Report 01-8

August 2001

FOREST HEALTH ASSESSMENT OF WHITEBARK PINE ON PYRAMID PASS, RUSSELL MOUNTAIN, AND BURTON RIDGE IN THE SELKIRK MOUNTAINS ON THE IDAHO PANHANDLE NATIONAL FORESTS

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INTRODUCTION

Whitebark pine (WBP) is an important high-elevation tree species. It plays a key role in the survival and distribution of wildlife species, such as the endangered grizzly bear; is important in watershed stabilization; and has important recreation and aesthetic values. Research has recently documented the rapid decline of WBP throughout much of the West due primarily to white pine blister rust (*Cronartium ribicola*), fire suppression and forest succession, and periodic outbreaks of mountain pine beetle (*Dendroctonus ponderosae*) (MPB) (Keane and Arno 1993). A current MPB outbreak is occurring in the Selkirk Mountains, Bonners Ferry Ranger District, in some of the last native WBP stands on the Idaho Panhandle National Forest. This outbreak prompted a more complete analysis of the forest health situation in those stands. This report documents data recorded during ground surveys conducted in fall 2000 as well as aerial survey information for the years 1992-2000.

AERIAL SURVEY

Aerial surveys are conducted every year on forests throughout the Northern Region. From low-flying aircraft, an aerial observer maps fading or damaged trees and estimates numbers of trees affected.

Aerial surveys are valuable in detecting outbreaks and directing where more intensive ground surveys should be conducted. However, trees killed by bark beetles take about a year to fade after they are attacked. Therefore, aerial survey data typically represents trees killed the previous year.

Aerial observers recently detected increasing MPB activity in WBP stands on the Kaniksu Reporting Area (figure 1). After a small increase in 1994 (detected in 1995), populations declined until 1998 (detected in 1999). Significant increases noted in 1999 continued in 2000. Most MPB activity is located on four major ridges northwest of Bonners Ferry (figure 2).

GROUND SURVEY

In fall 2000, we conducted ground surveys in whitebark pine stands in four different areas in the Selkirk Mountains. The areas were Burton Ridge, Russell Ridge (south side and ridge line of Russell Mtn.), Russell Mtn. (north side of Russell Mtn.), and Pyramid Pass. Fifteen to 25 variable-radius plots were established along transects in each of the four areas. Data recorded on each plot included tree species, diameter (D.B.H.), and insect and disease damage on every WBP.

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If a WBP had been attacked by MPB, year of attack was noted. On currently attacked trees, beetle life stages present under the bark were recorded. We also recorded blister rust infected WBP. Trees with dead branches, dead tops, and branch flagging were noted. These symptoms are usually indicators of blister rust infection even if cankers are not seen. At Burton Ridge, age growth, and phloem thickness was measured on a few beetle infested and uninfested WBP.

Figure 1. Aerial survey estimates of MPB infested acres and WBP trees killed on the Kaniksu Reporting area from 1992-2000.

