

Ryan P. Hanavan¹, Christian Hoffman², and Richard W. Hofstetter²

¹USDA Forest Service R2 Forest Health Protection, ²Northern Arizona University

Introduction:

The Pandora moth, *Coloradia pandora* (Lep.: Saturniidae) is a native defoliator that periodically causes severe damage to pine forests in Western U.S.A. Three subspecies are recognized in U.S.A.: *C. pandora pandora* Blake, *C. pandora davisi* Barnes & Benjamin, and *C. pandora linseyi* Barnes & Benjamin. The former two subspecies occur in the interior west and the latter occurs in California and Oregon.¹

Outbreaks have occurred in Arizona, California, Colorado, Utah, Oregon, and Wyoming in areas of loose, granular soils of volcanic origin, where larvae can easily burrow into the soil to pupate.¹ The last recorded outbreak in Northern Arizona took place from 1978-1984 on a limestone soil type.² The pandora moth typically goes through a two-year life cycle in Northern Arizona. Adult moths are heavy-bodied, gray-brown in color with a wingspan of 70-110 mm and have small dark spots near the center of each wing. Moths emerge in July and the females begin ovipositing on foliage immediately following mating. Eggs hatch in September-October and the larvae overwinter as 2nd instar with periodic feeding during warm periods. Noticeable defoliation takes place the following spring with the heaviest feeding occurring from April-June, when pupation begins. They remain as pupae for one year

Fire exclusion and current trends of drought and warmer climate have resulted in changes in fire characteristics and post-fire effects. No monitoring programs are in place for predicting when and where moth outbreaks will occur.

Our objective is to develop technologies to better monitor, predict, and quantitatively assess the risk of pandora moth outbreaks under changing climate and land use patterns that have ultimately resulted in different patterns of fire intensity at a landscape scale.



Figure 1. Adult pandora moth Figure 2. 2nd instar larvae Figure 3. Defoliated ponderosa pine

Materials and Methods:

We identified pheromone compounds from moths collected in northern Arizona during the spring of 2010. Treatments included four different blends using the two identified compounds² and one control. Pheromones were tested using flight traps.

We monitored fly activity using 3 light traps near Jacob Lake, AZ. Climatic data was also collected.

We established transects throughout the ponderosa pine type on the North Kaibab Ranger District (Fig. 4) to compare potential relationships between trap catches and egg and larval densities and subsequent defoliation. The Warm Fire of 2006 was used to compare potential differences in pandora moth density and defoliation.

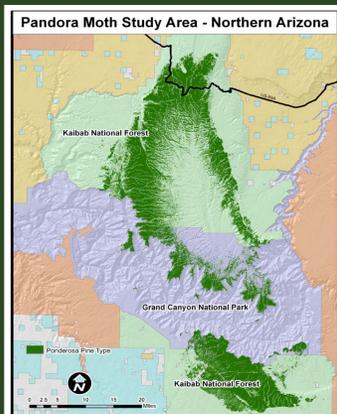


Figure 4. Ponderosa pine type within the pandora moth study area.

Landsat data were collected from the 1978 pandora moth infestation and 2010 through the end of this project (Figure 5). We plan to compare the historic and current infestation and attempt to identify trends.



Figure 5. Time series of Landsat imagery for the North Kaibab Ranger District.

Preliminary Results:

In our preliminary 2010 pheromone trapping study, 3 moths were attracted to lure 3 and 1 moth was collected with lure 1. No moths were attracted to the lure 2, lure 4 and control treatments. The lures were combinations of E10,Z12-16:Ald and E10,E12-16:Ac, and variable rates of E10,Z12-Ac. This was most likely a result of timing due to compound availability. Trapping will continue for the next 2 years.



Figure 6. (a) Light trap (b) pheromone trap (c) collection bucket used for adult pandora moth survey.

Light trap results were consistent with previous findings.³ Flight activity started in July, peaked in August, and ended in September (Fig. 7). Males were more abundant than female moths with a peak of 2,750 male moths collected on the night of August 11. Female moths were observed laying eggs on and around the light traps later in the season.

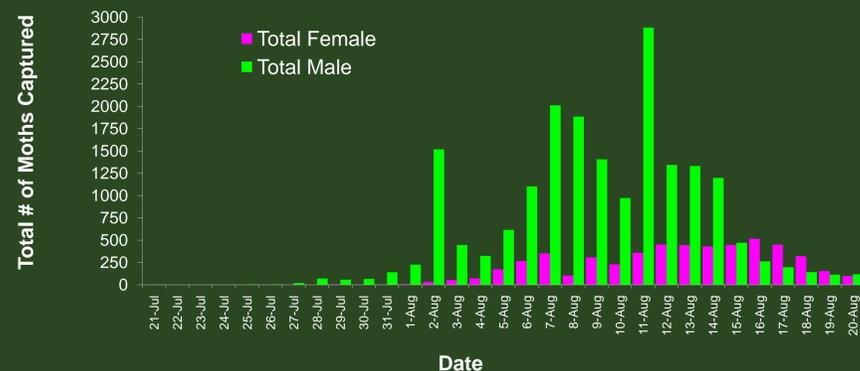


Figure 7. Pandora moth light trap activity from traps placed near Jacob Lake, AZ during 2010.

