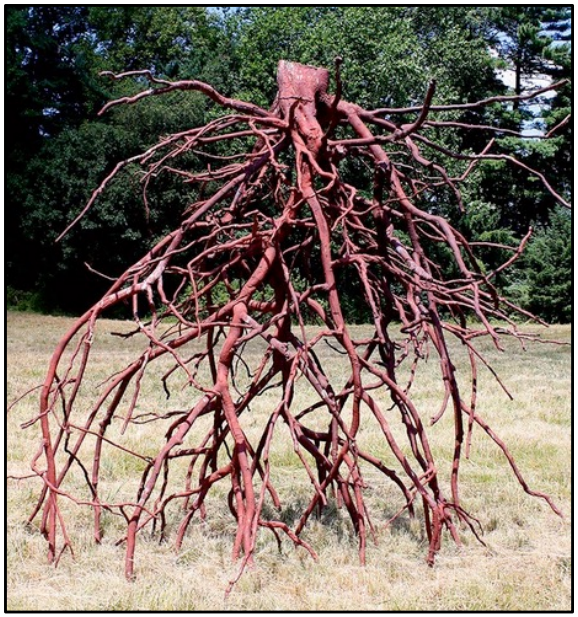
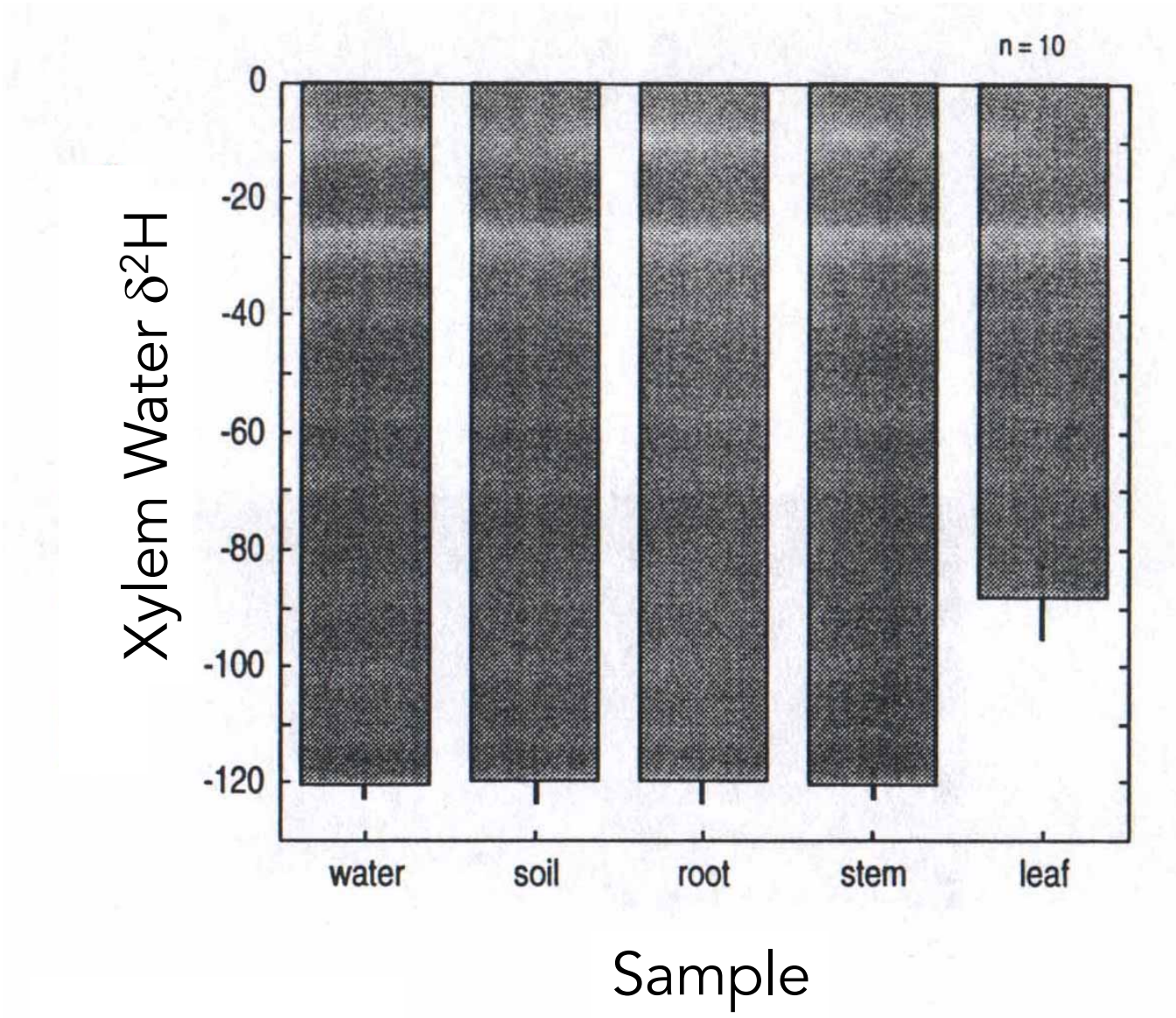
δ^2H and $\delta^{18}O$: Water Source Utilization by Plants



