TITLE: Tree Mortality and Increased Fuels following Severe Defoliation by Pine Butterfly in Oregon – Assessing the Aftermath of the 2008-2011 Epidemic

LOCATION: Central and Northeast Oregon (Malheur National Forest, BLM, and Private ownerships)

DATE: September 30, 2011

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

PROJECT LEADERS: Rob Flowers, Oregon Department of Forestry (503-945-7396, rflowers@odf.state.or.us); David Shaw, Oregon State University, Department of Forest Engineering, Resources, and Management (541-737-2845, dave.shaw@oregonstate.edu)

COOPERATORS: Michael McWilliams, Oregon Dept. of Forestry; Don Scott and Robert Schroeter, USDA-FS R6, Forest Health Protection; Paul Oester and Bob Parker, Oregon State University Forestry Extension Service; Robert Progar, USDA-FS PNW Research Station; Carole Holly, USDA-FS Malheur National Forest; George McFadden, USDI BLM; Private landowners

FHP SPONSORS/CONTACTS: Andris Eglitis, USDA-FS R6 FHP, Central Oregon Insect and Disease Service Center (541-383-5701,aeglitis@fs.fed.us); Lia Spiegel, USDA-FS R6 FHP, Blue Mountains Insect and Disease Service Center (541-962-6574, lspiegel@fs.fed.us)

PROJECT OBJECTIVES: To assess the levels of tree mortality following severe, landscape-scale defoliation by the pine butterfly that has occurred in central Oregon from 2008 to 2011. Ground surveys will be conducted within the core area of defoliation identified by Aerial Detection Surveys (ADS) with findings used to address the immediate and practical needs of public and private forest managers in relation to increased fuels and fire risk.

Specific objectives include:

- Assess the current fuels within the affected area and evaluate the extent of additional tree mortality;
- Cooperate with local fuels and fire managers to collect needed data for fire modeling or planning;
- Quantify the primary causes and extent of post-epidemic tree mortality or other damage;
- Develop a methodology to assess relative stand/site risk of post-epidemic tree mortality;
- Evaluate climatic influences and management history on post-epidemic tree mortality;
- Review ADS coding to improve the accuracy of defoliation intensity measures;
- Relate and compare findings to other regions with previous pine butterfly epidemics;
- Develop practical guidelines and educational materials to assist forest and fire managers.

JUSTIFICATION:

a. **Linkage to FHM Detection Monitoring** – Increasing levels of defoliation by pine butterfly have been reported from ADS, state/federal forest managers, and the public in central Oregon since 2008. The 2011 ADS in Oregon estimated over 250,000 acres of detectable defoliation to pine hosts; an increase of nearly 600% relative to 2010[6]. This is currently the largest documented epidemic in Oregon's history. An estimated 78% (194,000 acres) of the defoliation was deemed in the "high" category indicating >50% crown loss. Previous pine butterfly epidemics, in association with western pine beetle epidemics and other factors, have caused significant levels of tree mortality in the Pacific Northwest. Annual Forest Insect and Disease Condition reports have only described 5 previous epidemics in Oregon, and virtually no post-epidemic monitoring has been done. This project will provide needed, practical information for forest managers in the Pacific Northwest as well as provide comparisons to the assessments that have been done in other regions. It will also provide valuable feedback to aerial surveyors in regard to defoliation intensity coding as well as supplemental tree mortality estimates to be used in other reporting. Due to the level of defoliation, many affected areas do not possess sufficient crowns for mortality to be documented using normal ADS procedures.

b. **Significance in terms of the geographic scale**: In addition to the Pacific Northwest, pine butterfly epidemics have been reported in many other regions historically (So. British Columbia, Pacific Southwest, Intermountain, Northern, and Rocky Mountains) since 1881[5]. Records document 14 epidemics in the Pacific Northwest with an average of 18 years between, 9 epidemics in the Intermountain region with an average of 9 years between, and 8 epidemics in the Northern region with an average of 9 years between. From this recent historical literature synthesis, we have discovered that pine butterfly epidemics have occurred with much greater frequency than initially thought, and in most regions have risen to the level of aerially-detectable defoliation on the average of once per decade. In 2010, increased detections of pine butterflies have also been reported in Idaho, Montana, and northern California.

