

Land-use controls on the export and processing of atmospheric NO₃

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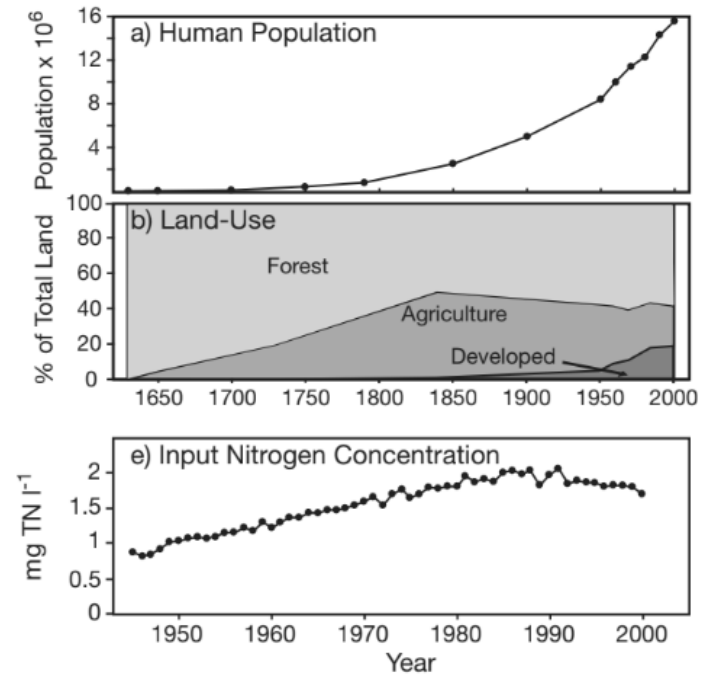
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

CBP Modeling Workgroup 4/3/19

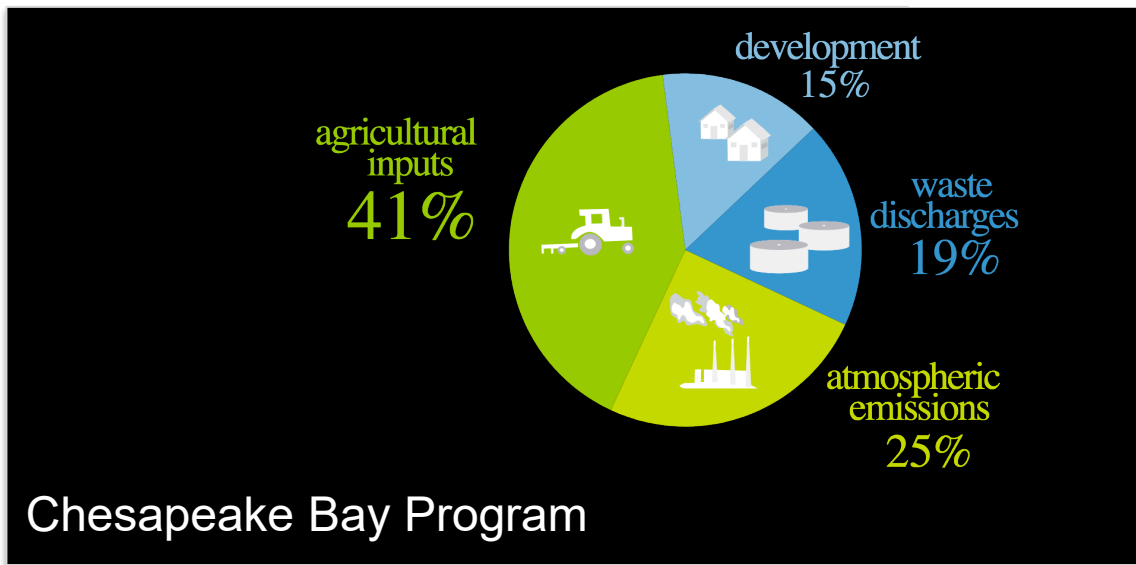
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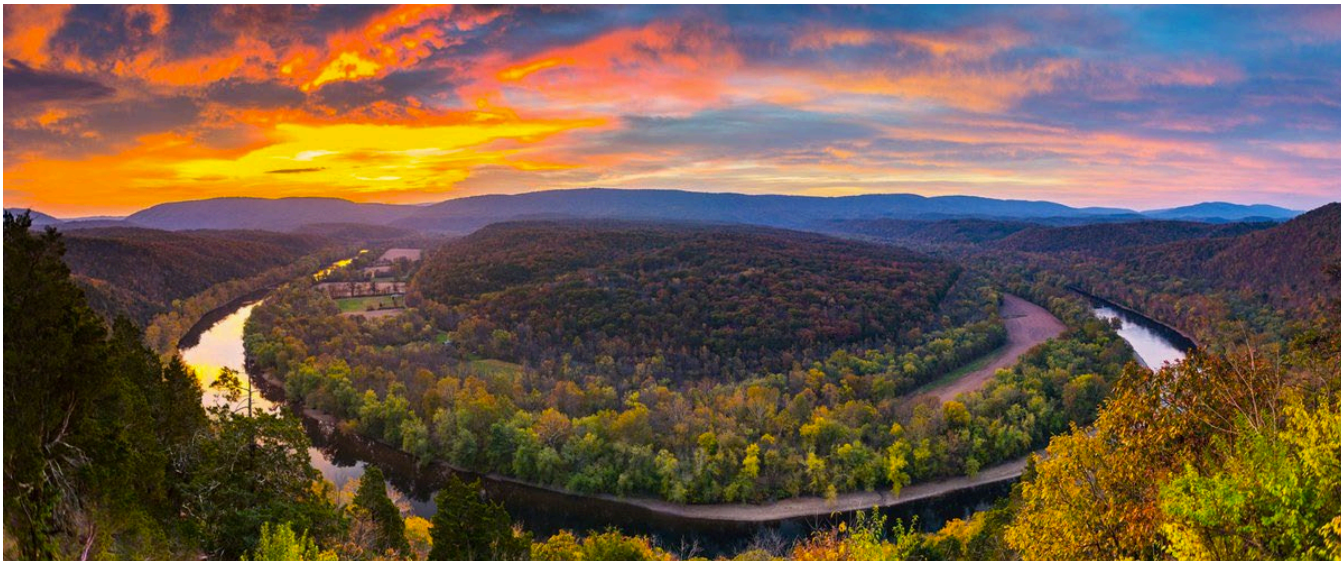
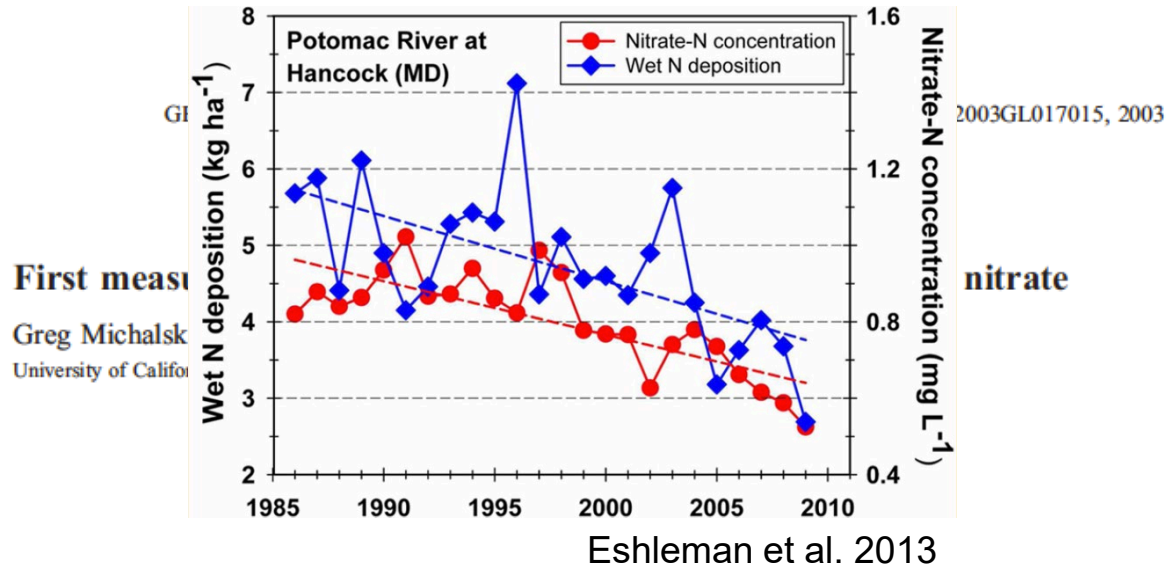
VIMS



