LANDSCAPE HETEROGENEITY MODULATES FOREST SENSITIVITY TO CLIMATE

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INTRODUCTION

At higher elevations in the Rocky Mountains, snowmelt strongly influences the magnitude and timing of net ecosystem productivity. Throughout the western U.S., increased spring temperatures, declining snowpack, and earlier snowmelt have been observed over multiple decades. These trends have been correlated with decreased water availability and coniferous forest productivity and concurrent increases in forest wildfire activity and tree mortality. However, previous work has provided little insight into how topographic complexity may modulate plant available water and therefore forest productivity. We hypothesize that landscape scale lateral water redistribution patterns influence the persistence of soil water during the growing season and subsequently tree biomass accumulation.

SITE DESCRIPTION

North Fork of Elk Creek - Lubrecht Experimental Forest

- Location – 25 miles NE of Missoula, MT
- 4 primary tree species
  - Pseudotsuga menziesii, Pinus ponderosa , Pinus contorta, Larix occidentalis
- Average Annual Precipitation 515mm
- Mean Elevation 1570m
- Snow dominated

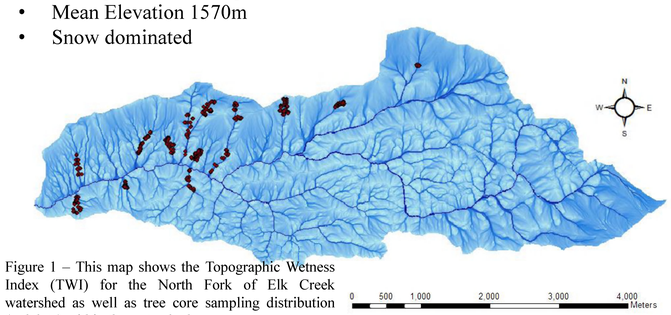


Figure 1 – This map shows the Topographic Wetness Index (TWI) for the North Fork of Elk Creek watershed as well as tree core sampling distribution (red dots) within the watershed

METHODOLOGY

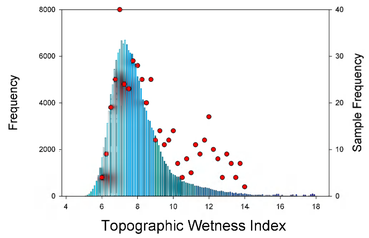


Figure 2 – This plot shows a histogram of the TWI frequency in the North Fork of Elk Creek and a point cloud (red dots) showing the sampling frequency of tree core TWI values.

- We collected 500 tree cores across a wide range of convergent and divergent topography
- We derived the topographic wetness index (TWI) from a 1m LiDAR derived DEM. The TWI represents moisture availability and the potential for lateral water redistribution.

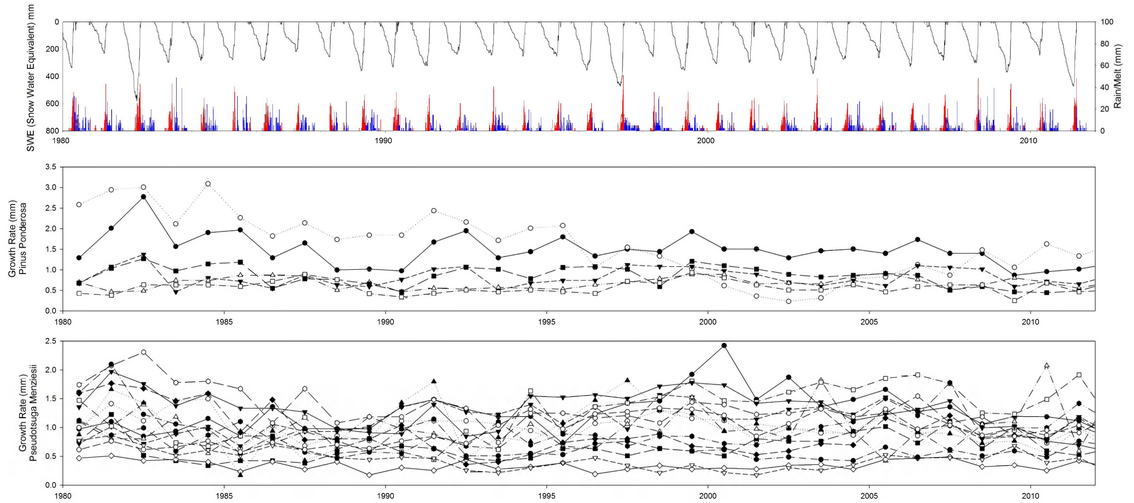


Figure 3 – 1. Precipitation data retrieved by a NRCS SNOWTEL site in Elk Creek (top) and 2. the annual growth rate for multiple stems from Pinus Ponderosa and Pseudotsuga Menziesii species (middle and bottom respectively.

