Plant-Water-Hydrology Relationships in Native Trees and Invasive Giant Reed (*Arundo donax*) in a Southern California Floodplain

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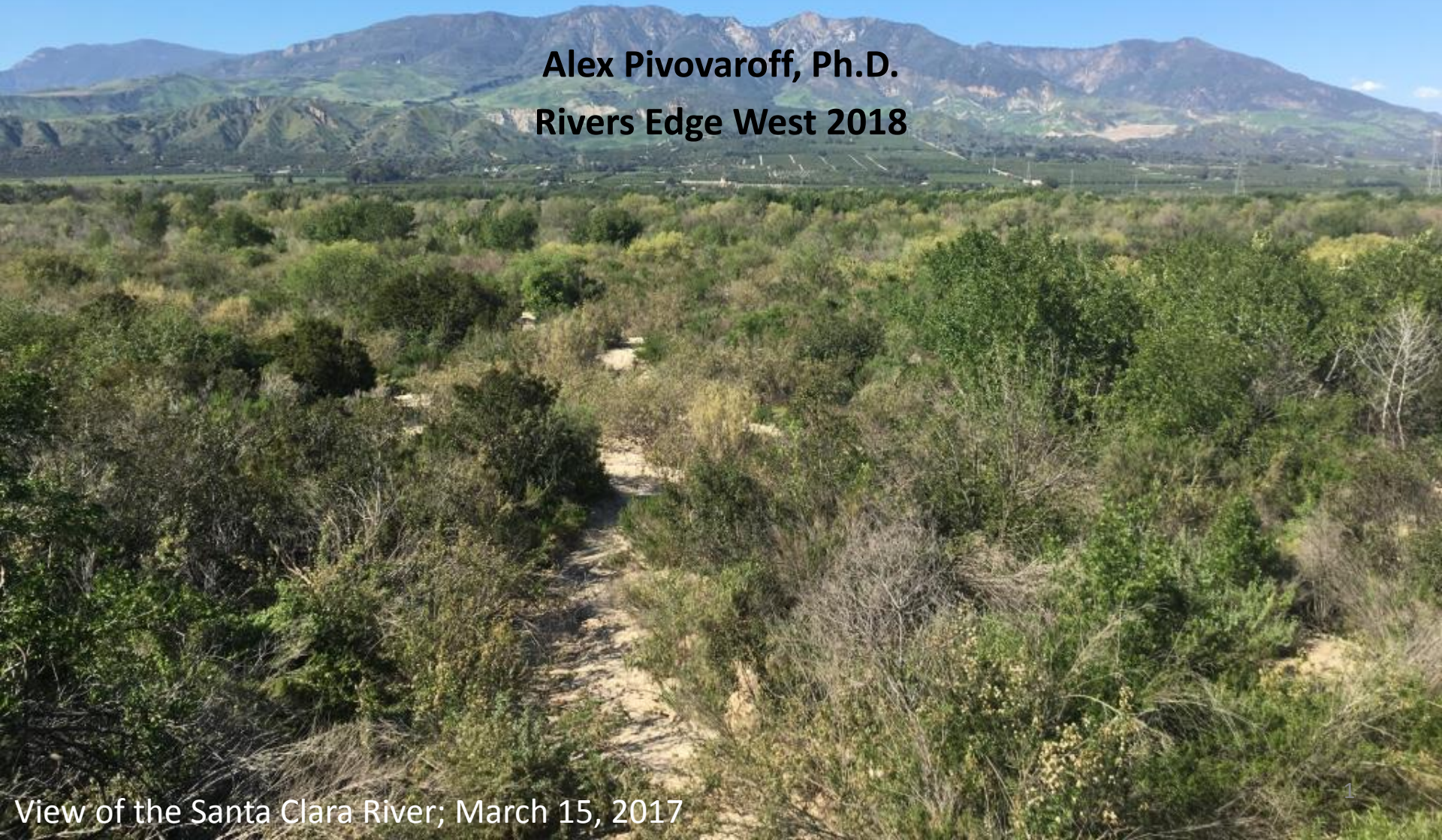
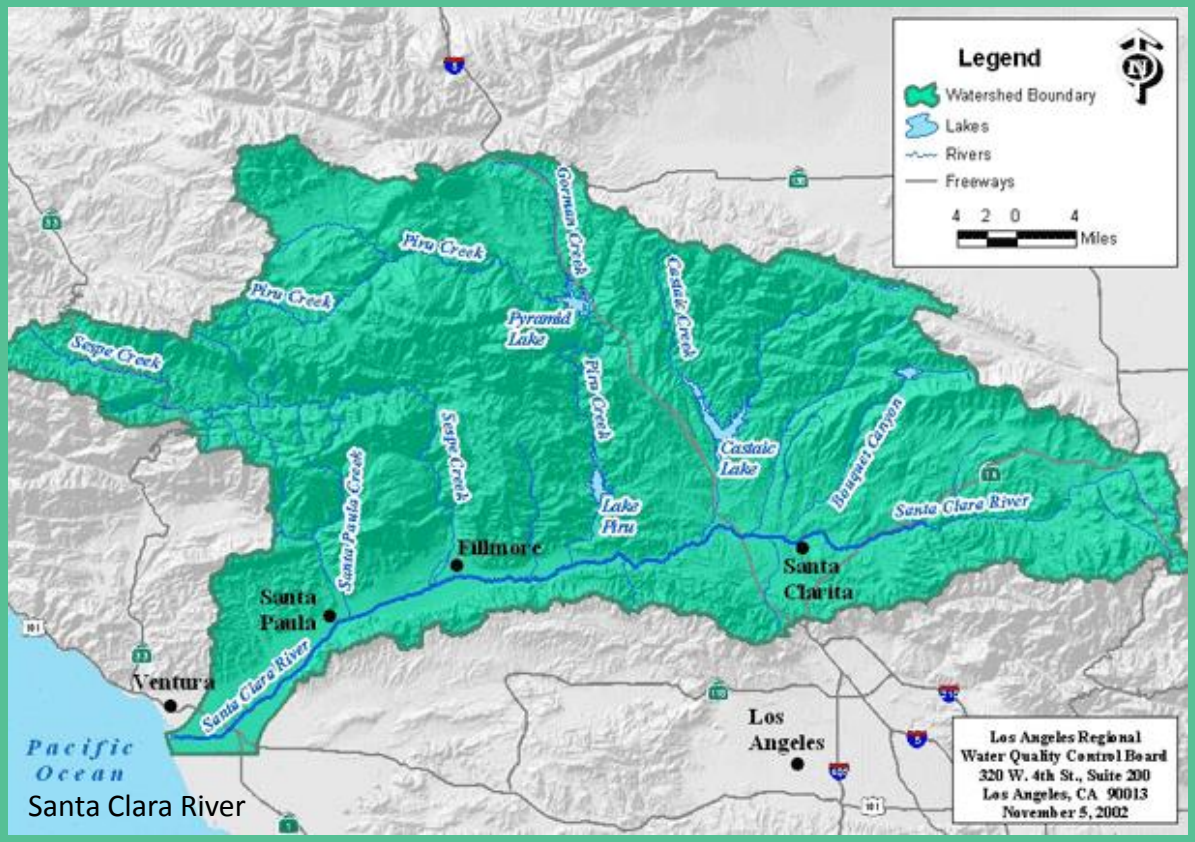
Rivers Edge West 2018



