

Title: Bugs & Burns: Effects of Fire on Ponderosa Pine Bark Beetle

LOCATION: Northern Arizona and Eastern New Mexico

INT-F-07-02

DURATION: Year 1 of 3-year project **FUNDING SOURCE:** Fire

PROJECT LEADER: Tom DeGomez, University of Arizona, Forest Health Program, 928-523-8385, degomez@ag.arizona.edu

COOPERATORS: John Anhold, Region 3, FHP; Tom Kolb, Northern Arizona University; Chris Hayes, University of Arizona; Kelly Williams, University of Arizona, Mike Manthei, Coconino N.F.

PROJECT OBJECTIVES:

1. Quantify long-term effects of operational prescribed fire on bark beetle attacks in ponderosa pine-dominated stands of Arizona and New Mexico.
2. Identify the species of bark beetles in prescribed burned and unburned ponderosa-pine dominated stands in Arizona and New Mexico.
3. Assess the utility of using measures of pre-fire bark beetle populations as predictors of future bark beetle caused mortality at prescribed fire sites. Quantify species of beetles and stand conditions in ponderosa pine dominated stands prior to igniting control burns.

JUSTIFICATION:

Linkage to FHM Detection Monitoring: Aerial and ground detection surveys have determined that trees continue to die for several years after fire from a combination of direct damage from fire and bark beetle attacks (USFS 2004), yet long-term data on long-term effects of fire on tree mortality and beetle attacks is rare

Significance in terms of geographic scale: Although this project will be conducted in USFS Region 3, similar impacts from fire are experienced throughout the range of ponderosa pine.

Biological and political importance: Management practices in the past have left many forests and woodlands in the Southwest US with high tree density and more susceptible to bark beetle outbreaks and stand-replacing wildfires (Covington and Moore 1994a, 1994b; Kolb et al. 1994). Forest managers have been conducting understory burning in conjunction with overstory thinning to reduce stand density. Prescribed fires, however, have led to the eventual death of some residual trees due to acute or non-lethal tissue damage, leading to bark beetle attacks. Both wildfire and bark beetle threats are important issues facing communities within the wildland urban interface. It is important that work to reduce the threat of wildfire does not exacerbate the bark beetle situation. Therefore, a better understanding of the relationship between fire and bark beetles is needed.

Feasibility or probability that the project will be successfully completed: Protocols for this work have been tested during other successful projects conducted by the PI's. We have qualified staff and infrastructure to conduct all aspects of the project. We have already collected three years of data in support of objectives 1 and 2.

DESCRIPTION:

a. Background: Fire-damaged trees can be killed by bark beetles that otherwise would have survived (McCullough et al. 1998, McHugh et al. 2003). Wallin et al. (2003) found that fire weakens a tree's defense against bark beetles. An unacceptable level of tree

mortality may occur after a controlled burn as a result of weakened tree defenses (Sullivan et al. 2003). Breece (2006) and PI Kolb monitored tree mortality in the Birds and Burns Network sites (coordinated by the USDA Forest Service Rocky Mountain Research Station) for the first three growing seasons (2004-6) after experimental implementation of prescribed fire treatments. Part I of this study will continue to monitor these sites for an additional three years. In part 2 we propose to set up additional sites in the Coconino N.F. that will monitor pre-burn bark beetle populations and stand conditions. This portion of the study will give us data prior to the burn cycle so we can identify potential indicators of future high levels of bark beetle caused mortality..

b. Methods: Part I study sites are part of the Birds and Burns Network (www.rmrs.nau.edu/lab/4251/birdsnburns) and are located in the Kaibab, Coconino and Apache-Sitgreaves National Forests of Arizona and Gila NF in New Mexico. These sites were treated and measured in 2004, 05' and 06' as follows.

Site characteristics - Stands range from ponderosa pine dominated to mixed conifer. Each 250-400 hectare site is paired with an unburned control site of similar size and stand structure. Burns were conducted in the fall of 2003 or spring of 2004. Each treatment and control site has a permanent sampling grid of 25-40 sampling stations.

Standard tree measurements - A total of 994 ponderosa pines on burned sites and 1097 on unburned control sites were sampled. Other non-dominant species such as Douglas-fir, Gambel oak, and alligator juniper were also sampled. At each sampling station a 10-meter radius circular permanent plot (0.03 ha) was established. Within each plot, all trees >13cm dbh were tagged and measured for tree species, diameter at breast height (dbh), tree height, length of live crown and live crown ratio.

Assessment of fire damage to trees - All trees at prescribed fire sites were measured for bole char severity; char height and direction; % of the bole circumference charred; % of crown scorched by fire; % of crown consumed by fire; length of the pre-fire live crown and the percent of the crown volume with green needles; and needles that were black or consumed by the fire (McHugh and Kolb 2003).

