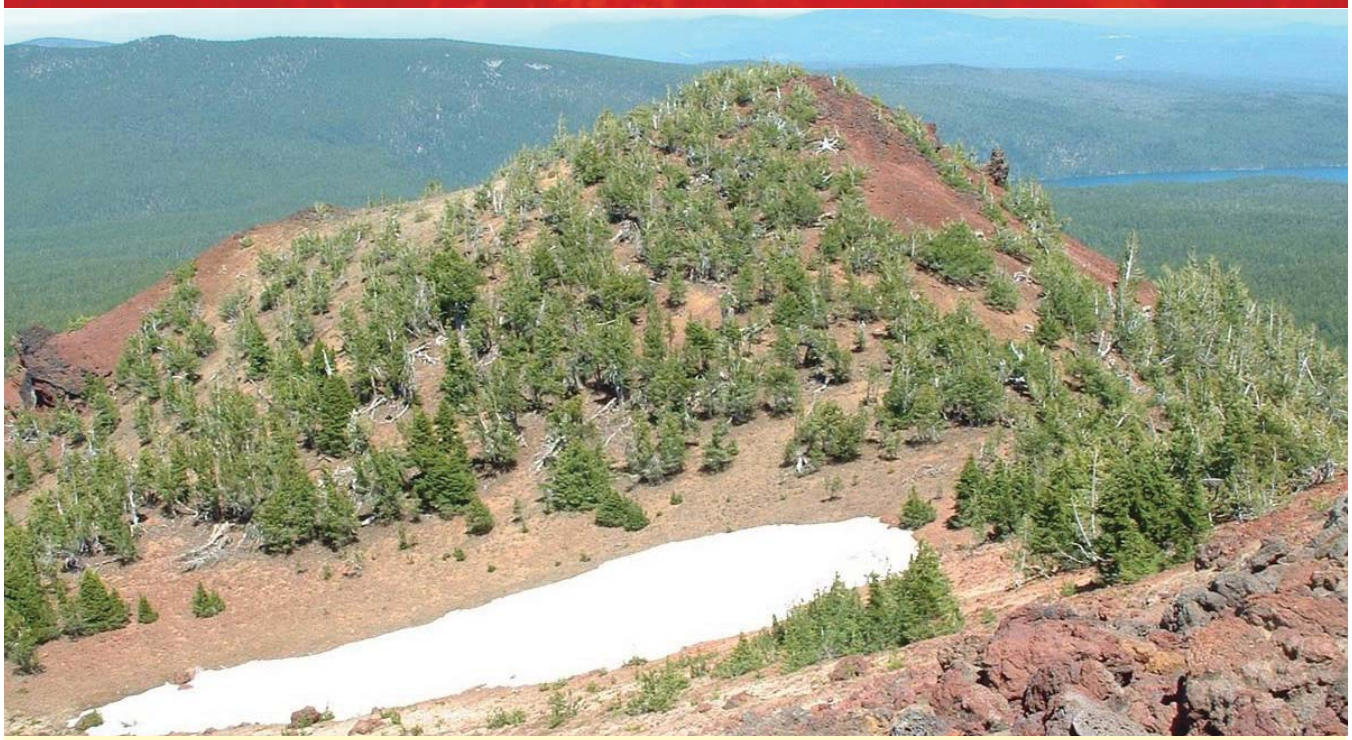
Joint Fire Science Program
Fire Science Brief
RESEARCH SUPPORTING SOUND DECISIONS



The whitebark pine survives where most other trees do not.
Tipsoo Peak, Mt. Thielsen Wilderness. Credit: Michael Murray.

All Fired-Up: Whitebark Pines are Crucial in the Cascades and Beyond

Summary

A tree exists in North America that survives some of the harshest physical conditions on Earth—it is the whitebark pine. But this tree, capable of surviving fire and extreme cold, confronts threats for which it is evolutionarily unprepared.

Michael Murray, an ecologist at Crater Lake National Park, along with his colleague Joel Siderius, found that whitebark pines have been impacted by fire exclusion in the Cascades. The trees also experience a range of fire severity uncommon in most other species. This exceptional tree faces emerging threats from the blister rust, and mountain pine beetle outbreaks that are shifting to higher elevations due to climate change. With detailed information on how the whitebark pine responds to fire in the Cascade Range, Murray hopes that managers and planners will be better prepared to restore this species.

