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Title:	Why do we study plants? -Ask a plant.
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Why do we study plants? - Ask a plant.

Sanna Sevanto
Earth and Environmental Sciences Division
Los Alamos National Laboratory

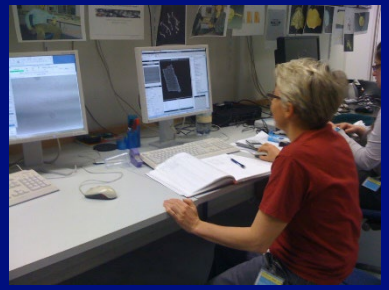
Periodic Table, June 19th, 2023

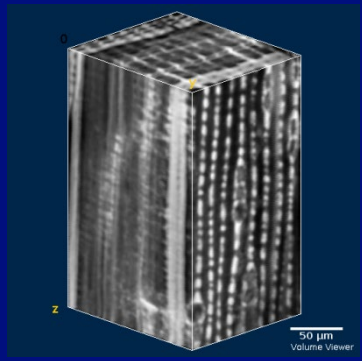
Who am I, and how did I get here?

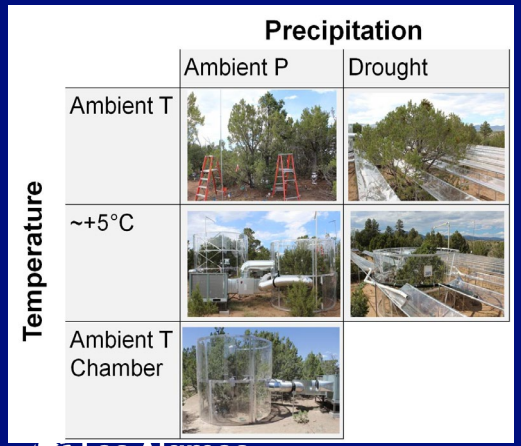
- Sanna Sevanto, Staff Scientist, Team leader: Landscape and Ecosystem Dynamics and Resilience
- PhD in Physics (Atmospheric and Environmental Physics)
- Master's in Materials Science, University of Helsinki, Finland

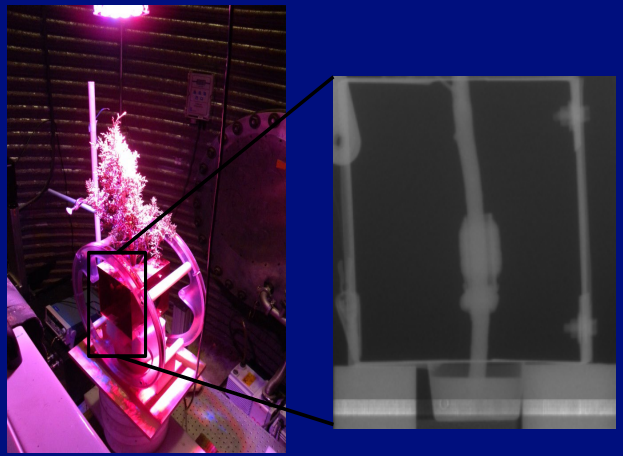
Who am I, and how did I get here?

- Experimentalist, interested in **systems science and extremes**
- Uses observations, manipulation experiments, biophysics and materials sciences tools to understand natural system drivers and bottle-necks/tipping-points
- **Scaling up from cellular to impacts on global scales**









Thank you!

Los Alamos National Laboratory:

-EES and vegetation team
-Bioenergy and Biome Sciences
-Physics Division
-Material Sciences
-NEN
-IRS

LANSCE
Los Alamos Neutron Science Center

UNM Pockman and Hanson groups

Duke University
Gaby Katul,
JC Domec,
Assaad Mrad,
Mazen Nakad

EMPA –Swiss Federal Laboratories of Materials Science
Dominique Derome, Jan Carmeliet, Thijs Defraeye, Alessandra Patera, David Mannes, David Habitur, Anne Bonnin @ Paul Scherrer Institute

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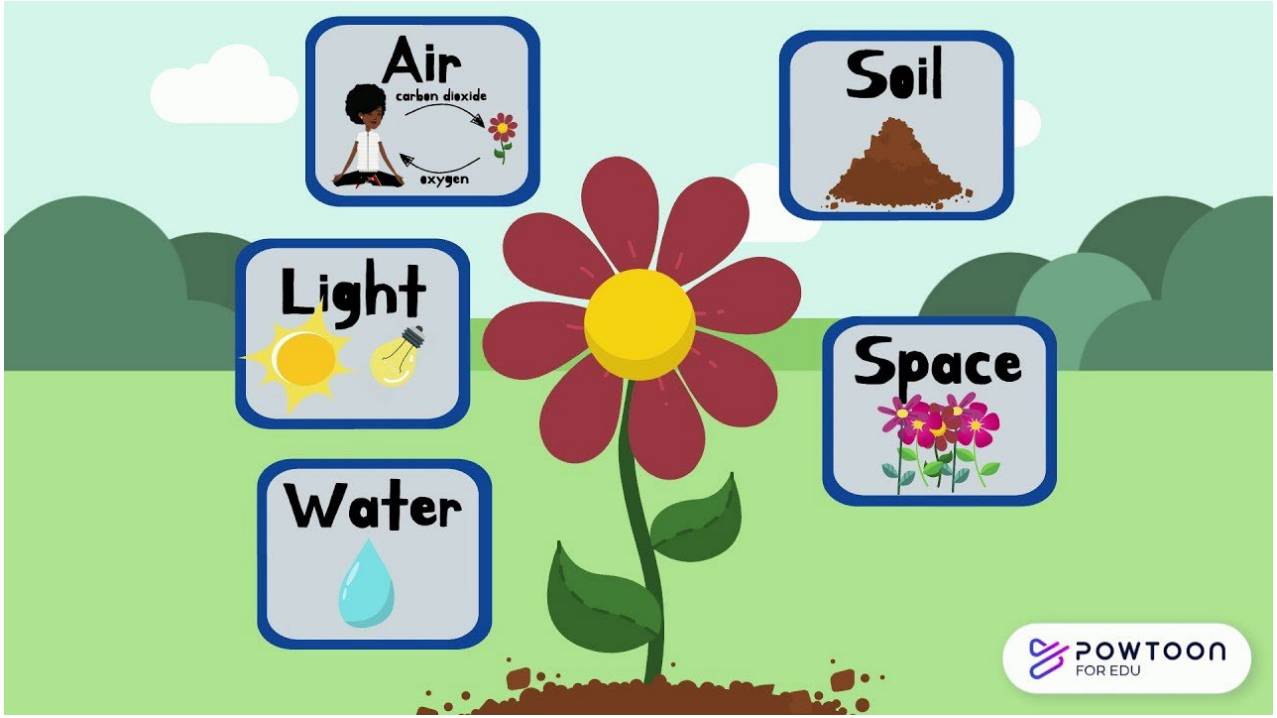
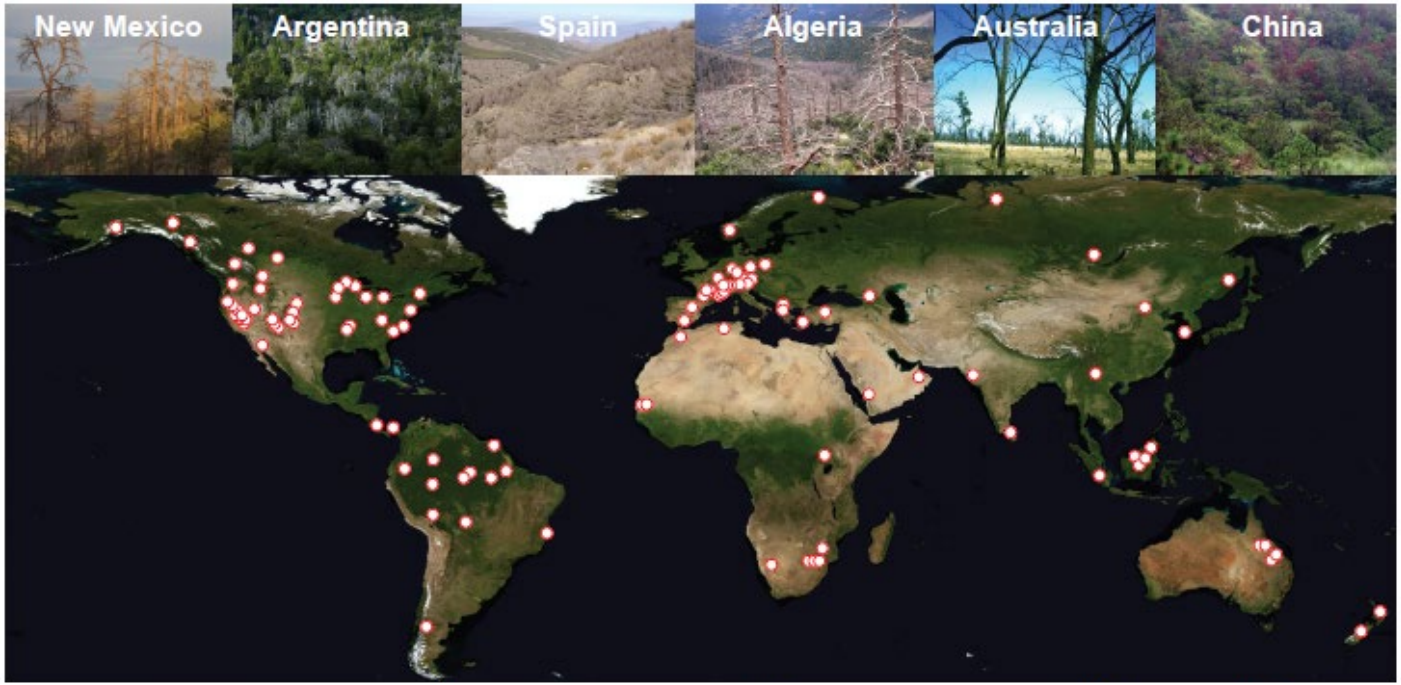
Why do we study plants?



