Project Title: Temporal dynamics of ground, surface, ladder, and crown fuels and their potential effects on fire behavior, following *Dendroctonus ponderosae* epidemics in the *Pinus contorta* zone of south-central Oregon.

Project Announcement No.: FA-RFAA09-0001 – Task 06

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Duration of Project: 3 years

Abstract

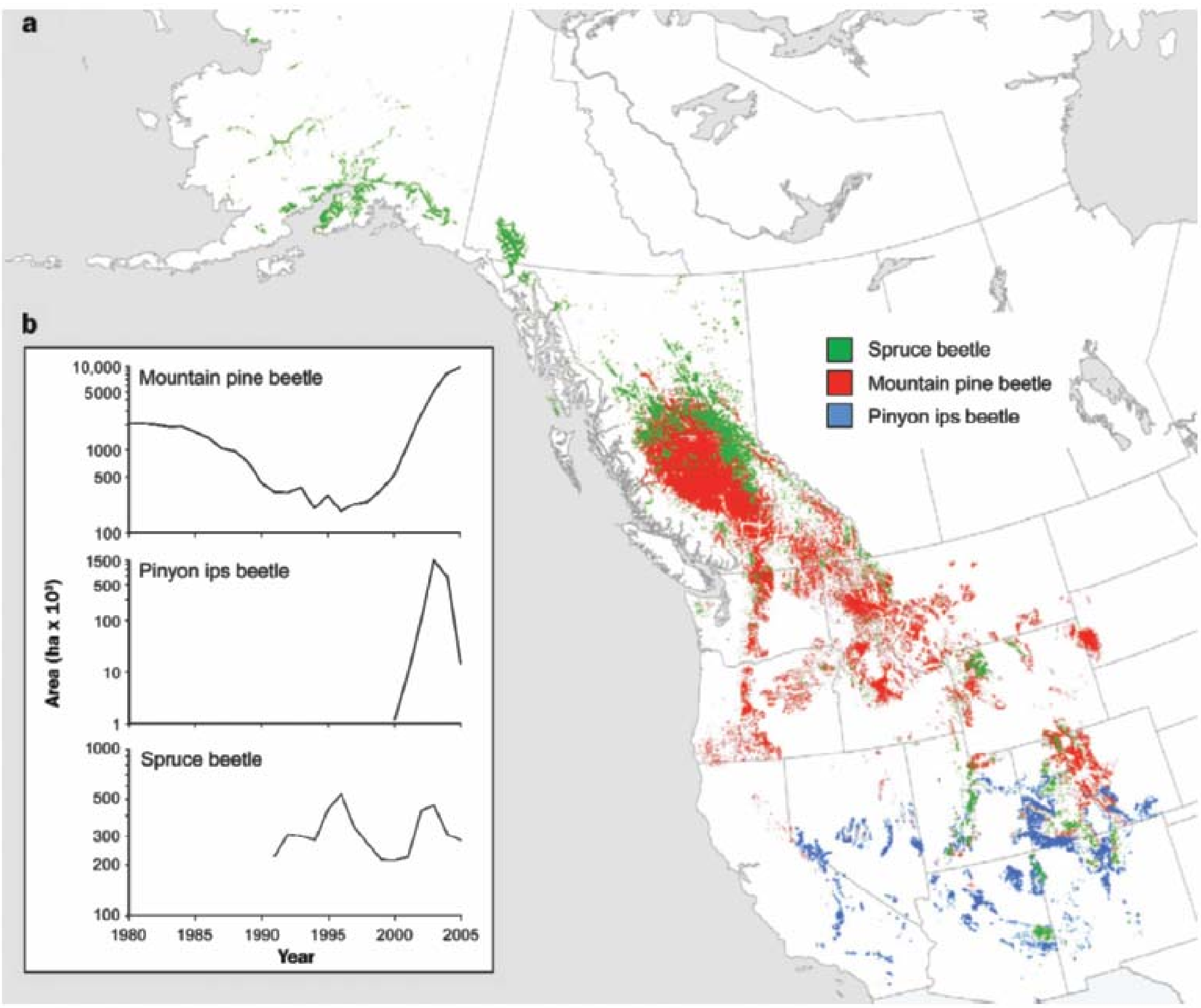
Bark beetles are important mortality agents in North America. These insects have caused mortality over millions of acres during the past 30 or so years. Recently however, the mountain pine beetle (*Dendroctonus ponderosae*) (MPB) has caused extensive lodgepole pine mortality in the western US. Several waves of MPB have occurred over the past 30 years in central and south-central Oregon which peaked at over 1,000,000 acres in 1986. Currently, over 400,000 acres are being impacted in the area. This extensive mortality from bark beetles, and especially the MPB, has raised questions about the potential for catastrophic fire following widespread mortality. Although there is a major concern about fire behavior following widespread tree mortality caused by bark beetles, recent literature has suggested that there is a lack of specific data concerning how MPB caused mortality influences temporal and spatial aspects of fuels and potential fire behavior. This lack of data seriously limits the ability of fire managers to determine when and if fuels treatments will be effective. Our objective is to answer two of the questions stated in PROJECT ANNOUNCEMENT No. FA-RFA09-000, Issue Date: September 24, 2008, Area of Interest, F. Fire, insect outbreak, and windstorm effects on fuel profiles and fire behavior. Specifically for the lodgepole pine forests of south central Oregon, on the Deschutes and Fremont-Winema National Forests, we will address the following: 1. How do fuel profiles (ground, surface, ladder and crown fuels) in lodgepole pine forests change over time in response to MPB epidemics in south-central Oregon? 2. What are the effects of MPB epidemics on future fire behavior in lodgepole pine forests of south-central Oregon and how does fire behavior change over time following the epidemics? We propose a retrospective approach to understanding post-MPB-epidemic fuels for the lodgepole pine type on the Deschutes and Fremont-Winema National Forests in order to reconstruct stand development and ground, surface, ladder, and crown fuels. By selecting stands with different time since MPB epidemic (i.e, developing a chronosequence) these reconstructions will be used to detect temporal changes in stand development and ground, surface, ladder, and crown fuels. To model and estimate the temporal and spatial change in potential fire behavior we will use standard fuel models or, if necessary, custom fuels models from our collected data, in conjunction with the fire behavior algorithms in *BehavePlus v 4.0.0, FlamMap, and FARSITE*. The dataset will also be provided to federal and state fire managers for fire management applications. These data are clearly needed by forest managers on the Deschutes and Fremont-Winema National Forests to aid prediction of fire hazards following MPB caused mortality.

I. Introduction

Justification and Expected Benefits

Bark beetles (Coleoptera: Curculionidae, Subfamily Scolytinae) are important mortality agents in North America (Raffa et al. 2008, Negron et al. 2008). These insects have caused mortality over millions of acres during the past 20 or so years (Figure 1). Recently however, the mountain pine beetle (*Dendroctonus ponderosae*) (MPB) has caused extensive lodgepole pine mortality in the western US (Figure 1.b), especially in Colorado, Wyoming, Montana, Idaho, Washington and Oregon. This extensive mortality from bark beetles, and especially the MPB, has raised questions about the potential for catastrophic fire following widespread mortality (Fire Science Brief, Issue 11, August 2008, Romme et al. 2006).

