GROUNDWATER/SURFACE WATER INTERACTIONS IN TAYLOR SLOUGH – EVERGLADES NATIONAL PARK

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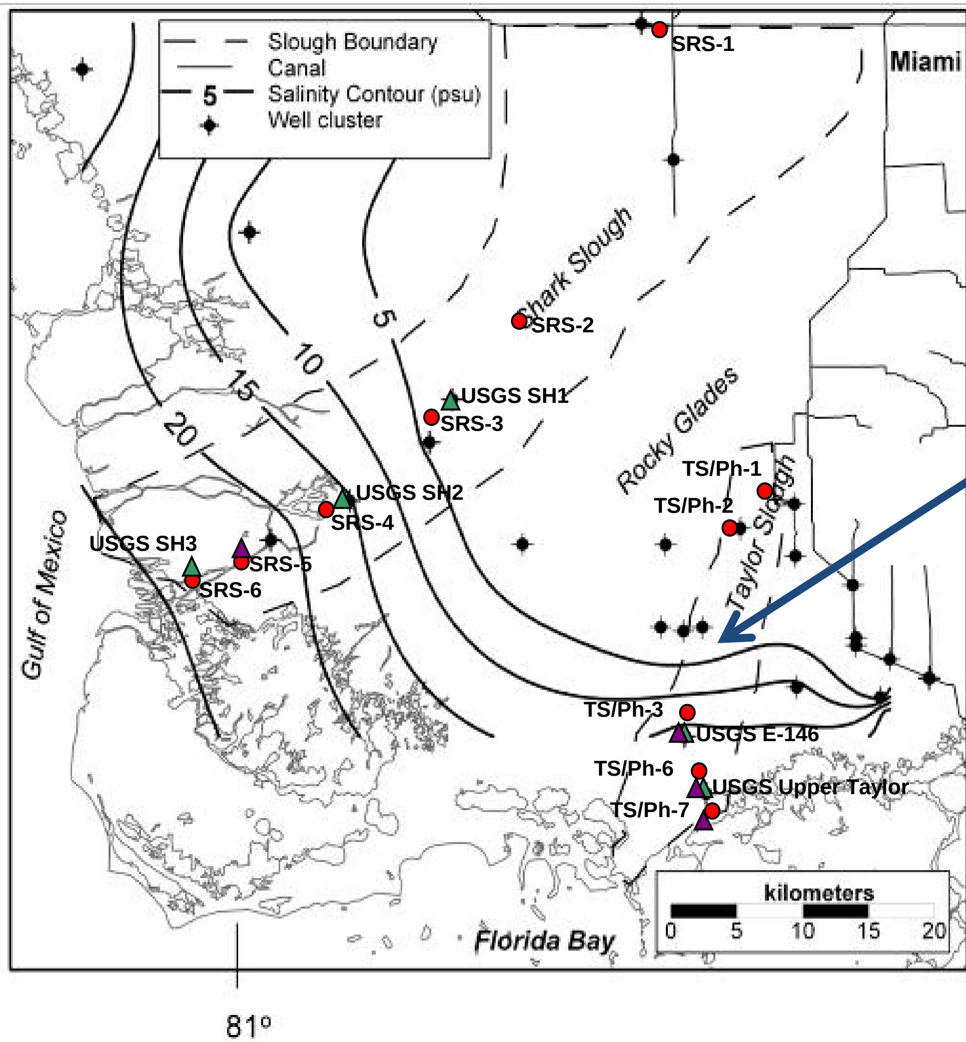
FIU FLORIDA INTERNATIONAL UNIVERSITY

Groundwater saltwater intrusion in Taylor Slough



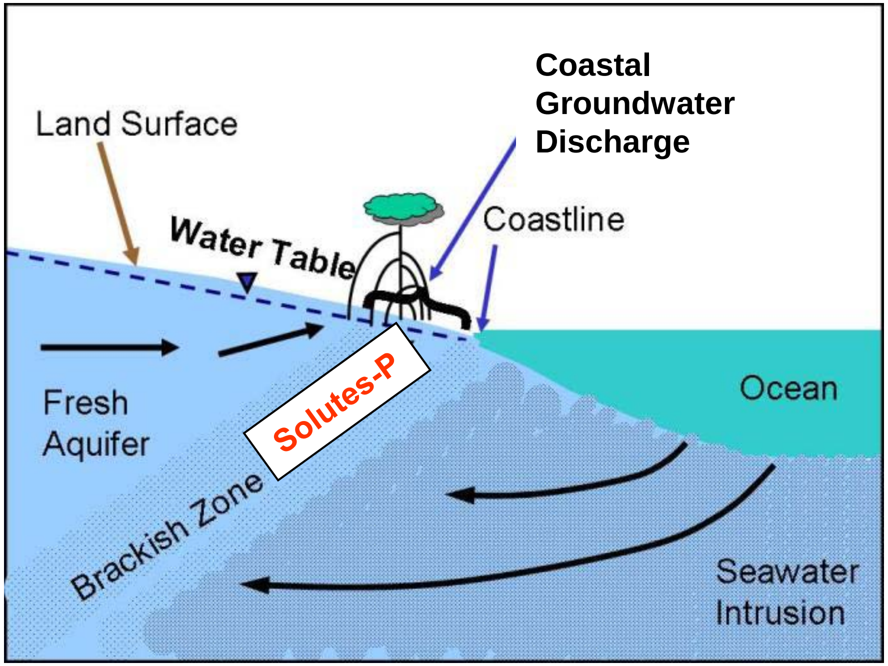
10-15km inland

Fitterman, D. V., M. Deszcz-Pan, and C. E. Stoddard, Results of time-domain electromagnetic soundings in Everglades National Park, Florida, *U.S. Geol. Surv. Open File Rep., 99-426*, 1999.

Price, Happell, Top, and Swart. 2003
Use of tritium and helium to define groundwater flow conditions in Everglades National Park. WRR, 39(9): doi:10.1029/2002WR001929.

Brackish Groundwater discharges to southern Taylor Slough as Coastal Groundwater discharge

The brackish groundwater discharge contains high concentrations of P

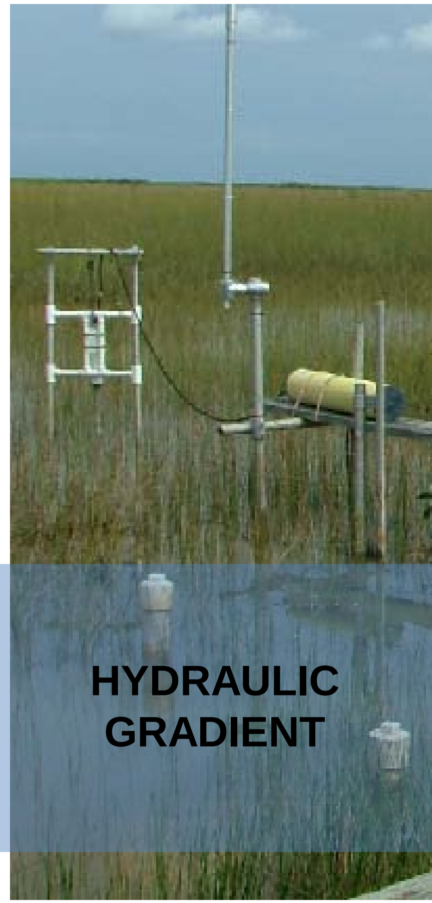


Price, R. M. P.K. Swart, P.K, and J. W. Fourqurean. 2006. *Coastal Groundwater Discharge - an additional source of phosphorus for the oligotrophic wetlands of the Everglades*. Hydrobiologia, 569: 23-36.

Objective of this research:

Quantify GW/SW interactions in Taylor Slough in both time and space

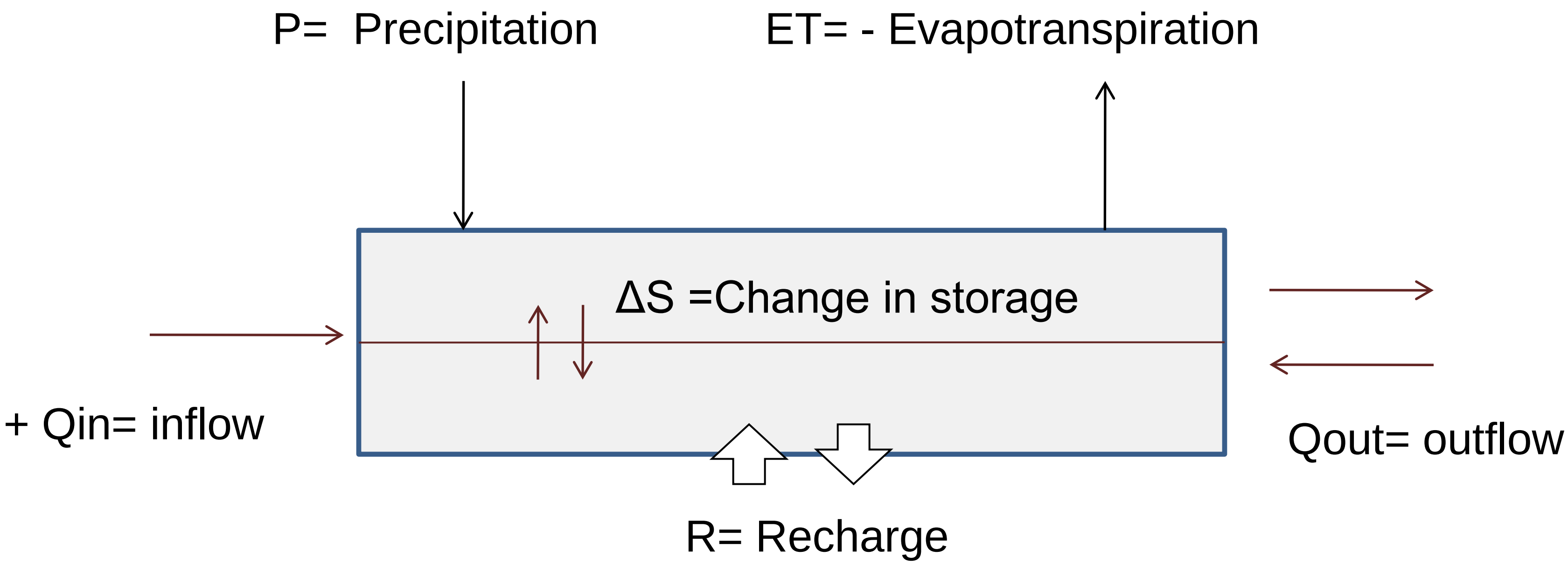
4 Methods were used varying with time and space