View of the Santa Clara River; March 15, 2017

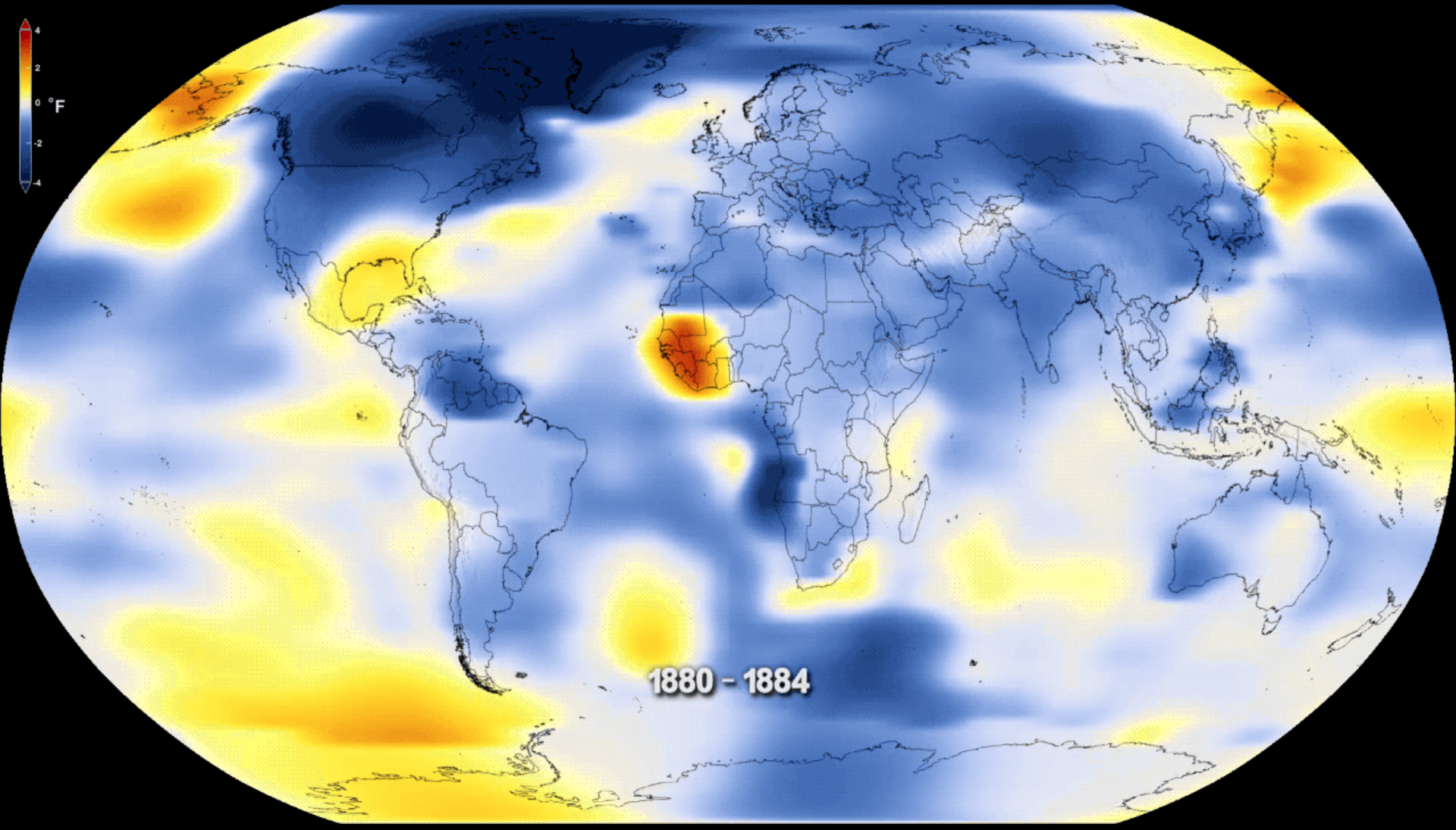
The Santa Clara River is one of the most dynamic river systems in southern California



