

Vegetation Cover Decreases Evaporative Water Loss in a Wetland Ecosystem

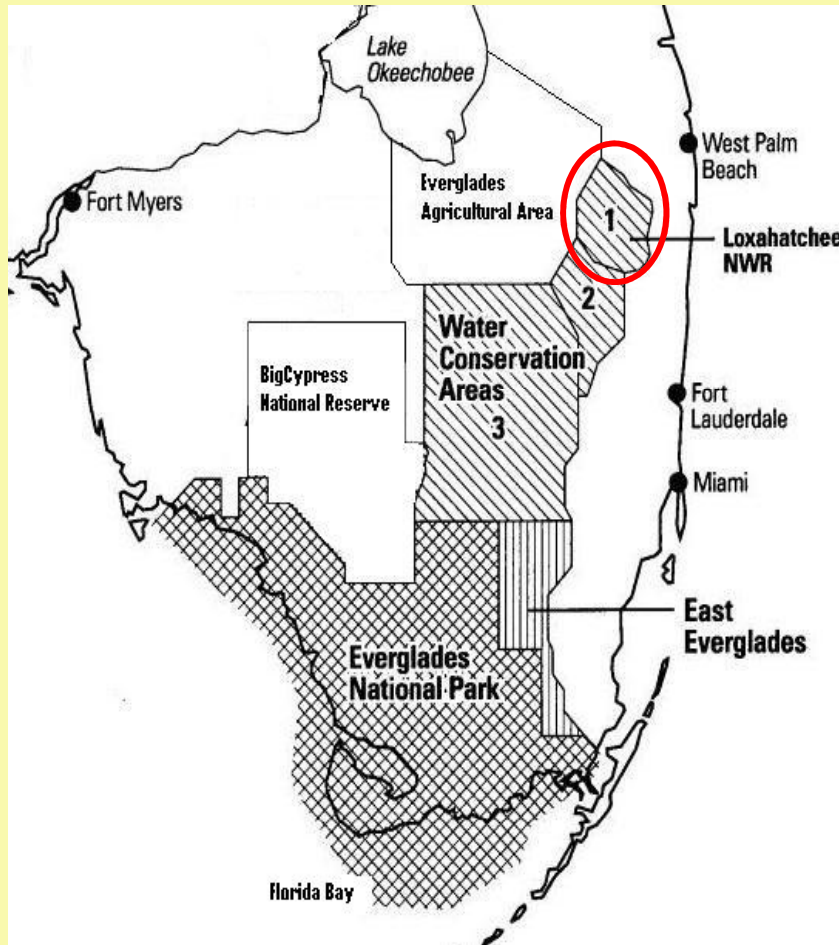
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Loxahatchee National Wild Life Refuge



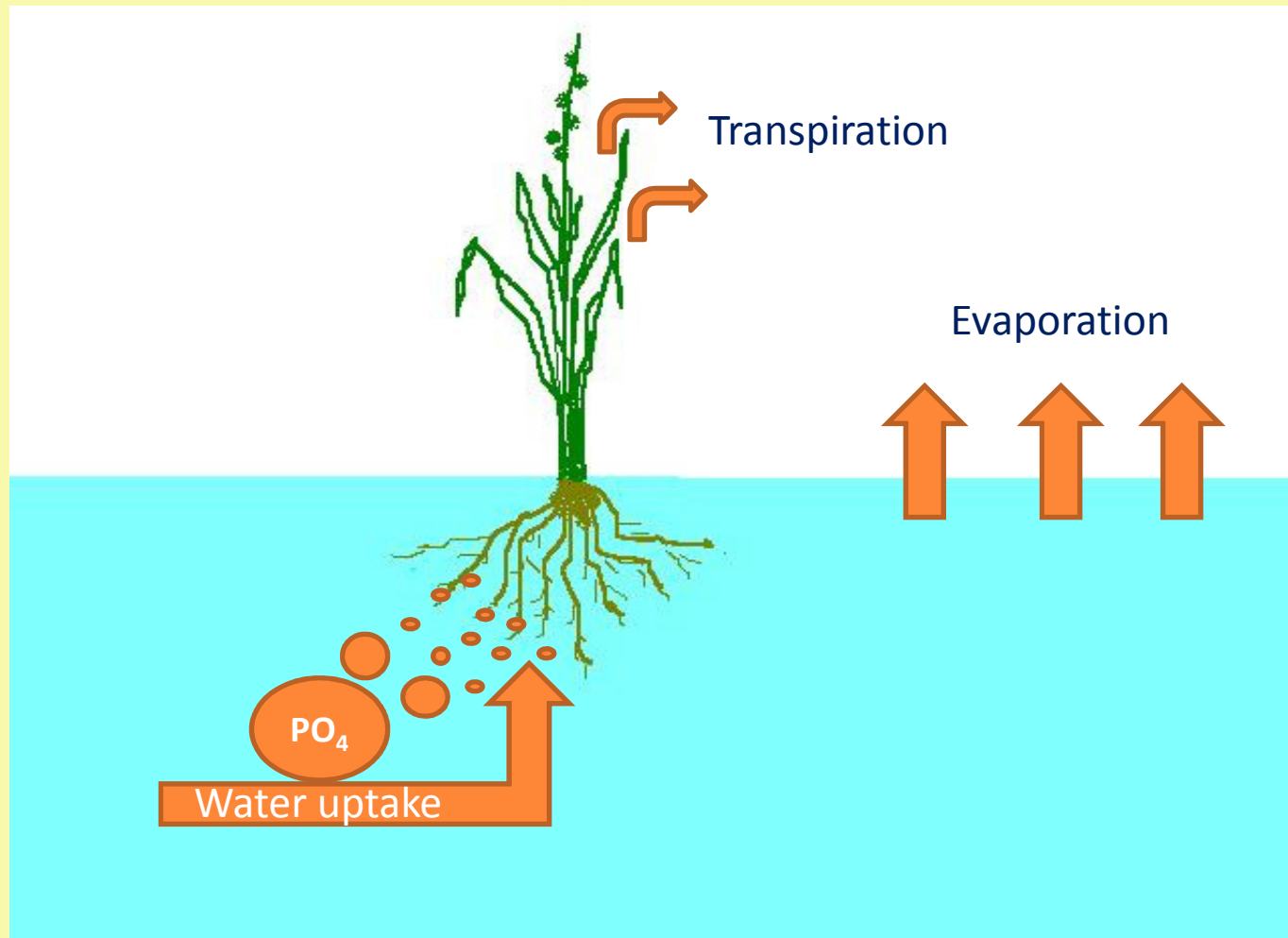
- Northernmost portion of the Everglades
- Dominated by fresh water sawgrass marsh
- Water conservation area
- High phosphate input

