Kevin R Hultine, Ray Froend, Davis Blasini, Susan E Bush, Melissa Karlinski, Dan F Koepke

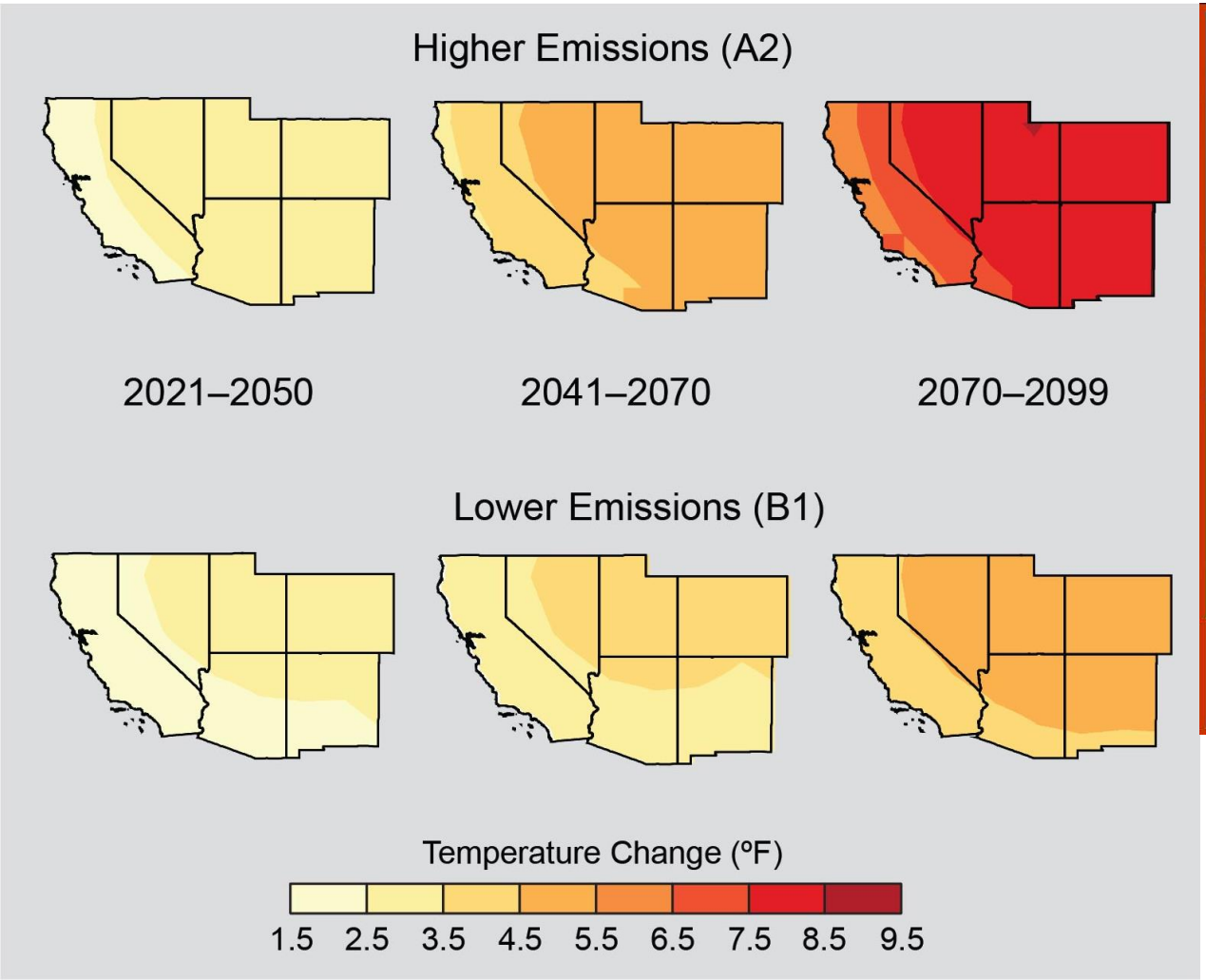
DESERT BOTANICAL garden

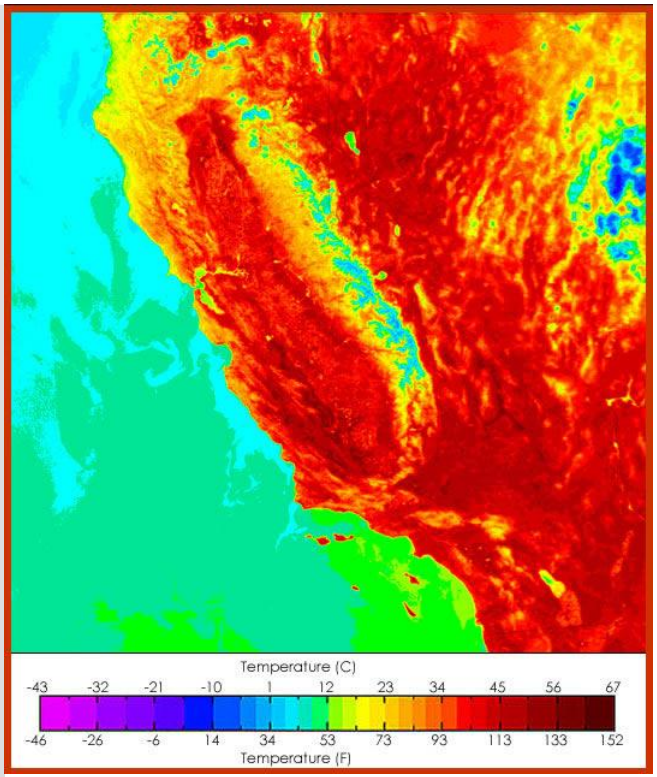
AUSTRALIA ECU EDITH COWAN UNIVERSITY

USDA NIFA

NSF

Southwestern US will experience dramatically warmer temperatures by the end of the century