Santa Clara River

There are multiple threats to our riparian ecosystems

Climate change is leading to warmer temperatures

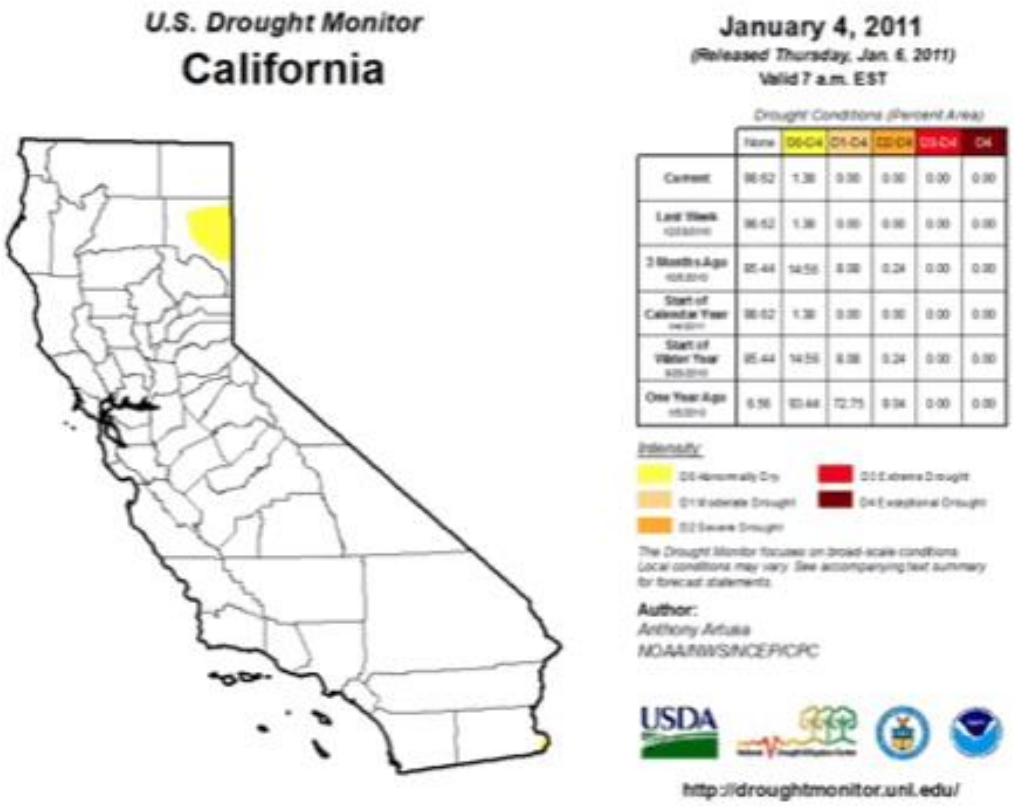


Gif: NASA GISS

“The Great California Drought”

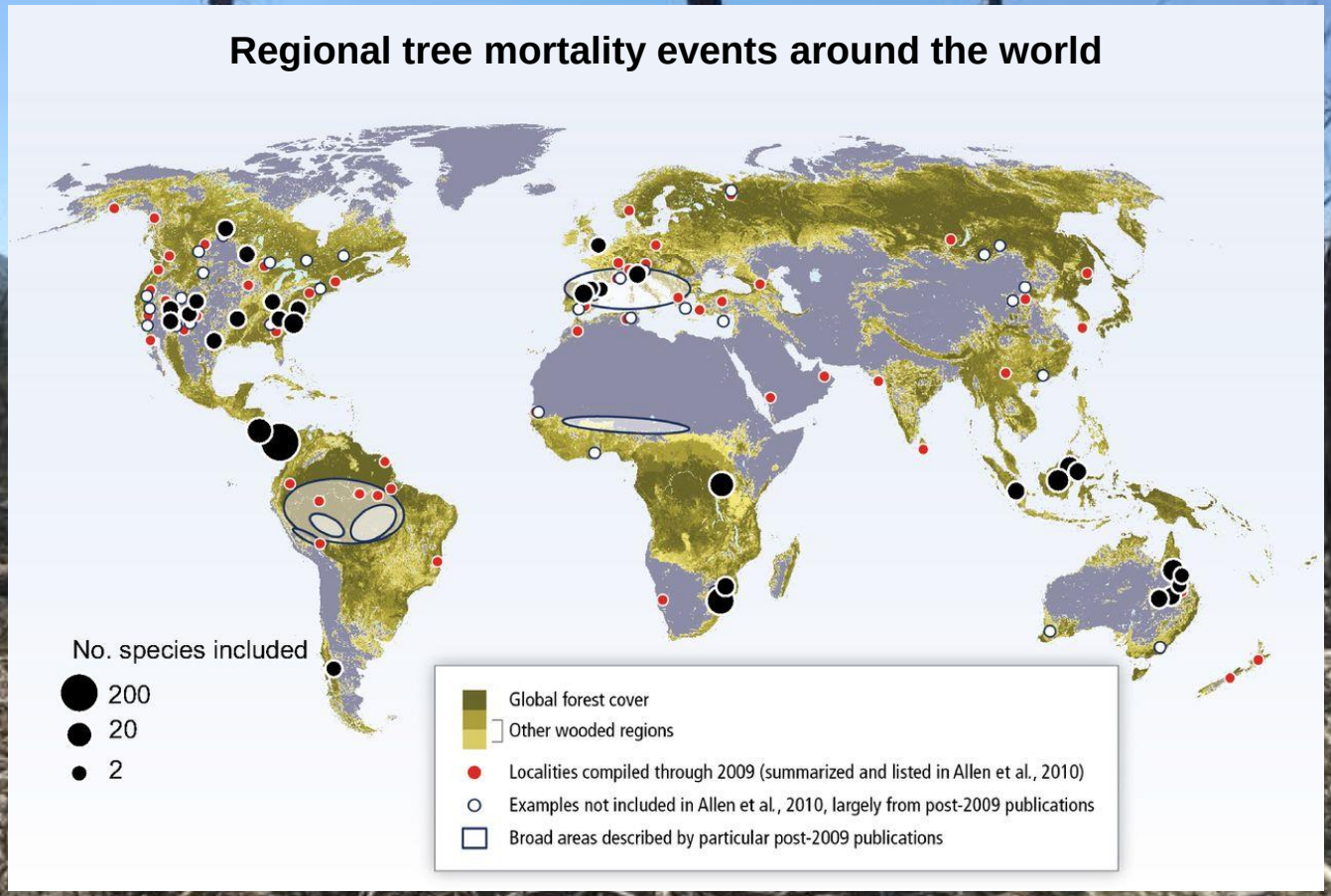
The 2012-2017 drought was the worst in 1200 years

(Griffin & Anchukaitis 2014)



Drought + hotter temps =

Global change-type drought or "hot" drought



William R. L. Anderegg et al. 2016. PNAS 113:18:5024-5029

Arundo donax is on the list of "100 of the World's Worst Invasive Alien Species"

Global distribution of *Arundo*

Map: A Global Biodiversity Information Facility

- Grows >13 ft tall
- Forms impenetrable monocultures
- Displaces native plants and associated wildlife
- Fuels catastrophic wildfires
- Suspected of altering hydrology and reducing groundwater availability

