Effects of Elevation and Aspect on Seasonal Drought Response in Bigcone Douglas-fir

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Background

Bigcone Douglas-fir (*Pseudotsuga macrocarpa*) is a little-studied species of conifer endemic to southern California's Transverse Range. Wildfires coupled with record droughts that have swept the region in recent years have resulted in high mortality in nearly 40% of surveyed stands (Salladay et. al., 2017), and replanting efforts by the Forest Service have been largely unsuccessful due to high seedling mortality rates. This loss is mainly due to drought. Understanding how the drought physiology of *P. macrocarpa* varies based on tree placement is crucial to the success of future replanting efforts, so I designed an experiment to study how two important factors affect the drought response of *Psuedotsuga macrocarpa*.

Bigcone burned in the 2017 Thomas Fire

***How do elevation and aspect affect the seasonal drought response of* Pseudotsuga macrocarpa?**

Methods

The drought response of four sites of *P. macrocarpa* (six individuals per site) in Los Padres National Forest was monitored three times over the course of the summer: once in mid-May, once in mid-June, and once in late July/ early August. In order to best understand the relationship between elevation, aspect, and seasonal drought response, two sites were chosen on north and south slopes at a relatively low elevation (approx. 3800 ft.), while the other two sites were chosen on north and south-facing slopes at a higher elevation (approx. 6000 ft.). The variables I assessed in the experiment were:

Field water potential measurement

- Predawn and midday water potential (Ψ_p)
- Xylem hydraulic conductivity
- Leaf fluorescence
- Stomatal conductivity
- Analysis of turgor loss point (TLP) via pressure-volume (PV) curves

Means were compared using multiple pairwise components followed by a Bonferoni adjustment.

Results

The low south-facing site demonstrates significantly lower ($p < 0.05$) end-of-summer predawn water potentials (*Fig. 1*) as well as significantly lower F_v/F_m fluorescence values (*Fig. 2*), both of which indicate greater water stress in the low south-facing site compared with both the high elevation sites and the low north-facing site.

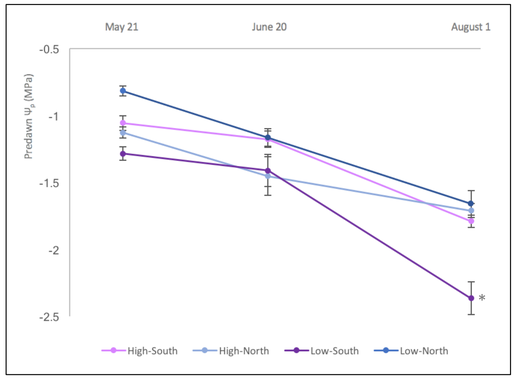


Figure 1. Predawn water potentials over the course of the summer dry season. More negative values indicate a greater drought stress that exists even before daily photosynthesis has dried out leaves. Asterisk marks significantly different value in late-season predawn. Error bars represent one standard error from the mean.

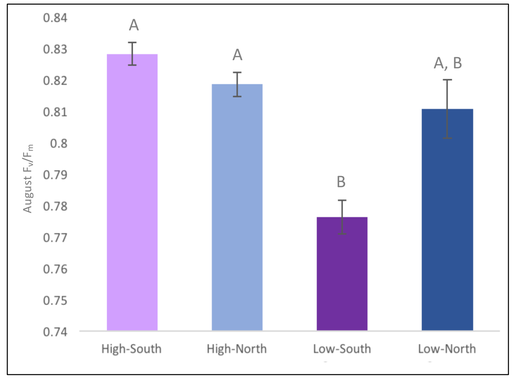


Figure 2. Leaf fluorescence F_v/F_m values for August. Lower F_v/F_m values indicate greater drought stress. Groups with significantly different F_v/F_m values are marked with different letters. Error bars represent one standard error from the mean.

