# The effects of macrophyte productivity and community composition on water and nutrient budgets of an aridland constructed treatment wetland

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## Introduction

### Wetlands are increasingly used for wastewater treatment in arid environments

Figure 1. 'Thatched' biomass at Tres Rios. Photo courtesy of Jorge Ramos

A hot, arid climate can pose unique hydrological challenges to CTWs.

Evaporative processes may affect system ability to uptake and process N

How different macrophyte species support N processing is unclear.

## Goals:

1) Develop robust water and N budgets to evaluate the impact of an arid climate on CTW N removal.
2) Quantify macrophyte community composition and develop estimates of species-specific contribution to the N and water budgets at a 42 ha CTW in arid Phoenix, Arizona.

## Experimental design and methods

### Bimonthly measurements of community composition, water chemistry, evaporation and transpiration were taken at the Tres Rios CTW


Figure 2. Constructed wetland study cell with approximate locations of 10 bimonthly sampled transects (denoted by red lines).

Plants were measured bimonthly to determine aboveground biomass using non-destructive phenometric models to relate plant characteristics to dry weight.

Five 0.25 $m^2$ quadrats were randomly placed along each of ten 60 m transects.

Tissue samples were dried, milled, & analyzed for N content.

Water samples were taken at inflow, outflow, and at the open water and shore end of each transect.

A handheld infrared gas analyzer was used to measure transpiration from each plant species.

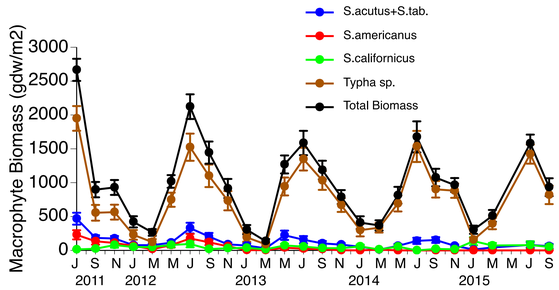
City of Phoenix provided inflow, outflow, and on-site meteorological data, which were used to estimate open water evaporation.

Meteorological and plant biomass data were used to extrapolate plant transpiration in time and space, respectively.

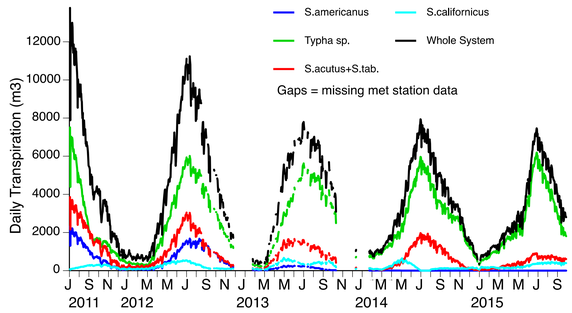
*Schoenoplectus acutus* and *S. tabernaemontani* are referred to as *Schoenoplectus spp.* unless otherwise noted. *Typha domingensis* and *T. latifolia* are referred to as *Typha spp*. *Schoenoplectus americanus* and *S. californicus were also present and are referred to individually*

## Results

### Biomass was comparable to other CTWs but transpiration was substantially higher

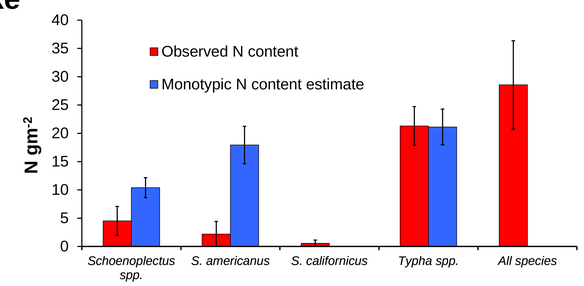



*Typha spp.* accounted for a majority (~2/3) of biomass, and is gradually outcompeting other species.

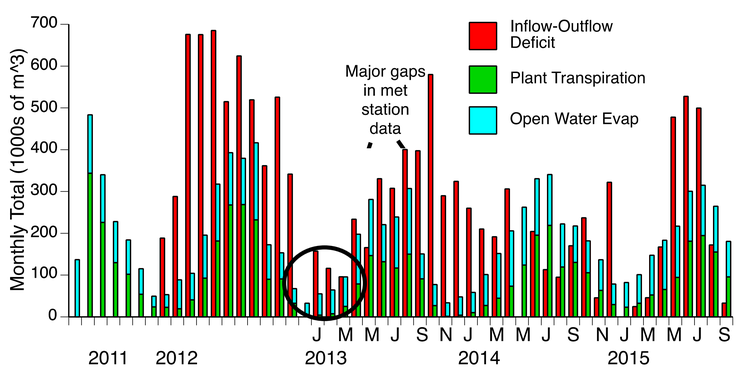



Transpiration rates were substantially higher than those in mesic wetland systems.

### Current community composition outperformed hypothetical monotypic systems in terms of plant N uptake

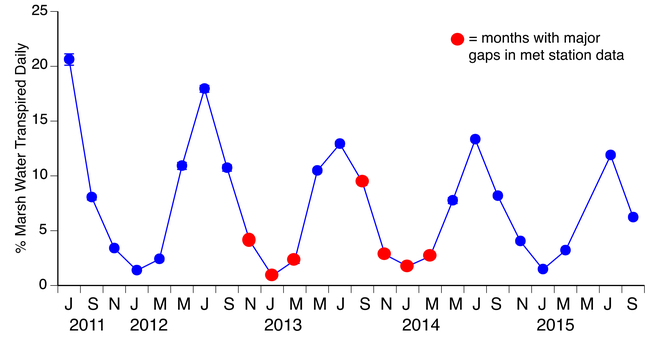



### Evaporation + transpiration balanced closely with the whole system water deficit in most months




## 'Biological Tide'

### High E+T rates in vegetated marsh create local water deficits that drive water flow from open water to marshes




## Discussion

### Plant community diversity appeared to improve system N retention

### High rates of evaporation and transpiration were observed but did not adversely affect system performance, as virtually all N that enters the marsh was consistently removed from the water

### Large water losses via evaporation + transpiration and the resulting "biological tide" enhanced N uptake by the marsh, making this system more efficient than similar systems in cooler or more mesic climates.

## Conclusion and future directions

### Macrophyte growth and community composition plays an important role in N and water budgets in arid CTW's

To our knowledge, this is the first time that biotically-mediated surface hydrology has been demonstrated in any wetland.

CTW managers should consider planting and managing for macrophyte diversity to promote N retention and processing.

A recently completed tracer and flume study and associated modeling work will enhance our understanding of system flow dynamics.

Figure 3. Vegetation monitoring during minimum live biomass in March 2012. Photo courtesy of Jorge Ramos.

Further work with site managers will strengthen partnerships for future studies and promote science-management dialogue.

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