Kemp et al. 2005



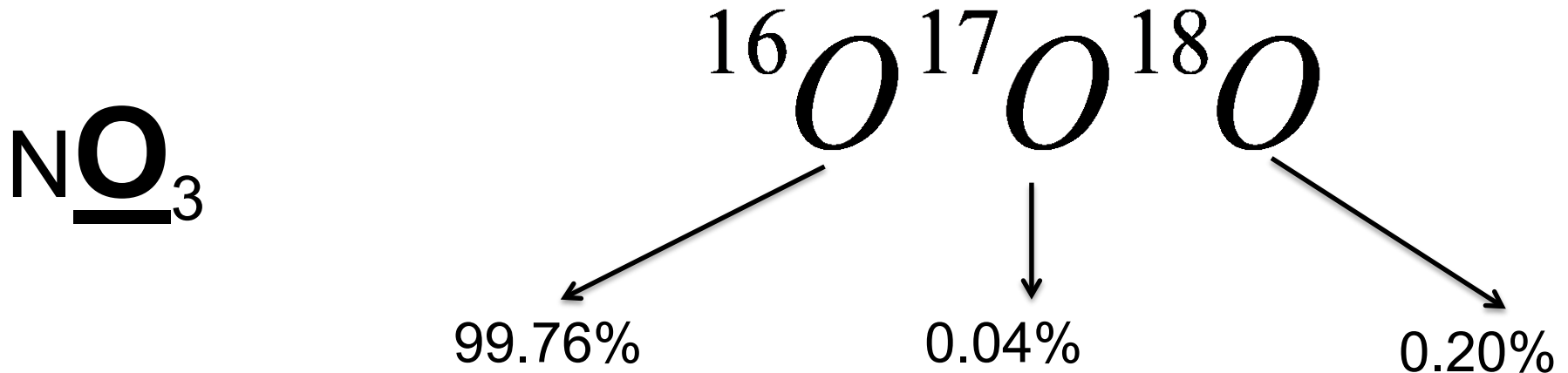
Background



Tom Hamilton

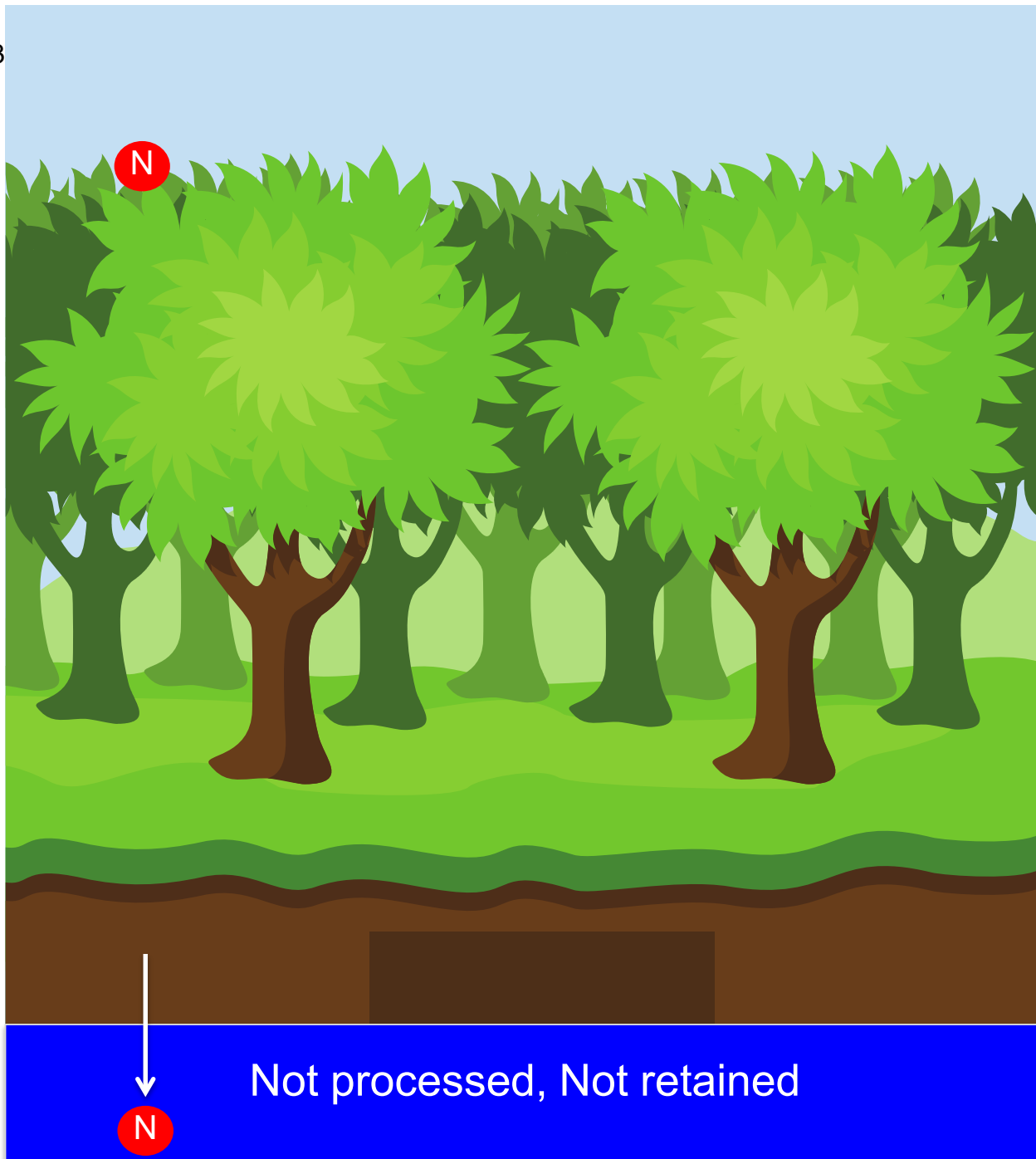
Unprocessed Atmospheric NO_3

Processing vs. Retention



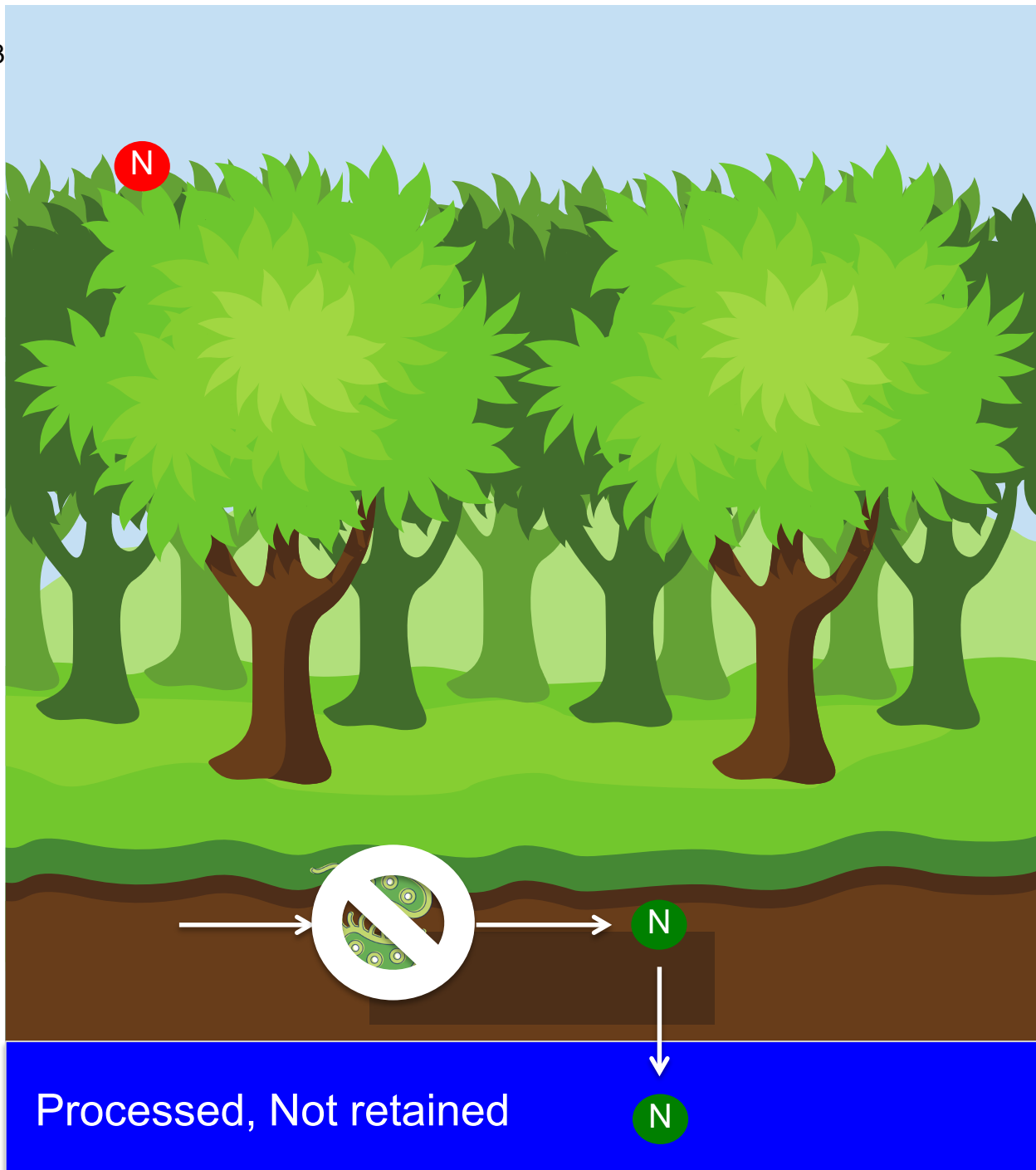
N Atm. NO_3

N Terr. NO_3



N Atm. NO_3

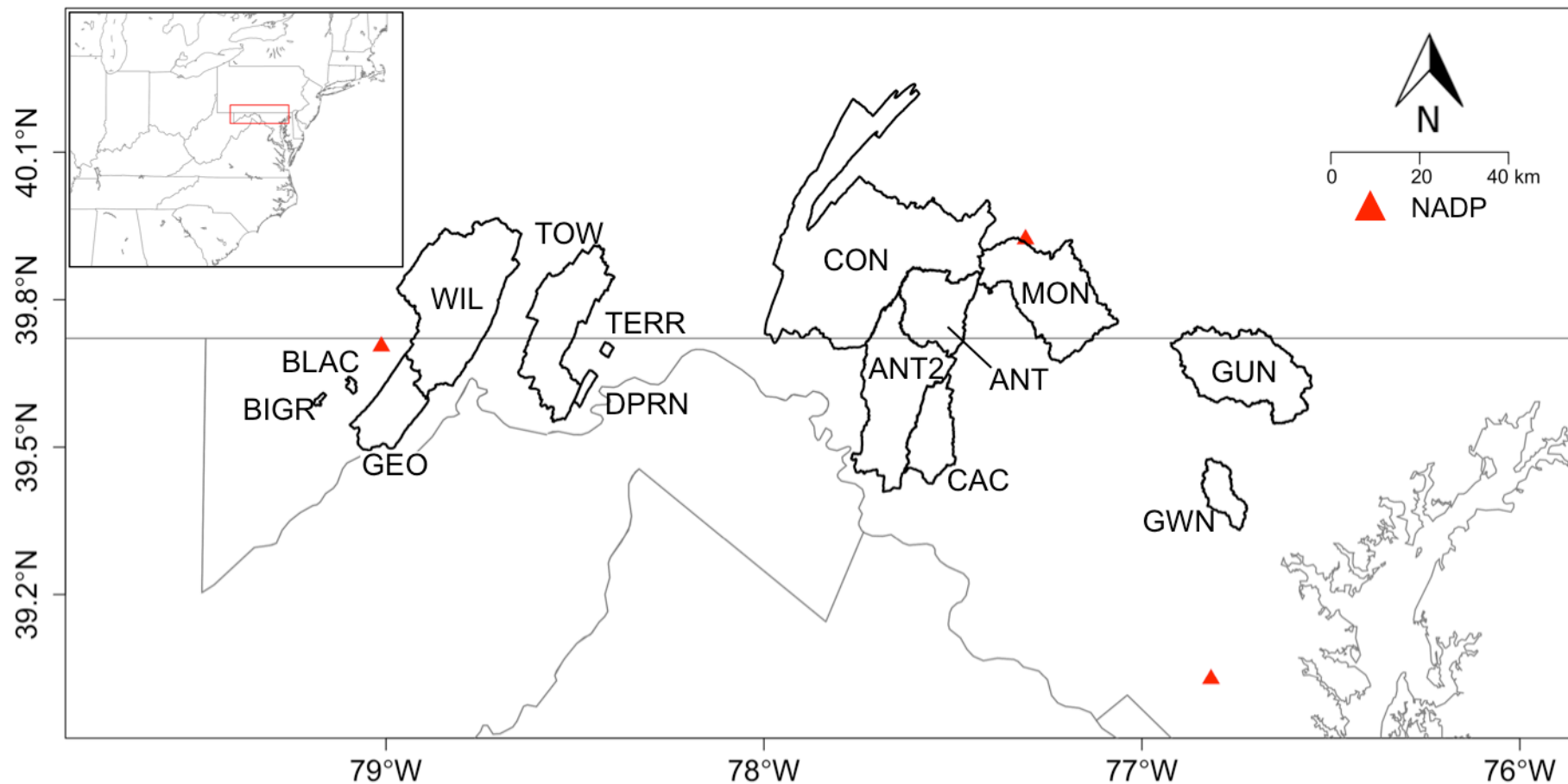
N Terr. NO_3



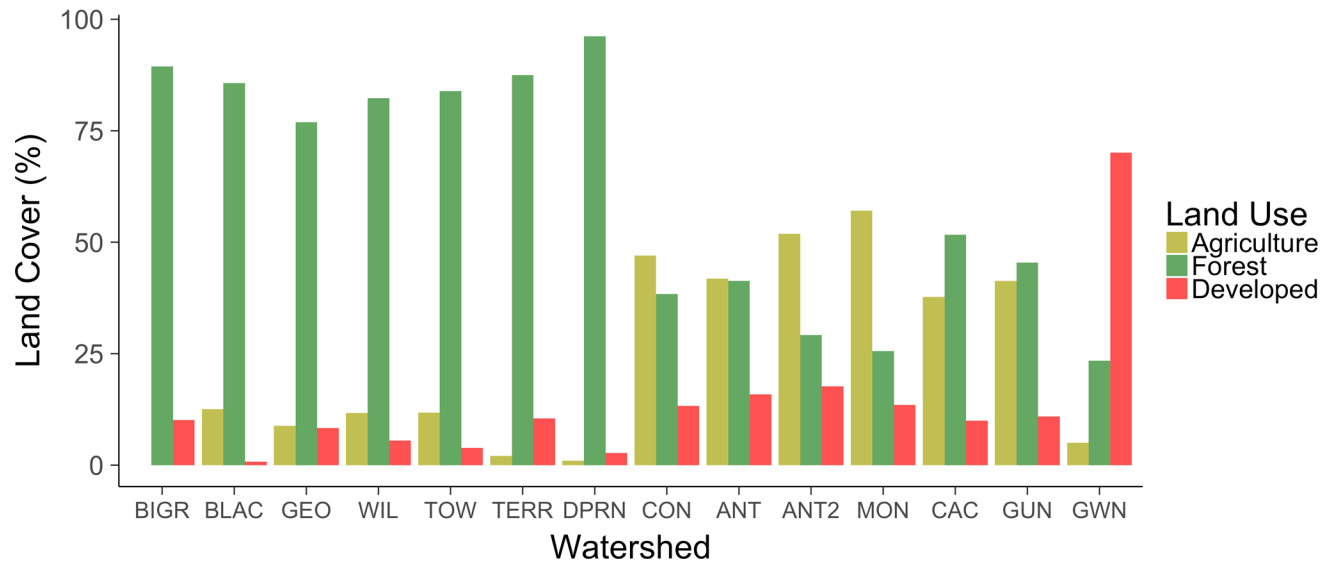
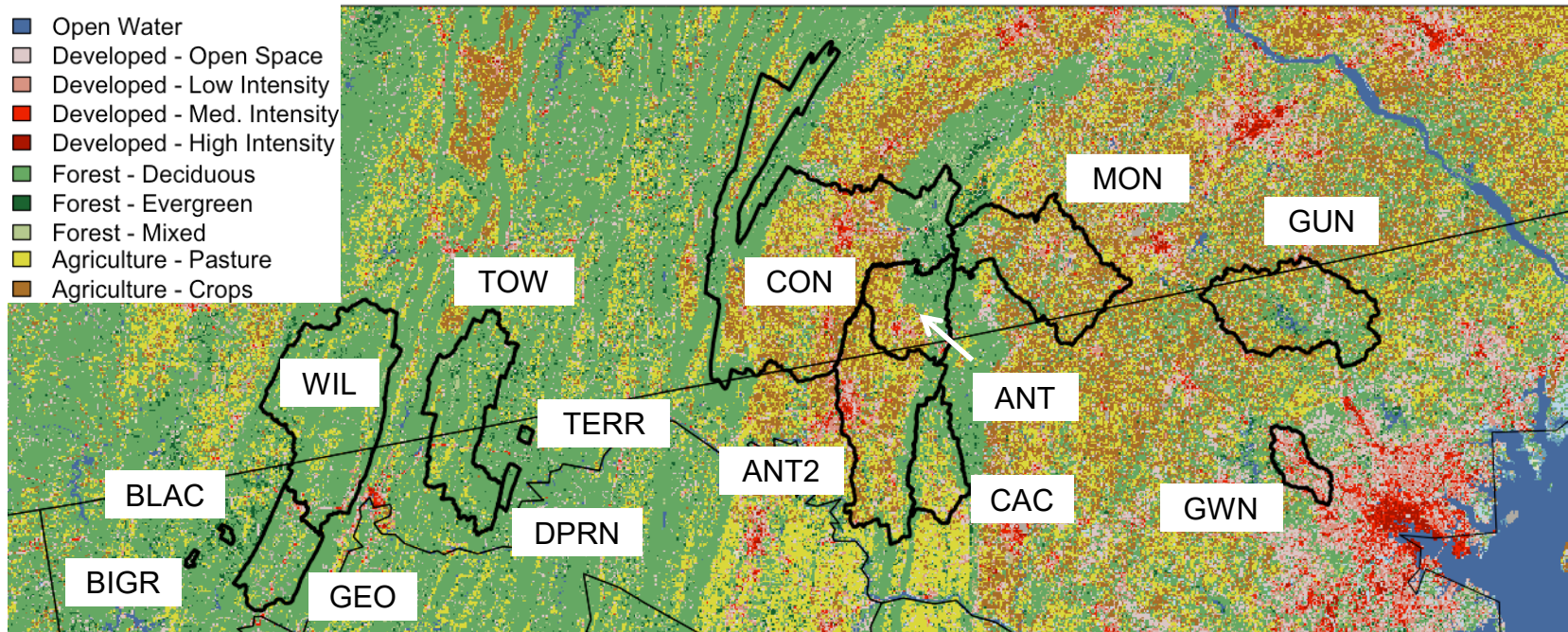
Research Objectives

