Down-gradient Stream Nutrient Concentration Responses to Wastewater Management Approaches in the North Carolina Piedmont

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Introduction

- Onsite wastewater treatment systems (OWTS) in the watershed of Falls Lake, NC may be a source of nitrogen (N) loading into the lake[2,3]
- Falls Lake provides the majority of drinking water for the city of Raleigh, NC[5]
- OWTS, land use, and geologic settings were examined at various sites to determine their influence on nitrate + nitrite nitrogen (NO_3-N+ NO_2-N) and total dissolved nitrogen (TDN) concentrations in surface waters in the Falls Lake watershed (Fig. 1)

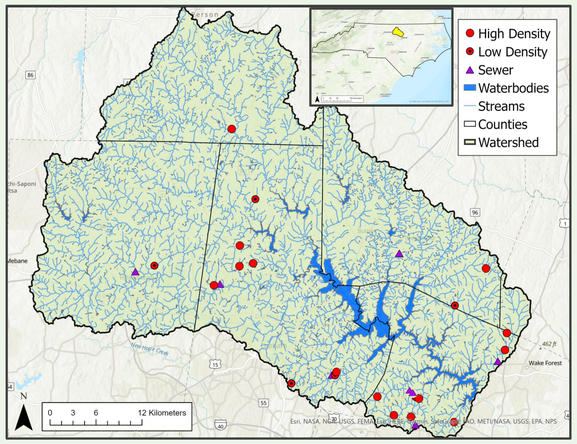


Figure 1. Inset map showing the location of the study area within NC and a map of the Falls Lake watershed with the 28 sampled sites and their wastewater management approaches.

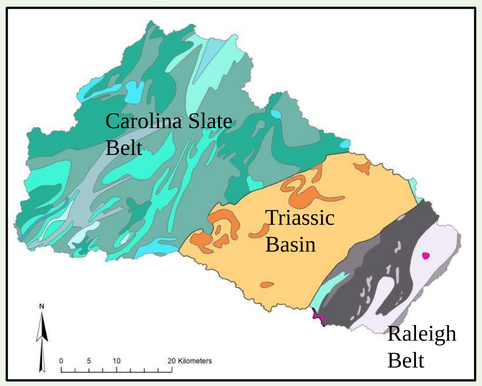


Figure 2. Map of geologic settings in the Falls Lake watershed.

Significance

- Understanding the correlation between wastewater management approach and in-stream nutrient concentrations provides insight on the source of nutrients

Results

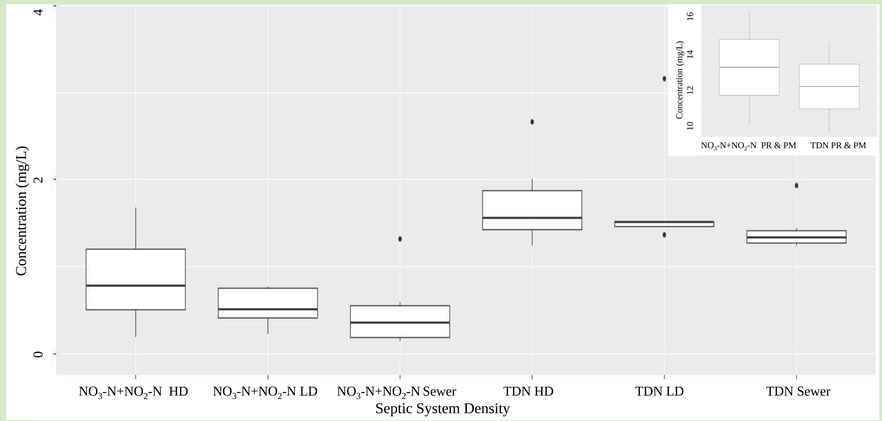


Figure 3. Median TDN and NO_3-N+NO_2-N concentrations vs septic system density (HD = high-density (≥ 1 system/ha), LD = low-density (< 1 system/ha)). Two outliers included in the inset graph.