Why do we need to study plants?

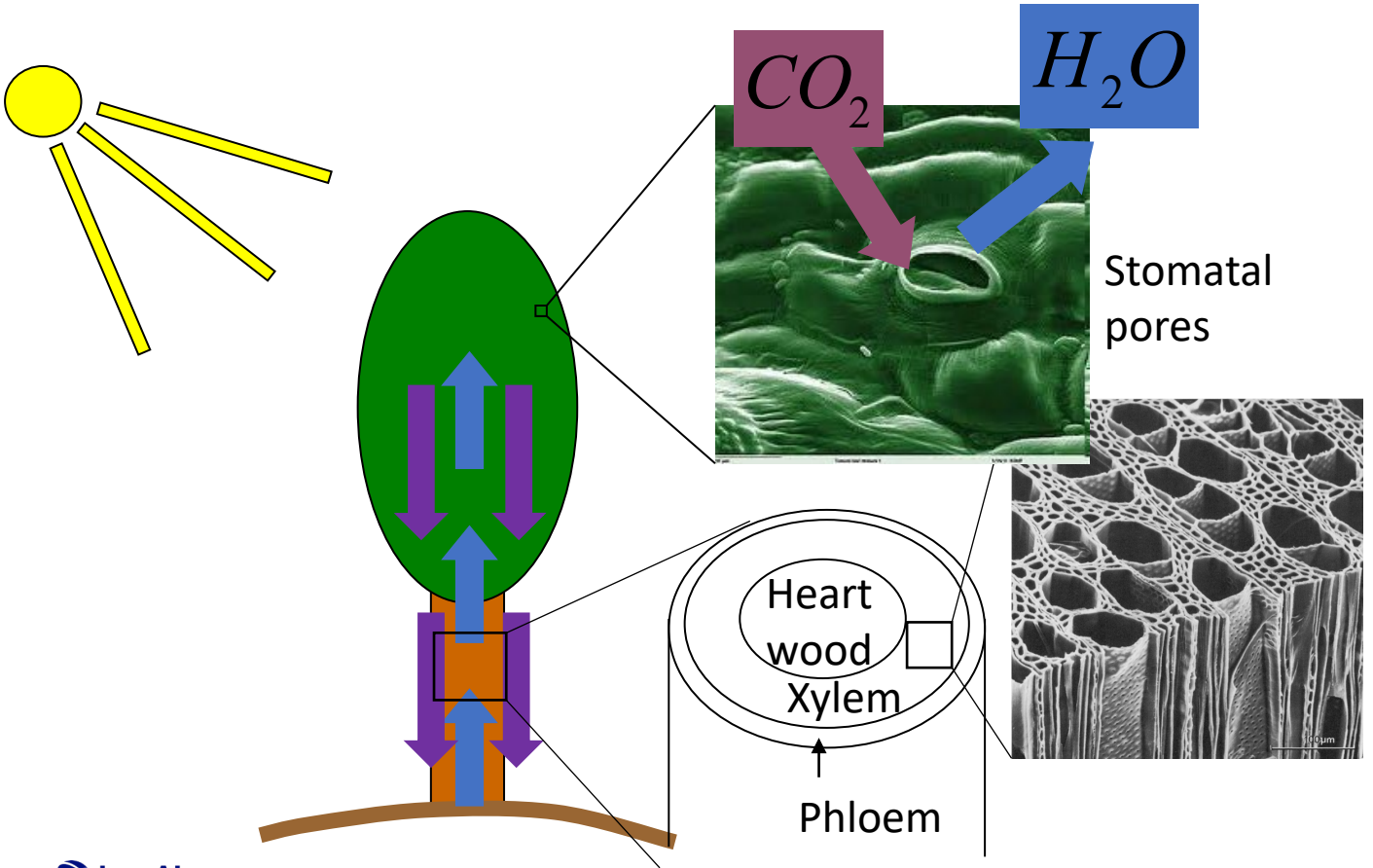


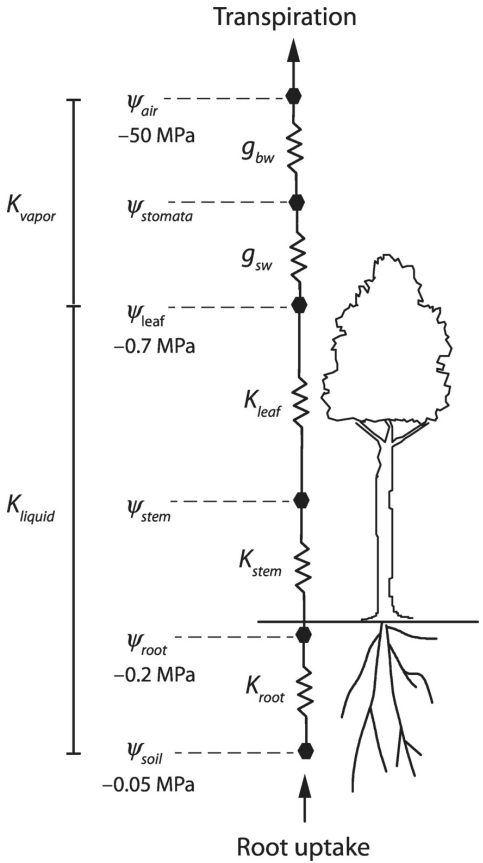
We would not be here without plants

https://nph.onlinelibrary.wiley.com/doi/10.1111/nph.18771

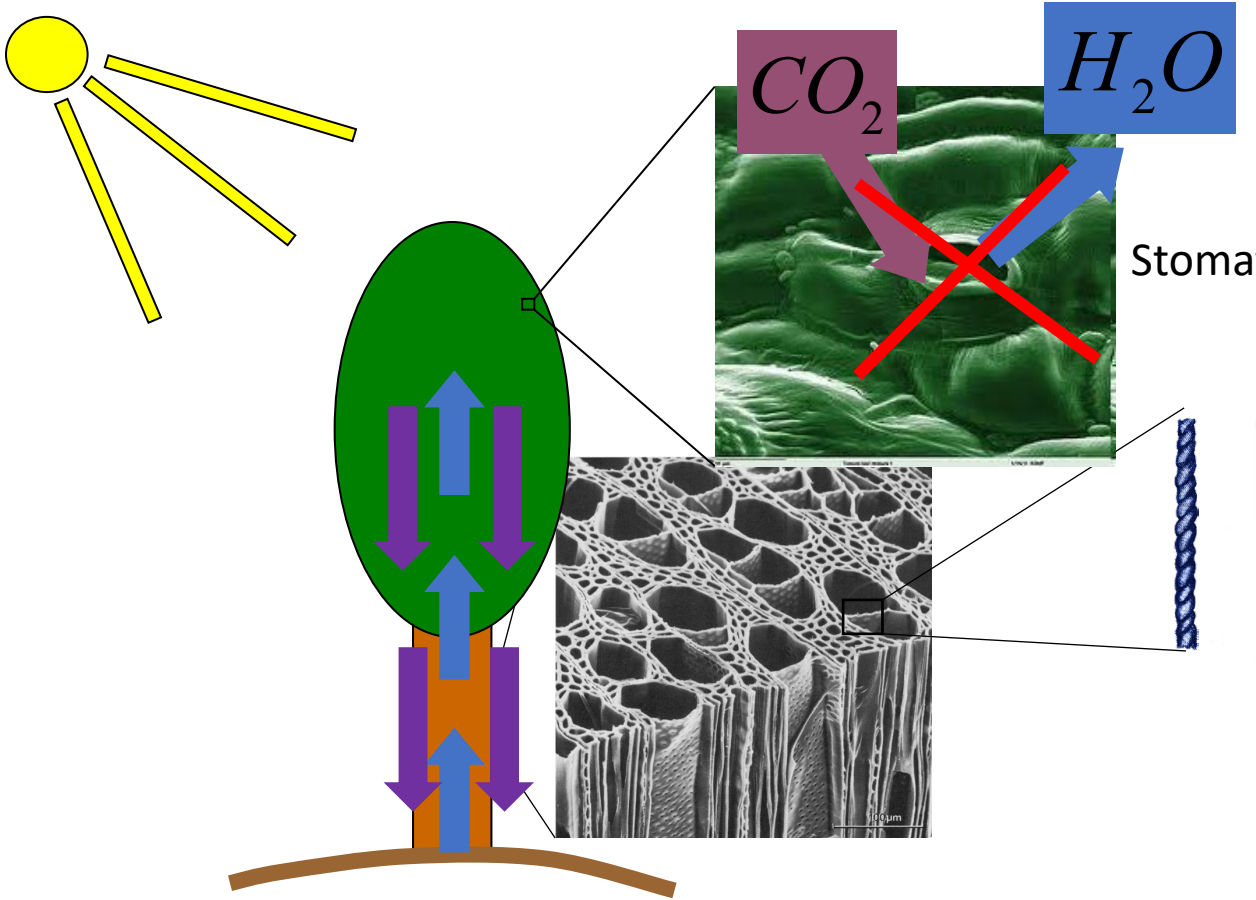
- **Climate change:** How will climate change impact plant abundance, productivity, bioregions and ecosystems?
- **Science in the community:** How can we ensure that the varied goals and needs of our diverse societies are understood and fulfilled by plant scientists?
- **Food security:** How do we leverage existing genetic diversity to create climate-resilient crops?
- **Biodiversity:** How does species diversity develop in novel ecosystems such as restored agricultural land, forests, grasslands and gardens?
- **Sustainability:** Could plant-defense priming be a platform for a new green revolution?
- **Plant-plant interactions:** How are interactions between plant species regulated?
