



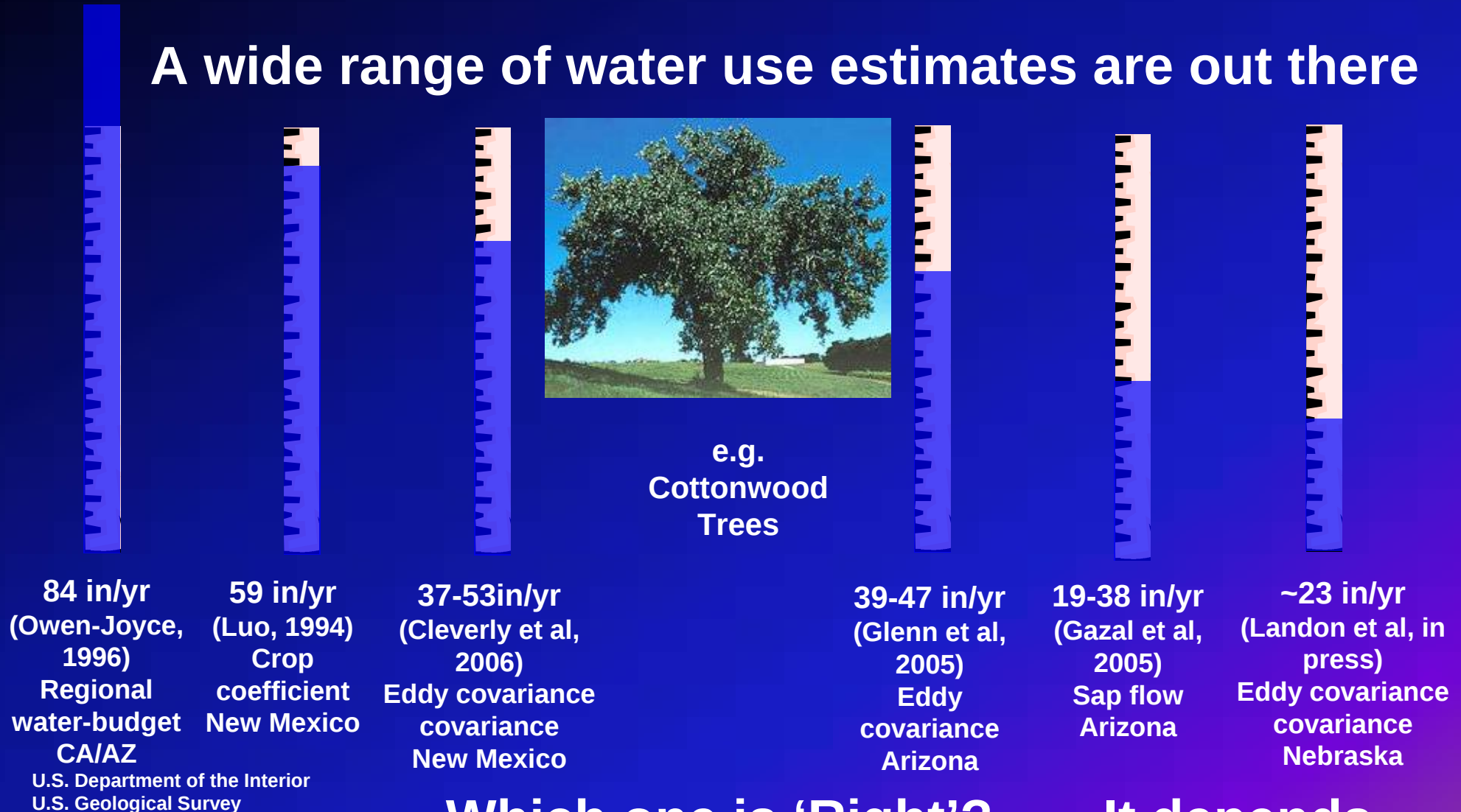
Water Use by Riparian Trees

Dave Rus
USGS Nebraska Water Science Center
Great Plains Riparian Forest Summit
Sioux Falls, SD September 10, 2008



Riparian Trees and Water

A wide range of water use estimates are out there



Which one is 'Right'?

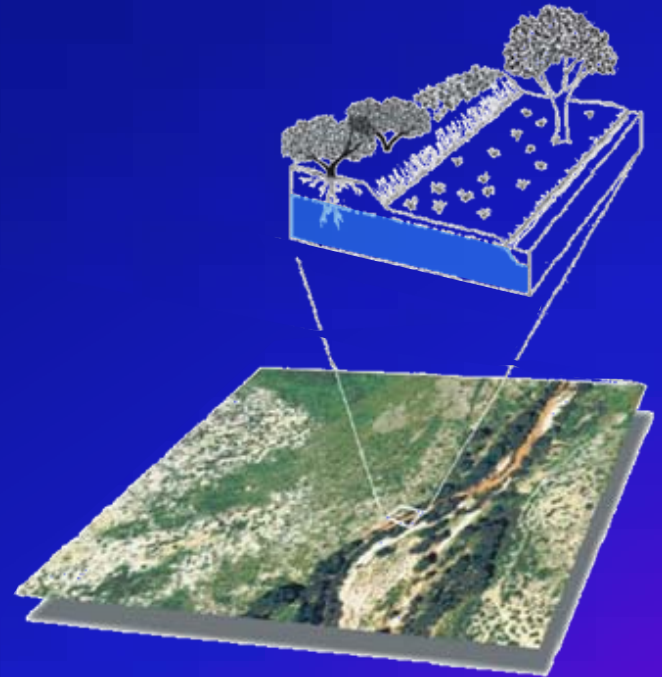
...It depends

Outline

- **Some context**
- **Some of the tools available**
- **Results from forests along the Platte River**
- **Some other relevant estimates**