Temperature was measured and compared against adult moth light trap activity. Peak flight activity occurred between 9 and 11 pm while temperatures averaged 50-55 F. Flight activity continued throughout the night with a noticeable decrease in activity as temperatures fell towards 40 F. (Fig. 8)

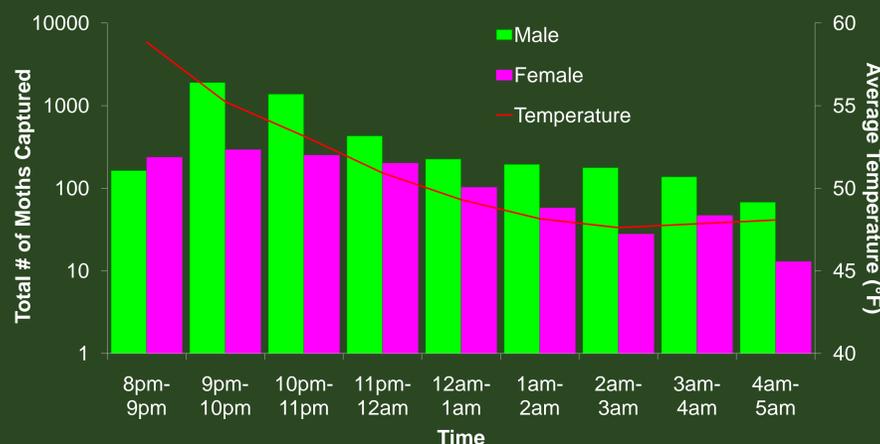


Figure 8. Pandora moth light trap activity by temperature.

Preliminary Results Continued:

No eggs or larvae were found during the fall transect surveys. We added additional survey locations to focus on areas closer to the light trap locations where thousands of moths were collected per night. These locations were also void of any evidence of current larvae activity. A winter/spring survey will be conducted in 2011.

Change detection was evaluated for a time series of Landsat images from June 2010 to November 2010 using the Normalized Difference Vegetation Index (NDVI). The largest area of change occurred within the 2006 warm fire area (Fig. 9). Ground validation is currently underway along with an investigation of forest change within the ponderosa pine type between 1978 and 1984.

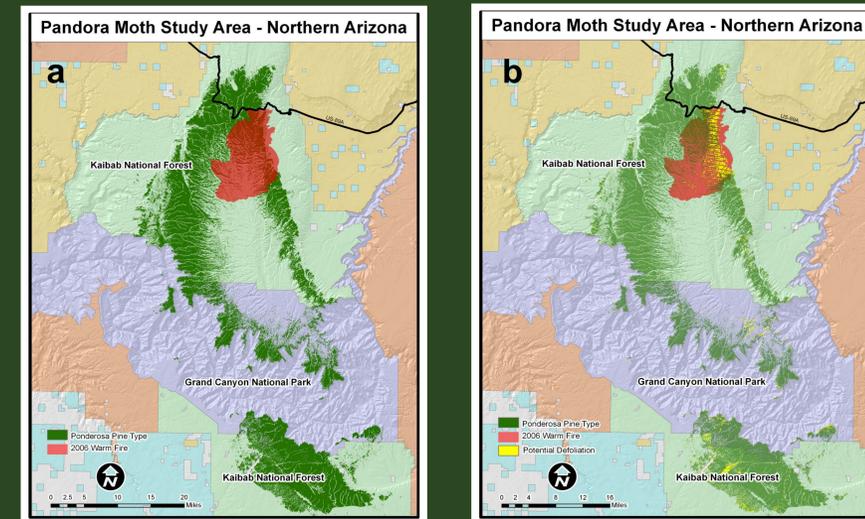


Figure 9. 2006 warm fire (a) and forest change detected between June 2010 and November 2010 (b).

Future Work:

This was the first year of a three year investigation. We will repeat this work over the course of the next two summers along with the Landsat change detection exercise. Additional plots will be established near Tusayon, AZ on the Williams Ranger District.



Acknowledgements:

We wish to thank Jocelyn Millar and Steve McElfresh (University of California Riverside) for their assistance with pheromone analysis and synthesis from adult pandora moths collected in northern Arizona. We would like to thank Ron Sieg (Arizona Game and Fish) for providing summer housing. We would also like to thank Gary Domis (Kaibab National Forest) for his assistance locating plot locations and trap sites.

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