Key Findings

- Fire is a common influence on whitebark pine communities of the Cascade Range.
- A 50% decrease in fire occurrence in these communities is evident from the 1800s to the 1900s.
- Whitebark pine communities here show a mixed severity fire regime, and a broad range of fire intervals. This variation probably stems from the highly complex subalpine topography and physical environment.
- This high variation attests to a complex relationship between fire and whitebark pine.

Introduction

Imagine a pine tree that is aesthetically pleasing and picturesque. Now put it at timberline where it survives some of the harshest physical conditions on Earth. In its native range no other tree can tolerate such severe habitat. As such it produces pure stands which create living conditions for other flora and fauna that cannot thrive without a protective canopy.

This is the whitebark pine; *Pinus albicaulis*. It is a poor competitor with other trees at lower elevations, but it can endure where its competitors cannot. "The whitebark is an extraordinary species," says Michael Murray an ecologist at Crater Lake National Park. "And yet, it was not long ago that the relationship between fire and whitebark pines was unknown for the entire Cascade Range."

This special tree is a "keystone species at the highest elevations in North America," he adds. Keystone species are those that have a large influence on their community relative to their abundance. So, he says, "If the tree did not grow here, no forest would exist. And without that forest, there would be no forest community. Yet it does grow here, and so a whole community of animals and understory flora thrive in these pure stands of whitebark."

"Relative to other tree species, few people find themselves in whitebark pine. Yet annually, I estimate about 2.5 million people encounter these stands in Oregon annually at ski areas, lodges, and Crater Lake National Park. The whitebark pine has made news headlines over and over again recently because many populations are in steep decline. In fact, it has now been petitioned to receive legal protection as an endangered species."

Fire can limit whitebark pine competitors and generate sites suitable for regeneration.

Perhaps most significant, whitebark pine communities are deeply linked to fire. In a sense, fire is a keystone process operating along with a keystone species. Fire can limit whitebark pine competitors and generate sites suitable for regeneration.

Yet, amazingly, Murray realized that no one had studied the relationship between fire and whitebarks in the Cascades. Over the last twenty years, researchers *have* looked at the role of fire in whitebark pine communities in the Bitterroots of Montana, the Shoshone National Forest in Wyoming, Yellowstone National Park, and in the West Big Hole Range of Montana and Idaho. In general, whitebark pine communities "appear to experience a spectrum of fire severity," according to the final JFSP report which Murray co-authored.

But he also writes, "Cascadian whitebark pine forests have been noticeably overlooked in scientific research." And he says, "No formal documentation of whitebark pine fire regimes has been offered for the Cascade Mountains. At 600 miles in extent, that's a major knowledge gap."

Given their special nature as a keystone species, their quickly dwindling numbers, their relationship to fire, and the near certainty that their fire history had changed over the last hundred years, Murray wanted to learn more. He realized that any information he found would be critical for managers and planners working to restore fire to the Cascade Range, and to those particularly interested in conserving and managing the plummeting numbers of whitebark pine trees. In 2002, Murray received a JFSP grant to explore fire and whitebark pine trees in the Cascades.

The core of the issue: Fire in Cascade whitebarks?

In a fortuitous moment Murray received the JFSP grant the same week he was invited to work at Crater Lake National Park, one of his major study sites. He left the Oregon Natural Heritage Program—a part of The Nature Conservancy—and took the grant along with him to Crater Lake.

"That meant that I couldn't do much of the field work myself because of my work at Crater Lake," he said. "But we were very lucky to enlist Joel Siderius, a biologist and the researcher who did most of the field work. He was hired by the National Park Service to work solely on this project." Indeed, Siderius is the first author on the JFSP final report for this research.

Murray says the overarching goals of this work were twofold. The first objective was to gain an understanding of fire regimes associated with whitebark pine in the Cascade Range. The dearth of this vital information cannot be overstated. To manage whitebark pine communities describing the historic fire regime was critical.

The second objective was to describe the historic and current stand conditions of whitebark pines, and to estimate the potential ecological effects of a hundred-year fire exclusion policy on those communities.

Murray and Siderius used standard fire history techniques—including increment coring, crossdating, and dendrochronology. They also searched for fire scarred trees at each of their study sites. On visibly scarred trees they

used a chain saw to cut a partial cross section—removing as little wood as possible—to determine the year of the fire.