Do Water Isotopes Fractionate in Plants?



Dawson and Ehleringer 1993

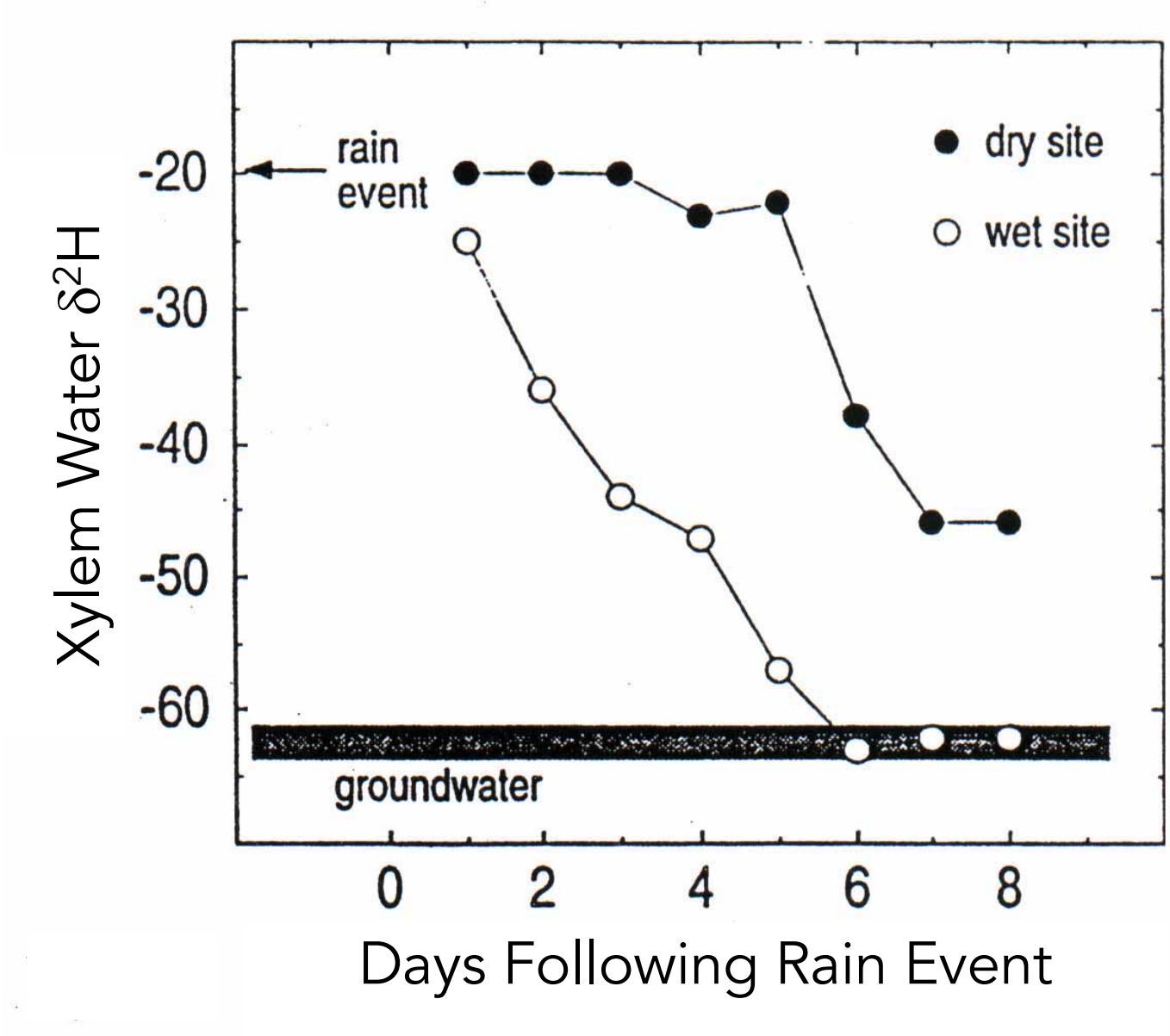
Patterns of Water Utilization in Plants

Identification and quantification of water source(s).
(groundwater, deep or shallow soil water, fog, rain pulses)

Intra- and interspecific resource competition and community water-use patterns, especially in aridland ecosystems.