Figure 4 – A representative tree core (Pseudotsuga Menziesii)

PRECIPITATION

These graphs display how precipitation and average annual growth for two species lack a clear relationship. This may change with an increase in data set size.

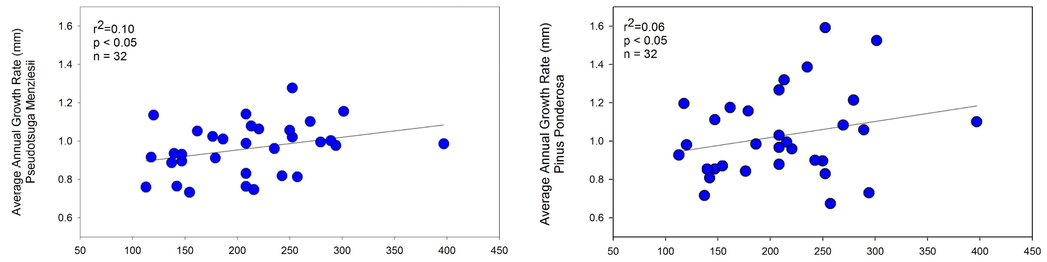


Figure 5 – These scatter plots display average annual growth for two species, plotted against annual precipitation.

TWI RELATIONSHIP

Initial comparisons of measured tree growth rates to the topographic wetness index suggest differential tree growth response as a function of landscape position. Generally, trees located in wetter landscape positions exhibited greater average growth rates.

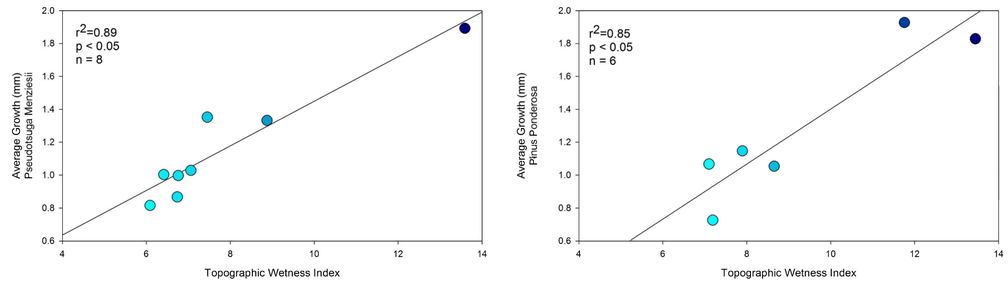


Figure 6 – These graphs show average growth rate plotted against the TWI value associated with each stem. (Left plot represents north aspect samples, right plot represents south aspect samples)

GROWTH/H_2O vs. TWI

Initial analysis of the slope produced by annual precipitation and annual growth, plotted against the stem's associated TWI value, show a differential growth rate related to TWI.

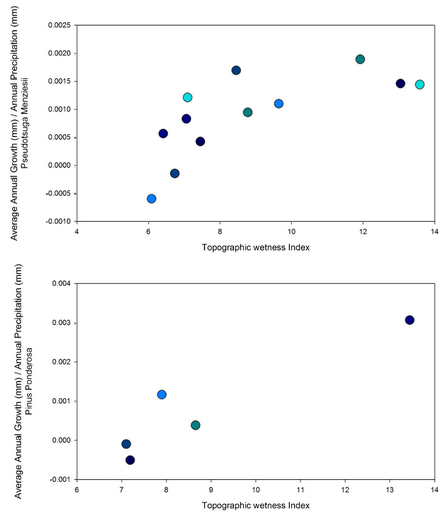


Figure 7 – These plots shows the relationship between TWI and the change in biomass per unit of precipitation for each tree.

WORK TO BE CONTINUED

Tree Cores

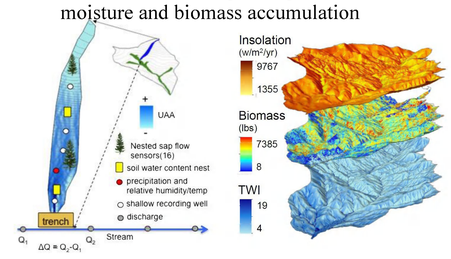
- Continued data analysis of tree cores

NDVI

- Explore TWI – NDVI relationship at the catchment scale.

Seasonal Response to Transpiration

- Data extraction from Sap-Flux sensors
- Examine relationship of Sap-Flux, soil moisture and biomass accumulation



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