Poster 7 Returning Sugar Pine and Western White Pine to the Pacific Northwest Forests—A Collective Effort

Richard A. Sniezko,[1] Robyn Darbyshire,[2] Holly Kearns,[3] Ellen Goheen,[3] Brennan Ferguson,[3] Brent Oblinger,[3] Betsy Goodrich,[3] Blakey Lockman,[3] Josh Bronson,[3] Michael McWilliams,[3] Mike Crawford,[4] George McFadden,[4] Jeff DeBell,[5] Dan Omdal,[5] Amy Ramsey,[5] Scott Kolpak,[6] Jim Hargrove,[7] Doug Manion,[8] Timothy Larkoski,[9] Gerald Barnes,[10] Rick Kern,[11] Dan Cress,[12] Bill Marshall,[13] Donald J. Kaczmarek,[14] Jun-Jun Liu,[15] Martin Nicholson,[16] Shawn Barnes,[17] Nicholas Ukrainetz,[18] Lorinda Bullington,[19] Lisa Winn,[1] Robert Danchok,[1] Emily Boes,[1] and Angelia Kegley[1*]

1 U.S. Department of Agriculture Forest Service, Dorena Genetic Resource Center, Cottage Grove, Oreg.
2 U.S. Department of Agriculture Forest Service, Pacific Northwest Region, Beaverton, Oreg.
3 U.S. Department of Agriculture Forest Service, Pacific Northwest Region, Forest Health Protection, Wash. and Oreg.
4 U.S. Department of Interior Bureau of Land Management, Lorane, Oreg.
5 Washington Department of Natural Resources, Olympia, Wash.
6 U.S. Department of Agriculture Forest Service, Genetic Resource Program, Corvallis, Oreg.
7 Quinault Indian Nation, Aberdeen, Wash.
8 Confederated Tribes of Warm Springs, Warm Springs, Oreg.
9 Kalispel Natural Resources, Usk, Wash.
10 G. Barnes Enterprises, Cottage Grove, Oreg.
11 Josephine County Forestry, Grants Pass, Oreg.
12 Regenetics Forest Genetics Consulting, Seattle, Wash.
13 Cascade Timber Consulting, Inc., Sweet Home, Oreg.
14 Oregon Department of Forestry, Saint Paul, Oreg.
15 Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.
16 Hoyt Arboretum, Portland, Oreg.
17 Geneseed Northwest, Cottage Grove, Oreg.
18 B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Surrey, B.C.
19 MPG Ranch, Missoula, Mont.
*Presenting and corresponding author: angelia.kegley@usda.gov

SUMMARY

Sugar pine (*Pinus lambertiana*) and western white pine (*P. monticola*) are important species in western North American forests (Figures 1 and 2); they provide wood products and ecosystem services, including enhancing biodiversity of our forests. However, both species are very susceptible to the non-native fungal pathogen *Cronartium ribicola*, causal agent of white pine blister rust disease (Goheen and Goheen 2014; Koester et al. 2018; Sniezko et al. 2019). Mortality from white pine blister rust has caused these species to be extirpated in some areas, and the frequency of their occurrence has diminished over time in many parts of their

