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Condition of Limber Pine Stands on the Bighorn National Forest

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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 Bighorn 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*), ponderosa (*P. ponderosa*), and limber pine. When mountain pine beetle populations reach epidemic proportions, large 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, killing trees.

Although this beetle's behavior is fairly well understood in lodgepole and ponderosa pine stands, little information exists on its behavior in limber pine stands. What is known is that brood production is fairly high in limber pine, indicating that the 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 subsequently 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 Bighorn 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 30 or more years.

This fungal pathogen infects pines when spores formed on the alternate host plants, *Ribes* spp., are blown and penetrate the stomata of 5-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 (Kendall and Schirokauer 1997).

METHODS

A total of 16 limber pine stands were sampled in 2017 (Figure 1). 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 impacting seedlings. In each plot a total of two live or recent dead trees were checked for signs of *Armillaria* root disease.

RESULTS

Almost 700 limber pines were sampled over the 16 stands. Overall limber pine mortality was relatively low with 90% alive and 10% found to be recently dead (killed within the last 5-6 years). Of the recently killed trees, over half had been killed by mountain pine beetle. 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 8.2 inches while those killed by MPB had an average DBH of 12.6 inches indicating the beetles were attacking larger diameter trees. Limber pine killed by other agents (*Ips*, mistletoe, shading, etc.) were generally smaller, with an average DBH of 6.8 inches. Most stands were dominated by limber pine (85% of all trees sampled), followed by Engelmann spruce (5%), Douglas-fir (4%), ponderosa pine, and lodgepole pine (3% each).

Thirty-eight 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. Engelmann spruce was the most common tree found for regeneration with 105 seedlings per acre. This number is skewed somewhat due to one stand which had an abundance of spruce regeneration. Both limber pine and Douglas-fir regeneration were found with about 60 seedlings per acre. Only 8% of the limber pine seedlings had evidence of white pine blister rust infection.

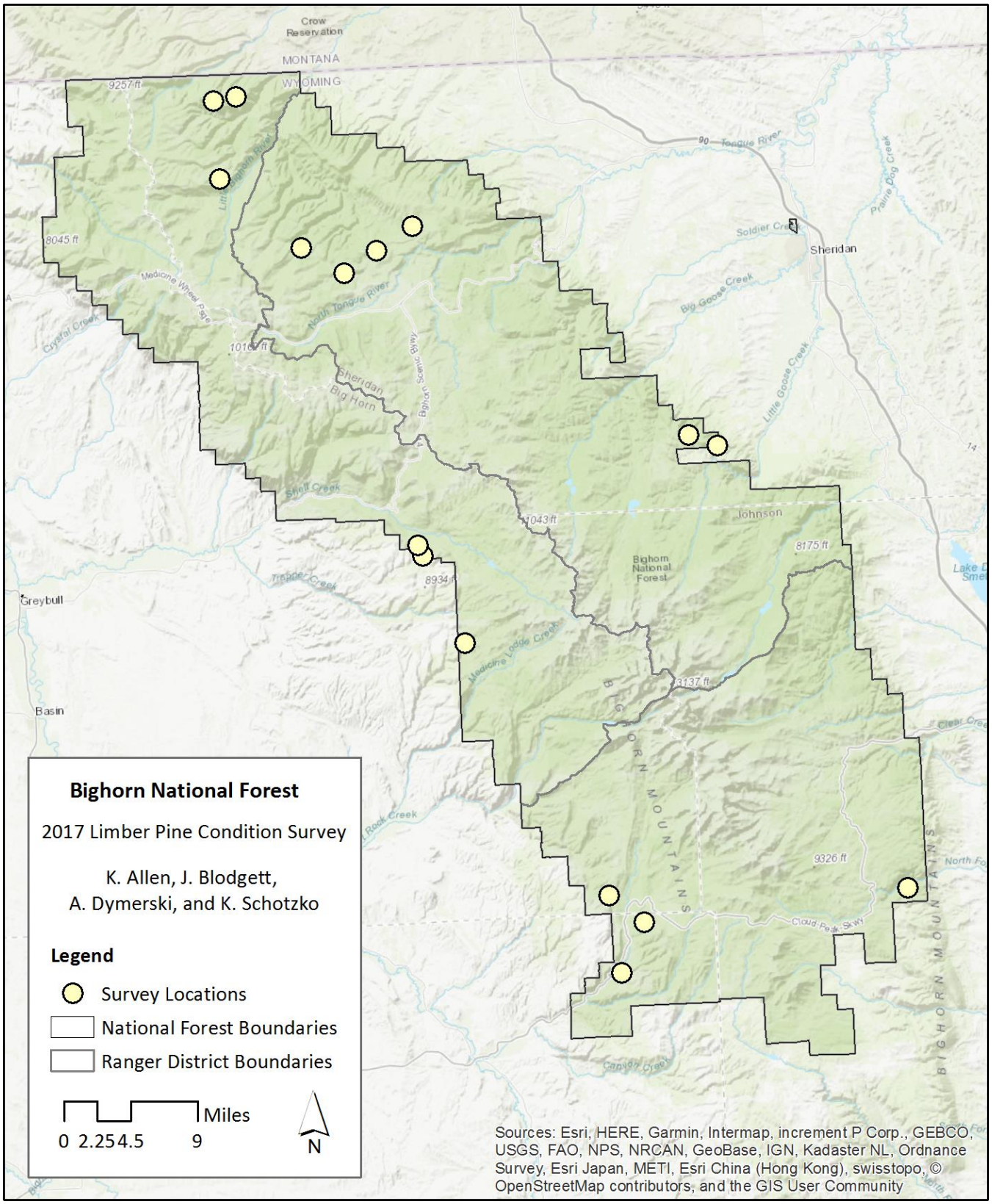

Figure 1. Map of limber pine stands surveyed in the Bighorn National Forest, 2017.

CONCLUSIONS

Overall limber pine mortality is light across the Bighorn National Forest, however, there are areas of high mortality, such as stands where mountain pine beetle has been very active (Figures 2A and B). There are also stands that have higher mortality due to localized infestations of other organisms, such as dwarf mistletoe and *Ips* beetles. Despite these areas of mortality, within the context of the entire forest high mortality stands are the exception and not the rule.

Where mountain pine beetle caused mortality is present, it is focused on larger diameter trees. This is a common theme among many bark beetle species, where 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 (Figure 2C). While white pine blister rust was found in all stands, it was not causing mortality of three inch or greater DBH trees.

Figure 2. Limber pine stands with mortality (A and B), and white pine blister rust infection on limber pine (C), Bighorn National Forest 2017.

Regeneration was light and scattered. In some cases, there was more spruce and/or Douglas-fir regeneration than limber pine regeneration. While there is not widespread mortality as of now, the lack of regeneration may be cause for concern in the future if mortality of mature limber pine increase in this cover type. Most of the stands are found on 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 on a year to year basis.

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