TITLE: Effects of Spruce Beetle (SB) Outbreaks on Fuels, Carbon and Stand Structure and Composition in Utah and Western Wyoming

LOCATION: Utah and Wyoming

DATE: 30 September 2012

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

PROJECT LEADER: Chris Fettig, Team Leader, Pacific Southwest Research Station; 530-759-1708; cfettig@fs.fed.us

COOPERATORS (Co-PIs): Steve Munson, Group Leader, FHP (Ogden); Justin Runyon, Research Entomologist/Invasive Plants, RMRS (Bozeman); Darrell Ross, Professor, Oregon State University (OSU); Dan Ott, Graduate Student, OSU

FHP SPONSOR/CONTACT: Steve Munson; 801-476-9720 (ext. 219); smunson@fs.fed.us

PROJECT OBJECTIVES: To quantify changes in forest fuels, carbon and other stand attributes associated with SB outbreaks in spruce-fir forests. Specifically, to document residual stand structure and composition associated with ground, surface and aerial fuel loads; tree age, size and species diversity; regeneration; invasive plants; and snag demography over multiple years.

JUSTIFICATION:

a. **Linkage to FHM program:** Data from FHM, FIA and FHP-sponsored surveys, among others, have reported significant tree mortality attributed to SB outbreaks in the western U.S. For example, >173,000 ha were impacted in 2011, similar to levels in 2010 (Mann 2012). In the Intermountain Region, substantial levels of SB-caused tree mortality were mapped on the Uinta-Wasatch-Cache, Fishlake and Bridger-Teton national forests in 2011. Preliminary results from the 2012 aerial survey suggest significant increases in SB-caused tree mortality occurred in both northern Utah and western Wyoming. Landscape level impacts occurred on the Manti-LaSal and Dixie national forests in central and southern Utah during 1990-2005.

b. **Significance/Impact of forest health issue:** SB is the most significant mortality agent of mature spruce in the U.S. (Holsten et al. 1999). The scope of this work encompasses areas where much of the SB-caused tree mortality has occurred in the continental U.S. since 1990 prompting questions about associated impacts to forests. Given recent experiences with mountain pine beetle in the Intermountain West, citizens and state and federal agencies alike are concerned about increases in hazardous fuels in spruce-fir forests due to SB outbreaks and the potential for extreme fire behavior to occur (Jorgensen and Jenkins 2011), especially in light of reduced snowpacks (Pederson et al. 2011) that have historically regulated the length of the fire return interval (i.e., typically >100 years) in these systems. Wildfire activity in forests impacted by SB occurred in Utah in 2012. Furthermore, SB outbreaks are expected to increase in extent and severity throughout the Intermountain as a result of climate change (Bentz et al. 2010).

SB outbreaks modify stand structure and composition by causing tree mortality, and impact timber and fiber production, fuel conditions, fire risk and severity, water quality and quantity, fish and wildlife populations, recreation, grazing capacity, real estate values, human safety, biodiversity, carbon pools, aesthetics, endangered species and cultural resources. Preliminary observations suggest that invasive plants may increase in SB-affected forests. Forests that were once carbon sinks may become carbon sources as large amounts of CO_2 are released when forests experience high levels of tree mortality. Alternatively, resilient forests have the potential to assimilate, accumulate, and sequester large amounts of carbon from the atmosphere, thus reducing one of the primary drivers of climate change.

c. **Scientific basis:** All methods are commonly recognized in the scientific literature and informed by previous work associated with FHM-EM. Our team has a strong track record of providing deliverables in a timely manner, including those originating from work previously funded by FHM-EM.

d. **Cost/economic efficiency:** The costs associated with this work are reduced through cost-sharing with FHP, PSW, OSU, and RMRS.

e. **Priority issues:** Several Fire Plan EM priorities are addressed: (1) climate change – effects, (2) fire risk and fuel loading, and (3) invasive species (i.e., plants). Base EM priorities are addressed as well.

DESCRIPTION:

a. **Background**: SB causes extensive tree mortality in high-elevation forests and plays an important role in the disturbance ecology of these ecosystems. However, limited information is available that fully defines these impacts (Hansen et al. 2010, DeRose et al. 2011, DeRose and Long 2007, 2012). A thorough examination of impacts to fuels, carbon and stand structure and composition will inform proper management in these systems.

b. **Methods:** All measurements will be conducted on GPS fixed-radius plots randomly distributed among areas recently (1990-present) impacted by SB (i.e., >30% of available stems killed as previously identified by FHM, FIA and FHP-sponsored surveys and subsequent ground reconnaissance). A minimum of 30 circular plots (0.081-ha) will be established. Adjacent plots will be separated by >100 m. Each tree ≥7.62 cm dbh (at 1.37 m in height) will be permanently tagged and the species, dbh, height, height to the base of the live crown, crown position, status (live or dead), and presence and impact of insect and disease agents will be recorded. The status of each tree will be evaluated annually.