WATER BUDGET

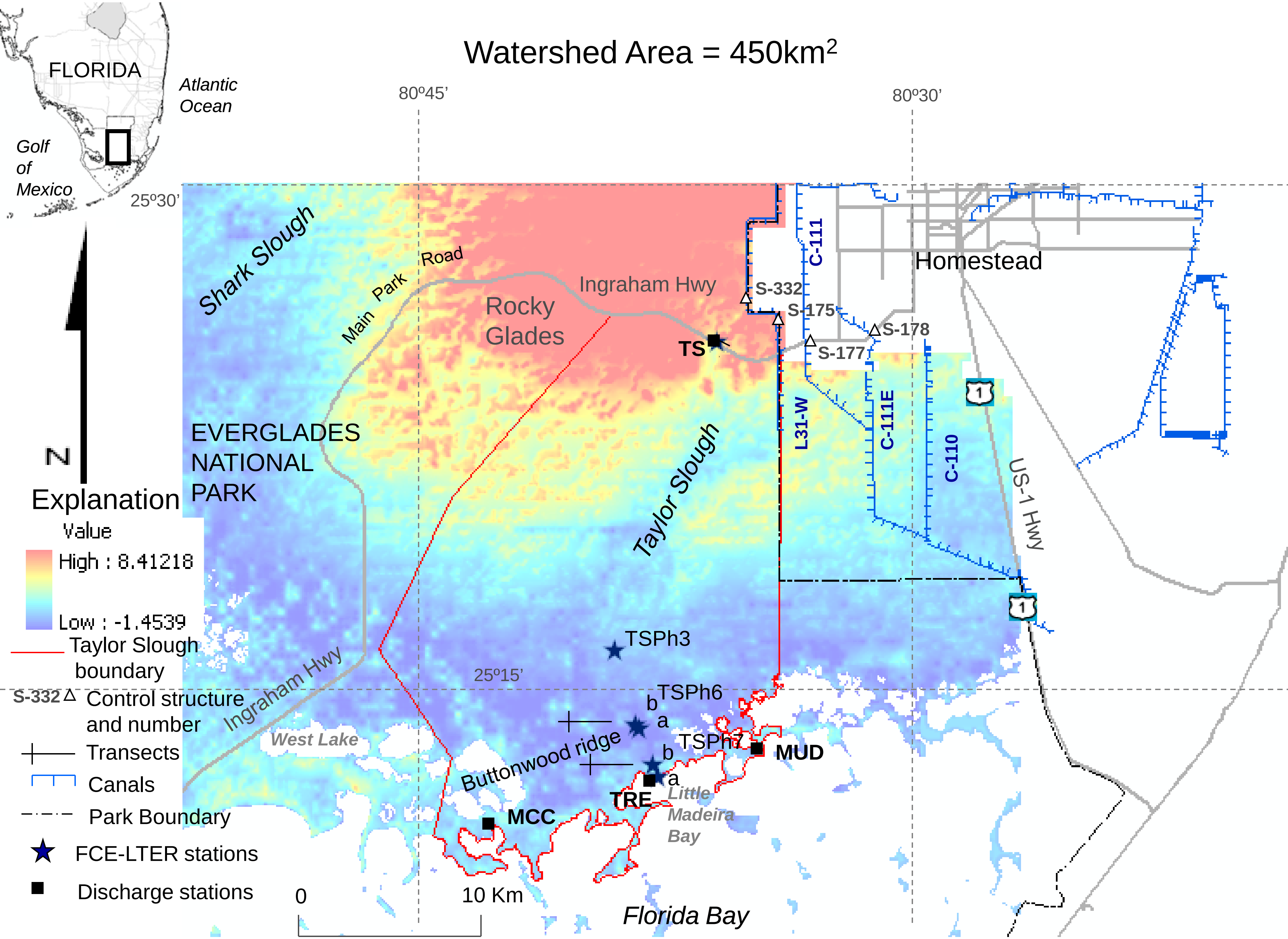
Inflows – Outflows = ΔS   Conservation of mass

$$P + Qin - ET \pm Qout \pm \Delta S = \pm R$$



ASSUMPTIONS

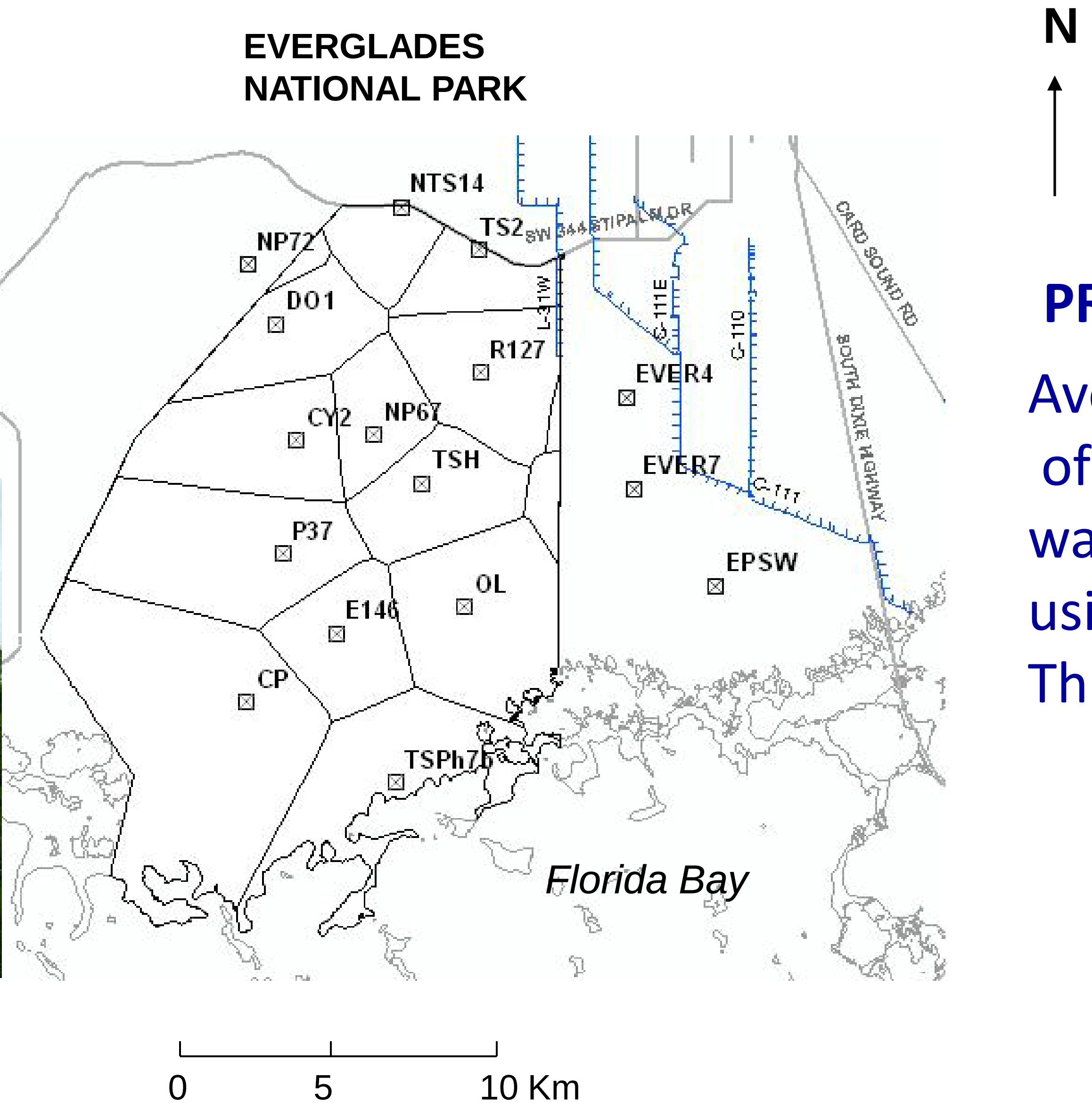
No further water exports and imports



Watershed Area = 450km²
FLORIDA
Atlantic Ocean
Golf of Mexico
80°45'
80°30'
25°30'
25°15'
Shark Slough
Main Park Road
Rocky Glades
Ingraham Hwy
TS
S-332
S-175
S-178
S-177
C-111
Homestead
L31-W
C-111E
C-110
US-1 Hwy
EVERGLADES NATIONAL PARK
Taylor Slough
N
Explanation
Value
High : 8.41218
Low : -1.4539
Taylor Slough boundary
S-332 Control structure and number
Transects
Canals
Park Boundary
FCE-LTER stations
Discharge stations
Ingraham Hwy
West Lake
TSPh3
TSPh6
TSPh7
MUD
TRE
MCC
Buttonwood ridge
Little Madeira Bay
Florida Bay
0
10 Km

