Cascade Mountains
Jennifer Beck, Crater Lake National Park
Regina Rochefort, North Coast Cascades Network
Sean Smith, Klamath Network

Rocky Mountains
Dawn LaFleur, Glacier National Park
Dan Reinhart, Grand Teton National Park
Kelly McCloskey, Grand Teton National Park
Roy Renkin, Yellowstone National Park
Erin Shanahan, Greater Yellowstone Network
Kristin Legg, Greater Yellowstone Network

Sierra Nevada Mountains
Jonathan Beals-Nesmith, Sierra Nevada Network
Garret Dickman, Yosemite National Park

Intermountain Region
Mike Wrigley

Pacific West Region
Mietek Kolipinski

Natural Resources Science and Stewardship – Biological Resource Division
Bill Austin, Endangered Species Coordinator
Over 130,000 hectares (321,237 acres)
Predominantly Wilderness
Pacific West & Intermountain

Cascade Mountains
Rocky Mountains
Southern Sierra
Nevada Mountains
<table>
<thead>
<tr>
<th>Region</th>
<th>Park(s)</th>
<th>Hectares (estimate)</th>
<th>Blister Rust Infection</th>
<th>Mortality</th>
<th>Agents of Mortality*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crater Lake</td>
<td>2100</td>
<td>51%</td>
<td>16%</td>
<td>Other MPB BR</td>
</tr>
<tr>
<td></td>
<td>Lassen Volcanic</td>
<td>260</td>
<td>54%</td>
<td>10%</td>
<td>Other Other bark beetles BR MPB</td>
</tr>
<tr>
<td></td>
<td>Mount Rainer</td>
<td>1200</td>
<td>38%</td>
<td>44%</td>
<td>BR</td>
</tr>
<tr>
<td></td>
<td>North Cascades</td>
<td>4000</td>
<td>44%</td>
<td>21%</td>
<td>BR</td>
</tr>
<tr>
<td></td>
<td>Olympic</td>
<td>40</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Teton</td>
<td>3000</td>
<td>13-25% for GYA**</td>
<td>26%</td>
<td>MPB BR Fire</td>
</tr>
<tr>
<td></td>
<td>John D. Rockefeller</td>
<td>450</td>
<td>(Grand Teton 38%)</td>
<td>(&gt;70% in overstory)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yellowstone</td>
<td>50000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Olympic</td>
<td>26000</td>
<td>78%</td>
<td>Significant</td>
<td>BR</td>
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<tr>
<td></td>
<td>Glacier</td>
<td>25000</td>
<td>0.5%</td>
<td>Low</td>
<td>NA</td>
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<tr>
<td></td>
<td>Yosemite</td>
<td>20000</td>
<td>0%</td>
<td>Low</td>
<td>NA</td>
</tr>
</tbody>
</table>

*MPB = Mountain Pine Beetle; BR = Blister Rust; other includes unknown, fire
**GYA infection rate
Regeneration
Conservation Management

- Monitoring
- Research
- Protection
- Restoration

NPS, 2006 Management Policies
Wilderness Act
Park Management Objectives
Monitoring & Research

Alpine and Subalpine Vegetation Monitoring Protocol for the North Coast and Cascades Network
Natural Resource Report NPS/NCCS/NR - 2015/570

Monitoring White Pine (Pinus albicaulis, P. balfouriana, P. flexilis) Community Dynamics in the Pacific West Region - Klamath, Sierra Nevada, and Upper Columbia Basin Networks
Narrative Version 1.1
Drafted Final Protocol Review Update April 2015

Crater Lake, Glacier, Grand Teton
Cascade Mountains
Klamath Network
https://science.nature.nps.gov/im/units/klmn/monitor/whitebark.cfm

North Coast Cascades Network
https://science.nature.nps.gov/im/units/nccn/monitor/subalpine.cfm

Rocky Mountains
Greater Yellowstone Network
https://science.nature.nps.gov/im/units/gryn/monitor/whitebark_pine.cfm

Greater Yellowstone Whitebark Pine Strategy

Crown of the Continent Research Learning Center
https://www.nps.gov/articles/whitebark-pine-brief.htm

Sierra Nevada Mountains
Sierra Nevada Network
https://science.nature.nps.gov/im/units/sien/monitor/forests.cfm
GLACIER WHITEBARK CONSERVATION
MANAGEMENT ACTIONS

Seed Collection

Purpose: to collect seed from potentially blister-rust resistant whitebark pine trees for propagation and use in future restoration projects.

Seedling survival

Purpose: Seed collected from whitebark pine trees that show signs of genetic resistance from blister rust is germinated and grown in a nursery setting. Seedlings are planted at specific sites around Glacier National Park in an effort to restore the ecosystem with disease-resistant trees.

Cone tree monitoring

Purpose: to identify and build baseline data for potential rust resistant whitebark pine trees ("plus trees") for field monitoring over time, as well as identify potential cone collection trees for the future.

Seed planting

Purpose: Due to the mortality and expense associated with growing and planting seedlings, seeds from potentially resistant whitebark pine trees were directly planted in the ground at specific sites around Glacier National Park in an effort to restore the ecosystem with disease-resistant trees.

WHITEBARK PLUS TREE MONITORING

A. INTRODUCTION

Whitebark pine (Pinus albicaulis) populations have declined dramatically in Glacier National Park, largely due to the introduction of a non-native fungus, white pine blister rust (Cronartium ribicola). White pine blister rust is a disease of five-needled pines and has been linked to the decline of all five-needled pines in the park. Spores from a secondary host infect trees through the needles and the fungus subsequently grows into the stem, producing fungal colonies, almost always eventually killing the tree (Hoff 1982). Glacier National Park not only has a high mortality rate associated with blister rust, but it also has an extremely high blister rust infection rate of remaining live trees. Infection is estimated at 70% for whitebark pine trees that remain in the Park (Kendall and Krebs 2001). A massive effort at removing secondary hosts for white pine blister rust in the Park was attempted between 1990 and 1970. Numerous numbers of Rubeus species were removed by hand-pulling and chemical control with no success at curtailing the disease (K5G-2001). Additionally, climate change may favor conditions that enhance distribution of blister rust spores. Recent climate conditions produce frequent "wave years" that promote massive numbers of infections (Kozack 2002). Therefore, it does not appear that preventing the spread of blister rust is an effective strategy for preservation of whitebark pine.

Taking advantage of natural blister rust resistance may be an even more effective strategy for preservation of whitebark pine. Natural genetic resistance has been found in several stands of five-needled pines and there is preliminary evidence that whitebark pine may have evolved natural resistance (Schwank 2004). A protocol has been implemented by U.S. Forest Service scientists wherein potential rust resistant seedlings are screened for resistance. Preliminary tests have revealed resistance in many whitebark pine seedlings (Muehlenbachs et al., 2006).

Glacier National Park has been attempting to utilize naturally resistant trees in its conservation program for the past 15 years. Cones have been collected from phenotypically resistant whitebark pine trees since 1997. Phenotypic indicators of blister rust resistance include no or very few active blister rust colonies, no or very few inactive blister rust colonies, no or very few rust-tipped twigs, no or very few rust-tipped needles, and the presence of cones. White cones are planted around trees during seed production for protection from birds with seed then collected later in the season. Despite these indications, seed was collected from 1997 to 2006 so that it is now impossible to tell which seedlings were grown from which potential rust resistant cone type. Beginning in 2007, seedlings were able to be tracked to a parent tree in a particular location and type. White cones have been placed around trees, and cones have been collected with these randomized cones.