- Quantify the proportion of atmospheric NO_3 in streams
- Investigate the effect of land use on processing efficiency of atmospheric NO_3

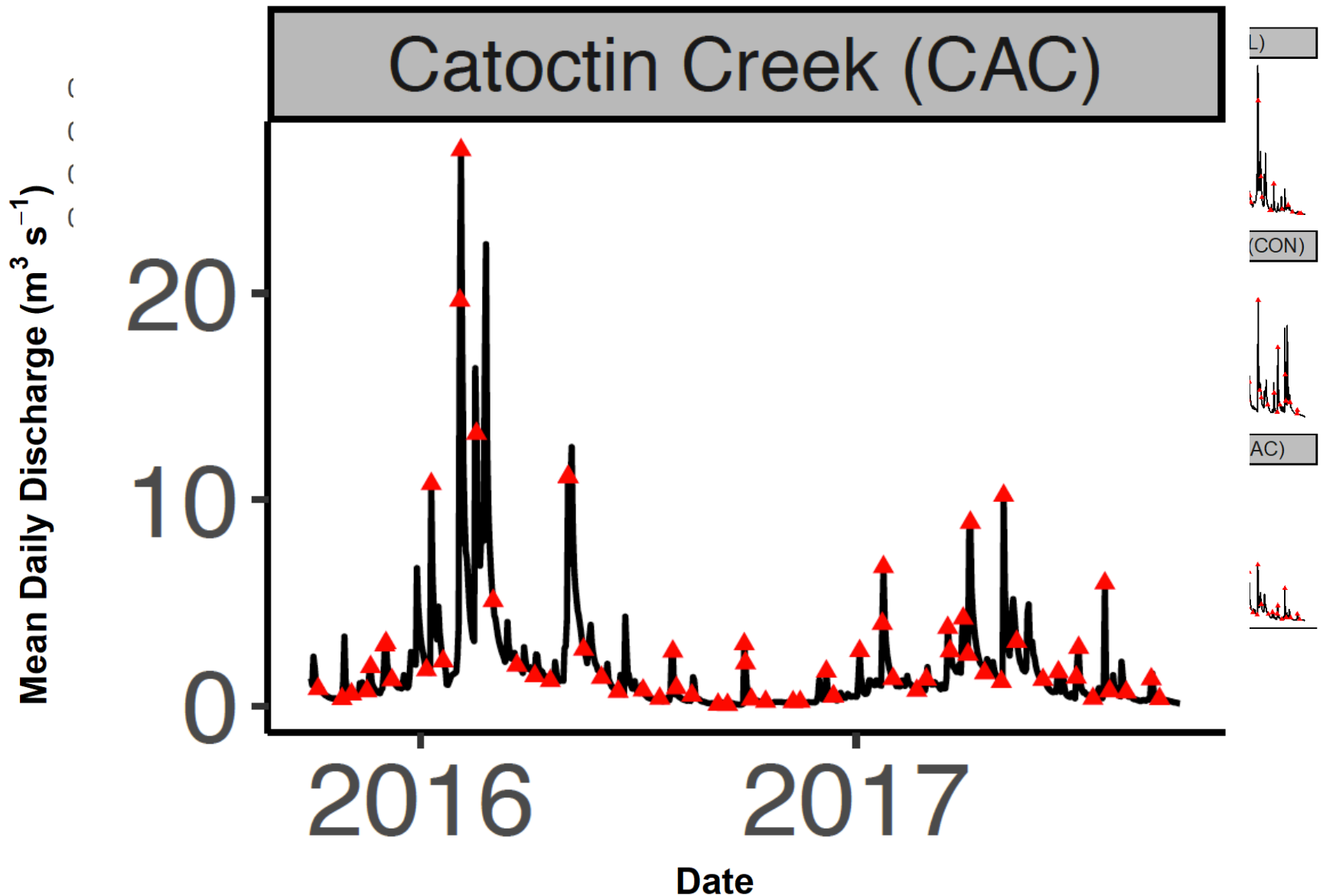
Study Watersheds



Watershed Land Use

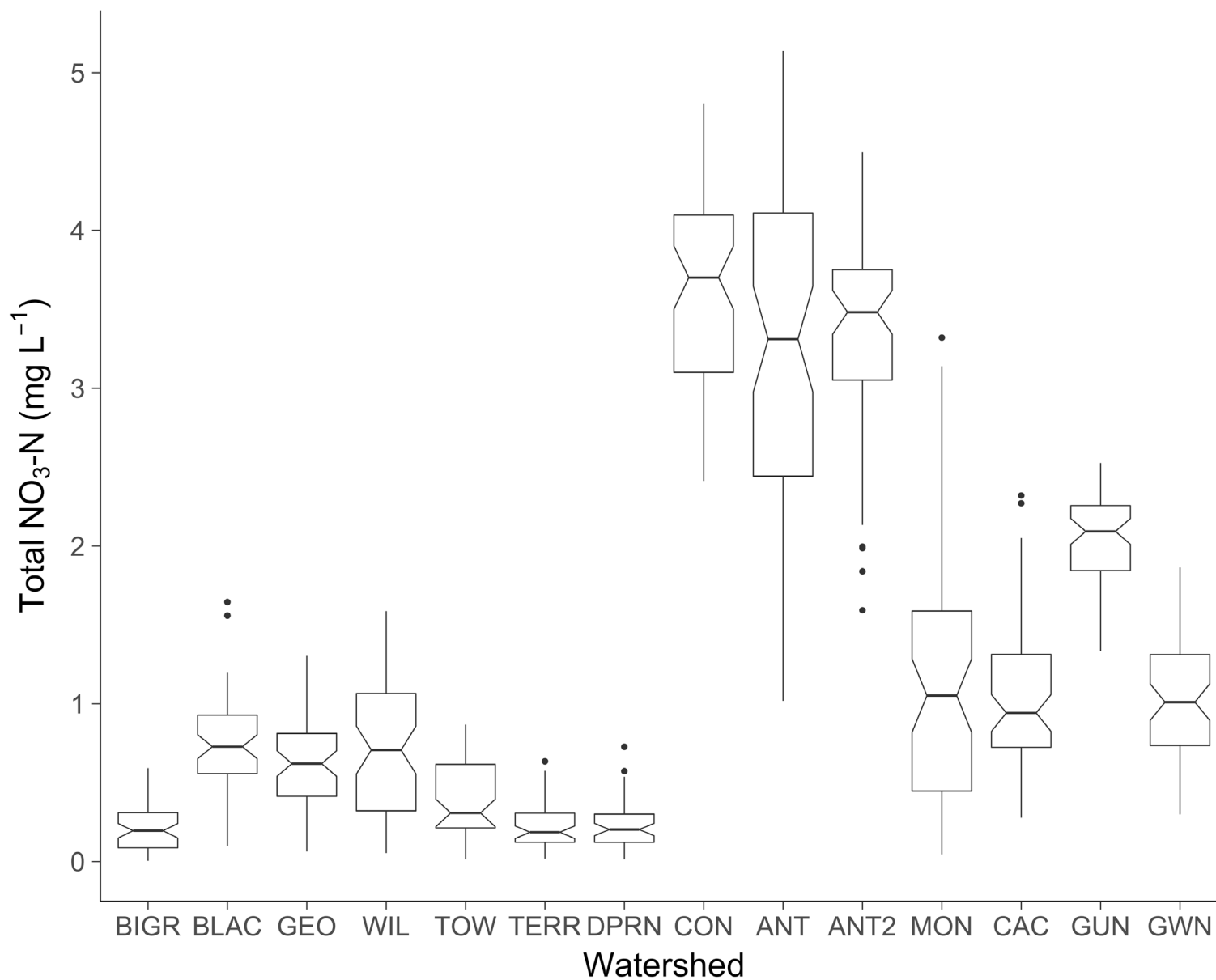


Stream Sampling

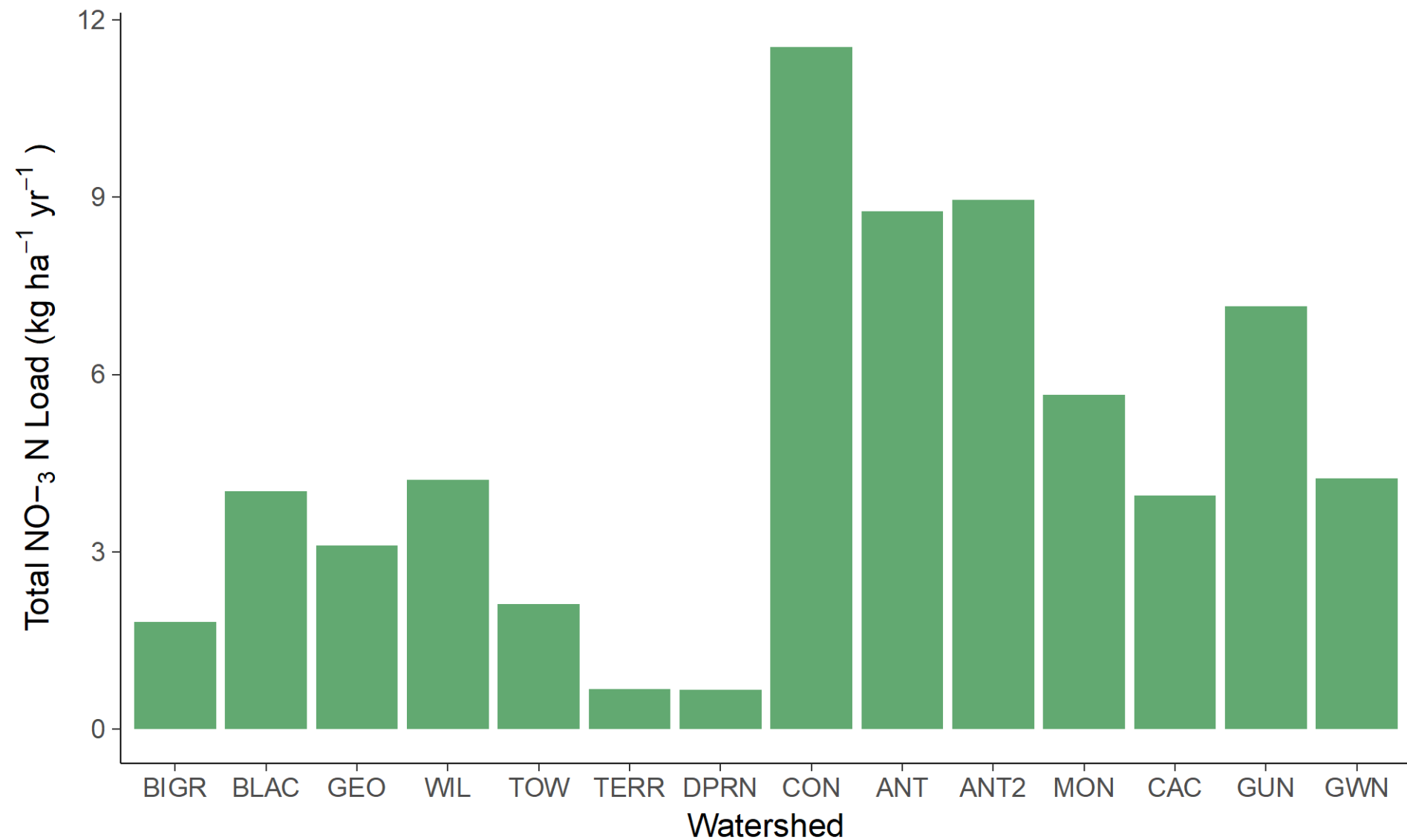


RESULTS