WATER BUDGET

$$P + Qin - (ET + Qout) = \Delta S \pm R$$

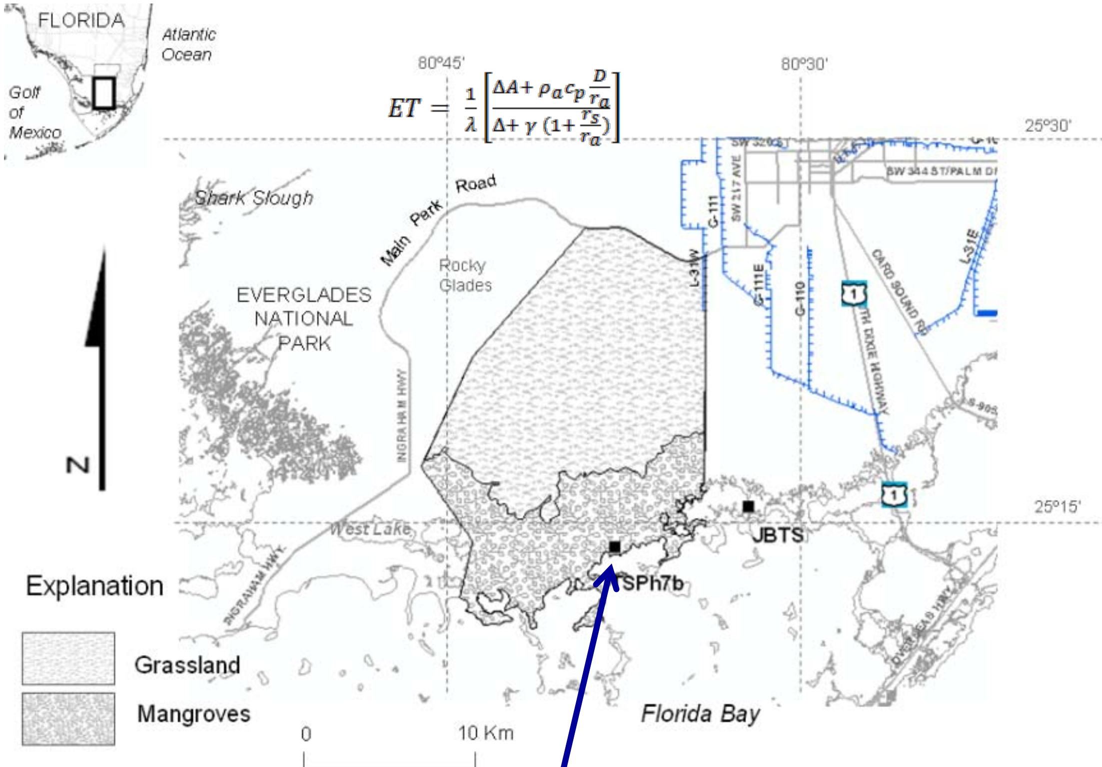


PRECIPITATION

Average depth of precipitation was estimated using Thiessen polygons

Evapotranspiration

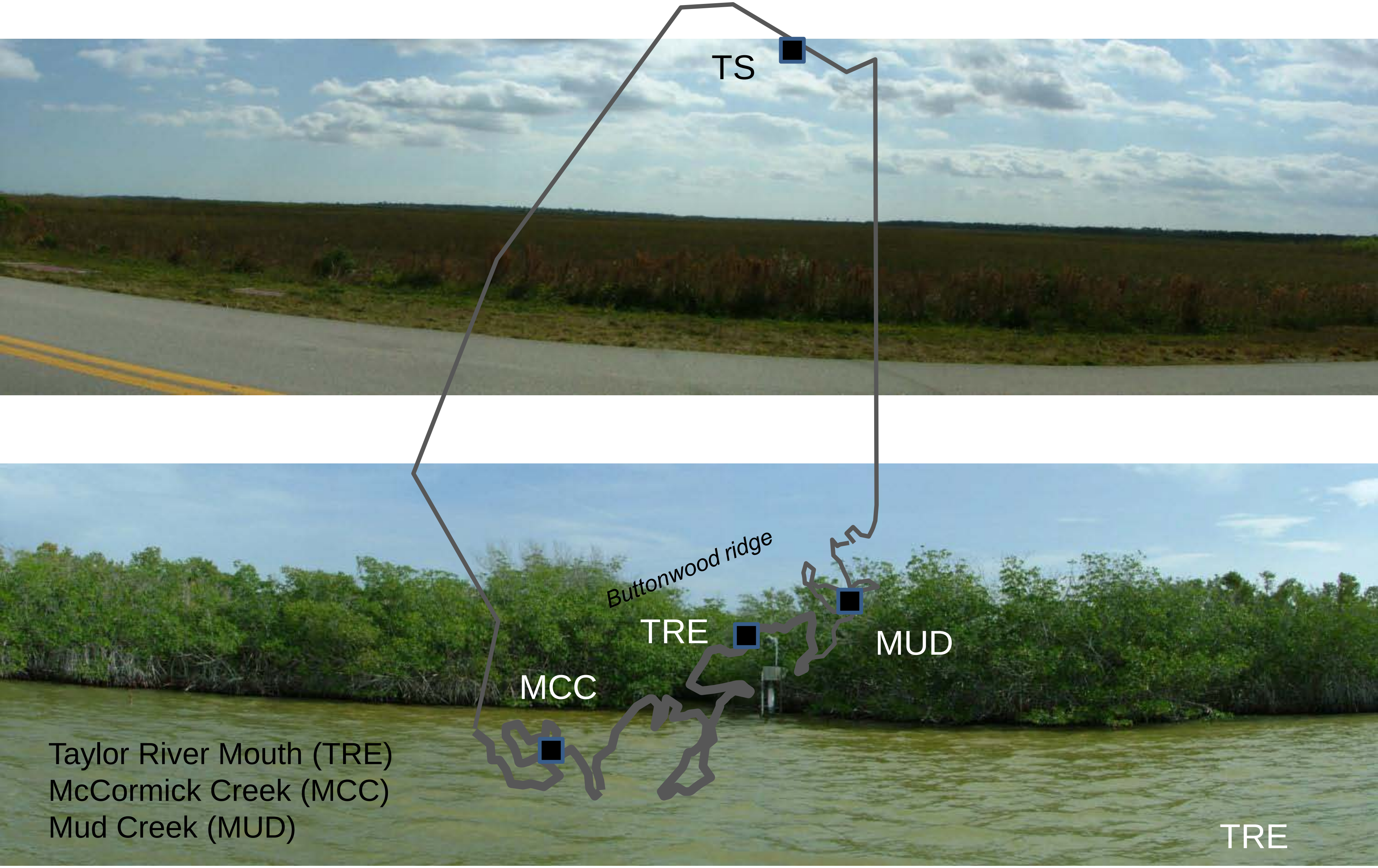
$$ET = \frac{1}{\lambda}\left[\frac{\Delta A + \rho_a c_p \frac{D}{r_a}}{\Delta + \gamma\,(1 + \frac{r_s}{r_a})}\right]$$



