Implications of Water Storage Variations in Three Herbaceous Asteraceae in the Sierra Nevada Mountains, California

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BACKGROUND

California is currently in its fifth year of severe drought.

With increased drought effects summers could become even more extreme and detrimental to California plant species

Previous research has shown that internal water reservoirs can greatly benefit plants during periods of soil water stress by prolonging leaf gas exchange while minimizing hydraulic failure and delaying desiccation[1,2].

Capacitance can affect the physiology of a plant and can change typical timing processes and dependencies in the plant[3].

To determine to what extent water storage can occur in root tissue in a Sierra Nevada system I will look at three Asteraceae species: *Balsamorhiza sagittata, Wyethia mollis*, and *Helianthella californica* mechanisms to deal with low water periods and how they differ from one another.

B. sagittata is a medium sized plant with medium sized roots (about 1-2 feet deep). *W. mollis* is a medium sized plant with a large root system (observed as deep as 6 feet) and *H. californica* is a smaller plant with a smaller root system (not deeper than 1 foot).

I am interested in what mechanisms allow these three species from the Asteraceae family to survive in such extreme summer conditions in a system that relies mainly on snowmelt as its water source.

I hypothesize that for these three Asters, roots can act as a water storing organ for the plant to be utilized in times of low water availability or drought conditions.

METHODS

This project was conducted at two study sites. First at Sagehen UC Berkeley Reserve System in a meadow system near Truckee, Ca (N39°26.203' W120°16.771'). The second at the trailhead of the Sierra Buttes in Plumas National Forest at higher elevation (N 39°36.846' W 120°39.980').

Water potential of the root of each species is taken as an indicator of how stressed the plant is for water.

Specifically root water potential samples are measured using Thermocouple Psychrometers. A Pressure-Volume curves is created to show capacitance of each species.

Diurnal variation in leaf water potential is also taken to determine water stress in the leaves and compare it with the timing of soil water availability. A pressure chamber is used to measure the water pressure in the leaf to indicate stress. And a Soil Moisture Meter is used to measure the moisture of the soil surrounding each plant.

If leaves have a higher water potential and are still functioning and transpiring well into the summer season despite low water availability then there could be a positive effect of water storage on the plant.

METHODS CONTINUED

Stomatal conductance and transpiration levels are measured in leaves with a Li-Cor 1600.

If water storage occurs in the roots and is used at a later date by the plant, and we see photosynthesis occurring well into the season with lack of an input of snowmelt, then there is water available to the plant and could be supplying it for photosynthesis which could be a benefit or effect of root water storage.

Balsamorhiza sagittata

Wyethia mollis

Helianthella californica

RESULTS

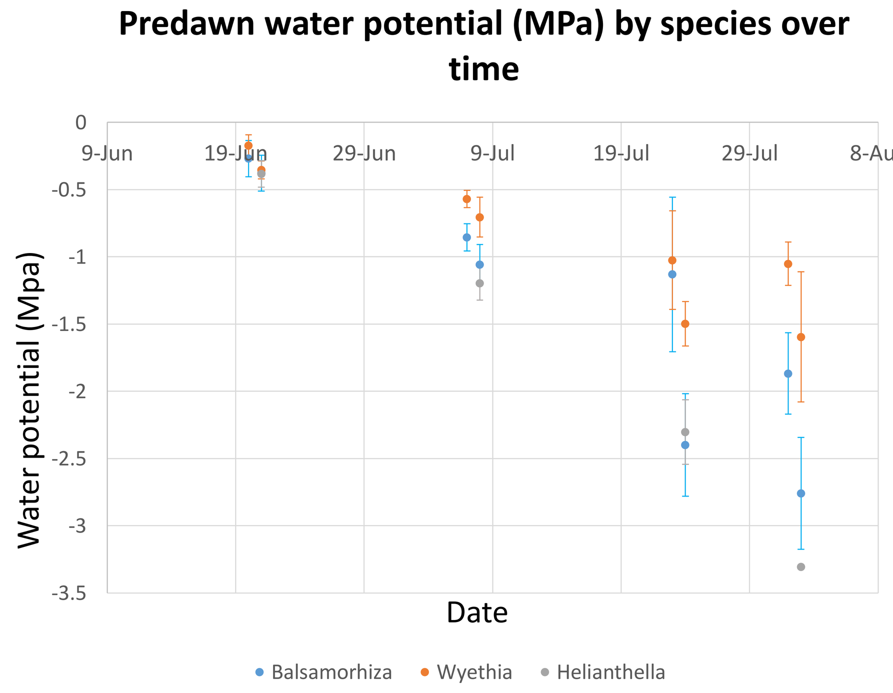

Figure 1. Predawn measurements are taken to see the water potential of the plant in a time where the plant is equal to the soil because stomatal should be closed at this time and there is no transpiration occurring. Though there is no transpiration occurring, there are still differences in water potential in the three species. What would cause different water potential is the plants not loosing water. This data shows that *W. mollis* has higher water potential readings throughout the summer than both *B. sagittata* and *H. californica*. Though the three species are co-occurring, there is a difference between the water source for the three species. This could be happening because *W. mollis* is merely tapping deeper pool of water in the soil to get its water because of its thicker and deeper root system. In general there is more water the deeper you are in the soil. This is because water is evaporating from the more shallow levels of the soil.

