What the ecosystem models are missing: Hydraulic functional traits differ among populations more so than subspecies of Big Sagebrush (*Artemisia tridentata*)

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Introduction

Big sagebrush (*Artemisia tridentata*), classified as a xerophytic evergreen shrub, is a dominant shrub in a wide range of semi-drought deciduous ecosystems within North America (Romo & Haferkamp 1989; Barker & McKell 1983, Kolb & Sperry 1999).

Three subspecies of big sagebrush are commonly recognized: *A. t. tridentata, vaseyana,* and *wyomingensis*. These subspecies are habitat specific, ranging from mesic mountain sides to xeric bajadas (Kolb & Sperry 1999). *A. t. wyomingensis* is commonly found in low elevation areas with dry soils, *A. t. vaseyana* is in high elevation areas with wet soils, and *A. t. tridentata* is in intermediate elevation zones with intermediate soil moisture. In addition, two ploidy levels have been identified (2n, 4n).

Differences in hydraulic functional traits have been observed across these three subspecies within their individual environments (Sharma 2018). However, it is unclear if these differences are due to genetic differences between the three subspecies, or due to environmental differences in their individual habitats.

Research Questions:

1. **How do hydraulic functional traits vary among subspecies, ploidy level, and seed source location of *A. tridentata*?**

2. **Can we find evidence for local adaptation using a common garden?**

Methods

All measurements were taken at the Orchard Common Garden, located just outside of Boise, ID. The site is characterized as a *A. t. wyomingensis* native environment. Shrubs within the common garden originate from 55 different populations spread throughout 11 different states.

Transpiration measurements were taken for 106 shrubs spread across three separate site visits (7/1/19, 7/11/19, & 7/25/19). This was performed utilizing a LICOR LI-6800 gas exchange system.

Branch samples were collected for every plant and taken back to the Reinhardt Lab at Idaho State University. There, maximum hydraulic conductivity was measured utilizing a Sperry apparatus within a week after sample collection.

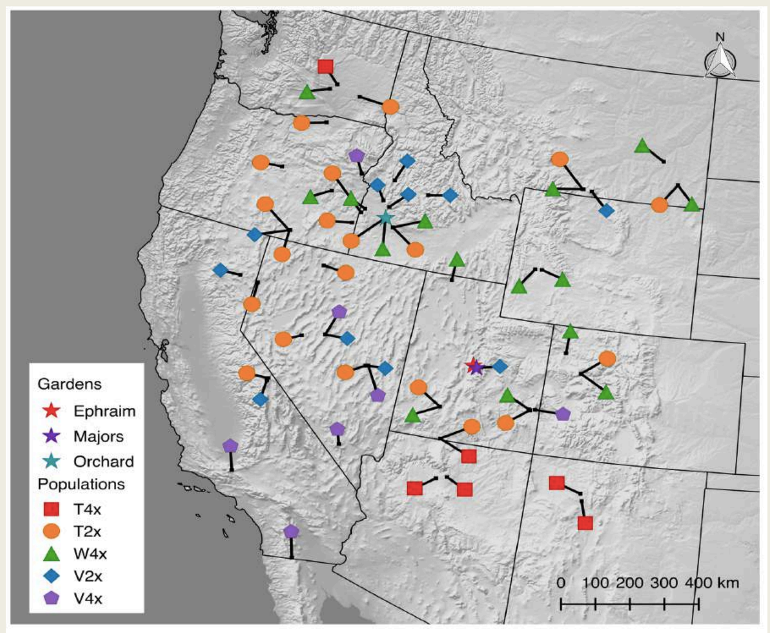

Figure 1. Map of big sagebrush (*Artemisia tridentata*) common gardens and seeds source locations indicating their subspecies and ploidy level. Common gardens were started in 2012 with 55 populations, 1-11 plants per population, and 7.8 shrubs per population.