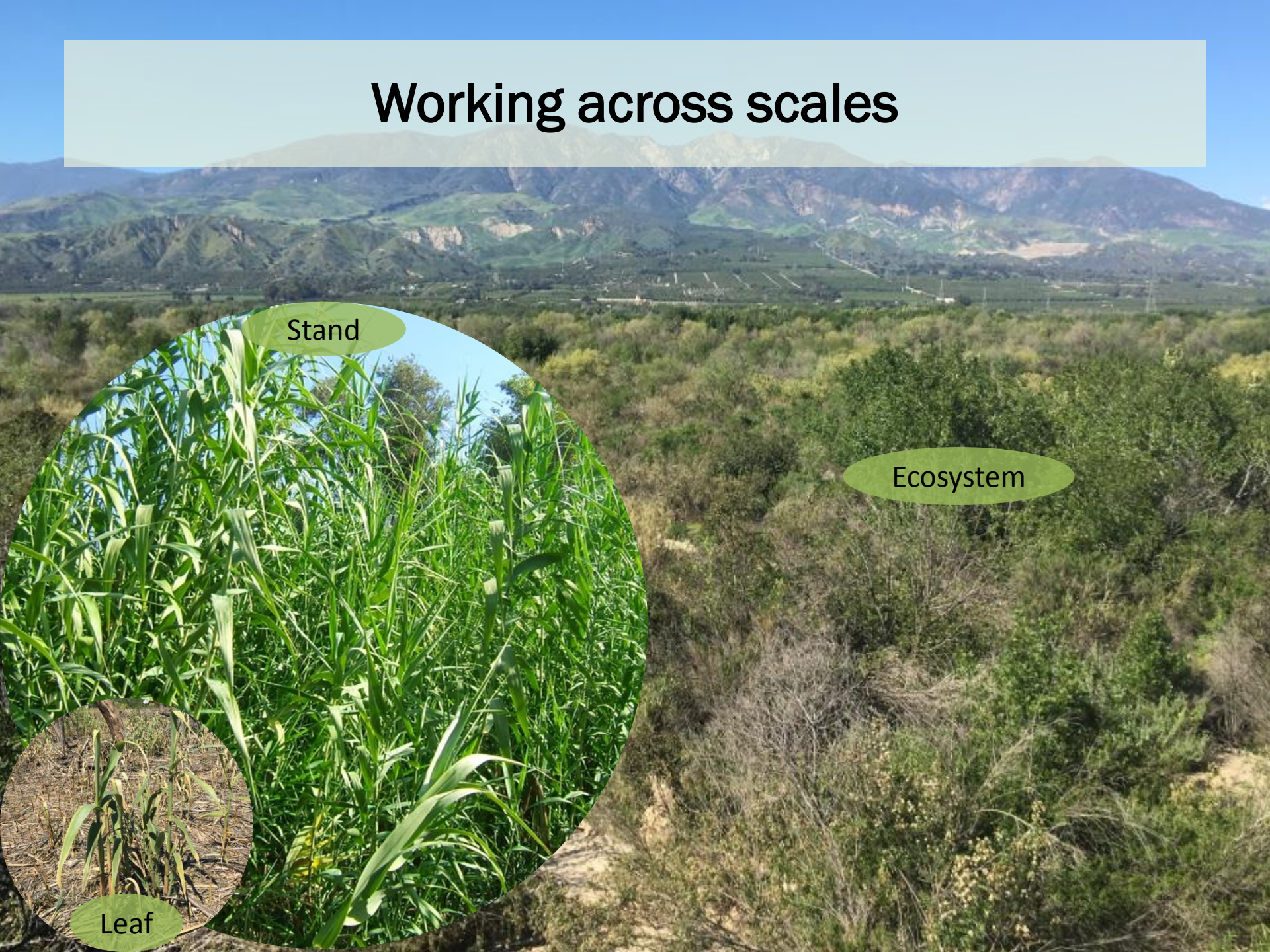
- **In a hotter + drier future, water will be even more limiting, which makes understanding the water use of *Arundo* vs. native riparian trees essential for successful restoration.**