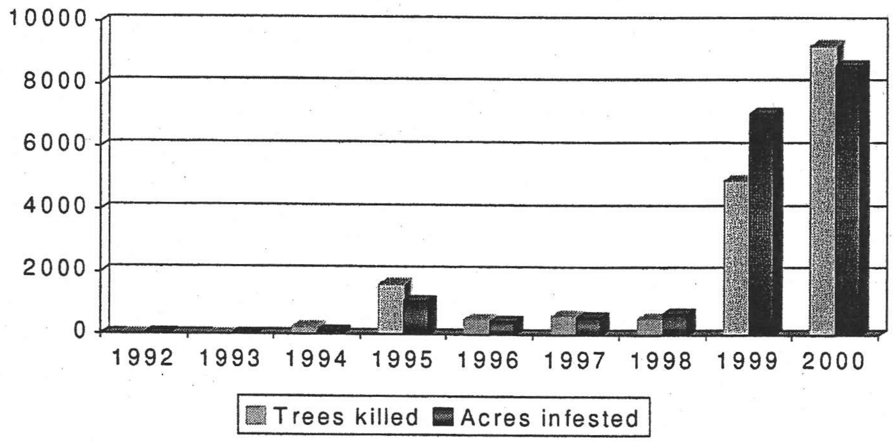
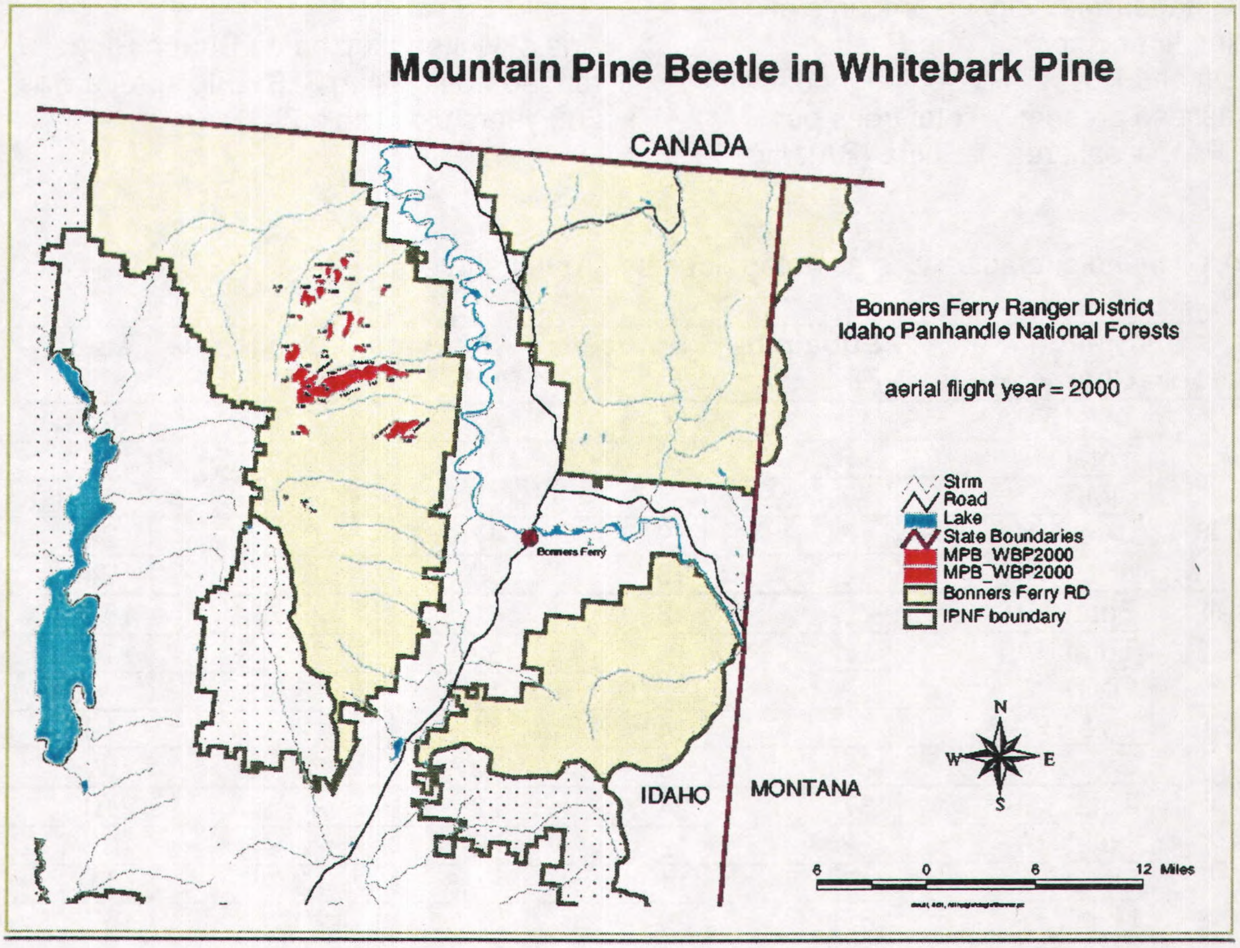


Figure 2. Aerial survey showing areas of WBP mortality on the Bonners Ferry Ranger District.



STAND ANALYSIS

In all areas, WBP is growing in mixed-species stands with varying amounts of subalpine fir and spruce. On Russell Mountain and Russell Ridge, lodgepole pine was also present. Total trees per acre (TPA), basal area per acre (BA), live TPA and BA, quadratic mean diameter (QMD) by species, and number of plots taken in each area are shown in table 1.