- **Plant disease:** How should we prepare for novel pathogens of trees, crops and the natural environment?
- **Plant-microbiome interactions:** How does the plant microbiome affect stress tolerance?
- **Plant adaption:** What is the plasticity of the epigenome of plants?
- **Plant stress responses:** How do plants cope with combined stressors?
- **Ecosystem services:** What natural materials could be invested in for a more sustainable future of manufacturing or residential development?

What do plants do?

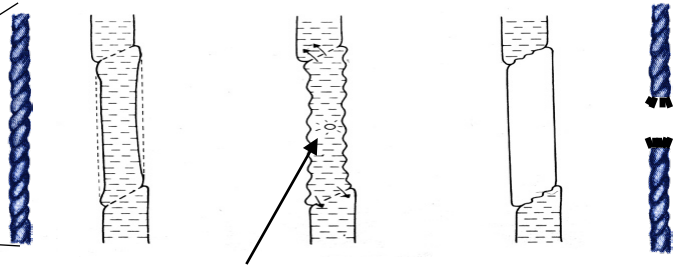




What are the main risks for plants?



Stomatal pores



Cavitation:

Rapid phase change from liquid to vapor caused by introduction of an air bubble

How do plants cope with the risks?

Changes in structure

Photo courtesy Sangeeta Negi

Changes biochemistry

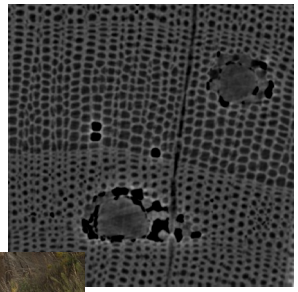
Migration **60-250 m yr^{-1}**

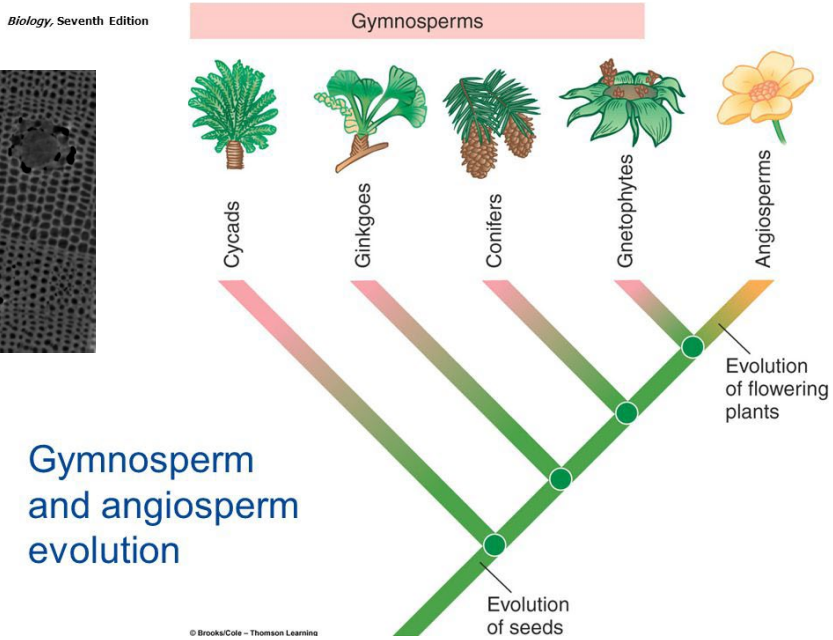
Adaptation **50-5000 years**

Acclimation

Right now

There are slow and fast plants:



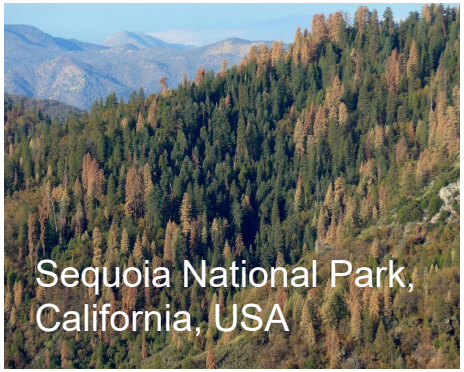


Gymnosperm and angiosperm evolution

Drought tolerance

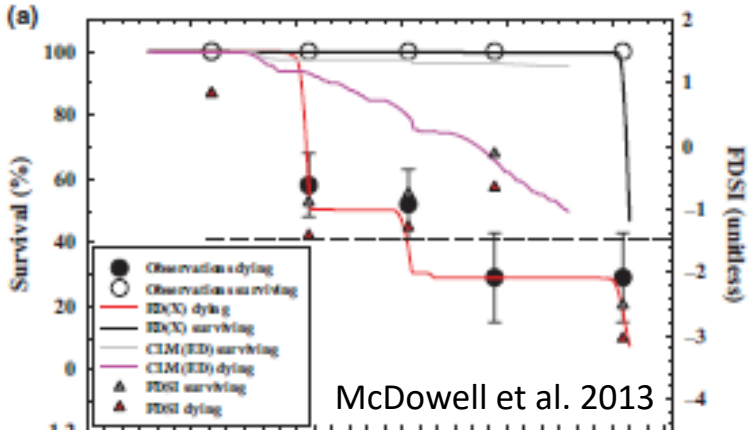
Growth rate

One of our challenges:



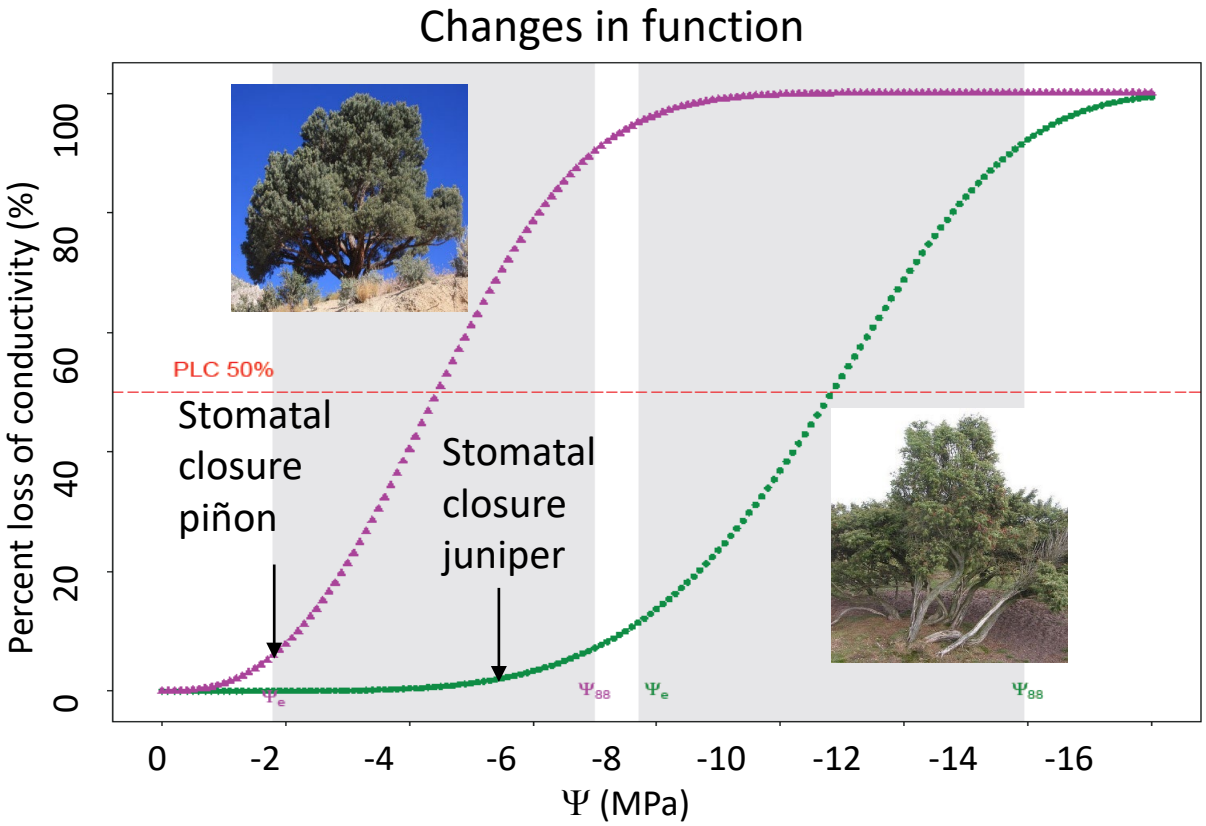
Forest mortality is often patchy

Models predict collapse of the whole population



McDowell et al. 2013

The known and unknown unknowns



Intriguing findings:
Stomatal closure point is not constant

Plant, Cell & Environment
Plant, Cell and Environment (2013)
doi: 10.1111/pce.12141

How do trees die? A test of the hydraulic failure and carbon starvation hypotheses

SANNA SEVANTO[1], NATE G. MCDOWELL[1], L. TURIN DICKMAN[1], ROBERT PANGLE[2] & WILLIAM T. POCKMAN[2]

