Quantifying the Short-and Long-term Impacts of Mountain Pine Beetle Outbreaks on Forest Fuels and Other Stand Attributes in the Intermountain West (INT-EM-F-10-03)

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Bark beetles influence forest ecosystem structure and function by regulating certain aspects of primary production, nutrient cycling, ecological succession and the size, distribution and abundance of trees (Fettig et al. 2007, For. Ecol. Manage. 238: 24-53). Currently, mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins, outbreaks are widespread across the western U.S. (Cain 2009, *in* Man, G. (ed.), FS-919), especially in lodgepole pine forests, requiring evaluation of ecological impacts (Fig. 1) and development of resource strategies that will address future forest conditions.

Figure 1. Mountain pine beetle-caused tree mortality, Montana, U.S., 2010.

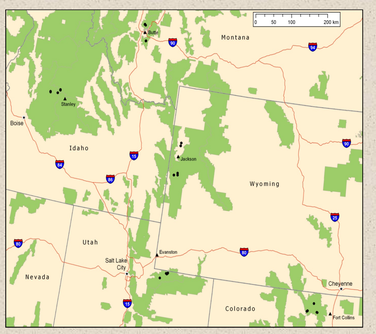


Figure 2. Plots (filled circles, n = 25/state, but overlapped). Green = National Forest.

Methods

Twenty-five 0.08-ha circular plots were established in each of five states (CO, ID, MT, UT, WY; Fig. 2) in predominately lodgepole pine stands with recent MPB-caused tree mortality (N = 125). Within each plot, all trees ≥7.6 cm dbh were tagged with species, dbh, height, height to base crown, status (live or dead), and year since death (Klutsch et al. 2008, For. Ecol. Manage. 258: 641-649) recorded. Three 16.1-m Brown's transects (Brown 1974, INT-GTR-16) were established at 0°, 120° and 240° from plot center to estimate surface fuels (Fig. 3). A 1-m² plot was established at the end of each Brown's transect (n = 3/plot) to determine forest floor composition (Fig. 4), and a 0.004-ha plot was established at plot center to estimate tree regeneration (data not presented). Increment cores were collected from the three tallest trees on each plot (N = 375) to determine stand age and site productivity (data not presented).

Figure 3. 16.1-m Brown's transect used for estimating surface fuel loads, Idaho, U.S., 2010.

Figure 4. 1-m² plot used for determining forest floor composition, Idaho, U.S., 2010.

Ongoing Assessment

Since 2004 there has been a significant loss of pines in the larger diameter classes (Fig. 5), due mostly to MPB (Fig. 6).

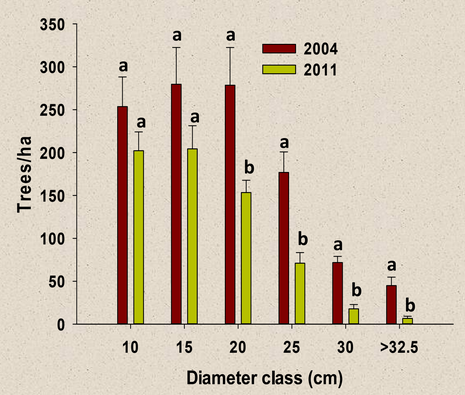


Figure 5. Mean (+ SEM) number of pines per hectare per diameter class (mid-point of 5-cm diameter classes shown except for largest). Bars followed by the same letter within diameter class are not significantly different ($P > 0.05$).

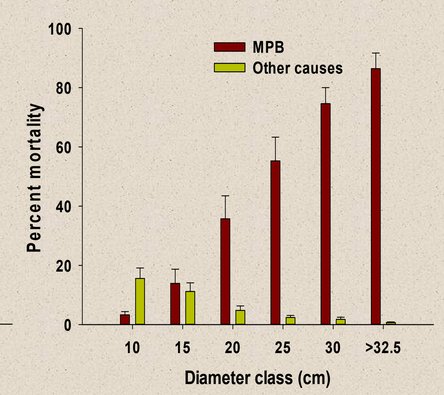


Figure 6. Mean (+ SEM) percentage of pines killed by diameter class (mid-point except for largest) caused by MPB and other sources.

Due to the significant mortality of pines in larger diameter classes (Fig. 5), reduction in live pine volume ranged from 49% (Idaho) to 67% (Montana) between 2004 and 2011 (Fig. 7).

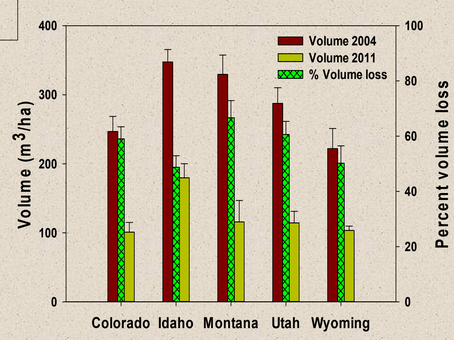


Figure 7. Mean (+ SEM) live pine stem volume, and mean (+ SEM) percentage of loss since 2004.

By 2010, mortality attributed to MPB declined to near pre-outbreak levels in all states, except Colorado (Fig. 8).

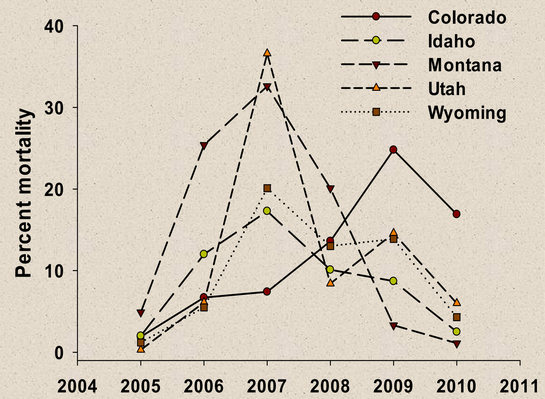
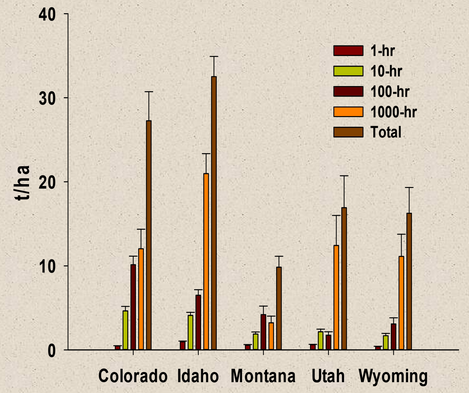


Figure 8. Mean percentage of basal area killed (m²/ha) per year of available pines by MPB.

With reduction in live pine volume (Fig. 7), substantial changes in the amount and distribution of fuels measured in 2010 (Fig. 9) are expected to occur as the needles, branches, limbs and boles fall to the forest floor. Levels of future tree mortality and the fall rates of individual trees will be recorded annually. Changes in regeneration, forest floor composition and fuel loads will be assessed every three years (next in 2013). The Forest Carbon and Emissions Model (FCEM) will be used to estimate carbon loss and emissions in 2013.

Figure 9. Mean (+ SEM) surface fuel loads (t/ha) by time lag categories, 2010.



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