Land-use controls on the export and processing of atmospheric NO_3

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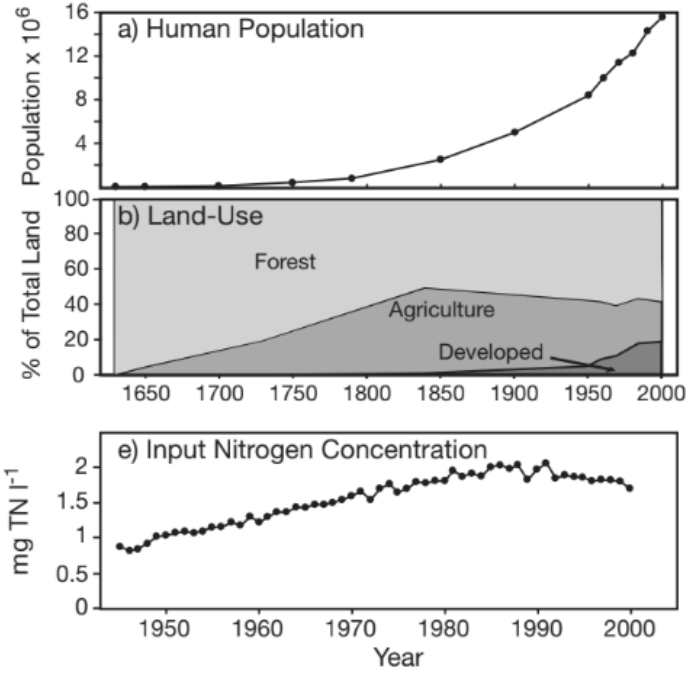
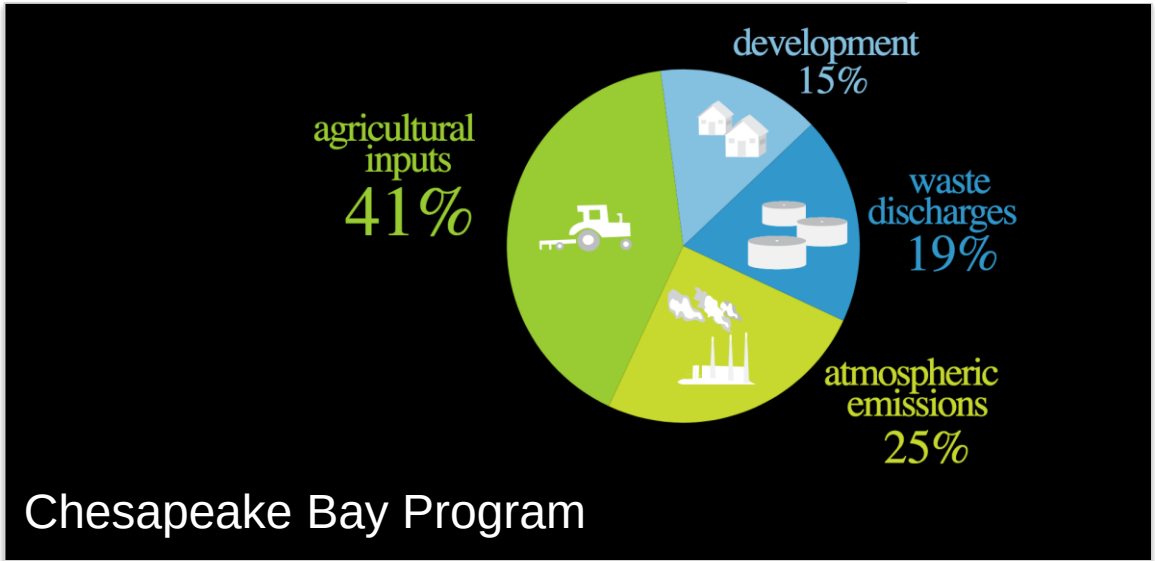
CBP Forestry Workgroup 2/6/19

