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8221 Mt. Rushmore Rd.
Rapid City, SD 57702

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Condition of Limber Pine Stands on the Shoshone National Forest

Kurt Allen, Entomologist
Jim Blodgett, Pathologist
Kendra Schotzko, Entomologist
Alan Dymerski, Forestry Technician

INTRODUCTION

Over the past decade, high elevation pine forests have seen increased levels of tree mortality due to forest insects and diseases, including limber pine (*Pinus flexilis*) stands on the Shoshone National Forest (Gibson *et al*. 2008). The most damaging agents to this cover type are the mountain pine beetle (*Dendroctonus ponderosae*) and white pine blister rust (*Cronartium ribicola*).

The most harmful insect pest of pine throughout the west is the mountain pine beetle. This is a native beetle that kills lodgepole (*P. contorta*), whitebark (*P. albicaulis*) and limber pine. All three of these pine species are found on the Shoshone National Forest. When the mountain pine beetle reaches epidemic proportions, significant numbers of susceptible host trees can be killed. In lodgepole pine the beetle generally attacks large diameter, overstory trees, but epidemics can result in the mortality of smaller trees as well (Amman and Cole 1983). Mountain pine beetles normally complete their life cycle in one year in lodgepole pine, although at higher elevations it can take two years (McGregor and Cole 1985). Adults typically emerge in July or August and attack standing green trees. If trees are successfully attacked, adults lay eggs and larvae develop under the bark. Immature larvae overwinter under the bark, and finish feeding in the spring and early summer. Developing larvae feed on the phloem, which kills the host tree.

Although this beetle's behavior is fairly well understood in lodgepole and ponderosa pine stands, little information exists on their behavior in limber pine stands. What is known is that brood production is fairly high in limber pine, indicating beetles do well in this species (Cerezke 1995). A retrospective look at a mountain pine beetle outbreak in the 1930's indicates that tree size (diameter) and stand density are potentially important to beetle behavior and outbreaks in whitebark pine ecosystems (Perkins and Roberts 2003).

White pine blister rust is a fungal pathogen that was introduced to the Northwest in the early 1900's and was reported in Wyoming in 1945 (Brown and Graham 1969). White pine blister rust severely impacts five-needle pines throughout many western forests (Hoff *et al.* 1992) and is contributing to mortality in many limber pine stands in the Rocky Mountains (Hoff *et al.* 1980). In the 1960's, disease incidence was described as low (6% of the trees infected) in the Shoshone National Forest (Brown and Graham 1969, Brown 1967, Brown 1978). By aging white pine blister rust cankers Brown (1978) estimated that the disease had been present in the Forest for at least 30 years.

This fungal pathogen infects pines when spores formed on the alternate host plants, *Ribes* spp., are blown and penetrate the needles of five-needle pines. The fungus grows into pine shoots developing cankers that girdle and kill branches. Branch mortality can result in a significant reduction in seed production (Keane et al. 1994) and can predispose trees to other pathogens or damaging insects (Krebill and Hoff 1995). If branch cankers are close to the main stem, cankers can expand and girdle the stem, killing the portion of trees above the cankers. White pine blister rust can continue to grow down stems resulting in tree mortality.

Although limber pine is not a marketable timber species, it is a common vegetative component in many harsh sites in the Rocky Mountains. Limber pine often occurs in pure stands on dry, windy sites where no other tree species and often little other vegetation can grow (Figure 1) (Kendall and Schirokauer 1997).

