Fuel Dynamics in South Pine Beetle Killed Stands and its Implication to Fire Behavior

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TITLE: Fuel Dynamics in South Pine Beetle Killed Stands and its Implication to Fire Behavior

LOCATION: National Forests in South Carolina

DATE: 2010 continue project

DURATION: Year 2 of a 2-year project **FUNDING SOURCE:** Fire Plan

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PROJECT OBJECTIVES: The objective of this project is to study fuel dynamics and its implication to fire behavior in forest stands killed by southern pine beetle (SPB). Specifically, we will measure fuels in healthy stands and stands killed by SPB outbreak at different years so that fuel dynamics (i.e., change with time since SPB kill) can be characterized and compared with healthy stands. Based on measured fuel data, we will model fire behavior using BehavePlus to understand the consequences of fuel changes.

JUSTIFICATION: Based on results from FHM Detection Monitoring, SPB (*Dendroctonus frontalis*) is the most serious pest of pine forests throughout the southern US. Because of increased severity of drought, recent outbreaks have been among the worst ever, and South Carolina was the most severely impacted State in 2002, with 25,000 outbreak spots. Since 2001, South Carolina alone has detected over 92,000 beetle-killed spots and the death of approximately 25 million trees, commercially valued at over $300 million. Severe outbreaks can produce 100 percent mortality of pines over an area of a hectare or more, and dead pines fall within one to two years. As a result, fuel loading in these SPB-killed spots increases suddenly and dramatically soon after SPB outbreak, representing a serious fire hazard with extreme fire behavior. Over time, this unique fuel complex will also change gradually due to natural decomposition. However, few studies have quantified fuel characteristics of SPB-killed stands, and none has studied the dynamics of this fuel complex. Moreover, how changes in fuels affect fire behavior remains unknown. To impair the ability of beetles to reproduce in the remaining stand, silvicultural treatments such as cut and remove (in which beetle infested trees are felled and removed from the site) or cut and leave (in which the felled trees remain on site) are commonly utilized after the outbreak. Very little is known about the effects of these treatments on fuel dynamics and fire behavior.

Our project will use a combination of field measurements and modeling to study fuel dynamics in SPB killed stands and its implication to fire behavior. Although our field data collection will be conducted in national forests of South Carolina, our results will be generally applicable to the entire Southern US. More importantly, our study will help managers to predict fire behavior associated with the fuel complex resulted from current and past SPB outbreaks. Understanding fuel dynamics and its implication to fire behavior is essential for managers to make fuel management decisions especially when prescribed fire is used.

DESCRIPTION:

a. Background: Increased SPB outbreaks in recent decades have significantly affected forests in the southern US, where pines are dominant timber species. With the predicted increase in drought frequency and severity due to climate change (Smith and Tirpak 1990), SPB outbreaks will likely increase in the future (Gan 2004). In addition to economic loss, SPB outbreaks greatly increase fire hazard due to accumulation of extremely high fuel loads. Severe outbreaks can produce 100 percent mortality of pines over an area of a hectare or more, and dead pines fall within one to two years. As a result, fuel loading in these SPB-killed stands increases suddenly and dramatically soon after SPB outbreak. Silvicultural treatments have been studied for its effectiveness to control spread (e.g., Hertel and Wallace 1983) and reduce stand susceptibility to SPB (e.g., Turchin et al. 1999). One of the common silvicultural treatments applied on national forests is 'cut and leave'. Although this treatment proved effective in disrupting and reducing beetle spread to healthy trees, it has left a large amount of fuel that is similar to that of untreated stands. This elevated fuel loading may result in fires with extreme behavior, which may affect ecosystems in undesirable ways. Surprisingly, characterizing the fuel complex in SPB-killed stands with or without subsequent silvicultural treatments has not been conducted, and how this fuel complex changes with time since SPB outbreak, due to natural decomposition, remains largely unknown. Past research efforts on SPB have been focused on the biology, population dynamics, and control of this insect (e.g., Klepzig 1998) as well as on how forests regenerate or recover after SPB outbreaks (e.g., Coleman et al. 2008).

