

Physiological, ecological and environmental factors that predispose trees, stands and landscapes to infestation by tree-killing *Dendroctonus* beetles

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Abstract

In the last century the frequency and severity of outbreaks of tree-killing *Dendroctonus* beetles (Coleoptera: Curculionidae) have increased. Small-scale drivers within trees likely drive outbreak dynamics across landscapes. At a small scale, variation in carbohydrate availability within the stems of lodgepole pines (*Pinus contorta* var. *latifolia*) impacts the fungal symbionts of the mountain pine beetle (*D. ponderosae* Hopkins). I found that, during the growing season, carbohydrates were less available in the lower stems of pines than in their upper stems. After inoculation with a fungal symbiont of the mountain pine beetle however, trees mobilized carbohydrates to lesion fronts regardless of inoculation height along the stem. Interestingly, lesions that formed in response to fungal inoculation were larger in the lower portion of the stem than in the upper stem, likely due to due to lower initial concentrations of carbohydrates available to fund responses to fungal attack. I evaluated the consequences of common silvicultural treatments in stands attacked by bark beetles and found that small-scale interactions remained important in these systems. Fertilization reduced carbohydrate reserves in the roots of lodgepole pine trees by promoting tree growth. As trees use carbohydrate reserves to fund defensive responses, fertilized trees may therefore exhibit weakened defenses against bark beetle attack. In a separate experiment I found that fertilization increased beetle survival in bolts that overwintered in the Crowsnest Pass—an effect that was mediated by their fungal symbionts. In a

landscape-scale analysis of a 30-year dataset, I found no evidence that defoliation by a lepidopteran (*Choristoneura biennis* Freeman) facilitates local spruce beetle (*D. rufipennis* Kirby) outbreaks in British Columbia. Thus, small-scale characteristics of bark beetle biology undoubtedly impact their populations whereas I was unable to confirm the importance of landscape scale ecological interactions.