

Monitoring Host Selection Behavior and Progression of an Infestation by the Mountain Pine Beetle, *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae), in Mixed Stands of Limber Pine, *Pinus flexilis* James, and Lodgepole Pine, *Pinus contorta latifolia* Engelmann.



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Objectives

- Assess mortality caused by mountain pine beetle (MPB) in mixed stands of limber and lodgepole pines in 2003, 2004, and 2005.
- Assess emergence density of MPB from both pines in 2005
- Monitor seasonal flight behavior of MPB in the mixed stands in 2004 and 2005
- Evaluate sex ratios of flying and emerging MPB in mixed stands in 2005

What is MPB seasonal flight behavior in mixed stands of limber and lodgepole pines?

Two funnel traps were set up outside the perimeter of each of the ten plots in 2004 (May 7th) and 2005 (June 3rd). In 2004, a three component bait consisting of terpinolene, *trans*-verbenol and *exo*-brevicomin was attached to each trap. In 2005, the trap procedure was repeated except *trans*-pityol was inadvertently used instead of *trans*-verbenol as the female pheromone component of the bait.

In 2004, we trapped the first MPB during the week of June 19th and the last MPB the week of Oct. 30th. In 2005, we trapped the first MPB during the week of July 1st and the last MPB the week of Oct. 3rd (Fig. 11). The attenuated flight in 2005 is likely the result of the *trans*-pityol. *trans*-Pityol is the female pheromone attractant for twig and cone beetles. NOTE: The number of twig beetles in the traps did triple in 2005 when compared with 2004. The sex ratios of MPB collected throughout each season were dissimilar between the two years. In 2004 the ratio of males to females was 1:1.5 whereas in 2005 the ratio of males to females was 1:3.3, probably the result of different



Lindgren funnel trap

Do more MPB emerge from limber pine than from lodgepole pine?

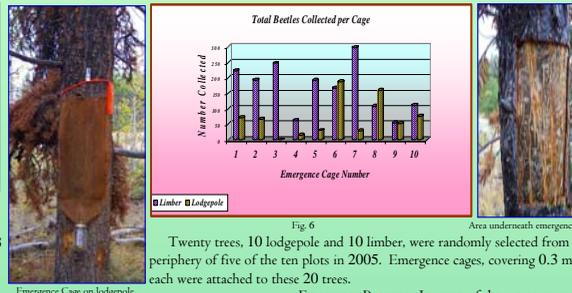


Fig. 6

Twenty trees, 10 lodgepole and 10 limber, were randomly selected from the periphery of five of the ten plots in 2005. Emergence cages, covering 0.3 m² each were attached to these trees.

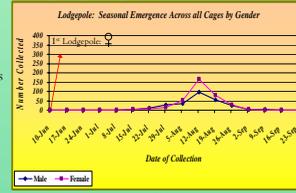


Fig. 7

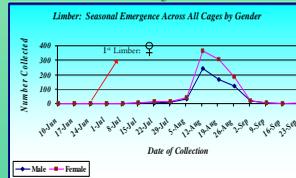


Fig. 8

MPB	Limber Mean Collected (no./0.3 m ²)	Lodgepole Mean Collected (no./0.3 m ²)	Limber Emergence Dates	Lodgepole Emergence Dates
Male	60.3	25.9	July 8 th through Sept. 16 th	June 17 th through Sept. 9 th
Female	94.5	35.5	June 24 th through Sept. 23 rd	June 10 th through Sept. 2 nd
Total	166.5	69.2		

Table 1

Emergence Patterns: In seven of the ten cases, more MPB emerged from limber pine than from lodgepole pine (Fig. 6). Overall emergence density, male emergence density and female emergence density varied by host species (Table 1). In addition, emergence varied by gender as well as by date from the two

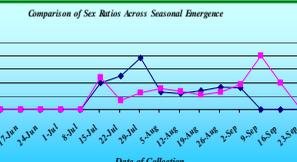


Fig. 9



Woodpecker predation of MPB on limber pine



Standing conifer plot 2 in the Medicine Bow National Forest

Is there a difference between lodgepole and limber pine mortality?

During the last decade, the mountain pine beetle (MPB) has developed elevated populations in the "white pines", including limber pine. Little is known of the behavior of MPB in limber pines, and even less is understood about their activities in mixed stands that include limber pine. Our study focused on mixed stands of limber and lodgepole pines in southeastern Wyoming

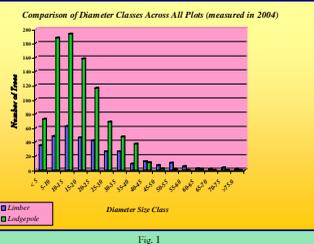


Fig. 1

(Medicine Bow National Forest) using ten 0.13 ha plots. Each plot had at least three attacked limber pines in 2003 with emergence from these trees in 2004. An analysis of the distribution of diameters of trees of both species in 2004 (Fig. 1) showed that: 1) many more lodgepole than limber pines were in the plots; 2) the greatest frequency of both species were between 5 and 20 cm in diameter; and 3) the largest diameter trees in the stands were limber pine. The mean density of trees (no./ha) across all plots was 1018; mean basal area (m²/ha) was 35.2. Mean density and basal area of limber pine were 193 trees/ha and 14.1 m²/ha, respectively. Corresponding measurements for lodgepole were more than three times (683) and more than 40% higher (20.1), respectively.

