Nitrogen gas emissions from stormwater retention basins during wet weather events in the Phoenix Metropolitan area: an additional ecosystem service?

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Do retention basins improve stormwater quality?

- Stormwater runoff is known to carry high levels of metals and nutrients such as nitrogen (N).
- Retention basins collect local runoff and potentially concentrate these pollutants in the soil and infiltrating water.
- However, plants and microbes have the ability to transform and remove nutrients from the water.
- Denitrification, a microbial process, permanently removes nitrate (NO_3^-) from the system, while producing the gases N_2 and N_2O.

We wanted to assess the ability of two types of retention basins, one xeriscaped and one grassy, to remove NO_3^- from incoming storm runoff.

Tapping fire hydrants to flood basins

We simulated a 1” storm in each basin with water from nearby hydrants. Water was directed into a pool to slow it down, and then through hoses to the basin. We pre-treated the basin with a heavy N isotope (^{15}N in NO_3^-) to trace the fate of the N added. Samples were then taken throughout the day to assess water concentrations and gas losses (see photos below).

Photo credits: Vince Palermo

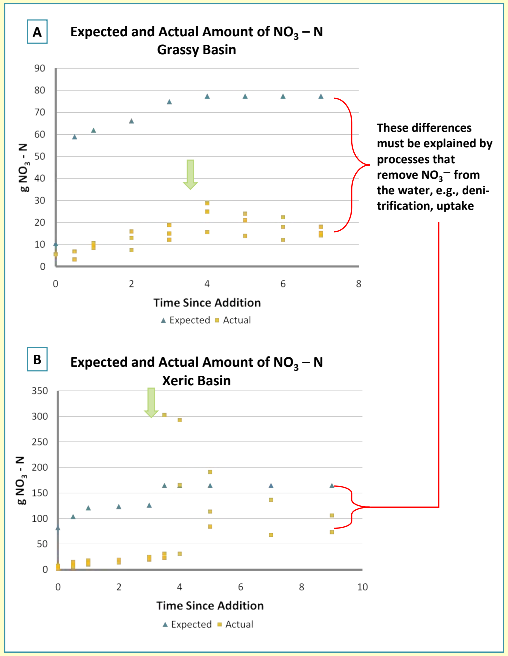

Figure 1: Expected vs. actual mass of NO_3 – N by time for Grassy (A) and Xeric (B) basins. Green arrows indicate when the last water was delivered. In the case of B, a “slug” of NO_3 was added with the last volume of water.

- Water nitrate concentrations indicate NO_3^- removal, especially in grassy basins (Figure 1)
- Gas emissions from basins via denitrification are a small portion of NO_3^- removal (Figure 2)
- Overall N_2O emissions from any process are significantly higher in xeric basins and grassy basins (Figure 3)

Basins are ameliorating NO_3^- inputs, but potentially producing considerable amounts of N_2O, a greenhouse gas

- Incoming data will allow complete analysis via a full mass-balance approach
- Trade-offs between aesthetics, recreation, water use, and stormwater improvements can be assessed for each basin design

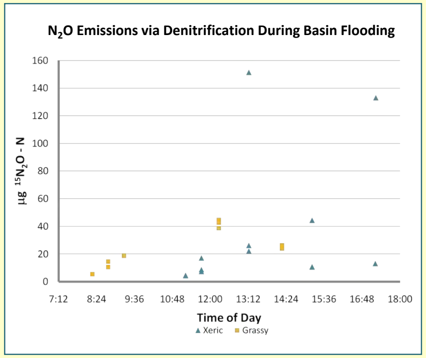

Figure 2: N_2O emissions via denitrification during basin flooding. Except for a couple outliers, the grassy and xeric basins produced similar, though comparatively small, amounts of N_2O. Note the change in units on the y-axis when compared to Figure 1.

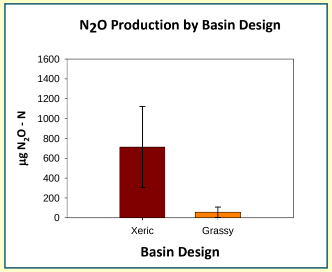

Figure 3: Overall N_2O emissions over 24 hours from any process by basin design. Data calculated from gas fluxes in chambers after water has receded and then extrapolated to 24 hours.

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