Population Projections and Resistance Gene Frequencies in the Presence of White Pine Blister Rust: A Population Genetic Model for High Elevation Five-Needle Pines

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The slow growth and long generation time of the five-needle pines have historically enabled these trees to persist on the landscape for centuries, but without sufficient regeneration opportunities these same traits hinder the species' ability to adapt to novel stresses such as the exotic disease white pine blister rust (WPBR). Increasing the frequency of resistance to WPBR is the foundation for options to sustain five-needle pine species in the presence of the pathogen *Cronartium ribicola*. The objective of management intervention in the high elevation ecosystems is to promote pine population resilience for many generations (Schoettle and Sniezko 2007; Schoettle et al. 2012). However, greater understanding of the regeneration cycle and the potential for increasing the frequency of resistance are needed. This is especially critical for the WPBR pathosystem as WPBR kills trees of all ages and therefore affects multiple stages of the regeneration cycle.

We developed a population genetic model, parameterized for high elevation five-needle pines, to improve our understanding of pine population dynamics in the presence of WPBR and identify key processes that affect resistance gene frequencies over time (Field et al. 2012). This model allows us to address questions such as: (1) What frequency of resistance to WPBR is enough to sustain a population under different initial conditions? (2) What regeneration densities are sufficient to promote increased frequency of resistance over time? (3) What is the effect of competition on population sustainability and frequency of resistance over time? (4) During what state of infestation and impact by WPBR is intervention most effective? The matrix model includes six age classes (cohorts): seeds, primary seedlings (1–4 yrs old), secondary seedlings (5–20 yrs), saplings (21–40 yrs), young adults (41–90 yrs), and mature adults (>90 yrs). The model includes nonlinear functions for the effects of competition (leaf area index) on germination and cone production. Population size, incidence of infection by WPBR, and frequency of a simply inherited dominant WPBR resistance gene by age class over time are all included in the model output. This presentation will demonstrate that regeneration is a stabilizing factor in populations and that how and when it is managed, in coordination with gene frequencies for resistance, will play an important role in the establishment of a new equilibrium for a host population and its ecosystems in the presence of a nonnative pest.

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