

Research Reports

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Will whitebark pine not fade away? Insight from Crater Lake National Park (2003–2009)

By Michael Murray

REGARDED AS A HARDY STALWART OF HIGH-ELEVATION

forests on the Pacific Coast and in Rocky Mountain ranges, whitebark pine (*Pinus albicaulis*) is a prominent feature in 10 western national parks (fig. 1). The picturesque, weather-beaten form of timberline veterans is captured on the pages of calendars, postcards, guides, and photo albums of visitors who come to national parks and forests to enjoy the breathtaking mountain scenery. Many sites where whitebark pine resides are too climatically harsh for other tree species. Thus, whitebark pine forests thrive where otherwise only meadow, talus, or other sparse natural communities would. Showy wildflowers such as heart-leaved arnica (*Arnica cordifolia*) and verdant tufts of smooth woodrush (*Luzula hitchcockii*) prefer the filtered sunlight afforded by groves of whitebark pine. This pine species also stabilizes soil on steep slopes and shades patches of snow, providing continuous flow of meltwater well into summer. As the producer of the largest tree seeds in the subalpine zone, whitebark pine supports more than

Figure 1. A grove of whitebark pine trees is being decimated by blister rust and mountain pine beetles at the North Junction area of Crater Lake National Park, Oregon, 2007.

two dozen species of foraging mammals and birds, including grizzly bear (*Ursus arctos horribilis*) and Clark's nutcracker (*Nucifraga columbiana*). The value of whitebark pine to wildlife simply cannot be overstated.

Unfortunately, populations of whitebark pine are increasingly threatened and their numbers are dwindling. The nonnative blister rust disease (caused by the fungus *Cronartium ribicola*) has crept across its natural range since it was first introduced in western North America in 1910. Natural resistance to blister rust among whitebark pine may be lower than 1% (Hoff et al. 1994). Ongoing epidemics of the native mountain pine beetle (*Dendroctonus ponderosae*) appear unprecedented in extent (Sharik et al. 2010) in addition to common stress from fire, dwarf mistletoe (*Arceuthobium* spp.), and ips beetles (*Ips* spp.).

Abstract

Populations of whitebark pine (*Pinus albicaulis*) are under threat from nonnative blister rust disease (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*), and climatic change throughout most of its range. Whitebark pine provides habitat for dozens of high-mountain plant and animal species and is a uniquely picturesque tree for thousands of visitors in the Pacific Northwest and Rocky Mountains every year. Crater Lake National Park, Oregon, supports the most extensive lakeside population of this species known. Findings acquired through annual monitoring indicate that healthy whitebark pine trees are declining by about 1% annually since 2003. Combined with a nearly one-third reduction in whitebark pine since the estimated spread of blister rust to Crater Lake in the 1930s, a continued downward trajectory indicates a significant loss of the species. Measures to protect and restore whitebark pine can include developing blister rust resistance, outplanting disease-resistant seedlings, and applying beetle deterrents.

Key words: blister rust, climate change, Crater Lake National Park, forest health, monitoring, mountain pine beetle, whitebark pine

Crater Lake National Park, Oregon, is home to the most extensive lakeside population of whitebark pine known. Some of the oldest trees in the park garnish the margins of the 33-mile-long (53 km) Rim Drive and Rim Village, enjoyed by nearly 500,000 visitors every year. By the late 1990s an accumulation of dead trees, such as those on the summit of Wizard Island in the middle of Crater Lake, had piqued the curiosity of park staff, visitors, and media. A subsequent survey revealed that most whitebark pine stands were infected with blister rust (Murray and Rasmussen 2003). In 2003, I initiated a long-term monitoring program to track mortality in whitebark pine at Crater Lake National Park. This is among the first established monitoring programs aimed specifically at whitebark pine in the National Park System.

Study methods

I monitored trees associated with a set of seven permanent sampling plots. At the time of installation (2003), the plots supported a total of 474 whitebark pine trees. I predetermined the general vicinity of each plot to represent the whitebark pine communities present in the park. I decided on the location of each plot based on field reconnaissance, and then chose each plot's center location based on its appearance as typical for the vicinity and community type. In relation to other tree species, whitebark pine comprised at least 75% of the plots by cover, number, and volume. Plots were circular, encompassing 300 square meters (0.7 ac). I geo-referenced each plot with a GPS (global positioning system).