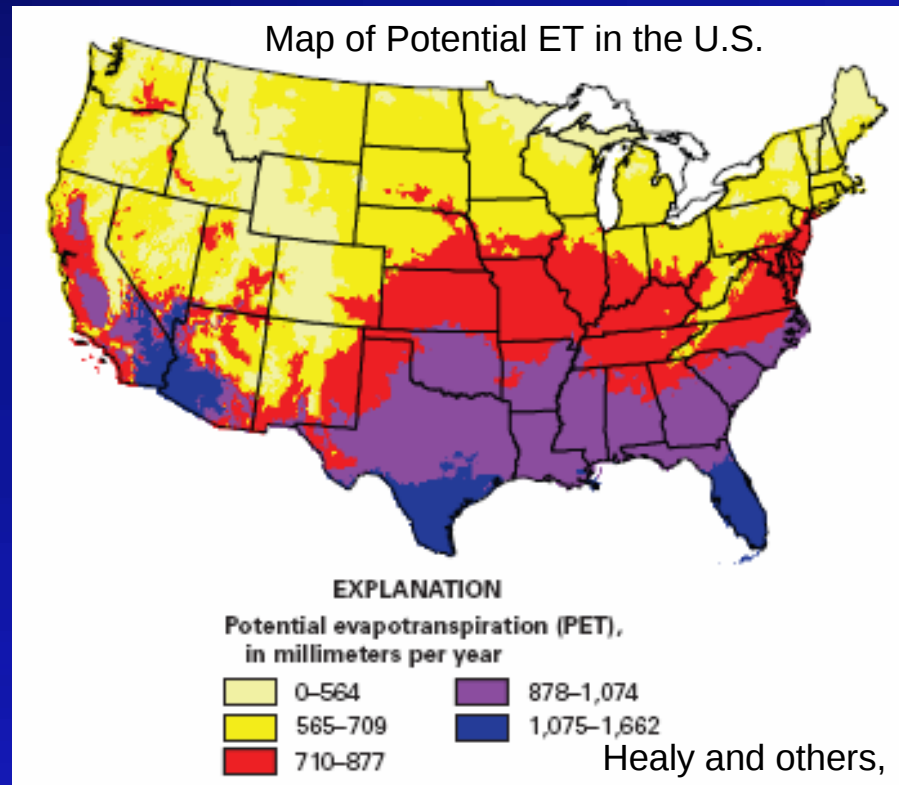
Some context

- Many riparian plants (trees included) are phreatophytic (Able to use shallow ground water)
 - Cottonwoods
 - Saltcedars
 - Russian Olives
 - Willows
- Riparian zones are characterized by shallow ground water



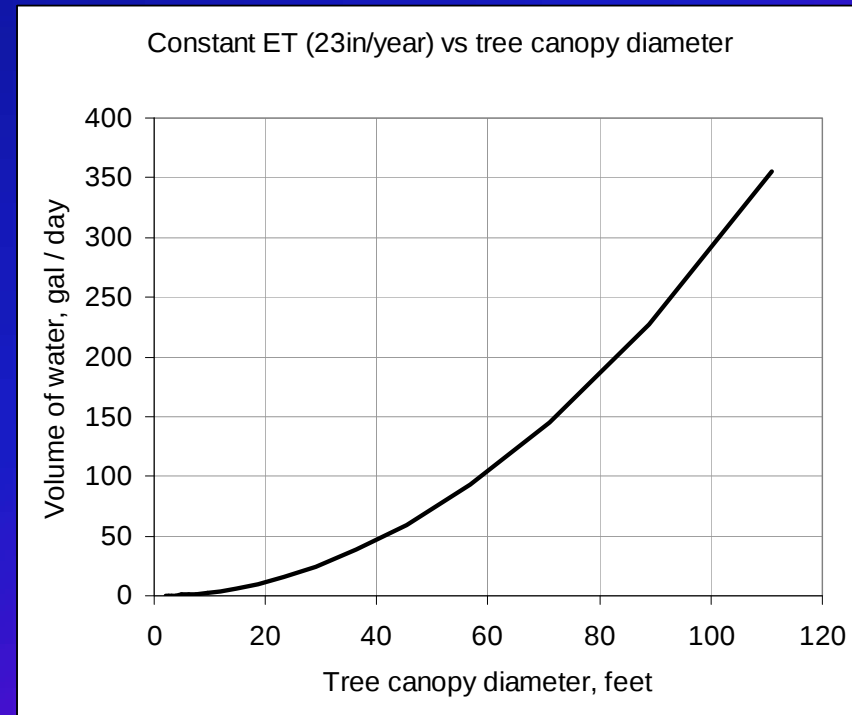
Some context

So phreatophytes in the presence of shallow ground water will use as much of that water as possible (e.g. at their potential ET rates), right?



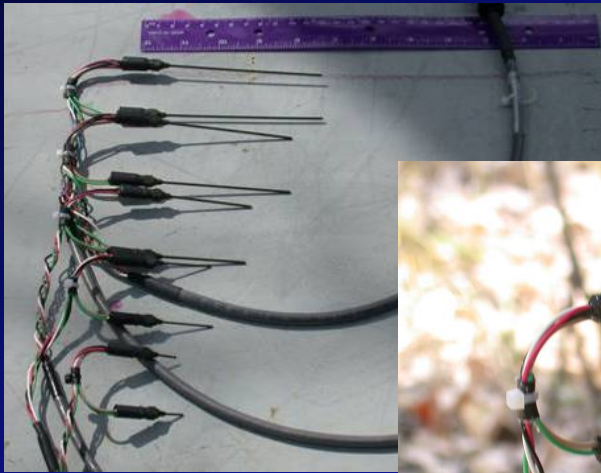
Some context

- The units you use may affect how they're heard
- Consider a scenario where:
 - A tree having a 60 ft canopy uses 100 gal/day
 - A corn plant (~2 sq ft) uses 0.085 gal/day
- Both use 23 in/year
 - Depth (e.g. in/year) is a better way of evaluating ET



Some tools used in estimating ET

- Individual plant estimates
 - Sap flux

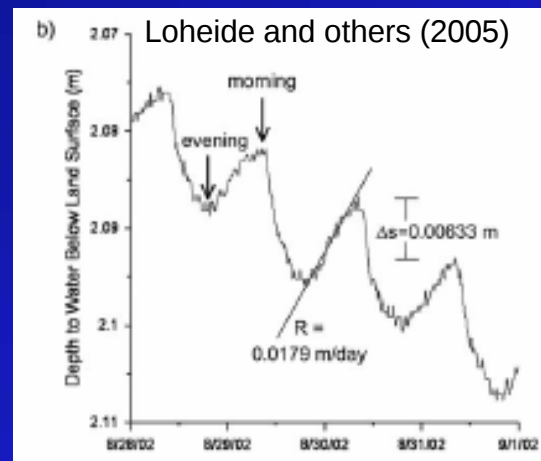


Some tools used in estimating ET

- Plot-scale estimates
 - Lysimeters



- Diurnal fluctuations in the water table



Some tools used in estimating ET

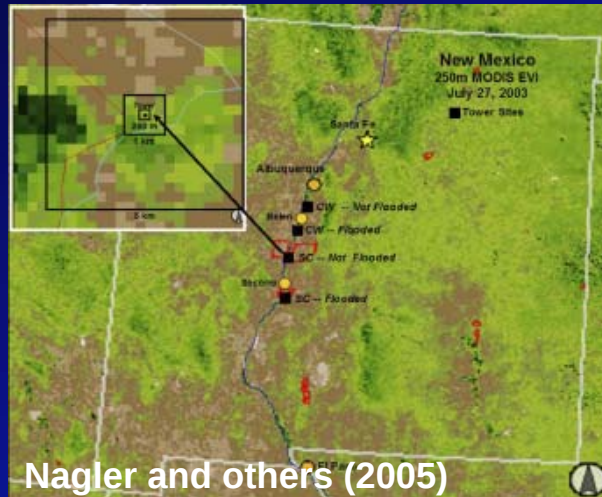
- Stand scale estimates
 - Micrometeorological techniques