Age of whitebark pine on Burton Ridge ranged from 174 to 326. One spruce was 208 years old (Table 2).

Table 1. Stand characteristics as determined by ground surveys.

Area # of plots	Stand Characteristic	Subalpine Fir	Spruce	Whitebark Pine	Lodgepole Pine	Total
Burton Ridge	Total TPA	18	19	147	0	184
	Total BA	5	20	148	0	172
	QMD	7.7	14.5	13.9	-	13.3
20 plots	Live TPA	18	19	47	0	83
	Live BA	5	19	50	0	74
Russell Ridge	Total TPA	79	13	41	22	155
	Total BA	27	9	52	23	111
	QMD	8.2	12.3	15.8	15.2	11.8
15 plots	Live TPA	76	14	11	12	113
	Live BA	26	9	13	13	61
Russell Mtn.	Total TPA	87	24	72	27	210
	Total BA	22	12	76	22	132
	QMD	7.9	11.3	14.6	13.9	11.3
25 plots	Live TPA	85	24	38	20	167
	Live BA	22	12	43	16	93
Pyramid Pass	Total TPA	152	37	46	0	235
	Total BA	71	36	86	0	193
	QMD	10.7	19.3	19.6	-	13.7
17 plots	Live TPA	152	37	7	0	196
	Live BA	71	36	15	0	122

Table 2. Age, diameter, growth rate, and phloem thickness of select trees at Burton Ridge.

Tree Species	Mountain pine beetle	DBH	Age	5 yr. Growth	Phloem thickness
Whitebark pine	Current attack	25	241+*	5/20	10/100
Whitebark pine	Current attack	14	326	4/20	9/100
Whitebark pine	None	21	214	4/20	11/100
Whitebark pine	None	18	174	5/20	8/100
Spruce	None	18	208	4/20	

* Core did not reach center

Mountain Pine Beetle Analysis

Evidence of old as well as recent and current attacks of MPB (galleries, pitch tubes, beetles under bark) was found in all four areas surveyed. An example of mortality observed on Russell Mountain is shown in figure 3. Trees currently infested with MPB ranged from 10-22% of WBP over 5 inches dbh. Cumulative WBP mortality from current and past MPB activity ranged from 36-74%, with 23-44% occurring in the last 2 years (Table 3).

At Pyramid Pass, beetle-caused mortality was recorded in 1995 as well as 2000. In 1995, 72% of WBP was green, and MPB had killed 22%. In 2000, only 18% of WBP was still green and MPB had killed 74% (Table 3). Total BA and average WBP diameter are greatest at Pyramid Pass but BA and diameters at all areas are conducive to MPB attack.

The life cycle of MPB in WBP ecosystems is not well known. At high elevations or more northern latitudes, beetles may take two years to complete their development in lodgepole pine stands (Safranyik et al. 1974, Amman 1973). In September 2000, we observed new attacks, eggs, larvae of varying instars, pupae, and new adults in infested WBP suggesting overlapping generations and life cycles requiring more than one year. Warm fall temperatures permit faster beetle development and mild winters may allow life stages not normally cold hardy to survive. The past few years of mild winters and long summers probably contributed to the current beetle outbreak.

Table 3. WBP uninfested, killed by MPB, or unknown or secondary beetle-caused mortality by location.

Location	**Pyramid Pass**		**Russell Mtn. (North)**	**Russell Ridge (South)**	**Burton Ridge**
Year examined	1995	2000	2000	2000	2000
#WBP examined	267	73	99	80	301
Uninfested WBP	191 (72%)	13 (18%)	54 (55%)	39 (49%)	140 (47%)
Current MPB attack	15 (6%)	16 (22%)	10 (10%)	12 (15%)	32 (11%)
Last year MPB attack	4 (1%)	16 (22%)	18 (18%)	8 (10%)	37 (12%)
Older MPB attack	40 (15%)	22 (30%)	14 (14%)	16 (20%)	39 (13%)
Unknown or secondary beetle mortality	17 (6%)	6 (8%)	3 (3%)	5 (6%)	53 (18%)
Total killed by MPB	59 (22%)	54 (74%)	42 (42%)	36 (45%)	108 (36%)
WBP killed by MPB in last 2 years		32 (44%)	28 (28%)	20 (25%)	69 (23%)

Figure 3. WBP mortality on Russell Mountain.