c. **Biological impact/political importance:** While varying impacts to forest resources have occurred during previous pine butterfly epidemics, significant tree mortality has been documented. One of the more well-described epidemics occurred from 1893 to 1895 on the Yakima Indian Reservation in Washington, it resulted in 20-90% tree mortality (an estimated 1 billion board ft) following the defoliation events, often in association with western pine beetles[3,4]. While it is unknown what degree of tree mortality will occur in Oregon, this event has the potential to significantly change the fuels and fire risk on a number of ownerships within affected areas. Significant radial growth loss (up to 39%) has also been documented in previous epidemics, and is of great interest to public and private forest managers[1,2]. Due to the unprecedented, landscape-level nature of this epidemic it has received increased attention from the public and media. Numerous newspaper articles have been written and the story will be featured on an episode of the popular "Field Guide" series on Oregon Public Broadcasting.

d. **Scientific Basis/Feasibility**: This project will complement the relatively few post-epidemic evaluations of pine butterfly in other regions, as well as provide additional focus on fuels and tree mortality to assist fire managers. It will also support on-going efforts in R6 to elucidate aspects of pine butterfly biology and ecology. Study cooperators have a great deal of expertise evaluating insect defoliators, fuels, and how these relate to forest health and fire concerns. Standard, permanent plot transects will be installed in the hope of facilitating longer-term, periodic monitoring as well as allow for inclusion of data from other regions. Annual ADS data and other geo-spatial information are readily available for R6 over all affected areas. The lead agencies have demonstrated the ability to manage and complete similar projects and have experience in reporting and product development. The broad expertise of the cooperators and the good working relationships that exist will allow for successful and timely project completion.

e. **Priority Issues** addressed from Request for Proposals.
   - **Climate Change**: Historical descriptions have suggested that climatic factors may correlate with pine butterfly epidemics, but these relationships have not been well-explored. The suspected link to epidemics has been hypothesized to do with declines or disruption of control of natural enemies (specifically parasitic wasps), whose populations may be more susceptible to climatic variations and patterns[5]. Historical and current climatic data are readily available over the planned survey area, and attempts will be made to examine the role of these factors and trends relative to the current (and possibly prior) epidemics in Oregon as well as to the subsequent levels of tree mortality that occur.
   - **Fire Risk, Fuel Loads, and Restoration:** The plot transects completed for this project will be designed in association with forest and fire managers to provide them with needed information on the current levels of standing and down fuels, as well as update them on additional tree mortality following the pine butterfly epidemic. This information is essential for fire modeling or other planned treatments. Attempts will be made to develop a methodology to assist managers in determining the relative stand/site risk of post-epidemic tree mortality with regard to insect defoliation and stand management history. In this way, managers may be better able to prioritize and design treatments to mitigate fire hazard, while also providing for desired wildlife habitat, stand regeneration, or other objectives.

DESCRIPTION:

a. Background: The pine butterfly, *Neophasia menapia*, occurs in ponderosa pine and Douglas-fir forest-types throughout much of the Western U.S. and British Columbia, Canada. While pine butterflies periodically become abundant in Douglas-fir stands west of the Cascade Range, epidemics are most commonly associated with ponderosa pine from the east side of the Cascade Range to the Rocky Mountains[5]. Their activity can range from minor growth impacts to large-scale tree mortality depending on the severity and duration of the defoliation as well as other factors (bark beetle epidemics, drought, etc.) [1,2]. Host trees weakened by defoliation become more susceptible to other agents, the most common being the western pine beetle, *Dendroctonus brevicomis*, with large, mature ponderosa pine typically more susceptible than younger, more vigorous trees. At endemic levels, small numbers of pine butterflies can be seen hovering at the tops of ponderosa pines, while epidemics are marked by widespread defoliation and immense numbers of adults during the flight period. Previously, epidemics were thought to erupt sporadically, often being separated by several decades; however, a recent review of the historical literature suggests that they occur much more frequently, perhaps even at regular intervals, similar to other, well-known defoliators like Douglas-fir tussock moth[5]. The current pine butterfly outbreak is believed to be the largest ever documented in Oregon. While the populations are expected to collapse this year, significant defoliation has occurred over successive years with anecdotal reports of vast areas with >90% defoliation and some tree mortality. While extensive tree mortality appears uncommon, the relatively few post-epidemic evaluations are not sufficient for developing reliable guidance. This epidemic provides us with a unique opportunity to address the immediate and practical needs of forest and fire managers, specifically in relation to the level of post-epidemic tree mortality that occurs, and how that will contribute to current fuels. The transect surveys proposed here will also provide valuable feedback to inform recently completed aerial survey assessments.