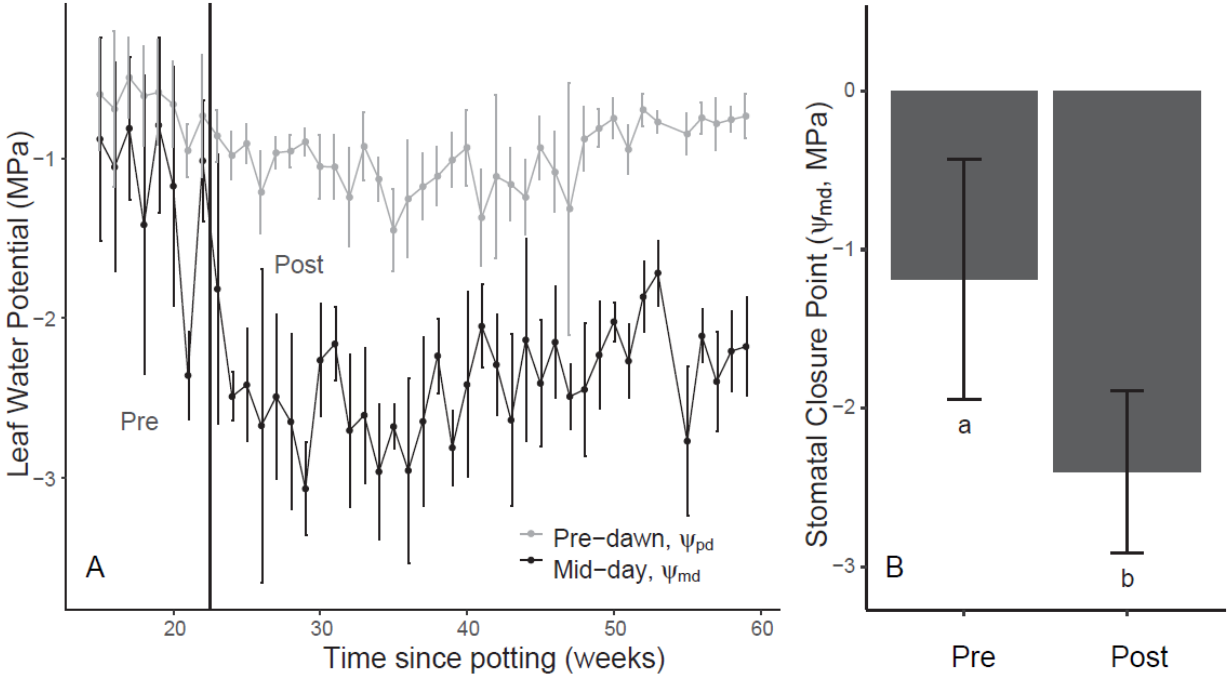
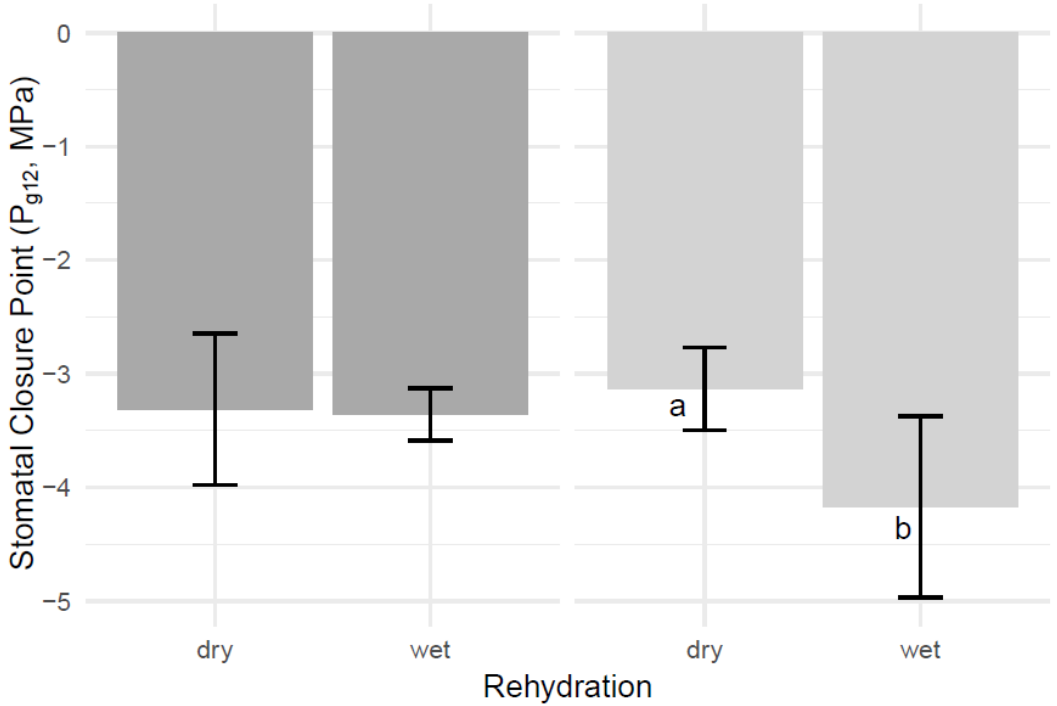


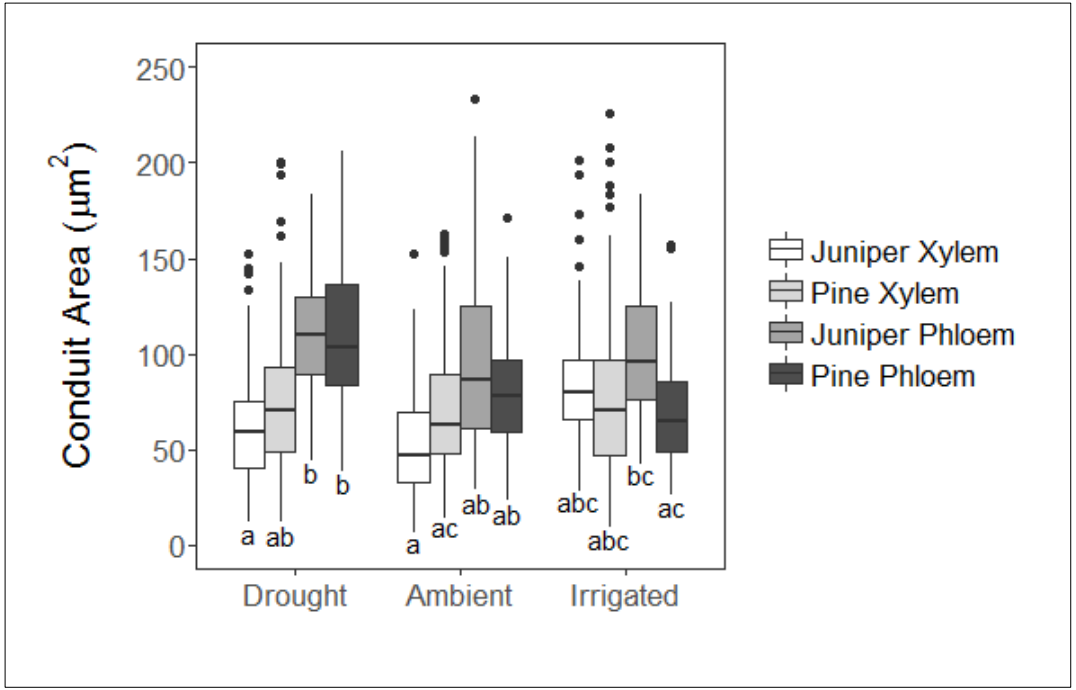
Figure courtesy Turin Dickman

Pine can shift stomatal closure point, juniper can't



Dickman et al. *in prep*

Conduit size between pinon pine and juniper does not differ.

