to result in changes in the distribution of ponderosa pine and elevated levels of bark beetle-caused tree mortality within this type (Bentz et al. 2010, Bioscience 60: 602-613).

DESCRIPTION:

a. **Background:** Forest management influences the amount and distribution of bark beetle-caused tree mortality at various spatial and temporal scales. For example, silvicultural treatments may affect the health, vigor and defenses of residual trees; the size, distribution and abundance of preferred hosts; and the physical environment within forest stands (Fettig et al. 2007, For. Ecol. Manage. 238: 24-53). Tree volatiles released during harvest operations or following the application of prescribed burns include monoterpenes, which, for example, are known to influence the behavior of bark beetles, and may increase rates of attack (Fettig et al. 2006, For. Ecol. Manage. 230: 55-68) and associated levels of tree mortality (DeGomez et al. 2008, AZ1448).

Recently, elevated populations of bark beetles have been observed in all conifer types heightening public awareness of the issue and triggering concerns about short- and long-term impacts to the forested landscape. In California, highly-effective fire suppression and selective harvesting of large-diameter, fire-tolerant tree species, such as ponderosa pine and Jeffrey pine, have resulted in substantial changes to the structure and composition of many forests, and in many cases, making them more susceptible to bark beetle attack. Today, mechanical thinning and the application of prescribed fire are commonly used to restore late-seral conditions and reduce fuel loads, but the propensity for some bark beetles and other forest pests to attack fire-injured trees has led to questions regarding how management objectives may be impacted by levels of delayed tree mortality attributed to bark beetle attack.

b. **Methods:**

In this effort, cruises will be conducted during the tenth year (field season) after the application of prescribed fire at each site (BMEF = 2011; GAMA = 2012). Primary variables of interest are the mean percentage of trees killed by (1) all bark beetle species across all tree species, (2) individual bark beetle and tree species, and (3) individual bark beetle by tree species and diameter class. Relationships between measures of stand density and levels bark beetle-caused tree mortality, and temporal trends of tree mortality (as related to abiotic conditions) will be evaluated.

<u>Site 1 - Blacks Mountain Experimental Forest</u>. BMEF (40°40’ N, 121°10’ W; 1700-2100 m elevation) is located on the Lassen National Forest, California. In the late 1990s, 12 experimental plots (77-144 ha) were established to create two distinct forest structural types: mid-seral stage (low structural diversity; LoD) and late-seral stage (high structural diversity; HiD). Structures were randomly assigned to four experimental plots (two replicates per structure per block) within each of three blocks. LoD was created by removing larger overstory trees and small understory trees leaving only trees of intermediate size, while HiD was attained by thinning smaller trees and retaining larger trees (i.e., thinning from below). Following harvesting, half of each plot was treated with prescribed fire in fall. Fettig et al. (2008) describe the climatic conditions, fuel moistures and other parameters that occurred during prescribed burns. Oliver (2000, PSW-GTR-179) and Zhang et al. (2008, Can. J. For. Res. 38: 909-918) provide comprehensive accounts of treatments and forest conditions.

<u>Site 2 – Goosenest Adaptive Management Area</u>. GAMA (41°30’ N, 121°52’ W; 1500-1780 m elevation) is located on the Klamath National Forest, California. Adaptive management areas were established to provide forest managers with areas in which to test and evaluate different management activities. The intended focus for GAMA is “Development of ecosystem management approaches, including use of prescribed burning and other silvicultural techniques for management of pine forests, including objectives related to forest health, production and maintenance of late-successional forest and riparian habitat and commercial timber production”. Treatments applied at GAMA include: (1) untreated control – no manipulation (C), (2) burn – prescribed burning in the fall (B), (3) thin – thinning from below and selection harvest with leave trees including all stems >76.2 cm dbh regardless of tree species, all sugar pine and incense cedar, and all codominant and dominant ponderosa pine (T), and (4) T + B – thinning from below and selection harvest followed by prescribed fire in fall. Implementation of treatments (exclusive of the untreated control) was guided by a desired future condition uniquely defined for each stand such that if a stand were impacted by a head fire under 80th percentile weather conditions ≥80% of the basal area of overstory trees would survive. Each treatment was randomly assigned to three experimental units (n = 12) 10-ha in size exclusive of buffers. Ritchie (2005, PSW-GTR-192) provides a comprehensive account of treatments and forest conditions.

c. **Products:**

- FHM Working Group presentations (two poster presentations as per RFP)
- Bark Beetle Technical Working Group presentation (oral); Western Forest Insect Work Conference (paper)
- Forest Science and/or Forest Ecology and Management (scientific/managerial papers)

d. **Schedule of Activities:**

Activity	Date
1. Study plan	Completed
2. Procure data at BMEF	May-July 2011
3. Collate data; prepare progress report/poster	Fall 2011
4. Procure data at GAMA	May-July 2012
5. Collate data; prepare progress report/poster	Fall 2012
6. Final report/poster; peer-reviewed publications submitted	Spring 2013

COSTS:

	Item	**Requested FHM EM Funding**	**Other-Source Funding**
YEAR - 2011			
Administration	Salary	23,364[1]	62,114[1]
	Overhead	673	
	Travel	7,200[2]	
Procurements	Contracting		
	Equipment		2,500[3]
	Supplies		
Total		**31,237**	**64,614**

	Item	**Requested FHM EM Funding**	**Other-Source Funding**
YEAR - 2012			
Administration	Salary	24,532[4]	65,220[4]
	Overhead	698	
	Travel	7,200[2]	
Procurements	Contracting		
	Equipment		2,500[3]
	Supplies		
Total		**32,430**	**67,720**

[1]GS-9 term (Sac-Yolo) for 8.5 pay periods. All others contributed by PSW and FHP.
[2]$144/day for 50 days. Any others to be contributed by PSW.
[3]Vehicles and mileage contributed by PSW.
[4]GS-9 term (assume 5% increase from 2011) for 8.5 pay periods. All others contributed by PSW and FHP.