Background

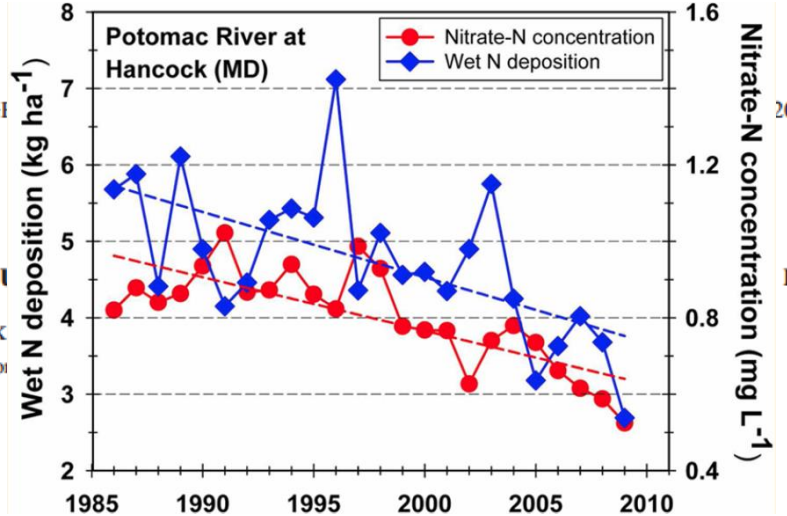
VIMS



Kemp et al. 2005



Background



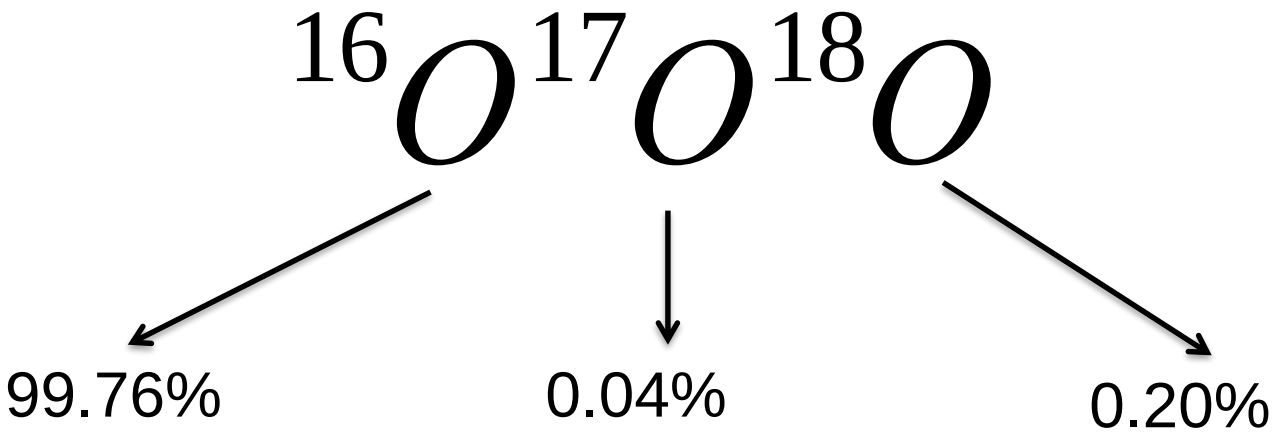
Eshleman et al. 2013