Figure 1. From Raffa et al. 2008. Recent mortality of major western conifer biomes to bark beetles. (a) Map of western North America showing regions of major eruptions by three species. (b) Sizes of conifer biome area affected by these three species over time. Data are from the Canadian Forest Service, the British Columbia Ministry of Forests and Range, and the US Forest Service.



Although there is a major concern about fire behavior following widespread tree mortality caused by bark beetles, recent literature reviews and research projects have suggested that there is a lack of specific data concerning how MPB caused mortality influences temporal and spatial aspects of fuels and potential fire behavior (Romme et al. 2006, Negron et al. 2008, Jenkins et al. 2008, Simard et al. 2008).This lack of data seriously limits the ability of fire managers to determine when and if fuels treatments will be effective.

We propose a chronosequence (retrospective) approach to understanding post-MPB-epidemic fuels for the lodgepole pine type on the Deschutes and Fremont-Winema National Forests. MPB has been historically active in this area (Figure 2), and is currently causing extensive lodgepole pine mortality (Figure 3). For example, MPB-related mortality in Oregon has gone from 50,000 acres to 500,000 acres from 2001 to 2008, with most of it in south-central Oregon (Rob Flowers, ODF, personal communication).

Figure 2. Mountain Pine Beetle caused mortality mapped from USFS-ODF cooperative aerial survey, 1980-2004. Note the extensive mortality in the lodgepole pine forests of south-central Oregon on the Deschutes and Fremont-Winema National Forests. Map from USFS Forest Health Protection powerpoint slides at website: http://www.fs.fed.us/r6/nr/fid/as/an-maps.shtml.

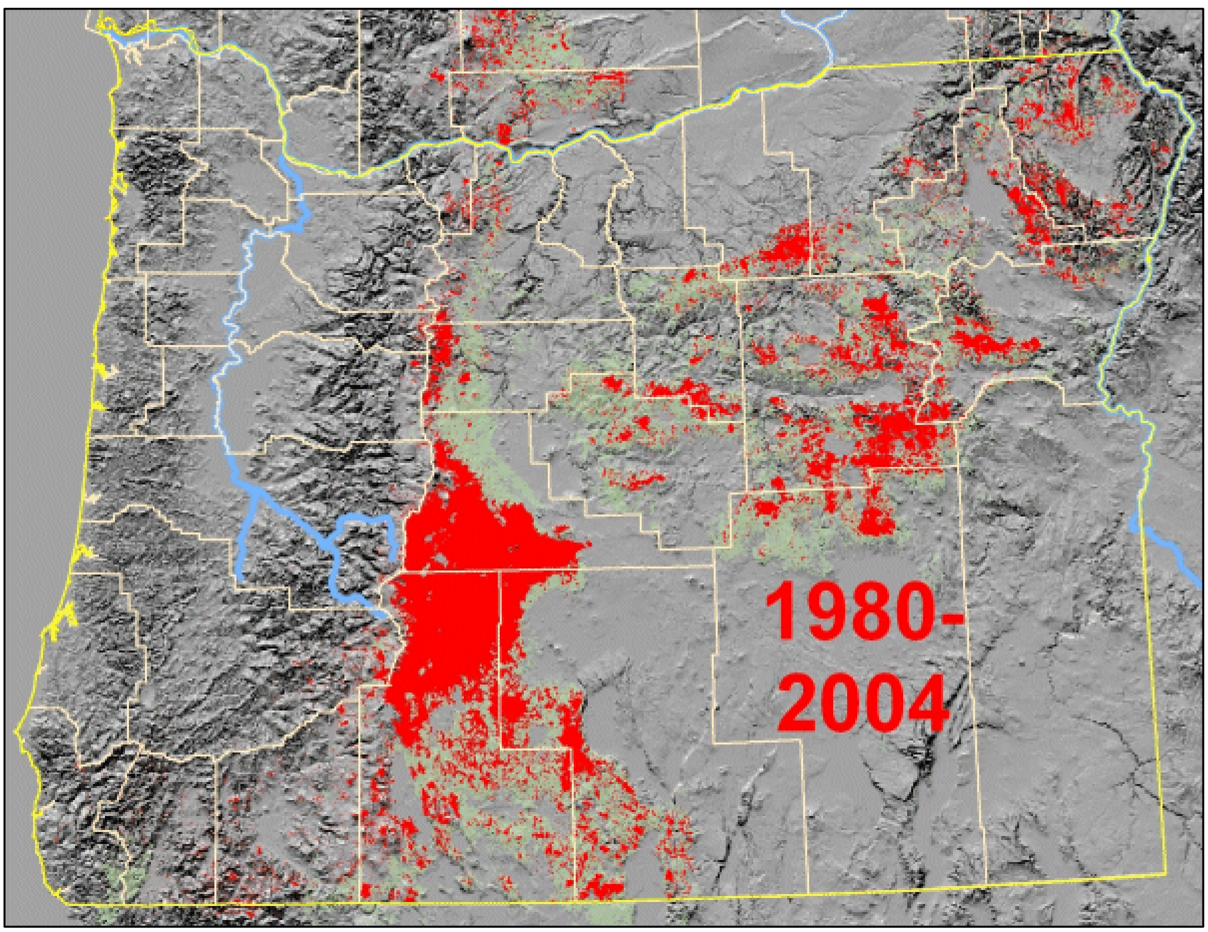
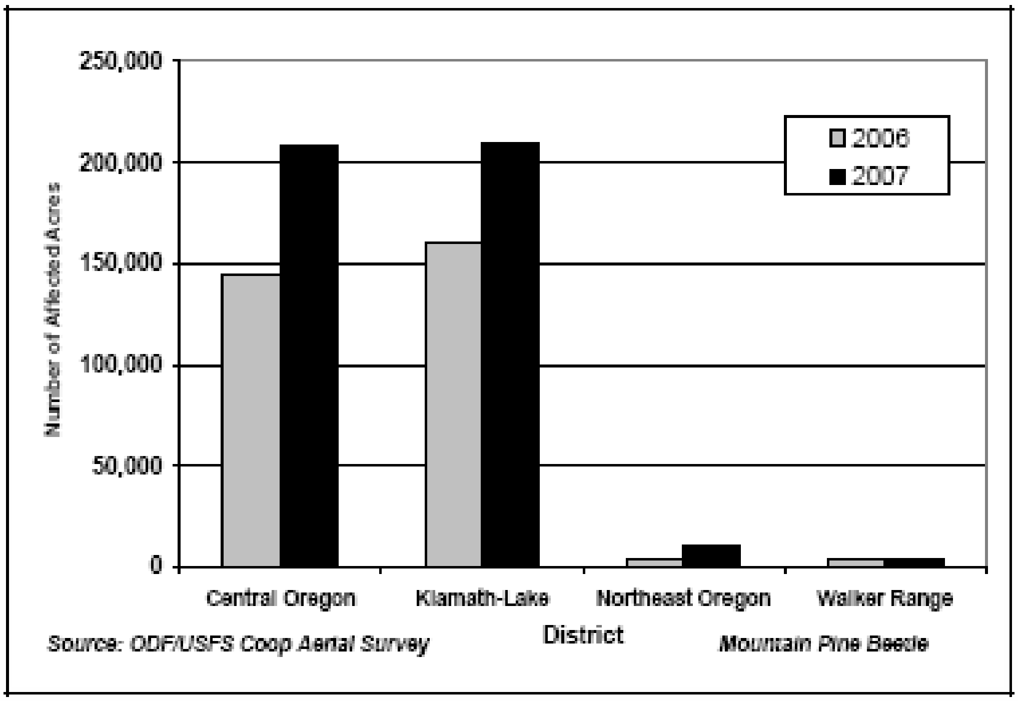


Figure 3. Area (acres) affected by mountain pine beetle in Eastern Oregon in 2006 and 2007. Mountain pine beetle accounted for >85% of total bark beetle damage (70% in lodgepole pine). (Figure and caption from Oregon Department of Forestry Statewide Aerial Survey Memorandum, January 15, 2008, R. Flowers and M. McWilliams). Note the significant acreage in Central Oregon and the Klamath-Lake region, our proposed study area.