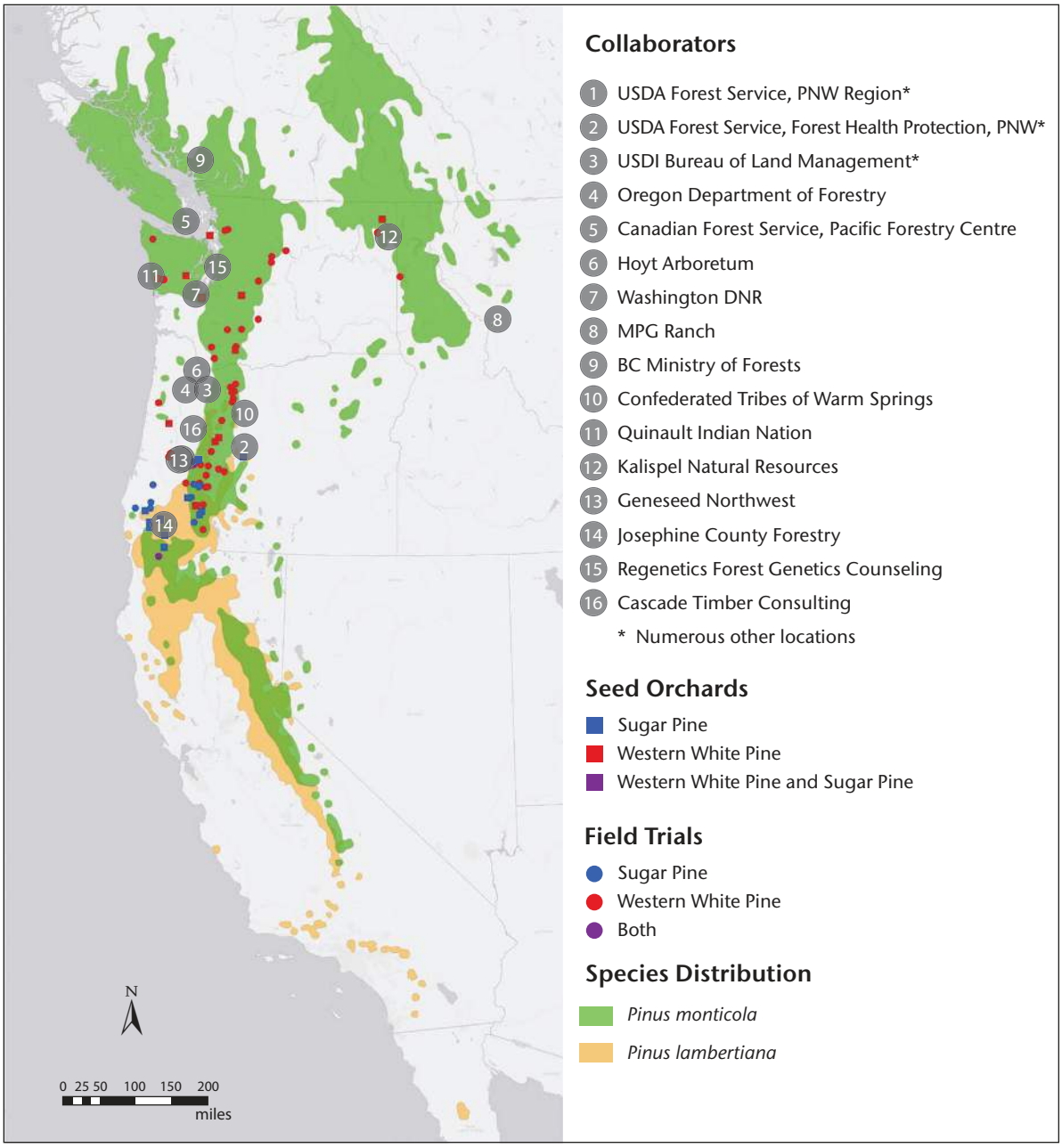

FIGURE 1 *Geographic range of western white pine* (Pinus monticola) *and sugar pine* (P. lambertiana)*, locations of seed orchards, and partners and collaborators who are assisting with developing genetic resistance to white pine blister rust (USDA: U.S. Department of Agriculture; PNW: Pacific Northwest; USDI: U.S. Department of the Interior; DNR: Department of Natural Resources; B.C.: British Columbia).*

ranges (Farjon 2013; Goheen and Goheen 2014; Lintz et al. 2016). In addition, land managers have been reluctant in the past to use these species for reforestation and restoration because of potential losses due to rust and to the lack of white pine blister rust–resistant planting stock. Breeding programs to create genetic resistance to white pine blister rust in both species have been underway for more than 50 years at the U.S. Department of Agriculture Forest Service (USFS) Dorena

Genetic Resource Center, and seed orchards are now producing seed that is suitable for many areas in the Pacific Northwest that are within the species' ranges. A wide range of cooperators and partners has assisted with varying components of these resistance breeding programs (Figures 1, 2, and 3). With the combination of available seed from resistance programs, rust hazard rating of sites, and early pruning of trees, these species are again becoming part of the silvicultural toolbox needed to maintain healthy forests.

Using selections from the white pine blister rust resistance program, seed orchards for sugar pine and western white pine have been established throughout their ranges in the Pacific Northwest on U.S. Forest Service, Department of the Interior Bureau of Land Management, tribal, Washington Department of Natural Resources, Josephine County, and private lands (Figures 1 and 2), which has made improved seed available in many areas. Field trials established to examine the durability and stability of resistance are also distributed throughout much of