Downed woody debris will be recorded along three modified Brown's planar transects radiating from plot center (Brown 1974). Litter, duff and fuel bed depth will be measured at the end of each fuel transect. Presence of fuel ladders will be carefully analyzed. Volume loss and rate of tree fall will also be recorded. Within each plot, tree regeneration and other flora will be recorded on a 0.004-ha subplot surrounding plot center and at the end of each Brown's transect. Invasive plants will be surveyed on the entire plot by conventional methods. These data will be collected every other year. Carbon pools will be calculated based on Pearson et al. (2007).

c. **Products:** Findings will be delivered in a timely manner in both verbal and written formats.

• FHM Working Group presentations (three poster presentations as per RFP)

• Bark Beetle Technical Working Group presentations (informal updates to colleagues)

• Western Forest Insect Work Conference (presentation)

• Forest Ecology and Management (scientific/managerial publication)

d. **Schedule of Activities:**

Research Activity	Date
1. Contact Forest/District, liaison	Completed
2. Select general field sites on each Forest	June-July 2013
3. Establish plots; procure data	June-August 2013
4. Collate data; prepare progress report/poster	Fall 2013
5. Procure data	June-August 2014
6. Collate data; prepare progress report/poster	Fall 2014
7. Presentation at Bark Beetle Technical Working Group	Fall 2014
8. Procure data	June-August 2015
9. Final report/poster `	Fall 2015
10. Peer-reviewed publication submitted	Spring 2016

e. **Relevant Citations:**

Bentz, B.J., Régnière, J., Fettig, C.J., Hansen, E.M., Hayes, J.L., Hicke, J.A., Kelsey, R.G., Lundquist, J., Negrón, J.F., Seybold, S.J. 2010. Climate change and bark beetles of the western United States and Canada: Direct and indirect effects. Bioscience 60: 602−613.

Brown, J.K. 1974. Handbook for inventorying downed woody material. GTR-INT-16. USDA Forest Service, Ogden UT.

DeRose, R.J., Long, J.N. 2007. Disturbance, structure, and composition: Spruce beetle and Engelmann spruce forests on the Markagunt Plateau, Utah. For. Ecol. Manage. 244:16-23.

DeRose, R.J., Long, J.N. 2012. Factors influencing the spatial and temporal dynamics of Engelmann spruce mortality during a spruce beetle outbreak on the Markagunt Plateau, Utah. For. Sci. 58:1-14.

DeRose, R.J., Long, J.N., Motta, R., Brang, P., Carcaillet, C. 2009. Wildfire and spruce beetle outbreak: simulation of interacting disturbances in the central Rocky Mountains. Écoscience 16:28-38

Jorgensen, C.A., Jenkins, M.J. 2011. Fuel complex alterations associated with spruce beetle-induced tree mortality in Intermountain spruce/fir forests. For. Sci. 57:232-240.

Hansen, E.M., Negron, J.F., Munson, A.S., Anhold, J.A. 2010. A retrospective assessment of partial cutting to reduce spruce beetle-caused mortality in the Southern Rocky Mountains. W. J. Appl. For. 25:81-87.

Holsten, E.H., Their, R.W., Munson, A.S., Gibson K.E. 1999. The spruce beetle. FIDL 127. USDA Forest Service, Portland, OR.

Mann, G. 2012. Major forest insect and disease conditions in the United States: 2011. FS-1000. USDA Forest Service, Washington, DC.

Pearson, T.R.H., Brown, S.L., Birdsey, R.A. 2007. Measurement guidelines for the sequestration of forest carbon. GTR-NRS-18. USDA Forest Service, Newton Square, PA.

Pederson, G.T., Gray, S.T., Woodhouse, C.A., Betancourt, J.L., Fagre, D.B., Littell, J.S., Watson, E., Luckman, B.T., Graumlich, L.J. 2011. The unusual nature of recent snowpack declines in the North American Cordillera. Science 333:332-335.

COSTS:

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR - 2013				
Administration	Salary	9,500[1]	70,000	[5]
	Overhead			
	Travel	8,400[2]	2,500	[6]
Procurements	Contracting			
	Equipment	2,000[3]		
	Supplies	1,000		
Total		**20,900**	**72,500**	

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR - 2014				
Administration	Salary	9,700[1]	71,400	[5]
	Overhead			
	Travel	4,900[4]	2,500	[6]
Procurements	Contracting			
	Equipment	2,000		
	Supplies			
Total		**16,600**	**73,900**	

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR - 2015				
Administration	Salary	9,900[1]	72,828	[5]
	Overhead			
	Travel	7,000[2]	2,500	[6]
Procurements	Contracting			
	Equipment	2,000		
	Supplies			
Total		**18,900**	**75,328**	

[1]Two summer student interns (Sacramento-Yolo pay scale; assume 2% increase in subsequent years).
[2]$140/d X 60 d. All others contributed.
[3]Lease of vehicle for 3 months.
[4]$140/d X 35 d. All others contributed.
[5]PI salaries (12.5%, cost-to-government) contributed by FHP, PSW, OSU and RMRS (assume 2% increase in subsequent years).
[6]Lodging and per diem contributed by FHP, PSW and OSU.