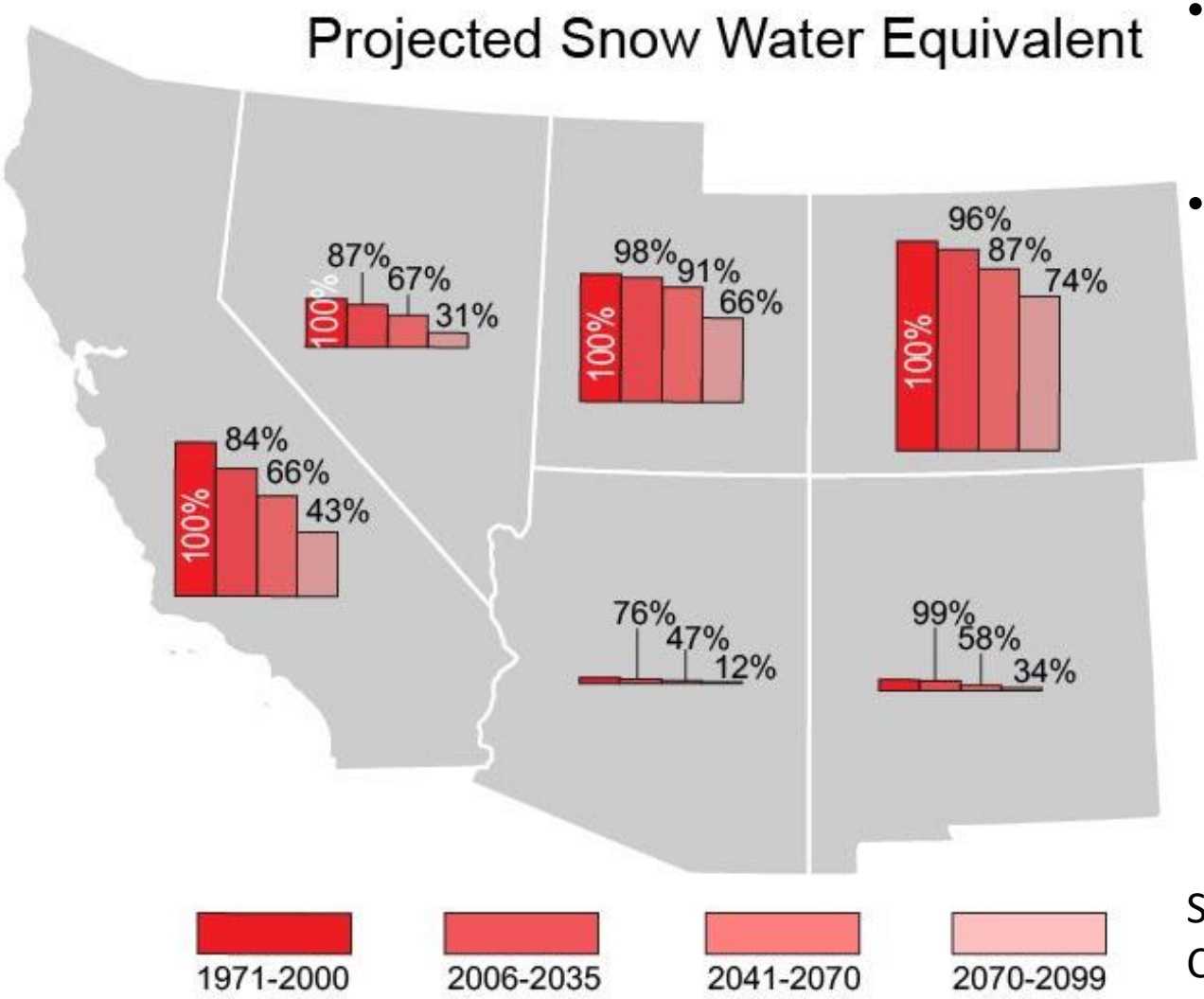




May, 2004

Source: Third National Climate assessment

Southwestern US will experience dramatically warmer temperatures by the end of the century



- Correlated with earlier timing of runoff and decreased total runoff
- Results in reduced water storage and groundwater recharge

Source: Third National Climate assessment

Patterns of woody-plant mortality have been well studied….

Predictors of mortality and (more importantly) survival remain elusive

Hydraulic strategies (Hydraulic architecture, xylem structure and function)

Water use efficiency (stomatal regulation)

Canopy thermal regulation

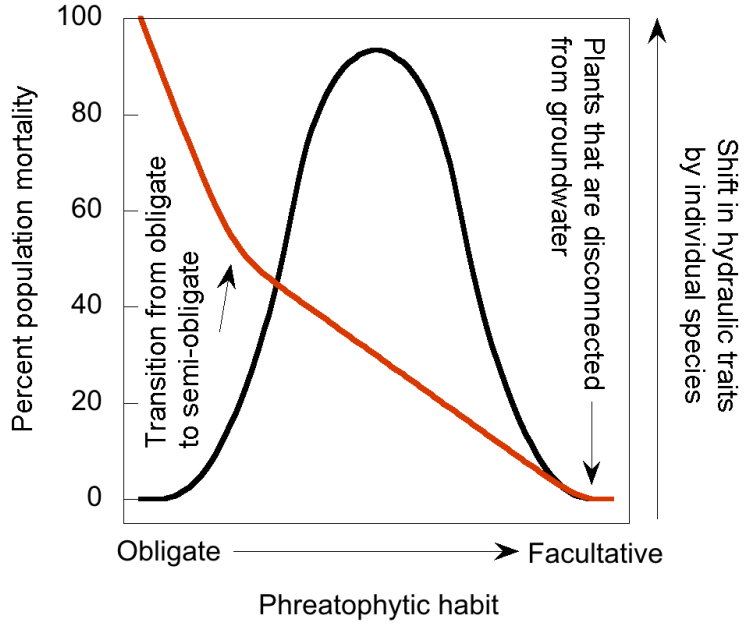
Patterns of woody-plant mortality have been well studied….

