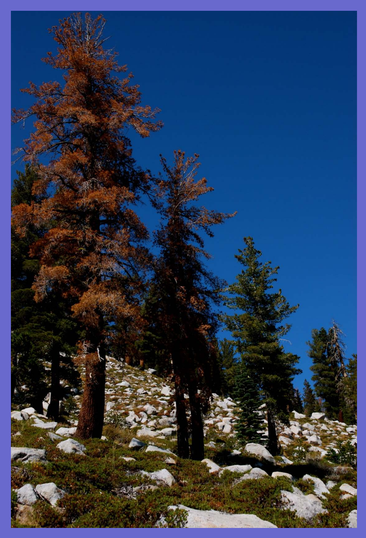

Monitoring Mountain Pine Beetle Life Cycle Timing and Phloem Temperatures at Multiple Elevations and Latitudes in California

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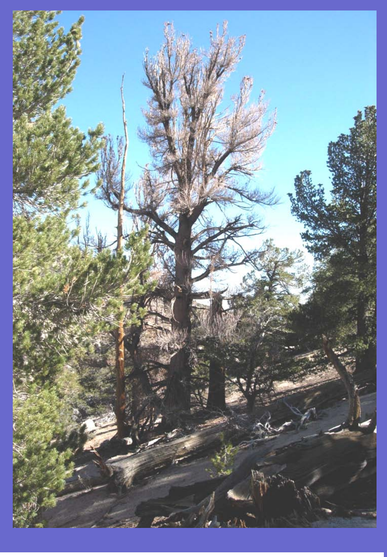

Introduction

The geographic distribution of mountain pine beetle (*Dendroctonus ponderosae*) (MPB) is extensive, encompassing all pine ecosystems from southern California to central British Columbia. In recent years, MPB outbreaks have become more intense and of longer duration, killing pines over millions of acres. This increase in, and expansion of, MPB activity is thought to be a direct result of warming temperatures and reduced precipitation. MPB fitness and population success are directly related to temperature as it affects multiple life history strategies and community associates. Future distributions of MPB (both expansions and contractions) will be dictated by climate regimes in susceptible pine forests as well as the ability of MPB to migrate and/or adapt to novel environments.

To describe and predict future trends in population success as a function of temperature, models describing MPB phenology have been developed using data derived from populations in central Idaho. However, little data is available on MPB population dynamics in the southern part of its range, including many areas in California, to evaluate the adequacy of current models. Constant temperature laboratory experiments and range-wide genetic analyses have demonstrated significant genetic and quantitative trait variation among MPB populations from different latitudes, but how this variation relates to population success throughout California is unclear. For example, the potential for MPB populations to successfully complete two generations in a single year in current or predicted climate regimes of California has not been investigated. California is home to six of the nine white pine species native to the US. Many of these are keystone, long-lived species growing at high elevations and are threatened by MPB and white pine blister rust. **Baseline data is needed on MPB temperature-dependent lifecycle timing to assess potential impacts to high-value pine species caused by current and changing climates throughout California.**

Methods

In 2009, we selected four areas in California to monitor MPB lifecycle timing, air temperature, and phloem temperature of MPB-infested host trees. The four areas had current MPB activity, and were chosen to provide a gradient of elevation with multiple host tree species from northern to southern California: 1) Lassen NF, sugar pine (*Pinus lambertiana*); 2) Tahoe NF and Lake Tahoe Basin NF, including three elevation zones with *P. contorta* (lodgepole pine), *P. monticola* (western white pine), and *P. albicaulis* (whitebark pine); 3) Inyo NF, foxtail pine (*P. balfouriana*); and 4) San Bernardino NF, *P. monophylla (Fig. 1).*

At each site, temperature probes were attached to 3-5 trees to monitor phloem temperatures hourly for the duration of the MPB lifecycle. Air temperature is also being monitored. The timing of MPB attacks was monitored and recorded on the lower bole of each sample tree at each site on at least a weekly basis. After the completion of MPB flight, 1x2 ft emergence cages were attached to north and south sides of each sample tree at each site. MPB emergence timing was monitored on each tree beginning spring 2010. Coincident with emergence from 2009 attacked trees, MPB attacks on live trees were monitored in 2010. Temperature probes were attached to these trees and temperature will continually being monitored through emergence in 2011. Trees were not probed at the Inyo NF site until October 2009. A portion of temperature data from the Tahoe NF lodgepole pine site was lost due to vandalism and datalogger malfunction.