Photo: Adam Lambert

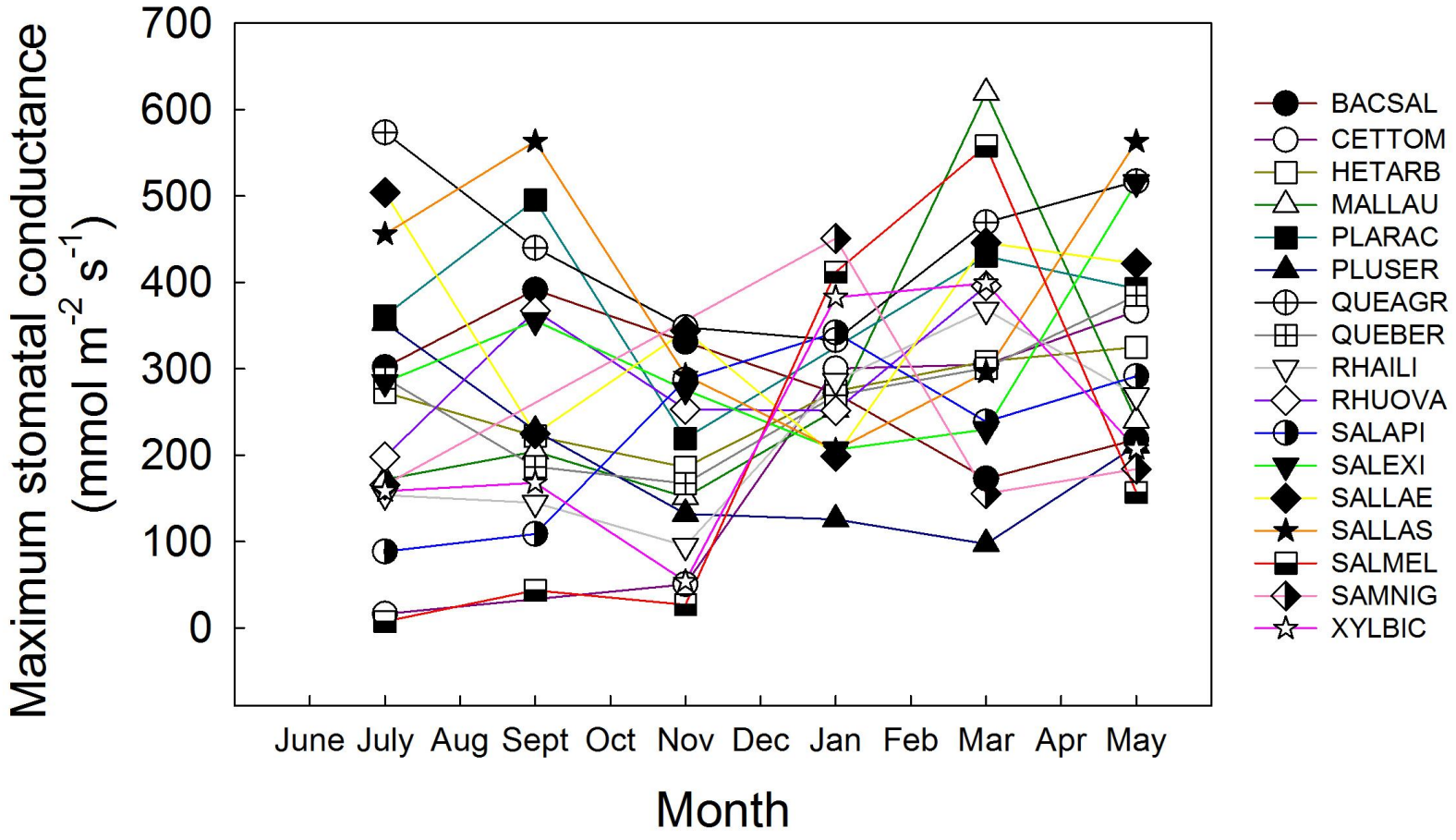
Research Questions

- **How do plant water relations and hydraulics compare between *Arundo* and native species?**
  - Are native or invasive species more equipped to deal with future environmental changes?
  - Does *Arundo* use more water than native species?
- **Can we use this knowledge to inform restoration efforts?**
  - If we eradicate *Arundo* and restore native vegetation, what will the water savings be?

Working across scales



Patterns of stomatal conductance vary broadly among species and across seasons



Arundo has remarkably high leaf-level water use efficiency

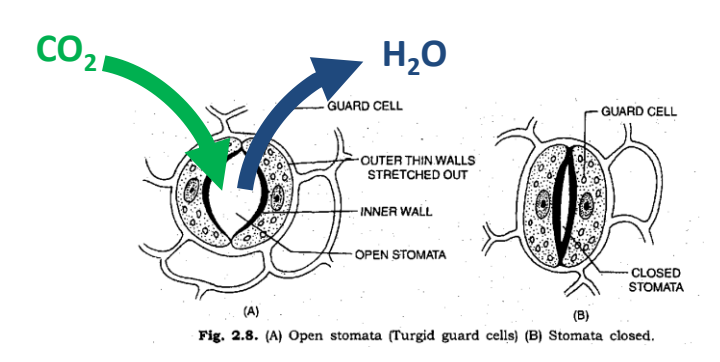
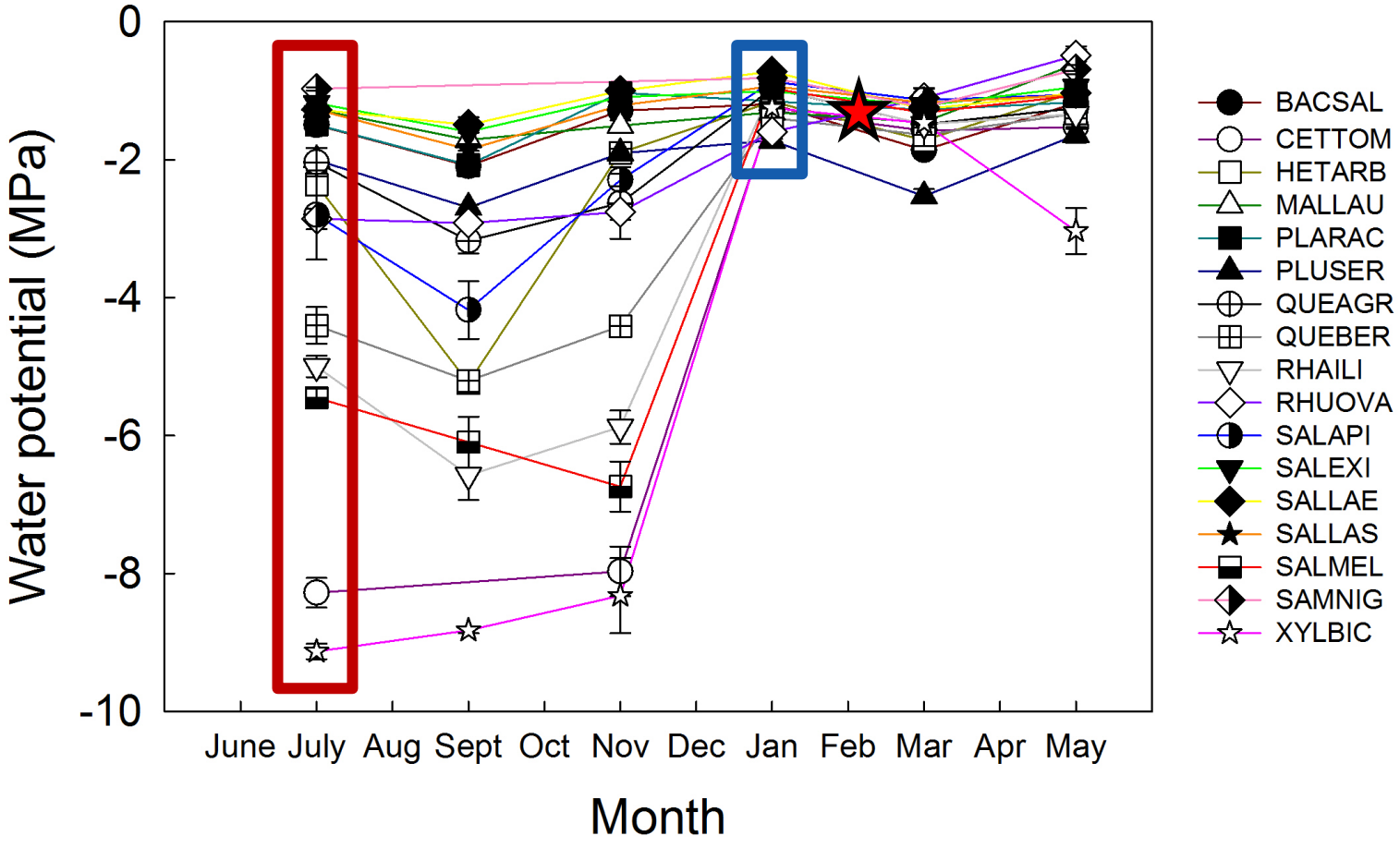