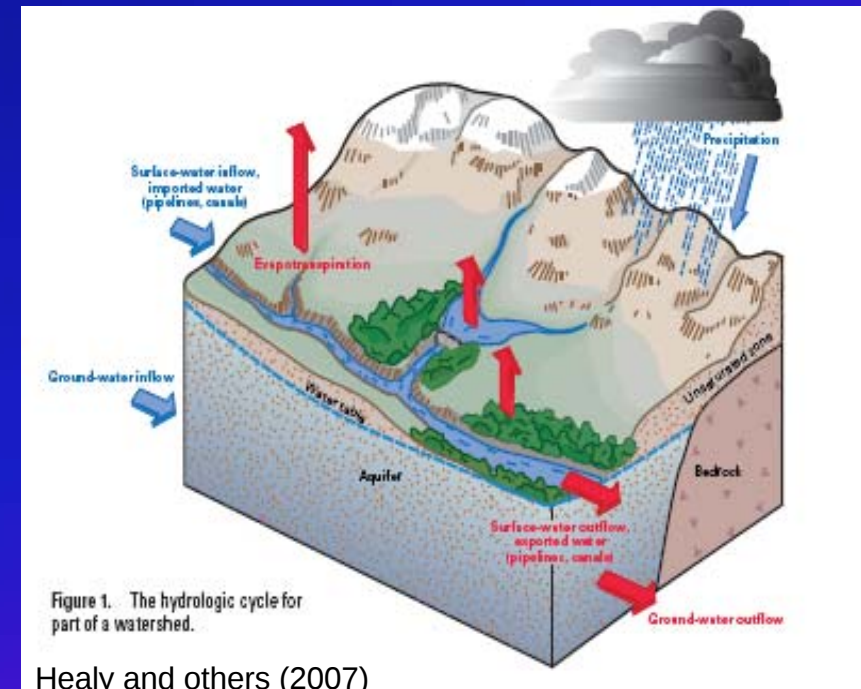
- Climatological techniques
 - Crop coefficients

Some tools used in estimating ET

- Regional estimates
 - Remote sensing techniques



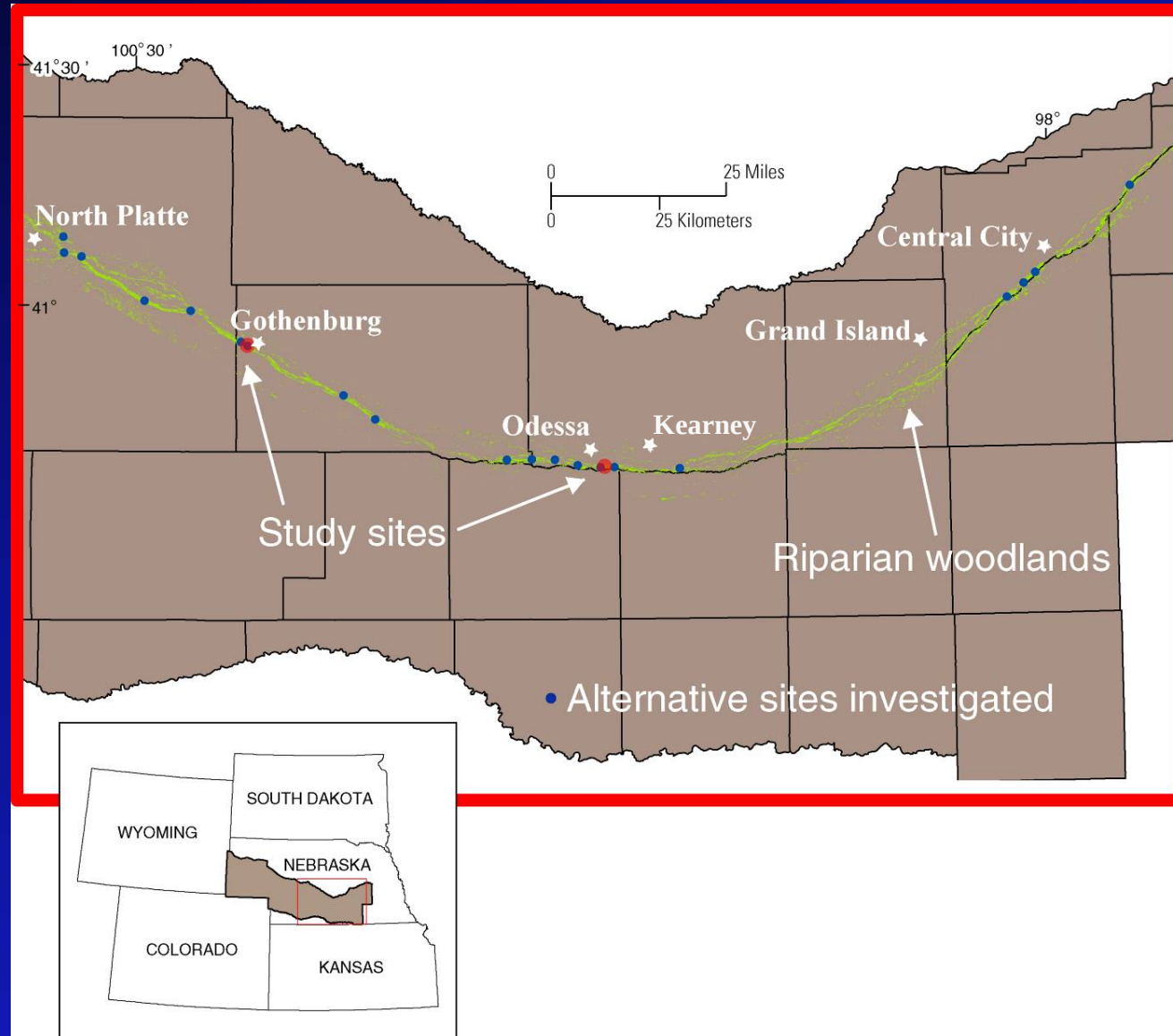
- Regional water-budgets



Platte River Riparian Forest ET

- Study originally designed to constrain a GW/SW model of the Platte R basin
 - Became relevant to drought mitigation strategies
- A cooperative effort between the USGS and the Nebraska Platte River Cooperative Hydrology Study (COHYST)
- Data collection from March 2002 – March 2006; Report preparation ongoing

