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

- Transpiration
- Evaporation
- Water uptake
- \( \text{PO}_4 \)
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 $^2$H enrichment of water—the greater the evaporation, the greater the enrichment;
- Transpiration does not cause isotopic enrichment of water;
- $\delta^2$H versus $\delta^{18}$O of evaporative water lies off the Meteoric Waterline;
- In this study we use $\delta^{18}$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

September 2006 Samples

November 2006 Samples

January 2007 Samples

August 2007 Samples

\[ y = 3.7996x + 4.0337 \]

\[ y = 6.551x + 4.281 \]

\[ y = 3.844x + 4.9555 \]

\[ y = 3.7118x + 5.1942 \]

\[ y = 3.8764x + 5.2082 \]
Evaporation of the Loxahatchee refuge is not homogeneous, with differences in δ^{18}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.
What is affecting evaporative water loss in the Loxahatchee Refuge?

- 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:

a. Vegetation provide shade and boundary layer to surface water-lower evaporation

b. Vegetation slows down water flow-higher evaporation

B. Distance from canal water discharge gates

This factor is more related to water turnover 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.

Multi-linear Regression Model

- Distance
- Vegetation
- Elevation

Oxygen isotope enrichment
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)
Applications

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