Results

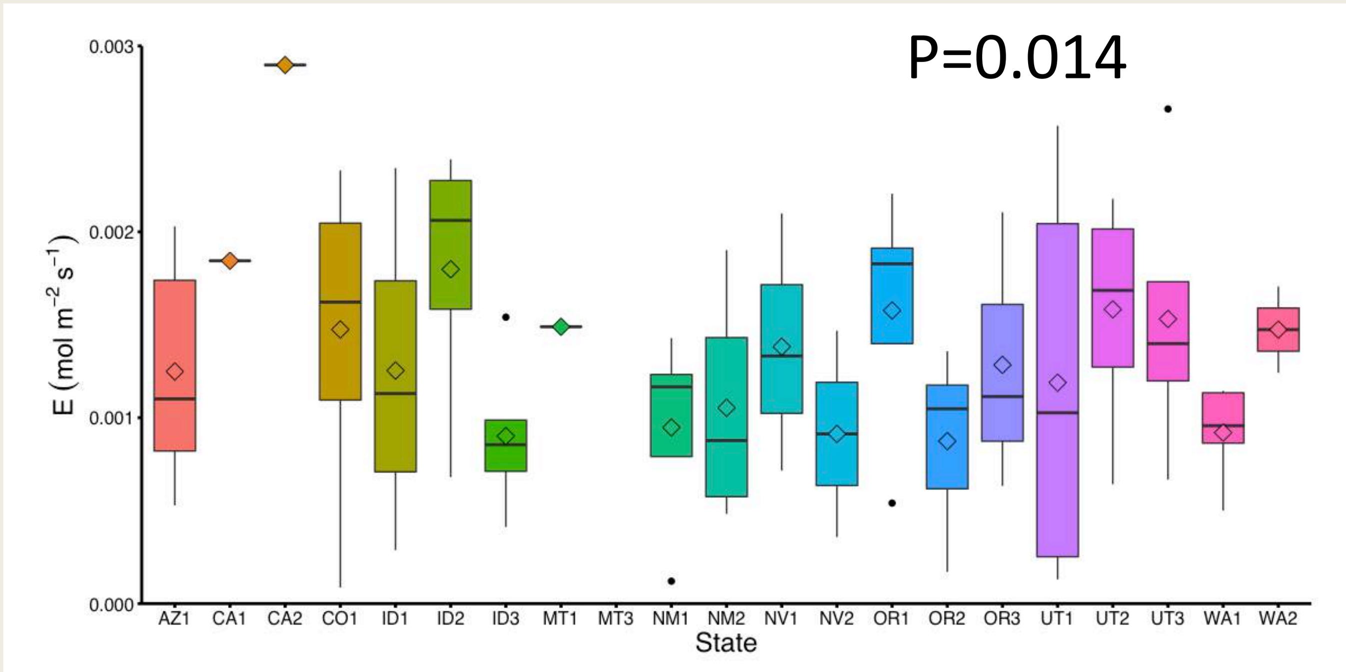

Figure 2. Variation in midday transpiration of big sagebrush (*A. tridentata*) within the Orchard Common Garden based on seed-source population.