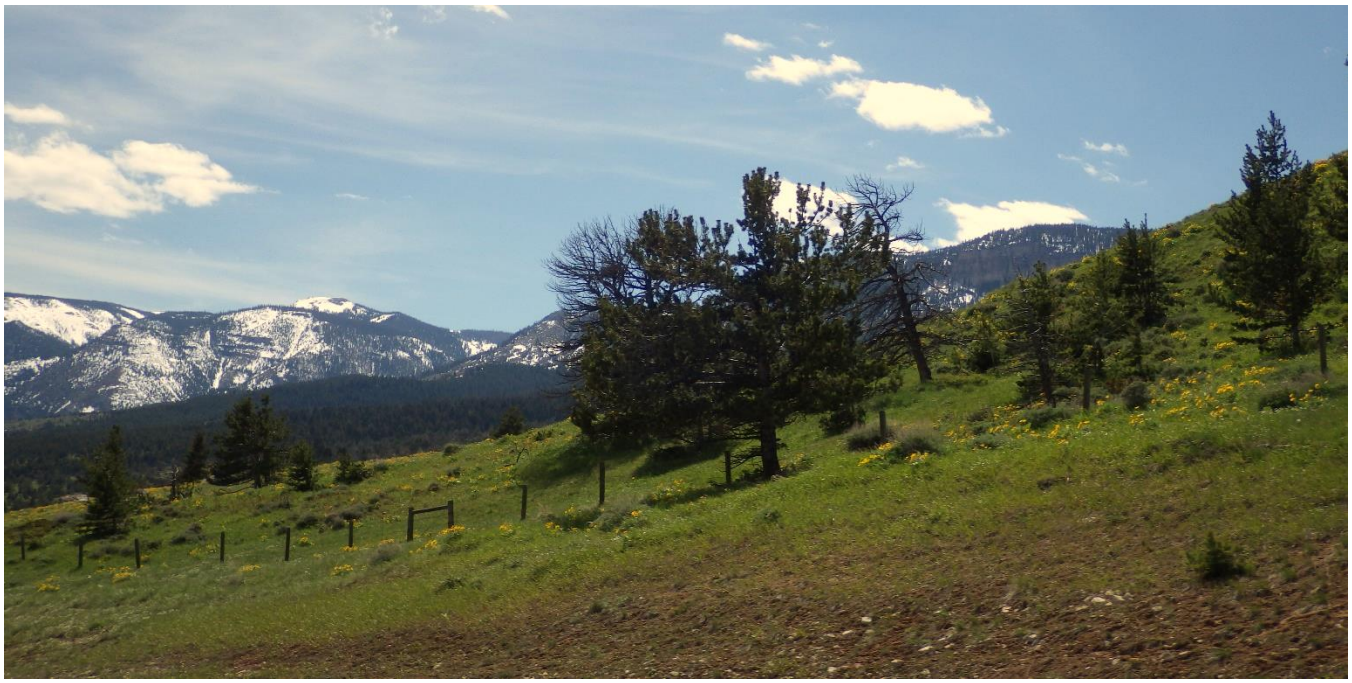

Figure 1. Limber pine, Shoshone National Forest, 2017.

METHODS

A total of 14 limber pine stands were sampled in 2017 (Figure 2). In each stand a series of four 1/10th acre plots were installed along a transect line through the stand. In each plot all trees larger than three inches diameter breast height (DBH) were counted. Measurements included species, DBH, status (live, recent mountain pine beetle (MPB) killed or other recent dead), and any damage agents. Additionally, regeneration was counted for the entire plot noting total number of each species present and any damage agents present on the seedlings. In each plot a total of two live or recent dead trees were checked for signs of *Armillaria* root disease.