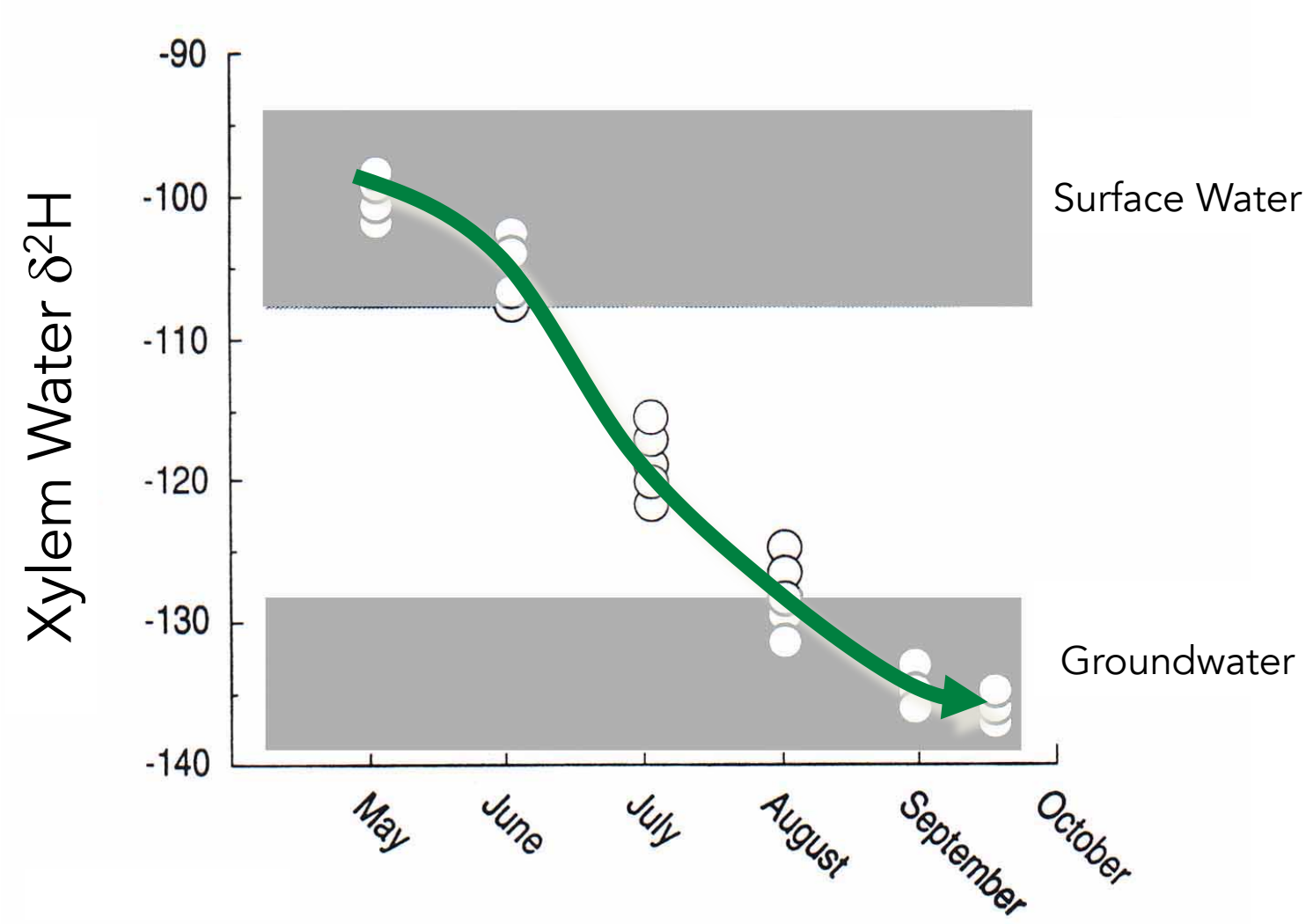
Plant effects on hydrological processes.
(hydraulic redistribution, water cycling, transpiration vs. evaporation)

Isotopes Reflect Soil Water Use Patterns



White et al. 1985

How Does Water Use Vary Seasonally?



