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Whitebark Pine Restoration Strategy for the Pacific Northwest Region

Executive Summary 2009–2013

Pesticide Precautionary Statement

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State or Federal agencies, or both, before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Cover Photos

Main photo; Robin Shoal, U.S. Forest Service; small photos—Clark's nutcracker obtaining seed from whitebark pine cone, Teresa Lorenz, U.S. Forest Service; four cones, Robin Shoal, U.S. Forest Service; krummholtz, Robin Shoal, U.S. Forest Service; grizzly cubs, National Park Service.

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Our Goal

Restore and conserve a network of viable populations of whitebark pine and associated species across the Pacific Northwest

- **Restore** degraded habitat
- **Protect** genetic resources through gene conservation
- **Increase** blister rust resistance in whitebark pine populations
- **Evaluate** the health and status of whitebark pine stands where lacking
- **Increase** our understanding of the threats to whitebark pine and develop practical and effective restoration techniques.

Priority Actions

Implement a comprehensive 5-year restoration plan to:

A. **Restore** areas where whitebark pine habitat has been affected by fire, mountain pine beetle, or white pine blister rust by planting seed or seedlings, thinning competing trees, or pruning tree infected limbs.

B. Collect whitebark pine seed samples across the Pacific Northwest and **protect** in long-term storage.

C. **Increase** levels of genetic resistance to blister rust infection by in whitebark pine populations through tree selection, resistance screening, and wise use of seed from resistant trees.

D. **Evaluate** units where health, stand condition, and restoration needs are unknown.

E. Work collaboratively with research scientists and land managers in other agencies to **increase** understanding of the complex and synergistic impacts of blister rust, fire, mountain pine beetle and climate change on present and future health and distribution of whitebark pine plant communities.

Why We Are Concerned

Whitebark pine has been widely described as a “keystone” species in high-elevation forests (Tomback et al. 2001, Schwandt 2006): an important ecosystem component that influences the success of other organisms. It plays a vital role in first colonizing areas disturbed by fire or landslides, stabilizing the soil, moderating snow melt, and providing the cover that allows regeneration of other tree species.

The future of whitebark pine in Oregon and Washington as well as throughout its range is of serious concern because of the species’ acute vulnerability to infection by the non-native fungus *Cronartium ribicola* (which causes white pine blister rust), its high susceptibility to infestation by mountain pine beetle (*Dendroctonus ponderosae*), its risk of being destroyed in large and intense wildfires, and the likelihood of its being replaced in some subalpine mixed conifer forests by more shade-tolerant tree species, a trend that is exacerbated by fire exclusion. There are also significant concerns about the impacts of climate change, particularly warming, on this high-elevation, cold-adapted species.

Proactive conservation and restoration are critical to prevent the permanent loss of whitebark pine habitat throughout much of its range in the Pacific Northwest.

Portrait of Whitebark Pine

Whitebark pine is a medium-sized tree with characteristics adapted for survival in high mountains (Arno and Hoff 1990). In Oregon and Washington, it occurs mainly at elevations of 1,600 m to 2,800 m. Multiple stems representing a single tree or several very closely associated trees are common in open stands. At the high end of its elevation range on exposed sites where hurricane-force winds are common in winter, it assumes a stunted, krummholz form. Even in less inhospitable locations, whitebark pine frequently exhibits a picturesque, wind-swept appearance. Whitebark pine habitat is characterized by severe conditions (Arno and Hoff 1990), including: short, cool, often droughty summers; growing seasons of fewer than 110 days; and frosts and even snow showers during summer months.

