



## Monitoring the Health of Five-needle Pines

Five-needle pine species, as their name suggests, have bundles of five needles and include species such as limber pine (*Pinus flexilis*) and bristlecone pine (*Pinus aristata*). Due to their ecological importance in high-elevation forests, they are of conservation interest in the Rocky Mountains. These species often grow on dry slopes and ridges near treeline where few other tree species thrive. They capture snowmelt and release it slowly serving to mediate erosion rates. Their seed cones are an important food source for black bears (*Ursus americanus*) and Clark's Nutcrackers (*Nucifraga columbiana*). Five-needle pines also contribute to the aesthetic and recreational experience of park visitors. For example, limber pine is common along many of the historic viewsheds and trails within the Great Sand Dunes National Park and Preserve, and at Rocky Mountain National Park, limber pine defines most of the alpine treeline and is the dominant species along the popular Rainbow Curve. In addition to charismatic wildlife that park visitors enjoy in these forests, the trees themselves can form dramatic, contorted shapes that provide an artistic dimension to already breathtaking vistas.

Five-needle pine populations throughout the Rocky Mountains are threatened by the invasive pathogen that causes white pine blister rust (WPBR; *Cronartium ribicola*), mountain pine beetle, and the effects of a changing climate.

White pine blister rust has contributed to high mortality in populations of whitebark pine (*Pinus albicaulis*) in the Northern Rockies and is a factor in the whitebark pine listing as protected under the federal Species at Risk Act in Canada, as endangered in Alberta under The Wildlife Act, and as warranting endangered species protection status under the Endangered Species Act in the United States. At Glacier National Park (NP), WPBR infection is estimated at 78% for both whitebark and limber pines, and is linked to the decline of all five-needle pine species in the park.

White pine blister rust was detected in the Southern Rockies in 1998. While many five-needle pine populations have not yet been affected, risk assessment suggests that WPBR will continue to spread throughout these forests. Infected trees have been found in Rocky Mountain NP and Great Sand Dunes National Park and Preserve (NPP) in recent years. Because WPBR is not yet as extensive in the Southern Rockies as it is in the Northern Rockies, there is opportunity to be proactive in an effort to moderate the widespread mortality observed in northern forests. Ongoing research will provide the science foundation to determine the best management strategies. Continued monitoring of these populations will provide valuable data regarding the extent of five-needle pine mortality, the encroachment of WPBR, and the success of management actions.



NPS, ERIN BORGMAN

The twisted shapes of five-needle pine trees are striking features on the landscape, whether dead or alive. These are whitebark pines in the wind-swept alpine areas of Glacier National Park in Montana.

### Monitoring Update

Since 1997, Glacier NP staff have actively planted whitebark and limber pine seedlings sourced from trees that demonstrate phenotypic resistance to WPBR ("plus trees"). The size, health, and mortality of planted seedlings has been monitored since 2001 and the health of plus trees has been documented since 2007. Seeds collected from

plus trees throughout the park have been entered into a U.S. Forest Service (USFS)-led genetic study designed to identify genetic resistance in five-needle pines. Information on those trees that demonstrate phenotypic resistance will help guide future seed collection. The overall goal of these monitoring projects is to restore susceptible ecosystems with disease-resistant trees to bolster forest resilience to prolonged WPBR pressure.