Besides Crater Lake—they had field sites at Mt. Rainier National Park and North Cascade National Park, as well as forested land and National Forest areas surrounding all three National Parks. The researchers included sites that had at least 25% or greater canopy coverage of the whitebark pine, in relation to other tree species.

The researchers cored all the species of trees found on each site, to create a standard reconstruction. Murray says, "We found one whitebark pine tree with fire scars that dated all the way back to the 1500s."

The researchers also looked for the simple presence/absence of charcoal—which lasts for centuries—to give them a clear "yes or no" answer about whether fire occurred in their study sites.

Fire confirmed, major variation evident

Despite a general belief that fire is not very common in the Cascade Range due to abundant snowfall and cool, moist summers, Murray and Siderius found that a whopping 88% of their whitebark pine study sites had charcoal. "Clearly," says Murray, "fire has a historic role in these forests." He adds that they found most charcoal in the litter, on the underside of downed trees, or in the root wads of trees that had toppled over.

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Zooming in, the researchers found and named the dates for dozens of different historic fire events in their study sites. Specifically, they found 51 separate fires that occurred in the 1800s and 22 separate fires in the 1900s—that's 43% less fire in the century.

Murray says, "This all led to a lot of lab work for Joel (Siderius). We wanted to understand not only the chronology of the fires, but also the intervals of those fires. We knew that this particular information would be critical for managers because it would help to set targets for the reintroduction of fire in these communities."

He adds, "We really wanted to understand how 'out-of-sync' current fire patterns are with those of the past. With this, we hope to offer information that will be valuable to those who want to realign current fire to historic patterns."

"We found intervals that were short, medium, and long. This is a diverse and impressive range of fire frequency."

The researchers found clear evidence that—for Cascade whitebark pine communities—fire intervals vary enormously. "We found intervals that were short, medium, and long. This is a diverse and impressive range of fire frequency." Similarly, the scientists found that fire severity was also highly variable in these communities.

"It was interesting to see a fairly even occurrence of both high and low severity fires in these stands," says Murray. "For comparison, ponderosa pine and Douglas fir communities generally have low severity fires and only rarely have high severity fires. We think the reason for the big variation in whitebark pine communities in the Cascades relates to the complex physical environment here."

Thus adds Murray, "These whitebark pine communities fit the classic definition of having a mixed severity fire regime. Some stands have a low severity underburn, whereas others occur where all the mature trees die in a fire event."

The severity of the fire, he says, is clearly a reflection of fuel conditions at a particular stand. And this speaks to the "dramatic and complex features of subalpine topography that affect both the severity and the frequency of fire. Perhaps our biggest insight with this research is that the complex environment means a very high level of variability in fire severity and the frequency of fire."

For those curious about the variation evident in Cascadian whitebark pine communities, Murray and Siderius explore this issue in depth in the JFSP final report (*see page 5 for further information*). They write, "Cascadian whitebark pine forests have typically burned in both high and low severity events and at a sub-stand, stand, and watershed scales. It appears site specific controls are primarily responsible for severity and area of fires."

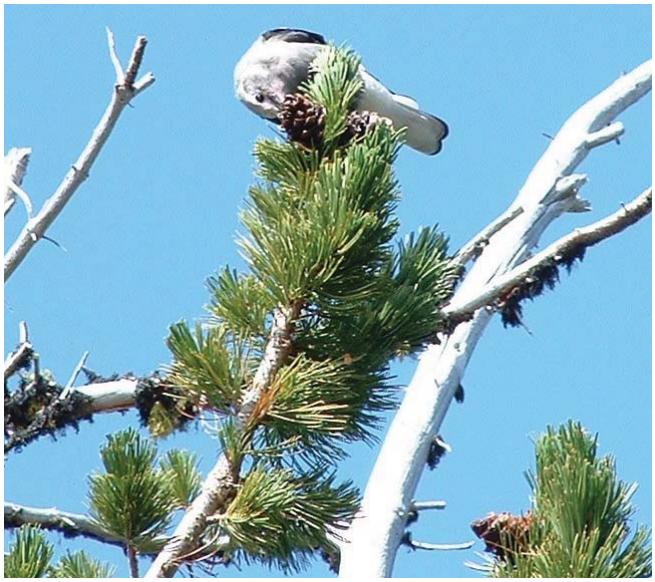
Birds, bugs, and bears…oh my!