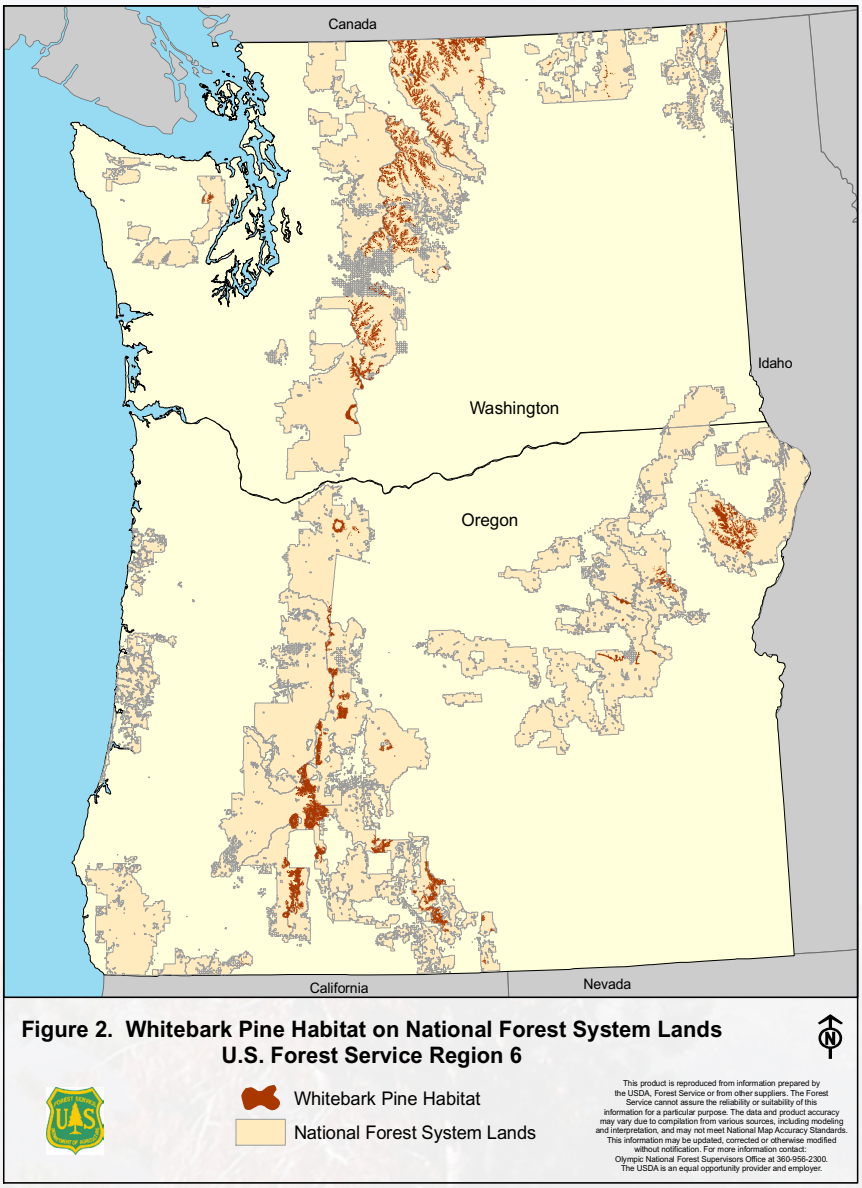

Figure 2. Whitebark Pine Habitat on National Forest System Lands U.S. Forest Service Region 6

Whitebark pine populations tend to be scattered and spotty because of the often discontinuous distribution of favorable habitat on high mountain peaks and ridges. Individual populations are of widely varying sizes, with some being quite small. Along the north–south running Cascades where the largest numbers of whitebark pine populations in the Pacific Northwest occur, the drier regions east of the Cascade Crest commonly have more suitable habitat than areas farther west (Ward et al. 2006b). Some Pacific Northwest whitebark pine populations, notably those in the Olympic and Blue Mountains, are widely separated from any other populations, and the populations in northeastern Washington are closer to the Rocky Mountain portion of the species' range than they are to the Cascades.

Robin Shoal, USFS

At the high end of its elevation range and on exposed or dry sites where conditions are too extreme for other tree species, whitebark pine may grow virtually alone and be the climax species. At lower elevations where more hospitable weather conditions prevail and whitebark pine is a component of subalpine mixed conifer forests, it is frequently the pioneer species that grows first on a site following disturbance and provides the cover that eventually allows more shade-tolerant tree species to become established. In the absence of additional disturbance, whitebark pine may be out-competed and replaced over time in such subalpine mixed stands by the more shade-tolerant true firs, spruces, and hemlocks.

Robin Shoal, USFS

Most whitebark pine habitat in Washington and Oregon occurs on federally administered land, and 81 percent is on lands administered by the Forest Service, Region 6. Sixty percent of the known occupied whitebark pine habitat on National Forest System land in the Pacific Northwest occurs in congressionally designated wilderness areas.

Seed dissemination by whitebark pine is unique among American pines. The species' large, wingless seeds are rarely if ever spread by wind or gravity. Instead whitebark pine seeds are mostly released from cones and disseminated by a bird species, the Clark's nutcracker (*Nucifraga columbiana*).

