Introduction

Wetlands are increasingly used for wastewater treatment. 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 evapotranspiration 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.

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 m² 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, Typha domingensis, S. maritimus, & S. californicus. Schoenoplectus americanus is referred to as Schoenoplectus spp unless otherwise noted. Typha domingensis & T. tefofa 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 topping of large stands of Typha spp. Approximately 2/3 of peak AG biomass was represented by Typha spp. in July 2011 & 2012.

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.

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/m²).

Preliminary nutrient budget results

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

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.

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Figure 2. Constructed wetland ready for use with approximate locations of 10 bimonthly sampled transects (denoted by red lines).

Figure 1. ‘Thatched’ biomass in the Tea-Roa constructed wetland. Photo courtesy of Jorge Ramos

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