Plant community changes and related nutrient retention within an aridland constructed wastewater treatment wetland

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Introduction

Wetlands are increasingly used for wastewater treatment

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

A variety of ecological processes (e.g, plant & microbial nutrient uptake) improve treated wastewater effluent quality.

Species-specific nutrient uptake rates may influence whole system nutrient dynamics through plant community changes.

Arid climates pose unique stresses to wetlands (e.g., high evapo-transpiration rates) that are not present in temperate wetland studies.

How does plant community composition change in an aridland constructed wastewater treatment wetland and how do those changes affect system nutrient dynamics?

Experimental design and methods

Bimonthly measurements of community composition and water chemistry were taken from a 21 ha constructed wetland in Phoenix, AZ starting in July 2011

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

Harvested plants were used to create species-specific multiple regression allometric models that relate measurable plant characteristics to dry weight (DW).

Every two months, five 0.25 m^2 quadrats were randomly placed along each of ten 60 m transects.

Plants were measured (using the characteristics found significant in allometric models) at each quadrat to determine aboveground biomass .

Root cores and corresponding aboveground biomass were taken to calculate above- to belowground biomass ratios.

Plant and root tissue samples (harvested November 2011) were dried, milled, & analyzed for C and N content using a PerkinElmer 2400 CHN Analyzer.

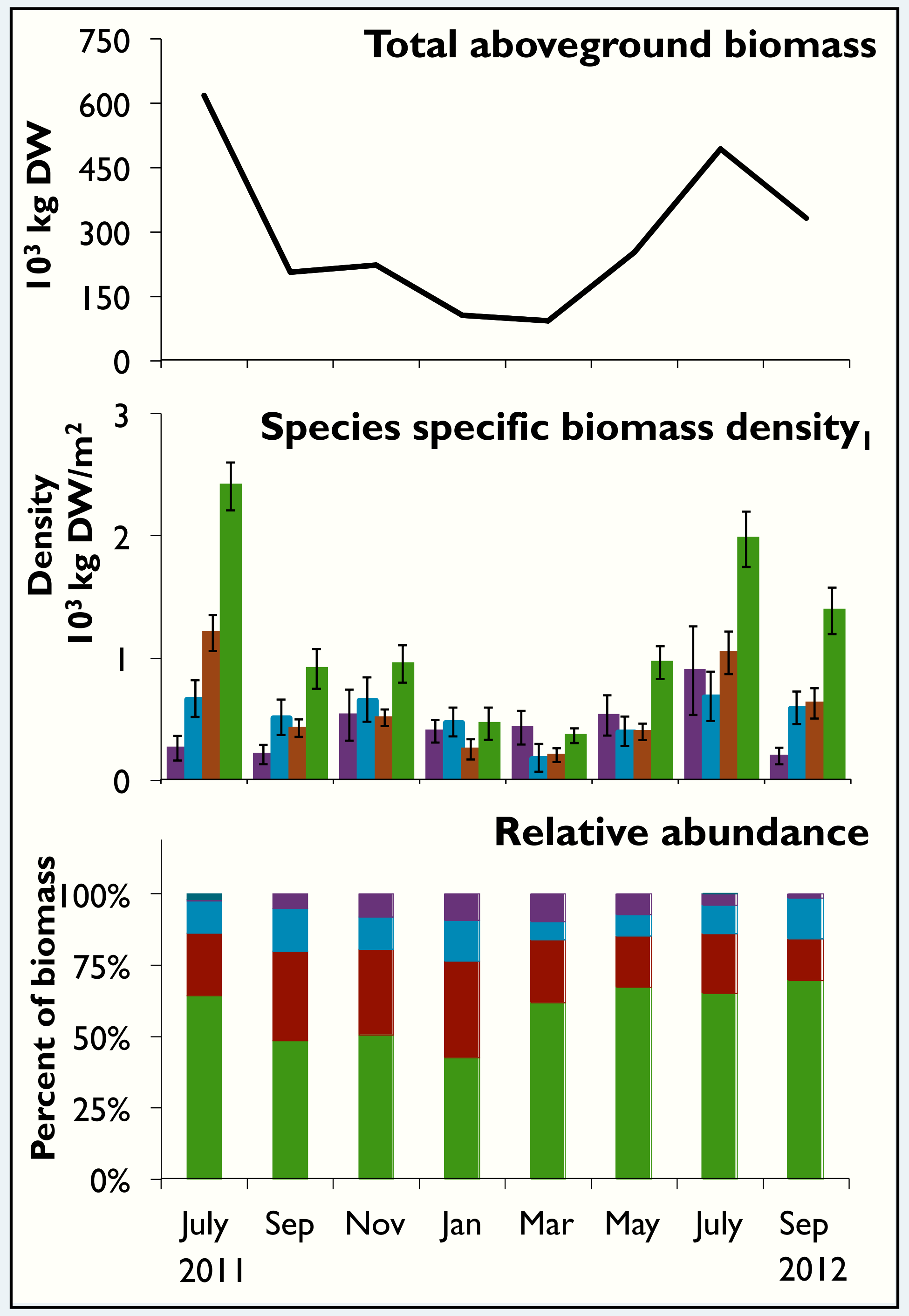
Seven emergent macrophyte species were present at the site:

Schoenoplectus acutus
Schoenoplectus tabernaemontani
Schoenoplectus californicus
Schoenoplectus americanus
Schoenoplectus maritimus
Typha domingensis
Typha latifolia

Schoenoplectus acutus, *S. tabernaemontani*, & *S. californicus* are referred to as *Schoenoplectus spp* unless otherwise noted. *Typha domingensis* & *T. latifolia* are referred to as *Typha spp.*

Results

Typha spp. accounted for the majority of aboveground(AG) biomass throughout 2011 and 2012



Maximum peak AG biomass (617,000 kg DW) occurred in July 2011; minimum AG biomass (93,000 kg DW) occurred in March 2012.

S. acutus and *S. tabernaemontani's* relative abundance grew through winter of 2011 due to 'thatching,' the toppling of large stands of *Typha spp.*

Approximately 2/3 of peak AG biomass was represented by *Typha spp.* in July 2011 & 2012.

[1] *S. maritimus* was not present in many quadrats and was thus excluded

[2] *Schoenoplectus spp.* refers to *S. acutus* & *S. tabernaemontani*

Typha spp. represented the majority of belowground (BG) biomass

Above and belowground biomass, November 2011[1]

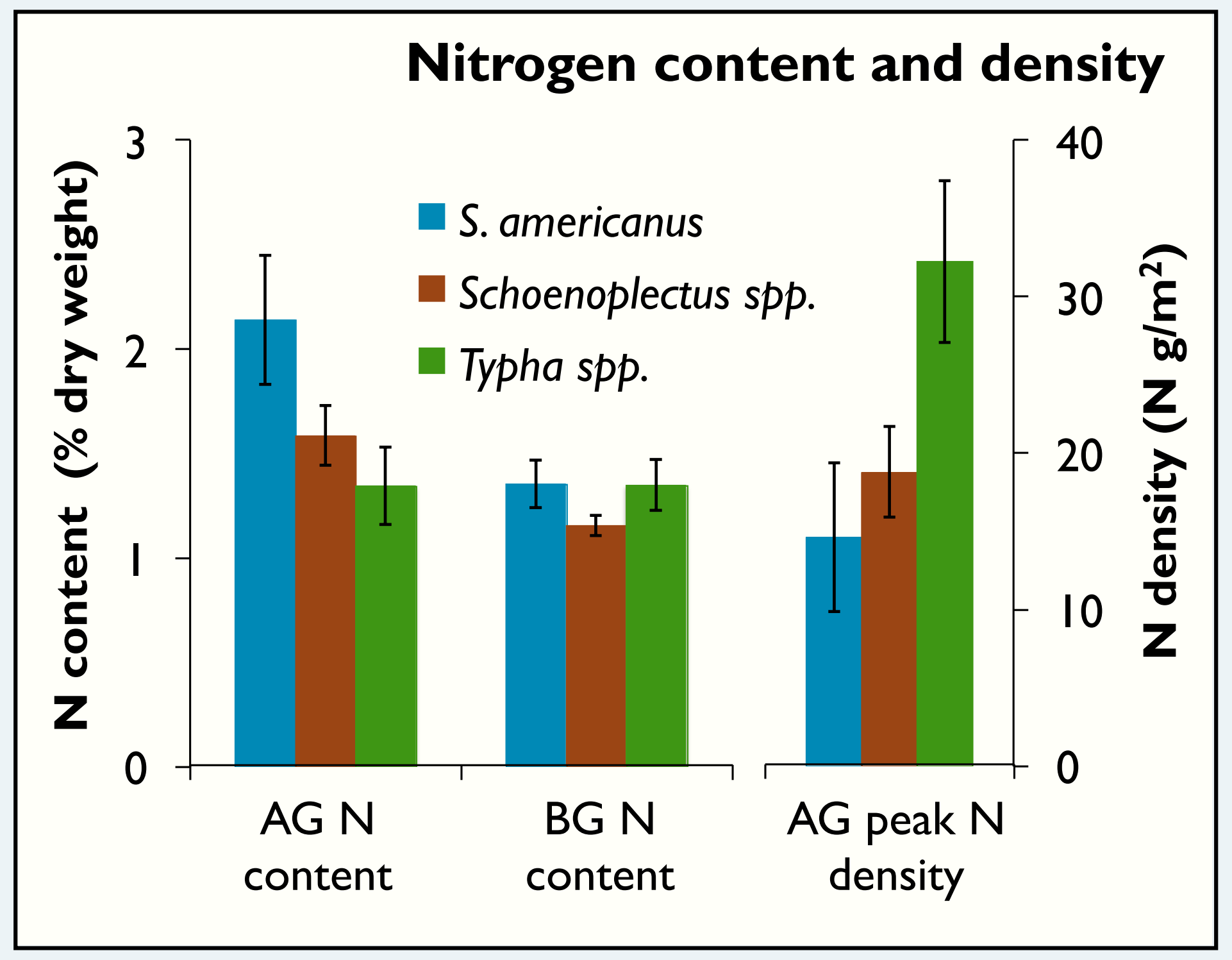
	Schoenoplectus spp.	*S. americanus*	*S. californicus*	*Typha spp.*	Total
Aboveground biomass (10^3 kg DW)	67	25	18	113	223
Belowground biomass (10^3 kg DW)	79	42	23	113	257
Above/belowground biomass	0.85	0.59	0.80	1.00	-

[1] Live *S. maritimus* biomass was not present in November 2011 and is thus not presented

Preliminary nutrient analysis shows slight variation in nitrogen content across species

Highest average above & belowground N content was 2.14% and 1.35%, respectively, for *S. americanus*.

Typha spp. had the lowest average aboveground N content (1.34%) but had the highest nitrogen density, the mass of nitrogen at average peak biomass per unit area, of any species (32.2 N g/m^2).