White Pine Blister Rust Analysis

Blister rust symptoms including top-kill, branch flagging, dead branches, and bole cankers were recorded on live trees with visible crowns. Cankers on dead and dying trees are very difficult to diagnose so only green trees are included in this blister rust analysis. This included all of the current MPB-infested WBP, some of last year's attacked trees that were still green, and WBP with no beetles. Even on green trees, incidence of blister rust may have been significantly underestimated because it was not always possible to see the entire crown or bole on mature trees; therefore, some blister rust cankers may have been missed.

Although most dead branches, flags, and dead tops in WBP are due to blister rust infections, some may be due to causes other than blister rust, which would be impossible to detect from the ground.

Mature green trees exhibiting blister rust symptoms ranged from 33% on the north side of Russell Ridge to 62% at Pyramid Pass, 82% on Burton Ridge and 87% on the south side of Russell Ridge (Table 4). There were so few remaining green trees at Pyramid Pass that only 29 trees were included in the sample, and additional sampling is planned to see if the infection level changes with a larger sample size. The Russell Mtn. north sample included 65 green trees, but infection levels are so much lower than the other areas, that additional sampling may also be needed to confirm the 33% infection level observed in this area.

The fact that top-kill was the most common rust symptom recorded on three sites and many trees had a combination of blister rust symptoms indicates that multiple infections have been occurring over a long period of time. The lack of top-kill at Pyramid Pass is hard to understand if it is not a sampling anomaly, and will be re-examined in future, surveys planned for 2001.

At two sites, Russell Ridge south and Burton Ridge, WBP regeneration greater than four feet tall were examined for evidence of blister rust. On Russell Ridge south 167 saplings were sampled and 59% had no evidence of blister rust infection, 32% were infected and an additional 9% had died from blister rust. Almost identical percentages were found on a 125-tree sample on Burton Ridge: 58% uninfected, 33% live infected and 9 % rust-caused mortality. These infection levels are considerably lower than those in the overstory, which is encouraging in terms of possible rust resistance. Ray Hoff has also made similar observations in other areas (personal communication), but this may simply reflect a shorter time of exposure to the rust rather than true resistance and further research will be needed to determine this.

Table 4. Trees with blister rust (BR) symptoms, with and without MPB attack by location.

Location	Pyramid Pass	Russell Mtn. (North)	Russell Ridge (South)	Burton Ridge
# Green WBP examined	29	65	53	179
Green clean trees (no BR or MPB)	4 (14%)	37 (56%)	4 (8%)	21 (12%)
Green trees with MPB only*	7 (24%)	7 (11%)	3 (6%)	11 (6%)
Green WBP with BR symptoms only	9 (31%)	19 (29%)	34 (64%)	117 (65%)
Green WBP with BR symptoms and MPB attack	9 (31%)	3 (5%)	12 (23%)	30 (17%)
Total green trees with BR symptoms	18 (62%)	22 (33%)	46 (87%)	147 (82%)
Trees with BR flagging	14	3	22	34
Trees with top kill	1	17	37	81
Trees with dead branches	3	0	10	58
Trees with bole cankers	0	3	2	3

*Does not include MPB attacked trees that are fading. See Table 3 for complete MPB Information.

MPB and Blister Rust Interactions

If we could diagnose blister rust infections on dead trees, we would have a large sample to examine for correlations between blister rust and MPB. However, rust infections in dead trees are difficult to determine, so we were limited to green tree data. If MPBs preferred trees infected by blister rust, we would expect to find significantly more MPB attacks in rust-infected trees. At Russell Ridge south and Burton Ridge there were more MPB attacks in rust-infected trees than uninfected trees, but there were so many rust-infected trees that MPB was less likely to attack an uninfected tree. At Pyramid Pass, there were about equal numbers of MPB in rust-infected trees as uninfected trees, but MPB populations were so high that most WBP were attacked regardless of blister rust infection. At Russell Mtn. north, there were fewer MPB attacks in rust-infected trees than uninfected trees.

These mixed results suggest no strong preference for MPB to attack rust-infected trees at these levels of rust and MPB populations. These results may be complicated by a small sample size. Further, we have no way of confirming these trends in MPB-killed trees that are already faded or have lost their needles.