Platte River Riparian Forest ET



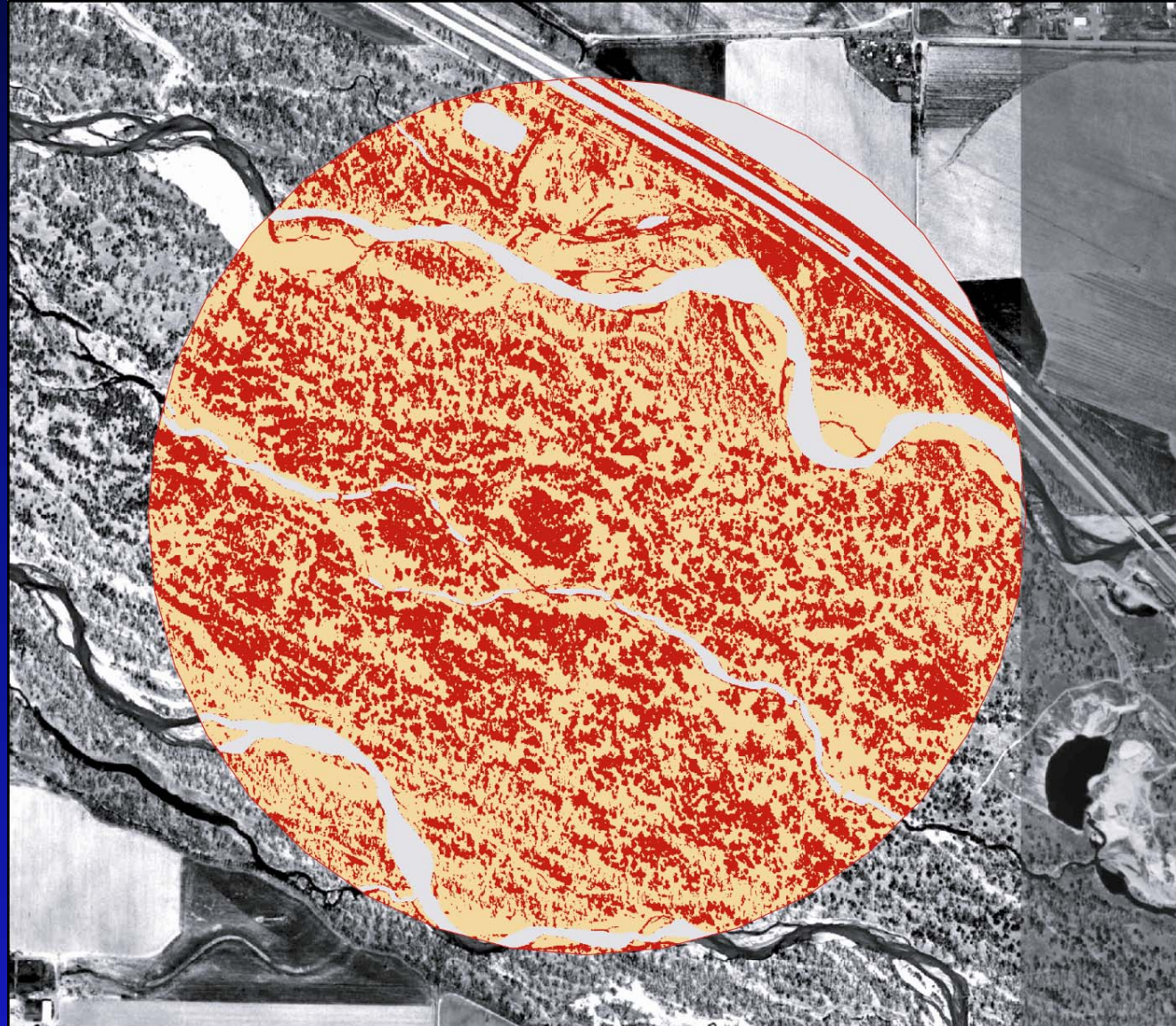
Platte River Riparian Forest ET

Gothenburg Site

EXPLANATION

Land cover

	Grass/Bare	49.9%
	Woody vegetation	40.6%
	Other	9.5%



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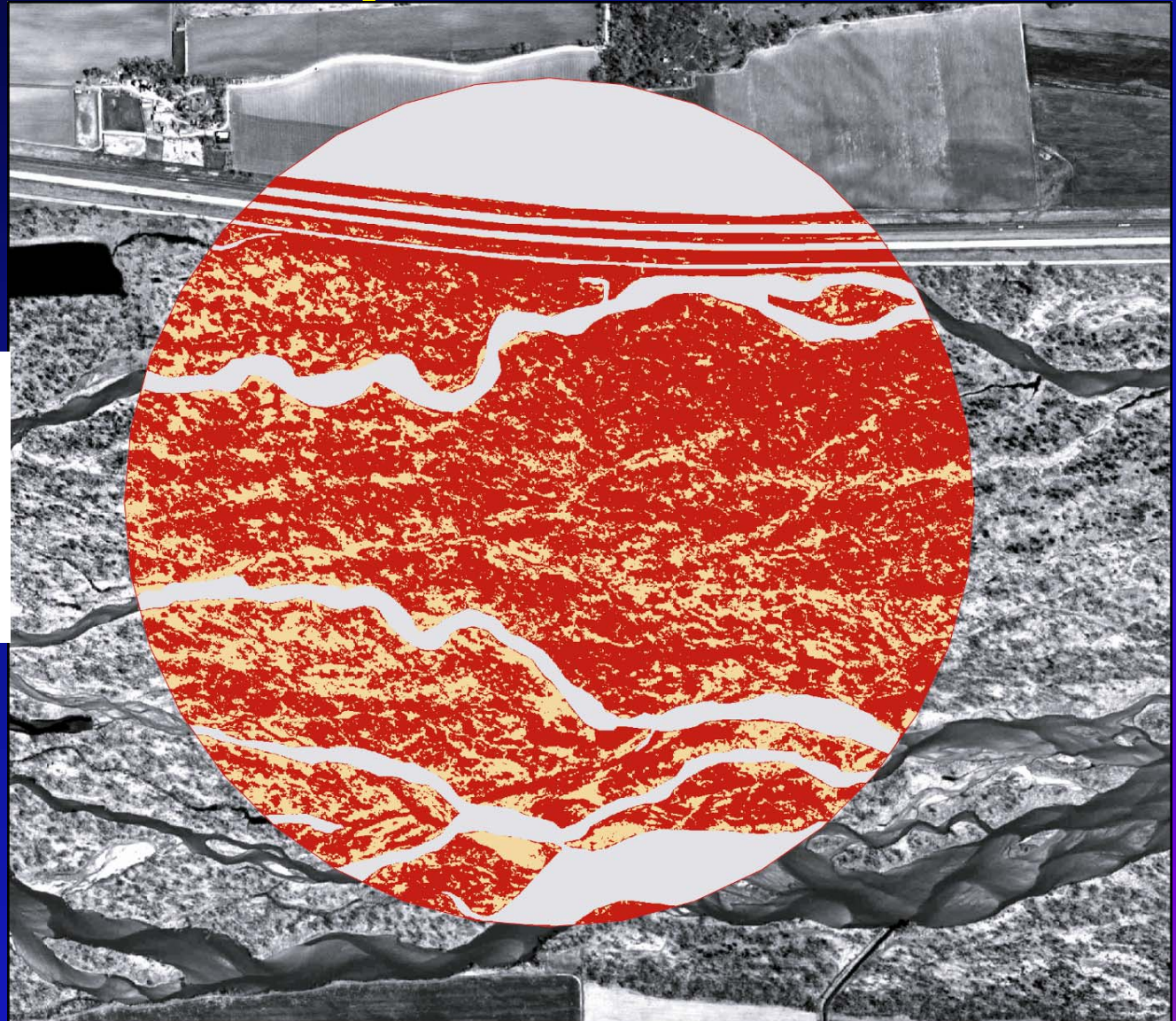
Platte River Riparian Forest ET

