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Extent of Western Balsam Bark Beetle Caused Mortality on the Shoshone NF

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INTRODUCTION

Subalpine fir, typically mixed with Engelmann spruce and various pine, occurs on about 10 million acres in the west. This cover type is an important component of western forests in terms of watershed protection, wildlife habitat, recreation, and scenic beauty. Over the past 20 years there has been widespread mortality of fir to varying levels across its range (Figure 1). One of the major mortality agents of subalpine fir is the western balsam bark beetle (WBBB).

Found throughout western North America, the western balsam bark beetle (*Dryocoetes confusus*) is the most aggressive and destructive member of its genus (Smith and Hulcr 2015). The beetle works in concert with the pathogenic fungi *Ceratocystis dryocoetidis* (Molnar 1964) and primarily attacks subalpine fir (*Abies lasiocarpa*) (Furniss and Carolin 1977). Additionally, root disease fungi are frequently thought to be associated with tree mortality in subalpine fir.



Figure 1. Tree mortality caused by WBBB.



Figure 2. WBBB adults and galleries.

While the life cycle of WBBB is not completely understood, generally, it is thought to have a 2 year life cycle, but can vary between 1 and 2 years depending on latitude, elevation and weather conditions (Bright 1963, Hansen 1996). Beetles fly throughout the summer beginning in June. Males typically initiate attacks on the boles of susceptible host trees. After initiating attack, males bore into the phloem, excavate a nuptial chamber, then attract and mate with several females. Two to seven egg

galleries radiate from the central nuptial chamber (Figure 2). Larvae feed through late summer and fall in the phloem and extend their galleries until freezing weather. The first overwintering period is typically spent as dormant larvae. Development is then resumed in the spring and summer. The second overwintering period is then usually spent as pupae or adults (Hansen 1996). There are some factors that are thought to contribute to host susceptibility to WBBB attack including tree diameter, age, radial growth and extent of crown (Bleiker et al 2002). Additionally, there has been some indication that storm damaged trees or blowdown can trigger WBBB buildup (McMillin et al 2003).

Subalpine fir mortality on the Shoshone NF can be characterized generally as salt and pepper scattered trees across the landscape, with occasional more concentrated groups the past 20 years. While other tree species have incurred large bark beetle epidemics recently, subalpine fir has not. However, due to its importance for wildlife and other ecosystem roles, continued losses are important. This report documents the current mortality scenario on the Shoshone NF.

METHODS

Stands were distributed across the forest in areas that had relatively high levels of subalpine fir (Figure 3). In each stand, four 1/10th acre plots were installed, each two chains apart on a compass bearing that kept the cruise line within the selected stand. A total of 16 stands were sampled. All trees above three inches DBH (diameter at breast height) were considered mature and potential host material for WBBB. The species, DBH, and condition (live, killed by WBBB, or killed by another mortality agent) were assessed for all trees with DBHs greater than three inches. Trees with DBH less than three inches were considered regeneration, and for these trees only species and condition were recorded. At each plot within the stand, five dead trees were examined for the presence of root rot fungi, particularly *Armillaria*.

RESULTS

Almost 1,200 mature trees were measured, of which 701 (59%) were subalpine fir. The second most common mature tree was Engelmann spruce (26%), followed by lodgepole pine (9%) and whitebark pine (7%). Of the mature subalpine fir, 26% were dead and killed by WBBB. There was a wide range in beetle caused mortality by stand, with 1 stand having no beetle mortality and the most impacted stand having 72% beetle mortality.

231 dead fir were checked and 23 (10%) had *Armillaria* present. There was resin found on only 3 (1%) of the dead trees indicating they were alive when colonized. There did not appear to be any relationship between *Armillaria* being present and level of mortality caused by WBBB. The trees that were checked were generally dead for 5-10 years, and *Armillaria* may have been occurring as a decay organism as opposed to a pathogen impacting tree health.

There was a slight trend for larger diameter trees to be killed by WBBB. The average DBH of a live tree was 8.1 inches and the average DBH of a beetle killed tree was 8.9 inches. All size classes of trees were susceptible to beetle attack (Figure 3), but there is a trend towards the larger size classes having a

greater percentage killed than those in lower size classes. There was roughly an equal number of trees from 3 to 7 inches as to trees 7 inches plus in diameter indicating that a large proportion of the trees were relatively small.