Water Management Goals

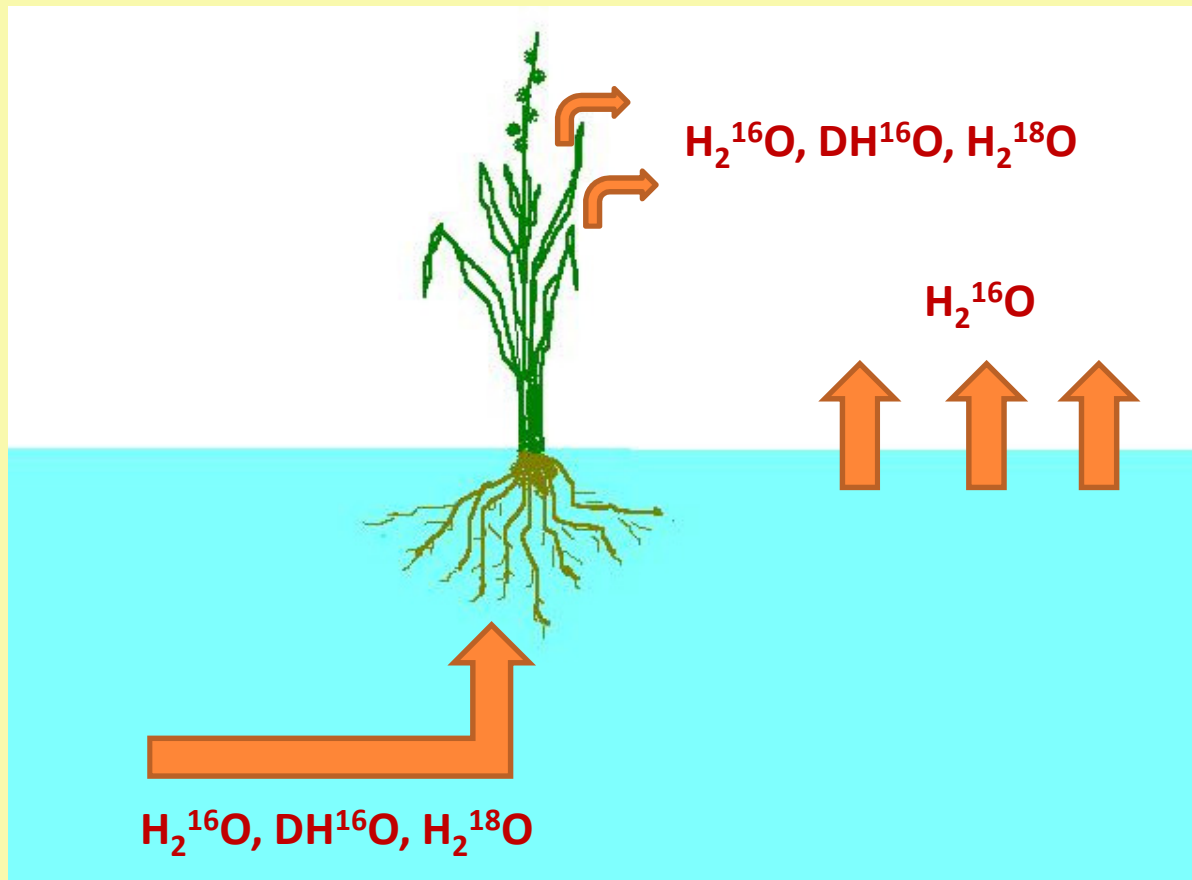
Conserve regional water resources

- Storage of fresh water
 - irrigation purposes
 - prevent saltwater intrusion
- Phosphorus sink
 - remove phosphate runoff

