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Mountain Pine Beetle Impacts on Whitebark Pine Stands on the Shoshone National Forest

Kurt Allen, Entomologist
Kendra Schotzko, Entomologist

Jim Blodgett, Pathologist
Alan Dymerski, Technician

INTRODUCTION

Pine stands, including whitebark pine, on the Shoshone National Forest have seen increased levels of mortality from mountain pine beetle (*Dendroctonus ponderosae*) over the past 15 years (Figure 1). Mountain pine beetle reached epidemic levels in parts of the forest around 2001. From then until about 2016, epidemic levels of mountain pine beetle existed in both lodgepole and whitebark pine in parts of the forest. In most cases, high levels of mortality occurred simultaneously in both lodgepole and whitebark pine where they were mixed. In the summer of 2017, a number of whitebark pine stands were sampled on the Shoshone National Forest to determine the patterns of mortality caused by mountain pine beetle during this recent epidemic.



Figure 1. Whitebark pine stand in the Shoshone National Forest impacted by mountain pine beetle. Photo: Schotzko 2017.

The mountain pine beetle is a significant cause of pine mortality throughout the western United States. This native beetle is able to utilize nearly all western pine species, and has been responsible for extensive mortality in whitebark pine on the Shoshone National Forest. Generally, the mountain pine beetle completes its lifecycle in one year, with the adult flight period occurring in early July and lasting into August. During this flight period, adult beetles emerge from the tree in which they developed and fly to a new host tree, which they will chew into, create galleries under the outer bark, mate, and lay

eggs. From these eggs larvae will emerge and feed within the phloem of the host tree during late summer and early fall. Depending on developmental rates, larvae, pupae, and/or callow adults overwinter under the outer bark of host trees. Beetle maturation is completed the following spring.

As a native species, mountain pine beetle has always been a part of this forest ecosystem, with periodic epidemics. Epidemics in whitebark pine were previously documented from the early 1900's to the 1930's, resulting in higher than normal tree mortality. Little work, however, has been done on mountain pine beetle attack behavior or stand conditions that encourage epidemics in whitebark pine.

A retrospective look at the mountain pine beetle epidemic in the 1930's indicates that tree size (diameter) and stand density are likely important to beetle behavior and increased tree mortality in whitebark pine systems (Perkins and Roberts, 2003). These are similar to the findings in more heavily studied pine species such as lodgepole and ponderosa pine. In lodgepole pine, stands of larger diameter trees are rated as higher risk to beetle mortality (Cole and Amman 1980, McGregor et al 1981). Tree diameter and stand density are also important factors in ponderosa pine habitats (Schmid et al 1994, Schmid et al 2007).

METHODS

Condition and mountain pine beetle caused mortality were measured in whitebark pine stands through a series of four 1/10th acre plots. The plots were approximately two to three chains apart and located near the center of each stand. In all, there were 29 stands sampled across the Shoshone National Forest. The plots were spread across all parts of the forest from north to south (Figure 2).

Tree species, diameter at breast height (DBH), tree status (live or dead), and presence or absence of white pine blister rust (*Cronartium ribicola*) was recorded for each tree three inches DBH and greater in the plot. When the tree status was dead, the main cause of tree mortality was also recorded. The main mortality agent sampled was mountain pine beetle.

The number, species, and status of seedlings and saplings (trees over 12 inches in height and less than three inches DBH) were also recorded for the entire plot. All whitebark pine seedlings and saplings were also checked for white pine blister rust (WPBR). Up to eight dead whitebark pine trees were checked in each stand to determine if *Armillaria* was present as a decay organism in the general area.

RESULTS

In the 29 stands sampled (Figure 2) there were a total of 1,864 whitebark pine trees measured. Of these, 1,330 (72%) were live and 519 (28%) were killed by mountain pine beetle. Six whitebark pines were determined to be killed by *Ips* beetles and nine were killed by other factors.

