WPEF student research grant awarded for 2016

*A call for proposals for the annual WPEF student research grant was released in the Spring/Summer issue of Nutcracker Notes. The proposals were reviewed by board members Edie Dooley, Bryan Donner and Cyndi Smith. **MAEGEN ROCHNER**, a doctoral candidate in Geography (with a specialty in dendrochronology, climate and environmental change) at University of Tennessee Knoxville, was chosen as the grant recipient for 2016. Following is a description of her project (references and additional detail may be obtained from Maegen at <mneal20@vols.utk.edu>):*

Past, present, and future climate change and forest dynamics in a high-elevation whitebark pine ecosystem in Wyoming

Introduction

I propose to use tree-ring science to examine the impact of Holocene climate change on a high-elevation whitebark pine (WBP) ecosystem in the Beartooth Mountains of Wyoming. Climate warming and the resulting upward movement of tree line in some locations has exacerbated other threats to WBP in the Greater Yellowstone Ecosystem (GYE), such as the mountain pine beetle (MPB). Historically, the threat of the MPB to high-elevation WBP forests was limited by the harsh conditions found near tree line, but warming temperatures have allowed for unprecedented infestations at previously protected sites. The combination of warming temperatures in the western United States, infestation, and other factors is projected to lead to the elimination of WBP in the GYE. The loss of this important keystone species could lead to dramatic environmental changes in not only the GYE but across the range of the species. Further understanding of WBP forest dynamics is essential for future management practices and conservation efforts, especially in light of ongoing climate change, because of the importance of this species as a wildlife food source and as a facilitator in the development of tree communities in harsh, high-elevation conditions. The best way to better understand how WBP forests will adapt to a warming climate is to study how they have responded in the past. The goal of this study is to investigate changing forest dynamics at a high-elevation site during two major Holocene climate fluctuations, the Medieval Warm Period (MWP, about AD 800 to 1500) and the Little Ice Age (LIA, about AD 1500 to 1850).

Study Area

I will sample both living and remnant WBP at Fantan Lake (FTL) in the Beartooth Mountains. The site is characterized by high-elevation (2800 to 3020 m) meadows and small islands of what look to be fairly young (< 300 years old) WBP. Associated tree species include Engelmann spruce and subalpine fir, but WBP continues to dominate. The remains of extremely large WBP (approximately 500 to over 1,000 years old based on cross-sections taken from a few trees during a preliminary collection in summer 2015) are found throughout the area. No living equivalent to these massive trees exists at the site today, which suggests that an open forest of much older and much larger WBP once thrived at the site, but were killed by some extensive mortality event.

Hypotheses

I hypothesize that these WBP logs represent an open forest that thrived during the MWP but was killed during the coldest period of the LIA. Such aberrant warmth would explain why the unusually large remnant trees at FTL survived at high-elevation. Eventually, however, the onset of the LIA decreased growth rates in the already-mature WBP until gradual thermal degradation and the persistence of snowpack through summer months (formation of a permanent snow field) eventually killed them. I will use methods in tree-ring science (dendrochronology) to test four hypotheses. If these hypotheses hold true, and WBP thrived during the MWP, high-elevation WBP may be more robust to increasing temperatures than current thinking suggests. Evidence from pollen and charcoal data has indicated that WBP can be resilient to warm temperatures and dry conditions, and that limiting factors might instead be disturbance (from fire or insect infestation) or competition. If this is the case, perhaps WBP will persist, given successful management of other threats, despite global warming.

Methods

I will sample 100 of the dead WBP remnants using a chain saw to extract complete cross sections of the tree trunks, and up to 200 living WBP trees in the same area using a non-destructive Haglof increment borer. Once samples have been returned to the lab, I will measure ring widths for the remnant pieces and date the floating chronology developed from these measurements against a local WBP reference chronology using statistical crossdating techniques. Absolute dating of the remnant pieces will provide the innermost and outermost ring dates for each tree and will allow for analysis of growth rates in relation to specific years. I will measure cores from living trees starting at the outermost year (sampling year) and will determine establishment dates using standardized pith estimators when curvature of rings is identified. I will map these establishment dates as a stem plot using ArcGIS software to identify any patterns associated with elevation or aspect. I will use ArcGIS to identify any clustering of living trees of similar ages and will plot establishment dates to identify any pulses in establishment. I will build a living WBP chronology for FTL and use it to determine climate-growth relationships, testing for correlations between ring width and climate variables, such as monthly mean temperature (MNTM) and total monthly precipitation (TPCP), obtained from the National Centers for Environmental Information (NCEI) NOAA climate divisional data. I will choose a climate variable to be reconstructed based on the analysis of climate-growth relationships in living WBP trees, and will then use the split-sample approach to reconstruct climate on a multi-century scale. Field collection will take place in 2016, with preliminary results available by summer 2017, and final dissertation in 2018.

Expected Outcomes

Results from this study will provide new knowledge on the response of high-elevation WBP to anomalously warm and cool temperatures and will provide data for climate reconstructions that will track in more detail how Holocene climate change affected the central Rocky Mountains and GYE.

Acknowledgements

I would like to thank my supervisor, Dr. Henri Grissino-Mayer, for funding much of this research through his Faculty Development Award. I would also like to thank the staff of the Custer/Gallatin and Shoshone national forests for their collaboration. And, I would like to extend my deepest appreciation to the Whitebark Pine Ecosystem Foundation for their support of this valuable research effort.