WPEF student research grant awarded for 2015

A call for proposals for the second 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. ***COLIN MAHER****, a doctoral candidate in Forestry at the University of Montana, was chosen as the grant recipient for 2015. Following is a short description of his project:*

Does whitebark pine have a refuge from mountain pine beetle at treeline?

Introduction

Recent climate-change-induced outbreaks of mountain pine beetle (*Dendroctonus ponderosae*; MPB) have caused drastic population declines in high-elevation whitebark pine over much of the species' range (Macfarlane et al. 2013). MPB population dynamics are directly linked to winter temperature regimes; recent mild winters at high elevations allow rapid beetle spread into novel territory (Logan and Powell 2001).

Treeline habitats in whitebark pine may be a refuge from MPB outbreak. In their analyses of MPB-caused whitebark mortality in the Greater Yellowstone Ecosystem, Logan et al. (2010) and Macfarlane et al. (2013) argued that the krummholz form is immune to MPB attack. Macfarlane et al. (2013) state that "long-term survival of the species likely resides in the [krummholz] growth form found throughout the ecosystem near treeline…" No data exist to evaluate these claims. However, a mortality gradient at treeline is visible on the landscape in some locations (Fig. 1).

Figure 1. Surviving whitebark individuals at treeline with extensive mortality (grey trees) in the subalpine forest below. Tobacco Root Mountains, Montana, USA.

Identification of refuge habitats is important to understanding the outcomes of predator-prey interactions and disturbance events. Refuges from predators maintain prey populations and buffer top-down control (Costamagna and Landis 2011) and refuges from herbivores appear to play a role in maintaining plant species diversity (Chollet et al. 2013).

Hypothesis and Methods

The observation of surviving whitebark at treeline motivated the hypothesis that stunted treeline growth forms escape because their stems are too small to attract beetles,

and that treeline populations may therefore enable long-term survival of whitebark pine. I am testing this hypothesis in three ways.

First, I am examining beetle-caused mortality gradients at upper treeline throughout the U.S. northern Rocky Mountains. I randomly selected whitebark pine treeline sites and surveyed beetle-caused mortality along 500-m elevational transects, capturing growth-form gradients from alpine treeline into subalpine forests.

Second, I am testing if beetle-caused mortality gradients in whitebark forests are unique to alpine treeline edges. Besides small stem sizes, temperature limitations on beetle physiology and edge effects on beetle spread are possible causal factors in alpine treeline mortality gradients. The simplest explanations to exclude are edge effects: I surveyed mortality along transects perpendicular to other (non-alpine) whitebark pine edges independent of elevation, including edges formed by meadows, lakes, talus slopes, etc. I will expand my sample by surveying 50 additional randomly selected transects of both edge types using aerial photography. If mortality gradients are stronger at alpine treeline edges than at other edges, generalized edge effects (Cadenasso et al. 2003) are not causing mortality gradients; indicating the causal factors are unique to alpine treeline.

Third, I will estimate fecundity of surviving whitebark pine across the treeline ecotone into beetle-affected subalpine forests. I will collect cones from whitebark pines in 50-m x 50-m sections along 500-m elevational transects at three sites. I will then extract seeds and determine viability using x-ray imagery. Fecundity will be estimated by multiplying the ratio of total viable seed in a transect section to total viable seed in the entire transect by the number of recruits in the entire transect, then dividing by the number of whitebark pine in the transect section (Maloney et al. 2012). I will infer that whitebark pine are currently viable within each transect section if fecundity exceeds mortality proportion in that section.

Preliminary Results

In the seven of ten field transects I have sampled so far, I consistently found that whitebark above the treeline evade beetles (Fig. 2). So far, I found no consistent mortality pattern at other forest edges (Fig. 2). This result indicates that generalized edge effects are not causing the mortality gradients at treeline. This pattern is apparently unique to alpine treeline edges, and could be caused by stem size or temperature limitations. During the summer and fall of 2016, I will complete field mortality transect sampling and collect cones for fecundity analyses.

This examination of treeline habitats as refuges is a novel aspect of subalpine forest and tree population ecology, and will provide new information that directly informs climate change adaptation efforts in whitebark pine forest.

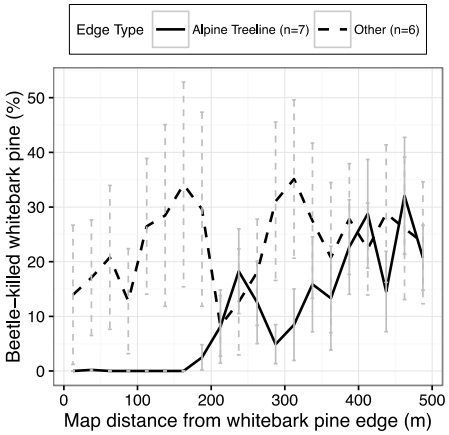

Figure 2. Mean % mountain pine beetle-killed whitebark pine along mortality transects in Montana, Wyoming, and Idaho. Vertical bars represent ± 1 s.e. So far, I found beetle evasion near all alpine treeline edges (7/10 transects complete), but not at other forest edges (e.g., cliffs, meadows, lakes, etc.; 6/10 transects complete). By investigating relative fecundity of remnant treeline populations, I will determine the viability of treeline habitats as refuges for whitebark pine.

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