Water loss Pathways



Isotopic Fractionation of Water



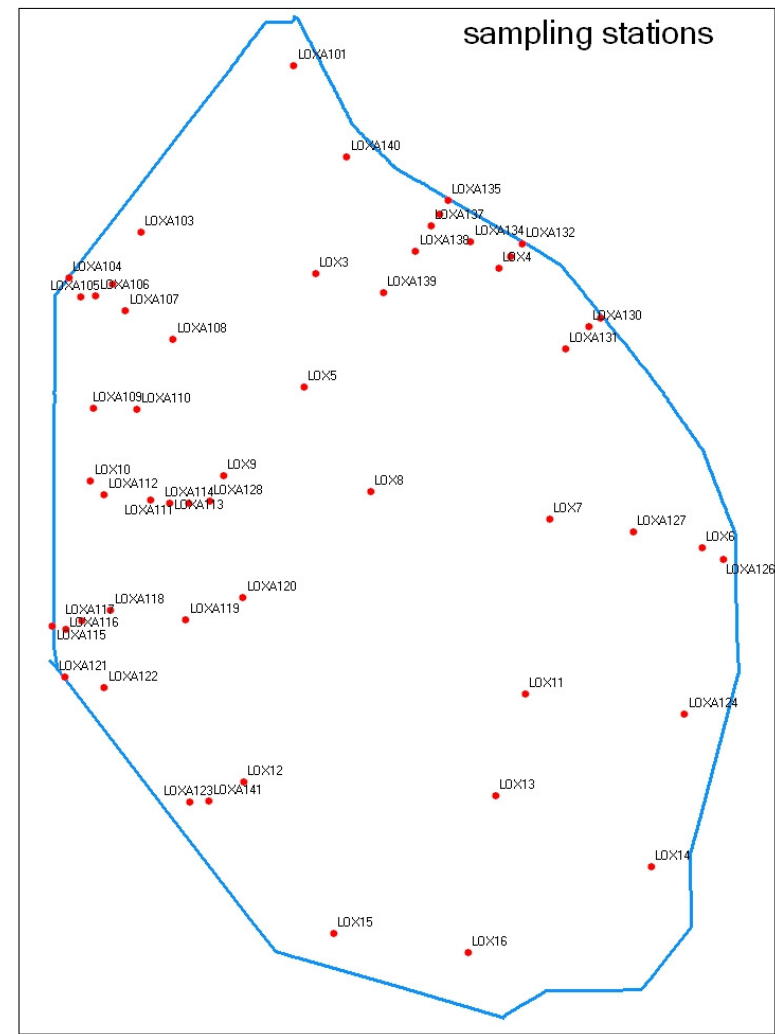
- Water loss through evaporation fractionate against heavy isotopes.
- Water loss through transpiration does not fractionate.

Stable Isotope Tools

- Evaporation causes ^{18}O and ^2H enrichment of water-the greater the evaporation, the greater the enrichment;
- Transpiration does not cause isotopic enrichment of water;
- $\delta^2\text{H}$ versus $\delta^{18}\text{O}$ of evaporative water lies off the Meteoric Waterline;
- In this study we use $\delta^{18}\text{O}$ value of remaining water as a proxy of water evaporation.

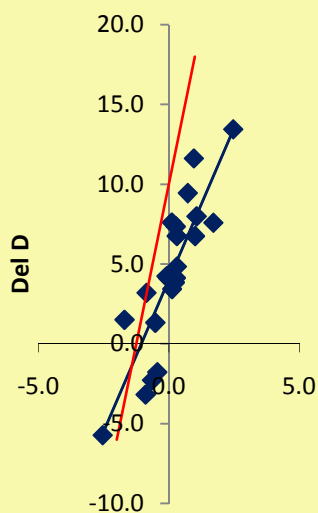
Evaporation Survey

- We collected water samples from 50 sampling stations in the refuge.
- Degrees of evaporation were estimated using oxygen isotopic composition.