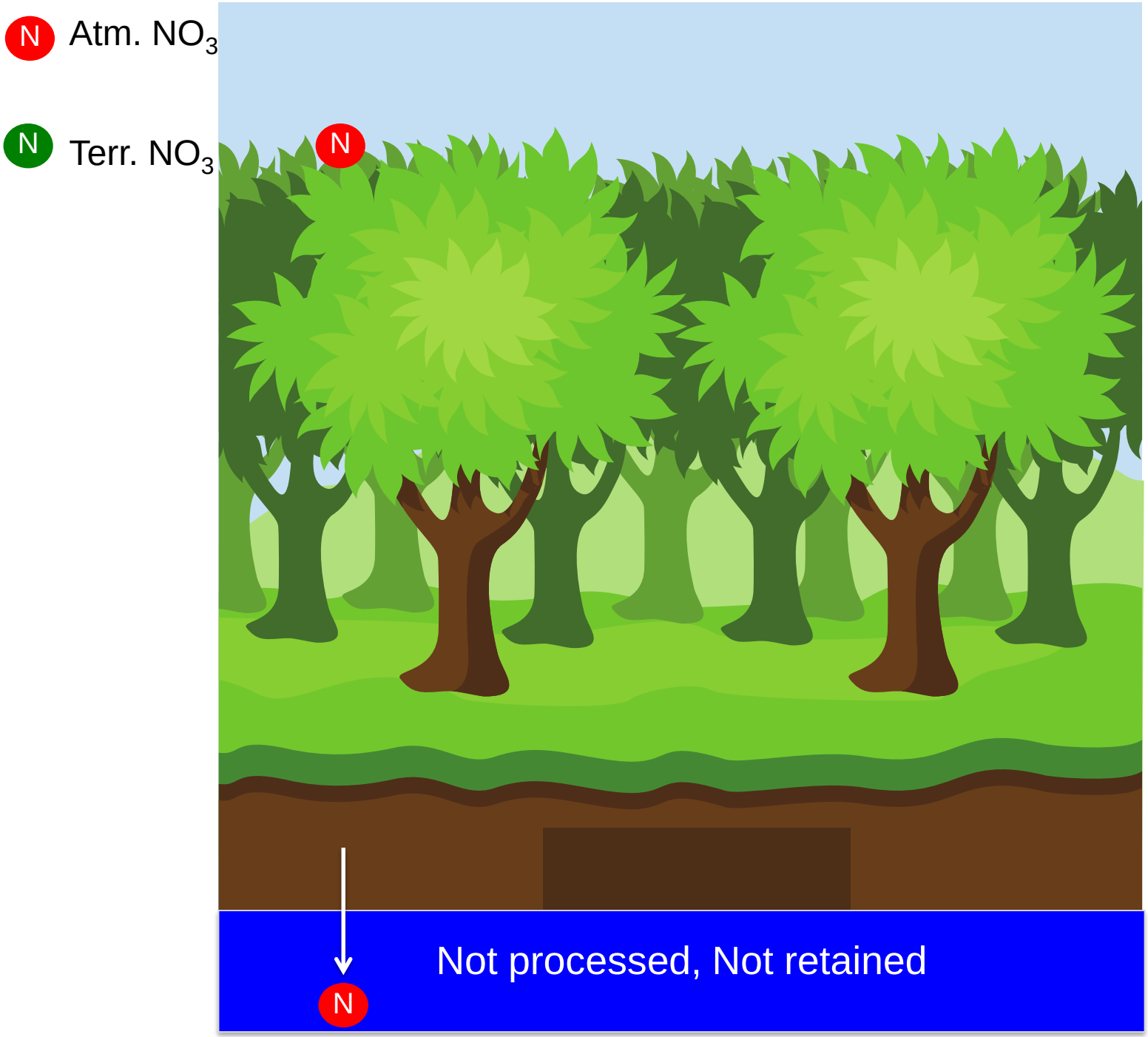
Tom Hamilton

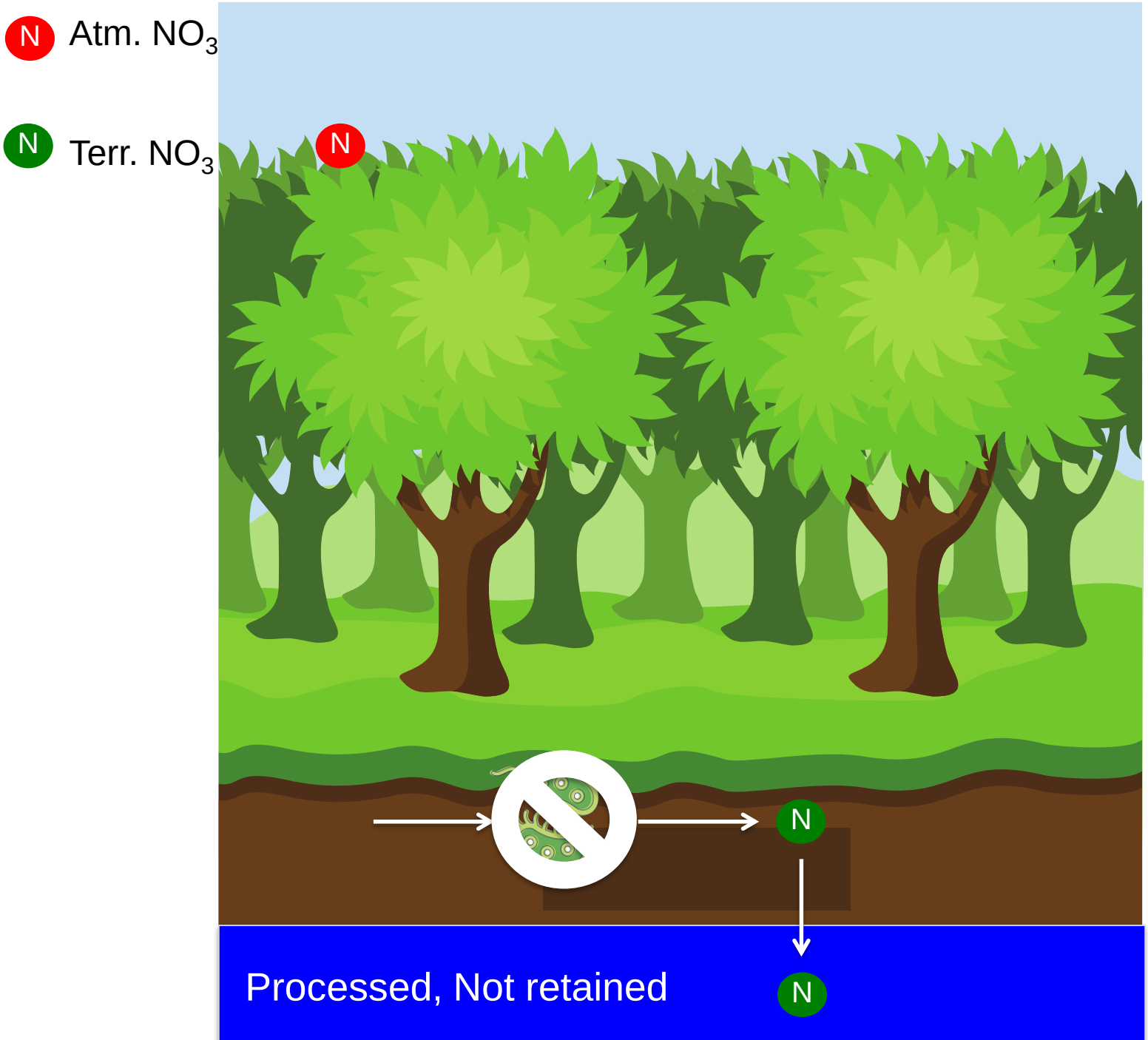
Unprocessed Atmospheric NO_3

Processing vs. Retention