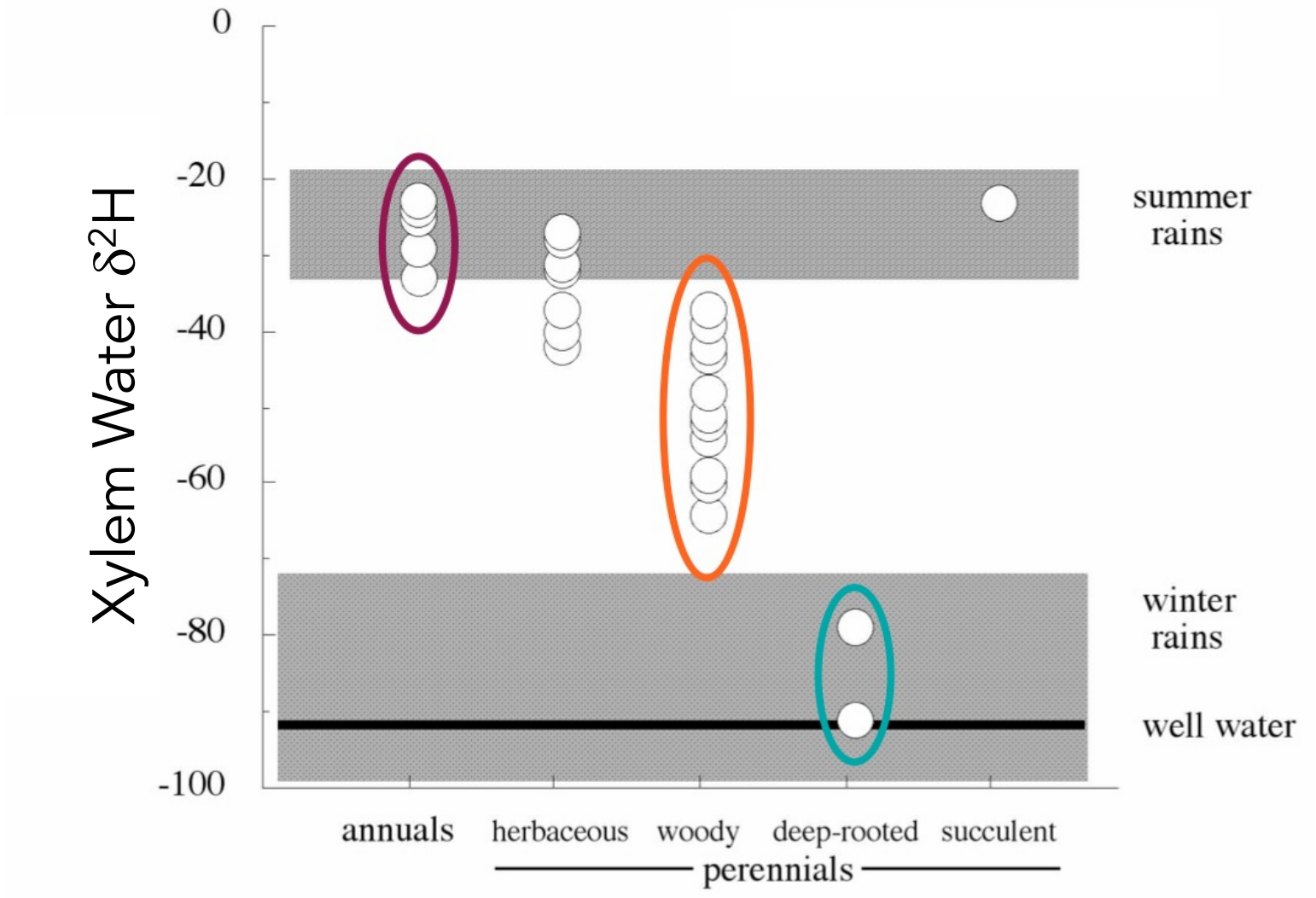
Adult poplar trees encountering a stream diversion.

Smith et al. 1991


Are All These Plants Using the Same Water Sources?

