The Proactive Strategy: Preparing the Landscape for Invasion by Accelerating the Evolution of Resistance

A.W. Schoettle[1, *], K.S. Burns[2], and R.A. Sniezko[3]

[1] USDA Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA

[2] USDA Forest Service, Forest Health Protection, Golden, Colorado, USA

[3] USDA Forest Service, Dorena Genetic Resource Center, Cottage Grove, Oregon, USA

[*] aschoettle@fs.fed.us

Restoration of forests devastated by nonnative invaders often dominates the attention of forest managers and their actions. However, taking a broader view of the invasion beyond the crisis areas reveals opportunities where proactive management can alter the outcome of the invasion in threatened areas. Proactive management moves past the idea of protecting the hosts from exposure to the established nonnative invader and shifts toward facilitating naturalization by preparing the landscape to sustain critical ecosystem function into the future in the presence of the invader (Schoettle and Sniezko 2007).

Increasing the frequencies of durable resistance or tolerance traits within tree populations is accepted as a promising avenue for the coexistence of native tree species and nonnative pathogens (King et al. 2010). Therefore the objective of proactive intervention is to position the ecosystem to facilitate the evolution of pathogen resistance in the tree populations upon invasion. Diversifying the age class structure by stimulating regeneration in the healthy forest will provide a larger population size for resistance selection upon invasion and simultaneous selection in both the younger and older cohorts (Schoettle and Sniezko 2007). Accelerating the generation time and natural selection process through silvicultural treatments will reduce the ecological consequences of mortality in any one cohort and increases the potential for development of durable resistance within the population while maintaining broad genetic diversity. Planting seedlings or seed from seed trees that have heritable resistance before pathogen invasion will provide additional time for these individuals to mature and contribute to gene flow before the overstory is heavily affected upon invasion. Screening for resistance and planting early, rather than after the stand is heavily infested, reduces the window of time when forest regeneration may be limited by seed availability.

Early attention to threatened but not yet infected species or stands also provides opportunity for gene conservation. Seed, pollen, or tissue collections can be made from the full genetic diversity of the population before the potential bottleneck caused by high pathogen-induced mortality. In the case of *Pinus aristata*, rangewide seed and tissue samples have now been archived before population impacts by *Cronartium ribicola*, and working collections are available for research collaborations.

The Proactive Strategy has been adopted for *P. flexilis*, *P. aristata*, *P. longevea*, and *P. strobiformis* in the southern Rocky Mountains, the Southwest, and portions of the Great Basin (which covers parts of six western States) for the white pine blister rust pathosystem (Goodrich et al., *Pinus strobiformis Gene Conservation and Genecology*, this

In: Schoettle, Anna W.; Sniezko, Richard A.; Kliejunas, John T., eds. 2018. Proceedings of the IUFRO joint conference: Genetics of five-needle pines, rusts of forest trees, and Strobusphere; 2014 June 15–20; Fort Collins, CO. Proc. RMRS-P-76. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 245 p.

Papers published in these proceedings were submitted by authors in electronic media. Editing was done for readability and to ensure consistent format and style. Authors are responsible for content and accuracy of their individual papers and the quality of illustrative materials. Opinions expressed may not necessarily reflect the position of the U.S. Department of Agriculture.

proceedings; Schoettle et al. 2011, 2013) and for healthy *Chamaecyparis lawsoniana* in stands at risk for impacts from *Phytophthora lateralis*. It has been incorporated into the National Strategic Framework for Invasive Species Management (2013) (http://www.fs.fed.us/foresthealth/publications/Framework_for_Invasive_Species_FS-1017.pdf).

REFERENCES

King, J.N.; David, A.; Noshad, D.; [et al.]. 2010. A review of genetic approaches to the management of blister rust in white pines. Forest Pathology. 40: 292–313.

Schoettle, A.W.; Connor, J.; Mack, J.; [et al.]. 2013. Establishing the science foundation to sustain high-elevation five-needle pine forests threatened by novel interacting stresses in four western National Parks. The George Wright Forum. 30: 302–312. http://www.georgewright.org/303schoettle.pdf.

Schoettle, A.W.; Goodrich, B.A.; Klutsch, J.G.; [et al.]. 2011. The proactive strategy for sustaining five-needle pine populations: An example of its implementation in the southern Rocky Mountains. In: Keane, R.E.; Tomback, D.F.; Murray, M.P.; [et al.], 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: 323–334.

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.