# Isotopic Effects of Hydroperiod in Tree Islands

**Xin Wang**[1], Amartya Saha[1], Leonel O. Sternberg[1], Michael S. Ross[2]

[1]Department of Biology, University of Miami, Coral Gables, FL 33146;

[2] Southeast Environmental Research Center, Florida International, Miami, FL, USA

## Study Site and Background Survey

The study took place in the Shark Valley Slough region of the Everglades National Park (ENP). A survey of foliar C and N isotope ratios of 18 tree islands showed a distinct pattern where $\delta^{15}N$ of upland tree species for islands within the slough (slough tree island) had higher values averaging +6.06±1.89 (±σ, n=10) than those for islands outside the slough (prairie tree island) averaging -1.58±1.53 (±σ, n=8).

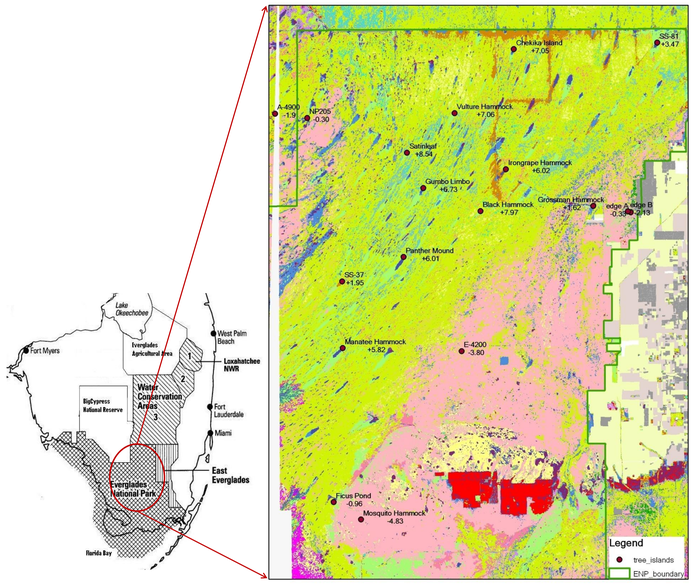


Fig.1 Upland foliar $\delta^{15}N$ values (‰) of sampled tree islands in the ENP. The numbers represent island averages. The base map represents land cover.

The variations in $\delta^{15}N$ values through season or between species are both very small compared to the differences among tree islands and are considered negligible.

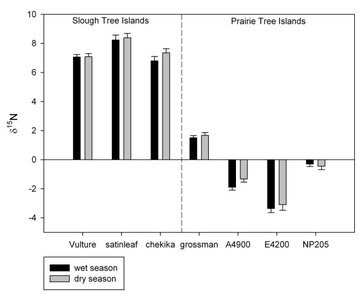


Fig.2 Upland folilar $\delta^{15}N$ (‰) of wet season and dry season. Data represent island averages. Error bars represent Standard Error of the Mean (SEM). No significant seasonal differences were found (P=0.388).

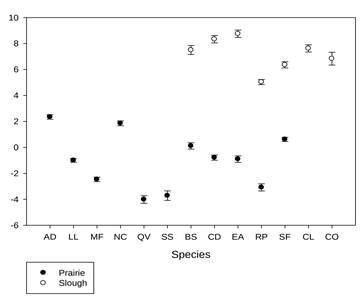


Fig.3 Folilar $\delta^{15}N$ (‰) of different species within each island. Data represent species averages throughout the year. Error bars represent SEMs.

Areas surrounding slough and prairie tree islands have distinct hydroperiods.

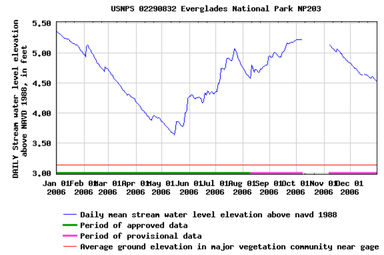


Fig.4 Water stage table of year 2006 near Satin Leaf Island (Slough).

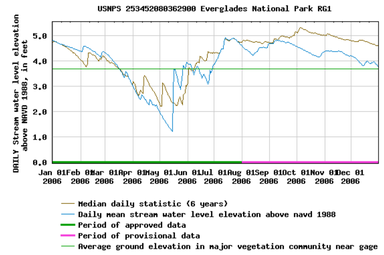


Fig.5 Water stage table of year 2006 near Grossman Island (Prairie).

## Our Question

We propose that $\delta^{15}N$ is tracing P limitation and that P limitation is determined by short hydroperiod induced water stress.

## Results

Average $\delta^{15}N$ is positively related to total soil phosphorus concentration of each tree island. Therefore we can use $\delta^{15}N$ as a proxy of P availability in the following analysis.