Predictors of mortality and (more importantly) survival remain elusive

Stand replacement of obligate phreatophytic species with more facultative species

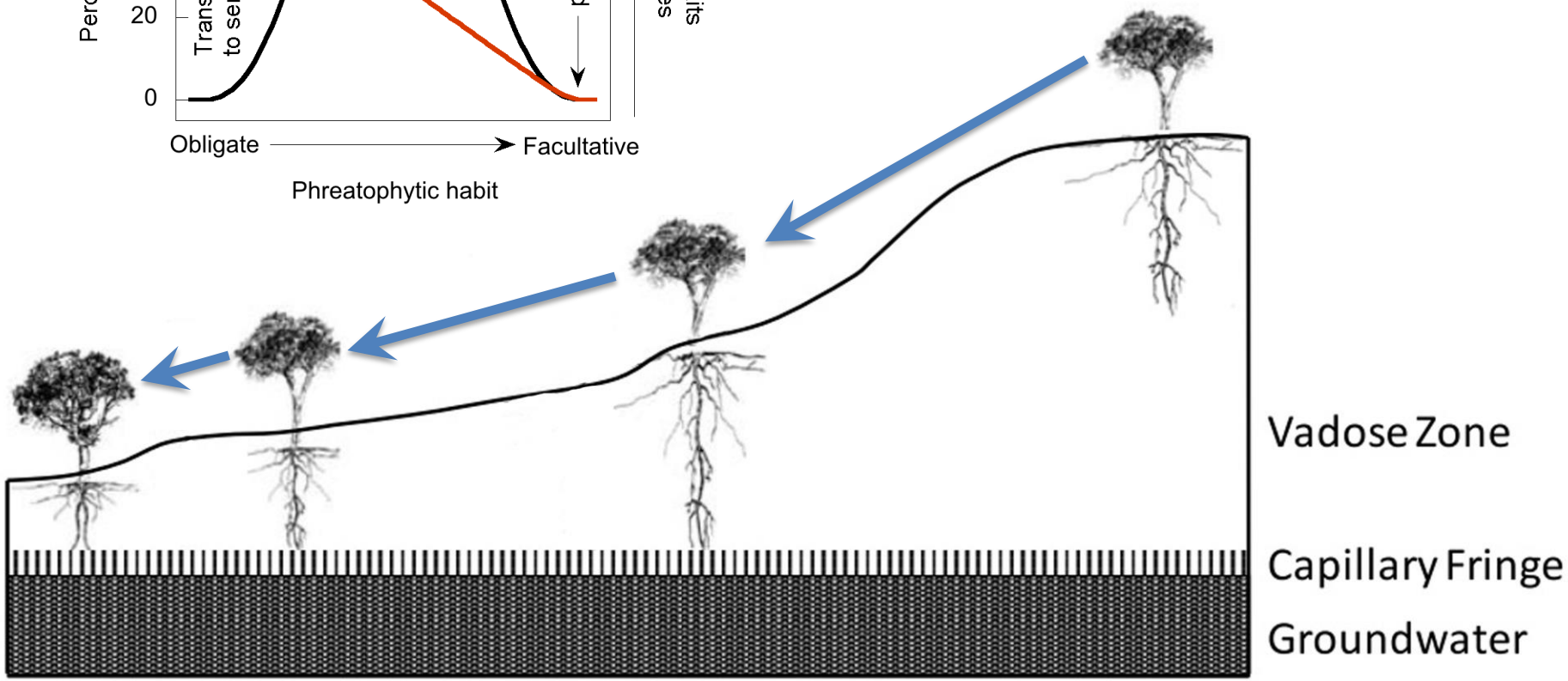
Directional selection towards the expression of traits associate with highly Facultative phreatophytes without stand replacement

Phreatophytes express a broad range of hydraulic traits depending on their preferred niche

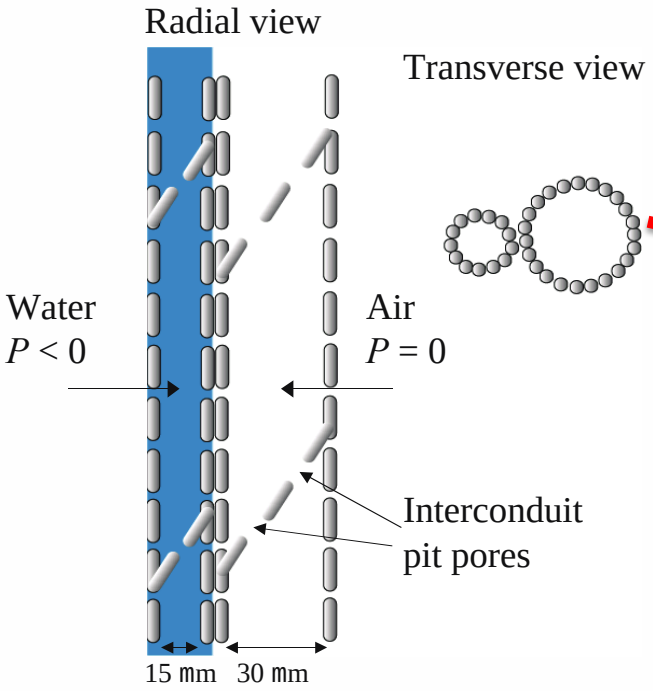


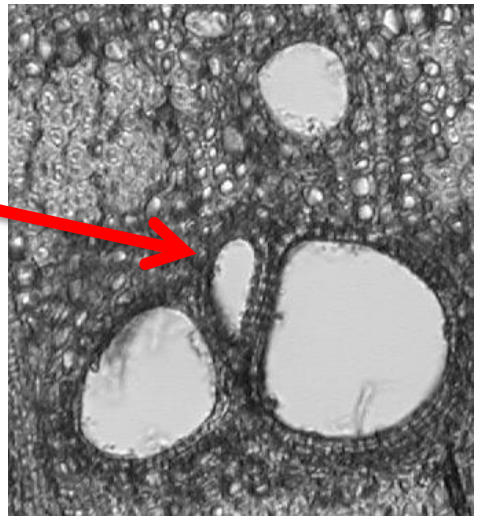
Shift in hydraulic traits: selection, plasticity or gene flow