As the outbreak progressed over time, host species selection began to shift from limber to lodgepole pine (Fig. 2, red ovals). Between 2004 and 2005, the incremental number of attacked lodgepole surpassed the number of attacked limber, which was the initial preferred host. Still, the 2005 cumulative attack ratio for lodgepole was much less (1:14.2) (attacked:unattacked) than for limber (1:1.7). As a result, the intermediate and larger diameter classes of limber pine were eliminated from the stand (Fig. 3), in contrast to lodgepole pine, which still had a substantial number of trees in the intermediate diameter classes (Fig. 4).

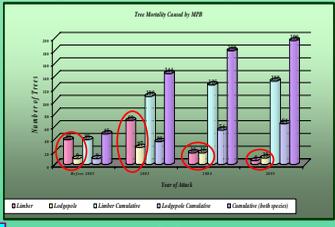


Fig. 2

At the end of the 2005 field season, a series of statistical analyses (Pearson's χ^2 statistic) within diameter class showed the cumulative percentage of limber pine attacked was significantly larger in four of eight classes analyzed (Fig. 5). Two other classes only had attacked limber pine in them. The most notable differences were in the intermediate diameter classes. Specifically:

- In the 25-30 cm class 92% of the limber and 21% of the lodgepole were killed
- In the 30-35 cm class 96% of the limber and 38% of the lodgepole were killed
- In the 35-40 cm class 89% of limber and 35% of the lodgepole were killed

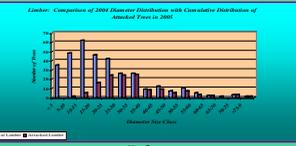


Fig. 3

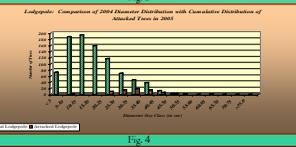


Fig. 4

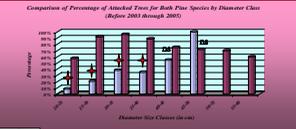


Fig. 5. Cumulative (before 2003-2005) percentages of attacked trees were compared by species within diameter class by using a 2X2 contingency table (Pearson's χ^2 statistic). Star denotes a significant difference within diameter class, ns = not significant, χ^2 < 0.05. NOTE: There were no lodgepole pines in the two largest size classes, the 40-45 cm size class had only two lodgepole pines, tending to skew results.

Area of Medicine Bow National Forest

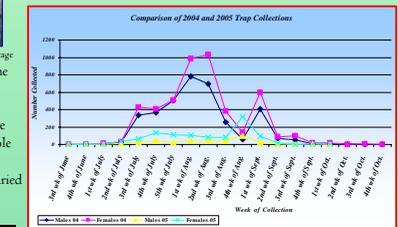


Fig. 11

2005 emergence cages shows a noteworthy similarity (Fig. 12). In 2005 MPB were collected in traps from July 1st through Oct. 3rd and emergence was June 10th (lodgepole) through Sept. 23rd (limber). But, in 2004 trap collections were more compatible with emergence of 2005: June 19th through Oct. 30th (Figs. 7, 8 and 11).

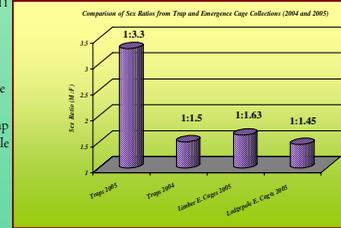


Fig. 12

Conclusions:

- Limber was the initial preferred host in the mixed stands of limber/lodgepole
- Several critical intermediate and large diameter size classes of limber were almost eliminated from these mixed stands, likely impacting succession
- This study suggests a possible shift in host preference from limber pine to lodgepole pine, but a longer term study would clarify the progress of the infestation
- In 7 out of 10 cases more MPB emerged from limber than from lodgepole
- The mean number of emerged MPB males was higher in limber than in lodgepole
- The mean number of emerged MPB females was higher in limber than in lodgepole
- MPB emergence periods varied between limber and lodgepole but peak emergence was identical
- Correlation between MPB emergence and MPB flight period is likely, but cannot be proven with this data

Future Directions:

The apparent fidelity to limber pine in the mixed stands, along with the reproductive success of MPB in limber, suggests a mechanism based on an underlying nutritional component and/or possible host race formation. The nutritional component was explored using stable isotope analysis. Results from this work will be available soon.

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