Historically, MPB was attacking WBP long before blister rust was introduced, so a cause and effect relationship is not implied. We have also found MPB attacks in trees with healthy crowns next to severely rust-infected trees that were not attacked, and vice versa. It is likely that bark beetle populations historically built up due to an overall decline in stand vigor or some sort of stand stress. Likewise, it is possible that widespread rust infection could produce similar effects in stands that might ordinarily have escaped beetle outbreaks for a while longer. Unfortunately, it is difficult it not possible to determine if this is currently the case.

Discussion and Management Options

The amount of WBP mortality from MPB and blister rust occurring on Burton Ridge, Russell Ridge, Russell Mountain, and Pyramid Pass is alarming. There is no indication that the current MPB outbreak is declining. Tree mortality caused by MPB and top-kill caused by blister rust threatens the remaining seed source, and there is limited natural regeneration because of the closed canopy condition of the stands. What natural regeneration exists is at high risk to blister rust infection.

Management of MPB in WBP ecosystems has seldom been attempted due to limited access, economics and the nature of typical open-grown WBP stands. However, in stands we examined, WBP dominate or co-dominate the forest canopy and stands are densely stocked. Partial cutting to reduce stand basal area to 80-120 square feet has reduced MPB infestations in lodgepole and ponderosa pine (Bollenacher and Gibson, 1986, Sartwell and Dolph 1976, McGregor et al. 1987) and may reduce susceptibility in whitebark pine stands.

Use of tree baits comprised of MPB attractant pheromones can concentrate beetles in areas scheduled for harvest (Borden et al. 1986). Removing infested trees prior to beetle emergence could decrease beetle populations and reduce future beetle-caused tree mortality. However, there must be a commitment to remove the baited trees. Failure to do so might increase the amount of additional tree mortality in baited areas.

Individual high-value trees may be protected from beetle attack with preventive sprays. Spraying the boles of trees as high as possible (preferably to a 5-inch top) with a water-based carbaryl spray prior to beetle flight will protect trees from attack for up to 2 years (Gibson & Bennett 1985). In order to spray high enough on the tree bole, a hydraulic sprayer is recommended. However, road access is necessary for the use of a hydraulic sprayer and is not often available in high elevation sites.

Verbenone (4,6,6-trimethylbicyclo[3.1.1]-hept-3-en-2-one) has been identified as an anti-aggregative component of the MPB pheromone complex. When added to funnel traps baited with MPB attractants, beetle catches were reduced 75-98% when compared to trap catches with attractants alone (Borden and others 1987, Schmitz and McGregor 1990). However, field tests using verbenone bubble capsules to protect stands have been inconsistent (Gibson and others 1991). Recent studies using verbenone "pouches", which release 10 times the amount of pheromone as bubble capsules, have shown promising results in lodgepole pine (Progar 2001).

Green leaf volatiles (GLV) include six-carbon alcohols commonly found in green plants and are released continuously by leaves. Tests using GLVs in funnel traps have also been found to disrupt MPB activity at similar levels as verbenone (Wilson et al. 1996). Field studies using a blend of verbenone bubble capsules, GLVs, and angiosperm nonhost volatiles (NHVs) significantly reduced MPB mass attack on pheromone baited lodgepole pine trees (Huber and Borden 2000).

Although verbenone pouches, GLVs and NHVs have shown promise in protecting lodgepole pine from MPB attack, these materials are not available for operational use. Further field testing of these materials in all hosts of MPB is needed before they can be recommended as tree or stand protectants. Field studies using verbenone, GLVs and NHVs in whitebark pine and lodgepole pine are being conducted in 2001.

An important component in the management of white pine blister rust in whitebark pine is cone collection from phenotypically blister rust resistant trees and planting resistant seedlings in openings. The Bonners Ferry Ranger District is planning a WBP restoration project including prescribed burning to open areas for regeneration. A combination of protecting the remaining mature WBP from MPB, opening the stands for regeneration, and planting blister rust resistant seedlings will help keep WBP as a viable tree component in the Selkirk Mountains.

Acknowledgements

Jeff Padgett, Nancy Sturdevant, Paul Flanagan, and Jim Hadfield assisted in data collection.

Tim McConnell and Larry Stipe provided aerial survey data.

Doug Wulff provided the aerial survey map.

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