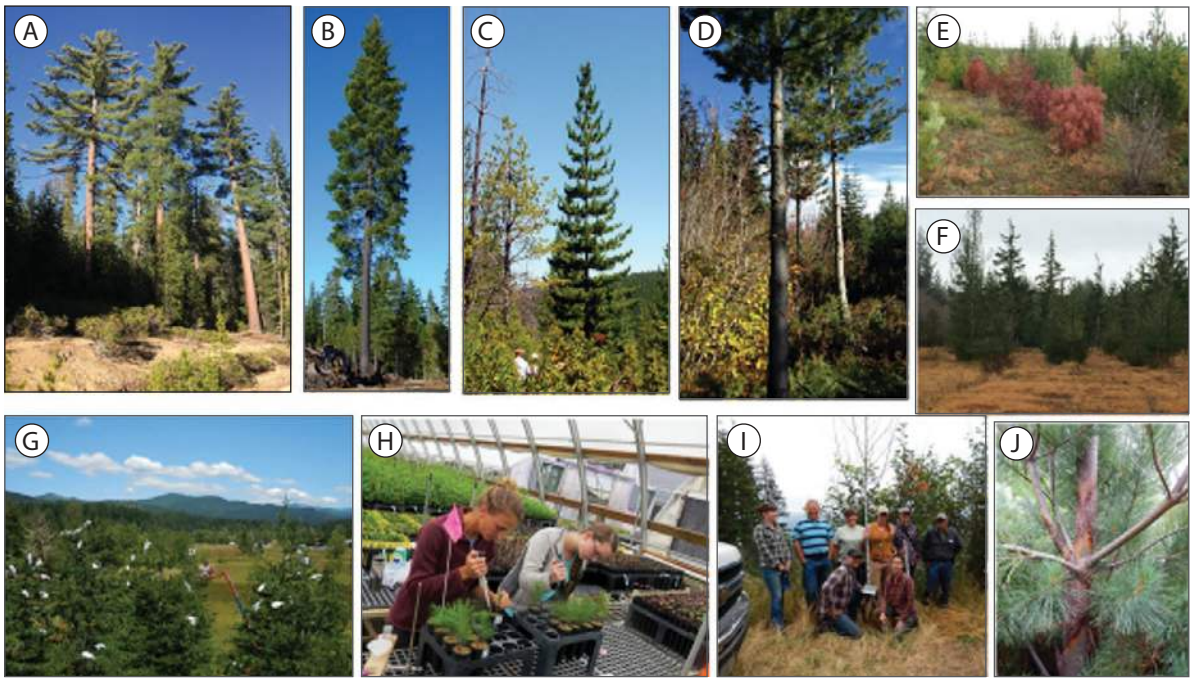

FIGURE 2 *(A, B) Healthy sugar pines; (C) healthy western white pine in area with very high incidence of white pine blister rust, Grass Creek trial in Cottage Grove Ranger District, Umpqua National Forest; (D) pruning of western white pine in a Confederated Tribes of Warm Springs Reservation planting; (E) effect of a virulent race of white pine blister rust on western white pine with major gene resistance (dead) in an Oregon field trial on Bureau of Land Management land: note healthy western white pine with quantitative resistance (see RV7 in Sniezko et al. [2019] for details); (F) Quinault Indian Nation's western white pine seed orchard provides seed for annual planting needs; (G) controlled pollination on western white pine in clone bank at Dorena Genetic Resource Center; (H) MPG Ranch and Dorena Genetic Resource Center personnel setting up a western white pine–fungal endophyte treatment prior to inoculation with white pine blister rust; (I) Washington Department of Natural Resources and U.S. Forest Service (Forest Health Program and Dorena Genetic Resource Center) employees at a western white pine field trial on Washington Department of Natural Resources land; (J) western white pine with numerous white pine blister rust cankers at a field trial on Washington Department of Natural Resources land (photo credits: Brent Oblinger [A, D], Bob Danchok [B], Richard Sniezko [C, E, I, J], Jim Hargrove [F], Emily Boes [G], Lorinda Bullington [H]).*