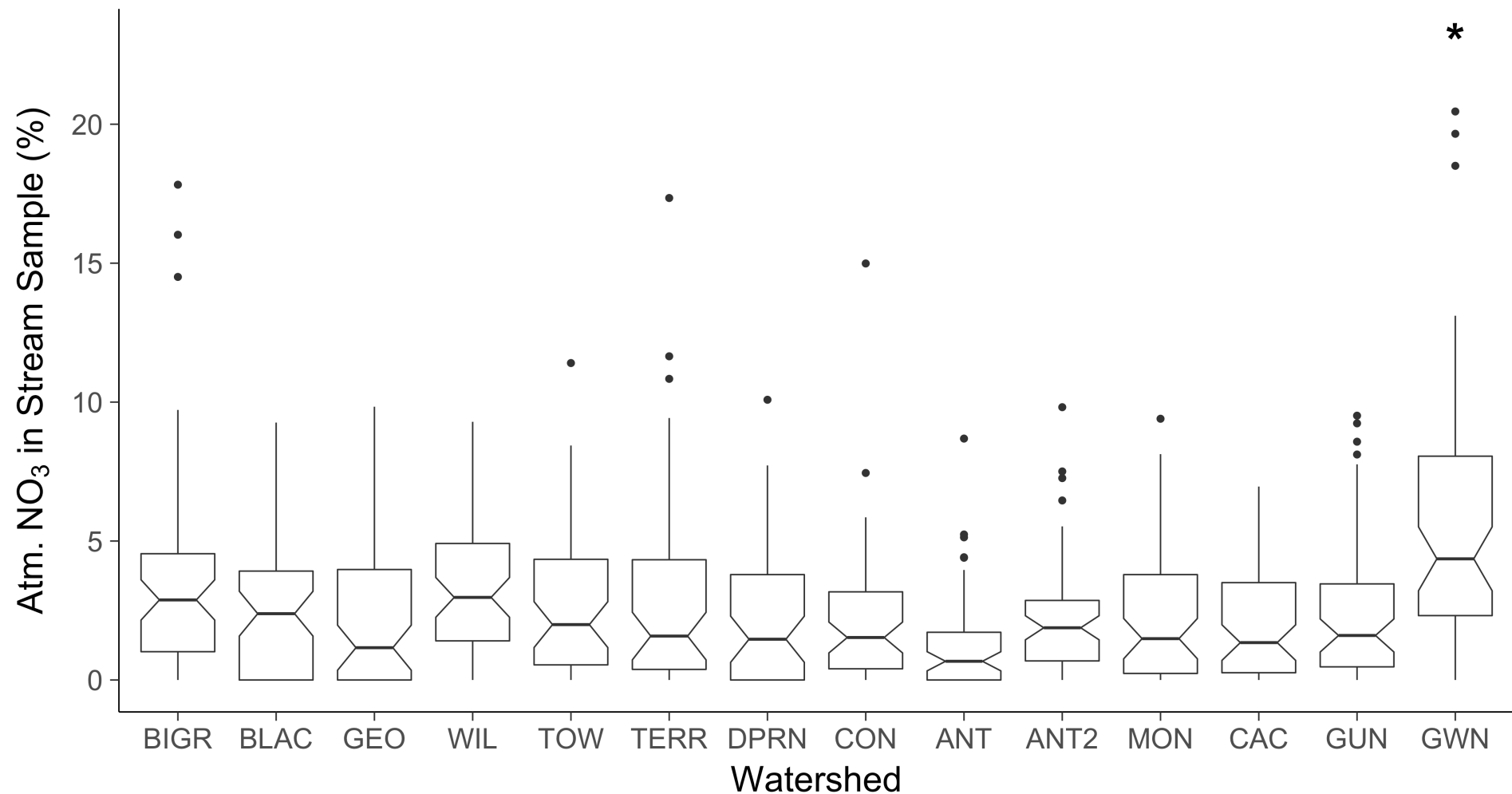
Total NO₃ Concentrations



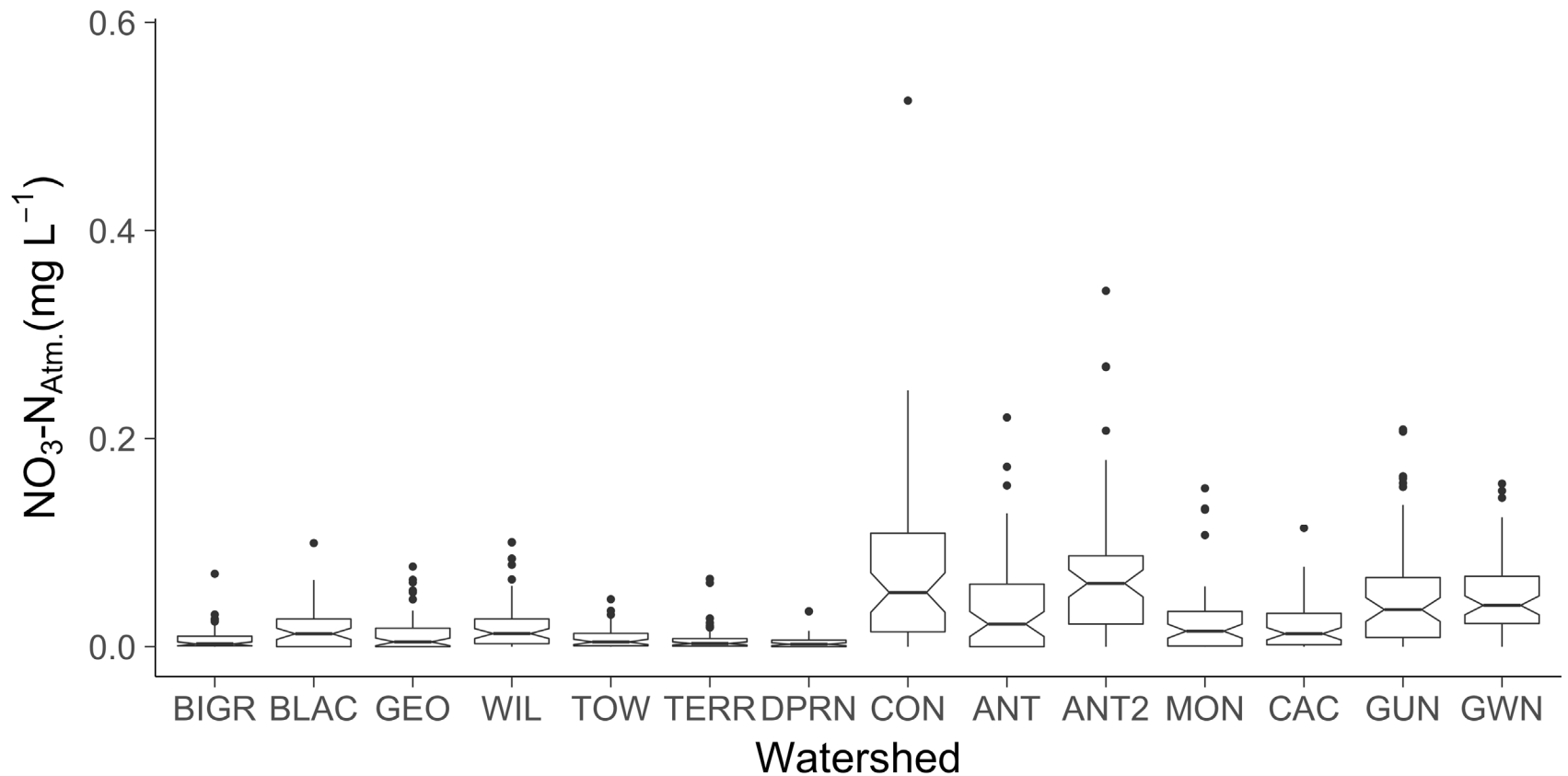
Total NO₃ Loads



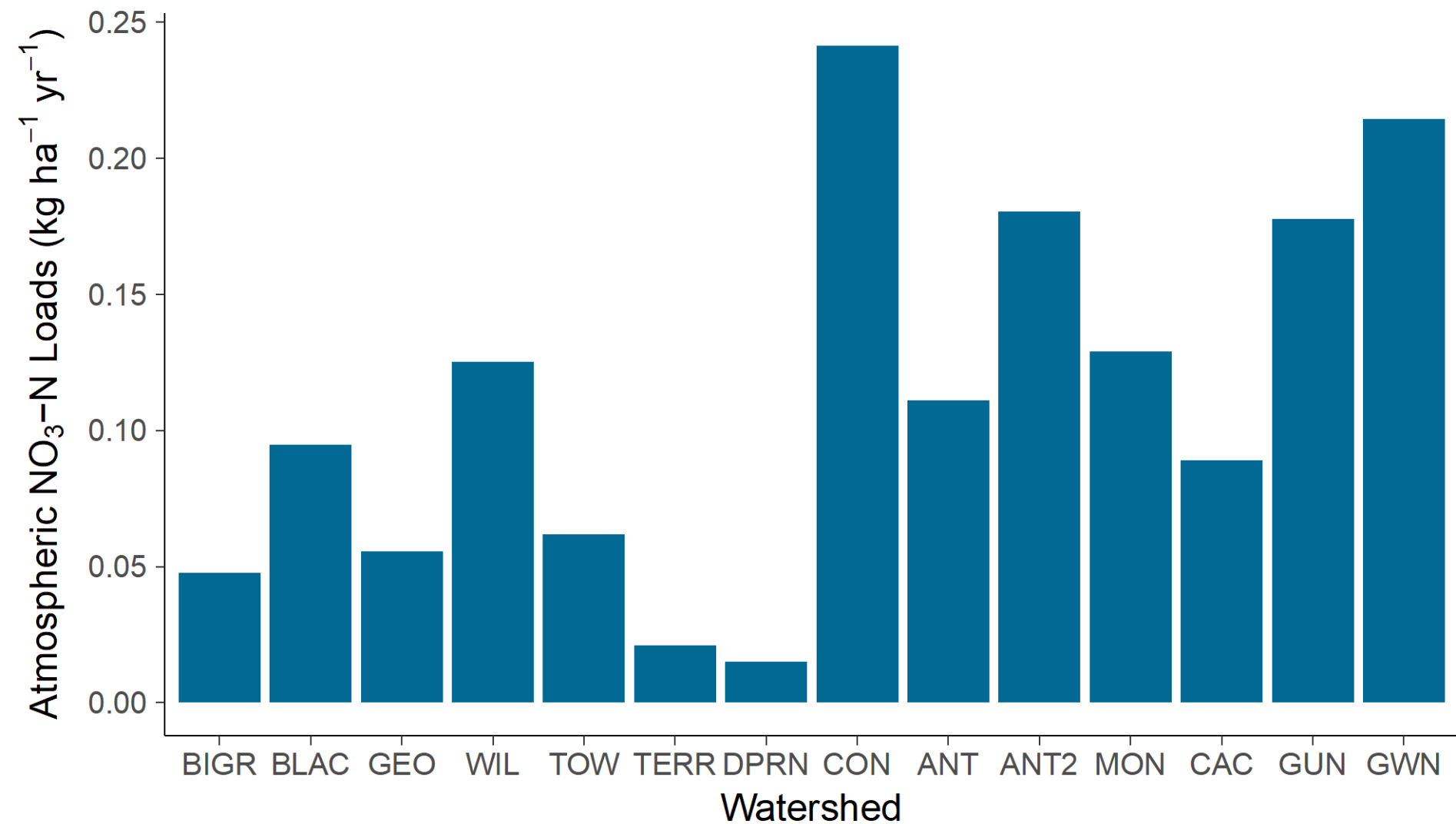
Atmospheric NO₃ in Stream Samples (%)



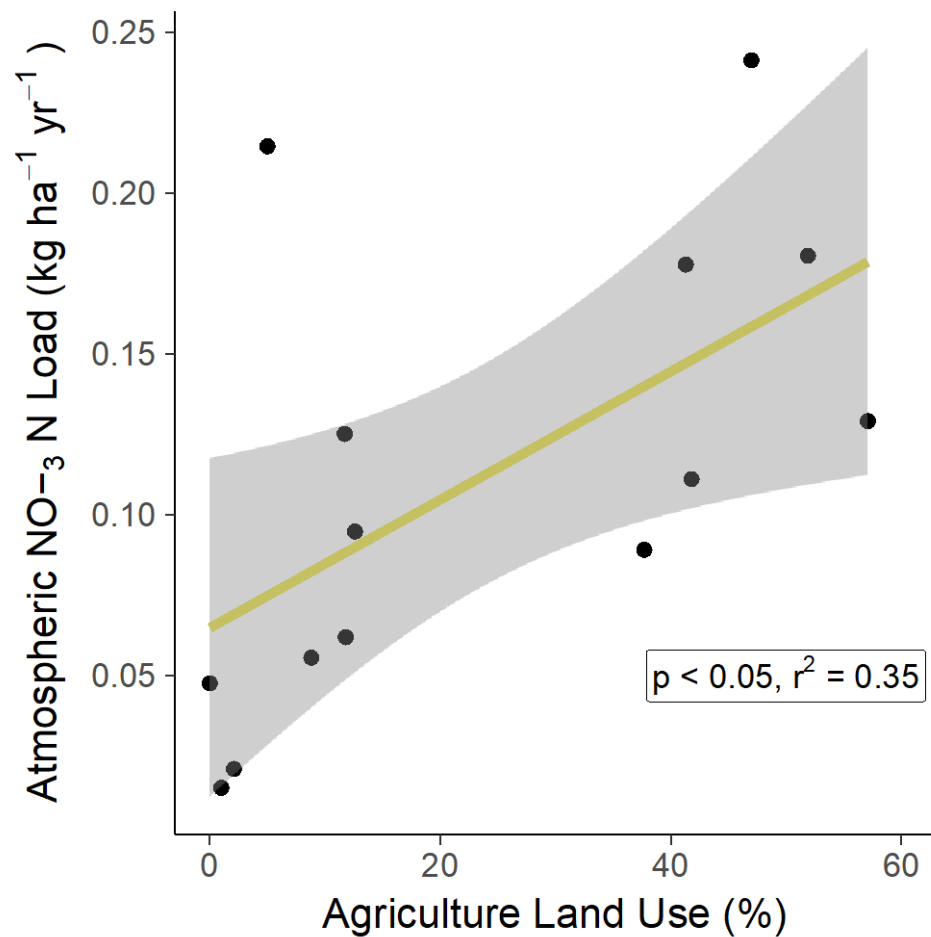
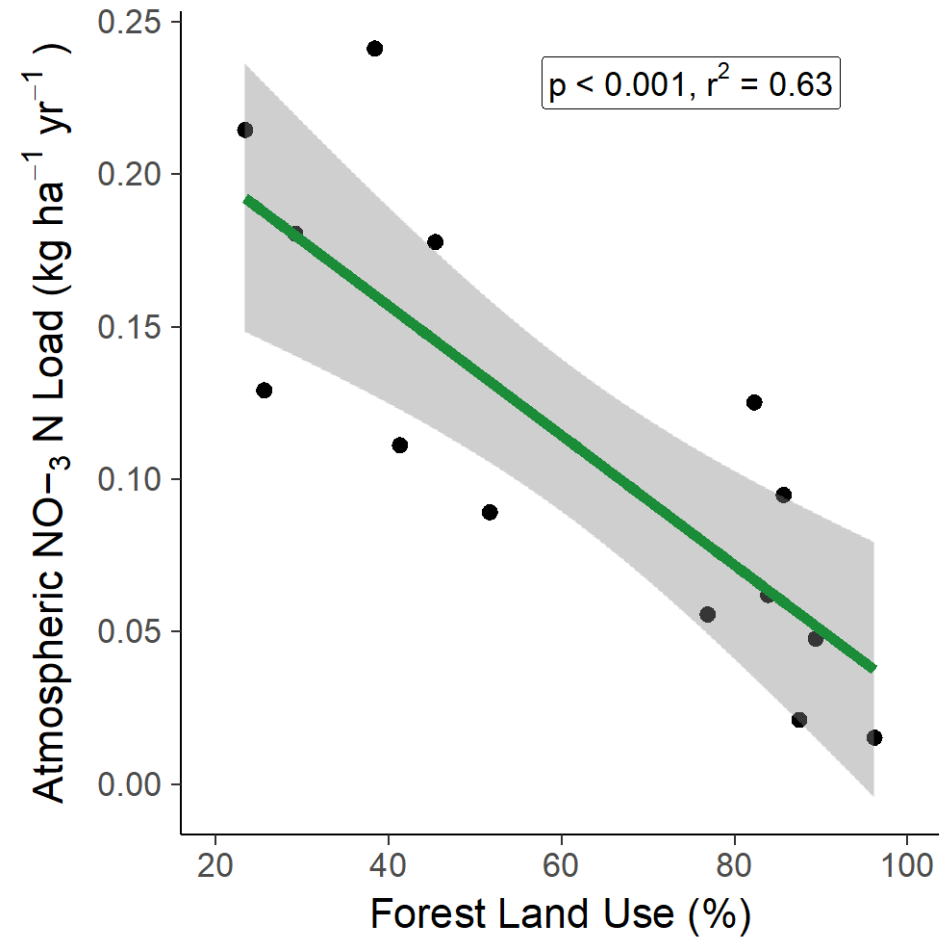
Atmospheric NO₃ Concentrations