Within each plot we mapped all trees regardless of species for ease of relocation in subsequent years. Aluminum identification tags were affixed to trees to provide additional reference. For all live and dead standing trees I recorded a unique alphanumeric identifier, species, diameter at breast height (in 2003 and 2007), and overall status (healthy, sick, dead). I also noted instances of physical damage that resulted in dead foliage.

Trees classified as sick were affected by disease, insects, or physical impacts. Trees that had died since the previous year's survey were labelled recently dead. For each sick tree, I documented the cause and magnitude of the affliction. Where white pine blister rust was found, I recorded the status (active or inactive) and location (distance from ground and main stem) of each canker, plus the percentage of crown killed. I noted blister rust cankers as active when one or more symptoms were present, such as resinous, fungal fruiting structures, and yellow- to orange-colored bark. Trees with inactive blister rust cankers were classified as healthy. Cankers were noted as occurring on either branches or stems. Using binoculars, I examined every tree for cones. Lack of staffing precluded monitoring in 2008.

Findings

Overall, we see evidence of a gradual decline (8%) in the number of healthy whitebark pine trees taller than 1.37 m (4.5 ft) (fig. 2). Despite witnessing a slight increase in 2005, I documented progressively lower numbers of healthy trees all other years. By 2009, sick and dead trees increased 3.7% and 4.5%, respectively.

Sixteen trees perished during the five-year study, equating to 5.4% of all trees (fig. 3, next page). The most common malady was mountain pine beetle, which affected most trees that died. This was indicative of a park-wide outbreak. Dwarf mistletoe (*A. cya-*

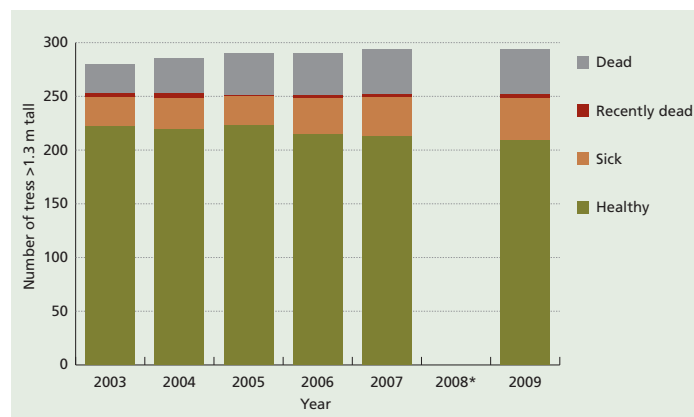


Figure 2. Healthy whitebark pine trees have declined 8% overall since 2003. *No sampling was conducted in 2008.

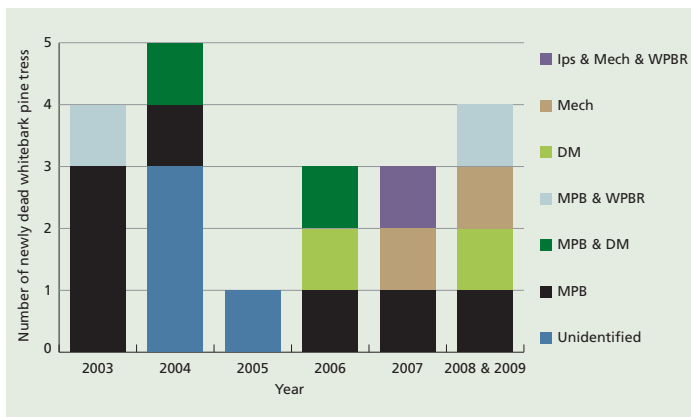


Figure 3. Mountain pine beetle (MPB) is the leading cause of tree mortality. Other causes of death: Ips (ips beetle), Mech (mechanical), WPBR (white pine blister rust), and DM (dwarf mistletoe).

nocarpum) was restricted to Wizard Island where nearly all trees had multiple infections, resulting in a severely impacted stand. Blister rust was associated with only three tree deaths observed.

I recorded 130 new recruits from 2004 to 2009. Recruits were not tallied in 2003 because this was the initial survey year. Thus, we could not determine which seedlings were new and which preceded 2003 (without destructive sampling). Curiously, half of all regeneration occurred in 2005, which preceded the best cone crops of the study (2005 and 2006). All plots exhibited regeneration except on Wizard Island (fig. 4). Mount Scott was the only location that generated recruits every year.