Bark beetle sampling - Each spring and fall of 2004-2006 each sample tree was examined for mortality and bark beetle activity. We assigned each tree an insect attack rating (IAR). If a tree had an IAR of 1 or 2 (partial or mass attack), and 75% or more of the crown was fading, a 30 x 30 cm section of the bark was cut out on the north side of the tree at heights of 1m, 3m, 5m, and 7m. Each bark sample was examined for bark beetles and galleries and, if possible, identified the species of bark beetle making the galleries.

We propose to continue sampling Part I sites in 2007, 08' and 09' for bark beetle activity and tree mortality as described in the "bark beetle sampling" section above.

Part II – Four new study sites will be identified by the Coconino N.F. as areas scheduled to be burned along with paired sites that will not be burned. We will look for sites that have similar site characteristics as those used in Part I. The "standard tree measurements", as described above, will be recorded prior to burning. In addition, an array of three Lindgren funnel traps will be placed at four locations within the four sites. Each trap will be baited with a different combination of lures targeting *Ips pini*, *Ips lecontei* and *Dendroctonus brevicomis*. We have found that this array of traps is an effective monitoring system for 11 species of bark beetles in Arizona ponderosa forests (Barton et al. 2005). Trap catches will be collected weekly (mid April – early Sept.) each of the years. After burning we will conduct "assessment of fire damage to trees" and "bark beetle sampling" as described above.

c. Products: Evaluation monitoring and technical reports will be sent to Northern Arizona forest managers and planners on the extent and severity ponderosa morality following burning. This information will also be useful for agencies outside the Forest Service, i.e. State Land, Fish and Game, Bureau of Indian Affairs, National Park Service, Bureau of Land Management, as well as the numerous mountain communities that are concerned with the effects of burning on forests within the urban wildland interface.

d. Schedule of Activities:

Year 1. Sample Part I sites for bark beetle activity and mortality. Establish Part II sites, monitor bark beetle populations with Lindgren funnel traps, assess damage to scorched trees, and sample bark beetle activity. (Manthei will locate study sites in Coconino N.F. Hayes and Williams will conduct field and bark beetle lab work. Kolb, DeGomez and Anhold will produce the proposal and field design.)

Year 2. Revisit all plots in Part I and II and collect information on bark beetle activity and mortality. Prepare annual progress report. Prepare and present poster at the annual FHM conference. (Hayes and Williams will conduct field and bark beetle lab work. Kolb, DeGomez and Anhold will conduct data analysis and produce the annual progress report. DeGomez will produce poster and attend annual FHM Conference)

Year 3. Revisit all plots in Part I and II and collect information on bark beetle activity and mortality. Complete final analysis and report. Prepare and present poster at the annual FHM conference. (Hayes and Williams will conduct field and bark beetle lab work. Kolb, DeGomez and Anhold will conduct data analysis, produce the final report and publication. DeGomez will produce poster and attend annual FHM Conference)

COSTS:

	Item	Requested FHM EM Funding			Other-Source Funding each Year	Source
		Year 1	Year 2	Year 3		
Administration	Salary	\$28,960.	\$26,655.	\$27,450.	(each yr) \$5,000.	UA, R3 FHP Base
	Overhead	1,050.	2,165.	2,230.	(Yr. 1) 8,970. (Yr. 2) 7,838. (Yr. 3) 8,008.	UA foregone indirect costs
	Travel	4,000.	4,000.	4,000.	(each yr.) 1,000.	UA, R3 FHP Base
Procurements	Supplies	4,000.	4,000.	4,000.	650.	
Totals		\$38,010.	\$36,820.	\$37,680.	(Yr. 1) \$15,620. (Yr. 2) \$14,488. (yr. 3) \$14,658.	

Year 1: Salary & ERE – Ten weeks for technicians Hayes and Williams (\$26,500), and 1 week for Kolb (\$2,190). Field travel - \$4,000. Supplies - \$3500 for bark beetle lures and \$500 for misc.

Year 2: Salary & ERE – Seven weeks for technicians Hayes and Williams (\$22,145), and 2 weeks for Kolb (\$4,510). Field travel \$3,000 and \$1,000 FHM annual meeting. Supplies - \$3500 for bark beetle lures and \$500 for misc.

Year 3: Salary & ERE – Seven weeks for technicians Hayes and Williams (\$22,800), and 2 weeks for Kolb (\$4,650). Field travel \$3,000 and \$1,000 FHM annual meeting. Supplies - \$3500 for bark beetle lures and \$500 for misc.

UA (University of Arizona)

REFERENCES upon request

Title: Monitoring bark beetle-caused mortality and relation to fire occurrence

Location: National Forests in Colorado

INT-F-07-03

Duration: 2 years

Funding Source: Fire

Project Leader:

- Sheryl Costello, Forest Health, Region 2, Lakewood, CO

Cooperators:

- Jose Negrón, Rocky Mountain Research Station, Fort Collins, CO
- Bill Jacobi, Colorado State University, Fort Collins, CO
- Steve Gregonis, GIS Coordinator, Forest Service Region 2

Project Objectives:

1. To determine if there is a relationship between bark beetle outbreaks and subsequent occurrence of forest fires.
2. To determine if absence of fire in bark beetle-affected stands is related to weather patterns.
3. To determine if there is a pattern in time since outbreak where fire is more likely to occur given appropriate fire-conducive weather.