Potential tradeoffs: reduced competitiveness

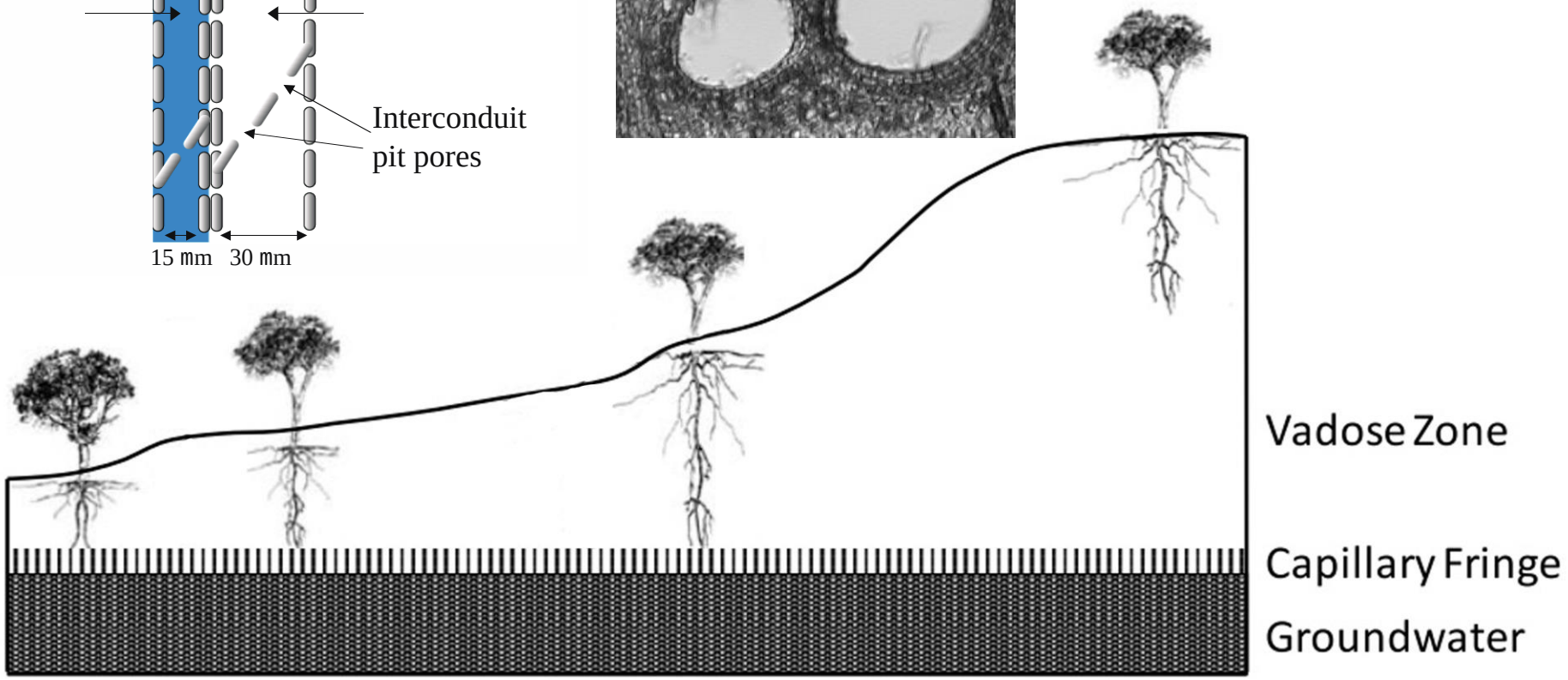


Phreatophytes express a broad range of hydraulic traits depending on their preferred niche