We propose to sample stands throughout the *Pinus contorta* zone (Franklin and Dyrness 1973) of the pumice plateau and surrounding lodgepole pine forests of south central Oregon in order to reconstruct stand development and ground, surface, ladder, and crown fuels. By selecting stands with different time since MPB epidemic (i.e, developing a chronosequence) these reconstructions will be used to detect changes in stand development and ground, surface, ladder, and crown fuels over time. To model and estimate the change in potential fire behavior we will use standard (Anderson 1982, Scott and Burgan 2005) and, if necessary, custom fuels models from our collected data. Surface and crown fire behavior will be modeled using *BehavePlus v 4.0.0* (Andrews *et al.* 2008), FARSITE, and FlamMap. The dataset will also be provided to federal and state fire managers to use in their preferred models.

Several waves of MPB have occurred over the past 30 years, which have been documented by USFS and Oregon Dept. of Forestry aerial detection surveys (Figure 4). The *Pinus contorta* zone of the in south-central Oregon is a unique situation to study because *Pinus contorta* is an edaphic or topoedaphic climax occurring on both well and poorly drained pumice soils, associated with broad depressions in the landscape where cold air pools. Cone serotiny is not common in lodgepole pine in central Oregon lodgepole pine forests (Lotan and Critchfield 1990) and therefore, the interaction of fire, bark beetles, and seed reproduction may be significantly different than in areas of the interior west where cone serotiny is high. In addition, lodgepole pine is the climax successional species here and the fuel characteristics associated with vegetation development are unique compared to upper montane forests of the Rocky Mountains where spruce and fir are the climax species.

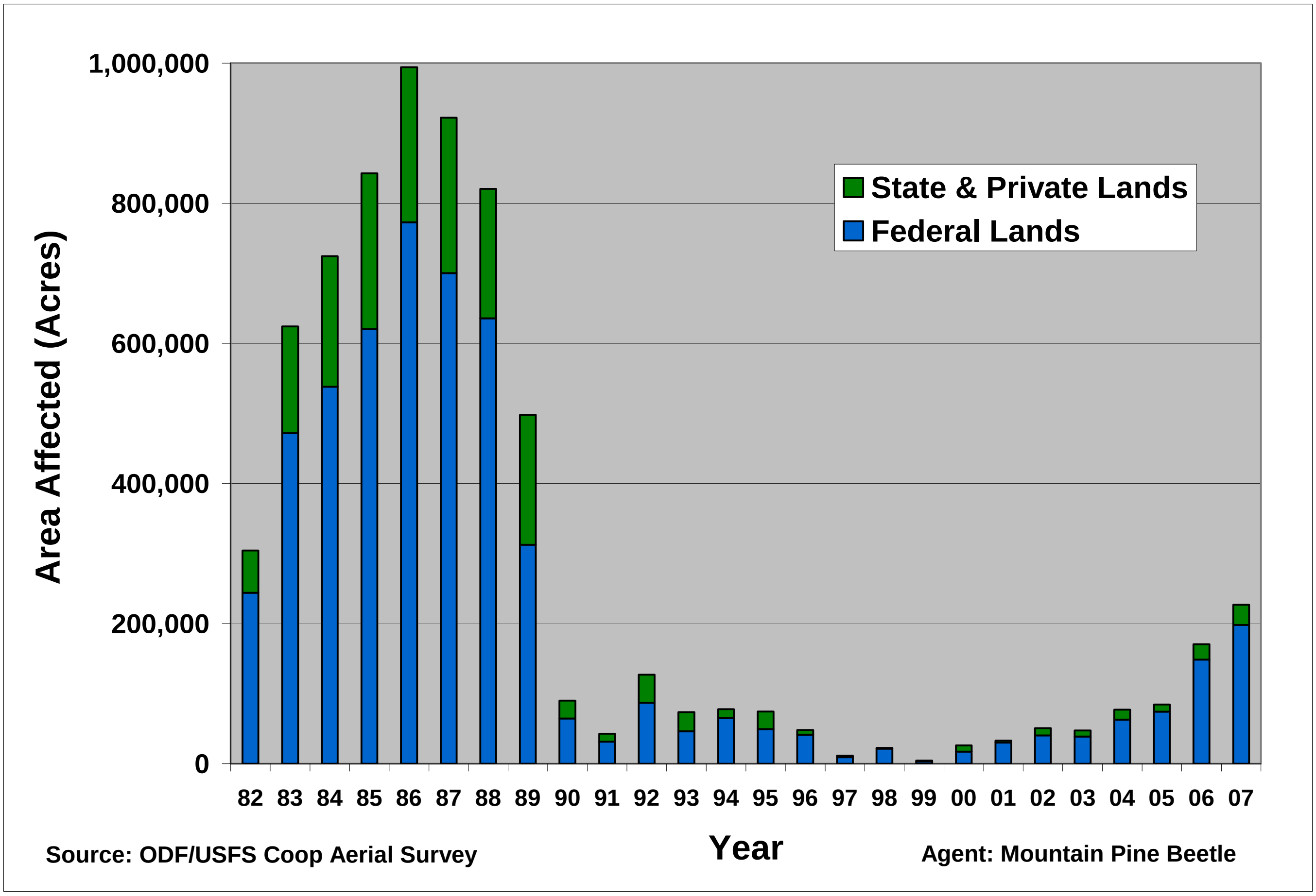


Figure 4. Area affected (acres) by mountain pine beetle in south-central (Klamath-Lake region) Oregon. 2008 will likely show an increase from 2007. Source: Oregon Department of Forestry (Rob Flowers), data from ODF/USFS Cooperative Aerial Survey.

The area has been impacted periodically by mountain pine beetle outbreaks (Figures 2, 3, 4), but to date we are not aware of studies that have quantified fuel loadings following these epidemics and regeneration dynamics.Geiszler *et al.* (1980) and Gara *et al.* (1984) examined the ecological interactions between fire, MPB, and post-fire root disease fungi in south-central Oregon. They hypothesized that mixed severity fires periodically occur every 100 years or so in these forests and many trees survive the fire. However, these trees may have fire-caused butt and root wounds which are subsequently invaded by root disease fungi. As the stand ages, bark beetles then begin to increase activity by attacking root disease infected and weakened trees, which contributes to long term fuel accumulations. The stand is eventually burned in another mixed severity fire and lodgepole pine regenerates across the site, beginning the cycle again. The implications are that although tree species diversity is low, stand development and mortality patterns are complicated, requiring a reconstruction approach to better understand the affects on temporal fuel dynamics.