Atmospheric NO₃ Loads

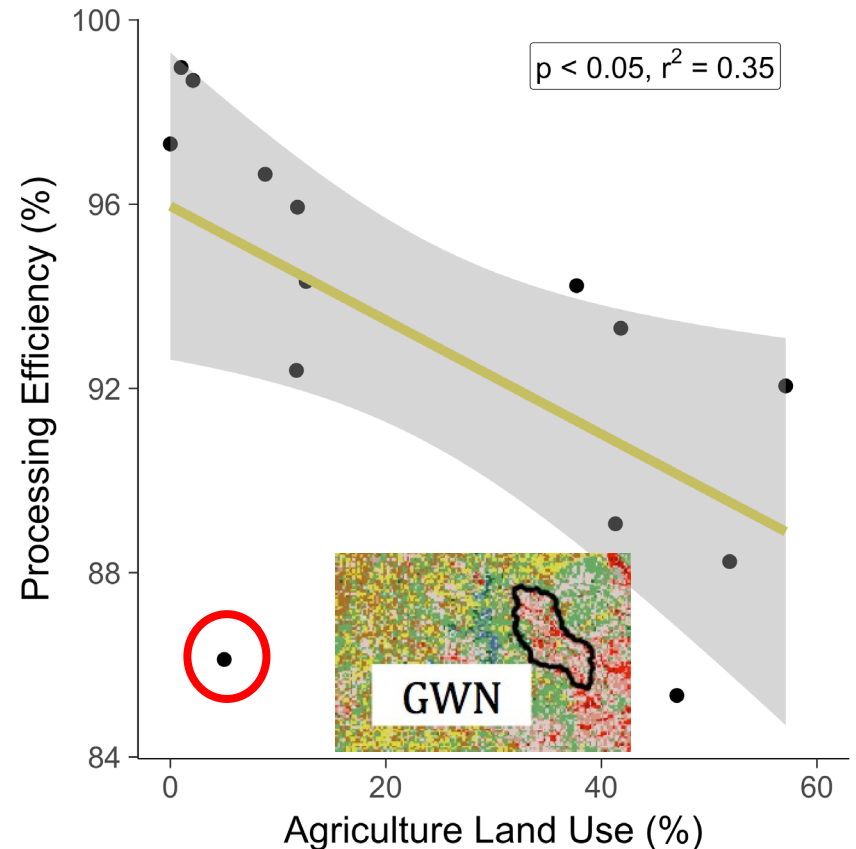
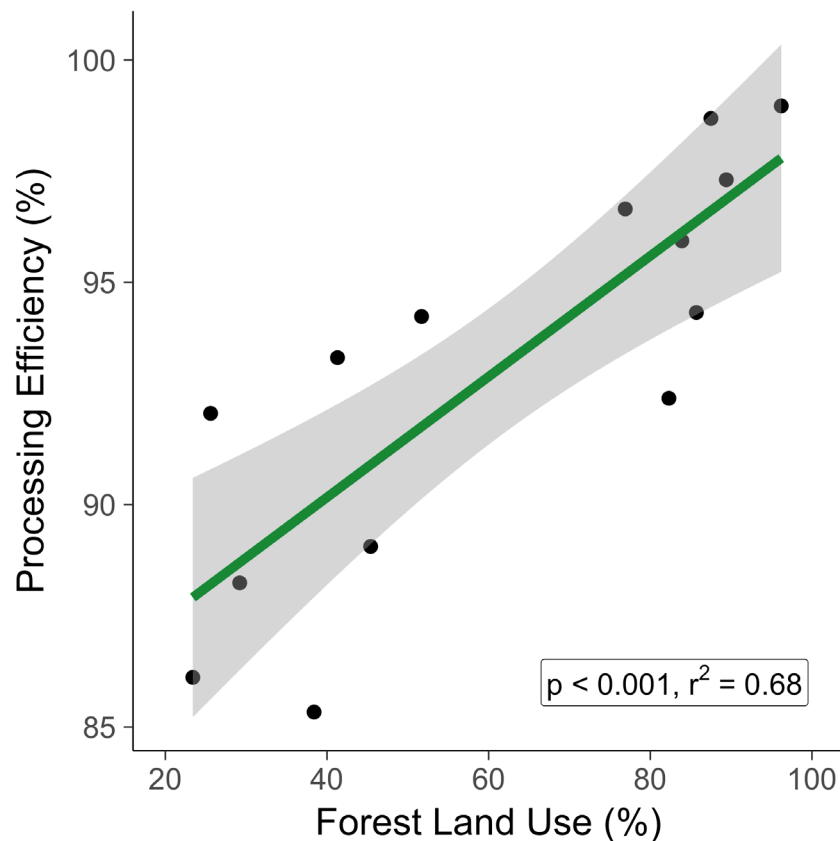


Atmospheric NO₃ Loads and Land Use



Processing Efficiency and Land-Use

$$\text{Processing Efficiency (\%)} = \left(1 - \frac{NO_{3-Atm.Load} (kg N ha^{-1} yr^{-1})}{NO_{3-Deposition} (kg N ha^{-1} yr^{-1})} \right) \times 100$$

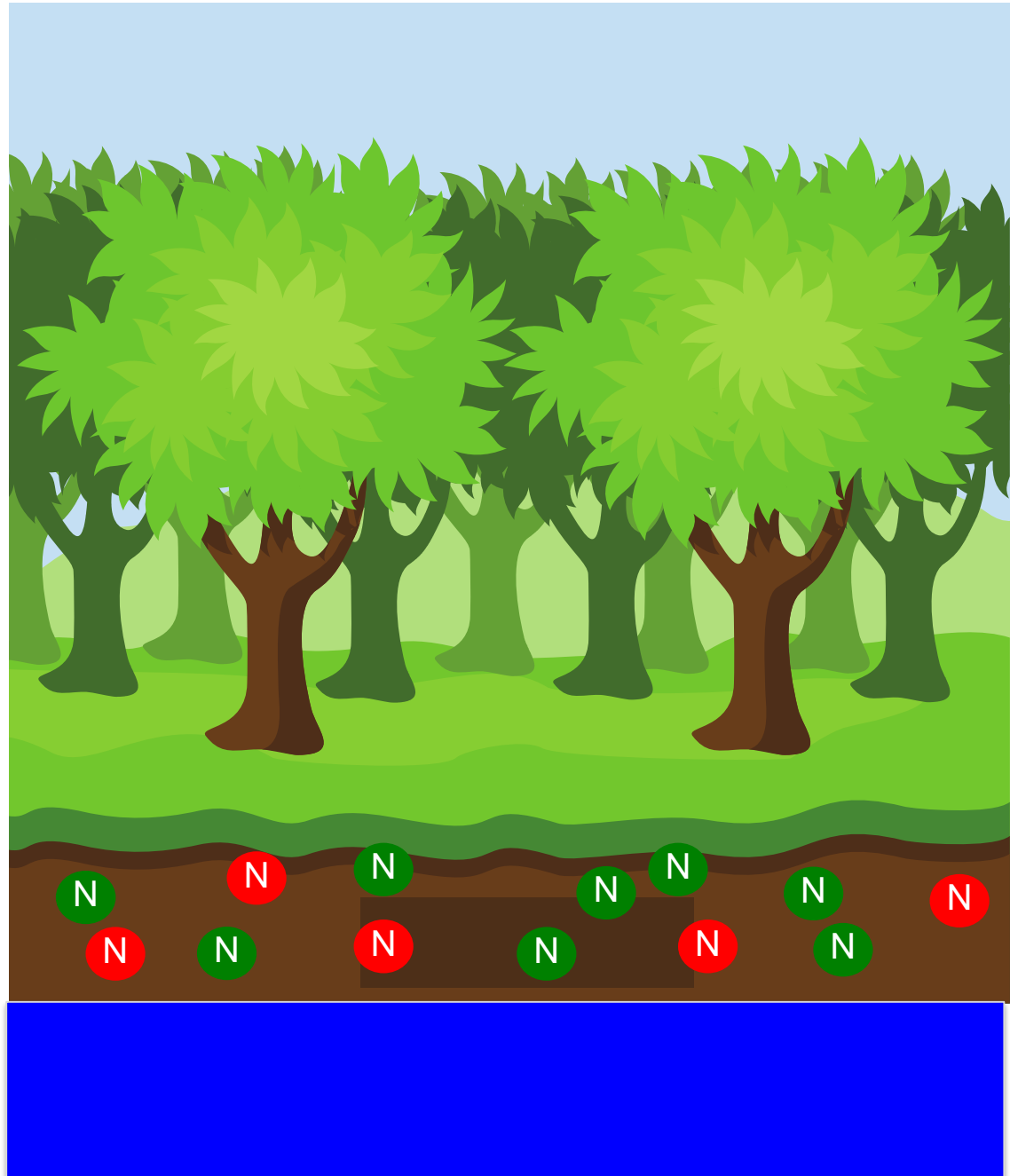


Conclusions

- Small (0-20%, mean = 3-4 %) percentage of NO_3 was unprocessed atmospheric NO_3 across forested and agricultural watersheds – but highest percentage in most developed watershed
- Forests: most “efficient” at processing deposited NO_3
- Agricultural/Developed watersheds: less “efficient” at processing deposited NO_3 – 2 potential controls:
 - 1: Hydrologic: Altered flowpaths in developed land-use watersheds reduce processing by rapidly routing water to streams
 - 2: N Saturation: Additional N inputs in agricultural land-use watersheds reduce processing by overwhelming ecosystem N capacity