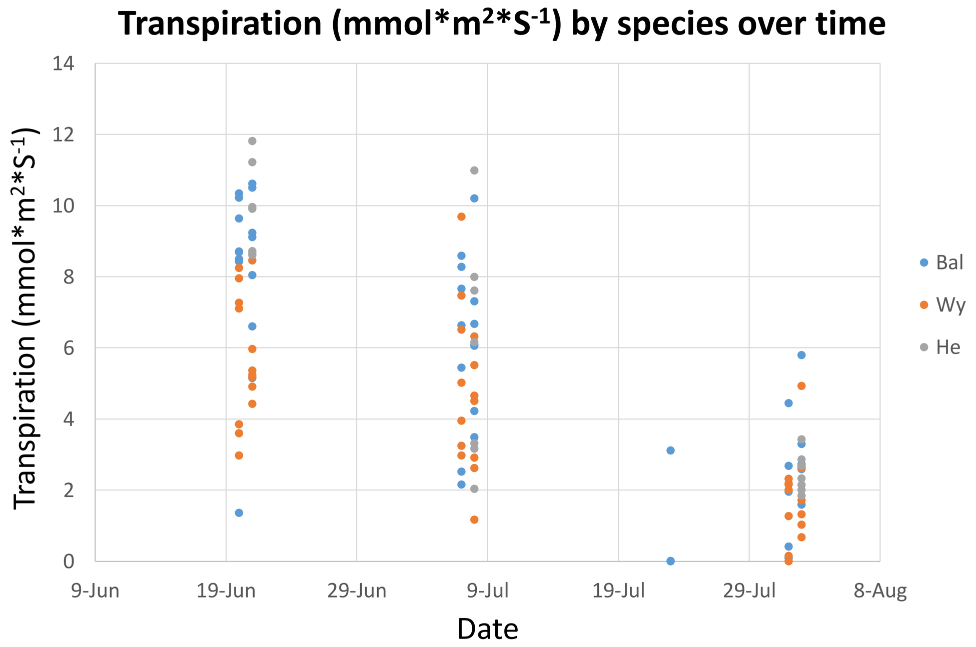

Figure 2. On trip *W. mollis* has significantly less transpiration occurring than *H. californica* or *B. sagittata*. The highest values are from *H. californica*. The third visit is missing data because the porometer stopped working, so full data set was not taken. However the general trend for transpiration shows that all three species lowered over the summer and was lowest in the end of the growing season. There were no significant differences by species as seen on the first trip. *W. mollis* could be exhibiting lower transpiration rates because it possibly has more water storage in its roots as thought in the hypothesis. It has more water, so it doesn't have to work as hard to make sure it photosynthesizes, it can take its time. However, we don't see that *W. mollis* has higher transpiration rates at the end of the summer justifying this idea. It seems that *W. mollis* has something physiologically different than the other two species.

