Nitrogen Dynamics in Urban Man-Made Lakes: Denitrification Potential of Sediments

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Introduction

Terrestrial and aquatic components of urban landscapes experience substantial nitrogen (N) loading due to:

- application of fertilizer
- fossil fuel combustion resulting in N oxide production and deposition
- introduction of N-fixing legumes

Heavy N loading can result in:

- loss of biodiversity
- changes in nutrient limitation status for vegetation
- eutrophication of receiving waters
- a public health threat to drinking water

Denitrification is a microbial process that converts nitrate (NO_3^-) into N_2 or nitrous oxide gases, and thus removes N from the ecosystem. We investigated the denitrification potential of sediments from lakes surrounded by differing land uses (residential, city park, or golf course) and fed by differing water sources (groundwater, canal, and effluent) throughout the Phoenix metropolitan area (figs. 1 – 3) to determine if water source and/or land use influences denitrification and thus the efficacy of these lakes for removing nitrogen from the CAP LTER.

Methods

Surface water, porewater, and sediment samples were collected from seventeen lakes in six regions across the CAP LTER area, representing each of the three land uses identified above (fig. 4). Water samples were analyzed for phosphate, nitrate, ammonium, total N, sulfate, chloride, and dissolved organic carbon. Sediment samples were used in a laboratory experiment to determine denitrification potential (i.e. maximum rate of denitrification possible given ideal conditions) using the acetylene-block method. Sediment percent water and ash-free dry mass were also measured.

Figure 1: Desert Harbor, a residential lake in Peoria, AZ

Figure 2: Roadrunner Lake, a City of Phoenix park lake

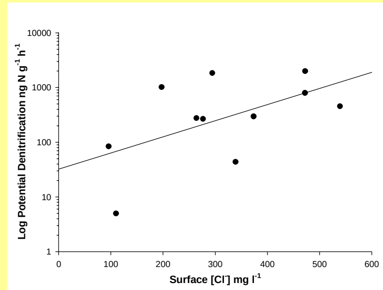
Figure 3: Lake at Gainey Ranch Golf Club in Scottsdale, AZ

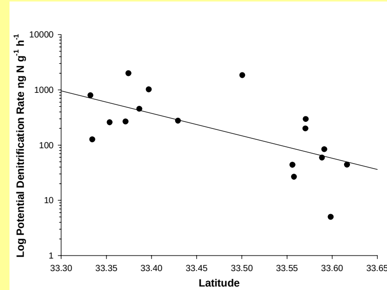
Figure 4: Lake coring device with protruding sediment

Results and Conclusions

Contrary to our predictions, significant correlations between land use or water source and denitrification potential were not found, nor were potential rates correlated with nitrate concentrations.

However, potential denitrification was correlated with chloride concentration (R^2=0.381, p=0.043, fig. 5) and latitude (R^2=0.403, p=0.006, fig. 6).





Figures 5 and 6: Potential Denitrification by Chloride Concentration and by Latitude

Chloride is a bioinert tracer, and can vary widely by water source. There are several factors that could affect denitrification may be represented by latitude, e.g. elevation, temperature, similar handling of storm runoff, and/or regional land use patterns. Perhaps the configuration of the landscape beyond the immediate surroundings influences both water composition and potential denitrification rates for these urban lakes.

Implications and Future Research Questions

Lakes are not a natural hydrologic feature of this arid region; all lakes in the area, now representing approximately 1% of the land cover, were created in the past 50 years. These lakes receive high nutrient inputs both from their intentional water sources, and from storm runoff.

- Average nitrate concentrations in these lakes is approximately 15 times higher than Sycamore Creek, a pristine Sonoran desert stream northeast of Phoenix.
- However, the lakes' average potential denitrification rate is > 5 times the maximum potential denitrification rates for Sycamore Creek.

Further investigation of actual, *in situ* rates and controls on denitrification in urban lakes will address the questions:

- Do urban lakes convert a substantial fraction of their nitrate load into nitrogen gases?
- At a landscape level and for the CAP LTER ecosystem, are lakes significant denitrification hot spots?

Continued research in this area will provide a key piece of information for the CAP LTER nitrogen budget