Numerous seeds buried in soil caches but not reclaimed by nutcrackers germinate, usually after two or more winters, and grow—resulting in successful whitebark pine regeneration, commonly found in small clumps. Using molecular markers, it has been determined that often the stems in these clumps represent more than one genetically distinct individual, with each one arising from a different seed.

Michael Murray, NPS

Levels of genetic diversity in whitebark pine are comparable to other stone pine species; however, whitebark pine appears to have lower levels of genetic differences among stands than wind-dispersed pines do. While genetic analysis using molecular markers have shown low levels of genetic differentiation, studies using measured traits generally have found considerably more genetic variation and moderate to high levels of population differentiation. The traits studied include cold injury, blister rust resistance, growth, and phenology. Winter temperature appears to be an important climatic determinant driving adaptation of populations to their local environment, and combined with data on population differentiation, has been used to determine guidelines for movement of seed for restoration or reforestation efforts.

Whitebark Pine and Wildlife

Although among wildlife species only the Clark's nutcracker plays an important part in whitebark pine seed dissemination, many other wildlife species of high-elevation ecosystems depend to varying degrees on whitebark pine seeds as food resources (Lanner 1996). Other birds known to feed on whitebark pine seeds include jays, ravens, grosbeaks, chickadees, and nuthatches. Mammals include mice, chipmunks, squirrels, and bears. Two species of squirrel, the red squirrel (*Tamiasciurus hudsonicus*) and the Douglas squirrel (*T. douglasii*), in particular, harvest large numbers of whitebark pine cones in good seed years and store them in midden piles for winter food (Lanner 1996, Mattson et al. 2001). Black bears (*Ursis americana*) and grizzly bears (*U. arctos*) harvest whitebark pine cones themselves but more commonly raid squirrel middens to take advantage of the concentrated, high-quality food represented by the pine seeds in them. A plentiful supply of whitebark pine seeds in squirrel middens has been shown to contribute substantially to the success of bear populations and also to reduce the amount of conflict between humans and grizzly bears (Mattson et al. 1992; Mattson et al. 2001). In northeastern Washington, the grizzly bear is a threatened species, so its welfare as it relates to whitebark pine is of considerable management importance.

National Park Service

The Four Threats to Whitebark Pine

The major threats to whitebark pine in the Pacific Northwest are white pine blister rust, mountain pine beetle, fire (both too much and not enough in different situations), and large-scale climate change. All have been influenced or directly caused by human activities.

White Pine Blister Rust

The pathogenic fungus *Cronartium ribicola,* which causes white pine blister rust, is native to eastern Asia. The pathogen was first recognized in 1921 in British Columbia, by which time it had already spread into adjacent five-needle pine populations. ***Since its introduction, the pathogen has caused unprecedented decline and mortality of susceptible hosts in Oregon and Washington as well as other parts of the West.*** *C. ribicola* has a complex life cycle involving five spore types and requiring both pine and alternate hosts for its successful completion (Boyce 1961); alternate hosts include currant and gooseberry shrubs in the genus *Ribes.* On infected five-needle pines, white pine blister rust causes formation of resinous cankers that commonly girdle host stems, especially those of 20-cm or smaller diameters. Girdling results in branch and top mortality of large trees, and, in the case of main stem infections on smaller hosts, frequently causes death of the entire tree. Large infected trees that are not killed immediately by the fungus may be predisposed to infestation by mountain pine beetle. White pine blister rust also has the potential to reduce cone production by killing cone-bearing branches (McKinney and Tomback 2007). In the Pacific Northwest, reported levels of infection of living trees in surveyed stands where blister rust was present varied from 17 to 92 percent.

Robin Shoal, USFS

Mountain Pine Beetle

The mountain pine beetle *(Dendroctonus ponderosae)* is the primary agent of insect-caused mortality in both lodgepole pine and whitebark pine. During the historically warm years of the 1930s, mountain pine beetles killed many clusters of whitebark pines (Perkins and Swetnam 1996). ***Between 2005 and 2007 an estimated 600,000 whitebark pines were killed by mountain pine beetles in Washington and Oregon.***

Robert Schroeter, USFS

Mountain pine beetles preferentially attack the largest trees first, and large trees produce more beetles per unit area of bark because of their greater circumference and height (Cole and Amman 1980). Because weakened trees are more easily colonized than vigorous trees, it would be expected that white pine blister rust infection would make a whitebark pine more susceptible to attack. However, the evidence for such a relationship has not been firmly established (Kegley et al 2003). Nevertheless, the combination of mountain pine beetles killing larger trees and white pine blister rust killing smaller trees has been particularly destructive to whitebark pine populations.

