WPEF student research grant awarded for 2019

A call for proposals for the annual WPEF student research grant was released in the Winter issue of Nutcracker Notes, on the website and through social media. The proposals were reviewed by the Evaluations Committee, composed of former board members Bryan Donner, Edie Dooley, Cyndi Smith, and Nutcracker Notes *editor and interim associate director Bob Keane.* ***IAIN REID****, an MSc student in the Faculty of Forestry at University of British Columbia, was chosen as the grant recipient for 2019. His supervisor is Dr. Sally Aitken. Following is a description of Iain's project:*

Whitebark pine (*Pinus albicaulis*) recovery: use of assisted migration and rust resistance in long-term restoration efforts

Whitebark pine (WBP) is faced with multiple threats, including climate change and white pine blister rust (WPBR). There is a great need for more rust resistant seedlings for restoration planting. Additionally, assisted migration is a potential option to mitigate loss of WBP habitat and genetic diversity, but its potential to be successful and for the species to survive outside of its range is relatively understudied. This proposal will utilize two established experiments to address two sub-projects aimed at guiding restoration and advancing knowledge of how WBP responds to climate and the WPBR pathogen.

Part 1: Rust resistance

WPBR represents the most widespread and direct threat to WBP (COSEWIC 2010). Mechanisms of resistance in WBP are variable, and further study is needed to determine the frequency and types of resistance. Complete resistance has been discovered in western white pine and other pines where a hypersensitive response (HR) occurs in the needles (Kinloch et al. 2003). Partial resistance refers to all non-HR kinds of resistance and tolerance (needle spots, needle shed, stem symptoms, latency of stem infection, bark reaction, survival with stem infection) (Sniezko et al. 2014). No complete resistance (HR) has been detected in WBP, but partial resistance has. Screening of seed stock for rust resistance is already occurring at the Dorena Genetic Resource Centre, Coeur D'Alene Nursery, and Kalamalka Forestry Centre, where field-collected seed is germinated, seedlings are inoculated with rust spores, and identification of more rust resistant parent trees is occurring. Results from rust resistance trials can serve to identify parent trees from which to collect seed for restoration planting.

In a trial established by Charlie Cartwright, Nicholas Ukrainetz, and Michael Murray (BC Ministry of Forests, Lands, Natural Resource Operations, and Rural Development), WBP seedlings have been planted at Skimikin nursery near Salmon Arm, BC from approximately 500 families and 46 populations across the species' range. These families have been split into two series of approximately 250 families each. A *Ribes* garden beside the crop has caused blister rust infection of many of the seedlings through natural inoculation. Because the seedlings of the first series are close to five years old, they are ready for phenotyping for blister rust. Objectives for this part of the study are to i) contribute to early-stage phenotyping efforts to identify more blister rust resistant or tolerant WBP progeny and locations of their parent trees; ii) examine if proximity to *Ribes* plants affects likelihood of infection by WPBR in a nursery setting; and iii) determine the relationships between environmental variables for provenance location and blister rust symptoms.

To better understand spatial variability in infection rate, I will assess how this natural inoculation has progressed across the seedlings and the prevalence of rust resistant seedlings from a variety of populations. Eighty-one WBP families previously screened by Richard Sniezko at Dorena are included in the first series of families at Skimikin, so the durability of resistance of these families can be assessed. At Skimikin, I will collect data on the percentage of seedlings with stem symptoms, number of stem symptoms per infected tree, percentage of infected seedlings surviving (stem infections or needle spots), percentage of seedlings surviving with only stem infections, and height of infected versus not infected seedlings. Using these data, I hope to identify families showing higher rust resistance, quantify genetic variation in heritable traits among parent trees, and determine how blister rust affects these traits. Although screening trials have been done before, most have used artificial rather than natural inoculation to infect WBP seedlings. Natural inoculation requires fewer resources and is less expensive, but also is less controlled. Additionally, environmental variables contributing to higher rust incidence have been studied, but it is worthwhile having a further study to compare results to. Climate data of parent tree locations will be used in analysis of rust data as well using ClimateNA software and 1981-2010 climate normals (Wang et al. 2016). The benefit of this particular study is that seedlings from the Skimikin families have also been established at field sites in suitable WBP habitat to assess the long-term durability of rust resistance and of seedling response to climate change.

Part 2: Climate adaptation

The second part of this project focuses on the potential for WBP to survive north of its current range. Studies utilizing species distribution models (SDMs) suggest that climatically suitable habitat for WBP is predicted to change substantially in the future, with suitable habitat lost in the southern part of the species' range and new potential habitat created in the north and west of BC (Hamann and Wang 2006, McLane and Aitken 2012). However, a migration lag exists due to the species' slow regeneration time and dispersal by Clark's nutcrackers, so WBP has not naturally migrated fast enough to fill its climatic niche prior to climate change, or occupy newly suitable regions.

Work proposed here builds on a study established by McLane and Aitken (2012) who tested the potential of WBP to establish in the current and future (2055) climatically predicted range. In their experiment, seed from seven populations was planted in eight locations spanning 600km southeast to 800km northwest of the northern edge of the species' range. Half of the seeds planted went through a treatment process of stratification and seed coat clipping to facilitate faster germination (n=6992) while the other half were left untreated (n=8960). Seeds were planted in 2007 and 2008. Seedlings from McLane and Aitken's 2012 study were reassessed in 2017, resulting in the potential for analysis of longer-term data on growth and survival, and for assisted migration of WBP to be further assessed as a restoration strategy for the species. The objectives of this present study are to i) examine the potential of assisted migration as a recovery method for WBP by re-assessing field common garden tests started in 2007/2008; ii) determine if seed stratification (treatment) improves WBP survival and growth in the long term when direct seeding is used for restoration; iii) determine variables contributing to variation in survival and growth among provenances.

To complete this research, I propose to analyze this newly collected data for the effects of outplant location, provenance location, seed mass, climate variables such as snowmelt timing and mean annual temperature, as well as seed treatment on growth and survival. Additionally, the effects of microsite conditions such as groundcover vegetation, slope, and soil depth on growth and survival will be tested. This trial is also a good test of the SDM for WBP, especially since SDMs have been updated since the previous (2012) analysis. Since growth data on the planted seeds were relatively limited in the last assessment due to the young age of the seedlings, I propose to put more emphasis on relationships between variables listed above and growth.

References

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