Figure 1. Site locations

Preliminary Results

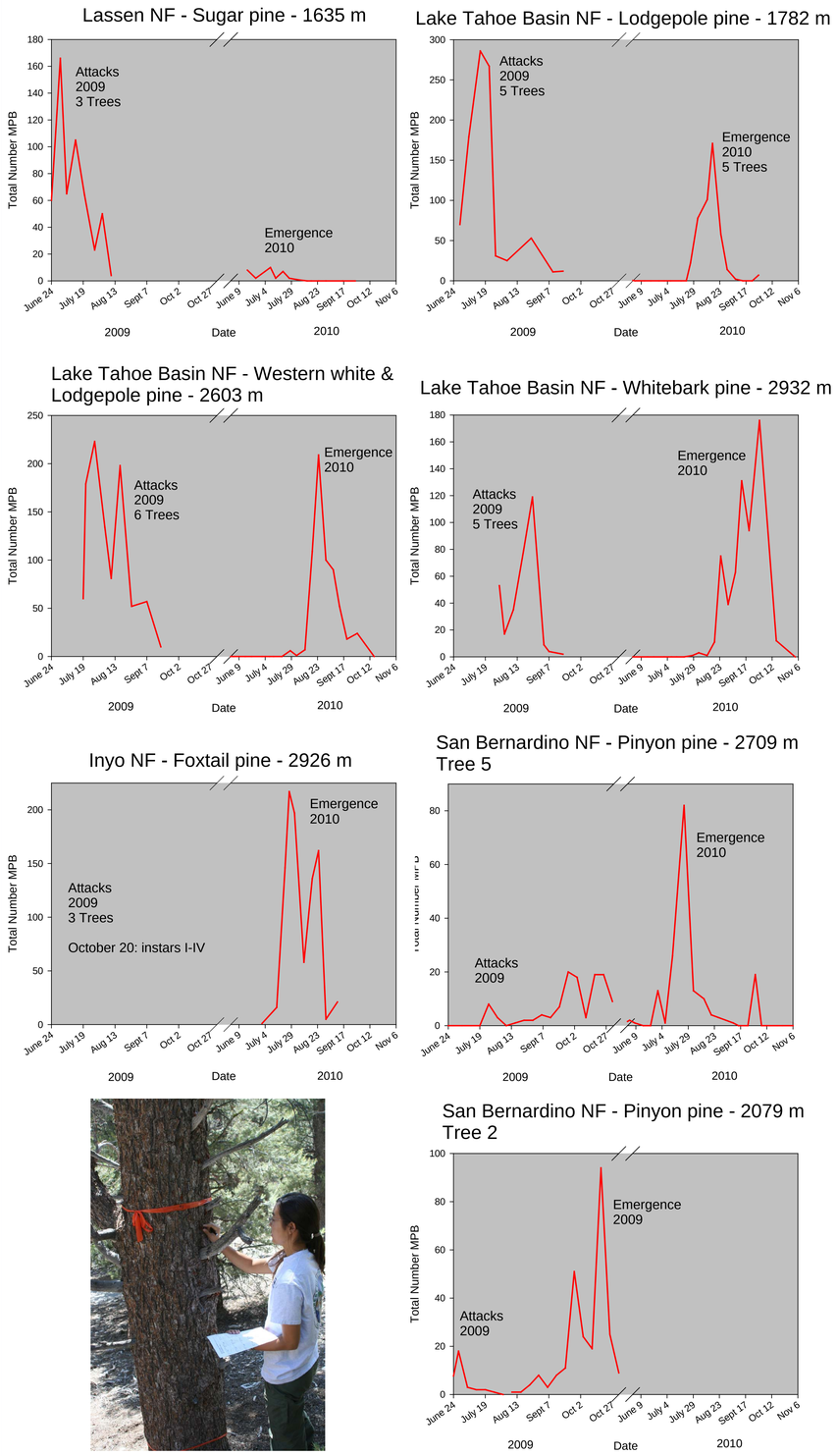

Figure 2. Weekly number of MPB attacks in 2009 and emergence in 2010, summed for all trees at each site. MPB emergence numbers for Tree 2, San Bernardino NF based on emergence holes. All other emergence numbers based on tree cages. Attacks were measured on the entire circumference of the tree bole between 1 and 6 ft. Emergence cages only sampled 4 sq ft. of this area.

Preliminary Results, cont.

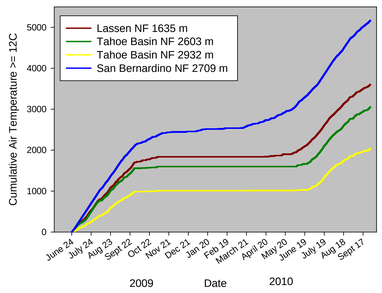

Figure 3. Cumulative thermal energy (>12˚C) at several MPB sites.

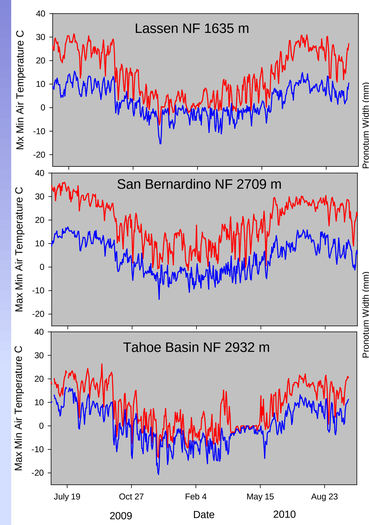

Figure 4. Daily maximum and minimum air temperatures at 3 MPB sites.

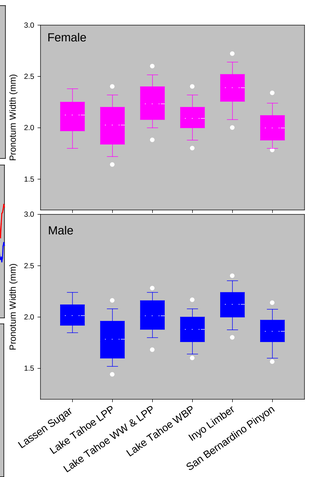

Figure 5. Size of adult MPB that emerged in 2010 at each site.

Summary

- MPB was univoltine in all trees at all sites, with the exception of Tree 2 at the San Bernardino site in 2009.
- Temperature was the warmest at the San Bernardino NF pinyon pine site, and coolest at the Lake Tahoe Basin NF whitebark pine site (Figs. 3, 4). At the San Bernardino NF site, thermal energy was more than 3000 units greater than at the Lake Tahoe NF whitebark pine site, although MPB was univoltine at both sites.
- Size of emerged MPB adults varied among the sites. Females were always larger than males. Beetles at the Inyo NF site were the largest.
- MPB emergence will be monitored again in spring/summer 2011, resulting in data on two complete MPB generations at each site.
- Data from multiple trees, sites, and years will be used to evaluate our MPB phenology model for use in predicting susceptibility of California pine forests to MPB outbreaks and to develop management strategies and prioritize cone collection for gene conservation.

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