Early studies of MPB impacts on fire in lodgepole pine ecosystems have found that previous MPB disturbance has increased the probability of fire occurrence (Lynch et al. 2006) or increased fire severity (Turner et al. 1999). More recent research into fuels (Page and Jenkins 2007a) and fire behavior models (Page and Jenkins 2007b) in lodgepole pine forests that had been impacted by MPB have begun to shed light on patterns in the Rocky mountains (Utah) where lodgepole pine is a high elevation early successional species that is replaced by spruce and fir. Page and Jenkins (2007a) examined changes to ground, surface, and aerial fuels during a current epidemic and at a site where beetles caused widespread mortality 20 years previous. There were significant increases in fine surface fuels in recently infested stands and in the previously infested stand there were significant increases in down woody debris in all but the smallest size classes. They suggest that MPB activity caused a change in species composition (shift to fir from lodgepole pine) and a very different fuels complex that was dominated by large dead woody fuels and live surface fuels. In their predicted fire behavior paper, Page and Jenkins (2007b) compared stands with endemic, current epidemic, and postepidemic MPB populations. For surface fires, both rates of fire spread and fireline intensities were higher in the current epidemic stands than in endemic stands due to increases in fine fuels, while in the postepidemic stands the rates of fires spread and fireline intensities were higher than in the endemic stands due to decreased vegetative sheltering and the effect on mid-flame wind speed. Large diameter fuels also increased in postepidemic stands and this increased possible total heat release and postfrontal combustion as well as potentially increasing resistance to fire control. Page and Jenkins also found that in postepidemic stands crown fires were more likely due to greater fireline intensities and lower crown base heights, but the critical rate of spread needed to sustain an active crown fire was higher in the postepidemic stands due to decreased aerial fuel continuity.

Our proposed research will shed light on the unique lodgepole pine forests of south-central Oregon where patterns of bark beetle mortality, stand development, and succession may lead to different conclusions than that arrived at by Page and Jenkins (2007a, 2007b).

Benefits of this research will be:

1. We will provide the dataset and resultant landscape files from measured ground, surface, ladder, and crown fuels following MPB mortality to USDA and USDI Fire Managers.

2. Deschutes and Fremont-Winema National Forests will gain a greater understanding of current fire hazards and risk associated with recent beetle kill in this unique forest type. This will aid in decisions about the need for conducting fuel reduction treatments in post-epidemic environment.

3. A chronosequence-retrospective approach will allow fire and fuel managers the opportunity to assess when active management is most called for during the cycling of outbreaks and forest development. This is especially important in the Wildland Urban Interface surrounded by lodgepole pine forests.

4. Fire managers in the west will have a better understanding of fuel and fire behavior dynamics for a climax lodgepole pine type, a unique insight into one of the many MPB-*Pinus contorta* scenarios.

Project Objectives and Hypotheses

Objective:

Our objective is to answer two of the questions stated in PROJECT ANNOUNCEMENT No. FA-RFA09-000, Issue Date: September 24, 2008, Area of Interest, F. Fire, insect outbreak, and windstorm effects on fuel profiles and fire behavior. Specifically for the lodgepole pine forests of south central Oregon, on the Deschutes and Fremont-Winema National Forests, we will address the following:

1. How do fuel profiles (ground, surface, ladder and crown fuels) in lodgepole pine forests change over time in response to MPB epidemics in south-central Oregon?

2. What are the effects of MPB epidemics on future fire behavior in lodgepole pine forests of south-central Oregon and how does fire behavior change over time following the epidemics?

Hypotheses:

Our hypotheses are:

Fuels (Figure 5)

- **1-5 years post-epidemic** - Crown fuels such as needles and fine branches will be transferred to the forest floor increasing litter and 1 hr and 10 hr fuels. The remaining aerial fuels will be comprised of standing dead trees from MPB induced mortality. Herbaceous vegetation and shrubs will begin to increase due to canopy openings.

- **6-10 years post-epidemic –** As ground litter from initial tree mortality decreases due to decomposition, duff accumulation will increase slightly. Herbaceous fuels will reach a peak, and a pulse of tree regeneration (due to non-serotiny) will dramatically increase shrub and seedling/sapling surface and ladder fuels. 1 and 10 hour fuel will peak in this time period from high input rates of decomposing standing dead material. Standing dead trees will begin to fall and add to 100 and 1,000 hour fuel categories.

- **11-20 years post-epidemic –**1,000 hour fuels will begin to monotonically increase as standing dead trees fall and decrease aerial fuel loads. However crown fuel loads in the crown may begin to increase as remaining live trees expand crowns. Shrub and sapling fuel loads are still relatively high as saplings have not reached previous crown height stature.

- **20+ years post-epidemic –** Litter, duff, shrub/sapling, and 1 and 10 hour fuels will begin to reach pre-epidemic levels, while 100 and 1,000 hour fuels will continue to increase on the surface. Saplings may be approaching substantial heights and increasing ladder and crown fuels.