$N\underline{O}_3$




N
Atm. NO3
N
Terr. NO3
N
Not processed, Not retained
N

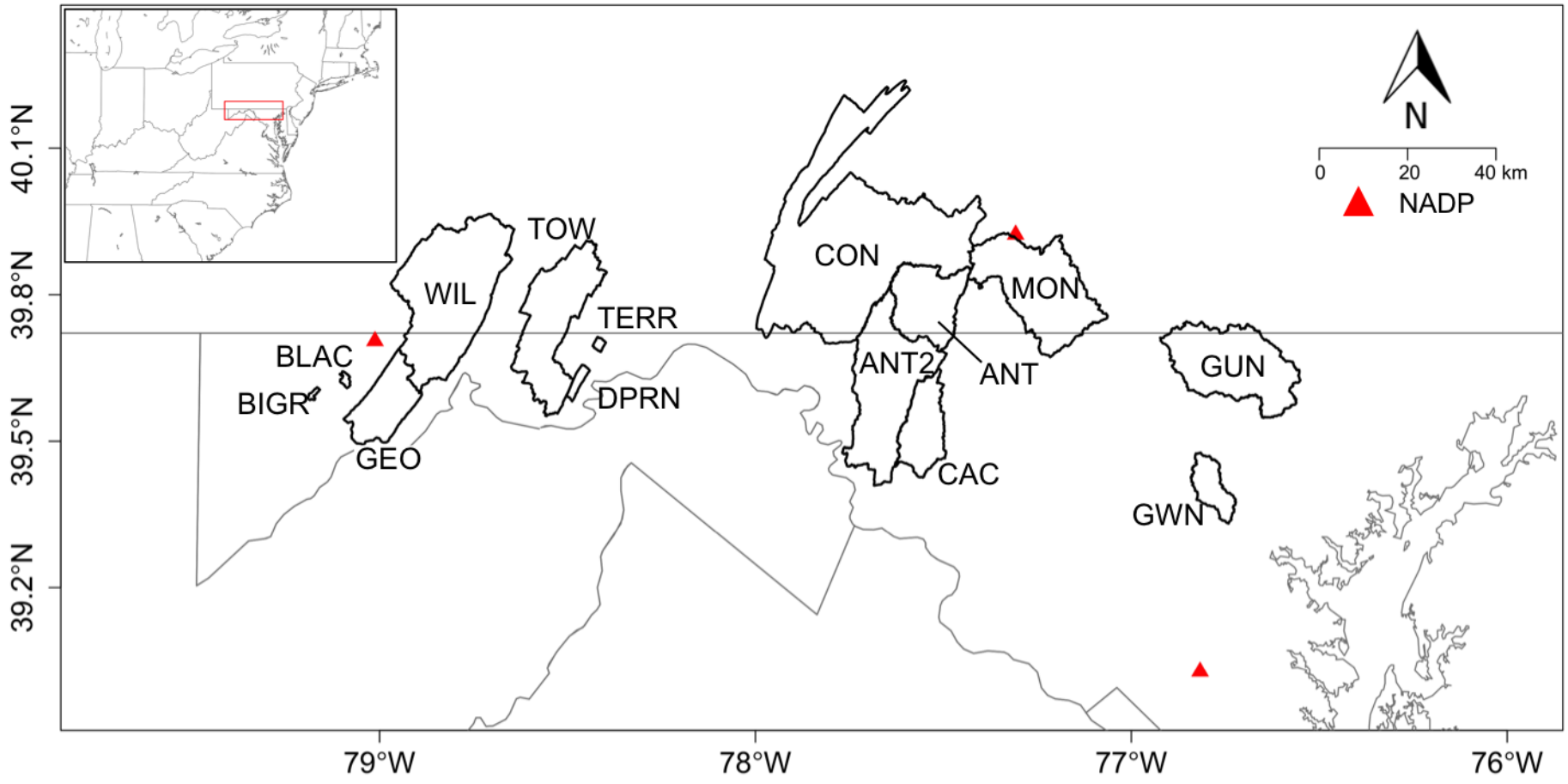

N Atm. NO_3
N Terr. NO_3