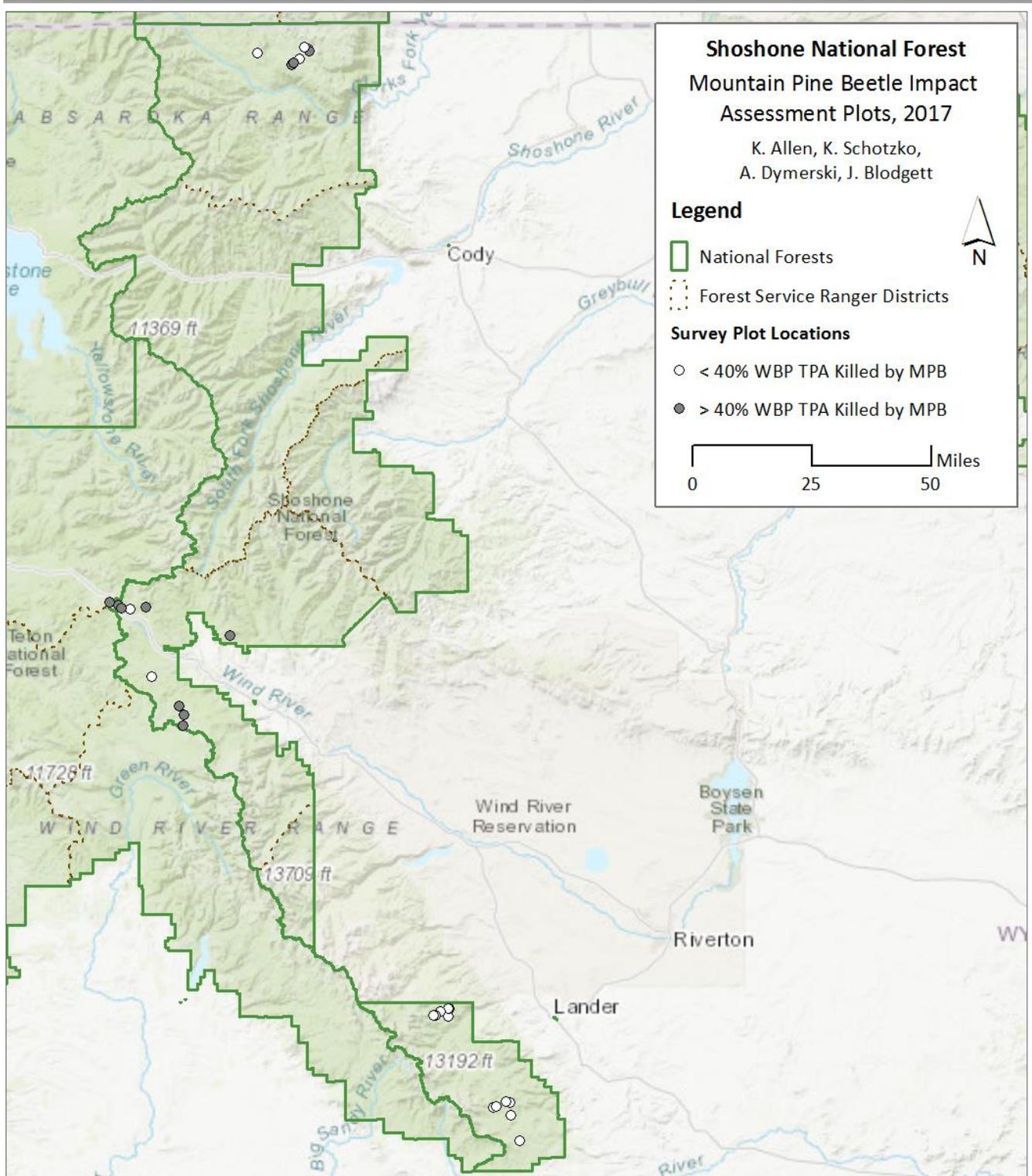


Figure 2. Map of stands surveyed in the Shoshone National Forest, 2017. White circles indicate stands where less than 40% of the whitebark pine (trees/acre) were killed by mountain pine beetle. Grey circles identify stands where more than 40% of the whitebark pine (trees/acre) were killed.

One of the main factors associated with mountain pine beetle caused tree mortality was tree diameter. The average DBH of a live whitebark pine was 7.8 inches and the average size of a whitebark pine killed by mountain pine beetle was 12.0 inches. The number of both live and dead whitebark pine trees from all stands is shown in Table 1.

Table 1. Number and percent of each DBH size class of whitebark pine killed by mountain pine beetle.

Size Class (Inches DBH)	Number of Live Whitebark Pine	% of Size Class-Live	Number of Dead Whitebark Pine	% of Size Class-Dead
30+	5	45	6	55
20 to 30	24	41	35	59
10 to 20	281	50	280	50
3 to 10	1020	84	198	16
Total	1330	-	519	-

The largest group of whitebark pine trees was in the three to ten inch size class. This size class also had relatively low amounts of mountain pine beetle caused mortality. When the three largest size classes (30+, 20 to 30, and 10 to 20 inch DBH) were combined, it was almost evenly split between live (49%) and dead (51%) whitebark.

Table 2 lists many of the stand characteristics measured. The percent whitebark pine killed was averaged for each stand. Eleven of the 29 stands (38%) were considered to have high mortality levels (about 50%+ mortality). Average stand mortality ranged from zero to 87%. Many of the high mortality stands are clustered in the Wind River District in areas outside of Dubois. No high mortality areas were found on the Washakie District at the south end of the forest (Figure 2).

Total stand basal area (BA) ranged from 54 to 316 ft²/acre. Most of the stands' basal areas were dominated by whitebark pine. Three stands, however, had other species dominate the basal area and in all three of those stands the more dominant species was lodgepole pine. Among all stands, 82% of trees measured were whitebark pine. Other trees species measured included lodgepole pine (9% of trees measured), Engelmann spruce (5%), and subalpine fir (4%). The stands with high mortality (50%) had an average BA of 143 ft²/acre, while the stands with lower mortality had an average BA of 102 ft²/acre. There does appear to be general trend for stands at higher total BA having increased stand mortality, though it does not appear to be as significant as the mortality/diameter relationship.