Penman-Monteith combination equation

67% grassland
33% Mangroves

SURFACE WATER INFLOW AND SURFACE WATER OUTLOW

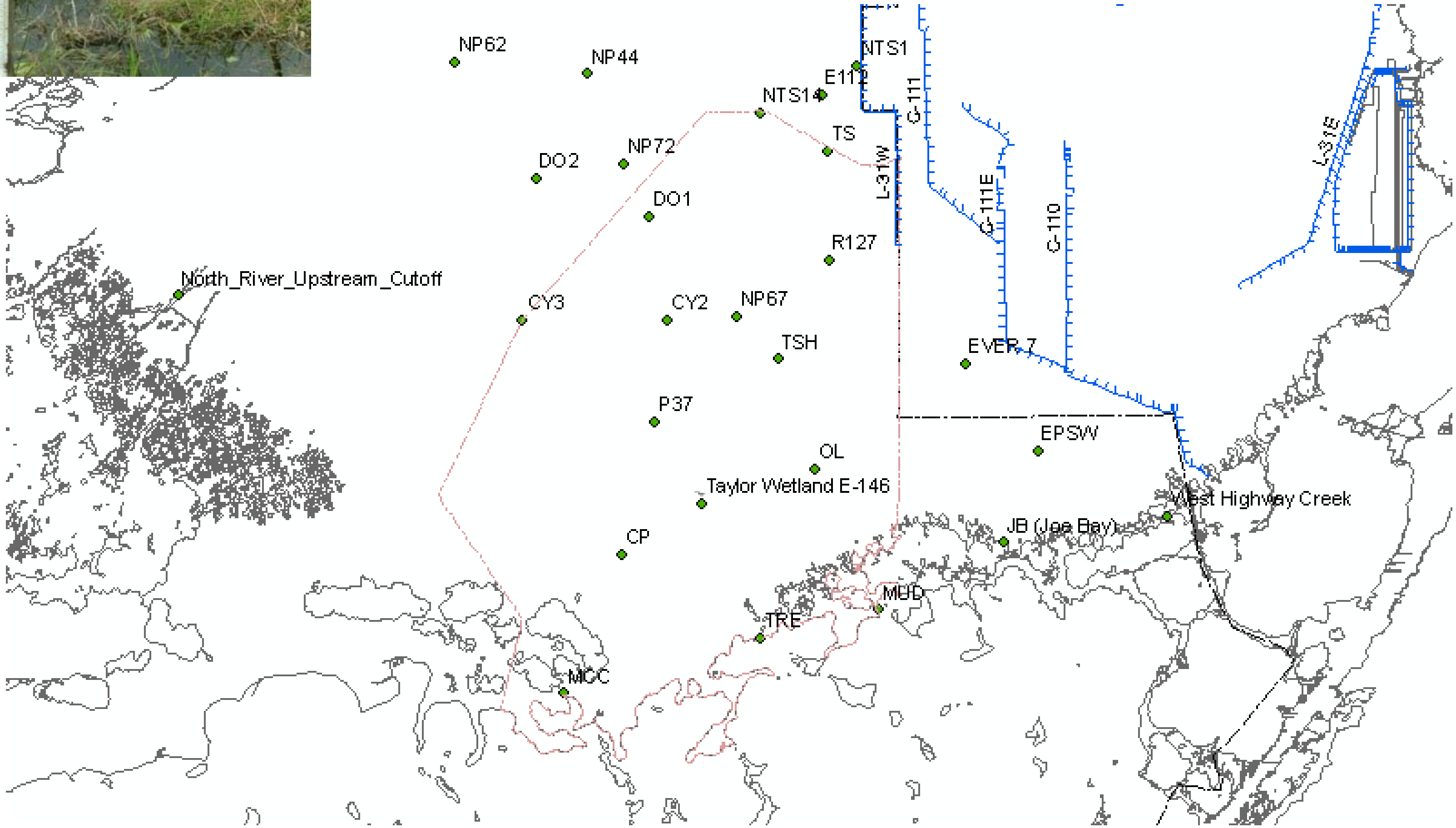


CHANGE IN STORAGE

32 Stages

TIN – is a vector representation made up of irregularly distributed nodes and lines with 3D coordinates.

TIN transformed to a Grid 100x100 m



HYDRAULIC GRADIENT

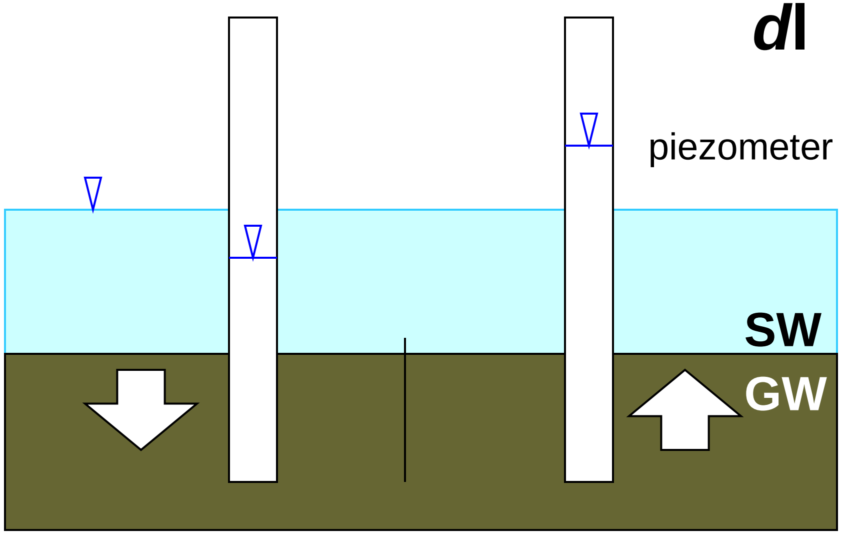
$$\frac{dh}{dl}$$

Darcy's law for fluid movement

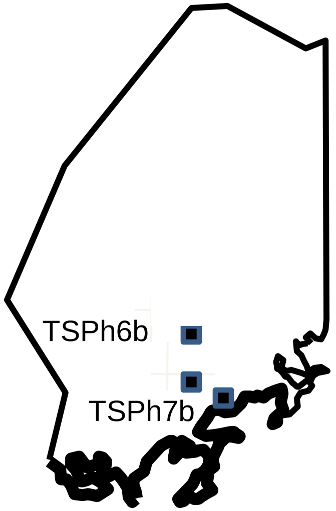
$$q = K_v \frac{\delta h}{\delta l}$$

Kv= 30 cm/day

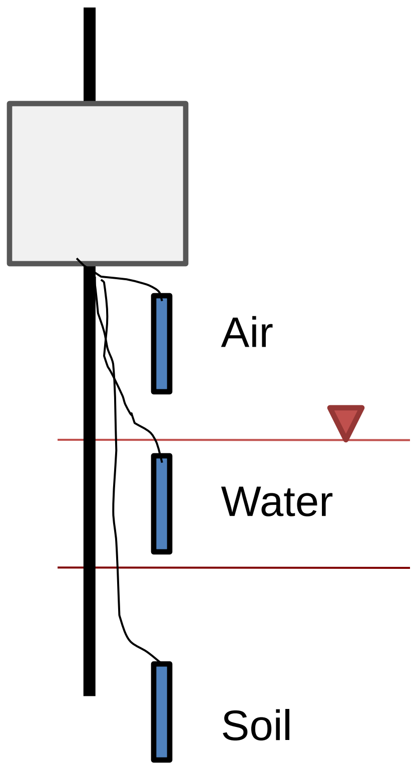
(Harvey et al, 2004)