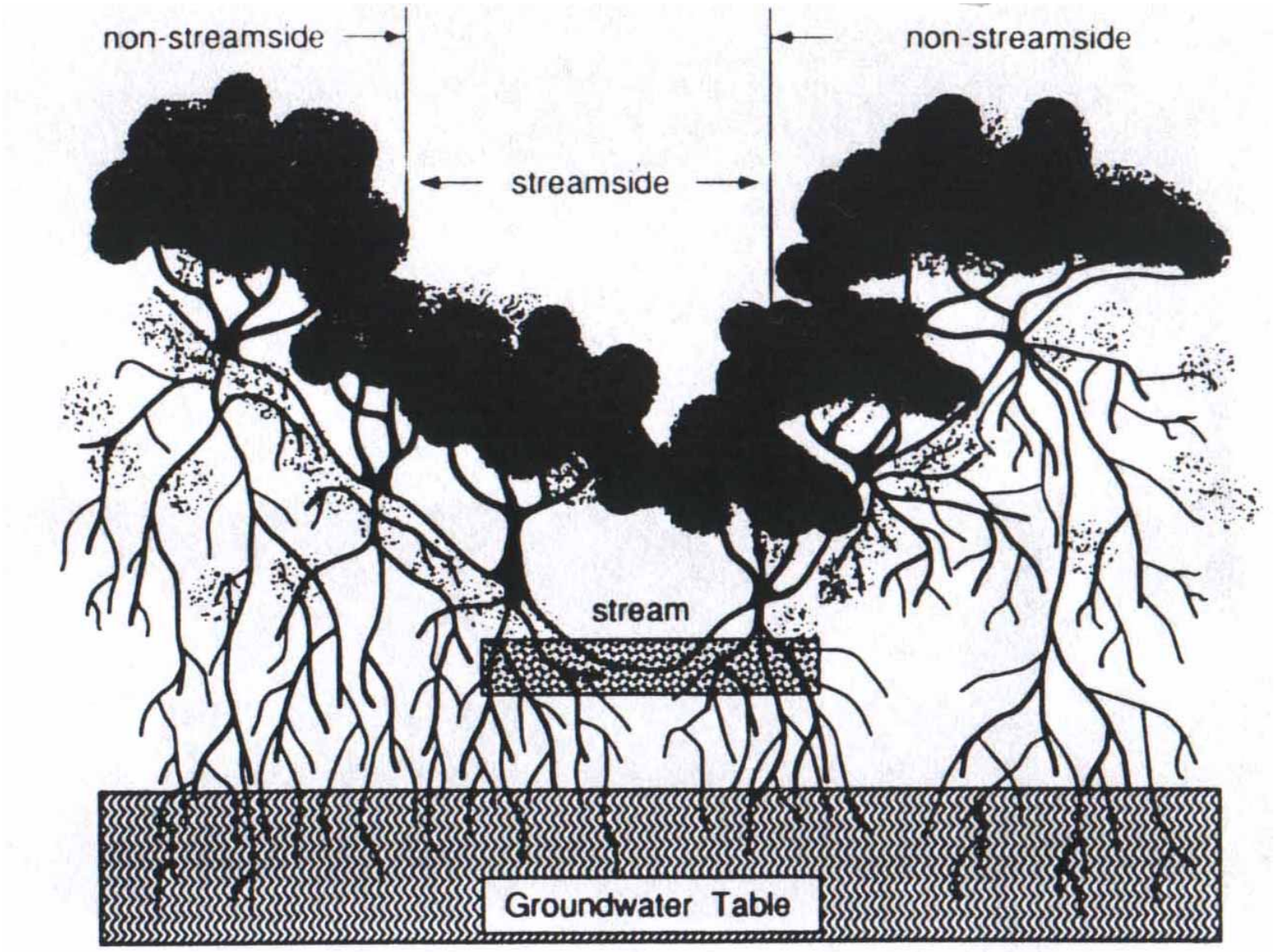
Inter-Specific Differences in Water-Use?

Can this sort of niche-partitioning among species help explain the high biodiversity on this otherwise water-limited desert?



Ehleringer et al. 1991

Intra-Specific Variation in Water-Use?