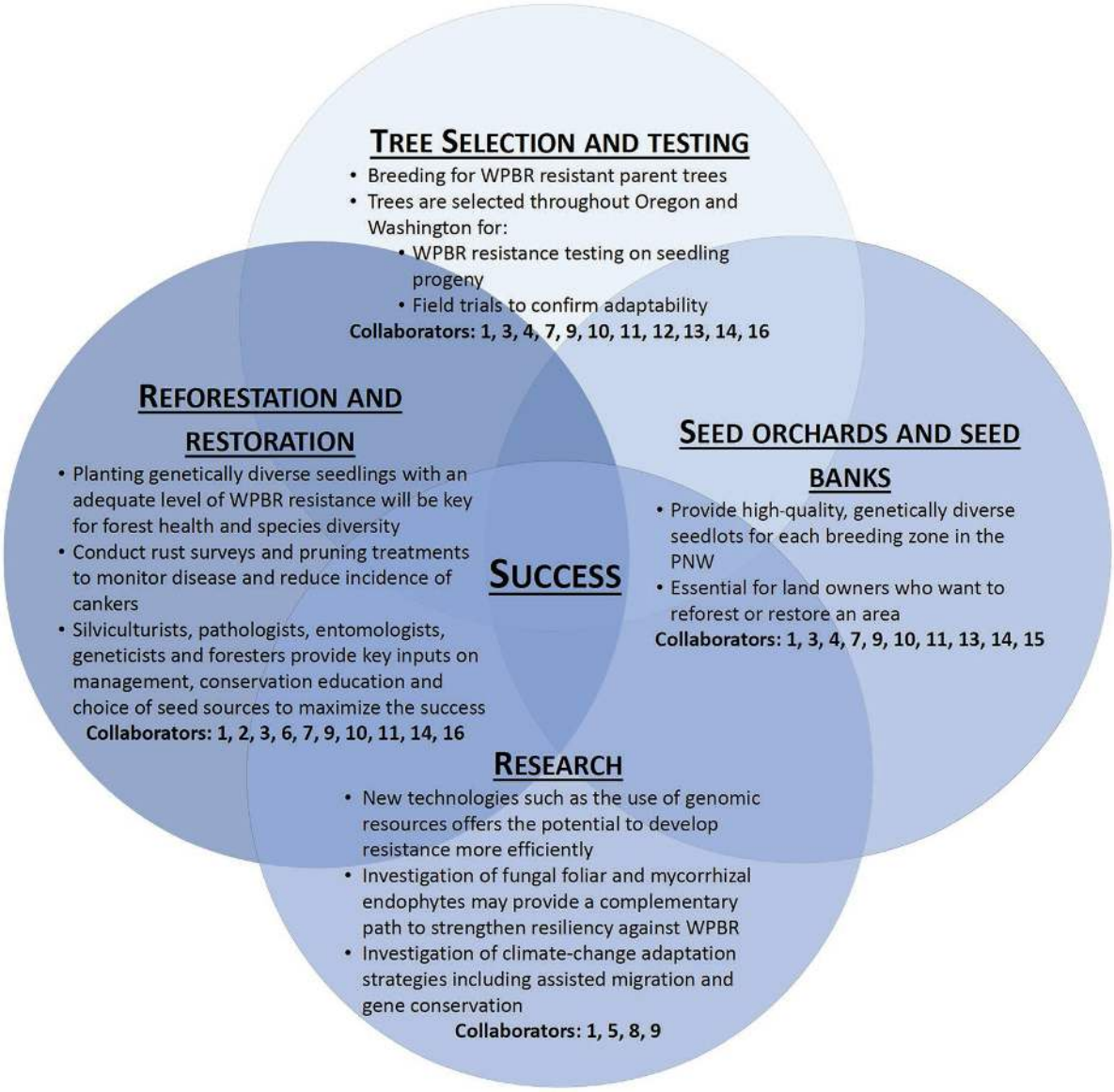

FIGURE 3 *Past and present collaborative activities underway to help retain the use of western white pine and sugar pine for reforestation and restoration in the presence of white pine blister rust. See Figure 1 for collaborator numbers (WPBR: white pine blister rust; PNW: Pacific Northwest).*

the species' ranges (Figures 1 and 2) (Omdal et al. 2015; Sniezko et al. 2019), and two new trials are slated for establishment in 2020 on private industry lands in Oregon. The Dorena Genetic Resource Center continues breeding for increased resistance in these species, which offers even more promise for the future (Sniezko et al. 2014). The development of genomic resources for these species (Liu et al. 2014, 2019; Stevens et al. 2016) has the potential to help increase breeding efficiencies in the future.

The USFS Forest Health Protection specialists and their counterparts from the Washington Department of Natural Resources and Oregon Department of Forestry provide managers with information on best site choices, rust pressure, and considerations for pruning treatments (Singleton and Oblinger 2017). In

collaboration with forest health specialists and others, each organization's silviculturists will direct the management of sugar pine and western white pine on their lands.

The interest in sugar pine and western white pine has brought together a wide array of federal, state, provincial, tribal, county, and private organizations throughout the Pacific Northwest. They all work together to increase white pine blister rust resistance and provide a variety of improvements to forest health through management activities. Seed from thousands of candidate tree selections has been screened for white pine blister rust resistance at the Dorena Genetic Resource Center. The parents rated as resistant, or selections from their progeny, have been grafted into seed orchards or clone banks, and advanced-generation breeding to increase resistance continues. These concerted efforts to conserve sugar pine and western white pine from seed to tree to orchard will help maintain healthy, diverse forests in the Pacific Northwest.

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