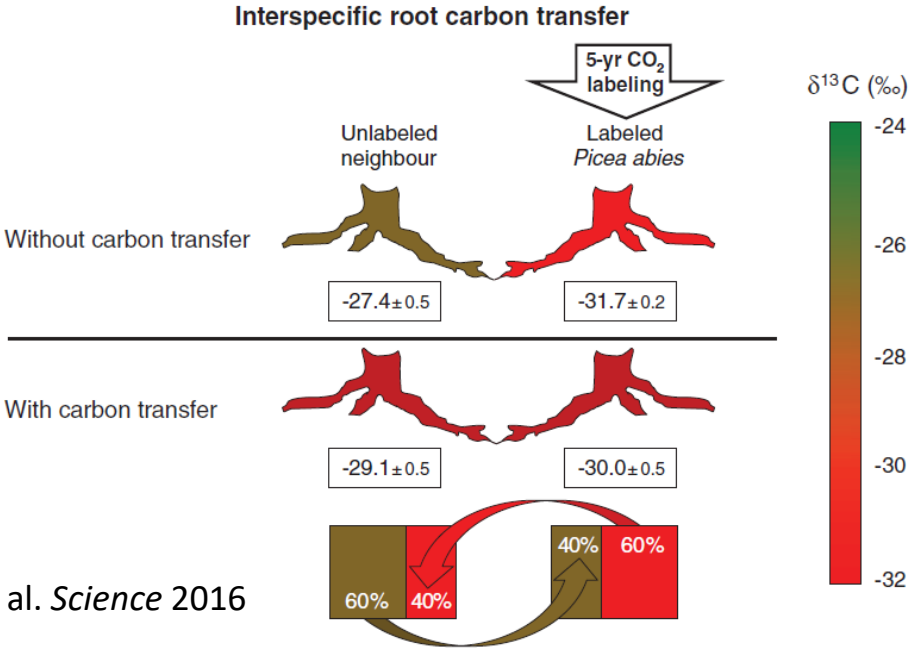


Sevanto et al. 2017, Plant, Cell and Environment

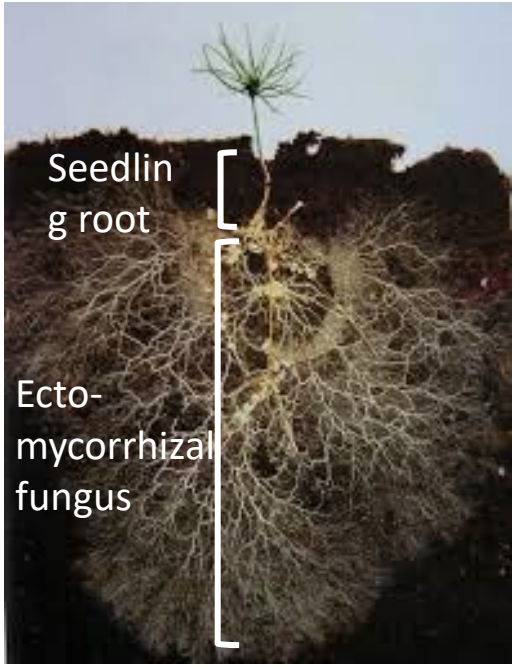
What determines plant survival under drought?

Maybe it's who has best support team

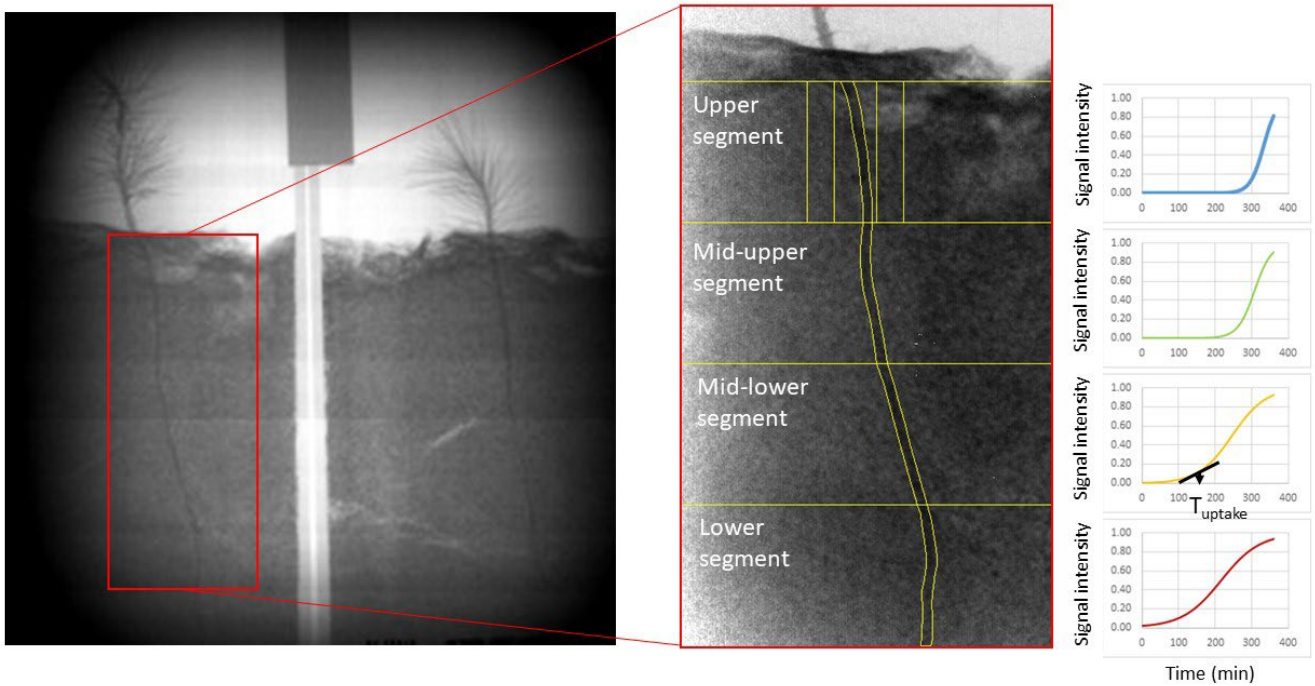
"Forest is more than the sum of its trees"



Klein et al. *Science* 2016

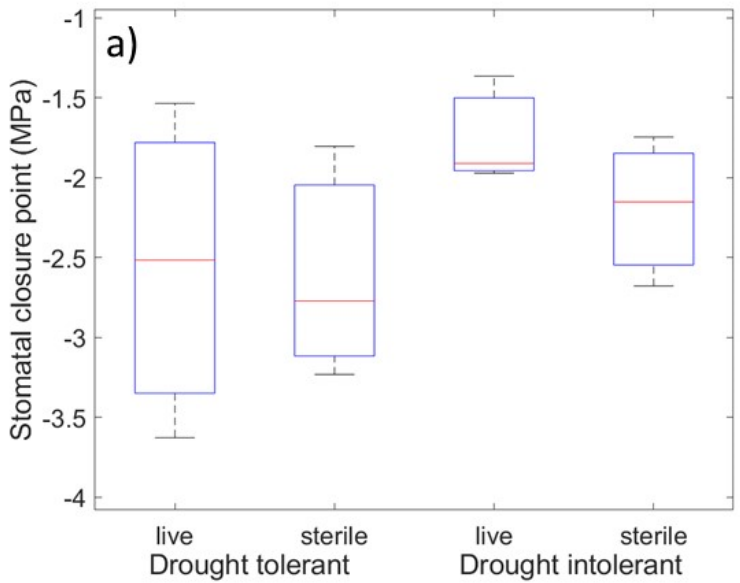


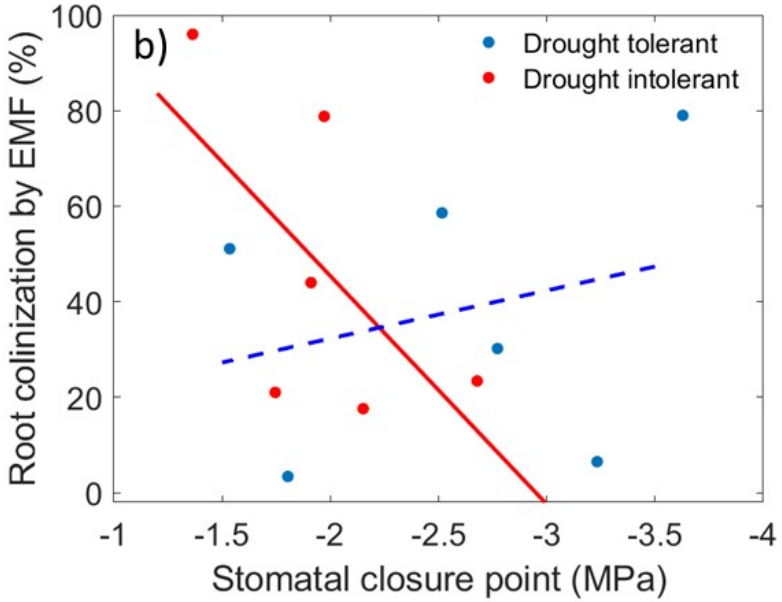
Do symbiotic microbes affect stomatal closure point?