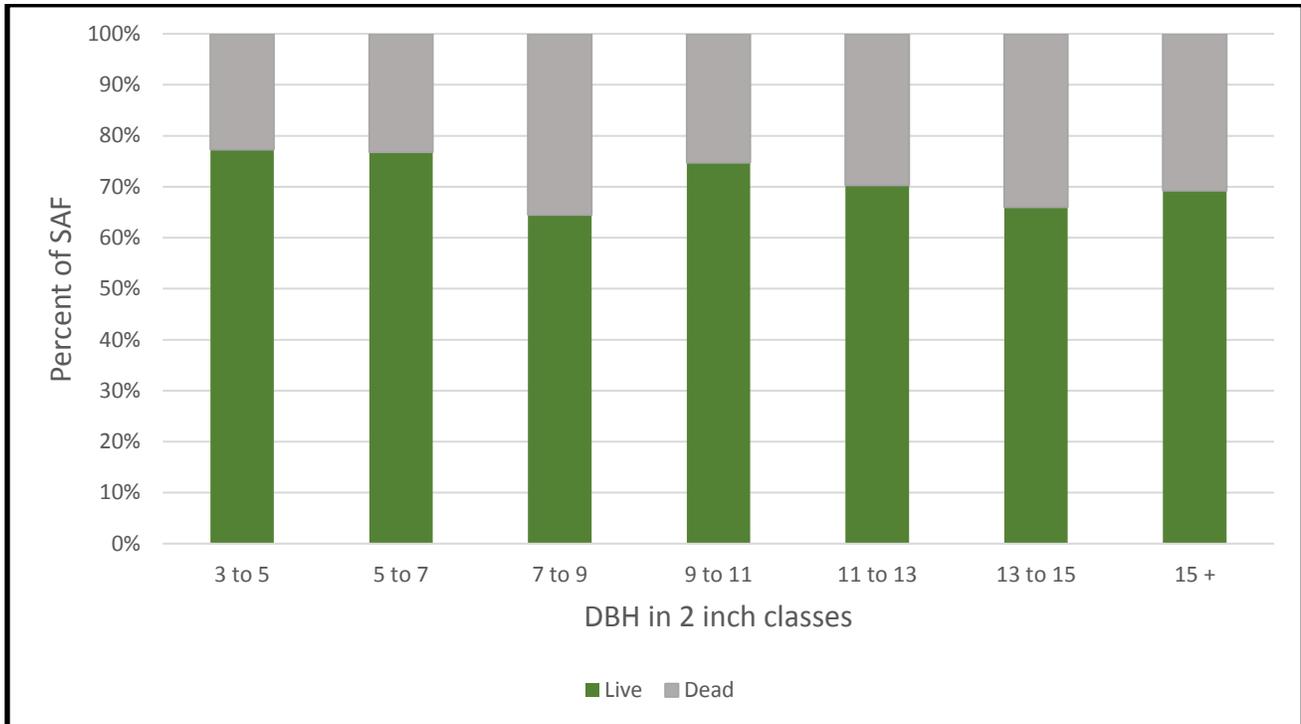


Figure 3. Percent of live and dead subalpine fir in 2 inch diameter classes. Dead trees were killed by WBBB. Due to limited number of trees, all trees above 15 inches are grouped together.

There also appears to be some association between increasing stand basal area and increasing WBBB caused mortality. Stands with higher overall basal area trended towards having more beetle caused mortality (Figure 4). There was less association with fir basal area and mortality as opposed to total basal area. Half of the stands sampled had more than 50% of their basal area composed of species other than subalpine fir.

For regeneration, over 2,100 trees were recorded. Regardless of mortality levels, the understory was dominated by subalpine fir. Fir seedlings and saplings accounted for 70% of the understory, which is an increase from the 59% of trees that were fir in the overstory. There was an average of 239 fir seedlings and saplings per acre across all stands. The range of fir regeneration across stands was from 0 to 625. Spruce was the second most common understory species found, and accounted for 19% of the seedlings and saplings. This is a reduction from the 26% of the overstory that is spruce in these areas. Whitebark pine accounted for 8% of regeneration and lodgepole pine accounted for 3% of regeneration.