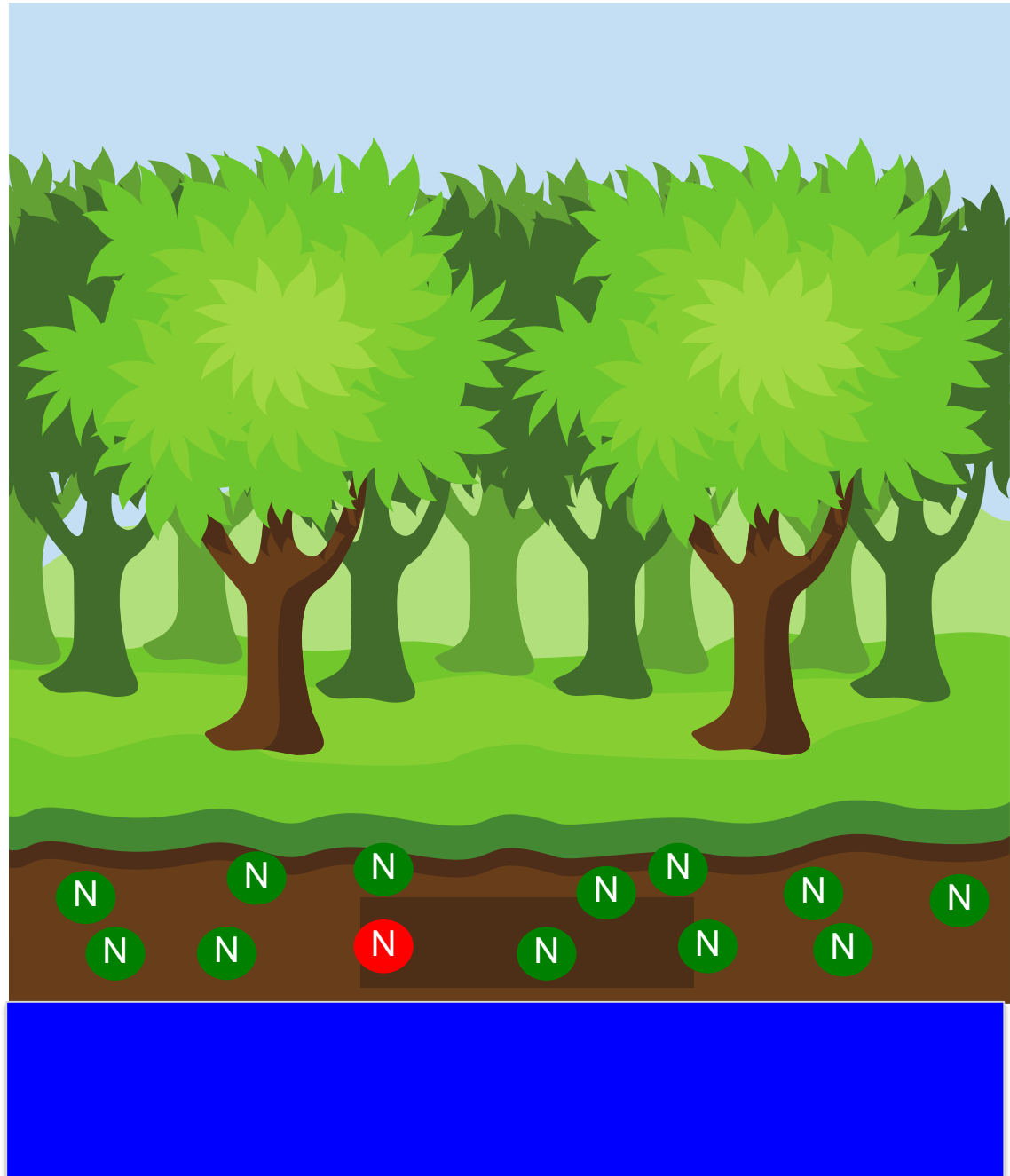
 Atm. NO_3

 Terr. NO_3



 Atm. NO_3

 Terr. NO_3



 Atm. NO_3

 Terr. NO_3





Atm. NO_3

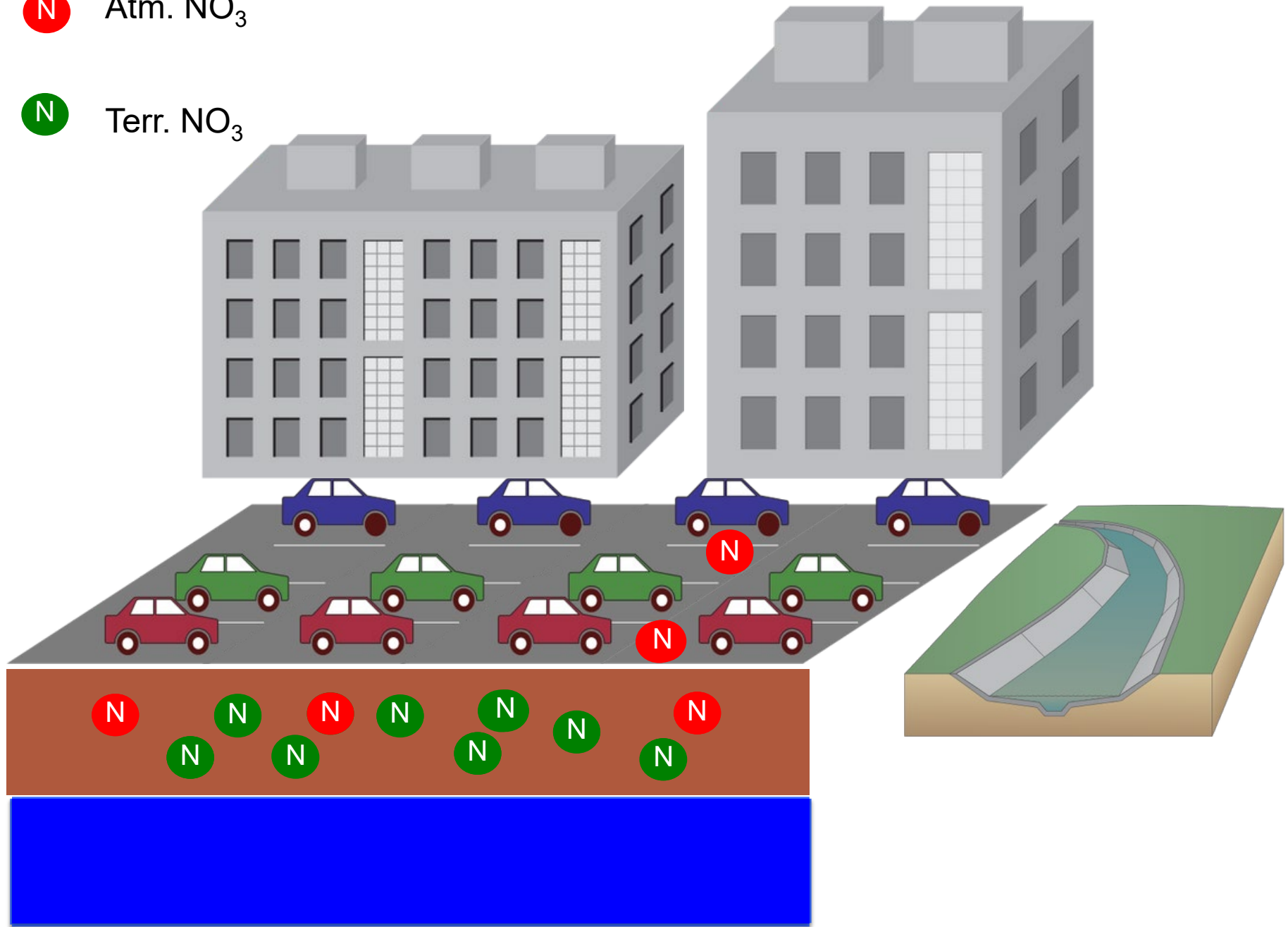


Terr. NO_3



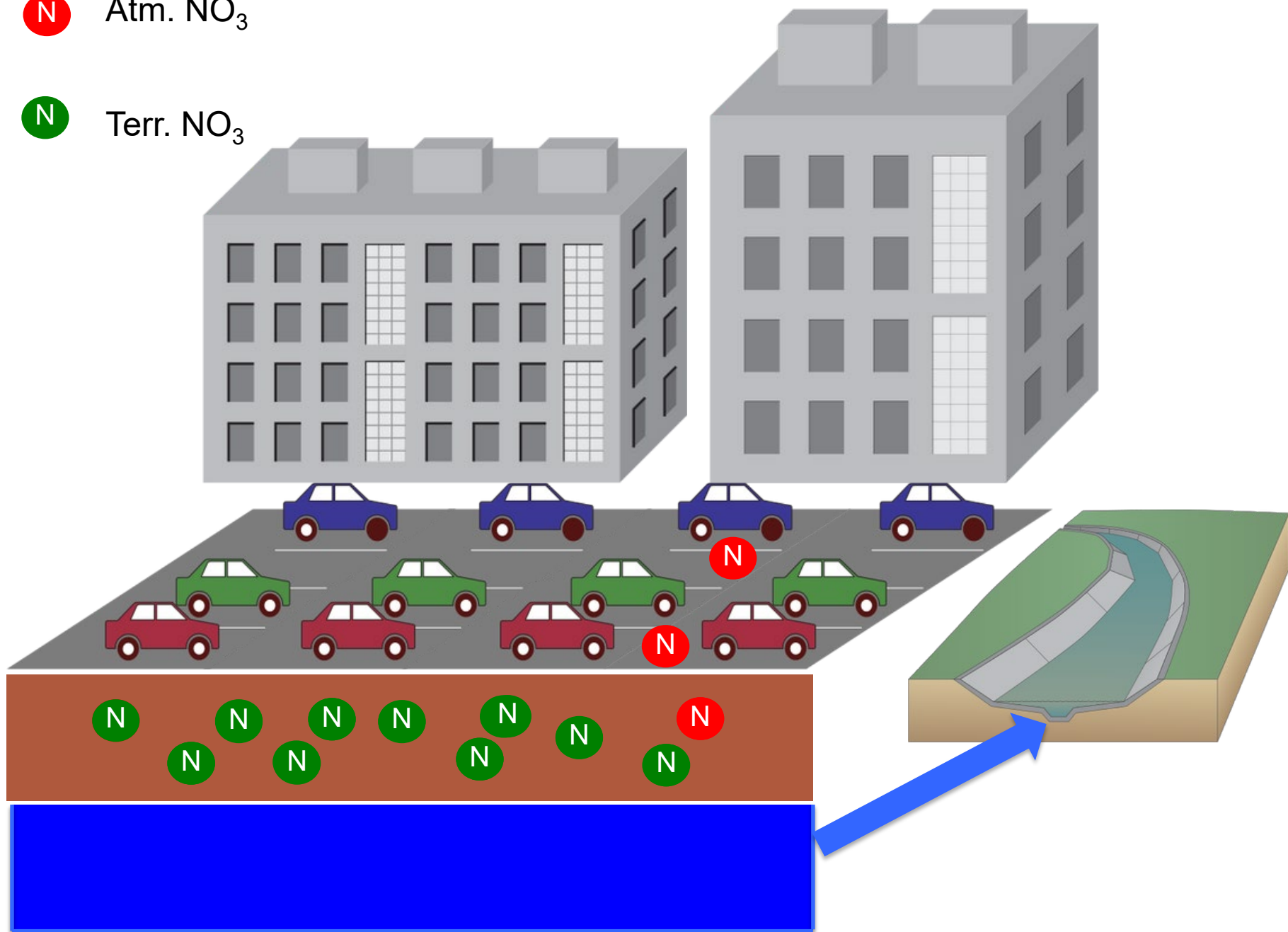
 Atm. NO₃

 Terr. NO₃

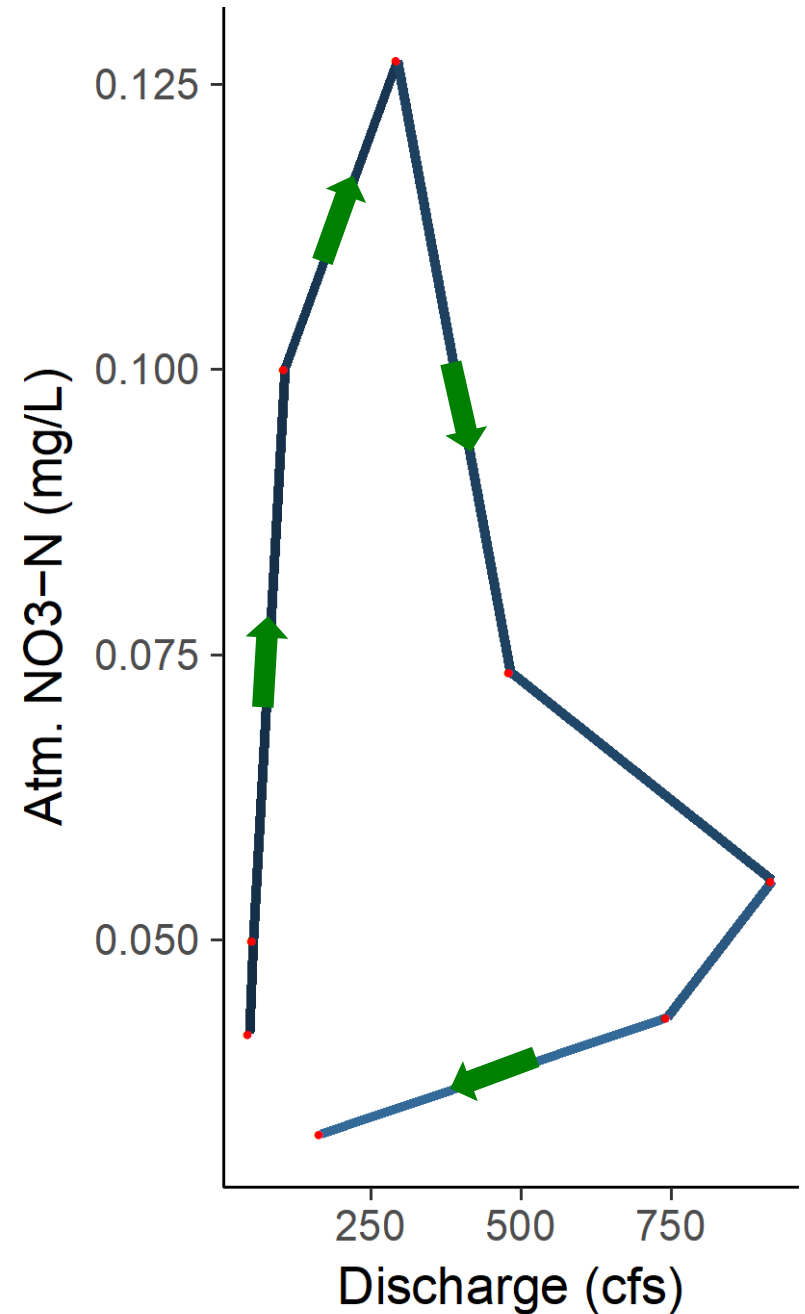
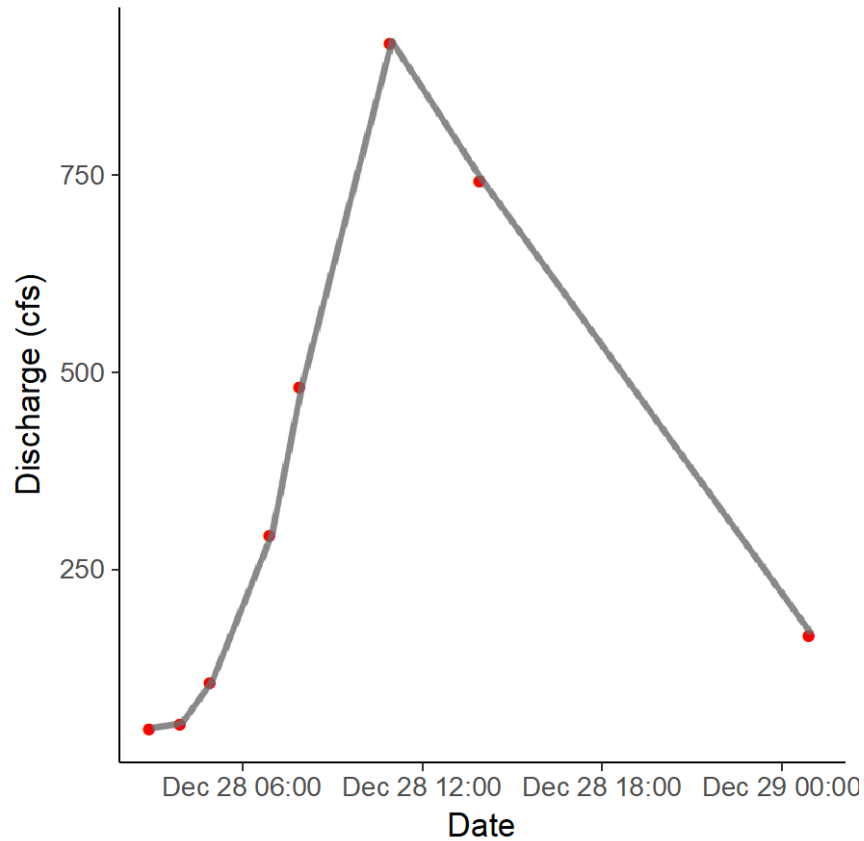