- Sub-watersheds dominated by OWTS (HD) are characterized by elevated median NO_3-N+NO_2-N and TDN concentrations
- Park Ridge (PR) and Passmore (PM) (sewer dominated sites in the Raleigh Belt) display extremely elevated N concentrations

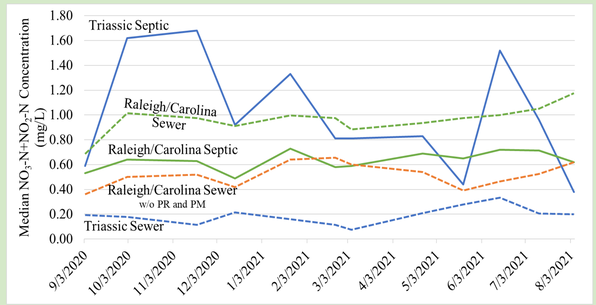


Figure 4. Median monthly in-stream NO_3-N+NO_2-N concentrations for sewered and septic dominated sub-watersheds in differing geologic settings.

- The Triassic Basin (more permeable soils) had higher NO_3-N+NO_2-N in-stream concentrations than all other geologic settings
- Median TDN vs cropland land use, $R^2 = 0.17$
- Median NO_3-N+NO_2-N vs cropland land use, $R^2 = 0.22$
- Isotopic ratios of nitrate suggest a manure & septic effluent source present in sewer and high-density (HD) septic sub-watersheds

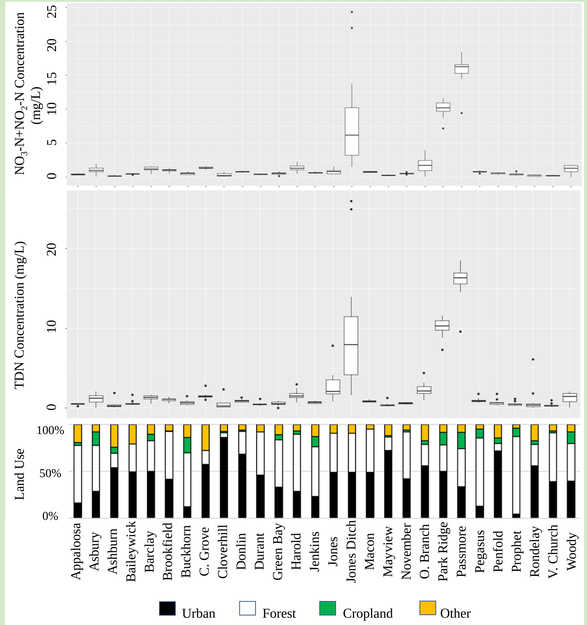


Figure 5. Monthly in-stream NO_3-N+NO_2-N and TDN concentrations compared to major land use percentages for each site.

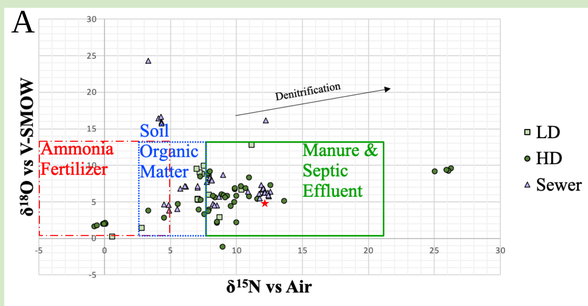
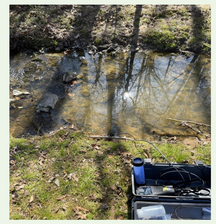


Figure 6. A) N^{15} in nitrate, representing the source of nitrate for each sample and a red star to indicate sites Passmore and Park Ridge. B) Median N^{15} in nitrate values for HD, LD, and sewer dominated sub-watersheds.

Methods

- 28 sites were sampled monthly from 9/2020 – 8/2021
- NO_3-N, turbidity, dissolved oxygen, specific conductivity, pH, oxidation reduction potential (using YSI ProDSS), and flow rate were recorded at each site
- Ammonium (NH_4), NO_3-N+NO_2-N, and TDN were analyzed at ECU's Environmental Research Lab
- N^{15} in nitrate was analyzed at UC-Davis Stable Isotope facility
- Septic system density and sub-watershed areas were determined using GIS and USGS *StreamStats* 4[4]



Discussion & Conclusions

- Stream N concentrations increase with septic system densities[1]
- Stream NO_3-N+NO_2-N concentrations were elevated in Triassic Basin septic sub-watersheds
- Isotopic ratios indicate possible OWTS N inputs or legacy nutrients in sewer and HD septic sub-watersheds, requiring further research
- Future steps should aim to identify and mitigate the source of in-stream N at PR and PM

References

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