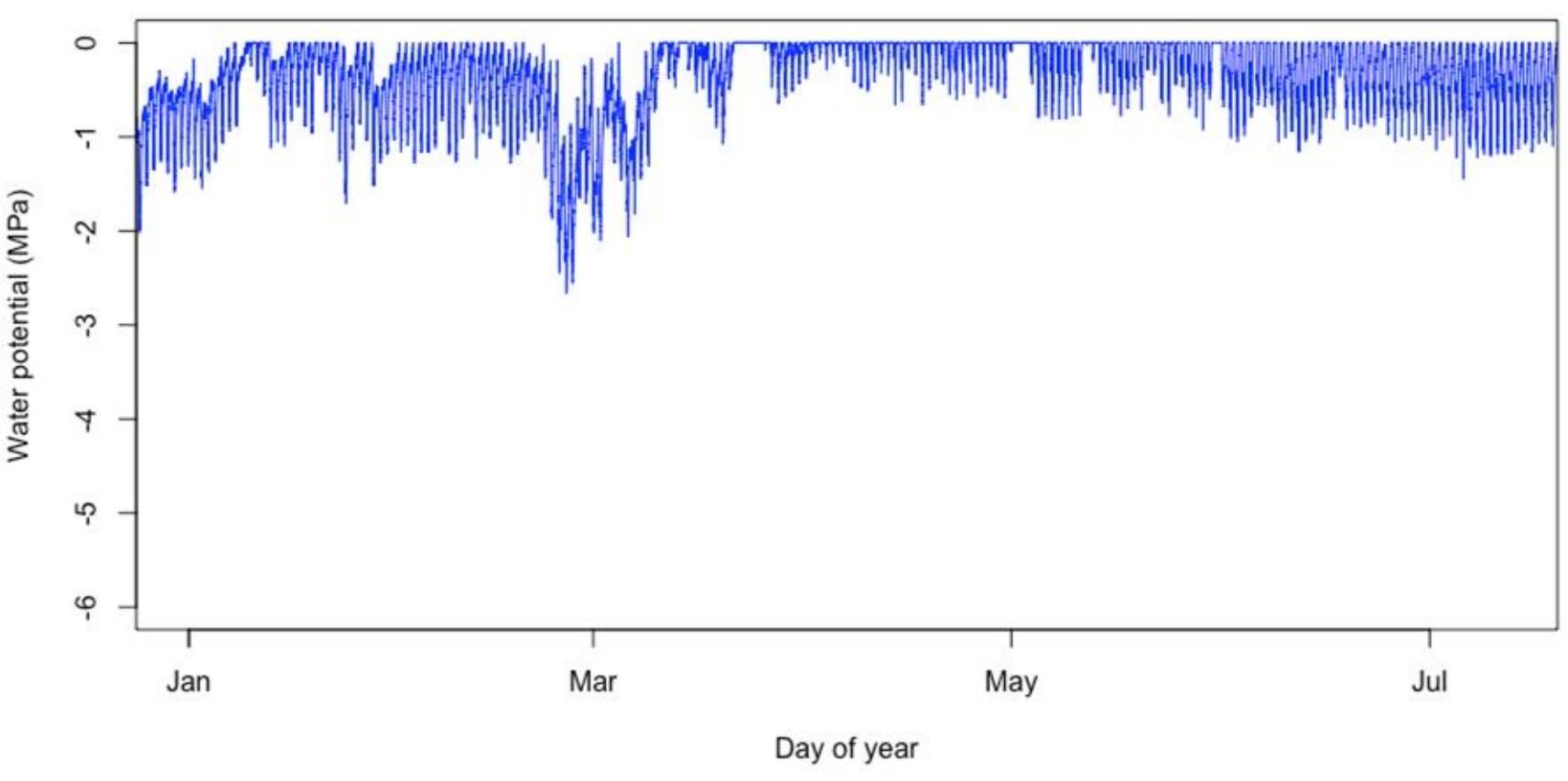
Fig. 2.8. (A) Open stomata (Turgid guard cells) (B) Stomata closed.

Trait	Mean ± SE		Comparison (n=78)
Photosynthesis (A_{max})	**9.91** ± 2.45	=	**9.42** ($\bar{x}$)
Stomatal conductance (g_s)	**55.78** ± 17.62	<	**42** (min); **142** ($\bar{x}$)
Water use efficiency (A/g_s)	**194.81** ± 14.0	>>	**142** (max); **59.4** ($\bar{x}$)

