Southern Rockies Rust Resistance Trial

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The nonnative pathogen *Cronartium ribicola*, the cause of the lethal white pine blister rust (WPBR) disease, is spreading through limber pine (*Pinus flexilis*) and Rocky Mountain bristlecone pine (*P. aristata*) forests of the southern Rocky Mountains (USA). An integrated regional program—the Proactive Strategy—is characterizing the infestation and gaining ecological and genetic knowledge of these less well studied ecosystems. This knowledge will provide the science foundation for early interventions to mitigate the development of ecological impacts to the high mountain headwater ecosystems (Burns et al. 2008; Schoettle and Sniezko 2007; Schoettle et al., this proceedings, *The Proactive Strategy: Preparing the Landscape for Invasion by Accelerating the Evolution of Resistance*). Identifying and developing planting material with genetic resistance to WPBR, and understanding its field performance, is essential for managers to sustain these forests into the future.

The Southern Rockies Rust Resistance Trial (SRRRT) was begun in 2013 to field verify genetic resistance to WPBR identified during seedling inoculation screening tests of limber and Rocky Mountain bristlecone pines conducted in collaboration with the U.S. Department of Agriculture, Forest Service (USDA FS) Dorena Genetic Resource Center (DGRC; Cottage Grove, Oregon, USA) and the Institute of Forest Genetics (IFG; Placerville, California, USA) (Schoettle et al. 2011, 2014). This field test will assess if the resistance frequencies and disease symptom phenotypes that develop under natural growing and inoculation conditions at SRRRT are similar to those observed for the same families under the controlled inoculation tests of young seedlings in a different environment and with a different geographic source of the pathogen. Growing conditions, rust hazard, and inoculum sources can affect the expression of disease resistance and susceptibility, so field verification increases restoration deployment guidance and the potential for restoration success.

An existing administrative site on the Pole Mountain Unit of Laramie Ranger District, Medicine Bow National Forest that was used as a USDA FS nursery in the past was revitalized for this project. Seed from previously tested resistant and susceptible individual-tree collections (i.e., families) was sown March 22–23, 2012, and seedlings grown at the Colorado State Forest Service Nursery (Fort Collins, Colorado). Thirteen limber pine families and 11 Rocky Mountain bristlecone pine families are included in the study and represent seed sources from throughout the southern Rocky Mountains (fig. 1). Administrative approval and site preparation were completed in 2012 and 2013. More than 700 seedlings were outplanted August 26–28, 2013, and another 700 seedlings planted May 27–28, 2014 (figs. 2 and 3). White pine blister rust is common in the limber pine forest in and around the SRRRT site, providing a natural source of inoculum to

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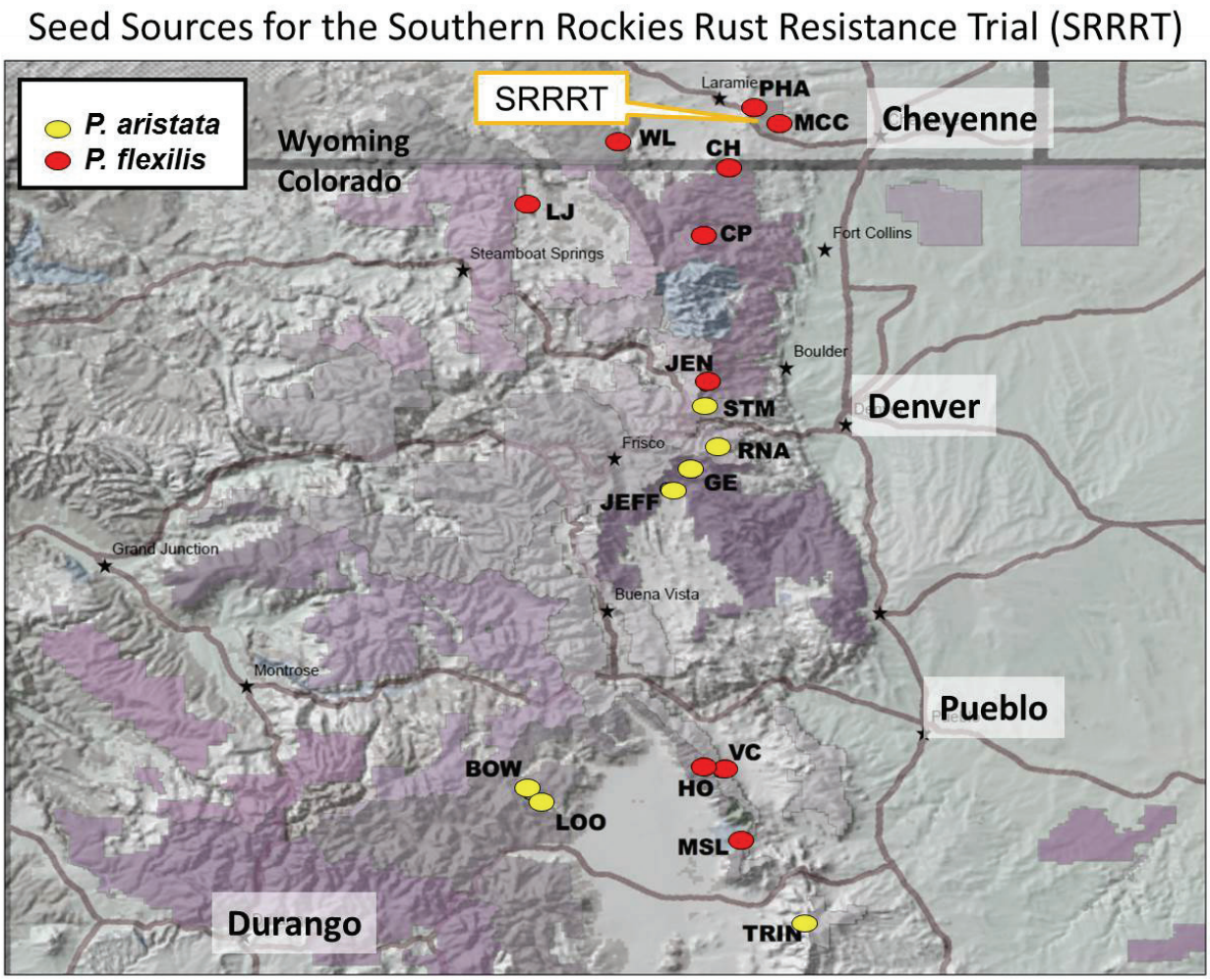