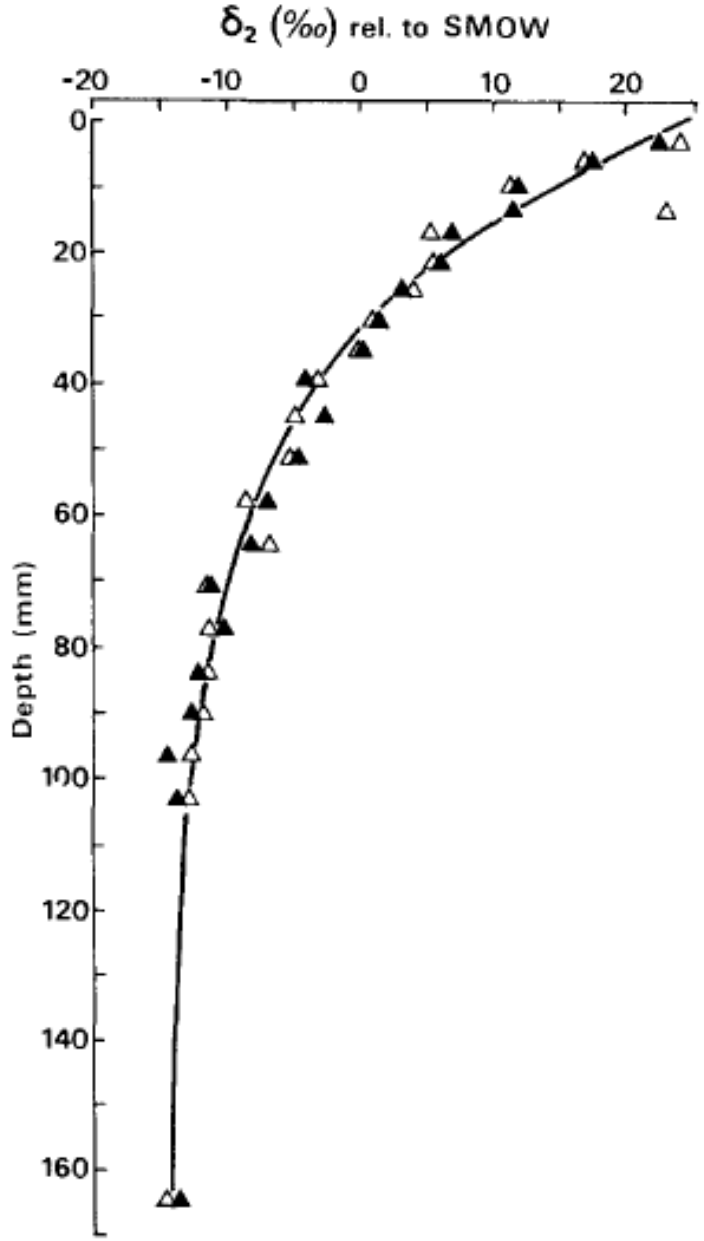
Water in Soils

Soils Act Like Reservoirs

- Water input (rain or snow)
- Water flows through soil column
- Evapo-concentration

But Each Soil Has Their Own Flavor

- Not well mixed
- Flow rate varies widely in space/time
- High resistance to diffusion