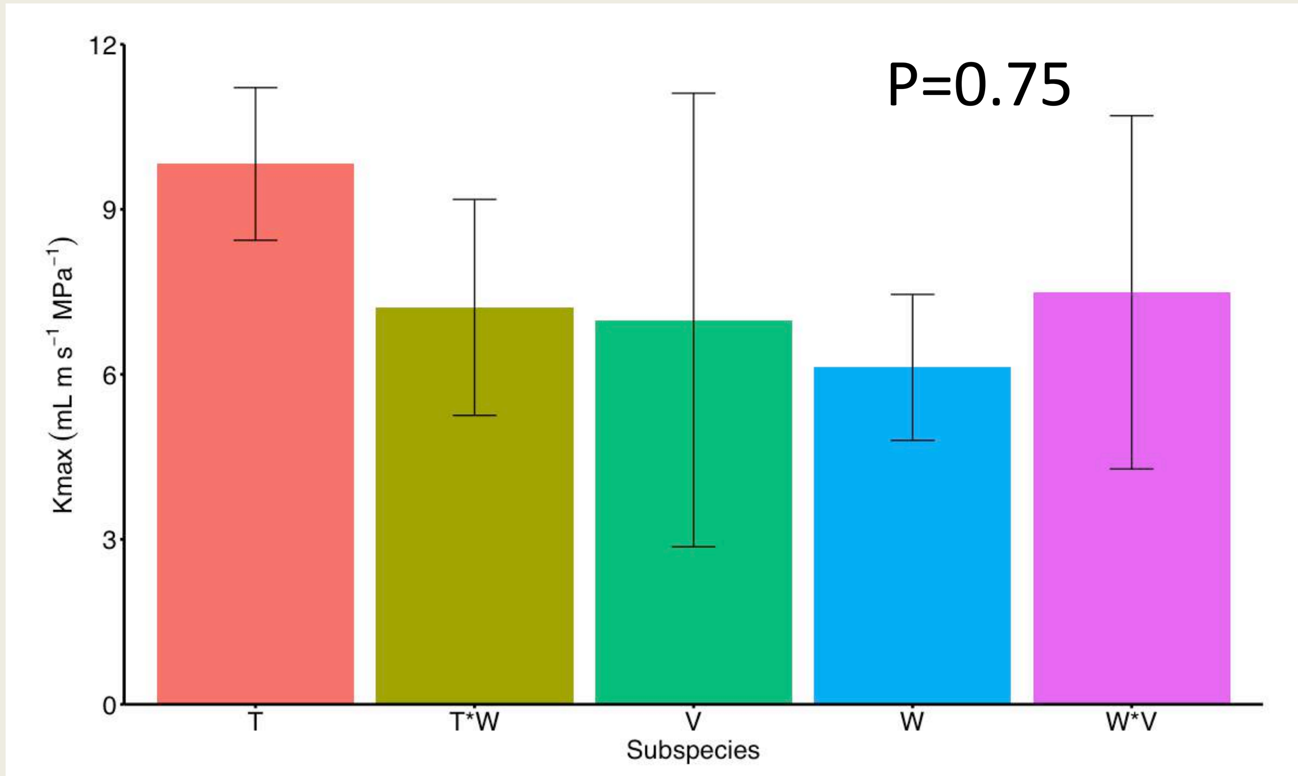

Figure 3. Variation in maximum sapwood-area-specific hydraulic conductivity (Kmax) of big sagebrush (*A. tridentata*) within the Orchard Common Garden based on subspecies.