Odessa Site

EXPLANATION

Land cover

	Grass/Bare	21.1%
	Woody vegetation	55.8%
	Other	23.2%



Platte River Riparian Forest ET

Odessa

Site Characteristics	Odessa	Gothenburg
Overstory dominated by	Cottonwood	Cottonwood
Understory dominated by	Shrubs and grass	Cedars and grass
Mean canopy closure, percent	56	52
Mean point to tree distance, meters	9.0	8.3
Density, trees/hectare		
All	124.6	145.4
Cottonwood (<i>Populus deltoides</i>)	38.9	37.1
Cedar (<i>Juniperus virginiana</i>)	26.8	79.8
Green Ash (<i>Fraxinus pennsylvanica</i>)	27.7	9.5
Willow (<i>Salix</i> spp.)	6.9	4.0
Russian Olive (<i>Elaeagnus angustifolia</i>)	6.1	4.7
Mulberry (<i>Morus rubra</i>)	15.6	1.6
Elm (<i>Ulmus americana</i>)	2.6	1.6
Boxelder (<i>Acer negundo</i>)	0.0	4.0
Cottonwood Tree height, median, meters	16.9	16.9



Gothenburg



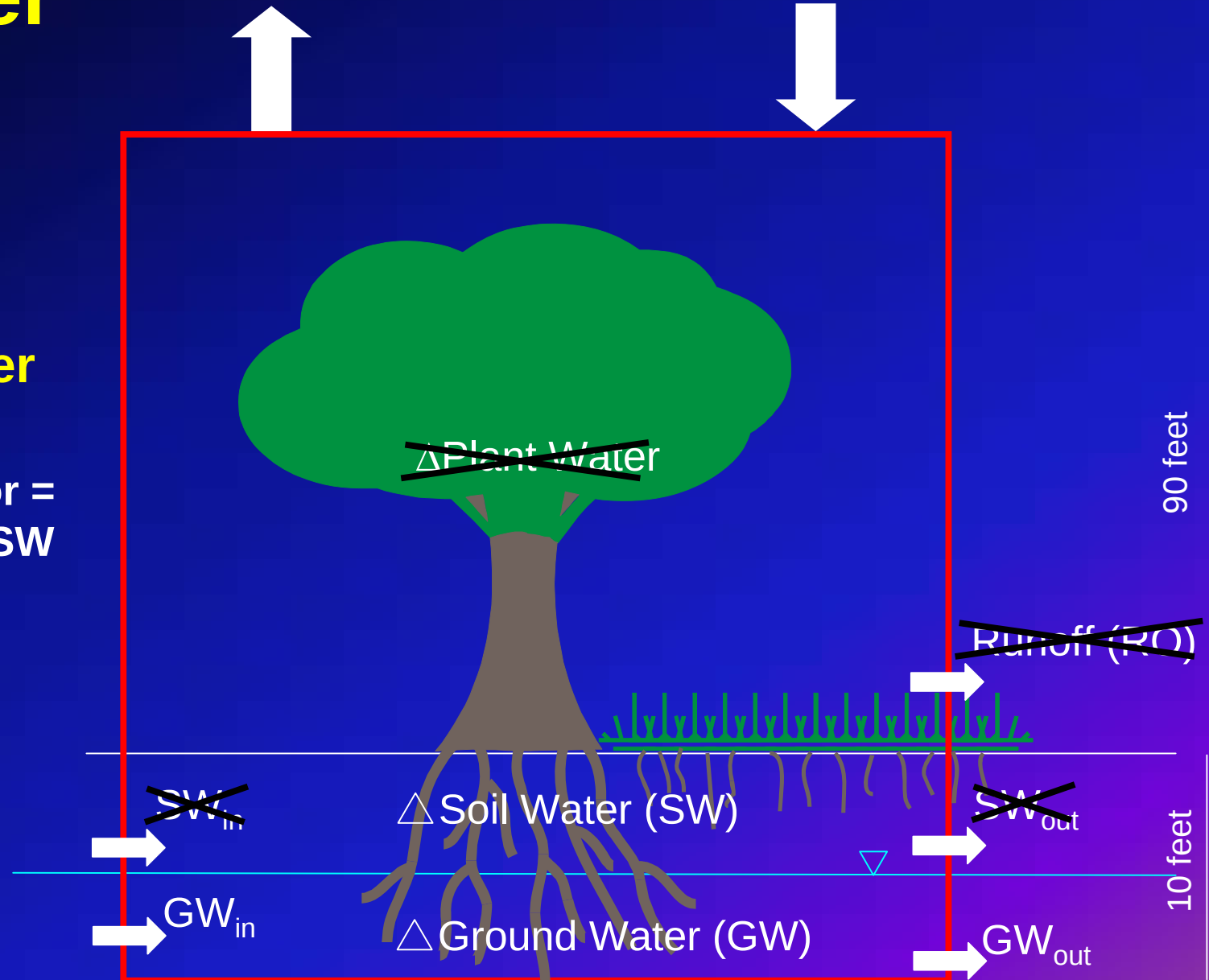
Platte River Riparian Forest ET

Study Design: Conceptual Water Balance

$$(GW_{in} - GW_{out}) + \text{Error} = ET - P + \Delta GW + \Delta SW$$

Evapotranspiration (ET)

Precipitation (P)



Platte River Riparian Forest ET

Evapotranspiration



Precipitation



Change in soil water



Change in GW storage





Platte River Riparian Forest ET

- Other measurements
 - Atmosphere: Wind direction/Speed; Vapor pressure; Air temp
 - Hydrologic: River level; canopy interception of rainfall;
 - Energy: Soil heat flux; net radiation; solar radiation;
 - Other: Leaf-area index; Surrounding land use; sap flux