Justification:

Bark beetle populations are at outbreak levels in many parts of the West and in many forest types. Forest health aerial survey maps and ground surveys well document this phenomenon. The implication of extensive tree mortality and subsequent fire risk is not well understood. This is a west-wide issue in all forest types. To adequately address the question we propose to work in the National Forests in Colorado. Findings will be applicable to other Rocky Mountain forests and provide a framework for continuing work across other western states.

Risk of catastrophic fire after bark beetle outbreaks is of concern among policy makers, land managers, and the public. The assumption is that catastrophic fires will undoubtedly occur. It is crucial to rigorously examine the question with thorough approaches to better inform all concerned groups. This understanding will lead to management approaches consistent with ecological processes.

Description:

a. Background

As early as Hopkins (1909)¹ references are found indicating that fires follow bark beetle-caused tree mortality. Furniss and Carolin (1977)² also state that extensive bark beetle-caused mortality “set the stage” for devastating fires. These reports are based primarily on anecdotal and observational evidence. Little empirical work has been

¹ USDA, Bureau of Entomology, Bulletin No. 83

² Western Forest Insects, USDA Forest Service, Misc. Publication No. 1339

conducted concerning this topic. Bebi et al. 2002³ and Kulakowski et al. (2003)⁴ examined disturbances in a spruce-fir forest in Colorado and suggested that there is no relationship between bark beetle mortality and fires. Bebi et al. 2002 indicated that disturbances such as fire following bark beetles are dependent on co-occurrence with extreme weather conditions suitable for fires. Studies need to be conducted in other spruce-fir forests and other forest types to identify conditions in which fire after beetles may or may not occur.

Stuart et al. (1989)⁵ indicated that the likelihood of fire increases as fuels accumulate after a mountain pine beetle outbreak in lodgepole pine. Considering the work of Agee (1981) and Gara et al. (1985) they suggest two periods in which a fire could spread after a bark beetle outbreak: the first few years after tree fall through aerially supported fine fuels and again 50 years later when fire could spread along partially decayed logs.

Clearly this is a significant gap in knowledge that needs to be addressed so that land managers can make informed decisions and assessments of fire risk after previous and current bark beetle outbreaks.

a. Methods

We propose to use historical fire maps from Colorado in combination with aerial detection surveys, ground surveys, and spatially referenced GIS modeling to examine the relationship between bark beetles and subsequent fires. To demonstrate this relationship a number of factors need to occur concurrently. Fuels accumulated from bark beetle-caused mortality need to be present and conditions suitable for a fire must occur. We will use GIS approaches to overlay historical fire locations over aerial detection maps. The frequency of areas where fires occurred after an outbreak will be compared to the frequency of areas where a fire did not occur after an outbreak. This will be followed by a historical weather conditions analysis to determine if areas without fire after an outbreak were ever exposed to fire-conducting weather. Finally, in areas where fire occurred after bark beetles, the time since outbreak will be examined to see if there is a given time at which fire frequency increases.

b. Products

Information from this study will be of value to land managers facing catastrophic mortality to current bark beetle epidemics and determining the urgency or timing needed for managing fuels resulting from extensive tree mortality.

c. Schedule of Activities

February – March 2007	Begin GIS analysis
Summer 2007	1 st summer ground verification
Fall - Winter 2007 - 08	Continue GIS analysis and identification of gaps and need for adjustments in methods
Summer 2008	2 nd summer ground
Winter 2008 – Spring 09	Final data analysis and report preparation

³ Ecology 84: 362-371

⁴ Journal of Biogeography 30: 1445-1456

⁵ Canadian Journal of Forest Research 19: 1096-1104

d. Progress / Accomplishments

- Document relationship between beetle-caused mortality and risk of subsequent fire.
- Discern if weather influences the lack of fire in bark beetle-attacked stands.
- Determining the role of time since mortality in influencing the risk of fire.

Costs:

	Item	Requested FHM EM Funding	Other-Source Funding	Source
Year 2006				
Administration	Salary *	20,100		
	Overhead	5,180		
	Travel	2,500		
Procurements	Contracting**	5,000		
	Equipment			
	Supplies			
	Mileage	1,500		
Total		34,280		

	Item	Requested FHM EM Funding	Other-Source Funding	Source
Year 2007				
Administration	Salary *	20,100		
	Overhead	4,290		
	Travel	2,500		
Procurements	Contracting			
	Equipment			
	Supplies			
	Mileage	1,500		
Total		28,390		

*Salary for a graduate student at Colorado State University.

**Contracting funds used for additional digitizing of aerial survey prior to 1994.