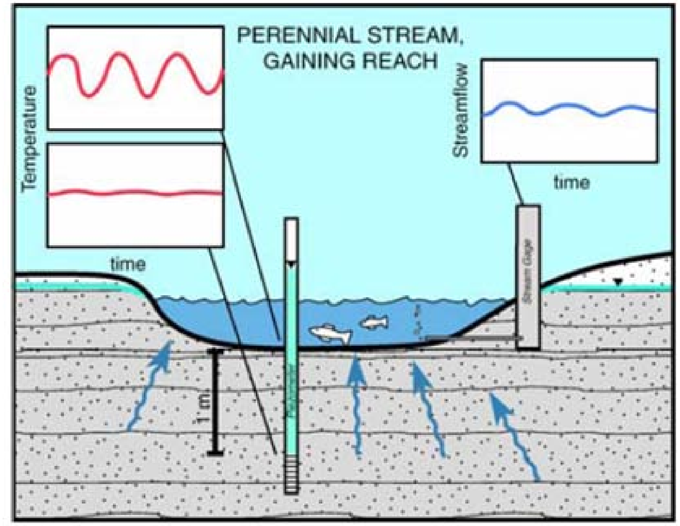


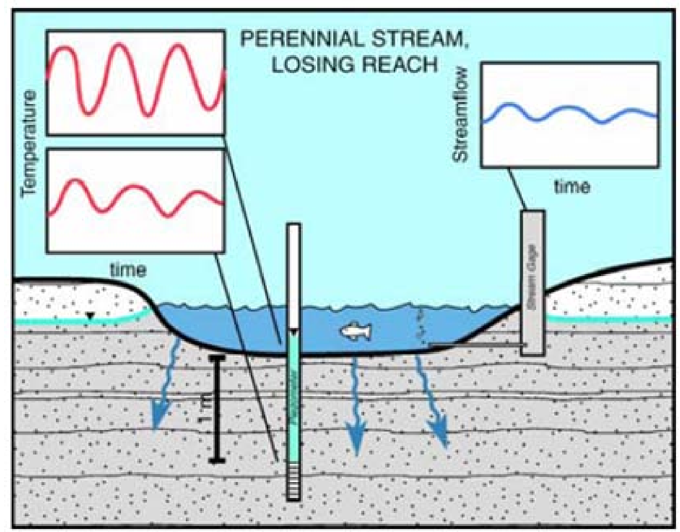
$$h_f = (\rho_p/\rho_f)h_p$$



TEMPERATURE STUDY







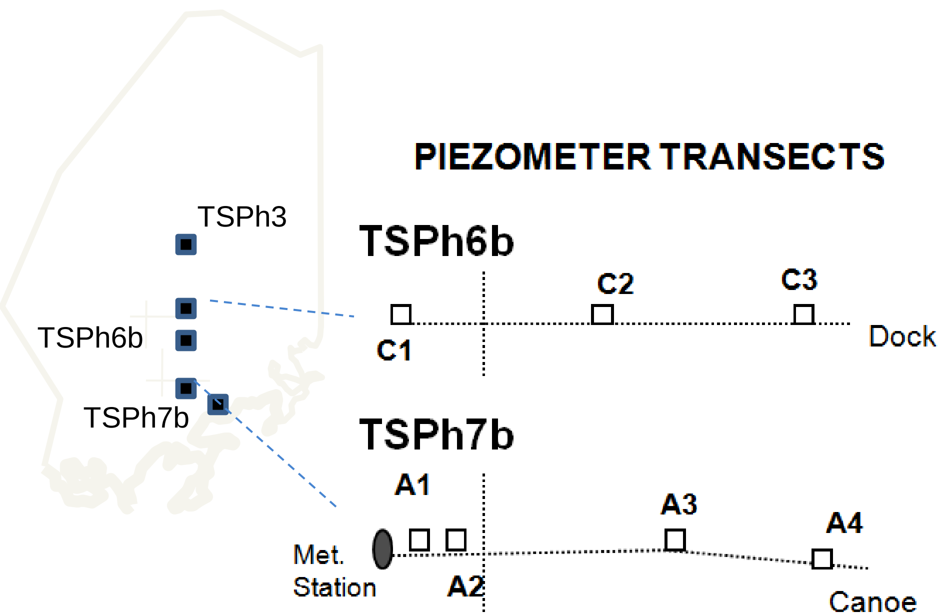
Source: Brodie et al, 2007

Exchange of water between SW and shallow aquifer plays a key role in influencing SW and GW temp.

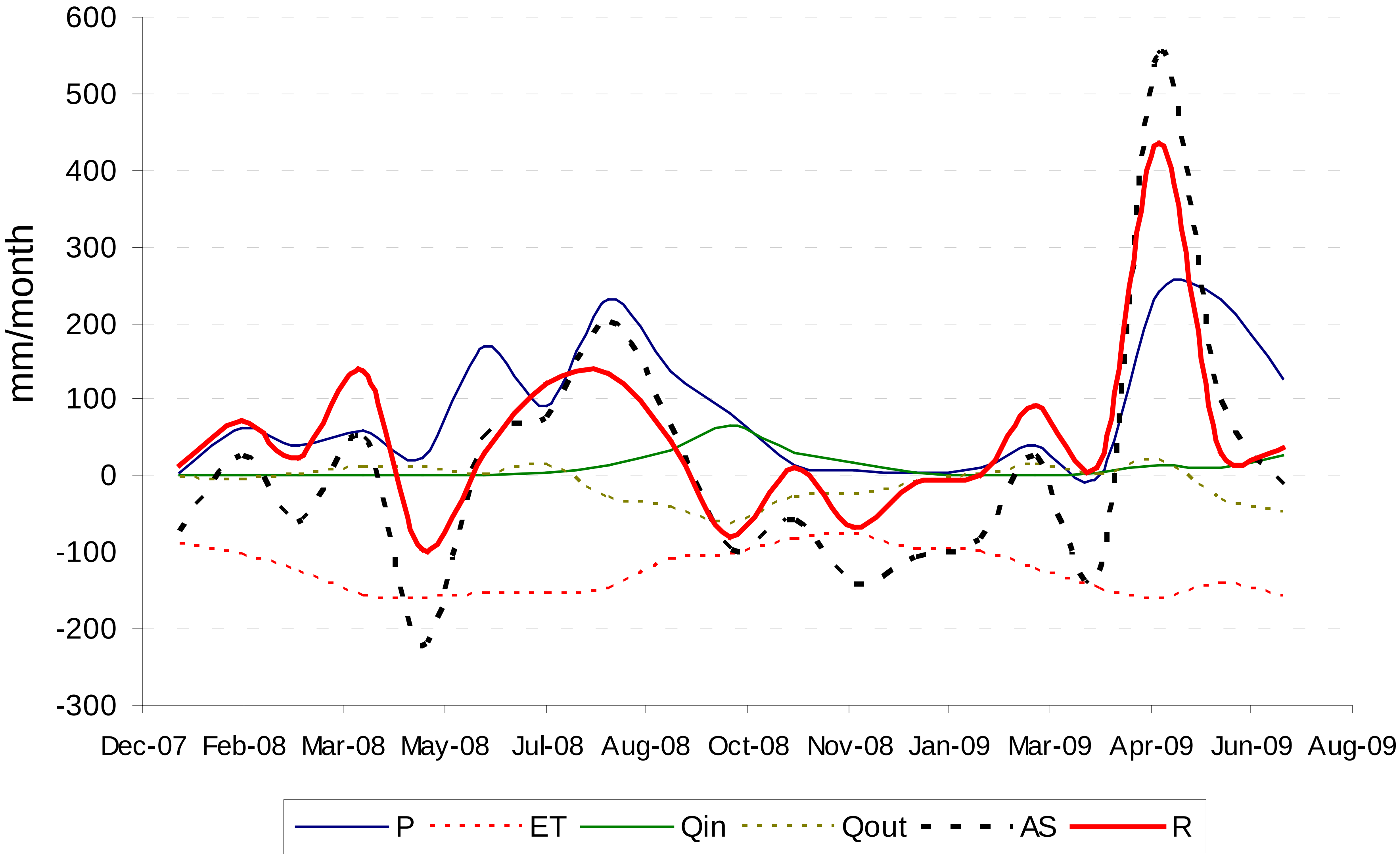
GEOCHEMISTRY AND ENVIRONMENTAL TRACERS

Natural chemical and isotopic substances

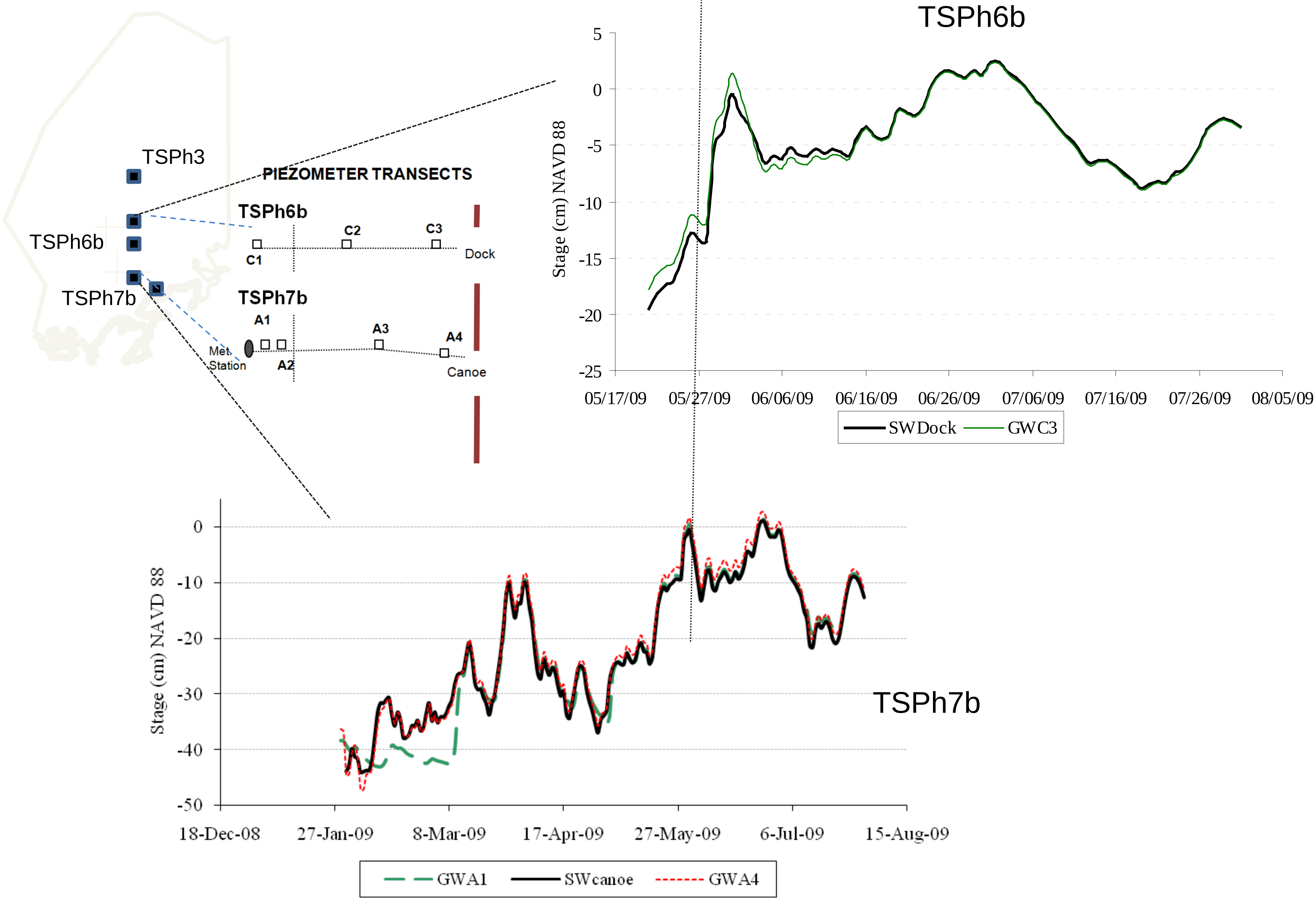
Electrical conductivity
pH
Temperature
Total alkalinity
Anions and cations
Stable isotopes of oxygen and hydrogen



