

Background

- The northeastern US is expected to have more frequent and extreme droughts in the future (Vose et al. 2019, USFS)
- However, most tree species in Maine are not well adapted to drought (Liénard et al. 2016, GCB) leading to uncertainty about how forests will respond to climate change
- Experiments that mimic future novel climate conditions are needed

Research Question

How do tree hydraulic traits relate to drought resistance and resilience of northeastern forest trees?

Methods

- This experiment was part of a novel greenhouse experiment manipulating seasonal drought conditions for 288 saplings of six species: red maple, paper birch, black cherry, eastern white pine, eastern red-cedar, and northern white-cedar

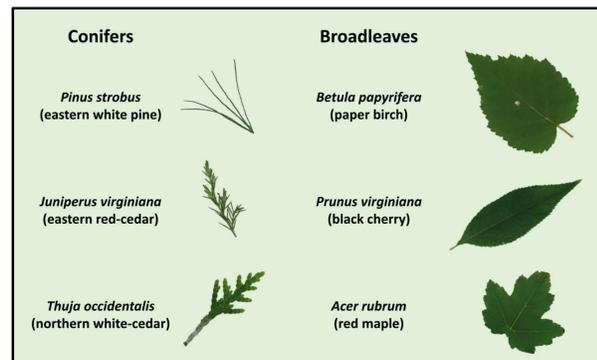
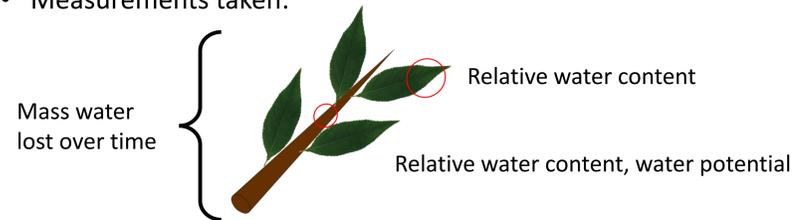


Figure 1. The six study species and representative leaves for this experiment.

Leafy-shoot dry down

- 71 leafy shoots from six study species
- Measurements taken:



- Relative water content calculated using:

$$RWC = \frac{mass_{fresh} - mass_{dry}}{mass_{dry}}$$

Water release curves

- Incrementally dry, weigh, and measure water potential of 1 cm xylem segments
- Capacitance = rate of water release standardized by volume
- Water storage = water storage standardized by volume

Results

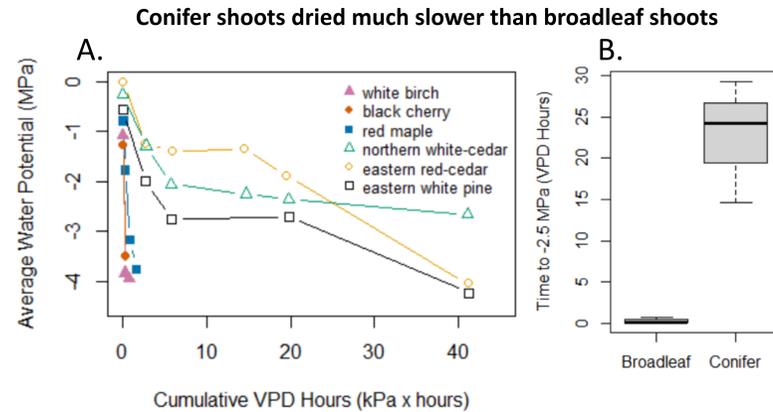


Figure 2. A) Mean stem water potential (MPa) over the course of the leafy shoot dry-down experiment in VPD (kPa) hours for six study species. B) Mean \pm SE of VPD hours to reach -2.5 MPa (estimated using a linear model) for broadleaved and coniferous species. Shoots were dried down over the course of one week and were sampled incrementally for water potential, mass, and relative water content.

- Generally, conifers had more water available in stems at the start, used water from stems and leaves at an equal rate, while broadleaved species used leaf water faster than stem water

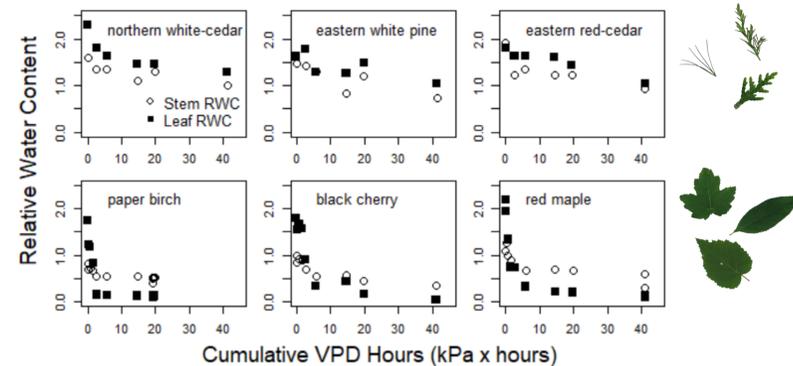


Figure 3. Mean relative water content of stems (filled circles), and leaves (empty circles) as a function of cumulative VPD hours over the course of the leafy shoot dry-down for six study species. Shoots were dried down over the course of one week and were sampled incrementally for water potential, mass, and relative water content.

