WPEF student research grant awarded for 2021

The proposals were reviewed by the Evaluations Committee, composed of former board members Bryan Donner, Cyndi Smith, and Kathy Tonnessen, and Nutcracker Notes *editor and interim associate director Bob Keane.* ***CHLOE WASTENEYS****, a MS student with Dr. Danielle Ulrich of the Faculty of Biological Sciences at Montana State University, was chosen as the grant recipient for 2021.*

Physiological traits and stress resistances of whitebark pine

Background, objectives, and justifications

High rates of mortality in whitebark pine (*Pinus albicaulis;* WBP) populations have been documented over the past few decades (Ellison *et al.* 2005, Goeking and Izlar 2018), attributed to white pine blister rust (*Cronartium ribicola*) infection, mountain pine beetle (*Dendroctonus ponderosae*) infestation, and interspecific competition due to decades of wildfire suppression (Kendall and Keane 2001, Hansen *et al.* 2016). All three of these agents are exacerbated by climate change. Ongoing restoration efforts (planting of seeds and seedlings) occur in suitable climatic locations based on WBP's current realized niche. Information used to guide planting practices is founded on WBP's distributional range as generated from species distribution models. However, these models may lack accurate data input on the species' true physiological traits and environmental stress tolerances (temperature, precipitation). Hansen *et. al.* (2016) proposed that WBP's fundamental niche is larger than perceived. Additionally, Clason *et. al.* (2020) found that suitable climatic habitat for WBP exists beyond its current northern limit based on their cold tolerance study. While multiple investigations have been conducted on WBP's cold tolerance capacities (Mahalovich *et al.* 2006, Bower and Aitken 2011), information regarding its upper temperature and general precipitation constraints are lacking.

Study Plan

Seedlings are highly susceptible to both abiotic and biotic stressors (Kolb and Robberecht 1996, Marias *et al.* 2016). As such, this is the ideal life stage to evaluate the effects of temperature and precipitation. I am quantifying WBP's photosynthetic capacity, photosynthetic limitations, and tolerance to drought, heat, and light. I will be comparing my results intra-specifically based on contrasting climates of origin and seedling age (2, 3, and 5 years old) to determine if these physiological traits and stress tolerances differ based on climate and ontogeny. Climate of origin may determine a plant's response to various environmental stressors (Marias *et al.* 2016); therefore, I am comparing results across contrasting climates to determine if there is phenotypic plasticity or ecotypic variation present in study seedlings. Either of these adaptations would suggest the ability of WBP seedlings to adjust to and survive changes in temperature and precipitation of various climates (Marias *et al.* 2016). Having an accurate understanding of a species-habitat relationship for WBP is essential for future restoration and conservation planning and will require physiological studies of temperature and precipitation limits of this species (Hansen *et al.* 2016, Clason *et al.* 2020).

Methods

WBP seedlings from different climate zones across 10 sites in Idaho and Montana were donated by the Coeur d'Alene Forest Service nursery to the Ulrich Lab's greenhouse within the Plant Growth Center at Montana State University. I am conducting my measurements on five seedlings each from 13 families ("families" referring to seedlings from the same climate of origin). At this point in my research project, I have measured WBP's photosynthetic capacity, photosynthetic limitations, and light tolerance in the greenhouse with our portable photosynthesis system from LICOR Biosciences. These measurements will be used to construct carbon assimilation curves and light tolerance curves (Sharkey 1985, Ögren and Evans 1993, Manter and Kerrigan 2004). I have measured drought tolerance of my seedlings by creating pressure-volume curves using a pressure chamber from PMS Instrument Company (Tyree and Hammel 1972, Bartlett *et al.* 2012). Currently, I am constructing needle thermotolerance curves by measuring chlorophyll fluorescence and electrolyte leakage with hot water baths and a conductivity meter to determine heat tolerance parameters (Cunningham and Read 2006, Marias *et al.* 2016). These curves will provide specific parameters for informing environmental traits and tolerances and will be compared across families.

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