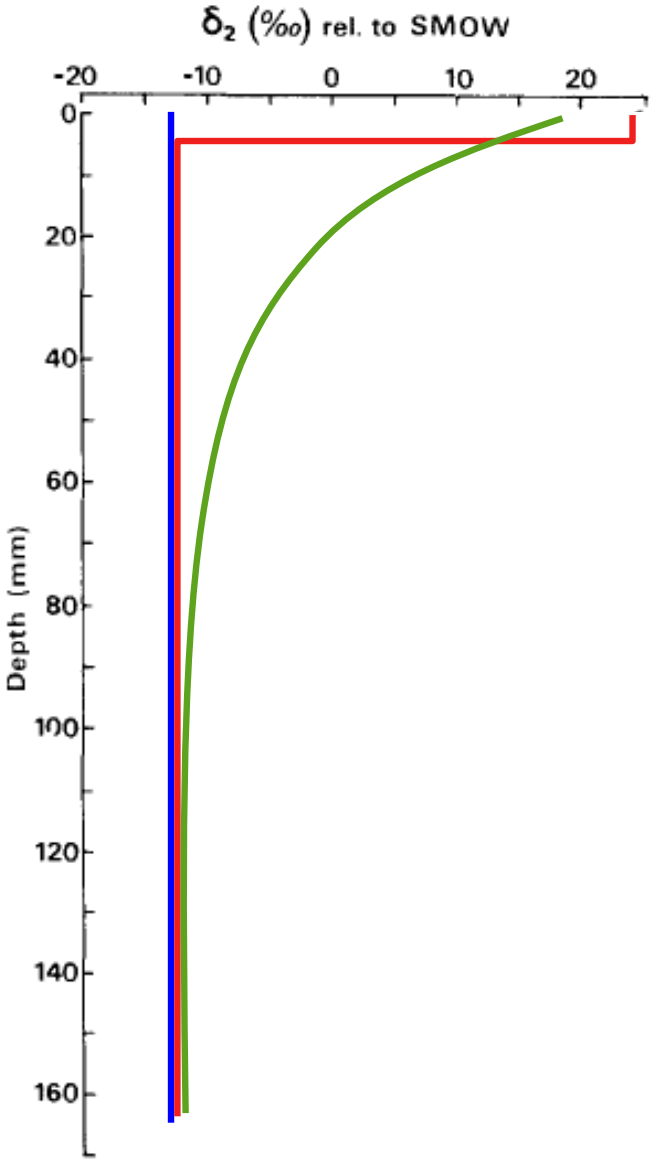


Barnes and Allison 1988

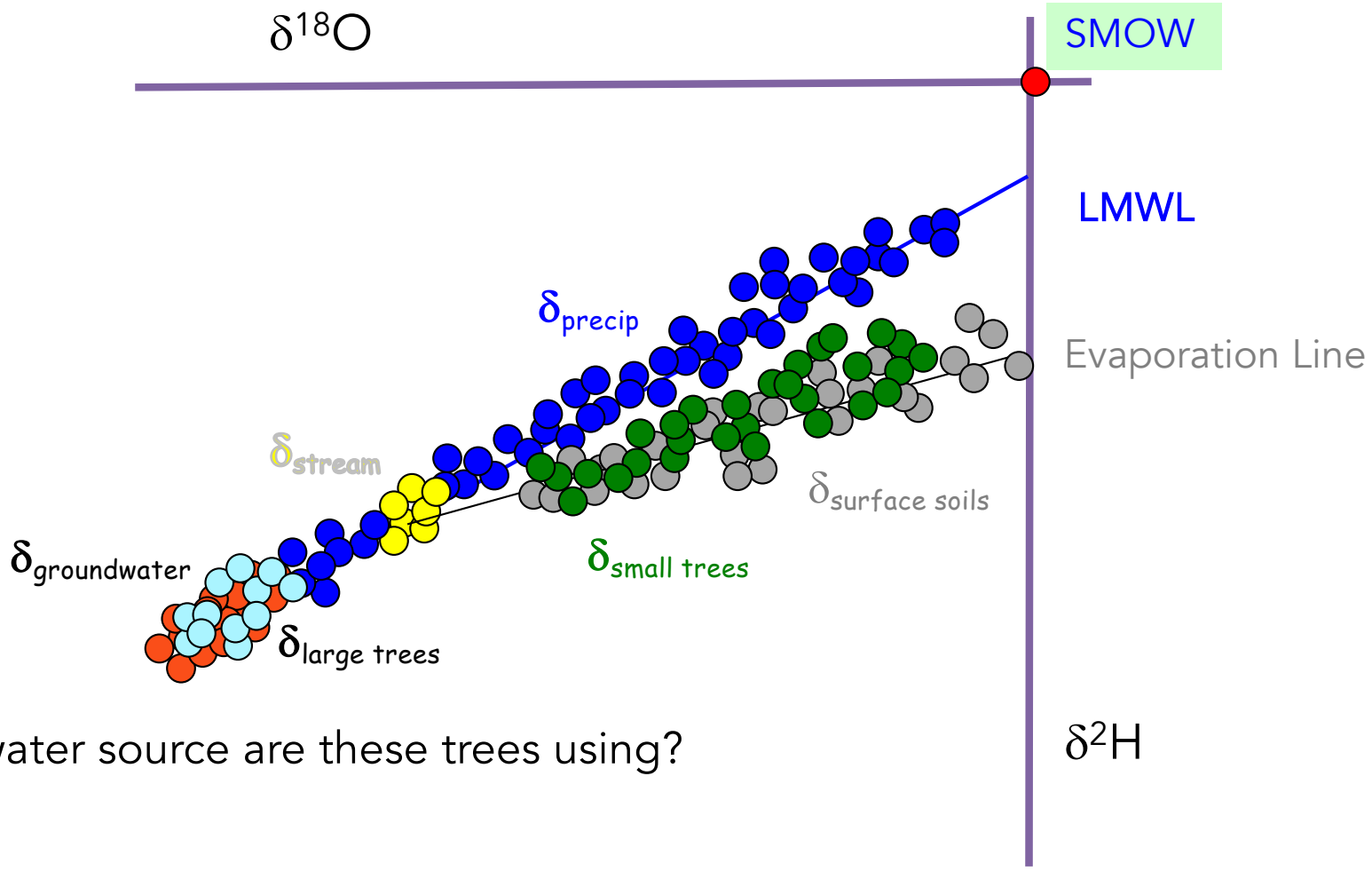
Building a Soil Water Profile

1. Start with Dry Soil
2. Add Rain and Saturate
3. Apply Heat (evapo-concentrate)
4. Restore Steady-State by Diffusion

In a Saturated Soil:
Highest $\delta_{\text{soil water}}$ at surface,
then exponential decrease to
$\delta_{\text{precipitation}}$ in deep part of soil profile.