b. Methods: The 2011 ADS results along with other available geo-spatial information will be reviewed to determine the survey area and approximate number and location of plot transects. Attempts will be made to establish permanent plot transects over the range of defoliation intensities, stand types and structures, site classes, elevations, ownerships, etc. within the affected area. For each plot transect we will describe 1) fuels - ground, surface, ladder and crown fuels using standard techniques, 2) stand/site conditions - tree species, density, size/crown class, growth rate, regeneration, aspect, slope, etc., and 3) forest health conditions - percent defoliation, bud/tree survival status, mortality/damage agent occurrence and severity, etc. Other, readily available remote-sensing data will be used to complement ground surveys and provide historical climatic information and trends. Plot transects will be evaluated in full over 2 years, with the hope of an additional 2 years of evaluation of forest health conditions only. Prior to establishing plot transects and sampling protocols, local forest resource and fire managers on affected ownerships (National Forest, BLM, and private) will be consulted so as to design project data collection to complement their on-going and future needs for modeling and planning efforts.

c. Products: Posters and/or presentations will be provided at the FHM Working Group Meeting, Western Forest Insect Work Conference, and other appropriate meetings. Project findings will be used to provide fuels data to federal, state, and private forest managers in affected areas as well as updates on post-epidemic tree mortality as it occurs. Feedback will also be provided to R6 aerial surveyors in regard to defoliation intensity coding. Project results will be provided to the public through established ODF and OSU outlets, as well as in-person at two planned educational workshops to be held following project completion. Attempts will be made to complete a general technical report and/or submit project results to refereed/professional journals for publication.

d. Schedule of Activities:

- **Winter-Spring 2012:** Review ADS and other geo-spatial information to select plot transects.
- **Summer-Fall 2012:** Establish plot transects and collect field data in consultation w/ managers.
- **Winter-Spring 2013:** Begin data analyses, present results at FHM-WG and other meetings.
- **Summer-Fall 2013:** Conduct re-measurement of plot transects, provide updated results.
- **Winter-Spring 2014:** Complete data analyses, prepare products, and conduct workshops.

COSTS:

YEAR **2012**	**Item**	**Requested FHM EM**	**Other-Source Funding**	**Source**
Administration	Salary [a]	20,000	25,000	ODF, OSU
	Travel	8,000	10,000	ODF, OSU
	Overhead (14.9%)	4,470		
Procurements	Equipment			
	Supplies	2,000		
Total		**34,470**	**35,000**	

YEAR **2013**	**Item**	**Requested FHM EM**	**Other-Source Funding**	**Source**
Administration	Salary [a]	20,000	25,000	ODF, OSU
	Travel	8,000	8,000	ODF, OSU
	Overhead (14.9%)	4,172		
Procurements	Equipment			
	Supplies			
Total		**32,172**	**33,000**	

YEAR **2014**	**Item**	**Requested FHM EM**	**Other-Source Funding**	**Source**
Administration	Salary			
	Travel	4,000	6,000	ODF, OSU
Procurements	Equipment			
	Supplies	2,000		
Total		**6,000**	**6,000**	

[a]Salary will be used to support a Master's level graduate student, with additional field assistance provided by project leaders and cooperators. Federal cooperator contributions will be from their individual offices and are not shown.

REFERENCES:

[1] **Cole, W.E. 1966.** Effect of pine butterfly defoliation on ponderosa pine in southern Idaho. USDA Forest Service, Intermountain Forest and Range Experiment Station. Res. Note INT-46. Ogden, UT. 7 p.

[2] **Evenden, J.C. 1940.** Effects of defoliation by pine butterfly upon ponderosa pine. Journal of Forestry 38(12): 949-955.

[3] **Furniss, R.L, and V.M. Carolin. 1977.** Western forest insects. Misc. Pub. 1339. USDA Forest Service, Washington, D.C. 654 p.

[4] **Keen, F.P. 1952.** Insect enemies of western forest. Misc. Pub. 273. U.S. Department of Agriculture, Washington, D.C. 280 p.

[5] **Scott, D.W. 2010.** Chronology of pine butterfly, *Neophasia menapia* (Felder & Felder), infestations in western North America. USDA Forest Service, Blue Mountains Insect and Disease Service Center. Report No. 10-01. La Grande, OR. 47 p.

. [6] **Schroeter, R. (pers. comm.)** USDA Forest Service, Southwest Oregon Insect and Disease Service Center.