Discussion

These findings indicate that healthy whitebark pine trees above breast height have declined overall about 1% every year since 2003. Combined with a nearly one-third reduction in whitebark pine since the estimated arrival of blister rust in the park in the 1930s (Murray and Rasmussen 2003), a continued downward trajectory indicates a significant loss in park whitebark pine.

Prior to 2003, blister rust was believed to be the leading cause of death in the park. However, this study reveals that mountain pine beetle is now the leading mortality agent. This native insect has been a subtle yet persistent force of change during the past seven years—which would not have been well understood without this monitoring effort. Crater Lake's infestation resembles mortality at Yellowstone National Park (Wyoming, Montana, and Idaho), which has seen about 10% of trees succumb to the current beetle outbreak (D. Reinhart, personal communication). Yellowstone lags in rust-caused death, but this also appears to be rising. Al-

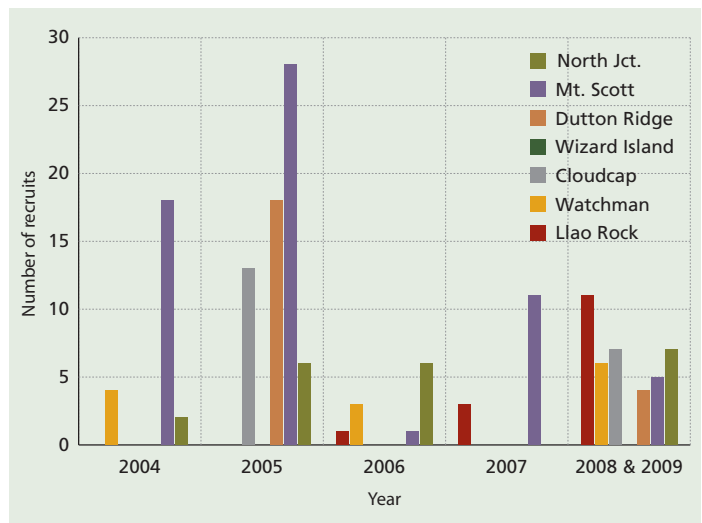


Figure 4. Nearly half of all recruited trees were observed in 2005.

Mountain pine beetle is now the leading mortality agent.

though Glacier National Park, Montana, was affected by mountain pine beetle in the 1930s and again in the 1970s and 1980s, research in 2001 determined blister rust to be the leading cause of death for whitebark pine, with 44% mortality, 78% of trees infected, and 26% crown loss (Kendall and Keane 2001). Glacier had largely escaped infestation by mountain pine beetle over the last couple of decades, but this is changing. Dawn LaFleur, integrated pest management biologist at Glacier National Park, estimates that of the 4,450 acres (1,802 ha) of beetle-killed pine total in the park (USDA Forest Service unpublished flight data 2008–2009), 3 acres (1.2 ha) consists of whitebark pine. Logan and others (2010) suggest the current eruption of beetles throughout most of whitebark pine's range is a result of global warming.

In the face of these challenges, maintaining whitebark pine will require our fervent attention well into the future. As noted earlier, a small percentage of trees may be naturally resistant to blister rust. By collecting (fig. 5) and propagating their seeds and out-planting the resulting seedlings, we can enhance the numbers of young pine that will survive the deadly disease. A beetle pheromone is also showing success in thwarting attacks by mountain pine beetle. Resource managers at Crater Lake National Park have stapled small packets of this synthetic deterrent, known as verbenone on the stems of culturally significant and potentially disease-



Figure 5. The author collects cones at Rim Village to propagate and test this parent tree for disease resistance.

resistant trees (fig. 6). Careful introduction of fire can also benefit whitebark pine by reducing competing tree species and opening up sites for enhanced regeneration. Guidance and awareness are increasing (Aubry et al. 2008; Schoettle and Snieszko 2007) with several additional national parks already implementing these measures. Collaborators with the National Park Service include the forest services of the United States and British Columbia, the U.S. Geological Survey, Parks Canada, universities, and the Whitebark Pine Ecosystem Foundation (www.whitebarkfound.org). Research and monitoring will continue to play critical roles in steering management and gauging success.

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Figure 6. Blister rust fruiting bodies threaten the tree (left), and a packet of verbenone (right) is used to repel mountain pine beetles.

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About the author

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