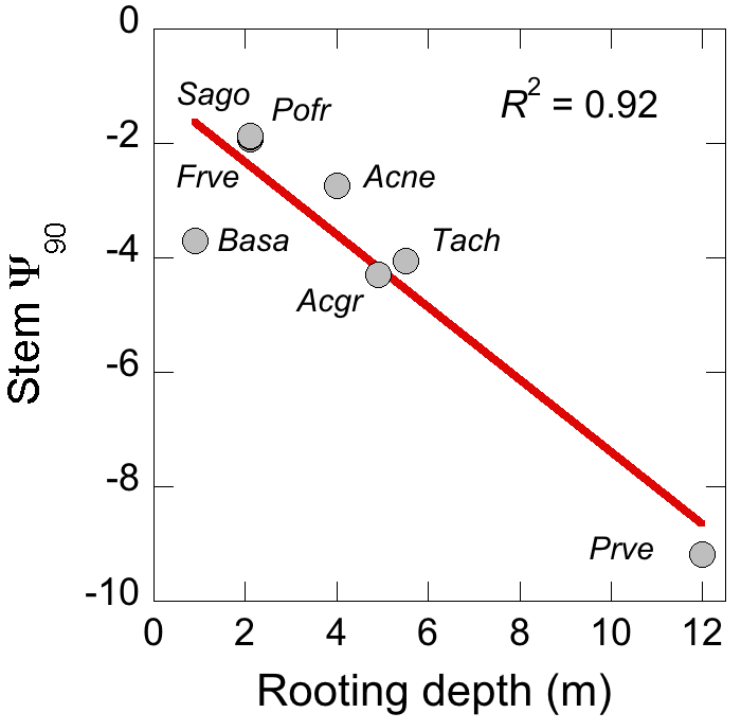




Highly efficient = higher vulnerability to drought

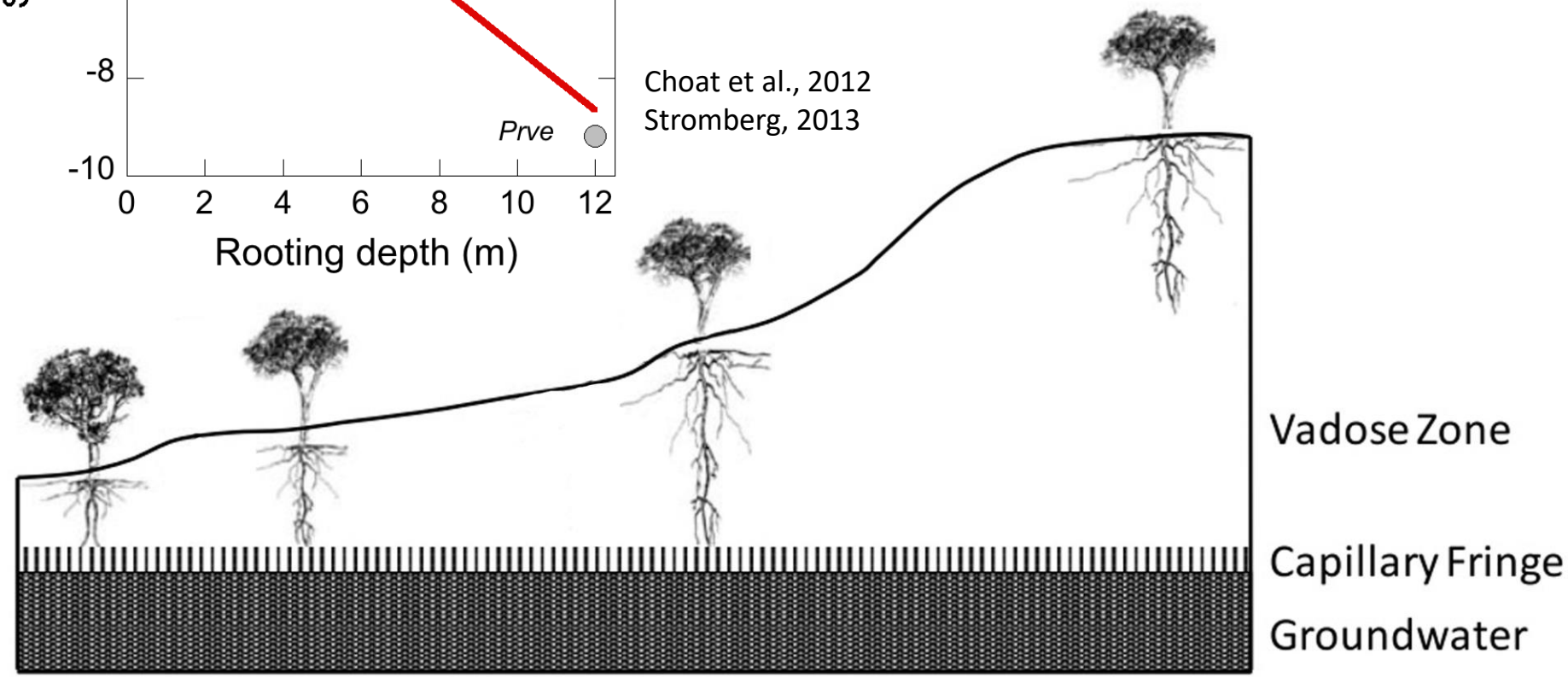


Phreatophytes express a broad range of hydraulic traits depending on their preferred niche

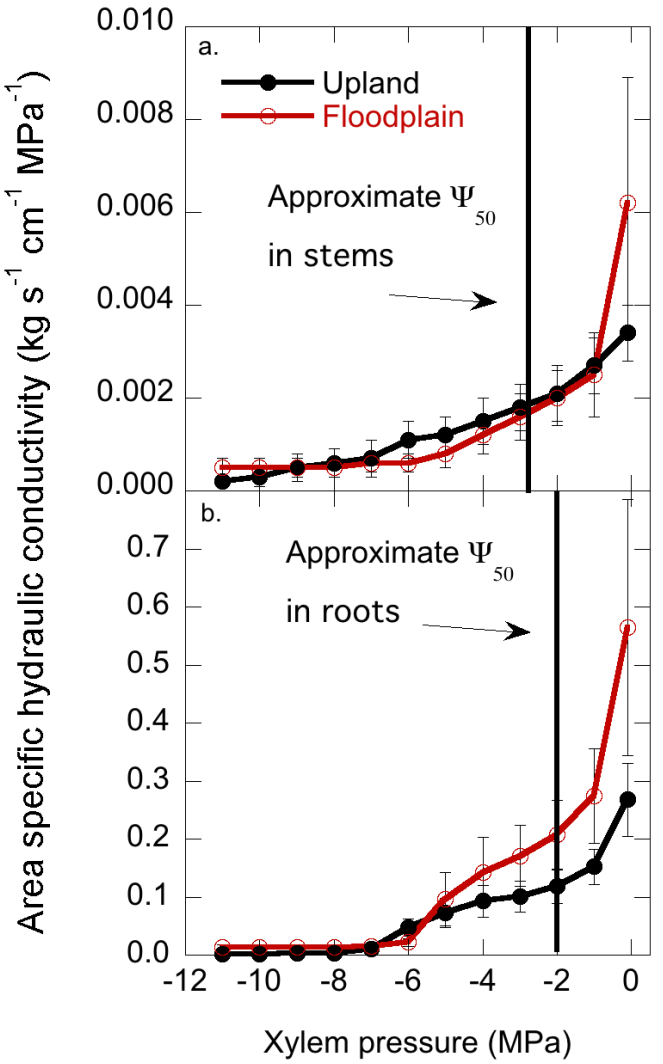


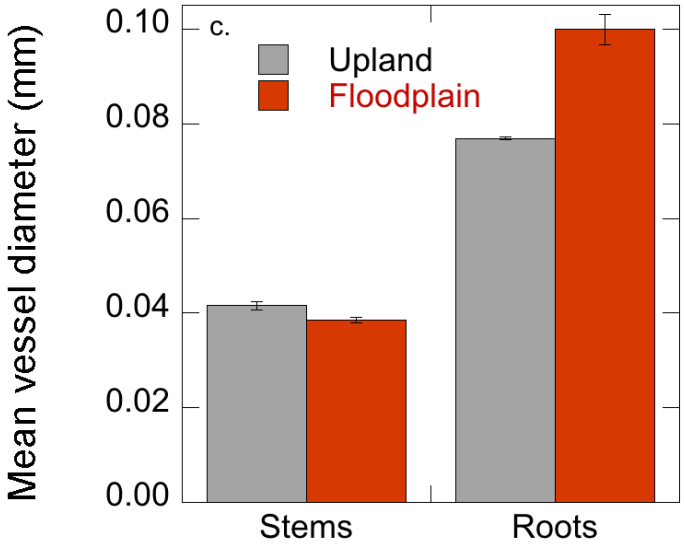
Greater rooting depth = reduced vulnerability to drought-induced xylem cavitation

Choat et al., 2012
Stromberg, 2013



Phreatophytes express a broad range of hydraulic traits depending on their preferred niche