Sevanto et al. Scientific Reports in review

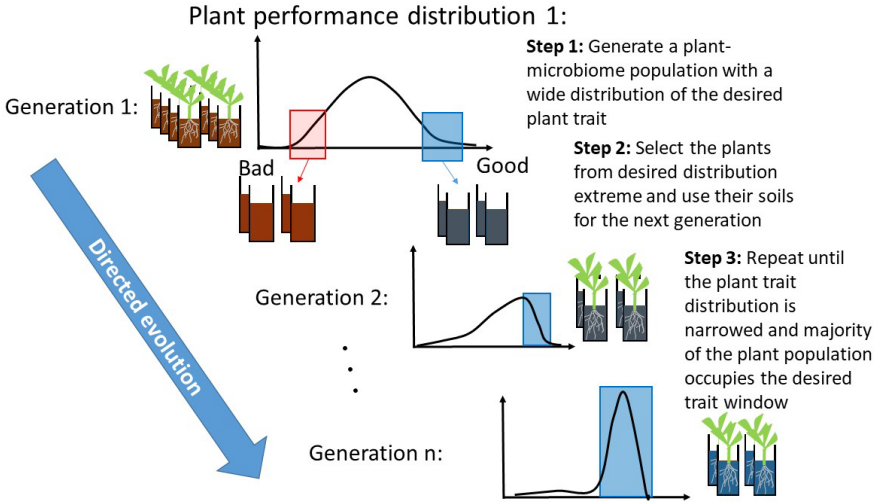
Yes, they can!