N
N
Processed, Not retained
N

Research Objectives

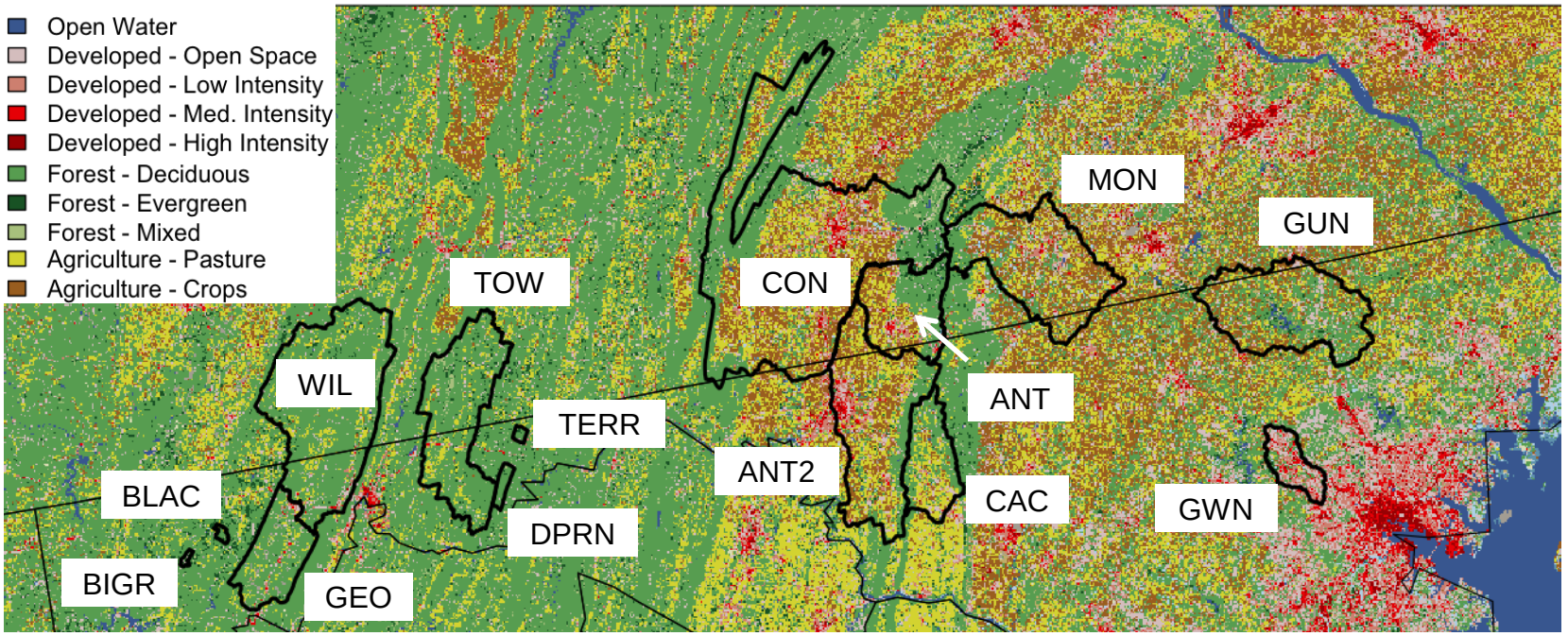
- Quantify the proportion of atmospheric NO_3 in streams