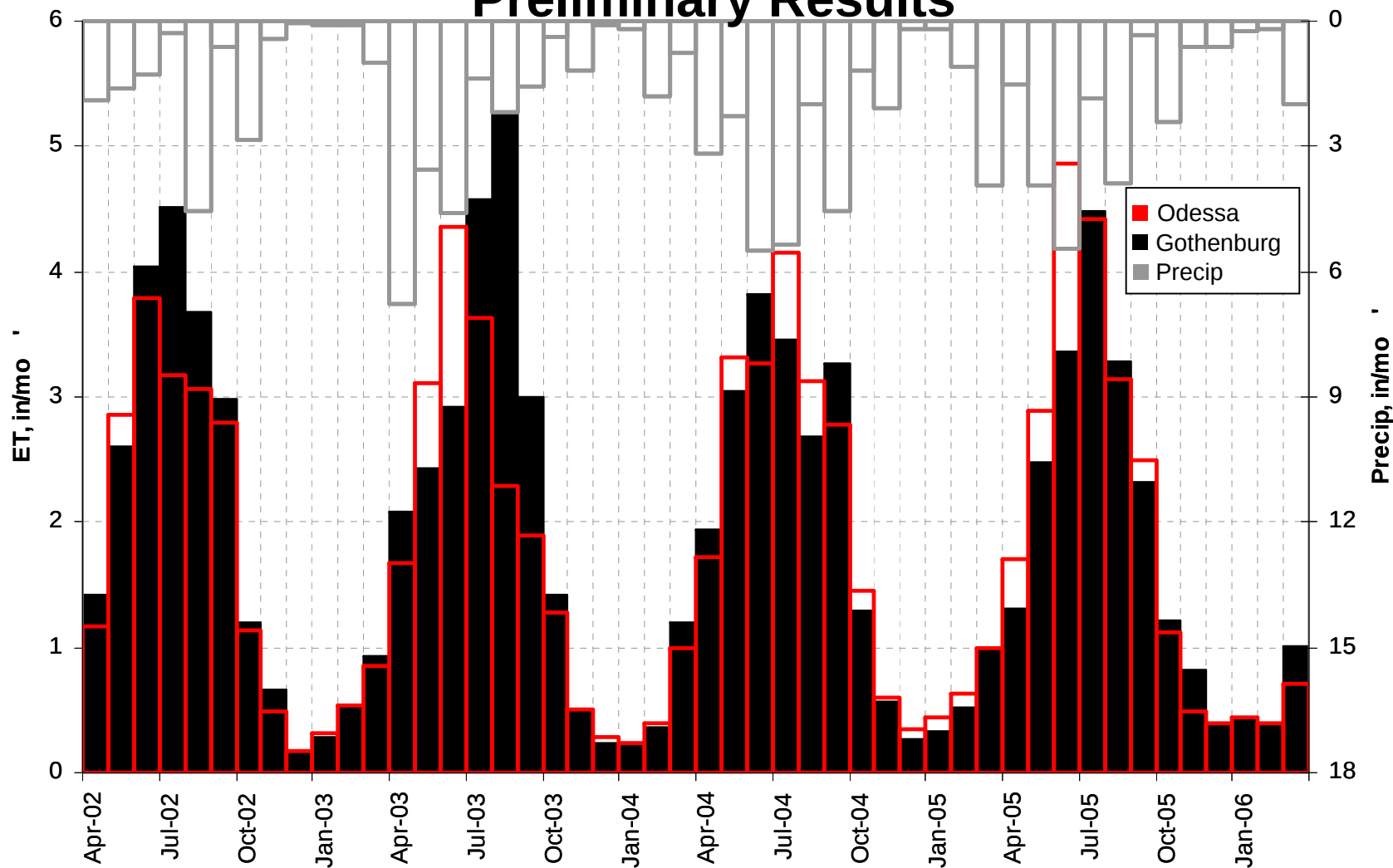


Apologies for my monotone phone voice



Platte River Riparian Forest ET

Preliminary Results

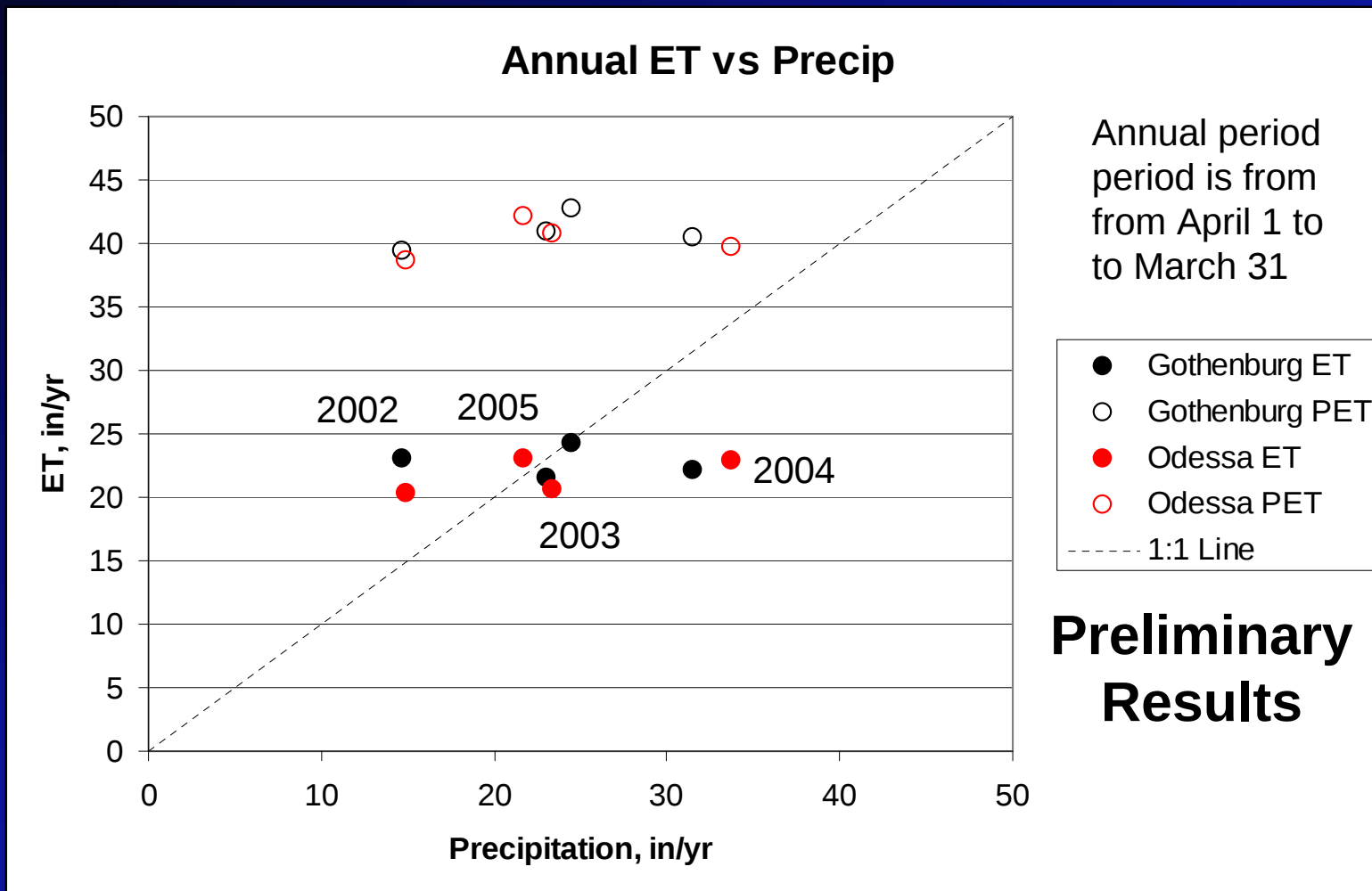


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*Note the difference in scale between ET and precipitation