Fire

Fire is a natural component of whitebark pine ecosystems. Low- and moderate-intensity fires keep fuel loads low and reduce competition from later seral conifers, shrubs, and dense grasses. High-intensity fire provides newly opened areas in which whitebark pine can successfully germinate and grow without competition. Absence (exclusion) of fire due to active fire suppression has led to replacement of whitebark pine by more shade-tolerant, later seral conifer species and has reduced regeneration opportunities for whitebark pine (Keane et al. 2002, Kendall and Keane 2001). Additionally, whitebark pine may currently be at a point of lowered fire tolerance due to the impacts of blister rust and increasing levels of mountain pine beetle activity (Kurth, pers. comm., 2008). ***Large high-severity fires have the potential to severely reduce or even eliminate cone-bearing whitebark pine across an extensive landscape.*** If a fire becomes intense and widespread enough that most or all cone-bearing whitebark pines within the fire perimeter are killed, seed from unburned stands within nutcracker caching range may be available to regenerate whitebark pine in the burned area. If there is no such seed source, natural regeneration of whitebark pine will be extremely slow, or the species may become locally extirpated.

Therese Ohlson, USFS

Robin Shoal, USFS

Global Climate Change

Whitebark pine may be particularly vulnerable to loss of favorable habitat due to the restriction of its range to the upper subalpine zone. ***The predicted impacts of warming temperatures include a severe decline in suitable habitat; increased mountain pine beetle activity; an increase in the number, intensity, and extent of wildfires; and perhaps an increase in white pine blister rust-related mortality.*** The present lack of scientific tools to predict climate change on regional or local scales limits the ability to quantify potential future impacts that can be applied to management decisions at the forest or stand level. However, a number of new initiatives that focus on the impacts of climate change on western forests will provide information and tools that can be used to create management strategies for whitebark pine in the Pacific Northwest that incorporate climate change. Part of the regional 5-year action plan is the development of specific management recommendations for whitebark pine and associated species that incorporate the best available science on the predicted impacts of climate change on whitebark pine.

Comprehensive 5-Year Restoration Plan

- Develop and implement a plan to plant priority management units.
- Collect seed to meet gene conservation, rust resistance screening, and planting objectives.
- Assess the condition and determine restoration needs for all priority management units.
- Develop and implement a plan to plant priority management units.
- Continue the ongoing rust screening program with emphasis on seed zones in grizzly bear recovery areas.
- Develop and implement a plan to treat mountain pine beetle in high risk units.
- Develop an approach for planting in designated wilderness areas that will allow the use of resistant plant material while maintaining wilderness character.
- Develop an approach to mitigate the predicted impacts of climate change.
- Develop monitoring plan(s) to track accomplishments, measure success of actions, provide information and feedback to improve procedures and outcomes of projects, and disseminate information.
- Work collaboratively to meet information needs.

Top Ten Management and Research Questions

1. What is the influence of climate change on the life cycles of C. ribicola, seed and cone insects, and mountain pine beetle in the Pacific Northwest?
2. How are fuel management dynamics best managed in different parts of whitebark pine's habitat?
3. How often and where would prescribed fire benefit different parts of whitebark pine's habitat and what would be the effects on mountain pine beetle activity?
4. Do whitebark pine seedlings survive and grow better when they occur in a close group (as is often the case in nature when they are planted by nutcrackers) than when they occur as widely spaced individuals?
5. What are the influences of various kinds of micro-sites on success of whitebark pine planting?
6. What type of site preparation is necessary and best for successful planting of whitebark pines?
7. Is it possible to successfully direct-sow whitebark pine seeds in the field?
8. How can thinning of trees be incorporated with other techniques such as prescribed fire to maintain whitebark pine habitat and deter mountain pine beetle attack?
9. How would thinning affect mountain pine beetle activity in different stand and landscape conditions?
10. What information is needed to make meaningful dynamic models of whitebark pine habitat in a changing climate scenario, including models that could provide site-specific information to managers for determining the best places to undertake restoration efforts?

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