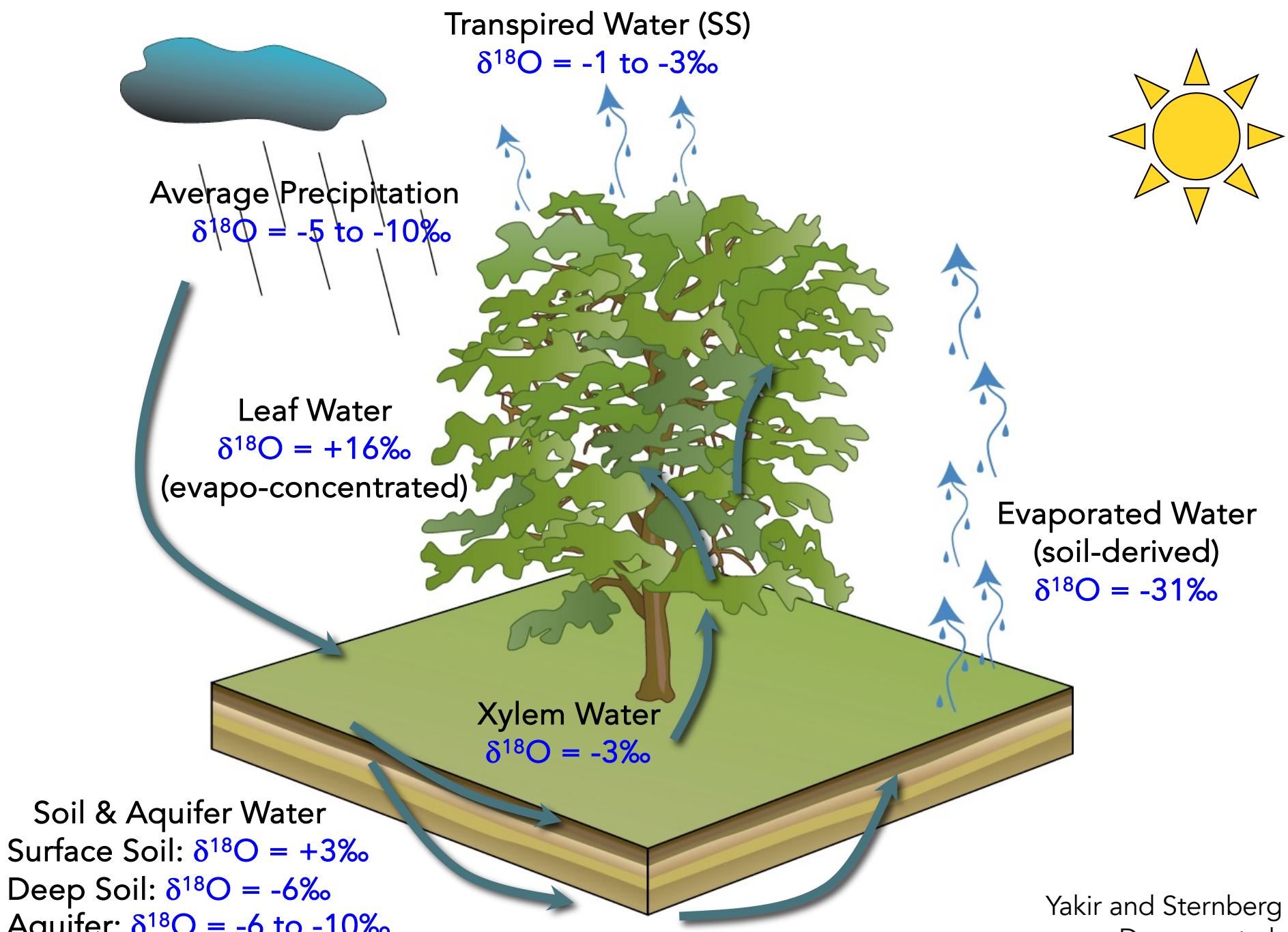
What Water Sources do Riparian Plants Use?



What water source are these trees using?

Isotope analyses of <u>ALL</u> water sources revealed that as tree grew larger, they were *not* using the most likely water source, but the most reliable one!

What About Soil and Sub-Surface Waters?



Yakir and Sternberg 2000
Dawson et al. 2002

Questions?