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Tree Growth Sensitivity of 11 Native and Non-Native Conifer Species to Climate Variability Across a Water Deficit Gradient in Western Oregon

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Background

In the Pacific Northwest, climate change is expected to increase average temperatures, shift precipitation regimes, and contribute to more severe and widespread disturbances. The higher evapotranspiration demands and the decrease in growing season water availability can be detrimental to the growth and survival of tree species in the PNW. Understanding how sensitive commercially and ecologically valuable species are to water balance deficits in western Oregon can help to guide management decisions on species selection for reforestation purposes to enhance stand resistance and resilience to projected climate changes and disturbances.

Research Questions

- How do growth and wood properties vary between 11 native and non-native conifer species in western Oregon across a water deficit gradient?
- How sensitive is the growth of these 11 species to climate changes across the water deficit gradient in western Oregon?

Research Objectives

- Measure and compare the cumulative growth and inter-annual diameter growth rate of the 11 species across the water deficit gradient.
- Determine how each species growth responded to past seasonal climate variability and drought conditions through the analysis of wood properties.

Hypotheses

- I hypothesize that certain tree species have higher relative growth compared to other species under certain climate conditions due to species adaptation to their local climate.
- I hypothesize that the extent to which water availability limits tree growth is partially species-dependent, and that wood properties can reflect tree growth response to climate variability over a tree's lifespan.

Assumptions

It is assumed that the wood properties are correlated with climate and water availability.

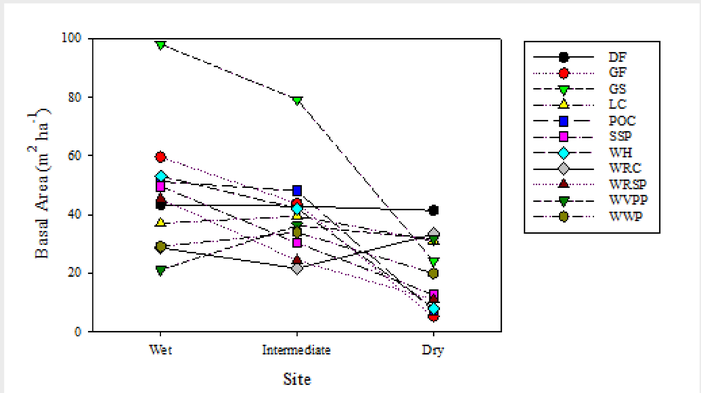

Figure 1. Basal area (m^2 ha^{-1}) of each species in the wet, intermediate, and dry site.

	Species
DF	Douglas-fir
POC	Port-Orford-Cedar
JL	Japanese Larch
WVPP	Willamette Valley Ponderosa Pine
GS	Giant Sequoia
WWP	Western White Pine (Blister Rust Resistant)
SSP	Sitka Spruce
WRC	Western Red-Cedar
WH	Western Hemlock
LC	Leland Cypress
GR	Grand Fir
WRSP	Sitka Spruce (Weevil Resistant)

Figure 2. List of species and their associated abbreviations.

Figure 3. Dendrometer band on a Willamette Valley ponderosa pine.

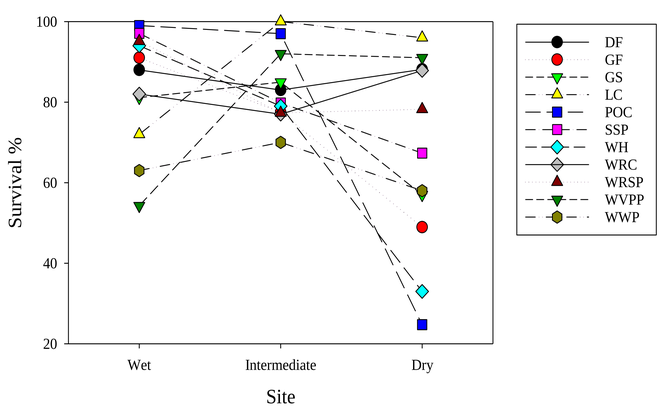

Figure 4. Survival (%) of each species in the wet, intermediate, and dry site.

Methodology Background

In 1996, 11 species were planted in respective 0.5 acre plots in three sites located along a water deficit gradient from the central Coast Range to the Willamette Valley of western Oregon (fig. 2 & 5).

The explanatory variables of the proposed observational study include PDSI, growing season length, and climate factors such as temperature, relative humidity, radiation, and VPD.

The response variables include growth factors such as basal area, volume, site index, and survival, diameter growth factors such as diameter increment, and wood properties such as ring width, wood specific gravity, and $^{13}C/^{12}C$ isotope ratios.

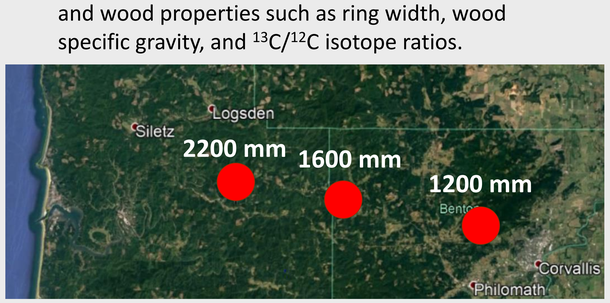

Figure 5. Study site locations and associated average annual rainfall (mm).

Methods

Climate

- Weather stations were established at each site to collect local climate data over a 1 year period.
- Climate models such as PRISM will be used to collect past data starting in 1996.

Cumulative growth

- Tree DBH, height, and survival were recorded.

Inter-annual diameter growth rate

- Dendrometer bands were installed on 10 trees per plot in each site (fig. 3).
- Diameter growth will be recorded monthly during the growing season.

Wood Properties

- Wood cores will be extracted from the trees with dendrometer bands after the growing season.
- Total ring, earlywood, and latewood width will be measured.
- Total ring, earlywood, and latewood specific gravity will be measured using an x-ray densitometer.
- $^{13}C/^{12}C$ isotope ratios will be measured to calculate the intrinsic water use efficiency (iWUE).

Interpretation

The implications of this study will be relevant to the 11 species that were included. This study is primarily limited to the western Oregon region, but could expand to other areas in the PNW with similar environmental conditions. The results may have the potential to inform future studies.

Significance

Western Oregon is a very productive timber region, with the 11 selected species being considered commercially and ecologically valuable. Knowing which species have the highest relative growth rate under different water deficits, as well as understanding how they respond to climate variability, can help to inform management decisions on species selection for reforestation purposes. This knowledge can aid in maximizing timber production on a given site, improve the long-term viability of restoration efforts, and minimize the effect of disturbances associated with climate change on a reforested ecosystem by improving stand resistance and resilience.

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STARKER FORESTS, INC.

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