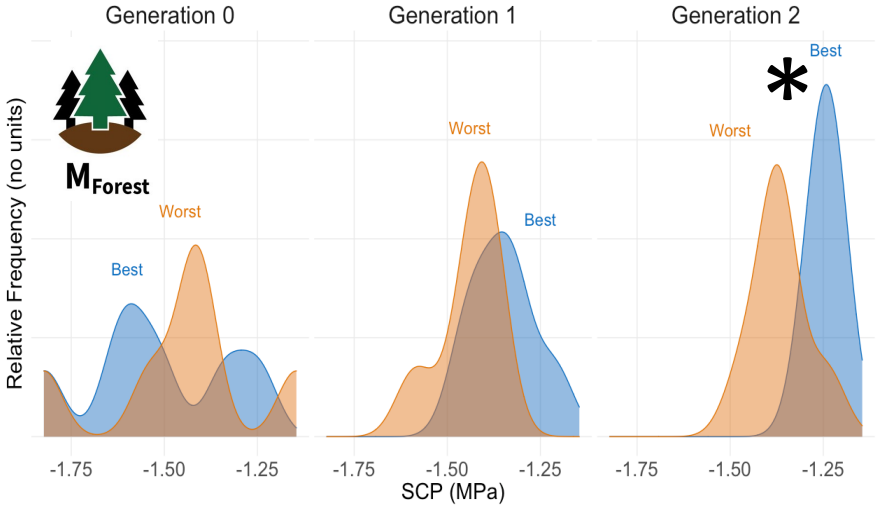




Sevanto et al. Scientific Reports in review

And we can engineer microbiomes that change stomatal closure point…

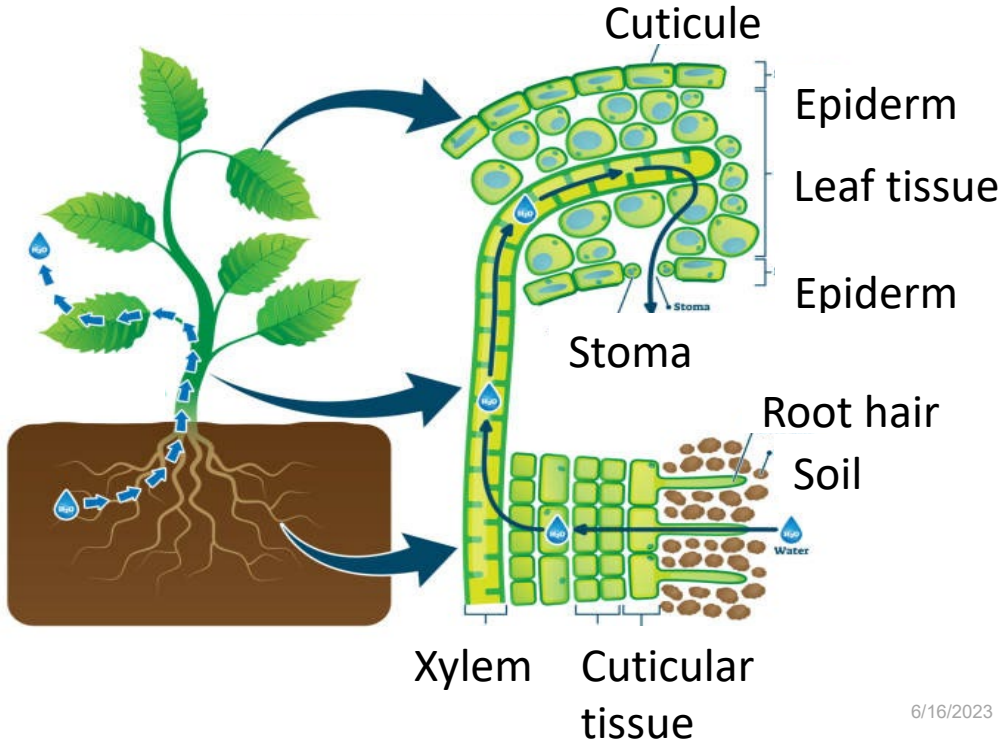




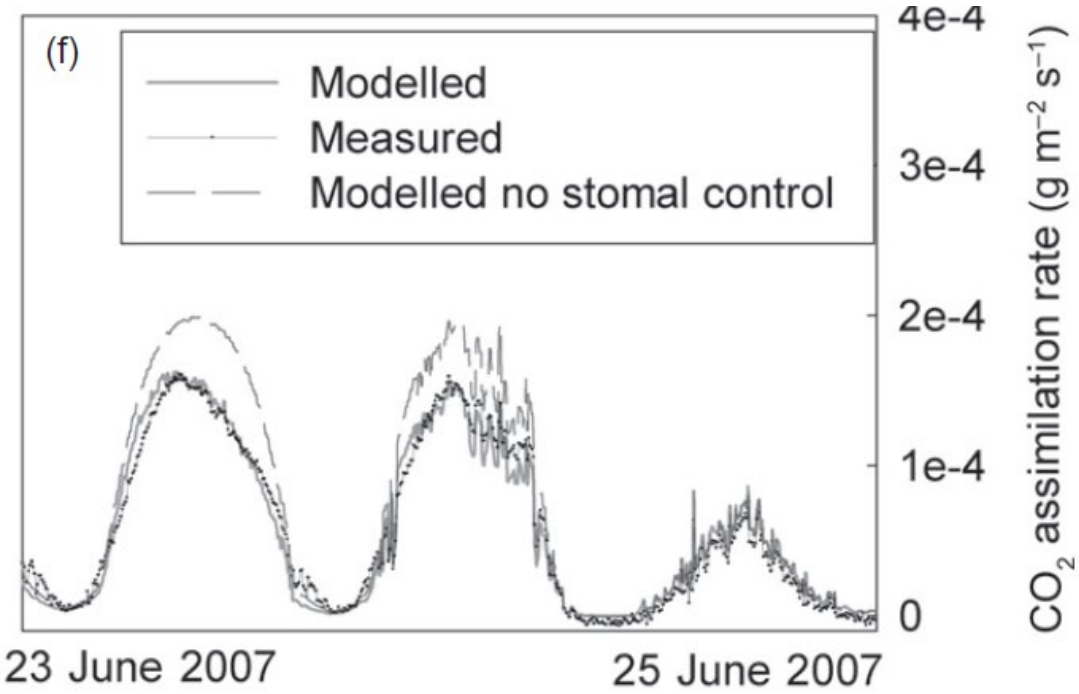
Sevanto et al. in prep

Where are we going:
-Food and biofuel security
-Plants as biosensors
-Optimizing carbon sequestration

- Structural strength and stability
- Minimization of water loss (bark, leaf cuticular tissue)
- Biochemical
- Scavenging for resources (root, symbiotic microbes)



But we can also model stomatal closure based on carbon transport:



Nikinmaa et al. 2013

Alternative hypotheses:

Plant, Cell & Environment
Plant, Cell and Environment (2013) doi: 10.1111/pce.12141

How do trees die? A test of the hydraulic failure and carbon starvation hypotheses

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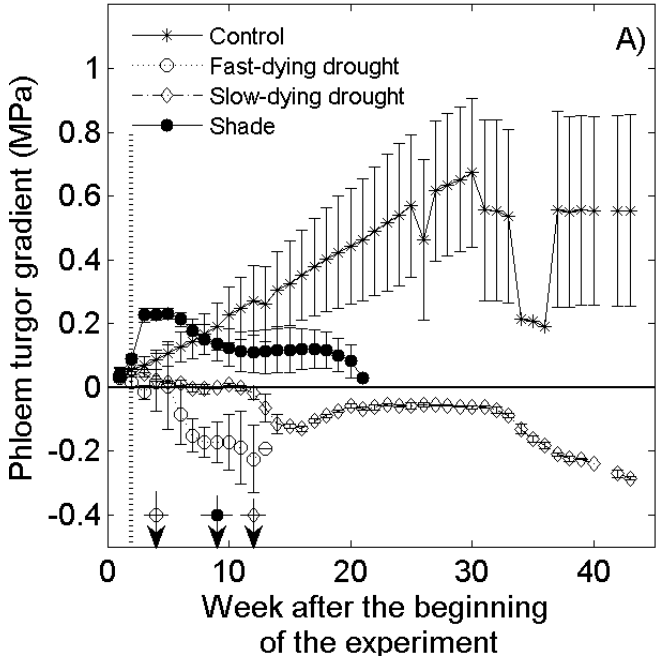
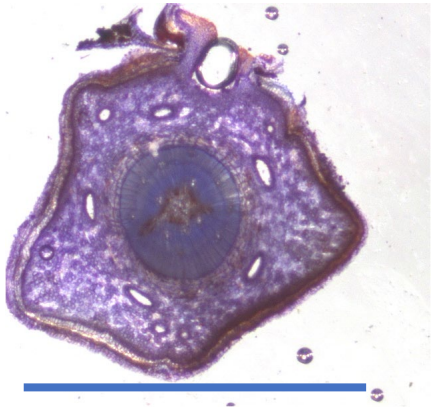


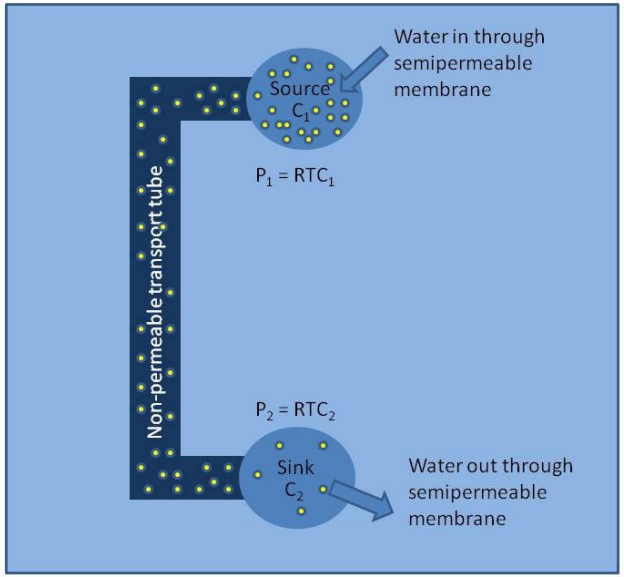
Turgor collapse occurred two weeks prior to permanent stomatal closure.

One week delay in turgor collapse led to four weeks of additional survival time

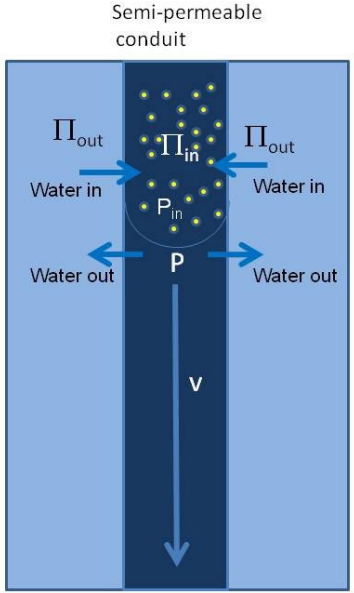


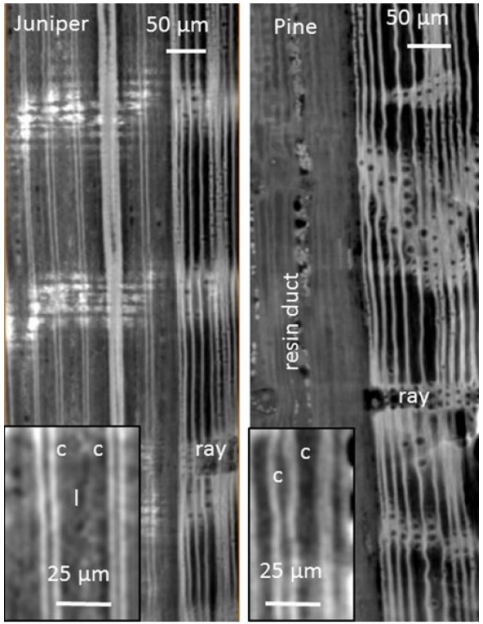
Phloem failure?

Non-permeable conduits walls



Semi-permeable conduits walls





Sevanto 2014 Journal of Experimental Botany

How about carbon sequestration?