Evaporative Water Line

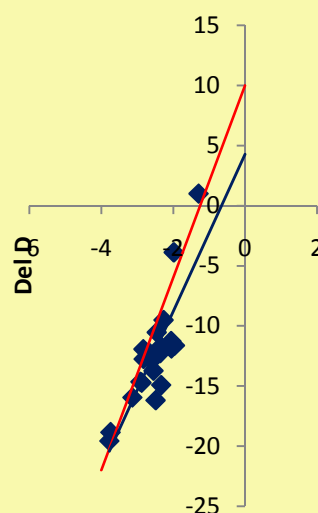
August 2006
Samples



Del O-18

$$y = 3.7996x + 4.0337$$

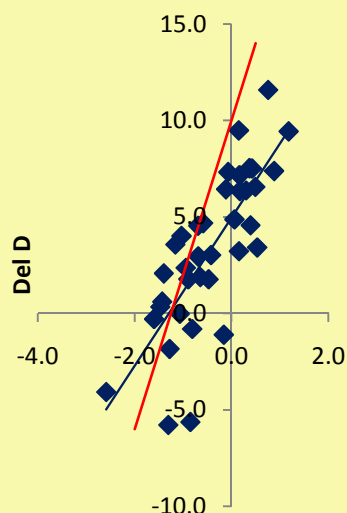
September
2006 Samples



Del O-18

$$y = 6.551x + 4.281$$

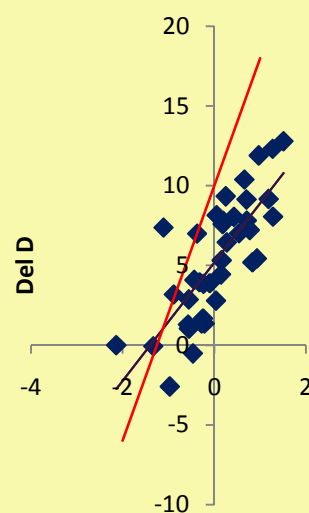
November 2006
Samples



Del O-18

$$y = 3.844x + 4.9555$$

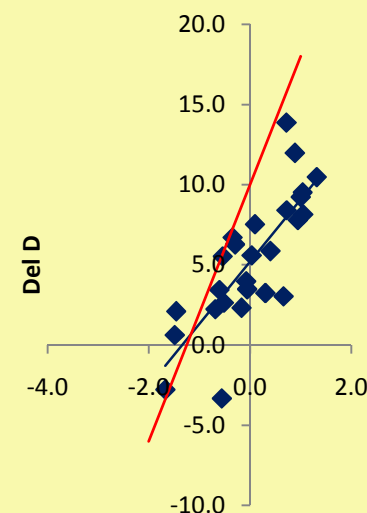
January 2007
Samples



Del O-18

$$y = 3.7118x + 5.1942$$

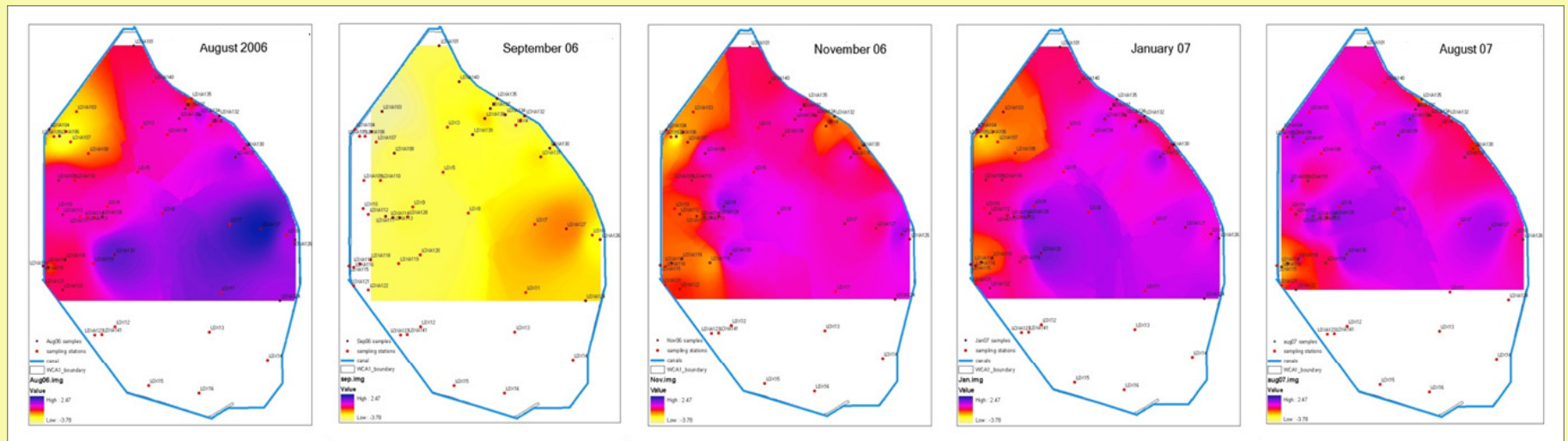
August 2007
Samples



Del O-18

$$y = 3.8764x + 5.2082$$

Spatial Water Evaporation Pattern

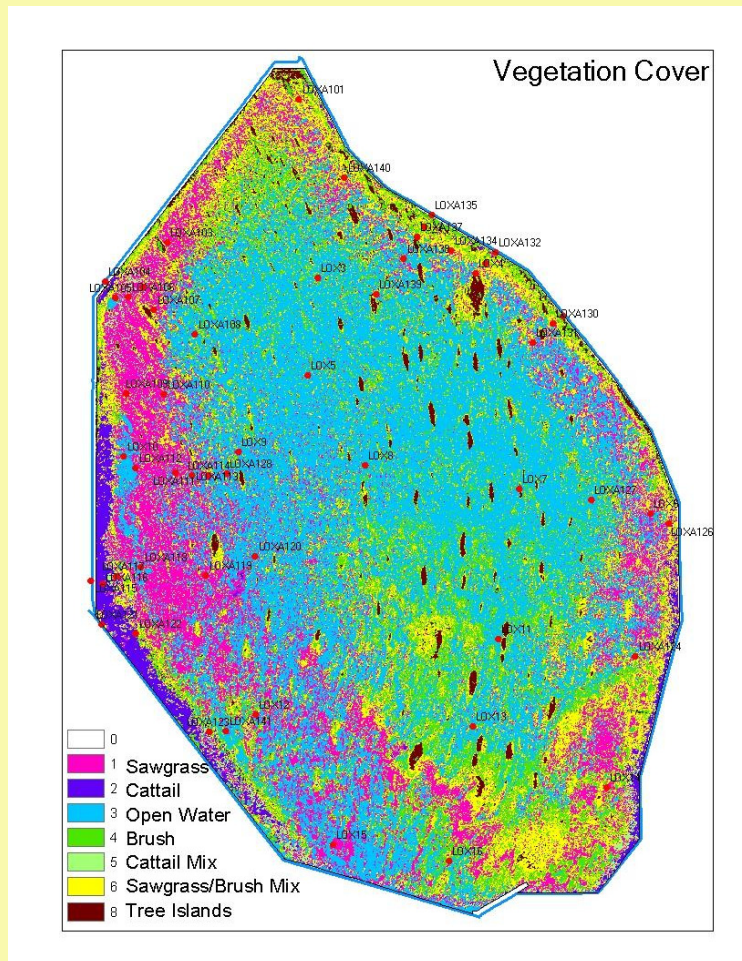


- Evaporation of the Loxahatchee refuge is not homogeneous, with differences in $\delta^{18}\text{O}$ values between stations of up to 5‰ within one month's samples.
- Although the isotopic enrichment range of different months are different, the general spatial pattern of ^{18}O enrichment remains the same.