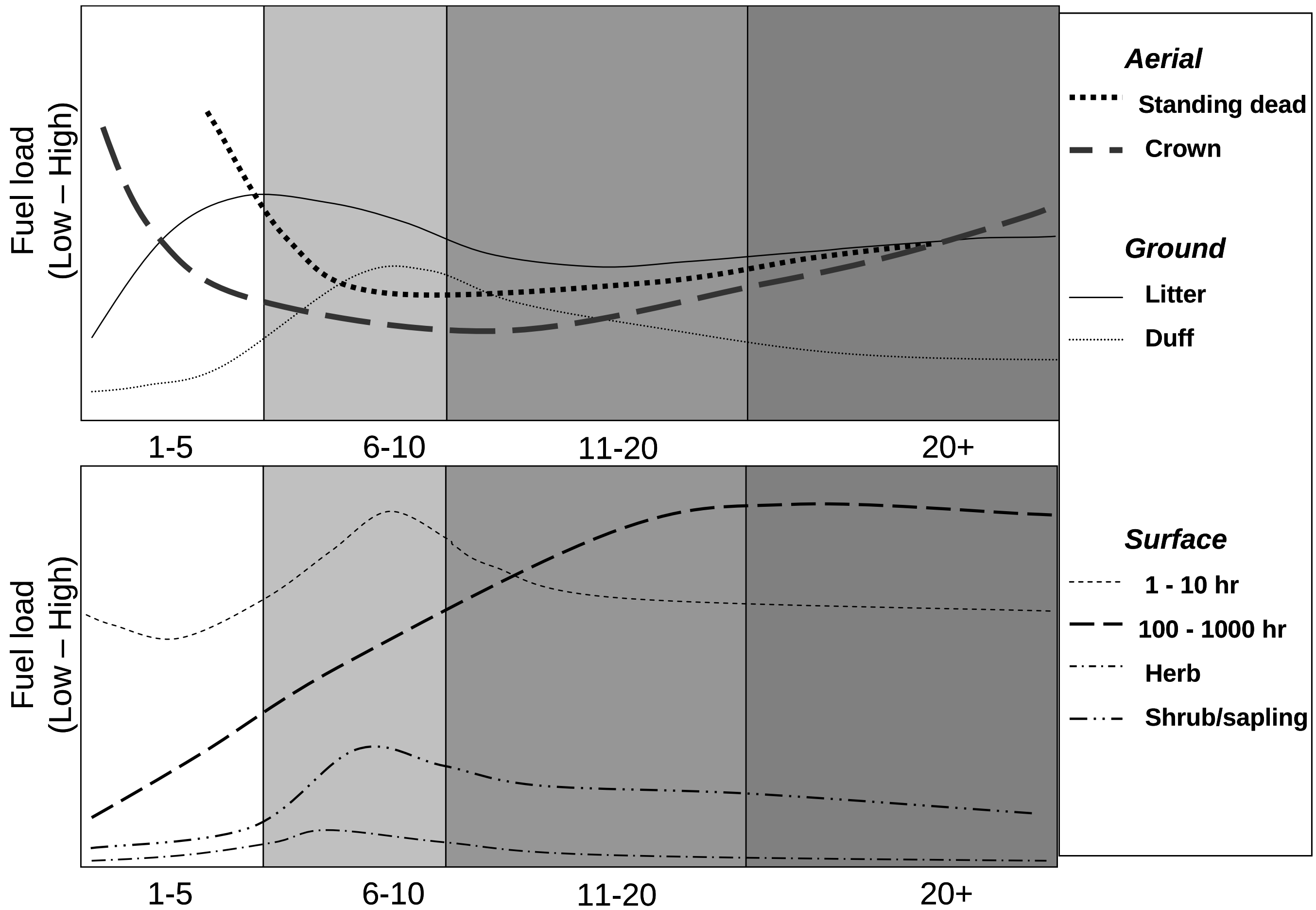


Figure 5. Hypothetical changes in fuel categories over time following MPB epidemics in lodgepole pine forests of south-central Oregon.

Fire Behavior

- **1-5 years post-epidemic –** Rates of fires spread for surface fires will initially be higher than pre-epidemic levels due to increase in fine surface fuels. In the first post-epidemic year aerial fuel continuity may still be high and potential for active crown fires will be high due to decreased foliar moisture content.

- **6-10 years post-epidemic –** Rates of surface fire spread will still be elevated due to remaining fines fuels and increasing herbaceous and shrub/sapling surface fuels. Total heat release and frontal combustion should begin to increase due to slight increases of 1,000 hour fuels. Potential for active crown fires should be substantially lowered with reduction in crown fuels.

- **11-20 years post-epidemic –** Fireline intensities and rates of spread may begin to decrease with less fine fuel accumulations, but ladder fuels will increase with increased shrub and sapling fuel loads, and may increase crown fire potential if some live crown remains. However, active crown fires will be less likely due to decreased crown fuel continuity. With an accumulation of 1,000 hour fuels, resistance to control with increase substantially.

- **20+ years post-epidemic –** The large flux of large diameter 1,000 hour fuels will increase total heat release, but fireline intensity and rate of spread should continue to decrease. Low crown base heights and possible continued shrub dominance may lead to increased potential for crown fire initiation (torching) and possible active crown fires as crown fuels reestablish.

II. Methods

Study Site

Stands selected for sampling will be located in the *Pinus contorta* zone (Franklin and Dyrness 1973) in the pumice plateau and surrounding lodgepole pine forests of south central Oregon. These sites are considered to be an edaphic or topoedaphic climax of *Pinus contorta* occurring on both well and poorly drained pumice soils. This vegetation zone can be characterized topographically by broad, level areas in enclosed depressions with gently rolling terrain. Elevations range from 1,200 to 3,000 meters.. Three distinct Plant Association Groups (PAGs) have been identified (Simpson 2008) that reflect temperature-precipitation zones. They are the *Pinus contorta* riparian PAG with higher effective moisture regimes and lower temperatures, *Pinus contorta* dry with excessively drained soil conditions and intermediate temperatures, and *Pinus contorta*/*Pinus albicalus* with both high precipitation and high temperatures occur. The area has been impacted periodically by MPB outbreaks, but to date we are not aware of studies that have quantified fuel loadings following these epidemics.

Stand Selection and Experimental Design

Using a combination of aerial detection surveys (Figure 1; 1980 to present), GIS layers of PAG and previous management and disturbance histories, local expertise, and ground surveys, current and post-epidemic MPB stands will be identified and delineated in the *Pinus contorta* zone of south central Oregon. These stands will be used to create a chronosequence (space for time substitution; (Pickett 1989) of time since mountain pine beetle outbreak. For comparison, plots will also be established in stands with relatively little or no MPB activity in the past 50 years. Within each stand a series of plots will be established to quantify forest structural attributes associated with fuels and fire behavior. The degree of plot replication within each stand will depend on the size and heterogeneity of existing stands (minimum of 3 plots/stand). At least 300 plots will be established throughout the study area using spatially balanced random sampling methods (Stevens and Olsen 2004). Stands will be stratified by PAG, stand age and/or stand density, and time since most recent MPB outbreak.

Field Measurements

To quantify forest structure and the associated fuels complex, the plot design in Figure 6 will be used. Each plot will consist of a central 250 m^2 (8.92 m radius) circular plot in which standing live and dead trees and aerial fuels will be measured. Canopy cover will be estimated for the plot. Diameter at breast height (1.37 m) and total tree height will be measured for both live and dead trees. Tree condition (vigor), canopy position (dominant, co-dominant, intermediate, suppressed), canopy base height, and crown lengths (Scott and Reinhardt 2001) will be taken for live trees, and with total available crown fuel load will be used to calculate crown bulk density (Keane *et al.* 1998). Each individual live tree will also be assessed for *Arceuthobium americana* (Nutt ex. Engelm.) and given a dwarf mistletoe rating (Hawksworth, 1977). Standing fuel volume and available crown fuel loads will be calculated using allometric equations from BIOPAK (Means 1994). A subset of live and dead trees will be cored to determine stand age as well as growth release dates which will provide the precise timing of MPB outbreak.

Surface and ground fuels will be quantified using 25 m length line intercept transects (Brown *et al.* 1982). At least 4 transects will be established, and supplemental transects will be installed if necessary to adequately capture fuel pieces. Litter, duff and high particle intercept depth will be measured at 10 and 25 m along each transect. The 1-h (0-0.64 cm), 10-h (0.65-2.54cm), 100-h (2.55-7.62cm), and 1,000-h (< 7.62 cm) timelag fuels will be measured along each transect in the following manner. The number of 1-h fuels will be recorded from 0-5 m along each transect, the number of 10-h fuels from 0-7.5 m along each transect, 100-h fuels from 0-10 m along each transect, and the number of 1,000-h fuels will be recorded along the entire 25 m transect length. 1,000-h fuels will also be given a decay class between 1 and 5 (Harmon *et al.* 1985).

A total of four, 2 m radius circular micro-plots will be placed 15 m from plot center at 45º from the fuels transects. These micro-plots will be used to estimate tree regeneration, total cover of live and dead herbaceous vegetation and shrubs, average live and dead shrub and herbaceous height, and a tally of shrub stems by size class and species similar to (Brown 1976). Tree regeneration will include any tree < 1.37 m in height and will be quantified by tallies of stems by species and size class, and total height.