 Atm. NO_3

 Terr. NO_3



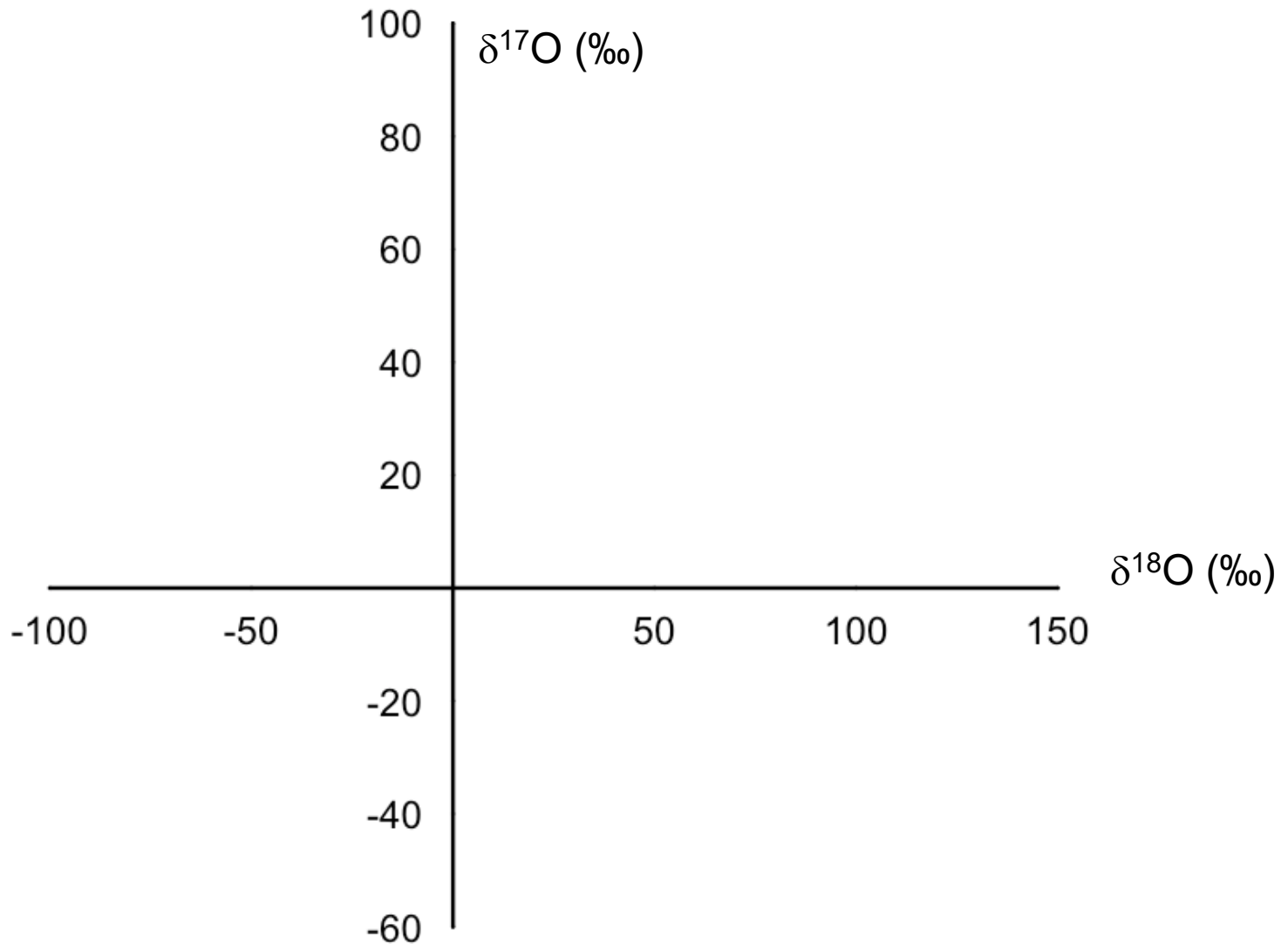
Next St



Acknowledgments

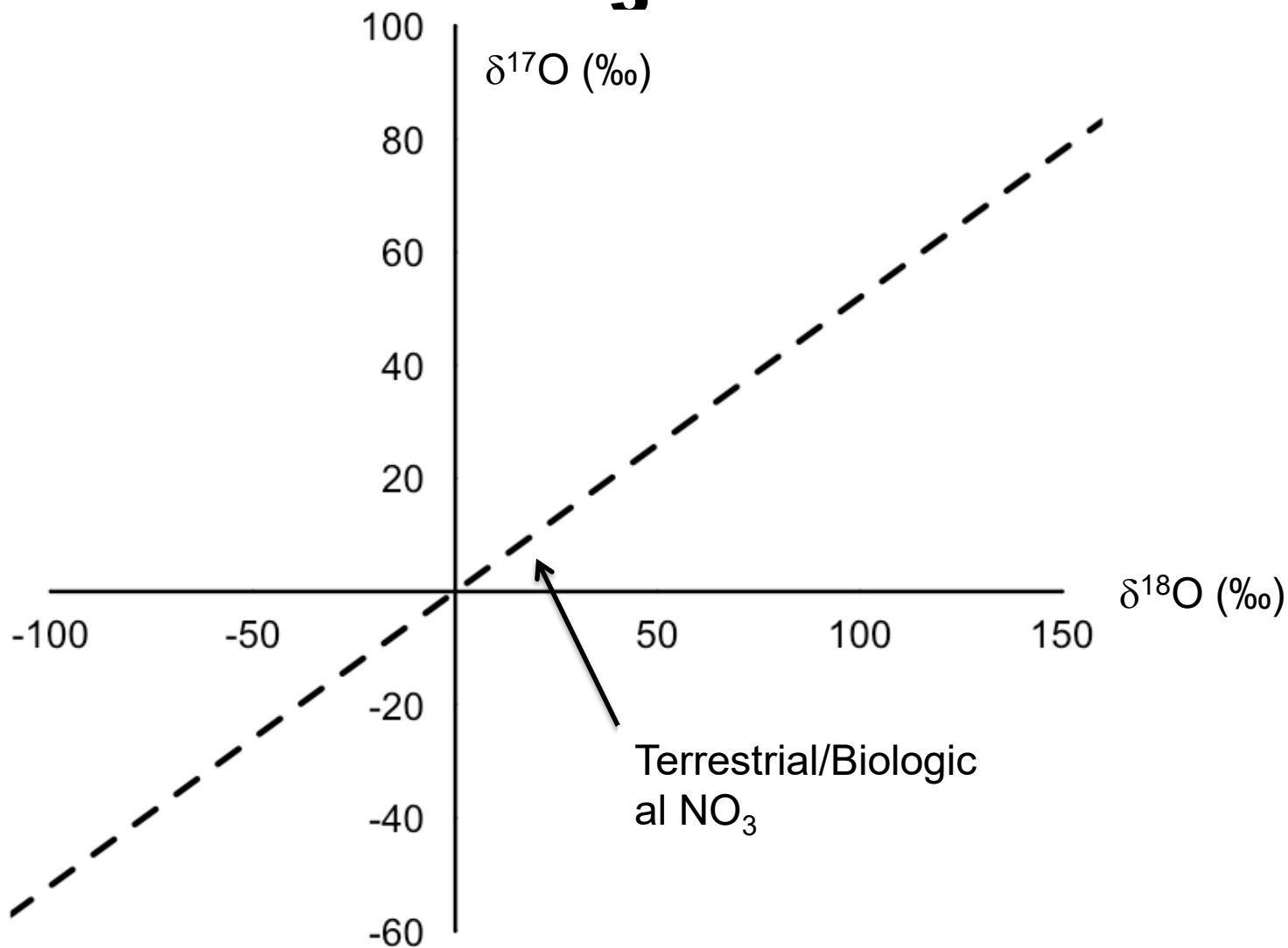
- Field Sampling: Maryland DNR
- Lab Assistance: Robin Paulman, Jim Garlitz, Katie Kline, Andrew Schauer
- Funding: Maryland Sea Grant, National Science Foundation