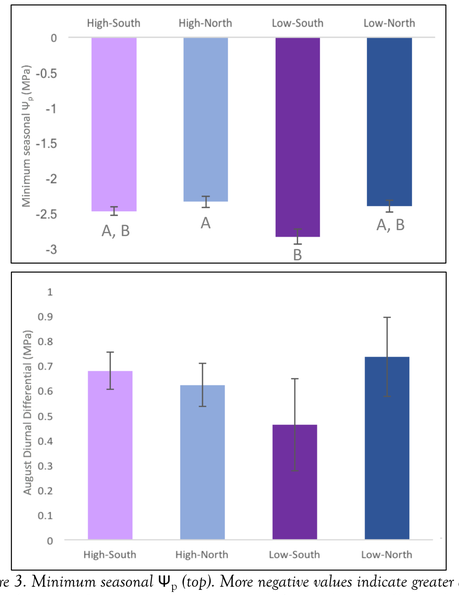


Figure 3. Minimum seasonal Ψ_p (top). More negative values indicate greater drought stress after the day's main photosynthetic period. August diurnal differentials (bottom) are the difference between midday and predawn Ψ_p; higher values indicate higher water loss due to photosynthesis. Groups with significantly different values are marked with different letters; no significant differences appear among diurnal differentials. Error bars represent one standard error from the mean.

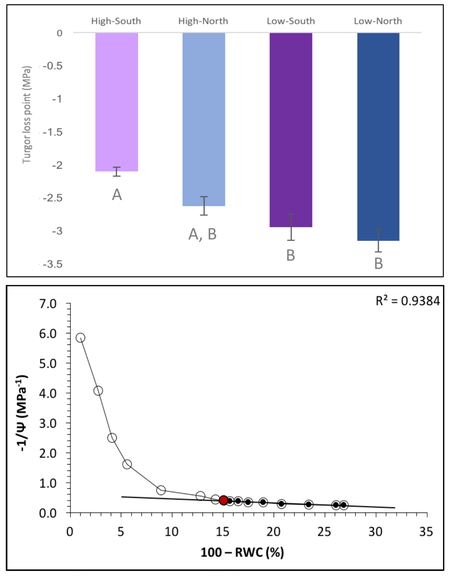
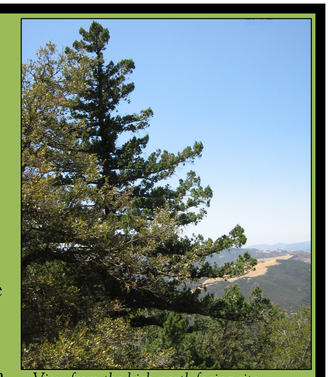


Figure 4. The turgor loss point (TLP) (top) is the first point on the linear portion of a pressure-volume curve (example on bottom, TLP in red). A more negative TLP indicates more drought-adapted plants. Groups with significantly different values are marked with different letters. Error bars represent one standard error from the mean.

Turgor loss points differ more by elevation than by aspect (*Fig. 4*). The minimum measured seasonal water potential (*Fig. 3*) shows significant differences between the high-north and low-south sites only. There are no significant correlations among the August diurnal differentials.

Conclusions



View from the high north-facing site

The data collected in this project strongly supports the existence of climate refugia for Bigcone Douglas-fir. A refugium is a location within a species' range that is relatively buffered from many of the effects of climate change (Morelli et al., 2016). Plants growing in refugia may be able to survive climactic changes that prove fatal to individuals growing in less sheltered locations. These refugia may allow the Bigcone Douglas-fir to survive the increasingly dry summers that will most likely be the result of climate change in southern California.

- High elevation sites had generally lower drought stress than the low south-facing site
  - ➢ This may be due to lower temperatures and higher rainfall at higher elevations
- The low north-facing site had drought responses more similar to the high elevation sites than it did to the low south-facing site
  - ➢ This suggests that sites similar to the low north-facing site may be valuable low-elevation refugia
  - ➢ These refugia may be good candidates for Forest Service replanting efforts

Acknowledgments

A special thanks to Dr. Aaron Ramirez and Dr. Mark De Guzman, and to the wonderful student members of the Summer 2018 Ramirez Lab: Madeline Schmidt, Edward Zhu, Piper Rodolf, Indra Boving, and Javin Demello-Folsom. Thanks also to the Reed College Biology Department and to the Arch & Fran Diack Student Field Research Award for funding this project.

Literature Cited

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