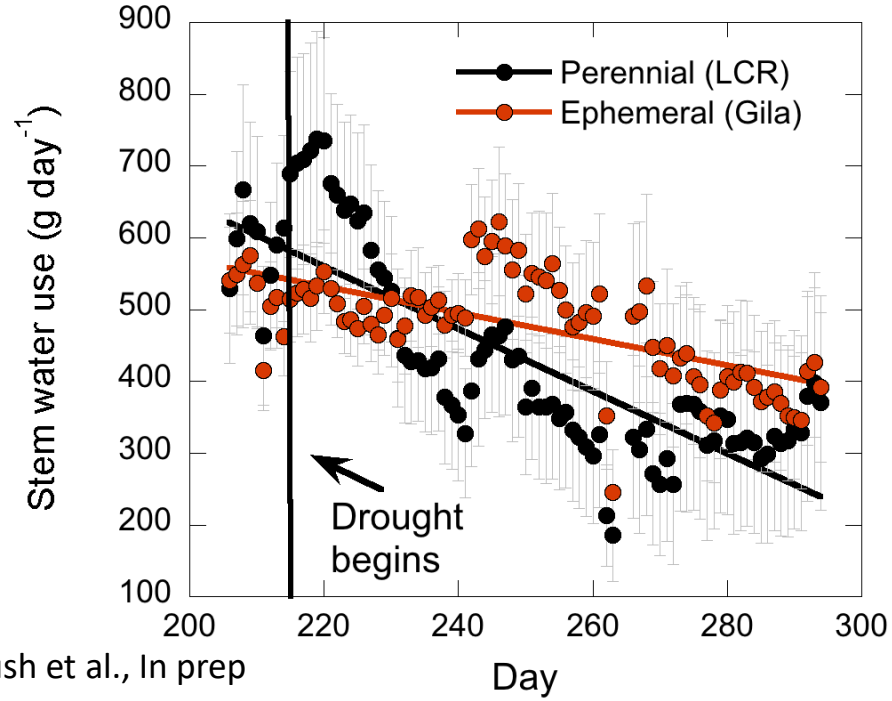


Hydraulic contrasts are often more profound in roots than stems

Hultine et al., In prep

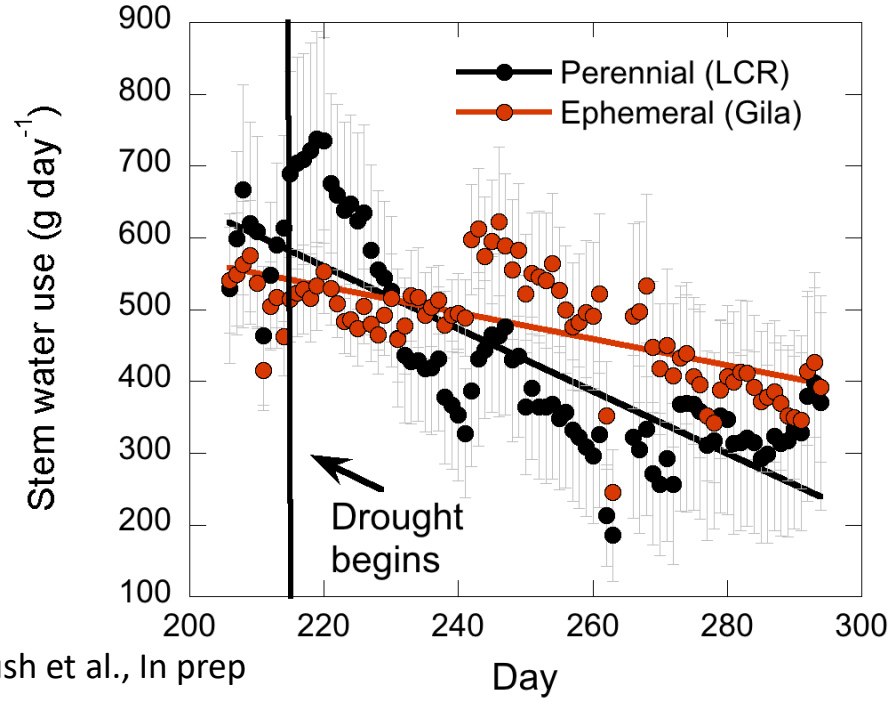
Evidence for local adaptation to hydrologic regime