This Leads to the Question

- **What is affecting evaporative water loss in the Loxahatchee Refuge?**
- factors we examined are:
 - vegetation cover
 - water turnover rate (average distance from the water discharge stations of surrounding canals)
 - water depth (base elevation)

A. Vegetation Cover

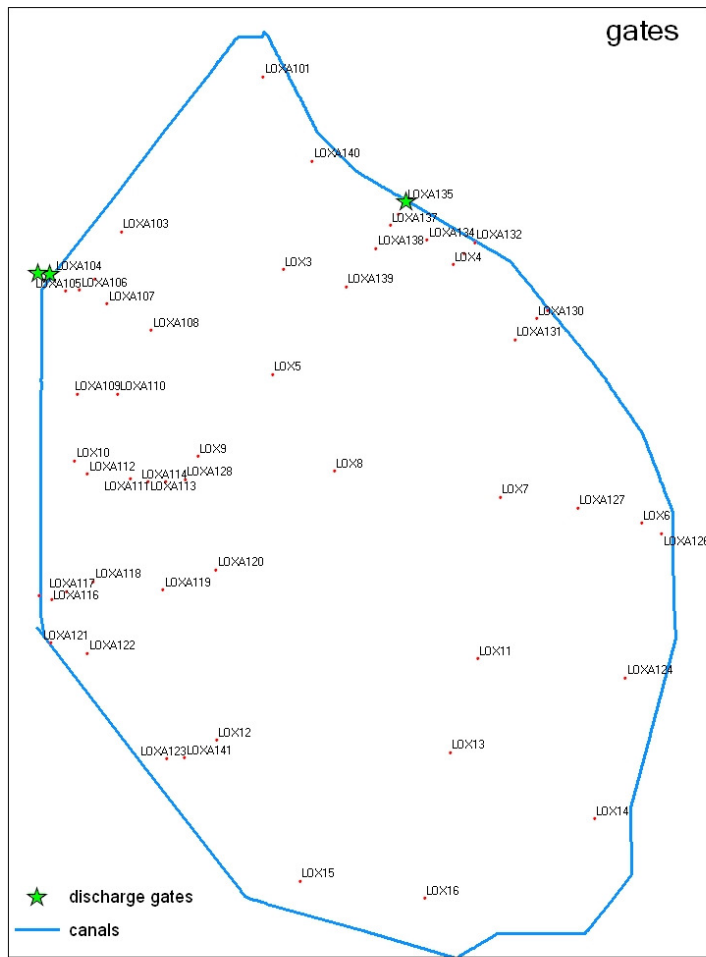


This factor has two possible effects on water evaporation:

- Vegetation provide shade and boundary layer to surface water-lower evaporation
- Vegetation slows down water flow-higher evaporation

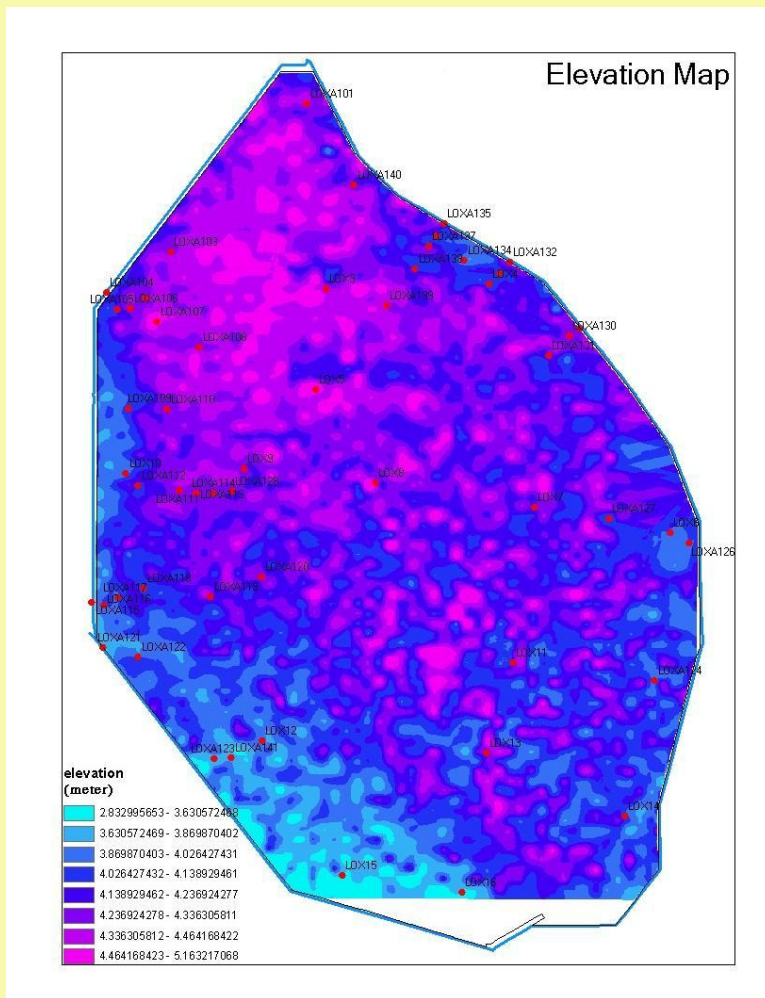
G. Thomas Bancroft, Dale E. Gawlik, and Ken Rutchey. "Distribution of Wading Birds Relative to Vegetation and Water Depths in the Northern Everglades of Florida, USA". *Waterbirds*. Vol. 25, no. 3, pp. 265-277. Sep 2002.