Whitebark pine trees are exceptional in their role as keystone species to their whole community. But they are also inextricably linked to particular species. Not only do whitebarks create a haven at elevations unheard of for most living creatures, they sustain grizzly bears and Clark's nutcrackers.

Grizzly bears need a lot of fat and protein. During the late summer and early fall, their primary food source often is whitebark pine seeds. Few other food sources are available then. The bears rely on seed caches made by squirrels, and need the seeds to prepare for the winter.

Grizzly bears' continued survival depends on whitebark pine success. Without the pines, the bears will have far less food available. It is thus imperative to those striving to protect grizzlies, to learn more about sustaining whitebark pine populations.

Then there's the Clark's nutcracker. The bird and its tree—the whitebark pine—enjoy a truly mutual relationship. The tree's only substantial route to regeneration is via Clark's opening, then caching, their seeds—which can then germinate. The trees depend entirely on the bird to open its tricky cones and extract its seeds. Meanwhile, Clark's rely heavily on the whitebark pine as a food source. They also release the seeds into the community via caching them, allowing a whole host of other creatures (including grizzly bears and squirrels) to find and eat this nutritious food source. What's more, the birds often cache whitebark pine seeds in areas recently burned where it is easier for them to bury and remember their caches. Thus whitebark pines are tightly linked to their communities, to many species, and to fire.



Clark's nutcracker extricating seeds from whitebark pine cone. Credit: Michael Murray and the National Park Service.

But the pine's plot gets even thicker. There are now bugs and disease involved that divorce the elegant simplicity and value of pines from their community. Blister rust is an introduced disease that lays waste to whitebark pine populations. The disease spreads on the wind and fog, and by way of another host—currant shrubs of the *Ribes* genus. With its first host, the shrub, the disease gains a foothold by creating spores that transform into windborn spores. These travel to the whitebark pines and create cankers that eventually spell near-certain death. Murray writes in an article in the journal *Kalmiopsis* that "experts warn that only 0 to 5% of the whitebark pine population will survive the alien pathogen."

Next there's the mountain pine beetle. The curtain of cool, high elevation climate had formerly kept mountain pine beetles at bay. But as the curtain begins to lift with the warming temperatures of climate change, mountain pine beetle outbreaks in whitepine communities are more and more common and devastating. To complicate matters for the tree, fire exclusion has allowed its less fire-resistant competitors—like fir and mountain hemlock—to flourish where formerly whitebarks ruled the day. Weakened trees,

Blister rust cankers on a whitebark pine tree. Credit: Michael Murray and the National Park Service.

and communities of trees, are more vulnerable to both beetles and blister rust. The prognosis appears dire.

Grim future or successful restoration?

Murray and Siderius found yet another discouraging result. Probably as a consequence of fire exclusion, competitors of whitebark pine (late seral species like Shasta and subalpine fir) are increasing dramatically in volume across the sites they studied. Without fire to bolster the pine's competitive success, other species are shouldering it out of the way. With the continued "invasion" of later seral species in previously whitebark pine-dominated high-elevation areas, it appears not only that the whitebark's are in decline, but the opportunities for them to regenerate, too, are diminishing.

But is this the nail in the whitebark's coffin? With blister rust, fire exclusion, and mountain pine beetles all impacting the whitebark, it will take concentrated and unflagging participation of managers and planners to chart a course to restoration.

Murray stresses the need to protect disease resistant trees. He writes in a USDA conference proceedings paper, "Fire managers should always be cognizant of the unique status and threats to whitebark pine– a 'sensitive species.' Fire-induced mortality of potentially disease resistant trees should be strictly avoided. They are the life-link to the species' future. Where blister rust infection is high, it's strongly recommended that pathologists or trained technicians survey for healthy mature trees prior to burning operations or during lightning-fires (safety permitting)."

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Another step in re-instating the whitebark is acquiring better tools to understand and manage the emerging threat of the mountain pine beetle. So far, the ability to ward off

such outbreaks is expensive and unwieldy—it involves pheromone packets that use scent to signal beetles that trees are already infested; as well as hundreds of physical hours of labor.