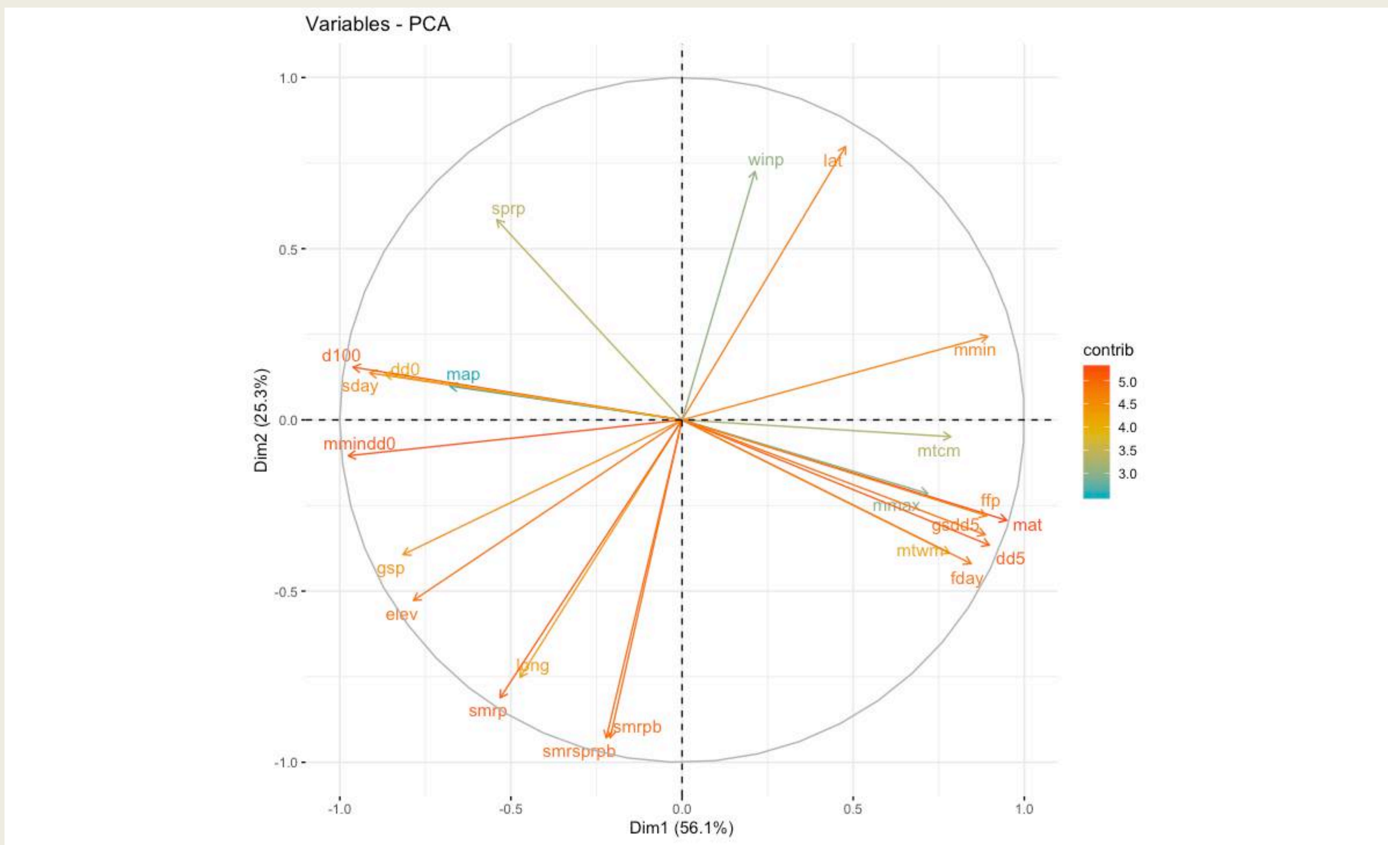

Figure 4. Principle Component Analysis (PCA) of climatic and geographical data for all shrubs in which data was collected from.

Results, Conclusions, and Future Work

There were no significant differences in hydraulic traits due to subspecies or ploidy level (not shown), but seed-source-population differences were evident (P=0.014). Thus, population effects swamp subspecies effects in our garden. Also, we saw little evidence of local adaptation, as the variability of E in ID populations was on the same scale as all the states in our study. One reason for a lack of differences among subspecies could be that measurements were conducted and samples were collected early to late July, which is a time period when physiology in sagebrush may be changing substantially due to varying moisture conditions.

Figure 5. LICOR 6800 testing on shrubs at orchard Common Garden site, Boise, ID.

As drought stress increases, xylem pressure increases and hydraulic conductivity decreases due to the presence of cavitation (Kolb & Sperry 1999). It could be possible that as stress increases for all three subspecies, they respond similarly enough that hydraulic trait differences can't be seen. Therefore, it might be beneficial to look at differences among the shrubs during the growth season (March-June).

Looking at the principle component analysis (PCA), one dimension suggests that variations within the data is contributed by temperature variables of the seed source population climates.

The second dimension suggests that variation within the data is negatively driven by summer precipitation of seed source population climates.

Figure 6. Orchard Common Garden site, Boise, ID.

Acknowledgements

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