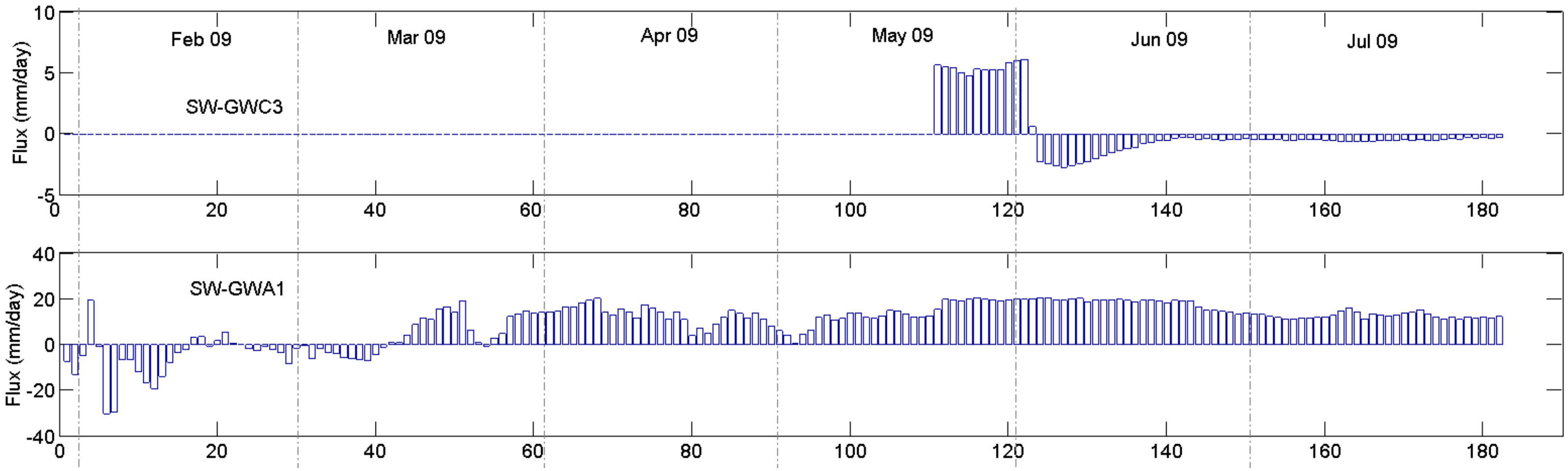
WATER BALANCE RESULTS



HYDRAULIC GRADIENT RESULTS

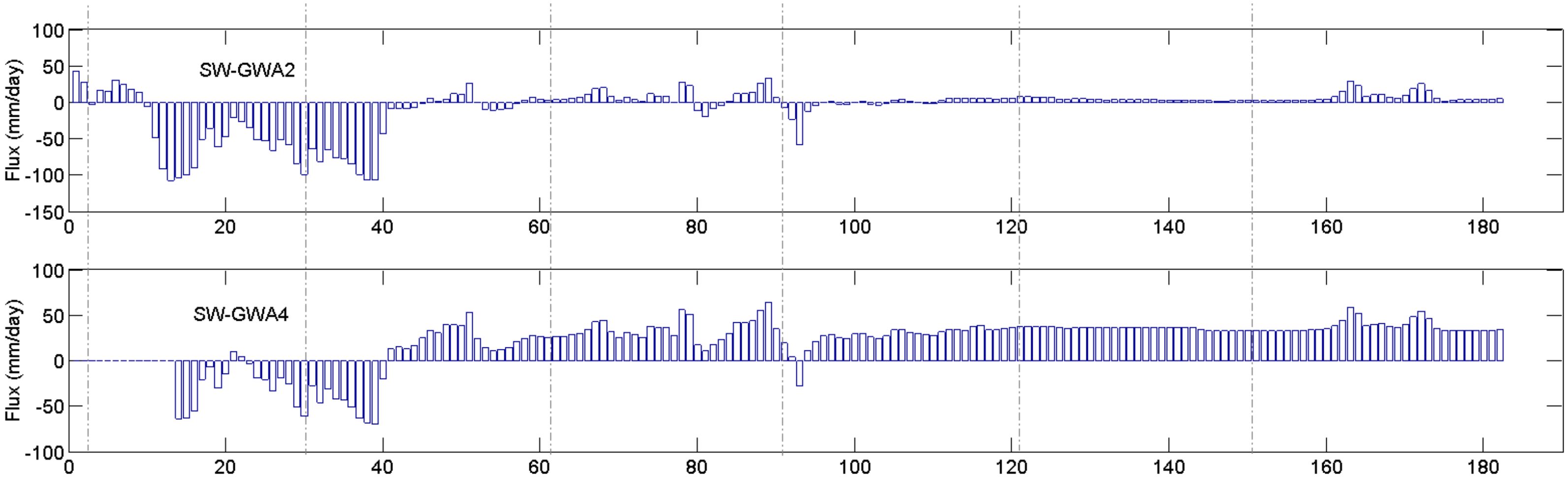


HYDRAULIC GRADIENT RESULTS



TSPh6b

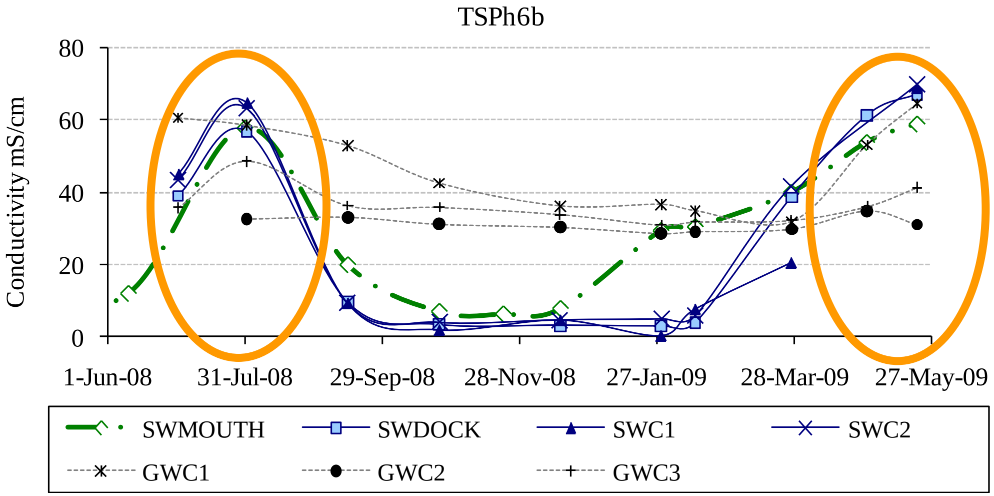
Positive flux indicates groundwater discharge to Taylor Slough



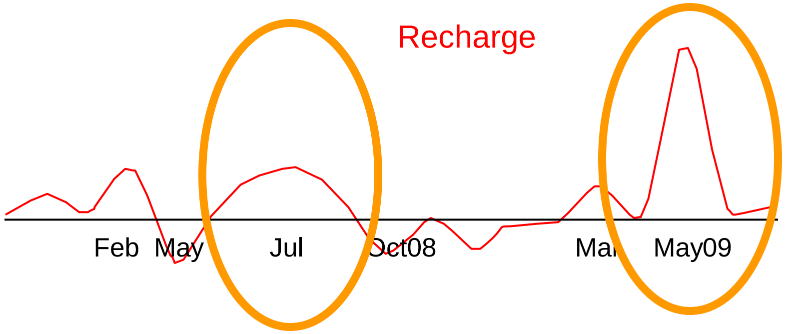
TSPh7b

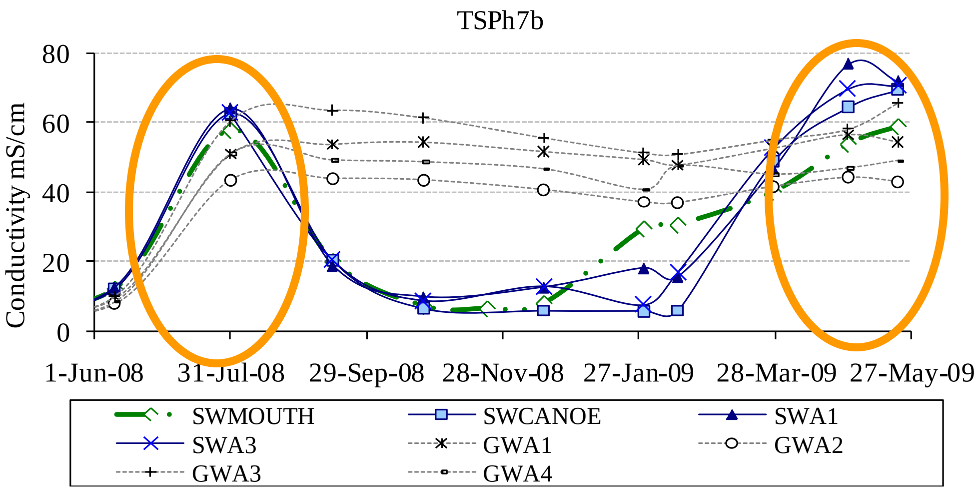
Groundwater fluxes tended to be higher closer to Florida Bay