Evidence for local adaptation to hydrologic regime



Bush et al., In prep

Evidence for local adaptation to hydrologic regime

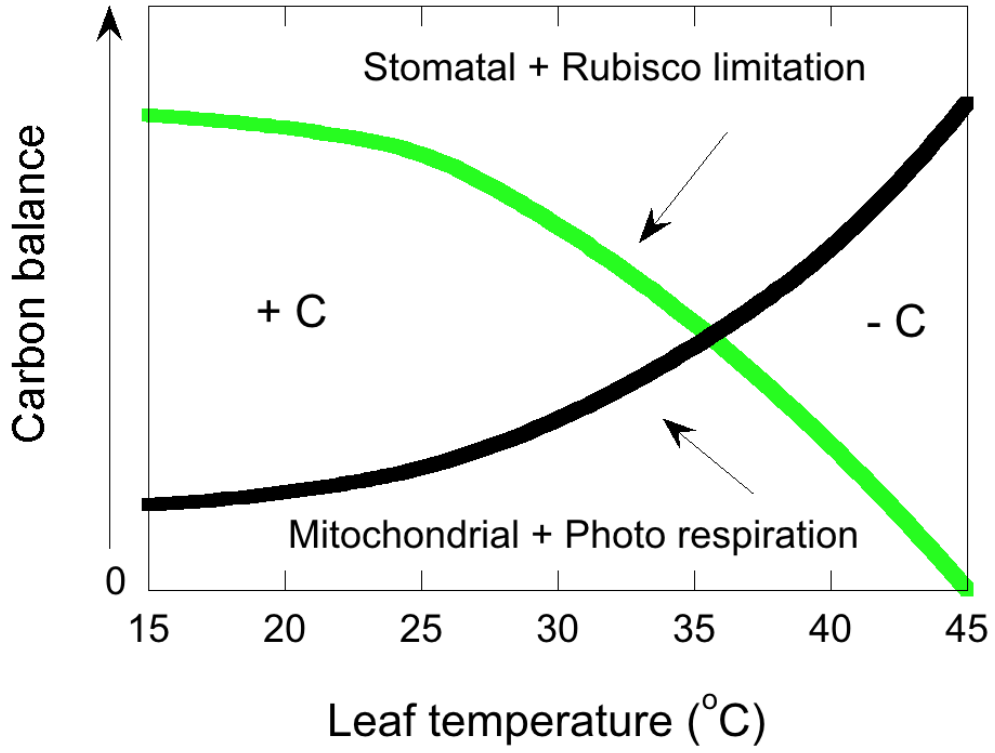


Bush et al., In prep

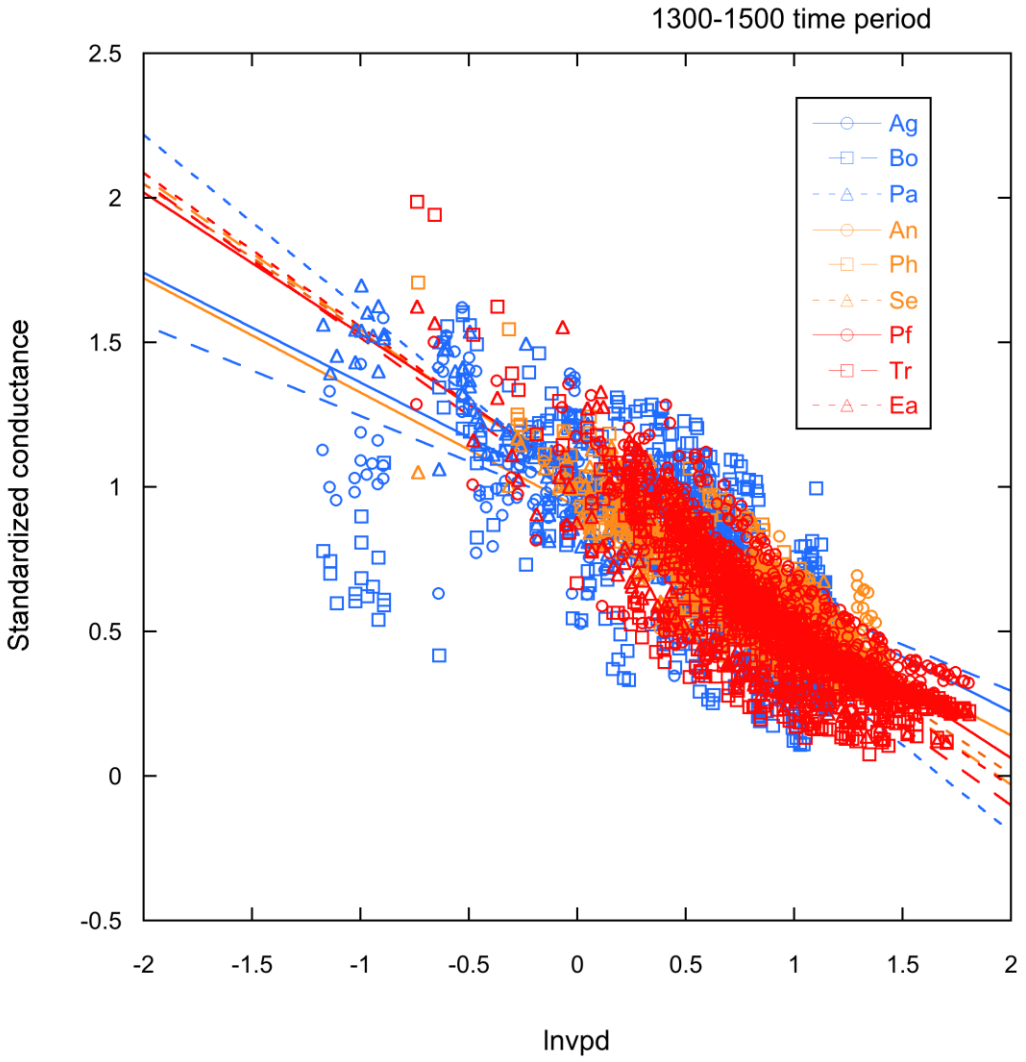
Stem water use = -4.34 g day^{-1} in LCR, and -1.84 g day^{-1} in Gila ($P < 0.0001$)

Fine root distribution:
81%, 0 – 150 cm, 19%, 150 – 300 cm (LCW)
75%, 0 – 150 cm, 25%, 150 – 300 cm (Gila)