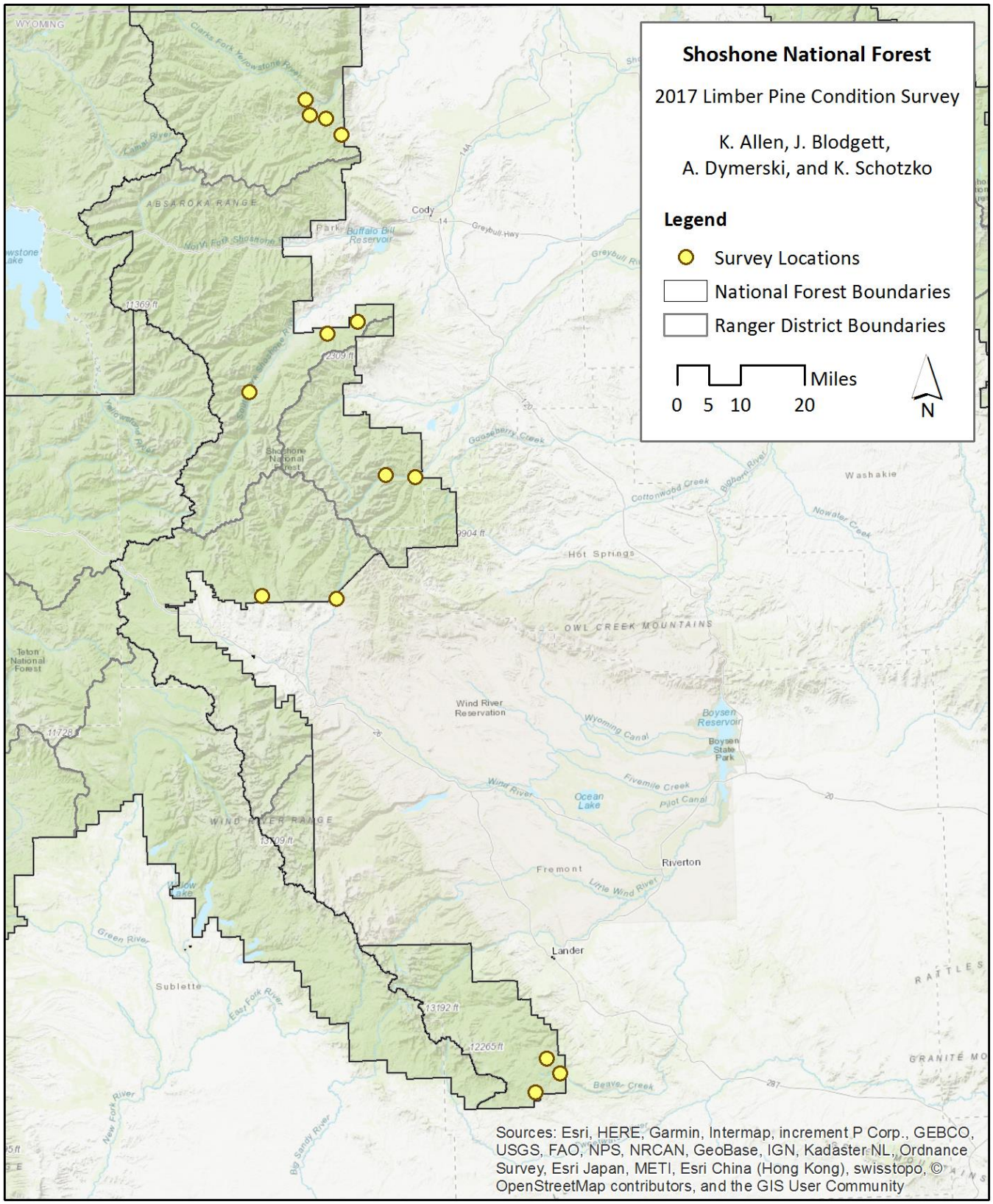

Figure 2. Map of surveyed limber pine stand locations on the Shoshone National Forest, 2017.

RESULTS

Almost 500 limber pines were sampled over the 14 stands. Overall, limber pine mortality was relatively high with 47% alive and 48% found to be recently killed (killed within the last 5-6 years) by mountain pine beetle (MPB). There was also occasional, scattered trees killed by *Ips* beetles and one stand that had high levels of dwarf mistletoe. Live limber pine had an average DBH of 6.9 inches while those killed by MPB had an average DBH of 8.6 inches, indicating the beetles were attacking larger diameter trees. Those killed by other agents (*Ips*, mistletoe, shading, etc.) had the smallest average DBH at 3.7 inches. Most stands were dominated by limber pine (91% of all trees sampled), followed by Douglas-fir (4%), lodgepole pine (3%), and Engelmann spruce (2%).

Twenty-six percent of the limber pines sampled had evidence of white pine blister rust infection, although there was no attempt to rate its extent on a tree to tree basis. There was no sign of *Armillaria* in any stand.

Regeneration was light and spotty from stand to stand. Limber pine was the most common tree found for regeneration at 46 seedlings per acre. Douglas-fir regeneration was the next most common at about 20 seedlings per acre. No other species accounted for more than five trees per acre. Only 2% of the limber pine seedlings had evidence of white pine blister rust infection.

CONCLUSIONS

Overall limber pine mortality was high across the entire forest. This was largely due to the recent MPB epidemic which affected stands across the forest and caused about 50% mortality of mature limber pine trees. Also, there are stands which have higher mortality due to localized infestations of other organisms, such as dwarf mistletoe and *Ips* beetles.

Where there is MPB caused mortality, it is focused in larger diameter trees. This is a common theme among many bark beetle species, such that larger diameter trees are attacked first. Other mortality agents such as *Ips*, mistletoe, and white pine blister rust are causing minor amounts of mortality in smaller diameter trees. While white pine blister rust was found in all stands, it was not causing mortality of three inch or greater DBH trees.

Regeneration was light and scattered. In a number of stands there was very little regeneration. With the widespread mortality of the mature trees and a lack of regeneration commonly found, the overall limber pine component will be much sparser in the future. Most of the stands are found in harsh sites which likely do not lend themselves to abundant regeneration. It is of note that very little of the regeneration had evidence of white pine blister rust, indicating that new infections are occurring at very low levels in this forest on a year to year basis.

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