GEOCHEMISTRY AND ENVIRONMENTAL TRACERS

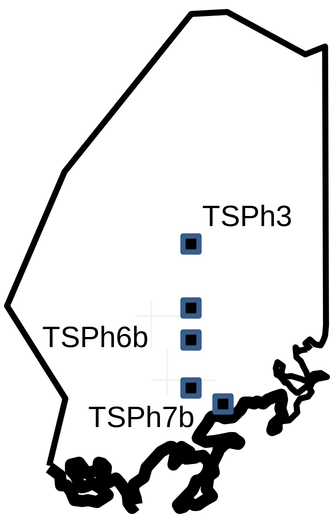


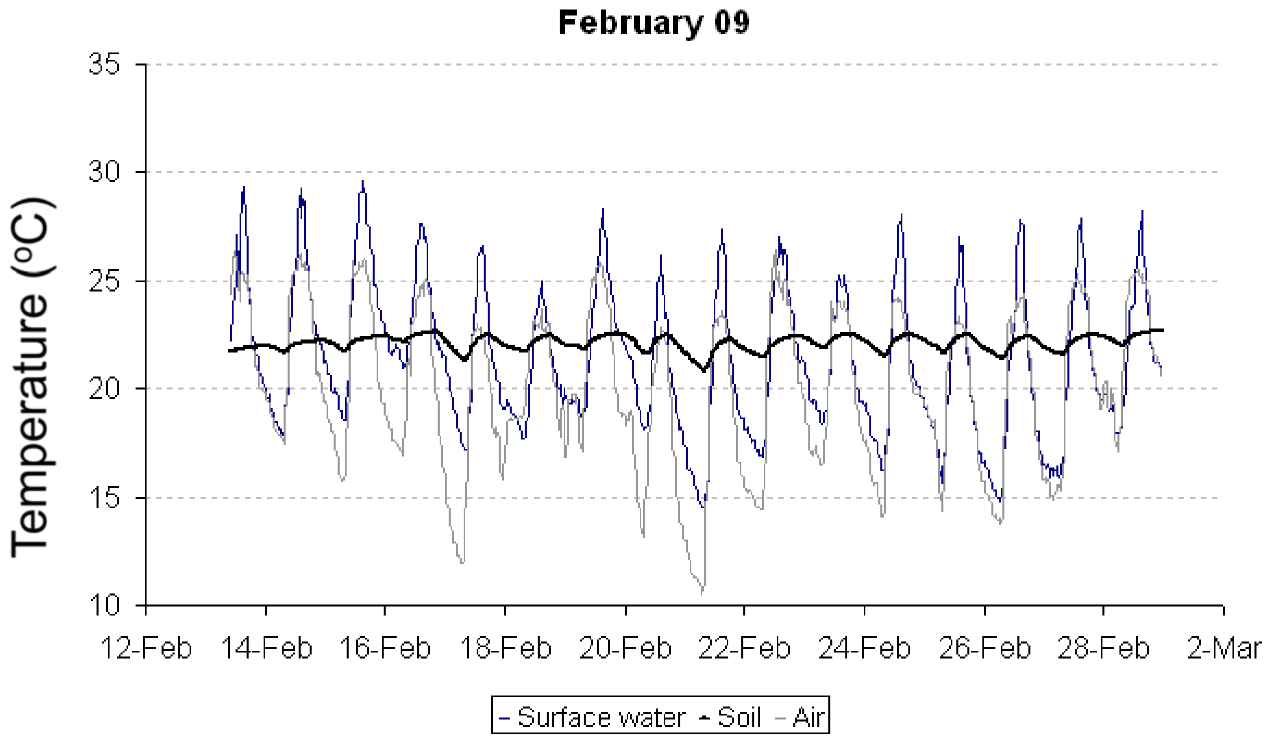
Water Balance

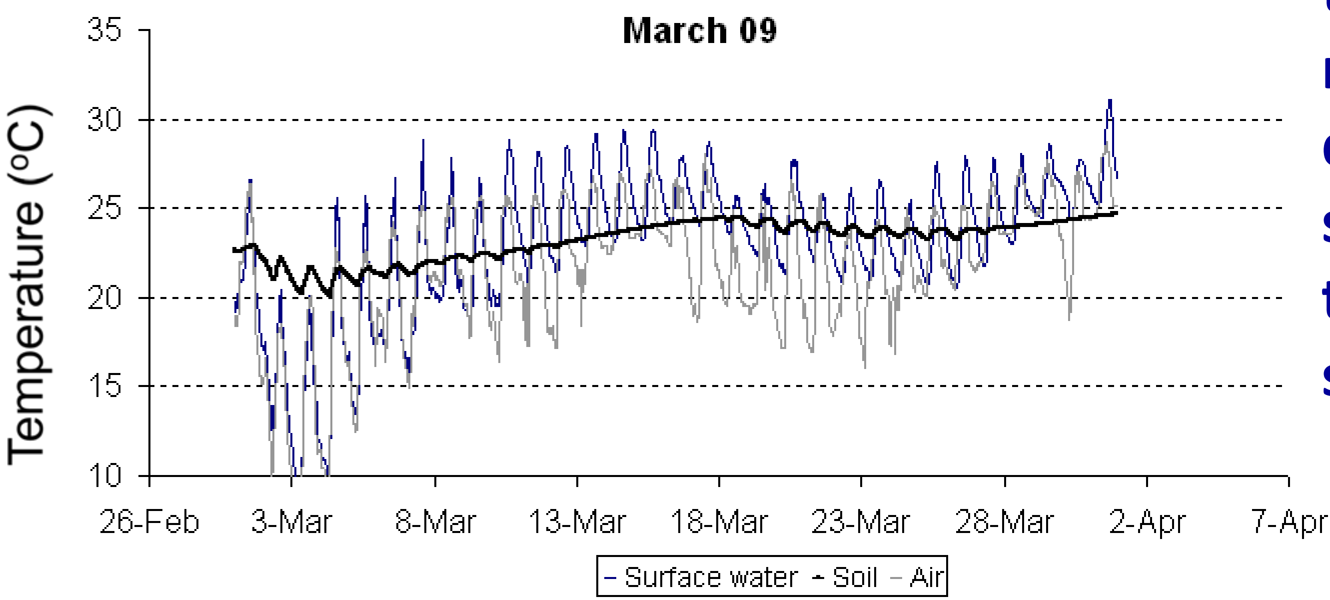




GW discharge is observed when the SW chemistry matches the GW chemistry

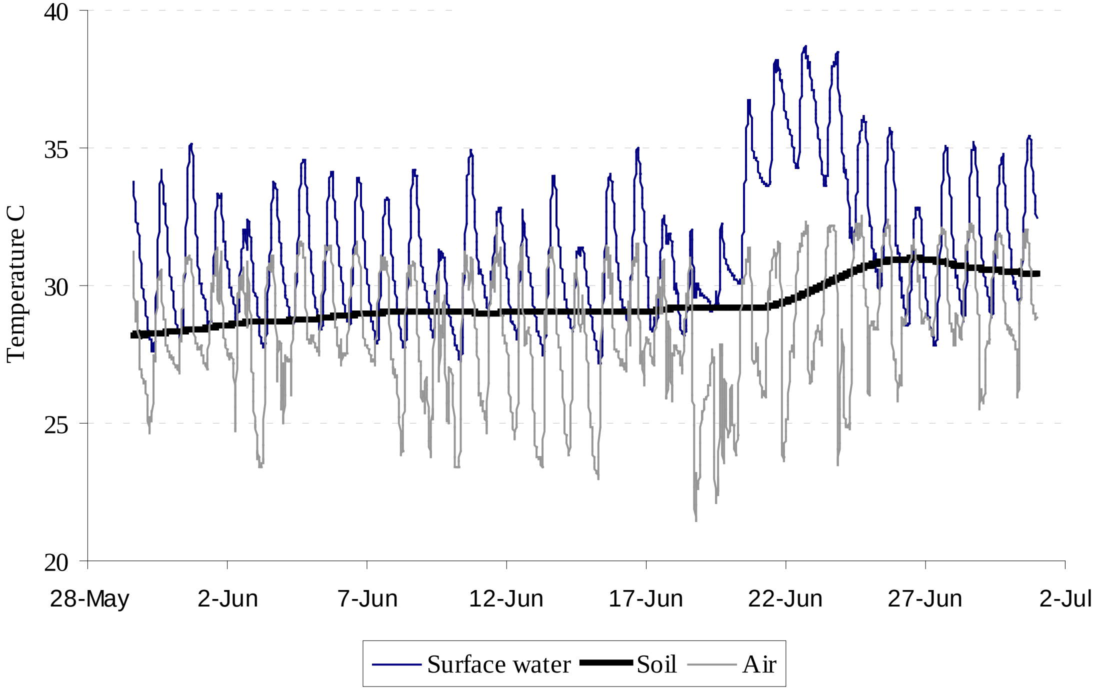






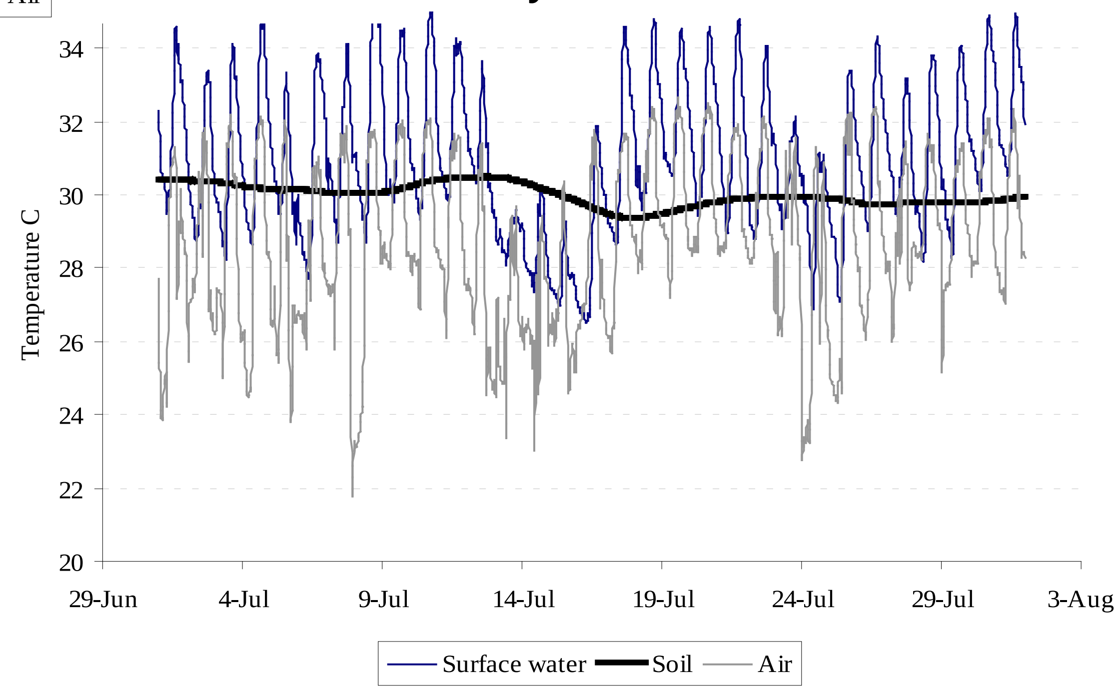
Groundwater Recharge occurs when the soil water temperature mimics the diurnal temp. signal observed in the air and surface water

June 2008

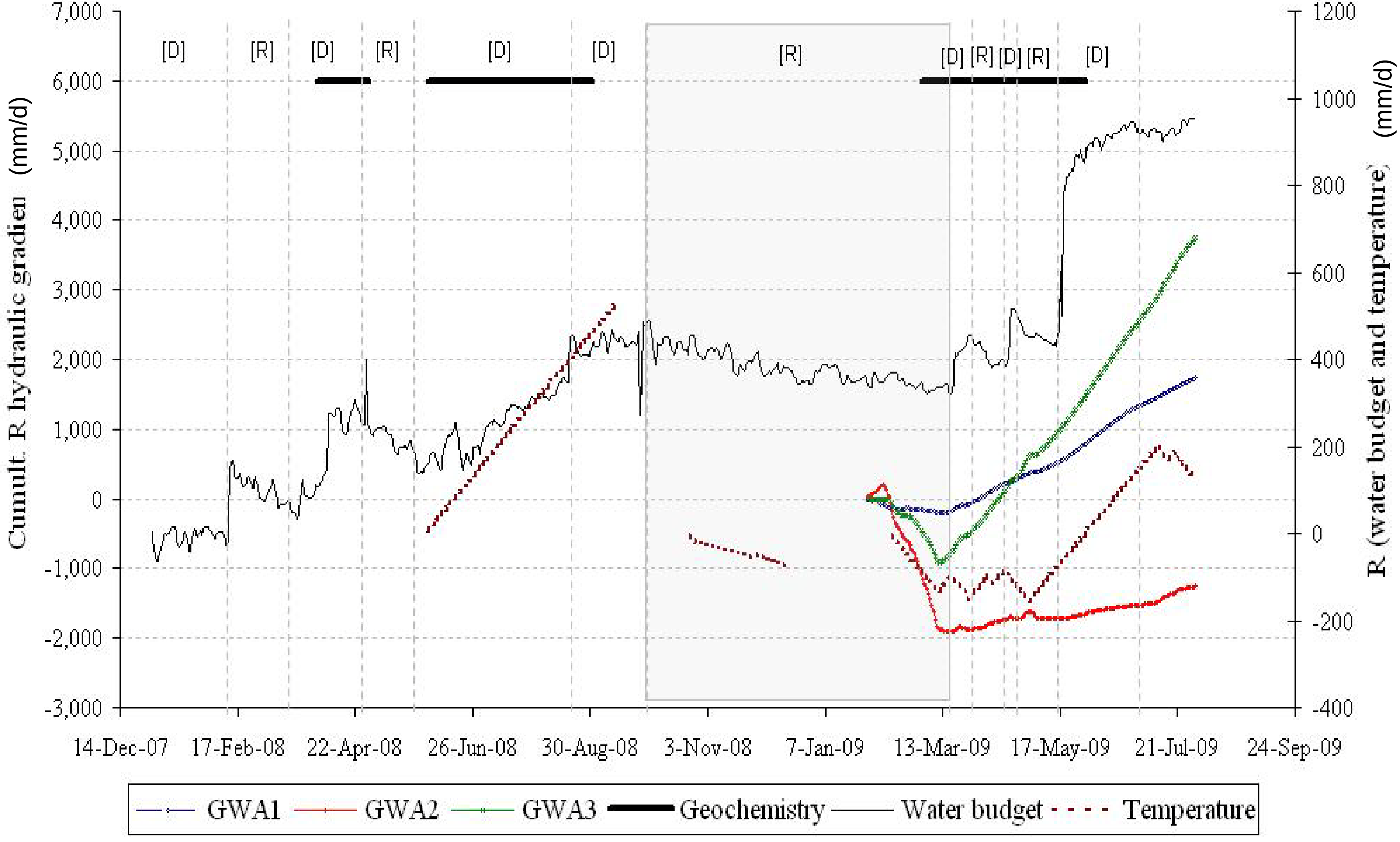


Soil temperature is stable at times of groundwater discharge

July 2008