Water potentials diverge during summer drought but converge with winter rains

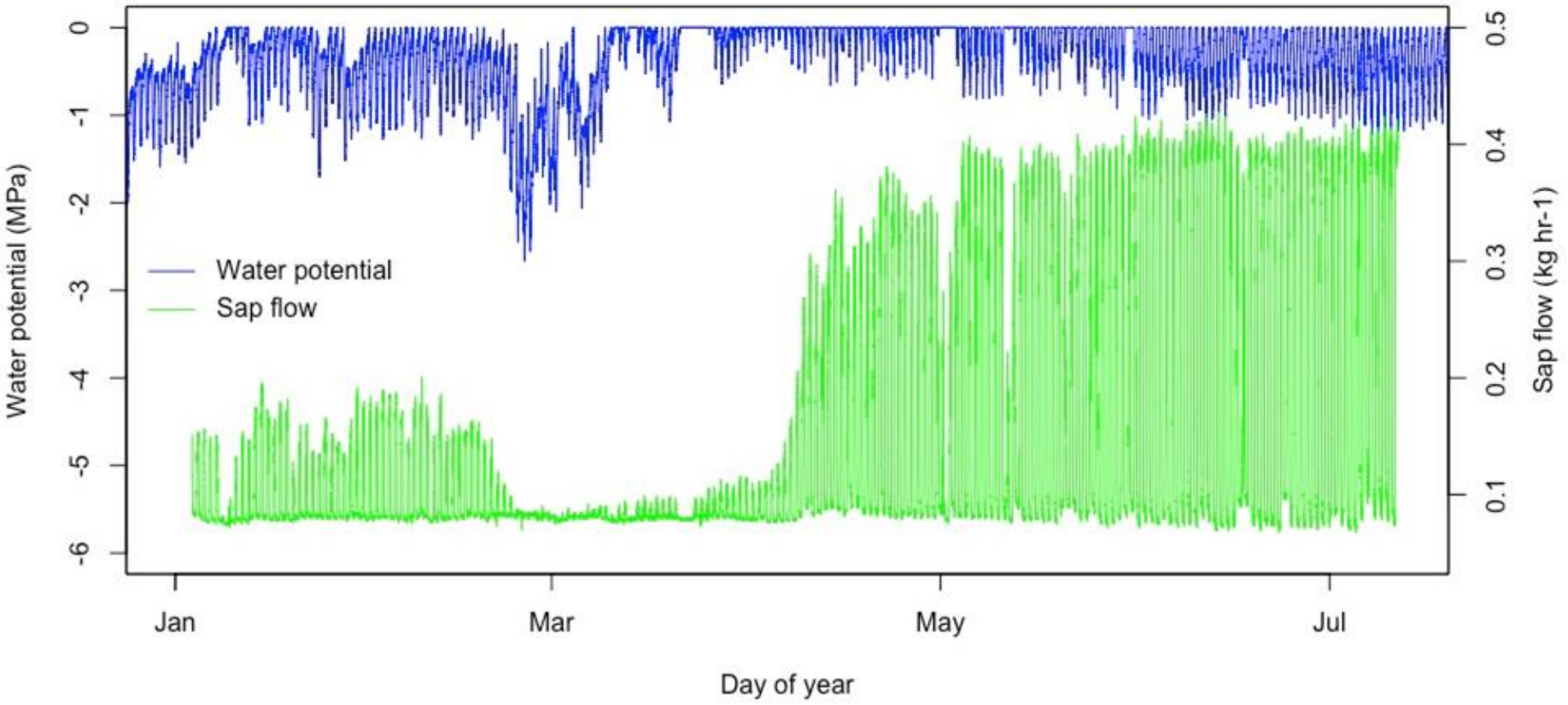


Arundo maintains high water potentials across seasons



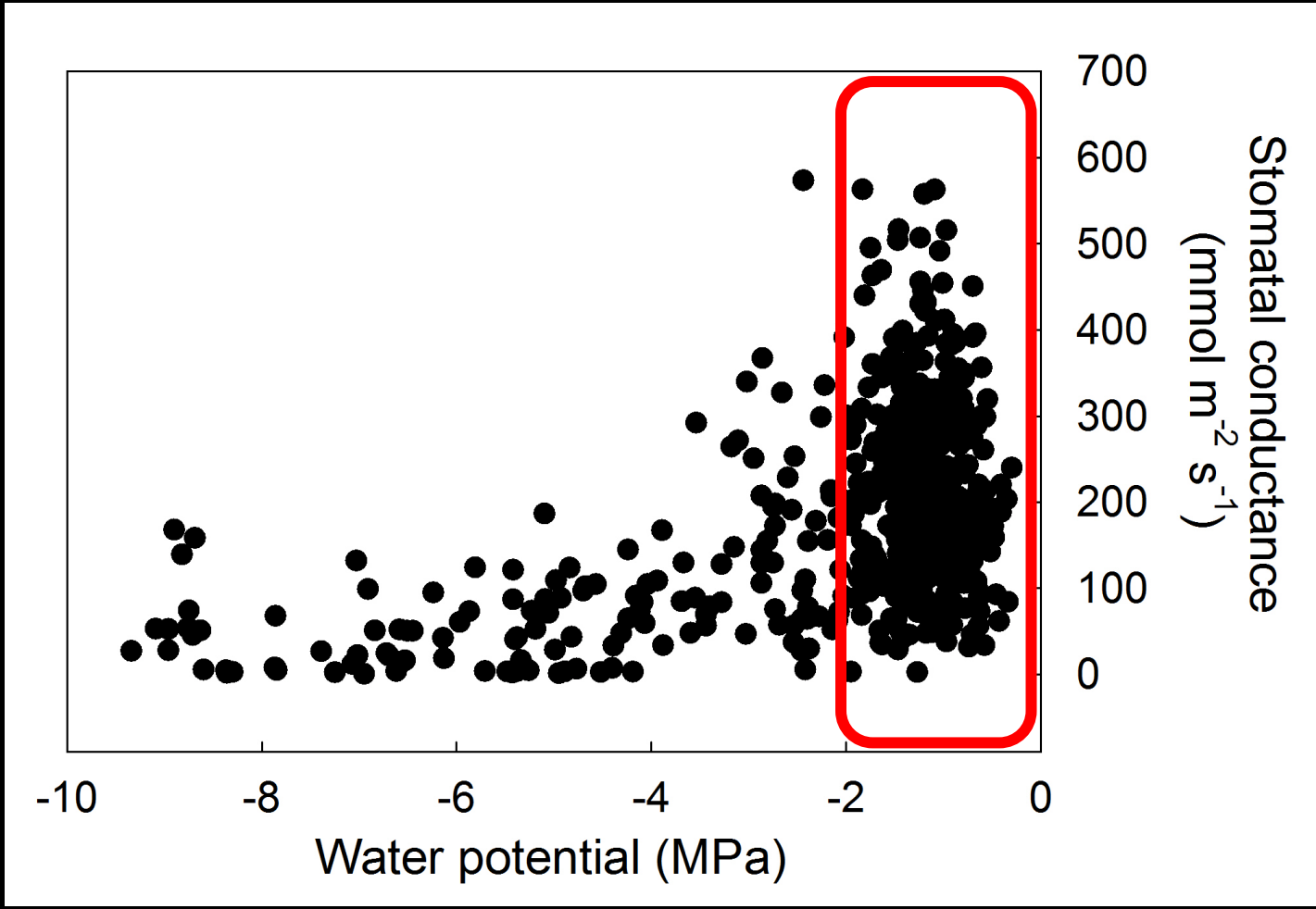
This may be indicative of access to groundwater

Arundo also maintains high transpiration rates when water potentials are high (less negative)

