



Mountain pine beetle-caused mortality over eight years in two pine hosts in mixed-conifer stands of the southern Rocky Mountains



Daniel R. West^{a,*}, Jennifer S. Briggs^b, William R. Jacobi^a, José F. Negrón^c

^a Colorado State University, Dept. of Bioagricultural Sciences and Pest Management, C202 Plant Sciences Bldg., Fort Collins, CO 80523-1177, United States

^b U.S. Geological Survey, Geosciences and Environmental Change Science Center, Box 25046, M.S. 980, Bldg 25, Denver Federal Center, Denver, CO 80225, United States

^c USDA Forest Service, Rocky Mountain Research Station, 240 West Prospect, Fort Collins, CO 80525, United States

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ABSTRACT

Eruptive mountain pine beetle (*Dendroctonus ponderosae*, MPB) populations have caused widespread mortality of pines throughout western North America since the late 1990s. Early work by A.D. Hopkins suggested that when alternate host species are available, MPB will prefer to breed in the host to which it has become adapted. In Colorado, epidemic MPB populations that originated in lodgepole pine expanded into mixed-conifer stands containing ponderosa pine, a related host. We evaluated the susceptibility of both hosts to successful MPB colonization in a survey of 19 sites in pine-dominated mixed-conifer stands spanning 140 km of the Front Range, CO, USA. In each of three 0.2-ha plots at each site, we (1) assessed trees in the annual flights of 2008–2011 to compare MPB-caused mortality between lodgepole and ponderosa pine; (2) recorded previous MPB-caused tree mortality from 2004–2007 to establish baseline mortality levels; and (3) measured characteristics of the stands (e.g. tree basal area) and sites (e.g. elevation, aspect) that might be correlated with MPB colonization. Uninfested average live basal area of lodgepole and ponderosa pine was 74% of total basal area before 2004. We found that for both species, annual percent basal area of attacked trees was greatest in one year (2009), and was lower in all other years (2004–2007, 2008, 2010, and 2011). Both pine species had similar average total mortality of 38–39% by 2011. Significant predictors of ponderosa pine mortality in a given year were basal area of uninfested ponderosa pine and the previous year's mortality levels in both ponderosa and lodgepole pine. Lodgepole pine mortality was predicted by uninfested basal areas of both lodgepole and ponderosa pine, and the previous year's lodgepole pine mortality. These results indicate host selection by MPB from lodgepole pine natal hosts into ponderosa pine the following year, but not the reverse. In both species, diameters of attacked trees within each year were similar, and were progressively smaller the last four years of the study period. Our results suggest that, in contrast to previous reports, ponderosa and lodgepole pine were equally susceptible to MPB infestation in the CO Front Range during our study period. This suggests that forest managers may anticipate similar impacts in both hosts during similar environmental conditions when epidemic-level MPB populations are active in mixed-pine stands.

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1. Introduction

The mountain pine beetle (*Dendroctonus ponderosae*, MPB) is considered the most destructive of all native western North American forest insects (Furniss and Carolin, 1977). It attacks all native and exotic pines in western North America (Safaryik and Carroll, 2006). Beetle populations persist at low, endemic levels in numerous forest types, but can expand rapidly into epidemic levels if conditions occur that either decrease the resistance of the host trees, increase the annual survival of the beetles, or both (Raffa et al.,

2008; Bentz et al., 2010). Eruptive MPB populations that developed over the past two decades in western North America have caused pine mortality throughout millions of hectares since the late 1990s (Meddens et al., 2012). The scale and intensity of recent epidemics have been attributed to several factors acting in concert: an increase in both winter and summer temperatures, promoting MPB survival and reproduction; an increase in contiguous area of pine-dominated stands whose age and density were optimally susceptible to MPB attack; and a decrease in resistance of individual trees due to drought stress (Bentz et al., 2010; Raffa et al., 2008; Taylor et al., 2006).

In the forests of Colorado and southern Wyoming, epidemic populations of MPBs killed trees across more than 1.6 million

* Corresponding author. Tel.: +1 303 349 1688; fax: +1 970 491 3862.

E-mail addresses: drwest73@gmail.com, dan.west@colostate.edu (D.R. West).

hectares between 1996 and 2011 (USFS, 2011). Primarily lodgepole (*Pinus contorta* Douglas ex Loudon var. *latifolia* Engelm. ex S. Watson) and ponderosa pines (*Pinus ponderosa* Lawson var. *scopulorum* Engelm.) were killed along with some mortality in limber pine (*Pinus flexilis* James) and bristlecone pine (*Pinus aristata* Engelm.; USFS, 2011). Colorado has approximately 800,000 hectares of ponderosa pine, commonly found from 1800 to 2750 m of elevation, while lodgepole pine occupies about 600,000 hectares between 2450 and 3050 m (CSFS, 2012). East of the Continental Divide in Colorado, the two species overlap in a mixed-conifer 'ecotone' zone on the eastern slopes of the Front Range mountains. These mixed-conifer stands grow at intermediate elevations (between 2450 and 2750 m) and include other conifer species such as Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco), limber pine (*P. flexilis* James), Engelmann spruce (*Picea engelmannii* Parry ex Engelm.), and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.).