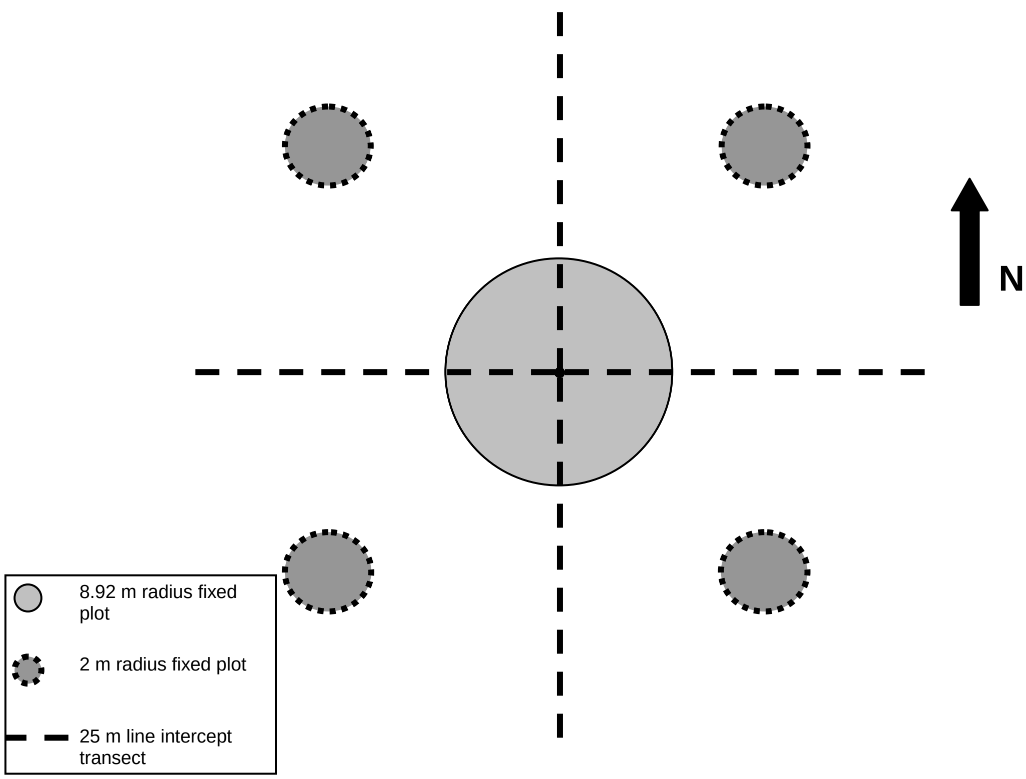


Figure 6. Diagram showing the plot design for sampling forest structure and the fuels complex following MPB epidemics.

Data Analysis

Data collected from the field will be processed and subjected to quality assurance and quality control procedures to assure accuracy. Metadata and basic collection descriptions will be developed for all data including modeling input/output.

The Forest Vegetation Simulator (FVS) will be used to convert plot tree data to canopy base height, canopy bulk density, canopy height, and canopy cover at the stand scale. This information will then be applied during fire behavior modeling.

An Analysis of Variance (ANOVA) will be used (SAS, version 9.1; SAS 2002) to compare and determine differences in each fuel category (e.g., 1-h, 10-h, 100-h, 1,000-h, shrub volume, aerial fuels, tree regeneration, etc) between age classes within the chronosequence of time since MPB outbreak. An alpha of 0.05 will be used to determine significant differences. Any necessary transformations due to non-normality or unequal variance will be applied.

To model and estimate the change in potential fire behavior over time following MPB epidemics we will use both standard (Anderson 1982, Scott and Burgan 2005) and, if necessary, custom fuels models from our collected data. Surface and crown fire behavior will be modeled using *BehavePlus v 4.0.0* (Andrews *et al.* 2008) and FlamMap. FlamMap will be used to demonstrate the potential fire behavior across a landscape and show how the potential varies spatially and temporally as the MPB progresses. Minimum travel time in FlamMap will be used to determine burn probability and show potential fire movement across the landscape and how these vary as the MPB progresses. Using weather station data from the region, several weather scenarios will be used to capture the range in possible fuel moistures and fire weather conditions. If a high degree of variability exists within any given fuel type within a specified time since MPB outbreak, a sensitivity analysis will be performed that applies this variability in multiple modeling runs.

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III. Project Duration and Timeline

The project duration is three years. Assuming a project start date of January 1, 2010, all work including deliverables will be completed in December 31, 2012. Forest structure and fuels data will be collected in summer of 2010 and 2011. Data will be processed and analyzed by spring and summer of 2012. All statistical analyses and modeling of fire behavior, as will as field tours will be completed by fall of 2012. Final reports and dissemination of information via publication submission and data transfer will be complete by the end of 2012.

Project Milestone	Description	Delivery Dates
Data and information Collection Complete	All field data and any spatial or other pertinent information will be collected in order to begin statistical analyses and modeling.	October 1, 2011
Data QA/QC procedures complete	Procedures to ensure data quality will be complete and data will be ready for analysis and modeling.	January 1, 2012
Statistical Analysis Results	Statistical Analyses will be completed and results will be summarized.	June 30, 2012
Fire Behavior Modeling Results	Fire behavior modeling will be completed and results will be summarized.	September 30, 2012
Technology Transfer	Field tours, Extension Publications, USFS GTR field guide, Trainings and Workshops, and Extension Programs for the interested public	October 31, 2012
Refereed Publications	Manuscripts for refereed publications will be submitted	December 31, 2012

VI. Research Linkage

This proposal is not linked to any current or proposed research projects by the Principal Investigator or co-Principal Investigators.

VII. Deliverables and Science Delivery

Results and information from the proposed research will be delivered in several ways. Two refereed publications will be produced to disseminate results of both fuels changes over time, and secondly the modeled changes in fire behavior over time with respect to temporal and spatial fuel dynamics. Results of this project and new knowledge concerning fire hazard post-MPB kill will also be transferred to USFS (specific focus on Deschutes and Fremont-Winema NF) and other managers, foresters, fire managers and ecologists and the interested public in collaboration with Oregon State University Forestry Extension Service. We plan to develop a dynamic web site with constant updates and information postings regarding preliminary results, Forestry Extension programs, and publications such as fact sheets. Oregon State University Extension Service "Extension Circular's" can get the information out very quickly to all interested parties and a General Technical Report targeted at USFS managers can serve as a field guide to fuels dynamics after MPB kill in lodgepole pine. We will also conduct a series of workshops/trainings and field tours with local forest managers, area ecologists, and other interested forest personnel. These will take place in the final year of the study once results have been obtained. Finally, the data sets acquired regarding fuels and the custom fuel model information and model output from fire behavior simulations in *BehavePlus* and *FlamMap* will be provided electronically.

Deliverable Type (See Format Overview, Section VIII)	**Description**	**Delivery Dates**
Refereed Publications	Two refereed publications in appropriate forest management or fire ecology journal.	2012
Technology Transfer	Field tours, Extension Publications, USFS GTR field guide, Trainings and Workshops, and Extension Programs for the interested public.	2012

Dataset	Archived data, including metadata and protocols will be transferred to the federal cooperator upon completion of the proposed project.	2012
Fuel model inputs and modeling results	Custom fuel model inputs and all modeling results will be summarized and transferred to the federal cooperator upon completion of the project.	2012
Annual Progress and Final report(s)	Annual reports as well as a final report of findings will be submitted to JFS and the federal cooperator.	2010, 2011 and 2012
Scientific Conference	Results will be presented at an appropriate scientific conference	2012

VIII. Roles of Investigators and Associated Personnel

Personnel	**Role**	**Responsibility**
David Shaw	PI	Project oversight and communication and collaboration with federal cooperator.
Andris Eglitis	Federal Cooperator	Collaboration and project assistance (providing local knowledge and resources for project implementation).
Travis Woolley	Co-PI	Works with PI, Co-PIs, and federal cooperator to implement project. Performs majority of tasks for project completion, including, training and supervising field crews, data collection, data quality assurance and quality control, statistical analyses, assisting with fire behavior analysis, and assistance with publication and dissemination of results.
Stephen Fitzgerald	Co-PI	Collaboration and project assistance. Preparation of publications and dissemination of results.
Field Crews and Student worker	Temporary employees	Data Collection and Processing.
Laurie Kurth	Co-PI	Fire Behavior analysis
Don Helmbrecht	Co-PI	Spatial data development

DAVID CARL SHAW
CURRICULUM VITAE

Assistant Professor **November 2008**
Extension Forest Health Specialist
Director, Swiss Needle Cast Cooperative
Associate Editor, Insects and Diseases, Western Journal of Applied Forestry

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EDUCATION:
Ph.D. 1991. College of Forest Resources, University of Washington, Seattle.
MS 1982. Biology Department, Western Washington University, Bellingham.
BS 1977. Biology Department, Northern Arizona University, Flagstaff, Arizona.