B. Distance from canal water discharge gates



This factor is more related to water turn over rate rather than evaporation rate. Water far from the gates has been exposed to evaporation for a longer time.

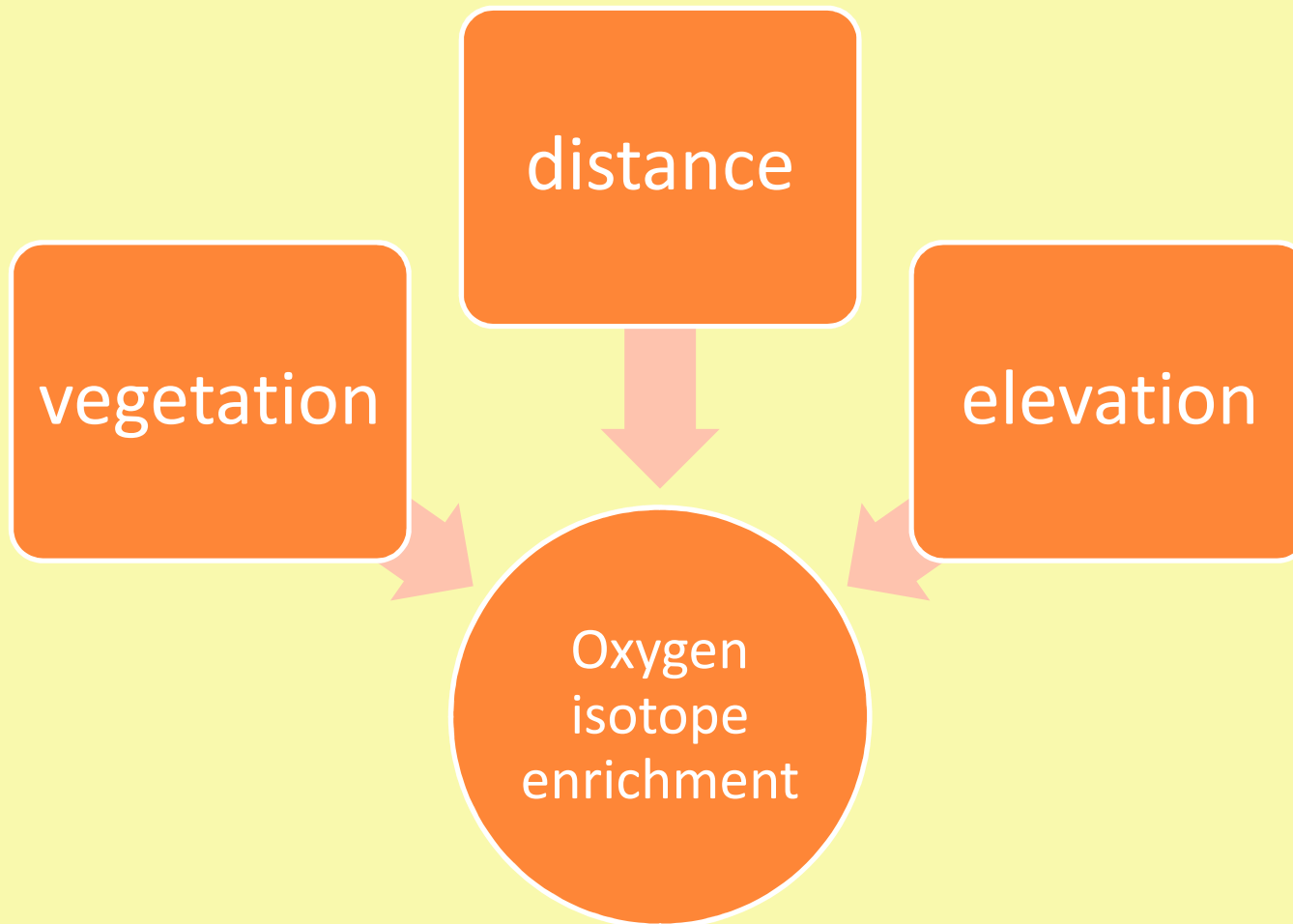
C. Elevation



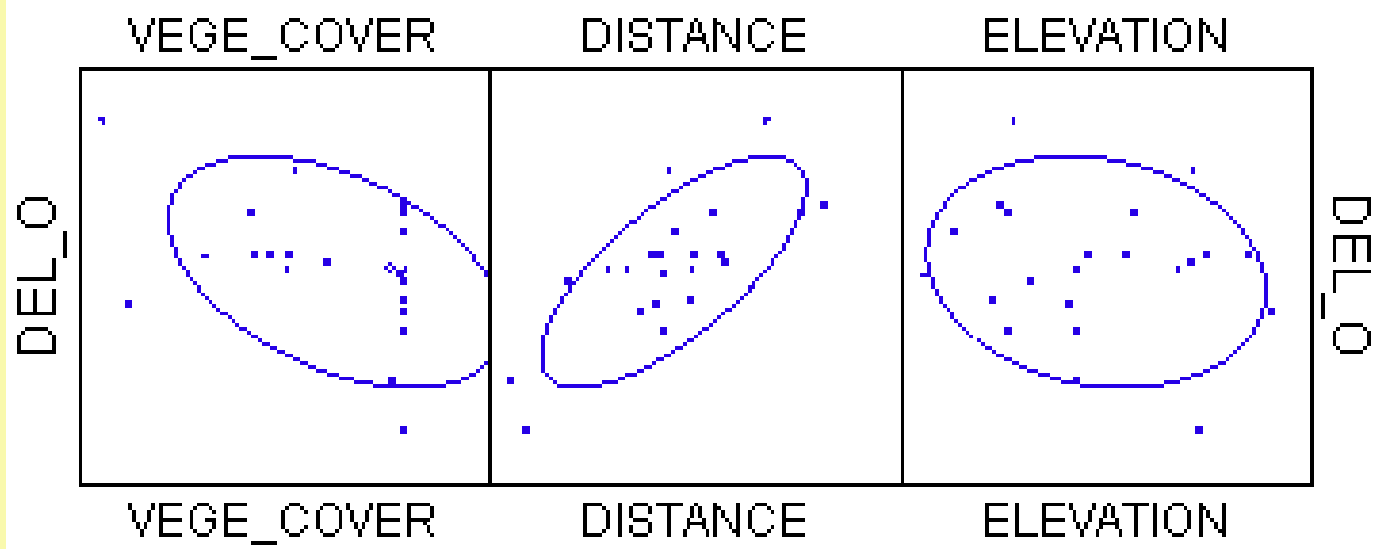
This factor is related to water depth: the lower the base elevation, the deeper the water. We hypothesized that shallow water evaporates faster than deep water.

John W. Jones, et al. Conceptual design of the Everglades Depth Estimation Network (EDEN) grid. USGS Open File Report 2007-1200.