Before 2007, the MPB outbreak in Colorado predominantly affected lodgepole pine forests on the west side of the Continental Divide (Witcosky, 2009). In 2007–2008, Aerial Detection Surveys (ADS) conducted by the U.S. Forest Service and its partners in Colorado documented increasing mortality from MPB in lodgepole-dominated pine forests east of the Continental Divide along the Colorado Front Range (Fig. 1; Witcosky 2008, 2009), raising concerns about the potential spread of MPB populations to ponderosa pine-dominated forests. The Front Range urban corridor contains most of Colorado's major population centers with a rapidly expanding wildland-urban interface; thus, there are significant values at risk from beetle-induced forest mortality (e.g. potential changes in wildfire hazard, hydrologic function, recreational opportunities, and aesthetic values; Binkley and Duncan, 2009; Witcosky, 2009). In 2008, the susceptibility of large tracts of ponderosa pine forest adjacent to infested

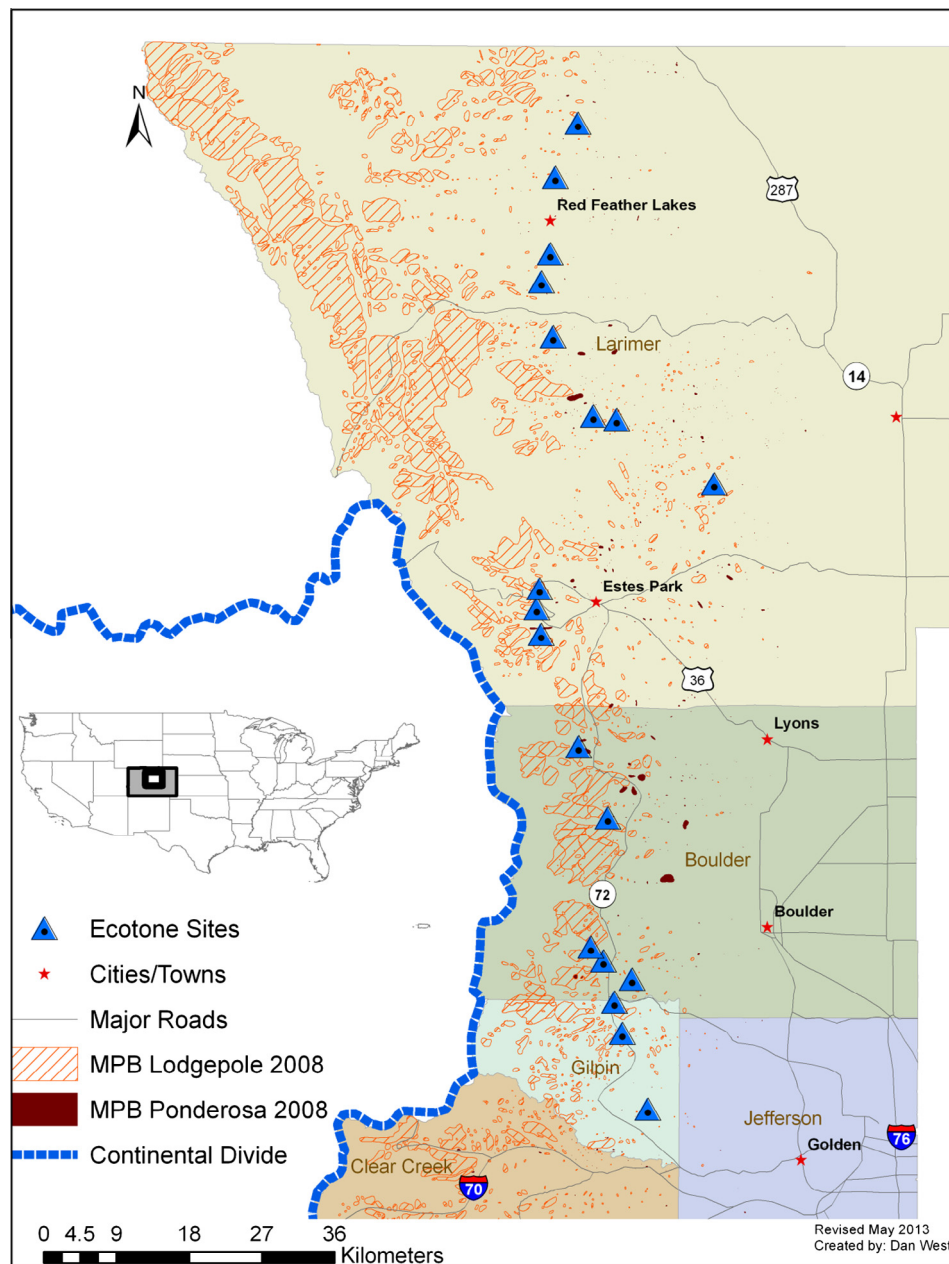


Fig. 1. Study sites (2009–2011) in the lodgepole–ponderosa pine ecotone along the Front Range, CO. USDA Forest Service and its partners, 2008 Aerial Detection Survey data depicting mountain pine beetle-caused mortality in lodgepole pines and ponderosa pines in 2007.

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