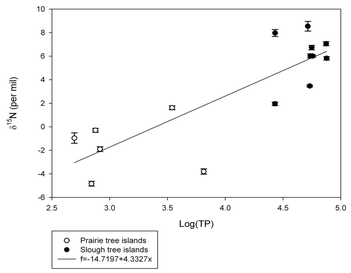


Fig.6 Correlation between foliar $\delta^{15}N$ (‰) and the log of soil total phosphorus concentration (ug/g soil) of emergent part of tree islands (uplands). R=0.8409. Nitrogen isotopic ratio data represent island averages and standard deviation of the mean (SEM).

Tree island plants are able to use evaporated marsh water or groundwater during dry season when precipitation is low (Fig. 7, Saha et al., in prepration). Using seasonal variation of foliar $\delta^{13}C$ as an indicator of water use effeciency (WUE), we found that hydroperiod affects plant water relations of tree islands. Slough tree islands experience less water stress than prairie tree islands during dry season .

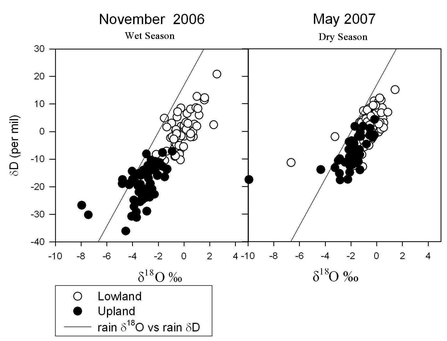


Fig.7 Stem water isotopic ratios in wet and dry season. Samples were collected from Chekika, Satin Leaf and Grossman islands.The line represent the Everglades local meteoric water line (δD = 8.5* $\delta^{18}O$ + 17‰, $R^2$=0.93).

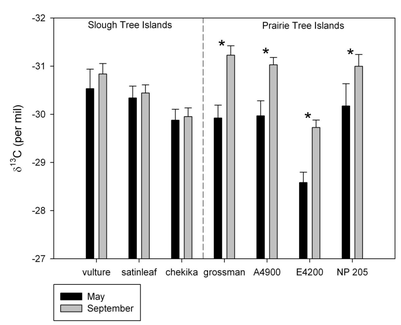


Fig. 8 Upland folilar $\delta^{13}C$ (‰) of wet season and dry season. Data represent island averages. Error bars represent Standard Error of the Mean (SEM).

The difference in water stress between slough and prairie tree islands is related to their foliar $\delta^{15}N$ values. Tree islands experiencing less water stress had higher $\delta^{15}N$ values, which indicated more available P for plants uptake.

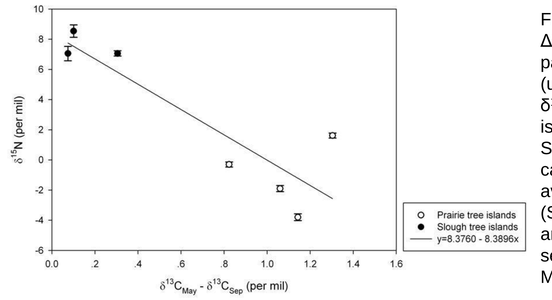


Fig.9 Foliar $\delta^{15}N$ (‰) and $\Delta\delta^{13}C$ (‰) of emergent part of tree islands (uplands). R=0.8822. $\delta^{15}N$ data represent island averages and SEMs. $\Delta\delta^{13}C$ data are calculated from island averages of wet season (Sep 2006 or Sep 2007) and the following dry season (May 2007 or May 2008).

Foliar $\delta^{15}N$ pattern for lowland plants are similar to that of upland tree species.

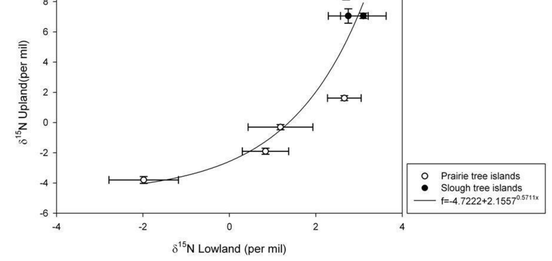


Fig.10 Foliar nitrogen isotopic ratio of lowland (bayhead) and upland (emergent) of tree islands. Data represent island averages and SEMs. R=0.9076.

## Discussion

Our results suggest that tree island plants have the ability to harvest water from surrounding marshes, which also serves as a source for P uptake. Hydroperiod affects water and nutrient accumulation of tree island plants in two ways. First, slough tree islands can harvest more water and therefore P due to marsh water existing in the slough during the dry season. Second, water surrounding slough tree islands have higher P concentration probably due to constant P input through large amounts of water flow.

Overall, This study shows that hydrological factors such as hydroperiod and water flow can have major impact on nutrient distribution of tree islands in the Everglades. This connection between hydrology and nutrient status of tree islands should be taken into account during future Everglades restoration plans.

## Acknowledgements

Thanks to Brooke Shamblin, Mike Kline, Pablo Ruiz, Daniel Gomez, Patrick Ellsworth, and Patricia Ellsworth for help with field work, and to Dr. Vic Engle and Dr. Steve Oberbauer for valuable comments and suggestions during the study.

Contact author at xin@bio.miami.edu