Isotopes and Atmospheric NO_3

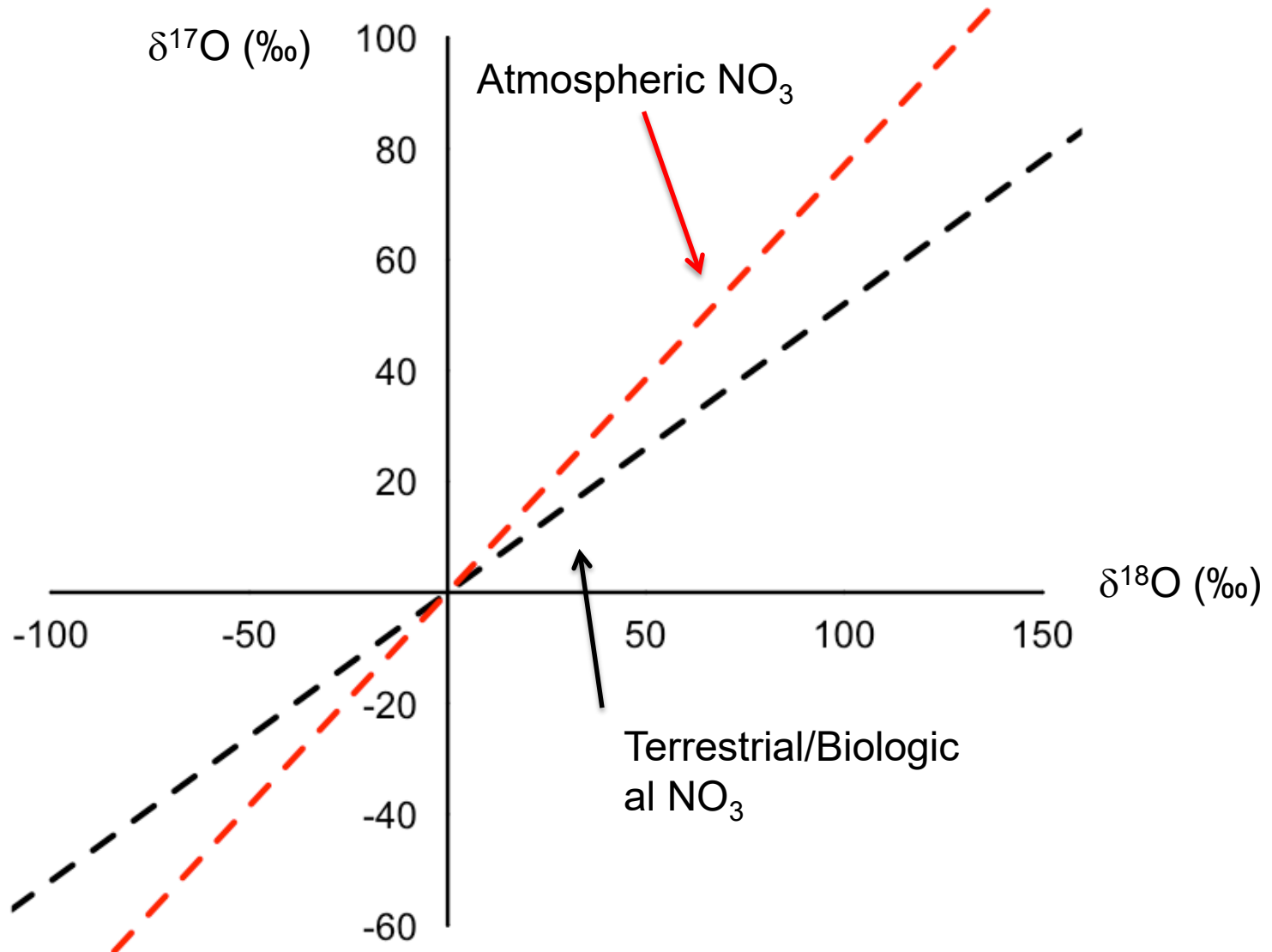


Isotopes and Atmospheric

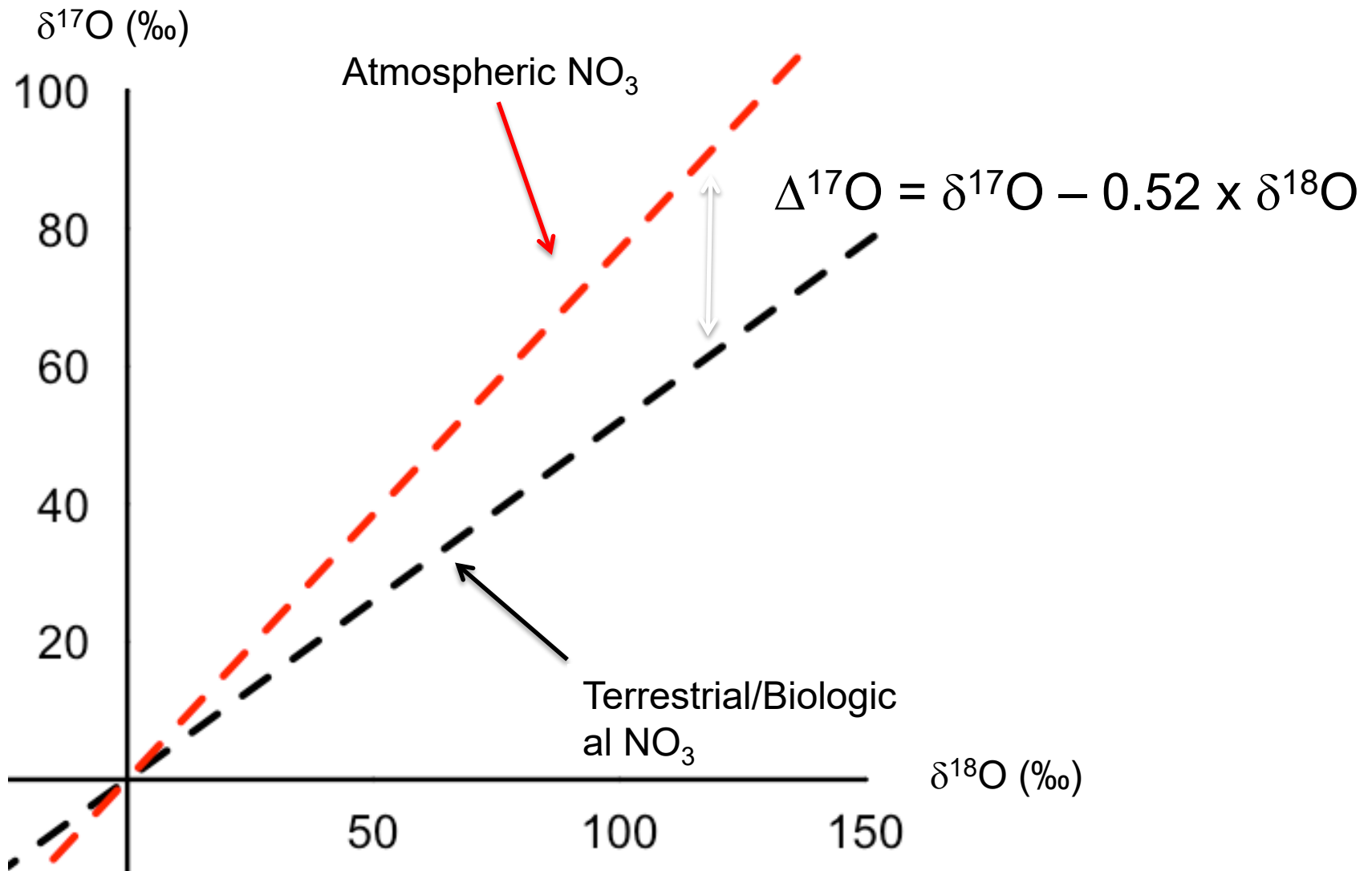
NO₃



Isotopes and Atmospheric NO_3



Isotopes and Atmospheric NO_3



Isotopes and Atmospheric NO_3

Atmospheric
Deposition NO_3
 $\Delta^{17}\text{O} \approx 25 \text{ ‰}$



Terrestrial/Biological
 NO_3
 $\Delta^{17}\text{O} = 0 \text{ ‰}$

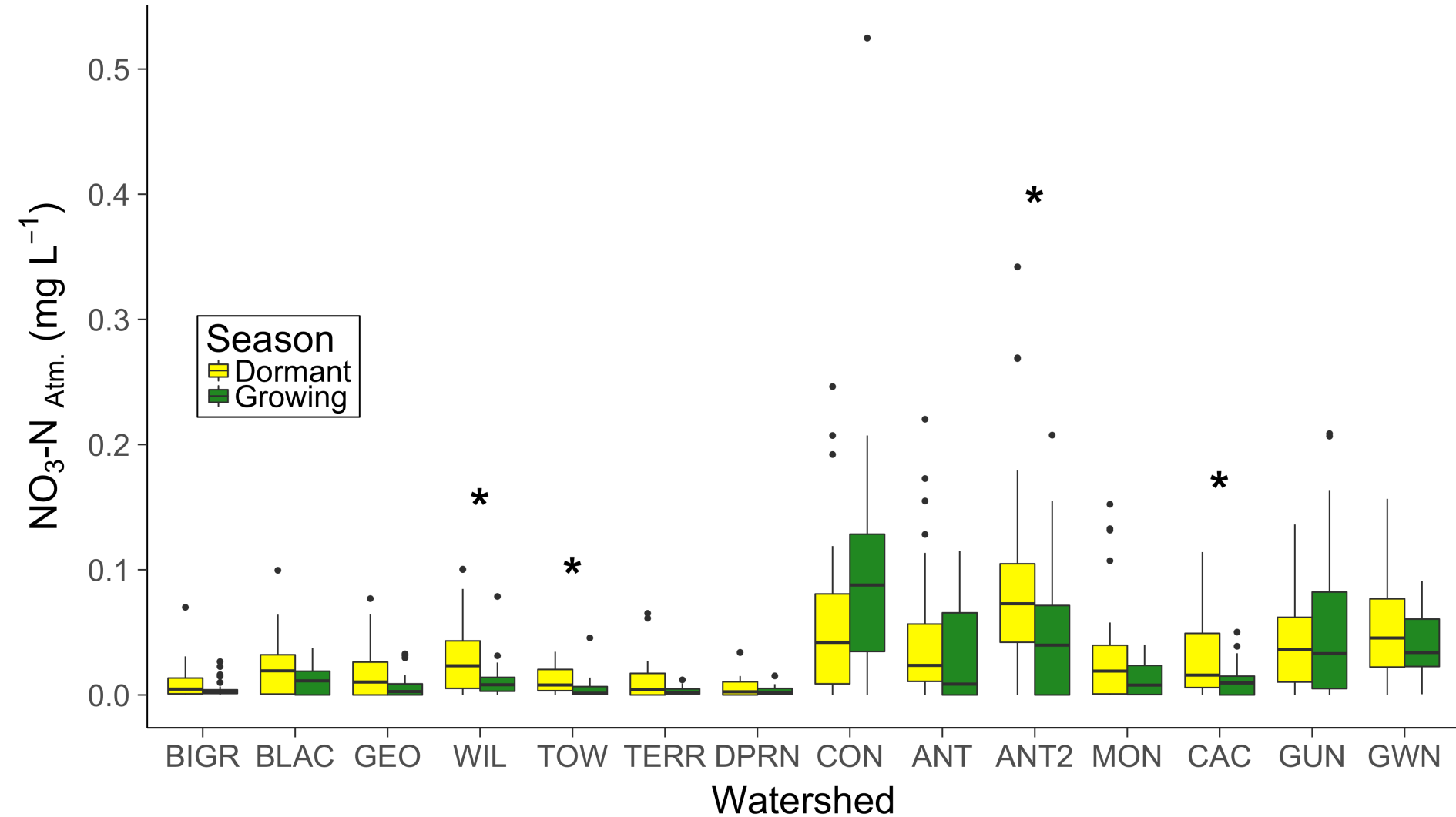
Fraction of total NO_3 that is
atmospheric NO_3

$$\text{Fraction Atm. NO}_3 = \frac{\Delta^{17}\text{O} - \text{NO}_{3\text{-Sample}}}{\Delta^{17}\text{O} - \text{NO}_{3\text{-Deposition}}}$$

- Concentration of atmospheric NO_3 in stream sample:

$$\text{NO}_{3\text{-Atm.}} = \frac{\Delta^{17}\text{O} - \text{NO}_{3\text{-Sample}}}{\Delta^{17}\text{O} - \text{NO}_{3\text{-Deposition}}} \times \text{NO}_3$$

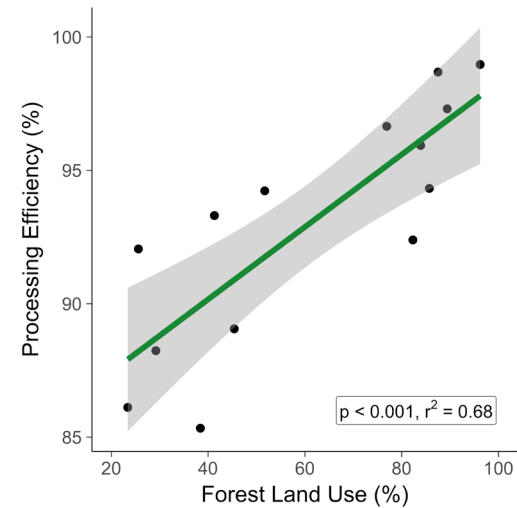
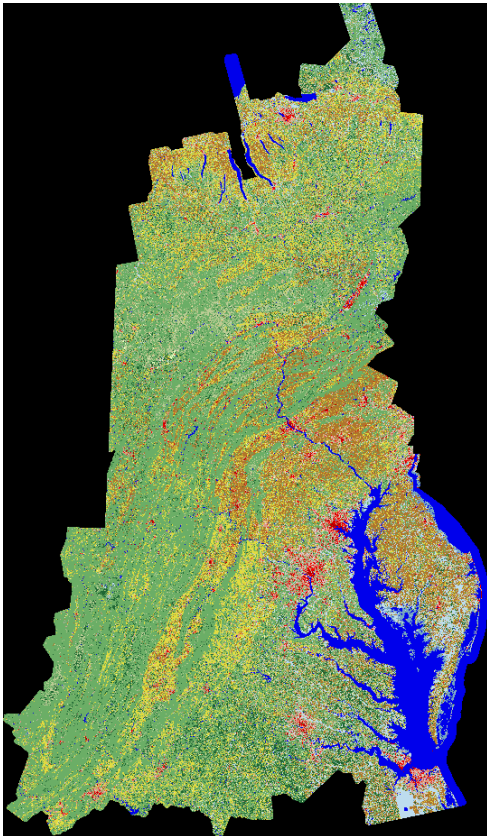
Seasonal Atm. NO₃



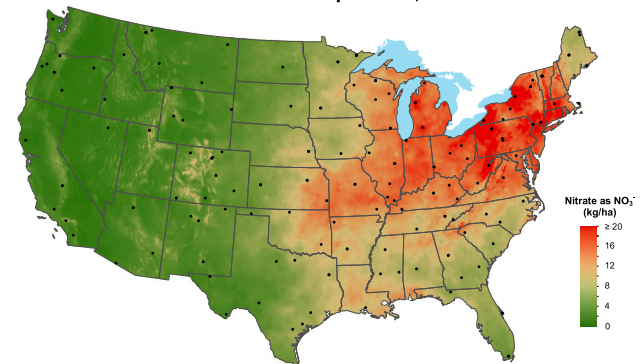
Next Steps

$$\text{Processing Efficiency (\%)} = \left(1 - \frac{NO_{3-Atm.Load} (kg N ha^{-1} yr^{-1})}{NO_{3-Deposition} (kg N ha^{-1} yr^{-1})} \right) \times 100$$

1984 CB Land Cover
(USGS)

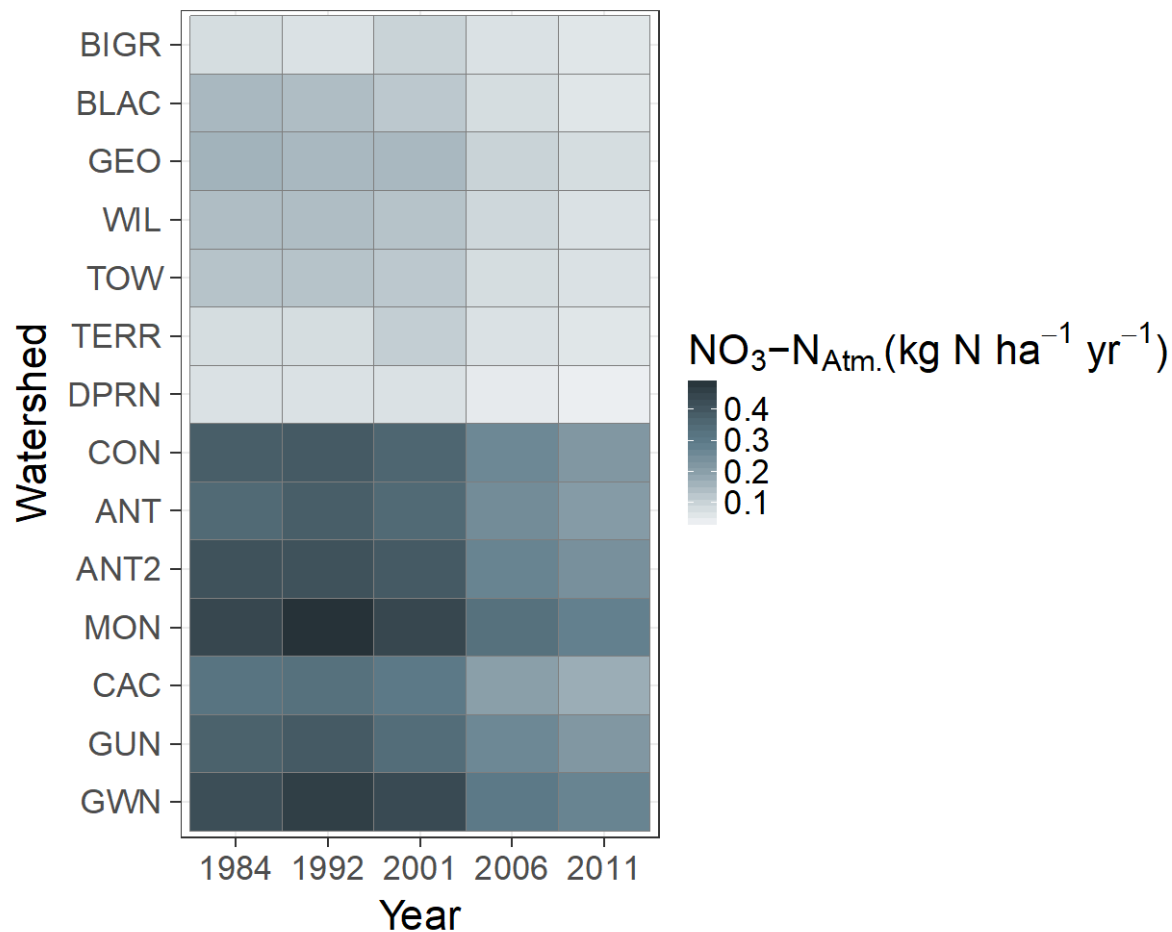


Nitrate ion wet deposition, 1985



Next Steps

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Next Steps

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