Summary of Results



Average R rates in mm/day

Water Budget

Jan – Sep 08	Oct 08 – Mar 09	Mar 14 09 – Jul 09
↑ 14.6 ↓ 13.1	↑ 6.0 ↓ 9.3	↑ 15.3 ↓ 7.8

Hydraulic gradient

TSPh7b: ↑ 18.3 ↓ 27.7

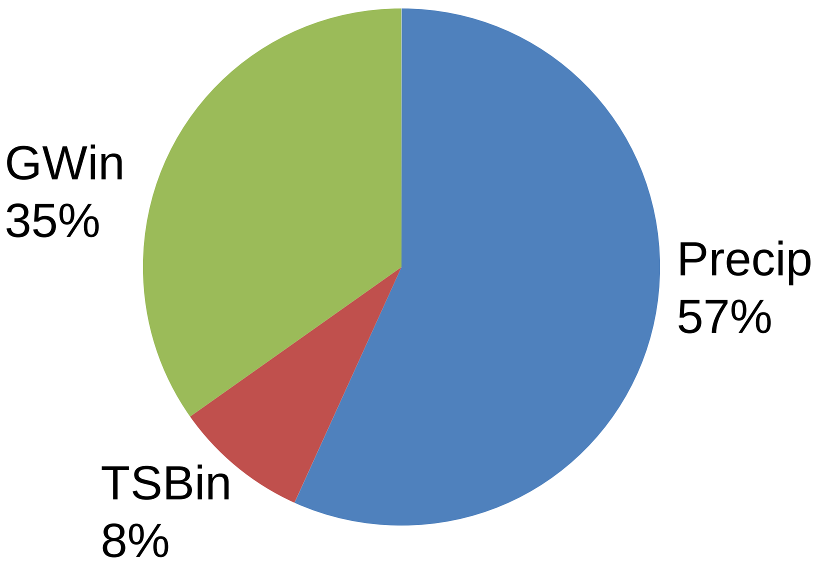
Feb 09 – Jul 09

TSPh6b: ↑ 5.0 ↓ 0.8

Harvey et al (2002) for the Everglades Nutrient Removal project 0.4—9mm/day ↓
and 0.2 --- 1 mm/day ↑

Conclusions

- Groundwater discharge accounted for 35% of the input to Taylor Slough Watershed between Jan 2008 and July 2009



- Groundwater discharge was highest in July 2008 and May 2009

- Groundwater discharge rates varied from 5 to 18 mm/day