PAST EMPLOYMENT:
2005-2008. Department of Forest Science, Oregon State University.
Assistant Professor, Extension Forest Health Specialist. Director, Swiss Needle Cast Cooperative
1994-2005. Wind River Canopy Crane Research Facility, University of Washington at the US Forest Service Wind River Experimental Forest, Carson, Washington.
1991-1994: Olympic Natural Resource Center, College of Forest Resources, University of Washington. Project Manager, Olympic Canopy Crane, Forks, WA.
1987-1990. University of Washington, Graduate Research Assistantships
1990. Jim Agee PI. Project Leader. Tree Inventory and Hazard Tree Survey, Ft. Lewis Historical District, near Tacoma, Washington.
1987-1990. Graduate Research Assistant. Influence of pre-commercial thinning on Annosus root disease in coastal western hemlock.
1983-1989. US Forest Service, Area Ecology Program. Term Ecologist, Seasonal Field Botanist. Colville, Olympic, and Mt. Baker-Snoqualmie National Forests, Washington.
1983-1986. Resource Specialist. Multnomah County Educational Service District, Outdoor School, Environmental Education, Portland, Oregon.

SELECTED PUBLICATIONS:
Woolley, T., Ganio, L.M., Shaw, D.C., Fitzgerald, S., and C. Shaw. 2008. A Framework to Evaluate Post-fire Tree Mortality Logistic Models. Pages 000-000 *in* R.E. Masters, K.E.M. Galley, and D.G., Despain (eds.). The'88 Fires: Yellowstone and Beyond. Tall Timbers Miscellaneous Publication No. 16, Tall Timbers Research Station, Tallahasseee, Florida, USA.

Mathiasen, R.L., D.L. Nickrent, D.C. Shaw, and D.M. Watson. 2008. Mistletoes: Systematics, Pathology, Ecology, and Management. Plant Disease. 92: 988-1006.

Shaw, D.C., M. Huso, H. Bruner. 2008. Basal area growth impacts of dwarf mistletoe on western hemlock in an old-growth forest. Canadian Journal of Forest Research 38: 576-583.

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Australia – ecological analogs and reciprocal models for ecosystem management. Australian Journal of Botany 52: 481-498.
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Parker, G.G., M.E. Harmon, M.A. Lefsky, J. Chen, R. Van Pelt, S.B. Weiss, S.C. Thomas, W.E. Winner, D.C. Shaw, and J.F. Franklin. 2004. Three dimensional structure of an old-growth Pseudotsuga-Tsuga canopy and its implications for radiation balance, microclimate, and atmospheric gas exchange. Ecosystems 7:440-453.
Franklin, J.F., T.A. Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D.R. Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible, and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. Forest Ecology and Management 155: 399-423.

RESEARCH SUPPORT: FIRE

Developing a validation approach for post fire tree mortality models. $31,000 Western Wildland Environmental Threats Assessment Center, USDA, PNW Research Station. 2007-2008. David Shaw, Travis Woolley, Lisa Ganio and Steve Fitzgerald.

Evaluation of models used to predict post-fir tree mortality. David Shaw, Steve Fitzgerald, Lisa Ganio. July-Dec. 2007. $23,700. Western Wildland Environmental Threats Assessment Center, USDA, PNW Research Station.

Impacts of post-fire salvage logging and wildfire burn intensity on soil productivity and forest recovery. USDA Forest Service. With Jane Smith, USFS. $15,000. (portion of larger project that ends Jan 2009).

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Professional Preparation:

2001 B.S. Natural Resources, Oregon State University Corvallis, OR
2006 M.S. in Forest Science, Oregon State University Corvallis, OR

Appointments:

2007-present	Faculty Research Assistant, Forest Science Dept, Oregon State University
2006-2007	Biological Science Technician, Forest Science Dept., Oregon State University
2002-2005	Graduate Research Assistant, Forest Science Dept, Oregon State University
2000-2002	Forest Ecology Field/Lab Assistant, Forest Science Dept, Oregon State University
1998-1999	Timber Inventory Crew Leader, OSU Research Forests, Oregon State University

Publications:

Woolley, T.J., Harmon, M.E., and O'Connell, K.E. (2007) *Estimating Annual Bole Biomass Production Using Uncertainty Analysis*. Forest Ecology and Management 253, 202-210.

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Professional Affiliations:

International Association of Wildland Fire
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EDUCATION:
MS 1983. Forest Management, University of Idaho, Moscow, Idaho.

BS 1979. Forest Biology, SUNY, College of Environmental Science & Forestry, Syracuse, New York.
PAST EMPLOYMENT:

2003-2008. Dept. of Forest Engineering, Resources and Management, Oregon State University Ext. Service. Professor and Extension Eastside Silviculture & Wildland Fire Specialist, Redmond,OR.

1988-2003. Dept. of Forest Resources, Oregon State University Extension Service, Asst. and Assoc. Professor and Area Extension Forester, Central Oregon Region, Redmond, OR.

1984-1988. Dept. of Forest Resources, Oregon State University Ext. Service. Asst. Professor and Area Extension Forester, South Coast Region, Coquille, OR.

SELECTED PUBLICATIONS:

Woolley, T., Ganio, L.M., Shaw, D.C., Fitzgerald, S., and C. Shaw. (*In Press*). A Framework to Evaluate Post-fire Tree Mortality Logistic Models. Pages 000-000 *in* R.E. Masters, K.E.M. Galley, and D.G. Despain (eds.). The '88' Fires: Yellowstone and Beyond. Tall Timbers Miscellaneous Publication No. 16, Tall Timbers Research Station, Tallahassee, Florida, USA.

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Fitzgerald, S.A., D.A. Maguire, and R. Singleton. 2005. Simulating Structural Development and Fire Resistance of Second-Growth Ponderosa Pine Stands. *In* C.E. Peterson and D.A. Maguire (Editors) Proceedings of the Conference Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry. General Technical Report PNW-GTR-635. Pacific Northwest Research Station, USDA Forest Service, Portland, OR. 389 p.

Fitzgerald, S.A. (Lead Author & Editor). 2002. Fire in Oregon's Forests: Risks, Effects, and Treatment Options. A synthesis of current issues and scientific literature. Special Report for the Oregon Forest Resources Institute, Portland, OR. 164 p.

Fitzgerald, S.A., W.H. Emmingham, P.T. Oester. 2000. Exploring Methods for Maintaining Old-Growth Structures in Forests with a Frequent-Fire History: A Case Study. Pages 199-206 *in* W.K. Moser and C.F. Moser (eds.). Fire and Forest Ecology: Innovative Silviculture and Vegetation Management. Tall Timbers Fire Ecology Conference Proceedings, No. 21. Tall Timbers Research Station, Tallahassee, FL.

