The Effects of Prescribed Fire on Bark Beetle Dynamics in Ponderosa Pine

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Introduction

Fire-damaged trees can be killed by bark beetles that otherwise would have survived (McCullough et al. 1998, McHugh et al. 2003). An unacceptable level of tree mortality may occur after a controlled burn as a result of weakened tree defenses (Sullivan et al. 2003). Breece et al.(2008) monitored tree mortality in the Birds and Burns Network sites (coordinated by the USDA RMRS) for the first three growing seasons (2004-6) after experimental implementation of prescribed fire treatments. In this project, we continue to monitor these sites and establish new study sites to: quantify long-term effects of operational prescribed fire on bark beetle attacks in ponderosa pine-dominated stands of Arizona and New Mexico; identify species of bark beetles present in prescribed burned and unburned ponderosa-pine dominated stands; assess the utility of using measures of pre-fire bark beetle populations as predictors of future bark beetle caused mortality at prescribed fire sites; and quantify stand conditions in ponderosa pine dominated stands prior to igniting control burns.

Prescribed fire in ponderosa pine stand

Dendroctonus sp. in flight

Methods

Part one

- In a prior study (Breece et al 2008), four sites in Arizona and New Mexico were burned in the fall of 2003 or spring of 2004 and then monitored in the fall of 2004, 2005, 2006 for bark beetle-induced mortality.
- In fall 2007 and 2008, these four sites were checked for beetle induced mortality.

Part two

- Four additional sites composed of a paired treatment and control (~300 ha each) were established in ponderosa pine forests in northern Arizona in summer 2007.
- Two sets of three Lindgren funnel traps were deployed for 6 wk (July -August 2007 & 2008) in each treatment (burn and control) at each site and were baited with synthetic pheromone lures designed to attract *Ips pini*, *I. lecontei*, and *Dendroctonus brevicomis.*
- 24 to 30,10-meter radius circular permanent plots (0.03 ha) were established on a sampling grid in each treatment. All trees >13cm dbh were measured for tree species, diameter at breast height (dbh), tree height, length of live crown and live crown ratio.
- Controlled burning occurred in August 2007at the Sitgreaves site and in October 2007 at the Tusayan site. The Observatory site was a failed attempt at burning and the Bill Williams site was incomplete.
- Permanent plots were visited in spring 2008 to record crown scorch, consumption, and tree mortality.
- In fall 2008 these sites were checked for beetle-induced tree mortality. Bark samples were taken from dead trees.

Table 1. Bark beetles and predators caught with pheromone baited traps over a six week period in 2007 (9 July - 20 August), prior to burning, and in 2008 (17 July - 29 August), after burning. Sitgreaves and Tusayan were burned respectiviely in August and October 2007. Numbers are total individuals caught in both trapping sites at each treatment area. (Other *Ips* = *I. lecontei, I. calligraphus,* and *I. latidens*; Other *Dendroctonus* = *D. valens, and D. approximatus;* Predators = *Enoclerus lecontei*, *E. sphegeus*, and *Temnochila chlorodia*)

		I. pini		Other *Ips*		*D. frontalis*		*D. brevicomis*		Other *Dendroctonus*		Total Predators		Total Beetles		Predator to Beetle Ratio	
Site	Treatment	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Observatory	Burn	68	17	29	7	6	12	0	1	19	8	65	54	122	45	0.53	1.20
	Control	31	24	11	6	2	2	2	1	7	23	24	77	53	56	0.45	1.38
Sitgreaves	Burn	14	58	7	9	7	2	2	0	25	19	188	453	55	88	3.42	5.15
	Control	11	12	9	3	1	5	0	0	17	17	343	222	38	37	9.03	6.00
Bill Williams	Burn	4	8	11	26	11	17	0	8	19	7	431	223	45	66	9.58	3.38
	Control	3	29	11	12	12	6	0	0	8	8	222	135	34	55	6.53	2.45
Tusayan	Burn	12	208	4	6	1	1	7	0	1	10	11	14	25	225	0.44	0.06
	Control	17	38	4	1	1	3	1	0	5	1	31	10	28	43	1.11	0.23

Results

- For the original four sites, annual ponderosa mortality in burned stands dropped from 5.0% in 2004 (one year post burn) to 0.55% in 2008 (see Figure 1).
- In fall 2008, five years post burning, bark beetle-induced mortality was low (greatest mortality was 1%) in both the burned and control blocks, and no difference between the burned and control areas could be detected.
- At the new study sites, ponderosa mortality in burned stands was < 1.0% in 2008 (one year post burn) and zero trees died in the control blocks.
- There was no significant difference in trap catches among the burn and control treatments prior to and after the prescribed burning in Fall 2007.
- Two sites (Observatory and Tusayan) had fairly low predator to beetle ratios, while the other two sites (Sitgreaves and Bill Williams) caught more predators than beetles by a factor of 3 to almost 10 fold.

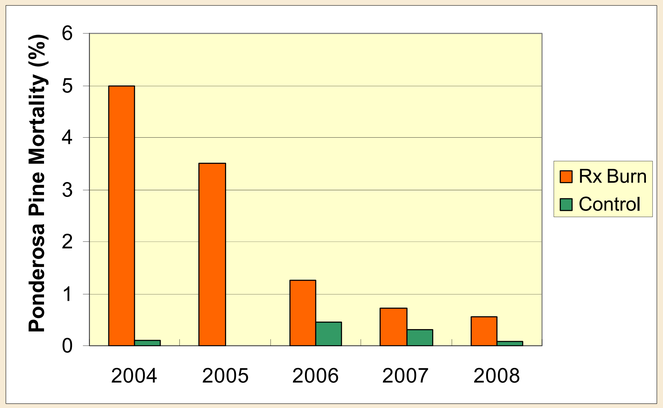

Figure 1. Annual bark beetle-induced ponderosa mortality found at sites in Arizona and New Mexico

Discussion

- In the Southwest under endemic beetle population levels, beetle-induced tree mortality levels may be expected to return to background levels within four years after burning.
- More long-term monitoring should be conducted to confirm this trend.
- Overall, beetle and predator populations did not appear to be greatly impacted by prescribed fire treatments one year after burning. Also tree mortality was not impacted by fire induced bark beetle attacks.
- Continued population monitoring would be beneficial for evaluating long term effects of prescribed burning on bark beetle dynamics.
- Differences in predator-to-prey ratios at our new sites presents an opportunity to study the importance of this relationship on post-fire beetle-induced mortality.

References

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