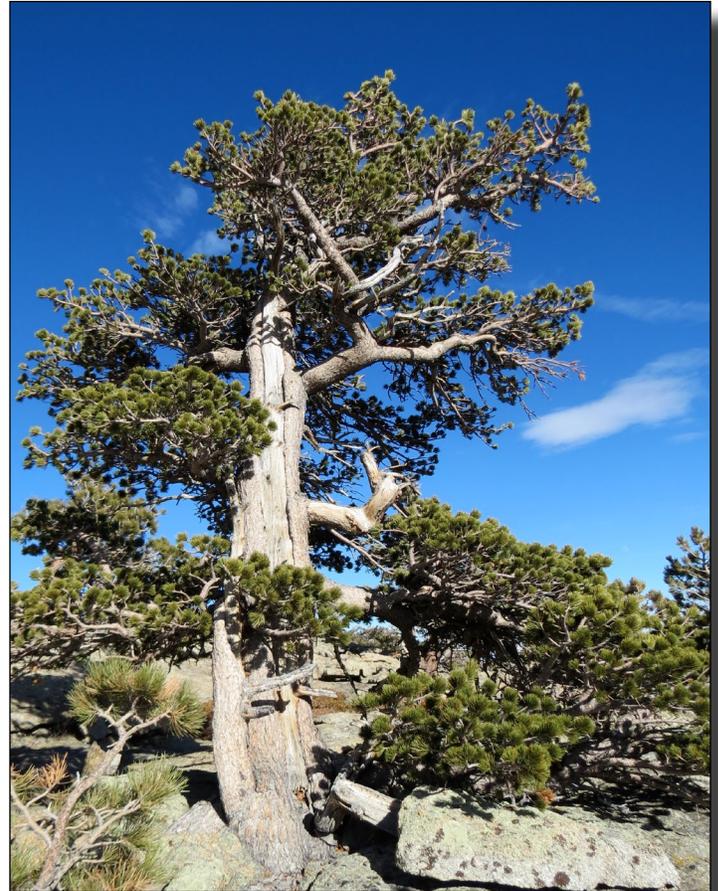
Five-needle pine monitoring also occurs in the Southern Rockies. The USFS has established permanent forest health plots in and around Great Sand Dunes NPP since 2003 and Rocky Mountain NP since 2006. These plots are designed to delimit the extent of WPBR infection and to monitor the distribution, spread, and ecological impacts of the infestation. The USFS has also conducted research to determine the frequency of genetic resistance to WPBR in limber and bristlecone pines at Great Sand Dunes NPP since 2006 and at Rocky Mountain NP since 2008. In 2013, through a cooperative agreement with Dr. David Roberts at Montana State University, field crews established additional plots or revisited permanent plots in Glacier NP, Rocky Mountain NP, and Great Sand Dunes NPP. The methodology used was similar to that used by the USFS and the Greater Yellowstone Network (GRYN) to allow for comparison across datasets. In the fall of 2014, Rocky Mountain NP staff plan on planting limber pine seedlings in restoration areas. They continue to collect cones as available and place verbenone, an anti-aggregate pheromone, on high-value trees to protect them from mountain pine beetle.

### Future Direction

Between the National Park Service and USFS monitoring efforts, important data are available that are not currently in a format conducive to comparison and analysis. The Rocky Mountain Network is collaborating with the GRYN and the USFS to create a comprehensive database to include relevant five-needle pine data from Glacier NP, Great Sand Dunes NPP, Rocky Mountain NP, Yellowstone NP, Grand Teton NP, and surrounding USFS units. Additionally, this database will have a push-button tool to allow the more comprehensive data from the plots to be uploaded into the “Hi5” database. Hi5 is being developed by the USFS and will allow users to view summary statistics and spatial locations of plots, make queries to refine the dataset, and facilitate the addition of data. Having integration with Hi5 will allow for a broader-scale view of the impact of WPBR.

Now that a solid baseline on the status of five-needle pine forests is established, the continuation of monitoring efforts will allow us to track changes in these forests and facilitate timely management decisions in preventing further widespread mortality and the potential collapse of five-needle pine ecosystems. Such monitoring would take place once every several years and would consist of revisiting permanent plots to collect data on the status

of five-needle pines, the presence of WPBR, and the overall health and composition of the forest. There are opportunities to collaborate further with other interested agencies and organizations to facilitate future monitoring efforts. Through these partnerships, we can collect the necessary data to inform management decisions to conserve these integral ecosystems for future generations.



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Limber pine trees like this one near Rocky Mountain NP can be thousands of years old. They often grow in very rocky, sparsely vegetated areas.

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