RESEARCH SUPPORT: FIRE

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Evaluation of models used to predict post-fir tree mortality. David Shaw, Stephen Fitzgerald, Lisa Ganio. July-Dec. 2007. $23,700. Western Wildland Environmental Threats Assessment Center, USDA, PNW Research Station.

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Fire Behavior Analyst **November 2008**
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EDUCATION:
MS 1986. Molecular Genetics and Cellular Biology, University of Chicago
BS 1984. Botany, Ohio University, Athens, Ohio

PAST EMPLOYMENT:
1999 – 2006 Mount Rainier National Park, Plant Ecologist, Ashford, Washington
1995 – 1999 Zion National Park, Plant Ecologist, Springdale, Utah
1988 – 1995 Glacier National Park, Plant Ecologist, West Glacier, Montana
1986 – 1988 US Army Corps of Engineers, Biologist, Chicago, Illinois
1985 – 1986 Indiana Dunes National Lakeshore, Biological Technician, Porter, Indiana
1982 – 1985 Olympic National Park, Cuyahoga Valley National Recreation Area, seasonal ranger

SELECTED PUBLICATIONS:
Stueve K.M., Cerney D.L., Rochefort R.M. and Kurth L.L. Post-fire tree establishment patterns at the alpine treeline ecotone: Mount Rainier National Park, Washington, USA. *Journal of Vegetation Science.* 20: 107-120.

FIRE SUPPORT
Use of fire modeling to determine effects of mountain pine beetle on water quality. USGS Colorado. 2008 - 2009.
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Fuels and fire behavior assessment for the CedarThom watershed project, Lolo National Forest, USDA Forest Service, Lolo National Forest. 2008 – 2009
Fire behavior assessment for the Bozeman water district, Gallatin National Forest. USDA Forest Service, Gallatin National Forest. 2006 – 2007
Fuels and fire behavior assessment of the Valles Caledera National Preserve. USDA Forest Service Valles Caldera National Preserve. 2008 – 2009.
Lead Instructor for development of the new fire behavior course – S495, Geospatial Fire Analysis, Interpretation and Application. 2008 – 2009.

Donald J. Helmbrecht
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GIS Specialist/Fire Analyst **April 2009**
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EDUCATION:
MS 2002. Forestry, University of Montana
BS 1999. Resource Conservation, University of Montana
AAS 1993. Forest Recreation, Paul Smith's College, Paul Smiths, NY

PAST EMPLOYMENT:
2001 – 2006 National Center for Landscape Fire Analysis, GIS Program Manager, University of Montana, Missoula, Montana
2000 – 2001 USDI Bureau of Land Management, Missoula Field Office, GIS Specialist, Missoula, Montana
1997 – 2000 USDA Forest Service, Lolo National Forest, Forestry Technician, Missoula, Montana
1996 – 1997 USDA Forest Service, Beaverhead-Deerlodge National Forest, Forestry Technician, Wise River, Montana
1994 – 1996 AAA Engineering and Drafting, Forester/Cartographer, Salt Lake City, Utah

SELECTED PUBLICATIONS:
Hesseln, Hayley; Helmbrecht, Don; Sullivan, Janet, Jones, Greg, Hyde, Kevin. An Economic Assessment of Fuel Treatments at the Landscape Level. In Gen. Tech. Rep. PSW-GTR-208. 2008.

FIRE SUPPORT
Development of First Order Fire Effects Model Mapping Tool, National Interagency Fuels Technology Team. 2007 – 2009.
Use of fire modeling to determine effects of mountain pine beetle on water quality. USGS Colorado. 2008 - 2009.
Fuels and fire behavior assessment for the HiGrouse project, Klamath National Forest. USDA Forest Service, Klamath National Forest. 2008 – 2009
Fuels and fire behavior assessment for the CedarThom watershed project, Lolo National Forest, USDA Forest Service, Lolo National Forest. 2008 – 2009
Fuels and fire behavior assessment of the Valles Caledera National Preserve. USDA Forest Service Valles Caldera National Preserve. 2008 – 2009.
Unit leader/steering committee member for development of the new fire behavior course – S495, Geospatial Fire Analysis, Interpretation and Application. 2008 – 2009.

Joint Fire Science Program
National Interagency Fire Center
Bureau of Land Management
US Department of the Interior
3833 S. Development Ave.
Boise, Idaho 83705

November 21, 2008

Dear Review Panel,

This letter is written in support of the proposal by **Dr. David Shaw** to examine the temporal dynamics of ground, surface, ladder and crown fuels and potential fire behavior following mountain pine beetle epidemics in lodgepole pine.

As the Area entomologist for central and south-central Oregon, I can identify the mountain pine beetle and its effects on the lodgepole pine resource as the most pressing issue facing land managers in my area. This year I answered questions from the governor of Oregon and from several county commissioners about the Forest Service plans to mitigate the bark beetle outbreak and the threat of wildfires that many people feel will inevitably occur. We have vast areas of lodgepole forest that have been affected by the mountain pine beetle and priorities need to be set for mitigating fire hazard. We are in desperate need of data and modeling tools to help us make those important decisions. I believe the work proposed by Dr. Shaw will provide a valuable be a valuable for advising managers on the most appropriate fuels management measures to protect our resources from wildfire.

Sincerely,

/s/ *Andris Eglitis*

Andris Eglitis, Ph. D.
Area Entomologist
Central Oregon Service Center for Insects and Diseases
Deschutes NF
Bend, Oregon

File Code: 1500
Date: November 20, 2008

Joint Fire Science Program
National Interagency Fire Center
US Department of Interior
3833 S. Development Avenue
Boise, ID 83705

Dear Review Panel,

The mountain pine beetle has been the most important disturbance agent in central and southcentral Oregon lodgepole pine forests for the past decade. Most of the vulnerable lodgepole pine forests have been affected and very few live trees remain where the beetle has been active. In 2008, the level of concern expressed by high ranking government and public officials was unprecedented. Most people are fearful of catastrophic wildfires in the aftermath of the bark beetle infestation and public land managers are being challenged to take corrective action. In order to respond appropriately and carry out our mandate, we need a strongly grounded scientific basis for that action.

The Deschutes and Fremont-Winema National Forests strongly support the proposal by **Dr. David Shaw** to the Joint Fire Science Program to examine the temporal dynamics of ground, surface, ladder and crown fuels and fire behavior following *Dendroctonus ponderosae* epidemics in the *Pinus contorta* zone of central and south-central Oregon.

This proposal would provide valuable data to forest managers in the area regarding the changes in fuels over time following bark beetle epidemics in lodgepole pine forests. This data combined with model outputs of potential fire behavior may assist in decisions made concerning fuel treatments in post-epidemic forests. These forests are very unique, and we need site specific data for this forest type.

The collaborations between forest health and fire specialists from Oregon State University and forest entomologists from local forests will ensure that this project produces results relevant to management of these areas. I encourage you to fund this proposal investigating the impacts of mountain pine beetle outbreaks on fuels and fire behavior relationships in the lodgepole pine pumice region of central and south-central Oregon.

Sincerely,

/s/ Karen Shimamoto
KAREN SHIMAMOTO
Forest Supervisor, Fremont-Winema NF

/s/ John Allen
JOHN ALLEN
Forest Supervisor, Deschutes National Forest