

A Holistic Approach to Genetic Conservation of *Pinus strobiformis*¹

K.M. Waring,² R. Sniezko,³ B.A. Goodrich,^{2,4} C. Wehenkel,⁵ and J.J. Jacobs⁶

Pinus strobiformis (southwestern white pine) is threatened by both a rapidly changing climate and the tree disease white pine blister rust, caused by an introduced fungal pathogen, *Cronartium ribicola*. We began a proactive program in ~2009 to sustain *P. strobiformis* that includes genetic conservation, research, and management strategies. Research is related to the silvics, ecology, genetics, and future climate profile of the species. The results of these investigations will be used to develop refined seed transfer zones and silvicultural approaches to managing southwestern white pine in a changing climate.

We began collecting *P. strobiformis* seed and foliage in 2012, and have collected from over 80 sites across Arizona and New Mexico. Seeds of 233 individual parent trees from 53 sites have been archived at the National Seed Laboratory in Fort Collins, Colorado for genetic conservation. Collections from 20 sites across Mexico were completed and will be included in the ongoing research. Foliage is being utilized for genomics and leaf trait (e.g., stomatal density) research; extra foliage is in storage at Northern Arizona University.

Research objectives in this program are broad and multi-faceted, but all lead to better management of this species. An initial common garden study determined population differentiation under stressful conditions and defined gradients of growth and drought tolerance across sampled populations and seed source climates (Goodrich, B.A.; Waring, K.M.; Kolb, T.E. 2016. Genetic variation in *Pinus strobiformis* growth and drought tolerance from southwestern United States populations. *Tree Physiology*. 36: 1219–1235.). We are expanding the initial greenhouse common garden to field trials with a series of sites and an elevation gradient in northern Arizona. These common gardens will test for population and family structures and genotype-by-environment interactions. Extensive disease resistance trials are ongoing at the U.S. Department of Agriculture Forest Service (USDA FS) Dorena Genetic Resource Center in Cottage Grove, Oregon to investigate both complete and partial gene resistance to the pathogen in populations from across the species range. Outplanting of families into field trials will complement and verify resistance trials. Genetic conservation is ongoing.

Results will be disseminated to resource managers by the research team in conjunction with USDA FS Forest Health Protection staff with the intent that the results be used to proactively and adaptively manage *P. strobiformis*. These results add to the knowledge base related to *P. strobiformis* silvics, regeneration ecology, and population genetics. Reducing maladaptation to seedling transfer will be a priority because the species may have genetic resistance to *C. ribicola* in a few populations. Both genetic resistance to disease and drought tolerance are desirable for *P. strobiformis* sustainability.

¹ A version of this paper was presented at the Gene Conservation of Tree Species – Banking on the Future Workshop, May 16–19, 2016, Chicago, IL.

² School of Forestry, Northern Arizona University, 200 E Pine Knoll Drive, Flagstaff, AZ 86011.

³ Dorena Genetic Resource Center, USDA Forest Service, 34963 Shoreview Drive, Cottage Grove, OR 97424.

⁴ Forest Health Protection, USDA Forest Service, Wenatchee Forestry Sciences Lab, 1133 N. Western Avenue, Wenatchee, WA 98801.

⁵ Instituto de Silvicultura e Industria de la Madera, Universidad Juarez del Estado de Durango Durango, Durango, México.

⁶ Forest Health Protection, USDA Forest Service, New Mexico Zone, 333 Broadway Blvd. SE, Albuquerque, NM 87102.
Corresponding author: Kristen.waring@nau.edu.