Figure 1—Source locations of the WPBR-resistant and susceptible families in the southern Rocky Mountains and the location of the SRRRT site. Yellow and red symbols denote source locations for bristlecone and limber pine families, respectively.

the seedlings; ponderosa pine (*P. ponderosa*) is also a common forest species in the area. The seedlings will be periodically assessed for signs and symptoms of WPBR over the next 10 years. This project was funded largely by the USDA Forest Service Rocky Mountain Region, Regional Office and is a cooperative effort between the Medicine Bow National Forest, Forest Health Protection, Rocky Mountain Research Station, and Colorado State University. Wyoming Conservation Corps provided a volunteer field crew that was instrumental in completing site preparation, and citizen and University of Wyoming volunteers assisted with seedling plantings.

Additional field trials of southern Rockies seed sources have been established at Happy Camp (California) with previously tested families of both species: Rocky Mountain bristlecone pine planting in 2006 and limber pine in 2012. The Happy Camp planting site is a component of the Pacific Southwest Region's Sugar Pine Resistance Program and offers exposure to the virulent strain of the *C. ribicola* (vcr1) that can overcome Cr1 complete resistance in sugar pine (*P. lambertiana*). Additional previously tested *P. flexilis* seedlings from the southern Rocky Mountains have also been planted in 2008 in an area of the Deschutes National Forest (Oregon).

All of these plantings, and those at SRRRT, include families that showed resistance in seedling inoculation testing at DGRC or IFG as well as families shown to be highly susceptible to *C. ribicola*. The susceptible families are monitored to detect exposure of the seedlings to rust spores to confirm that both resistant and