Murray concludes in his Kalmiopsis paper that, "The prognosis for (Cascade) whitebark pine is bleak. With mortality outpacing the ability of the forests to self-replenish, the loss of these distinctive timberline communities will continue. As the keystone whitebark pine dwindles, we expect the web of dependent living organisms to suffer."

But he adds in that article that, "Ecologists, geneticists, managers, and other concerned professionals are beginning to pool their expertise in a coordinated effort. Long-standing knowledge gained from protecting sugar and western white pines from blister rust is very useful. Identifying naturally occurring resistant trees is critical. Although blister rust appears to be a permanent element of Cascade communities, tenacious attention can ensure that healthy timberlines will persist."

The whitebark pine stands at the center of a unique web of interconnected species in community—but the elements coursing in its disfavor are grave and considerable. The question now is, can the web of people needed to rescue this exceptional tree come together to create a chance for its recovery?

Crater Lake in the summer. Credit: National Park Service.

Further Information: Publications and Web Resources

Fire knowledge for managing Cascadian whitebark pine ecosystems. A Final Report to the Joint Fire Sciences Program (#01B-3-3-26). Joel Siderius and Michael Murray, December 2005.

Our Threatened Timberlines: The Plight of Whitebark Pine Ecosystems. Michael Murray Kalmiopsis Volume 12, 2005. http://www.npsoregon.org/kalm/kalmiopsis12/timberlines.pdf

Fire and Pacific Coast Whitebark Pine. Proceedings of the Conference Whitebark Pine: A Pacific Coast Perspective, Michael Murray. USDA Forest Service R6-NR-FHP-2007-01. http://www.fs.fed.us/r6/nr/fid/wbpine/papers/2007-wbp-impacts-murray.pdf

Mountain Pine Beetle Conditions in Whitebark Pine Stands in the Greater Yellowstone Ecosystem. 2006, Ken Gibson, Entomologist. Numbered Report: 06-03, February 2006. http://www.fs.fed.us/r1-r4/spf/fhp/publications/bystate/R1Pub06-03_MPB_Yellowstone_gibson.pdf

The Whitebark Pine Ecosystem Foundation: www.whitebarkfound.org/

High Elevation White Pines: www.fs.fed.us/rm/highelevationwhitepines/

PNW Genetic Resource Program, Whitebark Pine Conservation: www.fs.fed.us/r6/genetics/programs/whitebark-pine/

Bark Beetle Links: www.barkbeetlelinks.ca/

Greater Yellowstone Grizzlies: http://www.greateryellowstone.org/ecosystem/wildlife/grizzly.php

Management Implications

- Promote fire as a natural element of whitebark pine forests. Nearly all Cascadian whitebark forests have burned in the past thus re-introduction of fire will support ecological integrity and fuel maintenance.
- Plan management burns based on site-specific regime. Not all whitebark pine forests burned the same. Site visits and analysis by fire ecologists will provide interpretation of historic regimes to guide management prescriptions.
- Prioritize stands with historically frequent non-stand replacing fires. These stands are most impacted by the modern exclusion of fire.
- Work with pathologists to protect disease-resistant trees. Trained forest technicians can identify such trees prior to burning operations or during lightning-fires.
- Support lightning-ignited fires. Because whitebark pine tends to be in remote wilderness and parks and often in areas of discontinuous fuels, immediate threats to human developments are rare. Lightning-ignited fires are beneficial from a cost-savings (dollar per acre) perspective while providing multiple ecological benefits.

Scientist Profiles

Michael P. Murray was a Terrestrial Ecologist at Crater Lake National Park in Oregon from 2002 to 2008. He now works as a Forest Pathologist with the British Colombia (BC) Forest Service. When he is not outdoors having fun with his family, he's hosting his weekly radio show, "Flashback 70's," on CJLY (www.cjly.com) in Nelson, BC.

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Joel Siderius was a Biologist at Crater Lake National Park in Oregon from 2004 to 2006. He now works for the University of Washington, College of Forest Resources in Seattle, WA where he is a National Park Service "Cooperator." He currently divides his time between the National Park Service's Inventory and Monitory Program – Mojave Desert Network and the Pacific Northwest Cooperative Ecosystem Studies Unit. While not on campus, Joel enjoys riding his bike, hiking, and cross country skiing with his family in search of fresh air and big vistas.

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