The high cost of heat waves

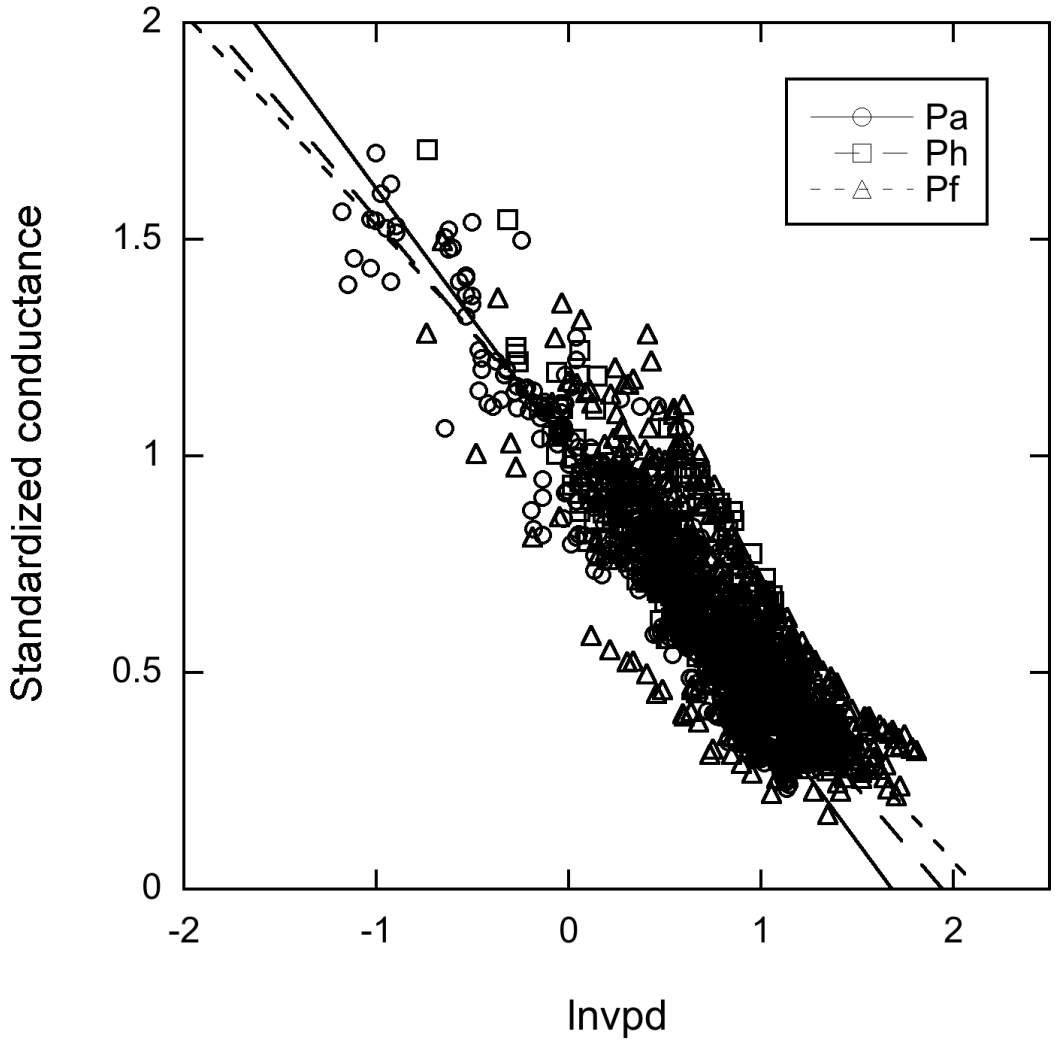


The high cost of heat waves



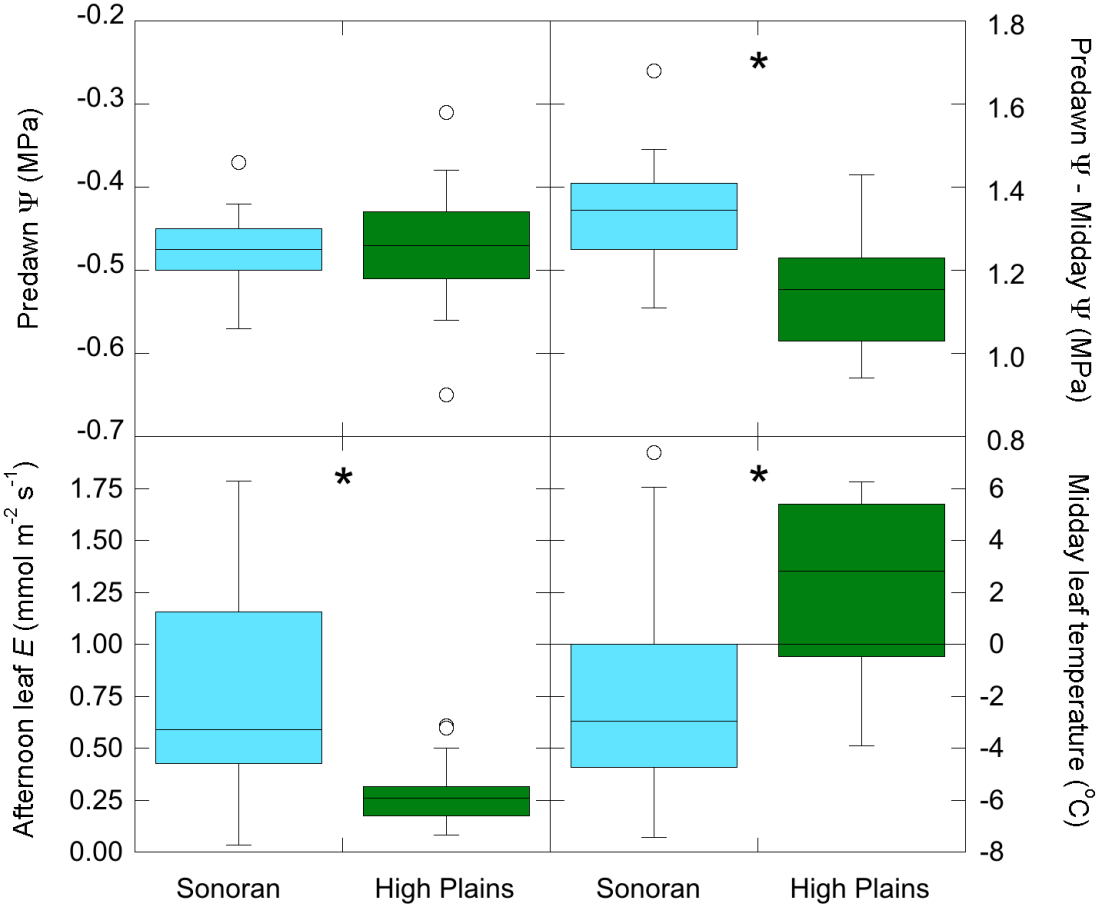
Bush and Hultine, In prep

The high cost of heat waves



Bush and Hultine, In prep

Better canopy thermal regulation in Arizona versus Utah cottonwood genotypes



- Arizona (warm-adapted) trees had 50% higher rates of *E*
- Lower stomatal sensitivity in AZ genotypes to water potential gradients
- AZ genotypes have a greater hydraulic efficiency but with a potential tradeoff of lower tolerance to soil water deficits

Blasini et al., In prep

Final thoughts

- Global change processes will induce dramatic shifts in mean trait expression independent of changes in species composition
- Heat waves will dramatically amplify the effects of groundwater depletion on tree survival
- Canopy temperature is a not only critical for plant carbon balance, but a strong indicator of stress

Groundwater dependent vegetation impacted by the effects of climate change and groundwater abstractions