RESULTS CONTINUED

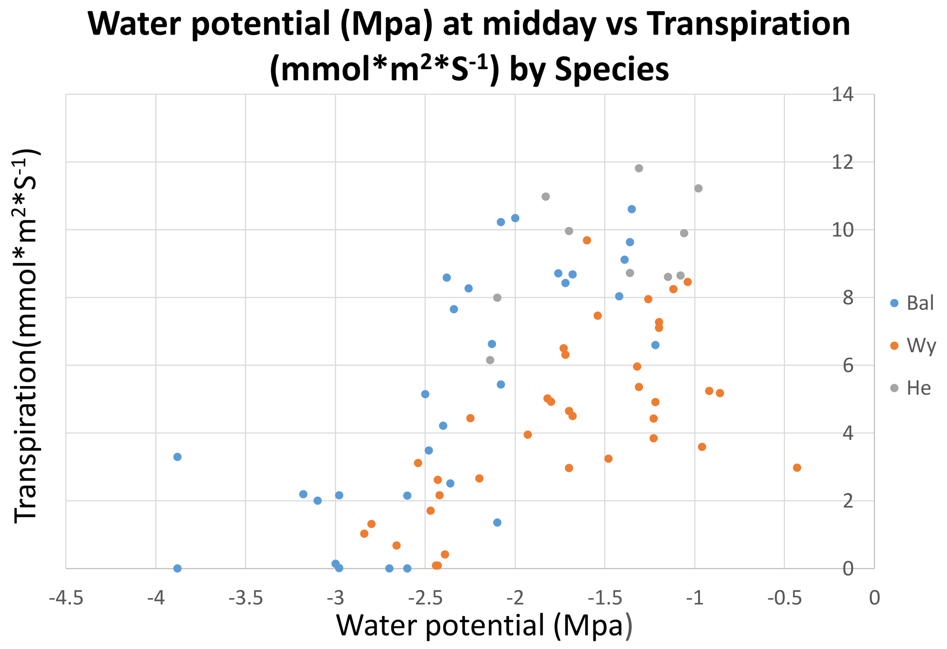

Figure 3. There's a drop in both *W. mollis* and *B. sagittata* for transpiration with lower water potential levels. There is a lack of data for *H. californica* because the porometer not working and the pressure bomb not being able to read the low water potential levels on the last trip . B. sagittata has a higher transpiration levels at a lower water potential than *W. mollis*. It seems that *W. mollis* is more sensitive to lower water potentials and starts closing its stomata's at higher water potentials than *B. sagittata. W. mollis* has more access to water, but seems more sensitive to changes in water potential!

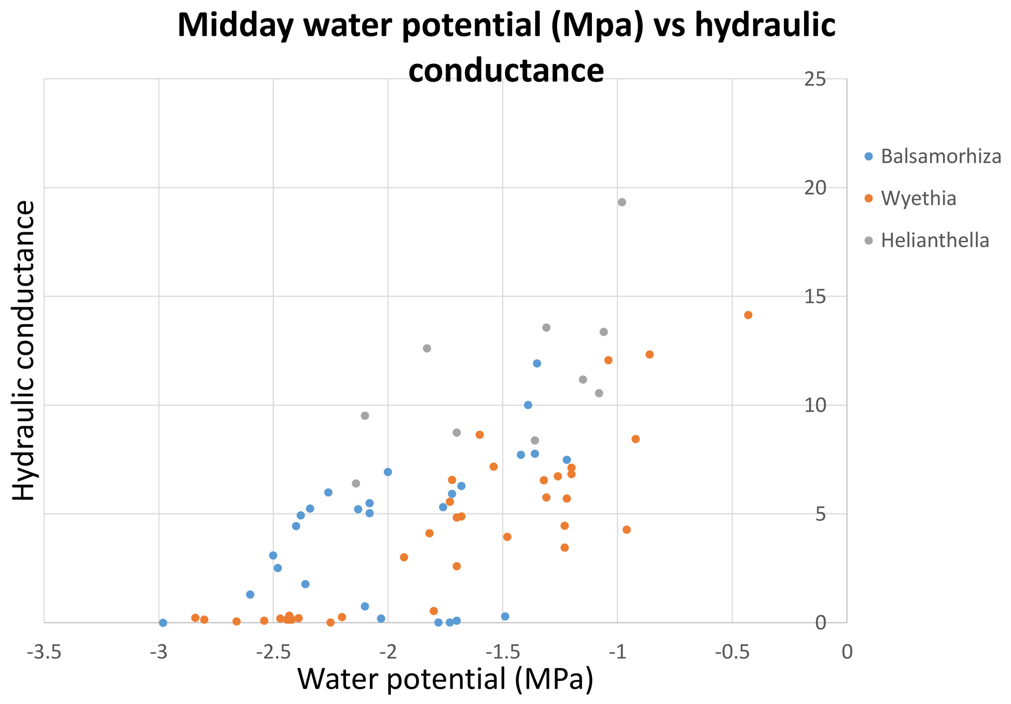

Figure 4. Hydraulic conductivity has a similar pattern as transpiration. Both *W. mollis* and *B. sagittata* drop at lower water potentials, but *B. sagittata* is able to have conductance at lower water potentials. This indicates that hydraulic conductivity influences transpiration in these two species. If you don't have water coming to the stomata, then they will go down in conductance.

CONCLUSIONS

Results of the psychrometer are still to be analyzed. From the data shown here we see that all three species of Asters have a lower water potential reading as the summer goes on. We see from Figure 1. that *W. mollis* could be using a different source of water then the other species because its water potential readings are higher at predawn. We also see from Figure 3 and 4 that both *W. mollis* and *B. sagittata* slow transpiration with lower water potentials. *B. sagittata* is more robust and still conducts at lower water potential values than *W. mollis*. We also see that hydraulic conductance seems to have an effect on transpiration (Figure 4) in these two species because the slope is similar for transpiration and we know that if water is not getting to the stomata then they can not conduct. There could be other factors that influence transpiration, but hydraulic conductivity seems to be one.

ACKNOWLEDGEMENTS & CITATIONS

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3. Hunt, E. R., & Nobel, P. S. (1987). Non-steady-state water flow for three desert perennials with different capacitances. *Functional Plant Biology*, *14*(4), 363-375.
4. Calflora.org for photos.

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