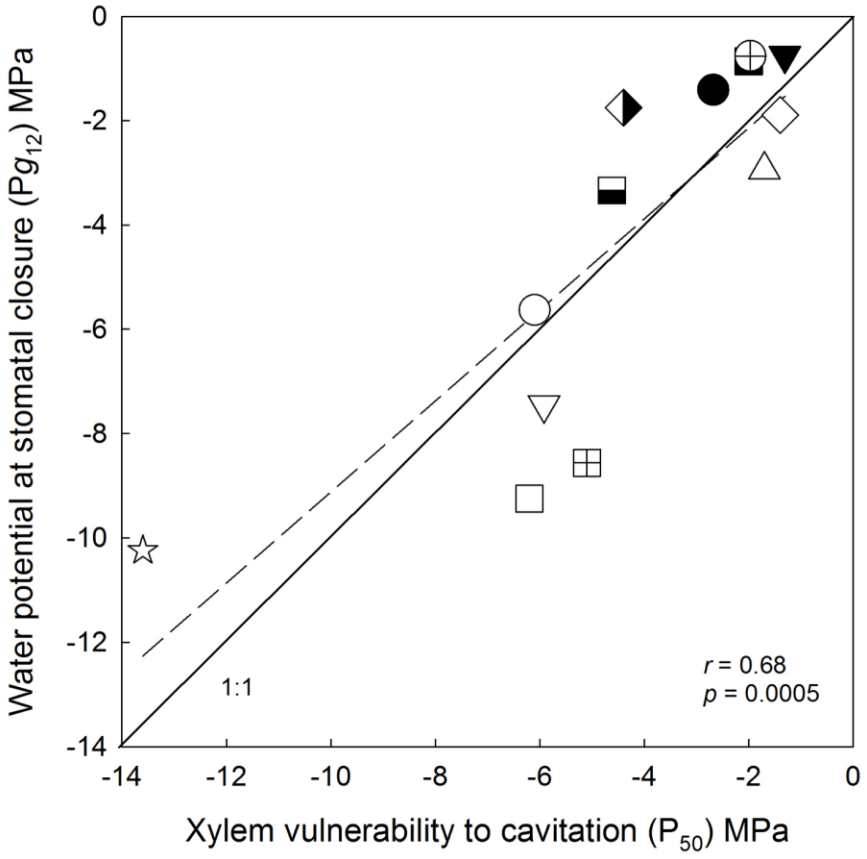


(analysis is on-going…)

Overall, stomatal conductance declines with lower water potentials



There was coordination among xylem and stomatal traits



Species with more resistant xylem were able to maintain stomatal conductance at more negative water potentials.

Embolisms in the vascular system: Bad for people and plants

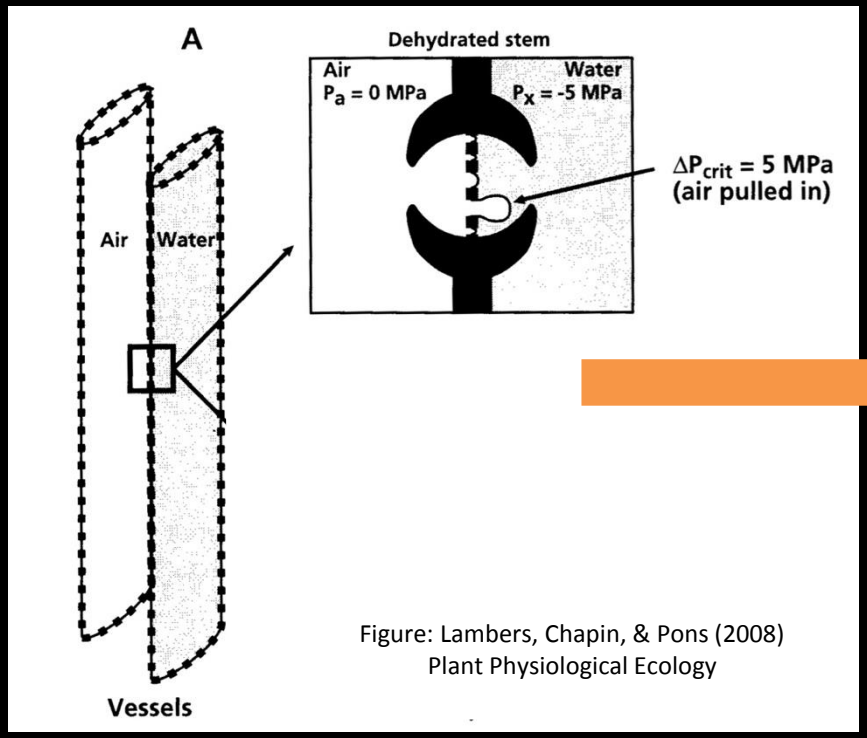


Figure: Lambers, Chapin, & Pons (2008)
Plant Physiological Ecology

Bubbles in xylem conduits

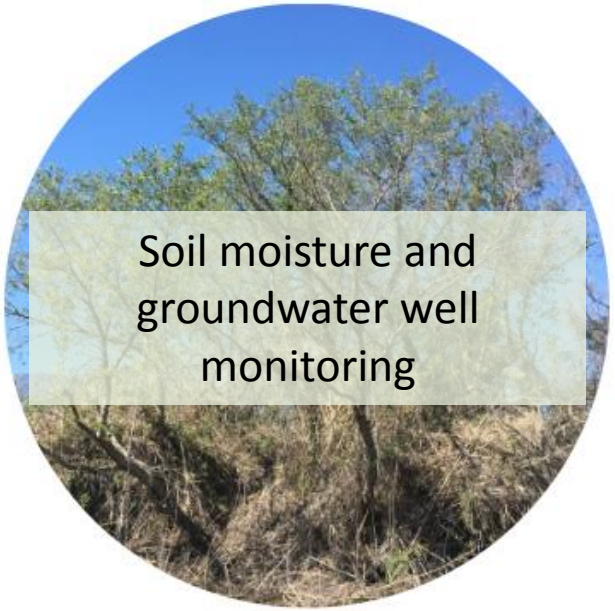
Image: Sperry lab

- Embolisms are air bubbles that block water flow through vessels
- Embolised vessels cannot move water
- We can quantify xylem vulnerability to cavitation

Cutting edge methods:

Using high resolution imagery to visual cavitation

Continuing Work & Future Directions



Conclusions

- Individuals leaves of *Arundo* are much more water use efficient than native riparian tree, but…
- Stand-level transpiration is high (but data analysis is on-going…)
- The Santa Clara River and its tributaries offer perhaps our best chance for protecting river habitat in southern California.