Platte River Riparian Forest ET

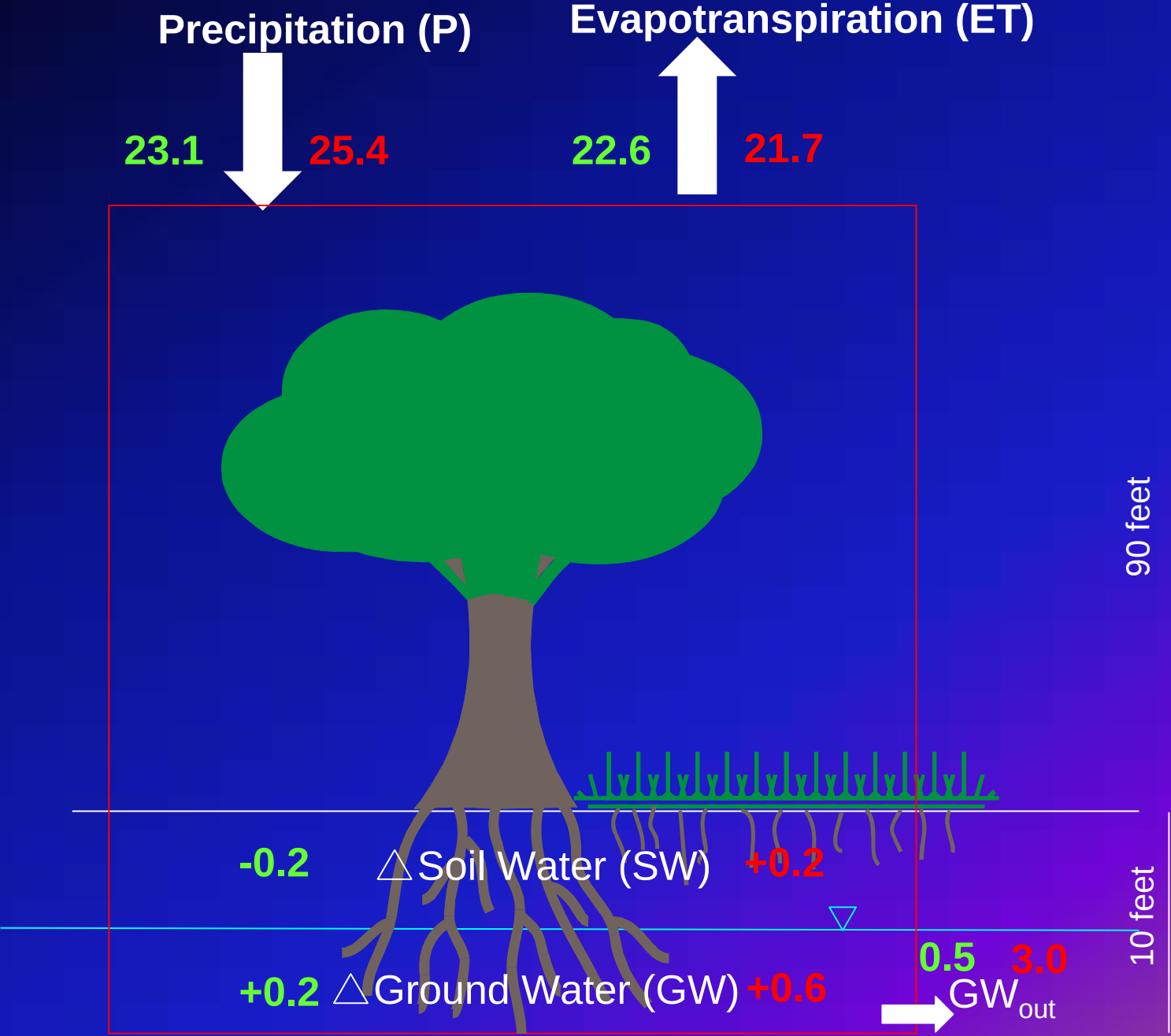


Platte River Riparian Forest ET

Preliminary 4-
year Average
Water Balance
(inches)

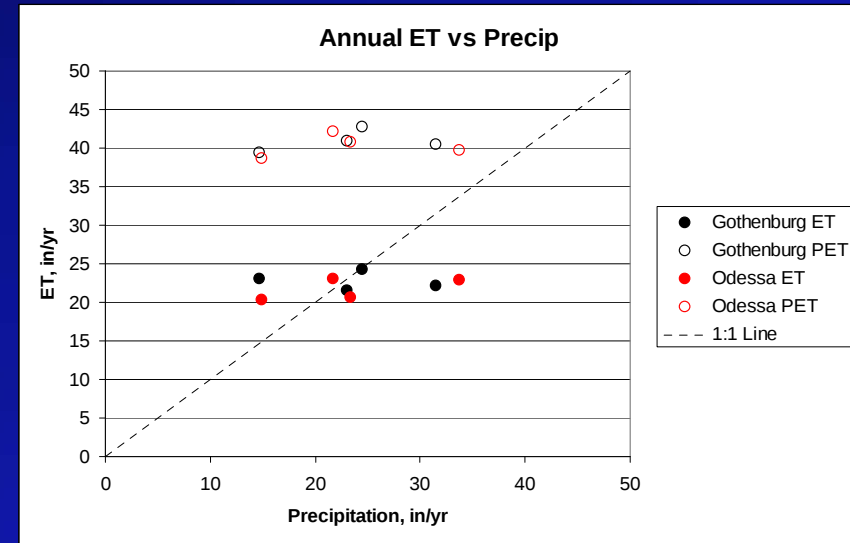
Gothenburg
Odessa

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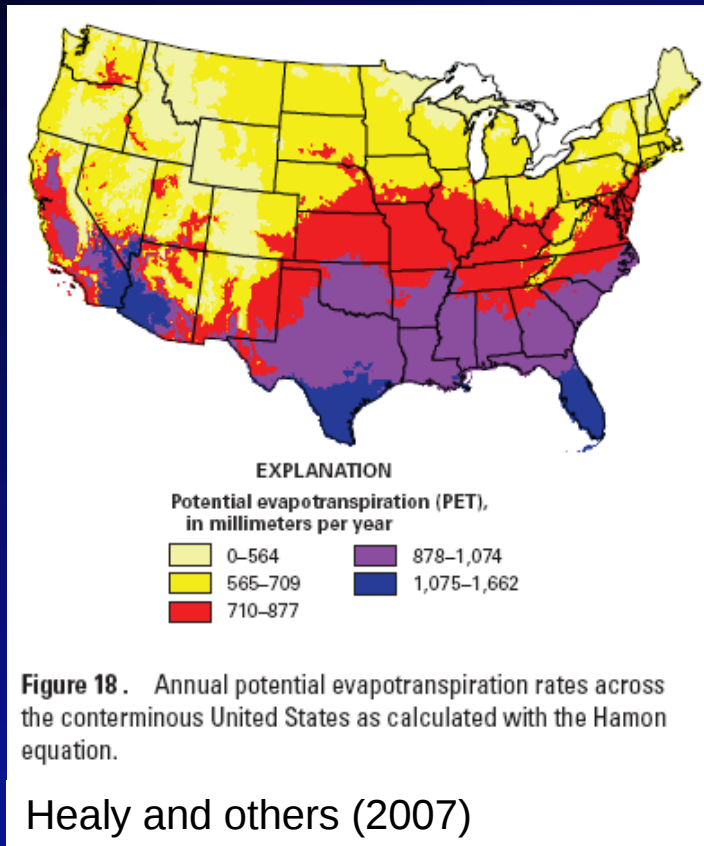
Platte River Riparian Forest ET