Multi-linear Regression Model



Scatter Plot Matrix



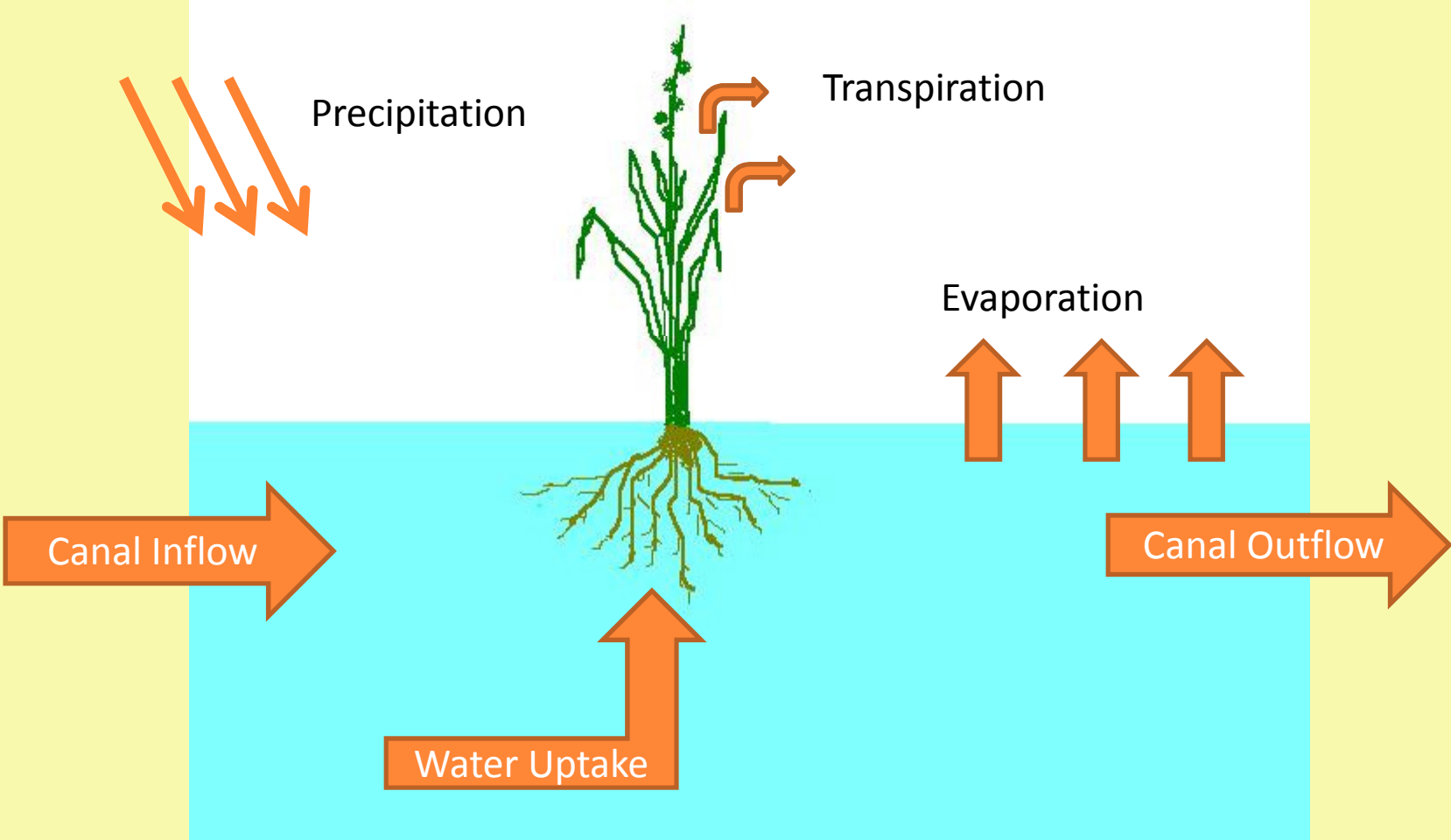
Results

- Water depth (elevation) has no significant effect on ^{18}O enrichment;
- Distance from discharge gates has significant positive effects on ^{18}O enrichment;
- Percentage of vegetation cover has significant negative effects on ^{18}O enrichment;
- Distance and vegetation do not covary
- **Vegetation cover decreases evaporation**

Applications

- **Water balance modeling**
 - Inputs: canal inflow, precipitation