The percent of live trees that had evidence of WPBR is also listed and ranged from 0 to 49% (Table 2). There were two stands where no evidence of WPBR was observed. Generally, it does not appear that WPBR and average stand mortality caused by mountain pine beetle were related. Overall, 34% of live whitebark pine were noted as having WPBR.

Table 2. Stand characteristics for mature whitebark pine stands sampled.

Stand	Average Whitebark Pine DBH	Whitebark pine Trees/Acre	% Dead Whitebark Trees/Acre	Average Total Basal Area (Live and recent dead)	% Live Whitebark With WPBR
1	5.6	110	2	55	43
2	8.3	335	22	160	35
3	7.6	320	7	134	37
4	7.7	97.5	13	68	45
5	6.3	105	5	79	10
6	7.6	112	2	64	49
7	7.1	130	2	87	49
8	10.1	130	2	115	0
9	24.1	52.5	5	211	15
10	9.5	120	67	97	20
11	9.6	115	50	111	5
12	6.1	137.5	13	59	36
13	7.0	160	58	54	19
14	11.0	130	87	112	0
15	11.0	105	52	135	10
16	9.4	232.5	78	157	11
17	11.2	125	76	121	0
18	6.7	87.5	29	79	24
19	11.8	112.5	71	123	10
20	8.8	145	9	91	9
21	16.8	122.5	47	316	19
22	8.0	167.5	13	96	26
23	7.7	172.5	14	76	8
24	7.0	167.5	0	55	36
25	12.8	162.5	57	215	21
26	10.9	152.5	46	132	18
27	6.9	305	1	92	2
28	10.6	207.5	11	156	9
29	8.1	340	15	156	21

In 17 of the stands (58%) *Armillaria* was identified on old mountain pine beetle killed trees. It appears to be largely a decay agent or saprophyte as opposed to a pathogen leading to reduced vigor in whitebark pine.

All of the stands sampled had at least some whitebark pine seedlings and saplings. The range was from five to 755 seedlings and saplings per acre, with 10 of the 29 stands having 100 or more trees regenerating per acre. Other species of regeneration were found in many of the stands as well, though generally at lower densities than whitebark pine. Subalpine fir regeneration outnumbered whitebark pine regeneration in a minority of stands (six of 29 stands). The range of trees per acre of other species regeneration was from zero to 332. The regeneration within seven stands of the stands was purely whitebark pine. Neither stand BA nor mountain pine beetle mortality appeared to be highly related to amount or type of regeneration.

There were a total of 1,463 whitebark pine seedlings and saplings sampled across all stands. Of the 1,463 seedlings and saplings sampled, only 34 (2%) had evidence of WPBR. The vast majority of seedlings and saplings infected with white pine blister rust were found in just three stands.

CONCLUSIONS

From approximately 2001 through 2016 there was a mountain pine beetle epidemic that occurred to some degree in pine stands across the entire Shoshone National Forest. One of the species affected was whitebark pine and the impacts to whitebark pine stands varied in the amount of mortality that occurred during the epidemic. Some stands were heavily impacted with 50% or greater mature tree cover being killed, while other stands had only minor mortality. Generally speaking, somewhere around a third of the stands were heavily impacted and about a third of mature trees were killed during this epidemic. While these are obviously above average losses, more whitebark pine remains on the landscape than was killed in the epidemic (Figure 3).

Generally, the larger diameter trees were more prone to beetle caused mortality than smaller trees. Even so, there is still a major component of large diameter live whitebark pine throughout the stands sampled. There is also a well-stocked group of live trees in the three to 10 inch diameter range regenerating these stands. This group will help maintain a strong and persistent whitebark pine presence on the landscape into the future.

Stand density also appears to play some role in determining which stands had higher levels of beetle caused mortality, with more dense stands generally experiencing higher mortality. In most stands, the bulk of the stand density was made up of whitebark pine, with relatively little of the stands' mature trees being other species such as lodgepole pine, subalpine fir, or Engelmann spruce.

White pine blister rust was observed at varying levels throughout the forest. Any interaction it may have with mountain pine beetle mortality appears to be limited. It did not appear to be a mortality agent by itself for trees three inches DBH and above. Based on the very small percentage of seedlings

and saplings that had WPBR, it also does not appear to be causing new infections at a high rate on trees under three inches DBH.

Regeneration of whitebark pine was present in all stands sampled, often at a very high level (Figure 3). There did not appear to be a relationship with either stand density or MPB caused mortality and the abundance of regeneration within the stand. The abundance of regeneration observed at these stands suggests that, at least recently, there have been relatively good whitebark pine cone crops that produced a large amount of viable seed.

Overall, there has been a large loss of whitebark pine, focused on large diameter trees. Many large whitebark pine, however, remain on the landscape. Additionally, the cohort of smaller diameter whitebark pine experienced minimal direct impacts from the recent mountain pine beetle epidemic, and appears to be abundant and healthy. Considering the recent, large scale mountain pine beetle epidemic, whitebark pine still occupies a similar scope on the landscape within the Shoshone National Forest.



Figure 3. Healthy whitebark pine stands were observed in the overstory (left) and understory (right) of stands. Photo: Schotzko 2017.

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