- Actual ET was:
 - << Potential ET
 - in the ballpark of precipitation
 - Thus, GWET could be small
 - not clearly tied to precipitation
 - Climate stationarity
- USGS Technical Report is in the works
 - *Evapotranspiration Rates from Riparian Woodlands, Platte River, Nebraska, March 2002 - March 2006*
 - By Matthew K. Landon, David L. Rus, Benjamin J. Dietsch, Michaela R. Johnson, and Kathleen D. Eggemeyer



Some other relevant studies

- Its hotter and drier in Arizona/New Mexico

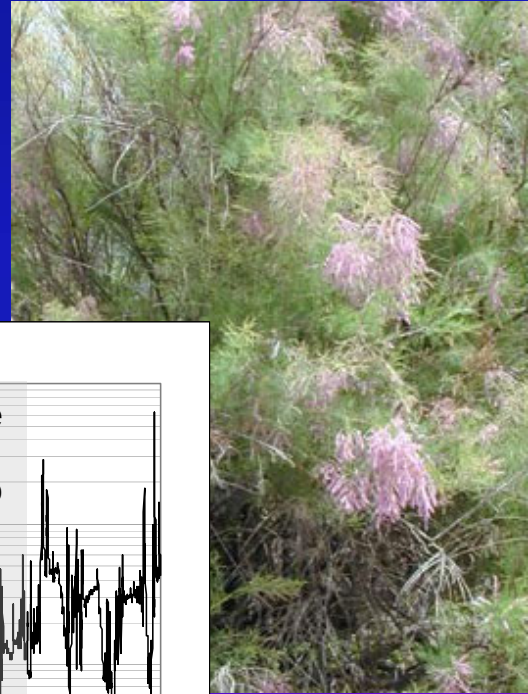


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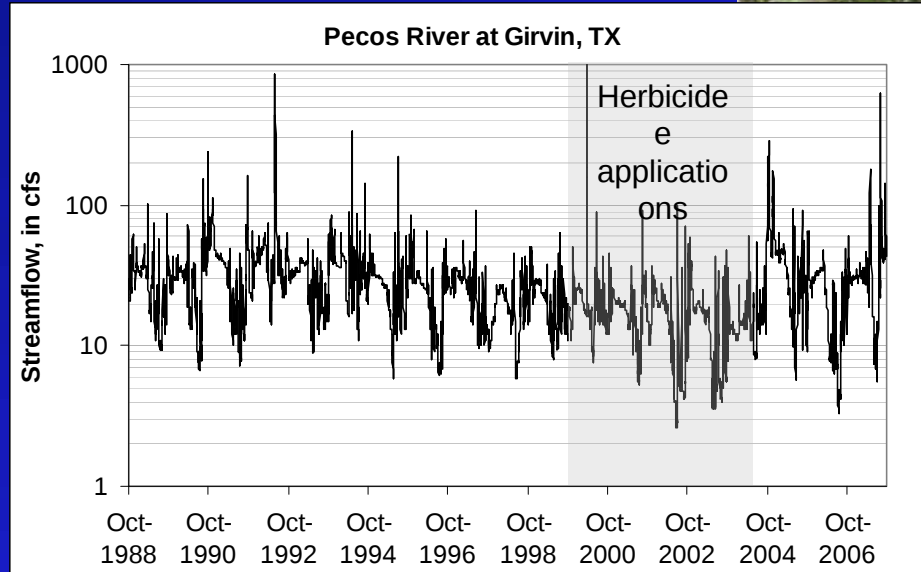
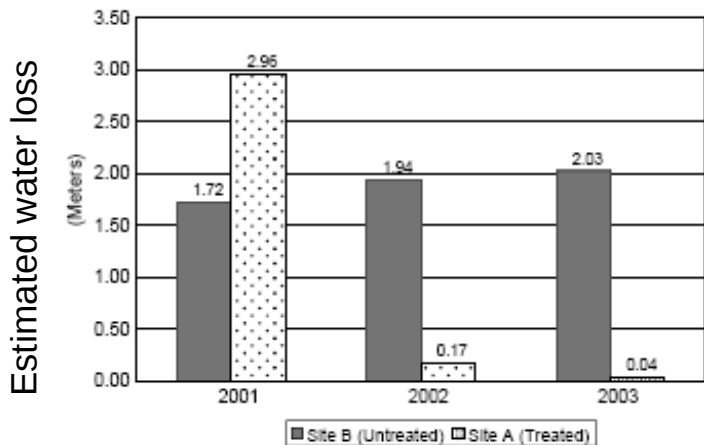
- The same plant will use more water in NM/AZ than NE (if water is abundant)
 - Cottonwoods:
 - 39-47in/yr (Glenn et al, 2005)
 - 37-53in/yr (Cleverly et al, 2006)
 - 19-38 in/yr (Gazal et al, 2005)
 - Saltcedar:
 - 31-47 in/yr (Glenn et al, 2006)
 - 27-46 in/yr (Cleverly et al, 2006)
 - 26-39 in/yr (Nagler et al, 2005)
 - Owens and Moore (2007) disproved the sometimes quoted 200 gpd estimate

Some other relevant studies

- Water salvaged from removal of saltcedars
 - KSU study along Cimmaron R in SW Kansas
 - Yr 1: 30-40% reduction in est. ET (Kluitenberg et al, 2006)
 - Yr 2: <20% reduction
 - Yr 3+: ?
 - Is the niche being filled?
 - Texas A&M study along the Pecos River



Estimated water loss due to saltcedars on research plots along the Pecos R



Some other relevant studies

- Burba et al (1999) studied Phragmites in a wetland in the Sandhills for 1 growing season in 1994
 - ET was 22.6 inches from June-Oct



Phragmites at our site



Photographs taken from the same perspective on the Platte River channel at channel at the Odessa site.

Currently in NE

- **USGS: Cooperative study w/ CPNRD and NET**
 - Comparing riparian grassland ET and forest ET along the Platte R
- **U. of Nebraska:**
 - Studying the effects of removing Russian Olives along the Republican R
 - Remote sensing of NE panhandle



Questions?

Dave Rus
USGS Nebraska Water Science Center
5231 South 19th St.
Lincoln, NE 68512-1271
(402) 328-4127
dlrus@usgs.gov

Robert B. Swanson
Director
(402) 328-4110
rswanon@usgs.gov

Philip J. Soenksen
Data Section Chief
(402) 328-4150
pjsoenks@usgs.gov

Richard C. Wilson
Studies Section Chief
(402) 328-4120
wilson@usgs.gov

Ronald B. Zelt
NAWQA Study Unit Chief
(402) 328-4140
rbzelt@usgs.gov