Comparison of soil biogeochemical characteristics in grassy and xeriscaped stormwater retention basins in the Phoenix metropolitan area

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Introduction

Arizona requires most building developments to handle storm runoff on site to ameliorate flooding. Thus stormwater retention basins are common in the Phoenix metropolitan area.

Basins in the Phoenix area differ in terms of vegetative cover (grassy or xeriscaped, Figure 1) and the presence or absence of a dry well.

Research has shown that urban stormwater tends to have high concentrations of nutrients, especially nitrogen (N). As local recipients of these nutrient inputs and water, retention basins may be hot spots for N removal via denitrification and therefore ***may improve stormwater quality***.

We wanted to assess the potential influence of two factors, vegetative cover and well presence, on soil biogeochemical properties, especially nitrate (NO_3^-) concentration and denitrification potential.

Figure 1: Examples of xeriscaped (left) and grassy (right) stormwater retention basins. Xeriscaped basins frequently have drip-irrigated vegetation on the upslope. Grassy basins must be irrigated frequently to maintain greenness.

Hypotheses

Denitrification is a microbial process which converts NO_3^- to N_2O or N_2 gas, effectively removing nitrogen from the ecosystem. It requires a source of organic carbon, and only occurs under anoxic conditions.

We hypothesized that both the vegetative cover and well presence would influence denitrification and therefore NO_3^- concentrations in retention basins because:

- ❖ Grassy basins will have much more organic matter
- ❖ Basins without wells will have longer water residence times, increasing the amount of time that the soil is anoxic.

Methods

We collected soil cores at 32 retention basins in the Phoenix metropolitan area in July 2006, 8 from each of the four types of basins (e.g., grassy w/well, grassy w/o well, etc.). Nitrate (NO_3^-) was extracted using ultrapure water. Denitrification potential (via acetylene block method), gravimetric soil water content and ash-free dry mass were also determined for core sub-samples.

Results

- ➢ The presence of a well did **not** significantly influence soil characteristics (data not shown).

	Grassy vs. Xeric
Nitrate	Lower but not sig. (P = 0.1051, Figure 2A)
Organic Matter	Higher (P < 0.0001, Figure 2B)
Water	Higher (P < 0.0001)
Denitrification	Higher (P < 0.0001)

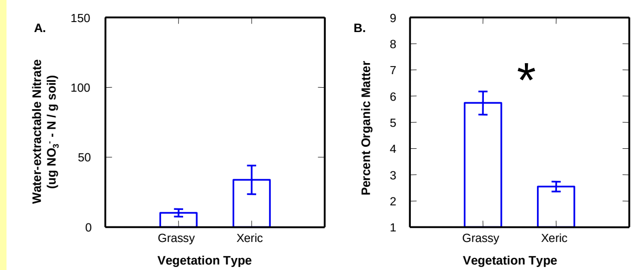

Figure 2: A) Extractable nitrate by vegetation type. B) Organic matter by vegetation type, results significant.

- ➢ There is a strong correlation between soil extractable nitrate and denitrification for grassy but not xeric basins (Fig. 3A).
- ➢ Grassy basins appear to have enough organic matter and water for substantial denitrification above xeric rates (Figures 3B and C).

Conclusion & Future Plans

Results indicate different limiting factors for denitrification for grassy vs. xeric retention basins. Future research includes:

- ❖ Nutrient limitation assays of potential and actual denitrification rates.
- ❖ Investigation of other potential drivers of nitrate storage and removal (e.g. soil texture, land use history, etc.)

This research has important implications for stormwater management. Grassy basins may be more effective than xeric basins at improving water quality, but it remains to be seen if this benefit offsets the increased maintenance costs for irrigation and mowing.

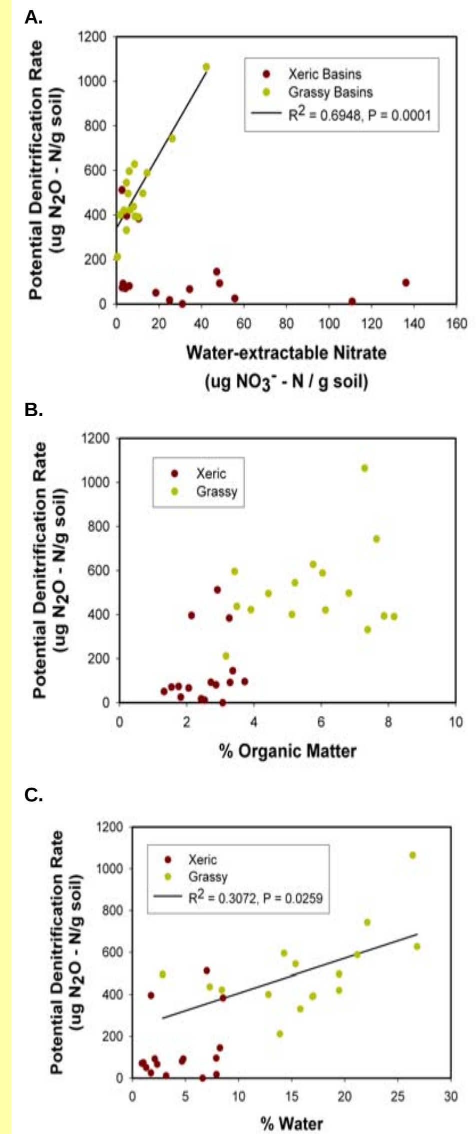

Figure 3: A) Denitrification potential by extractable nitrate concentration. B) Denitrification potential by percent organic matter. C) Denitrification potential by percent water.