- Species such as red maple that had higher total water storage in xylem were also able to release it more easily during drought conditions

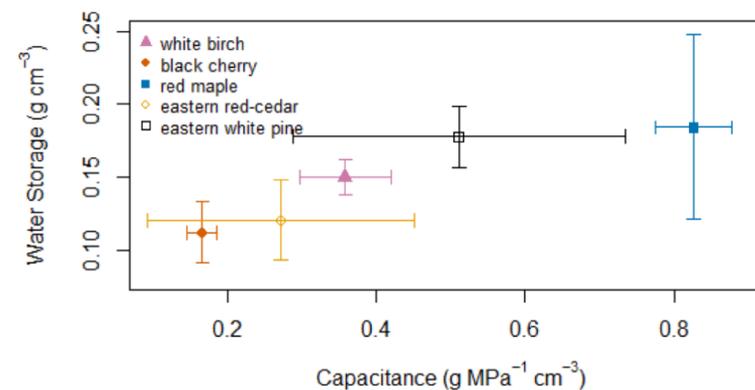


Figure 4. Mean \pm SE water storage ($g\ cm^{-3}$) as a function of mean \pm SE capacitance ($g\ MPa^{-1}\ cm^{-3}$) for five study species (northern white-cedar excluded due to low sample size). One centimeter stem segments were dried incrementally with water potential being taken at each increment. Water storage is quantified as the asymptote of the curve produced by these measurements and capacitance is the slope of the initial decline in water content (Meinzer 2003, Plant Cell Environ).

- Species with higher leaf to stem biomass also had higher minimum rates of water loss during drought

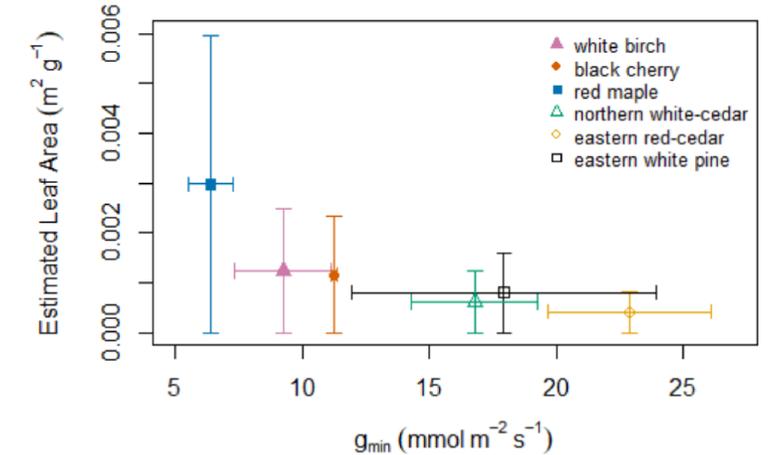


Figure 5. Estimated leaf area ($m^2\ g^{-1}$) as a function of mean \pm SE minimum stomatal conductance ($mmol\ m^{-2}\ s^{-1}$) for the six study species. The estimated leaf area data was calculated leaf mass area (LMA) and leafy-shoot dry down leaf biomass, while the minimum stomatal conductance data was obtained from the greenhouse drought experiment conducted as part of this larger study in summer 2020.

Conclusions

- Conifers have conservative water use strategies, while broadleaved species appear to be “water wasters”

Conifers	Broadleaves
Small leaf area	Large leaf area
Slow rate of leaf drying	Fast rate of leaf drying
Access stored xylem water	Variable access to stored water

- Future work needs to consider how these strategies impact individual and ecosystem level resilience to drought as well as legacy effects on carbon relations and tree growth

How well do you really know plant hydraulics?

- Test your knowledge of plant hydraulics with a short online quiz
- Scan the image to the right or follow [this link](https://tinyurl.com/y7spenym) (<https://tinyurl.com/y7spenym>)
- See results from the quiz at [this link](https://tinyurl.com/y9wablal) (<https://tinyurl.com/y9wablal>)



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