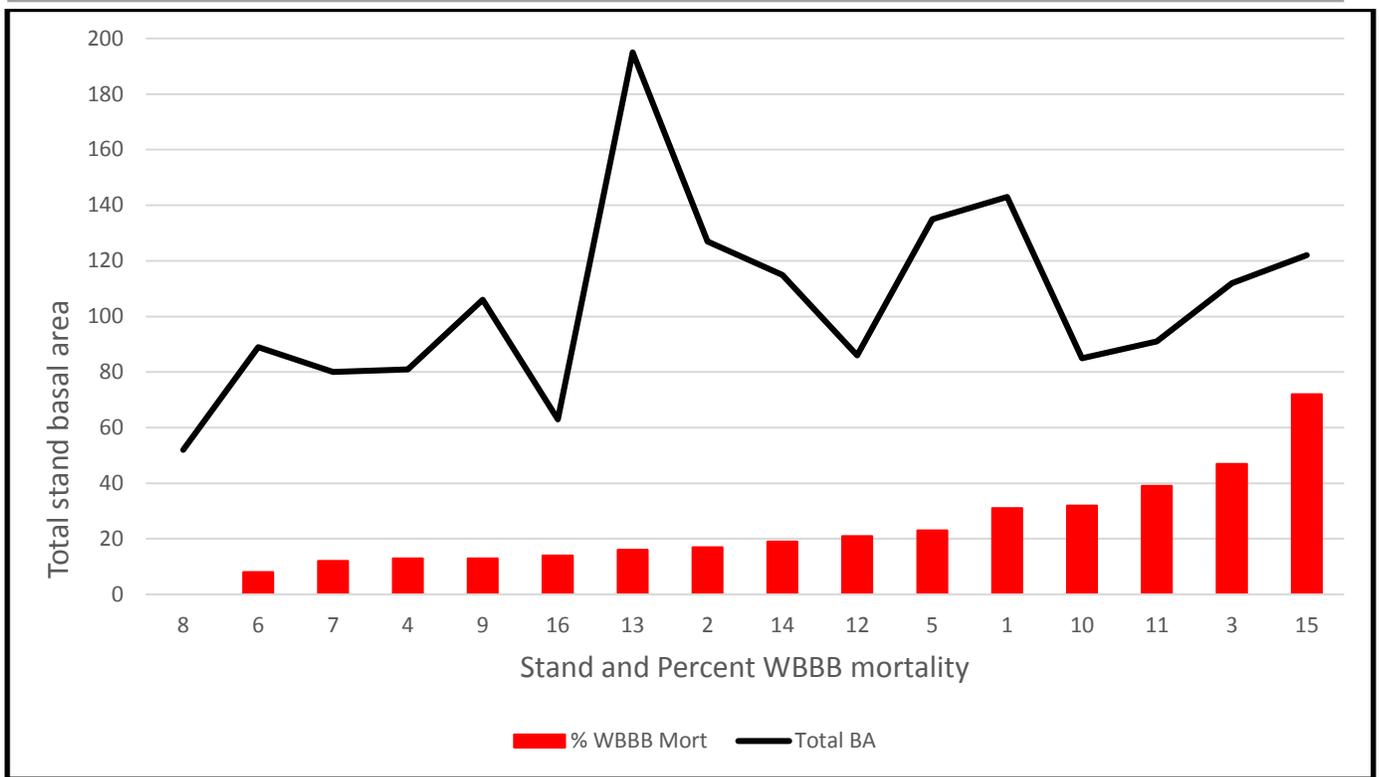


Figure 4. Total stand basal area and percent of trees killed by WBBB.

CONCLUSIONS

Over the past 10 to 15 years mortality of subalpine fir has been generally light and scattered. The bulk of the mortality can be attributed to the western balsam bark beetle. There are stands that have had larger groups of trees killed and have lost a large part of their overstory, but these are the exception not the norm. This is a difference between the Shoshone and the Bighorn NF which has had a WBBB epidemic over this time period and had much more beetle caused mortality.

While mortality has been light, there does still appear to be a positive relationship between tree diameter and beetle mortality. Larger diameter trees are more likely to be killed than smaller diameter trees. While it appears that larger diameter trees are more likely killed by the beetle, WBBB did attack and kill trees of all sizes. Also, it does appear that stand density plays a role in how much mortality will occur, with denser stands more likely to have more mortality. Both of these results are similar to what was found on the Bighorns which had much greater beetle pressure.

Armillaria was found very infrequently on the Shoshone NF, and only dead trees were examined. Any impacts to tree health from *Armillaria* appear to be minor. Frequently, death of subalpine fir is classified as a decline with multiple causal agents, such as beetles and root disease, responsible for tree death. In the case of the Shoshone, tree mortality appears to be the work of bark beetles.

Overall regeneration was good. All stands had over 100 trees per acre in regeneration and most had over 300 trees per acre. Most stands had both fir and spruce in the understory, with fir dominating regeneration in most cases. There were occasional stands that had relatively lower amounts of regeneration and this was mostly due to very little or no fir being present in the understory. The amount of regeneration did not appear to be related to amount of fir mortality that had occurred, so some other factor was responsible for low rates of fir regeneration.

Based on our results it appears that mortality caused by WBBB could be reduced in future stands through the following management actions:

1. Prompt cleanup of larger areas of blowdown.
2. Removal of larger DBH subalpine fir.
3. Reduction in overall stand density.

LITERATURE CITED

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