Although using fire in SPB spots would help reduce fuel loading (thus the risk of intense and/or severe wildfire) and achieve other management objectives at the same time, prescribed fire is seldom applied because of the lack of knowledge of fire behavior. For example, large fuels, such as logs over 10 cm in diameter, can greatly alter fire behavior and smoke production. With detailed fuel data, fire behavior can be modeled under various burning conditions using BehavePlus, a modeling system that described fire behavior, fire effects, and fire environment (Andrews et al. 2003). In a recent study, we have experimentally burned SPB killed stands under various conditions, these data may be used to evaluate our model predictions from BehavePlus.

b. Methods: Our study areas will be national forests located in the South Carolina Piedmont, where loblolly pines are dominant and many SPB outbreaks have occurred in the past. Within the study area, 50-100 loblolly pine stands killed by SPB outbreak at different years will be identified based on existing records and aerial photos. These stands will form a chronosequence, spanning from current outbreak to at least 10 years since the outbreak. In addition, a minimum of 10 healthy loblolly pine stands will also be identified. On each identified stand, down woody fuels will be measured using the planar intercept method (Brown 1974). Three 15 m transects will be established at each of 4 randomly-selected points within each stand. One- and 10-hour fuels intercepts will be counted along the first 1.8 m and 100-hour fuels will be counted along the first 3.6 m. Fuels in the 1000-hr class will be recorded by species, diameter, and decay class along the entire 15-m transect. Aboveground height of dead and down wood will be measured along 30 cm sections beginning at 4, 8, and 12 m. Litter and duff depth will be measured to the nearest 1 mm at 4, 8 and 12 m along every transect. Pine regeneration will be aged to help determine the outbreak date. Any silvicultural treatment applied after the outbreak will be recorded.

Counts of 1-, 10-, 100- and 1000-hour fuels obtained from transect sampling in the field will be converted to weights using equations given by Brown (1974). Litter and duff weight will be converted using regression equations developed Waldrop et al. (2004). Changes in fuels along the chronosequence will be quantified using regression (fuel loading vs. year-since-outbreak) and/or analyses of variance (breaking the chronosequence into groups). Fuels in the SPB-killed stands along the chronosequence will also be compared to healthy pine stands using a simple t-test. Based on measured fuel data, fire behavior under various burning conditions will be modeled using BehavePlus. Data collected from our recent experimental burn of SPB-killed stands will be acquired and used to evaluate predictions from BehavePlus. Under each modeled burning condition, changes in fire behavior along the chronosequence will be quantified and compared to healthy pine stands.

c. Products: Soon after funding approval, an outline of the research project will appear on website. By the end of the project, a MS thesis and a final report will be completed by the graduate student working on the project, and a manuscript will be submitted for publication at a refereed journal.

d. Schedule of Activities: The proposed project is for two years starting in January 2009 and ending December 2010. Each major activity and its starting date are listed below:

01/2009 – Identify study stands

02/2010 – Modeling and data analysis

05/2009 – Field sampling
11/2009 – Data entry and processing
07/2010 – Prepare final report and a manuscript

e. Progress/Accomplishments: The project started in June 2009 when funding was received, instead of the original start of January 2009. Therefore, the above schedule of activities is pushed back by 5 months, and we anticipate the project will be finished by May 2011, instead of December 2010. During past 3+ months, we worked closely with local Ranger District Offices to identify potential study stands. We also expanded our originally propose study area (SC national forests) to include Oconee National Forest in Georgia where recent (2007-2008) SPB outbreaks were found. Based on careful examination of available information and extensive field search, we have so far identified suitable stands representing 1-2 year (dead tree still standing), 3-4 year (most dead tree just fell on the ground), and 7-8 year since SPB outbreak. We are currently working with Steve Wilhelm (Long Cane Ranger District) and Tim Walker (Oconee Ranger District) to find stands killed by SBP 10+ years ago. We just started field sample on September 28.The following is a revised schedule of activities for the project:
06/2009 – Identify study stands (complete)
10/2009 – Field sampling
04/2010 – Data entry and processing
07/2010 – Modeling and data analysis
12/2010 – Prepare final report and a manuscript
05/2011 – Project completion, final report submitted

Costs (Total = $47,559)

	Item	Requested FHM EM Funding	Other-Source Funding	Source
Year 2				
Administration	Salary	$30,526		
	Overhead	$15,533		
	Travel	$1,000		
Procurements	Supplies	$500		

Budget Narrative: Salary: graduate assistantship (including fringe) = $18,918/ year. One month summer salary for project leader (including fringe) = $11,608. **Overhead = 48.5% of total direct costs.** Travel = $1,000. Supplies = $500.

f. Literature Cited:

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