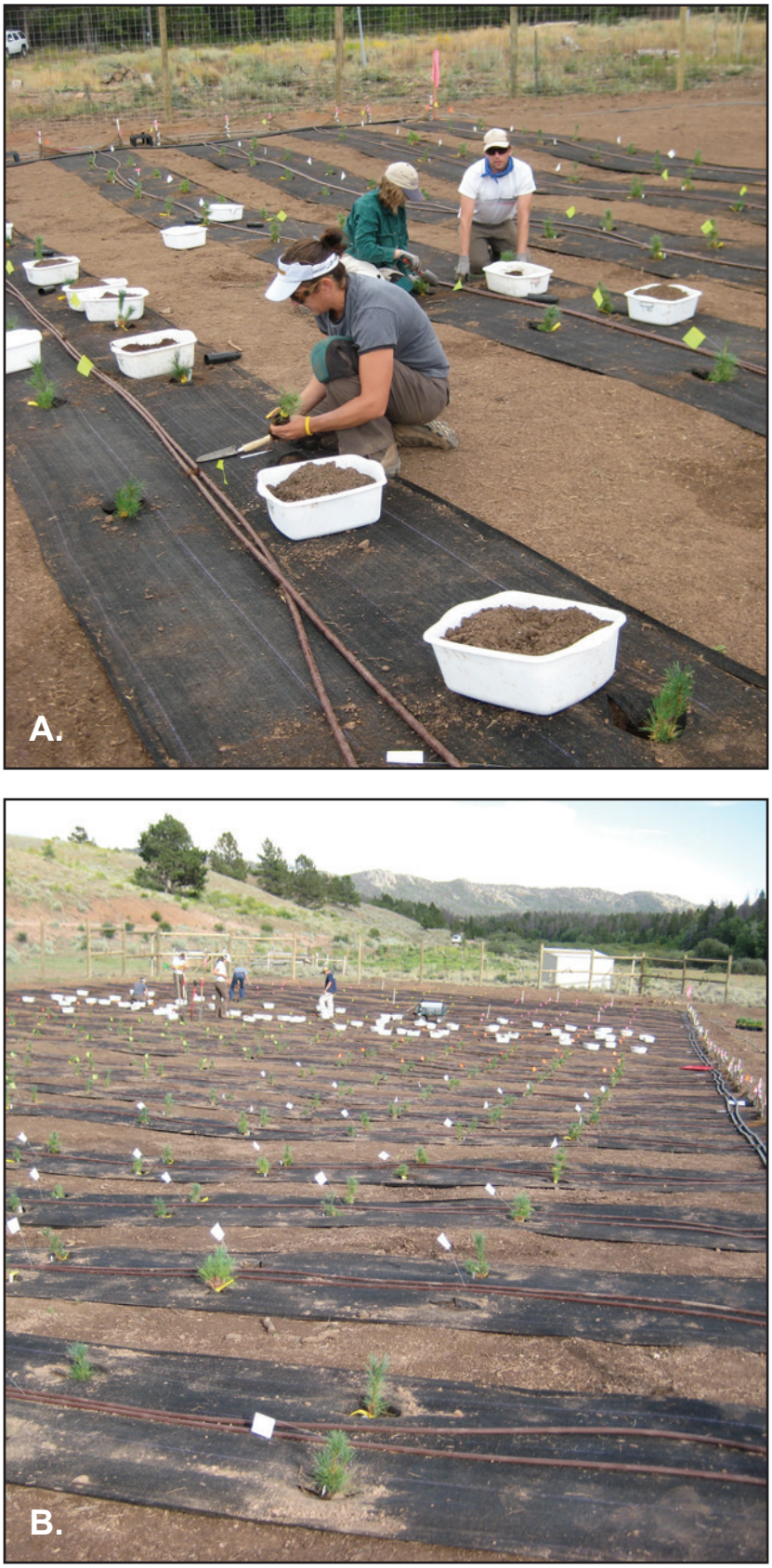

Figure 2—A. Planting seedling on the site. B. Overview of planting area.

Figure 3—Overview of the SRRRT site.

susceptible seedlings are being challenged over time. The resistant limber pine families have shown predominantly major gene resistance (Schoettle et al. 2011, 2014). Resistance in Rocky Mountain bristlecone pine is less well characterized at this point (Jacobi et al., this proceedings; Schoettle et al., this proceedings, *Patterns of Resistance to White Pine Blister Rust in Rocky Mountain Bristlecone Pine (*Pinus aristata*)*).

REFERENCES

Burns, K.S.; Schoettle, A.W.; Jacobi, W.R.; Mahalovich, M.F. 2008. Options for the management of white pine blister rust in the Rocky Mountain Region. Gen. Tech. Rep. RMRS-GTR-206. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 26 p. https://www.fs.usda.gov/treesearch/pubs/29450. (02 January 2016).

Schoettle, A.W.; Burns, K.S.; Cleaver, C.M.; Connor, J.J. [in press]. Proactive limber pine conservation strategy for the greater Rocky Mountain National Park Area. Gen. Tech. Rep. RMRS-GTR-xxx. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Schoettle, A.W.; Sniezko, R.A. 2007. Proactive intervention to sustain high elevation pine ecosystems threatened by white pine blister rust. Journal of Forest Research. 12: 327–336. http://www.springerlink.com/content/9v91t44278w74430/fulltext.pdf. (02 January 2016).

Schoettle, A.W.; Sniezko, R.A.; Kegley, A.; Burns, K.S. 2014. White pine blister rust resistance in limber pine: evidence for a major gene. Phytopathology. 104: 163–173. https://apsjournals.apsnet.org/doi/pdfplus/10.1094/PHYTO-04-13-0092-R. (02 January 2016).

Schoettle, A.W.; Sniezko, R.A.; Kegley, A.; Burns, K.S. 2011. Preliminary overview of the first extensive rust resistance screening tests of *Pinus flexilis* and *Pinus aristata*. In: Keane, R.E.; Tomback, D.F.; Murray, M.P.; Smith, C.M., eds. The future of high-elevation, five-needle white pines in western North America: proceedings of the high five symposium. Proceedings RMRS-P-63. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 265–269. https://www.fs.fed.us/rm/pubs/rmrs_p063/rmrs_p063_265_269.pdf. (02 January 2016).