 - Outputs: canal outflow, evaporation, plants uptake (transpiration)

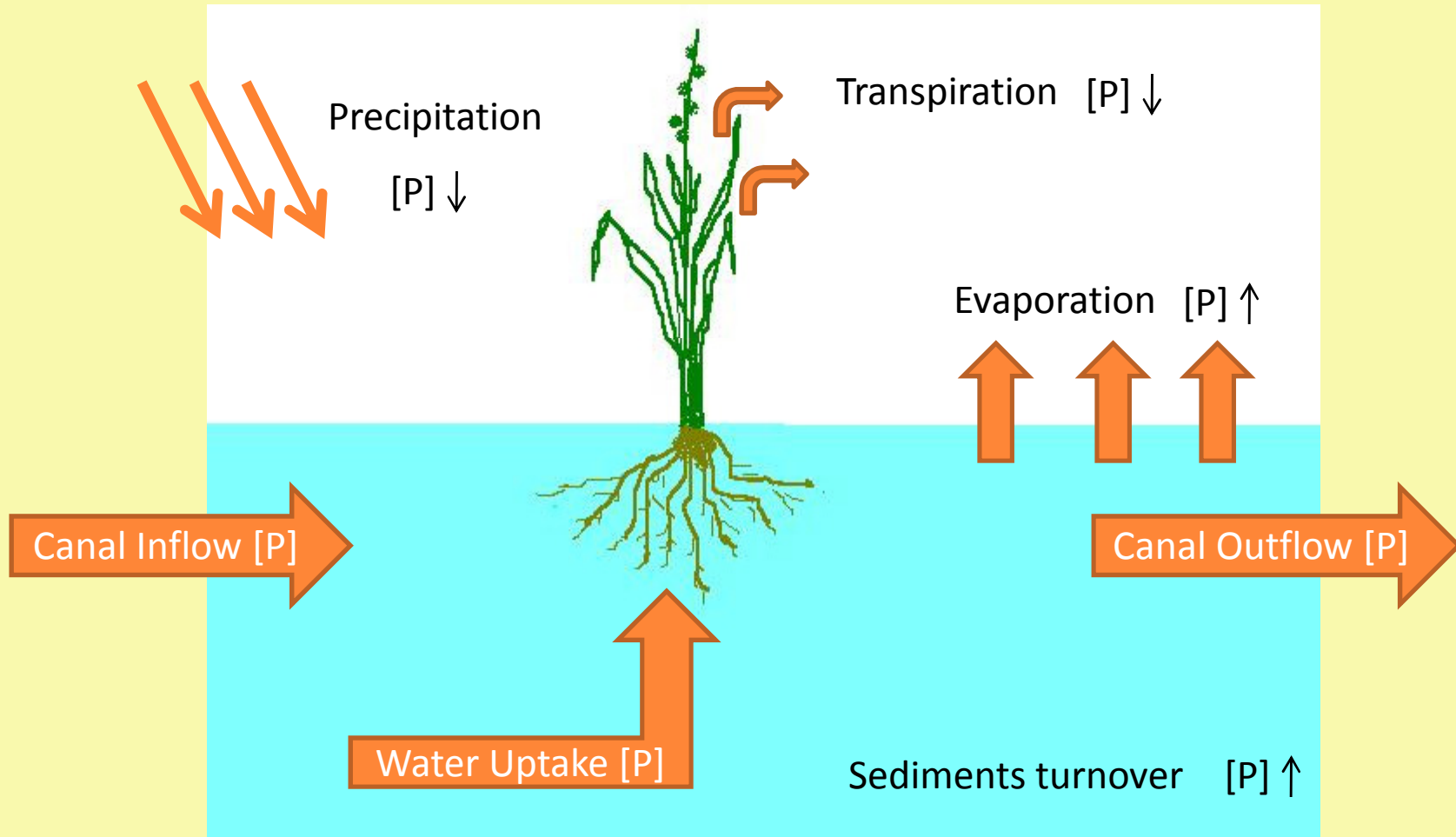
Water Balance



Applications

- Phosphate concentration modeling
 - Input: canal inflow, sediments turnover
 - Output: canal outflow, plants uptake
 - Other factors: evaporation, precipitation

Phosphorus Budget



Acknowledgements

- Tiffany Trent and other researchers from Loxahatchee NWR for help collecting water samples.
- Dr. Ken Rutchey for providing vegetation coverage digital map.
- Dr. Assefa Melesse and Chris Hasson for help with GIS.