Preliminary nitrogen budget results

Aboveground biomass growth accounted for 19% of N uptake from March – July 2012

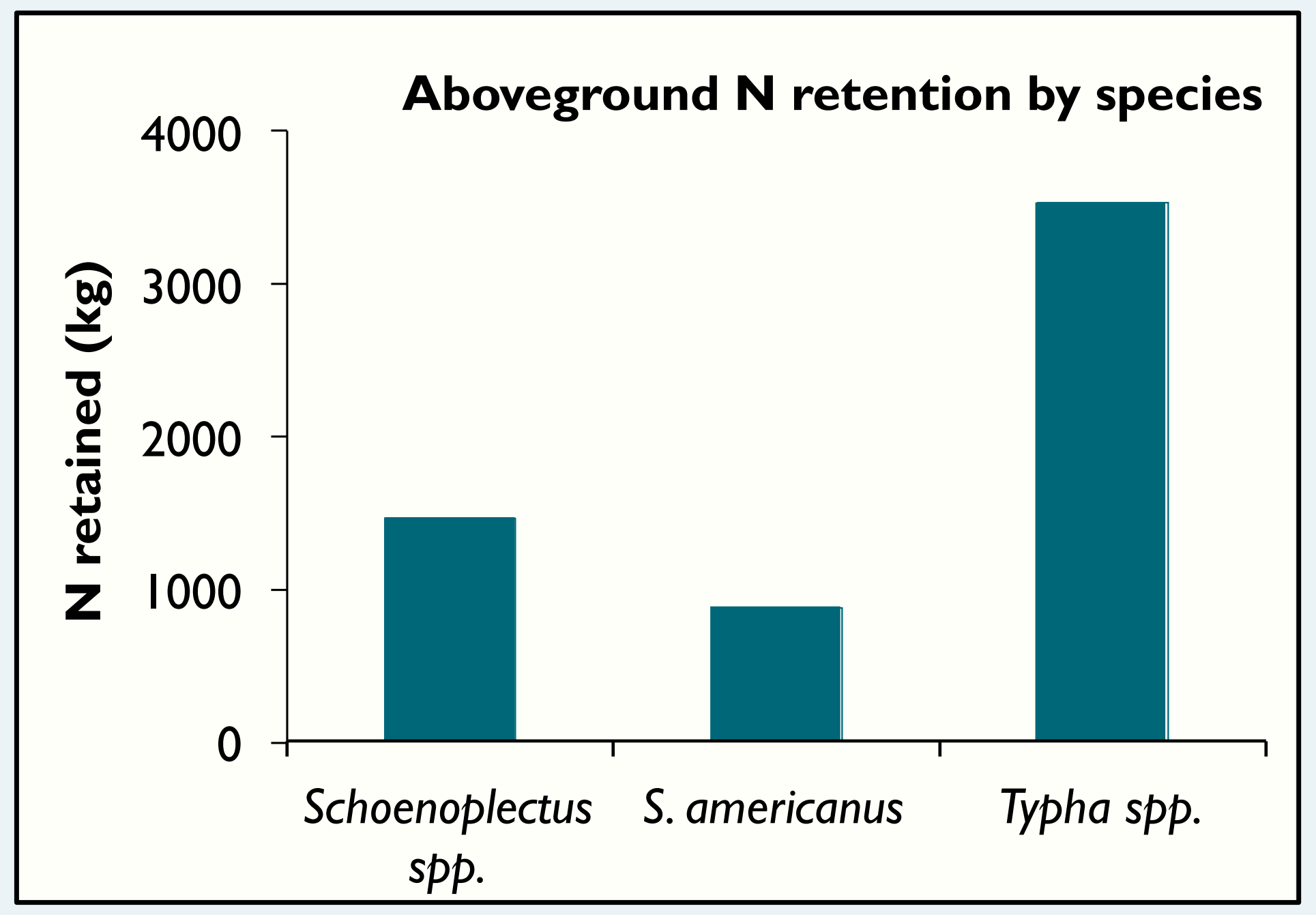
Total nitrogen and water flux, March – July 2012

	Average TN concentration (mg/L)	*Total water flux (10^6 m^3)*	*Total N flux (10^3 kg)*
Inflow	7.564 ± 1.260	13.1	86 ± 3.6
Outflow	3.695 ± 1.034	11.1	55 ± 1.9
N retained	-	-	**32 ± 4.0**

S. americanus (880 kg N retained) represented 7.9% of biomass but accounted for 15% of macrophyte N retention during the 4 month period.

Typha spp. biomass (3579 kg N retained) accounted for 11% of total system retention and 60% of macrophyte N retention.

All aboveground biomass (5880 kg N retained) accounted for 19% of total N retention and 7% of received N.



Conclusion and Discussion

Community composition varied through seasons but peak biomass composition remained relatively constant

Nitrogen content varied slightly between species

Schoenoplectus americanus had the highest N content; however, its low average biomass density makes Typha spp. the most efficient nitrogen retaining plant per unit area.

Macrophyte community facilitated nitrogen retention is a fraction of total retention

Other physical and biological process (e.g., denitrification, sedimentation) must account reduced nitrogen export from the system.

Continued monitoring and further studies will investigate the role of macrophyte community changes in nutrient retention

Figure 3. Vegetation monitoring during minimum live biomass in March 2012

Continued monitoring will allow for further examination of this relationship.

A decomposition study will examine the fate of nutrients retained within the macrophyte community, an important insight in the development of biomass management strategies.

Development of nutrient and macrophyte community dynamic models will aide in the understanding and management of this system.

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