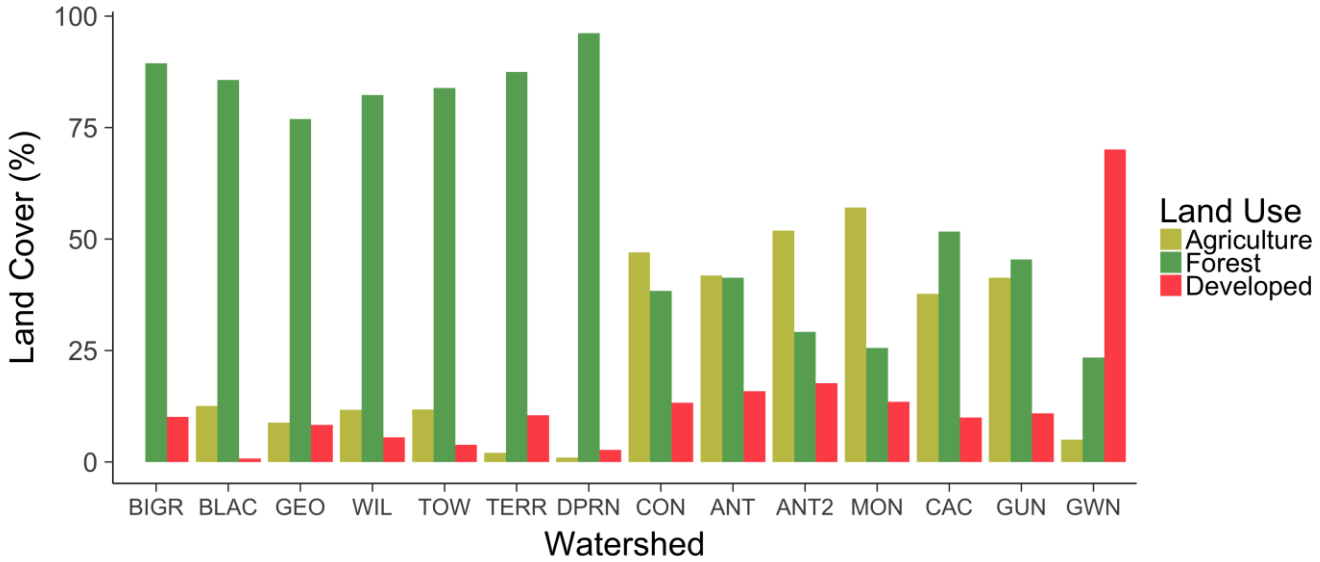
- Investigate the effect of land use on processing efficiency of atmospheric NO_3

Study Watersheds

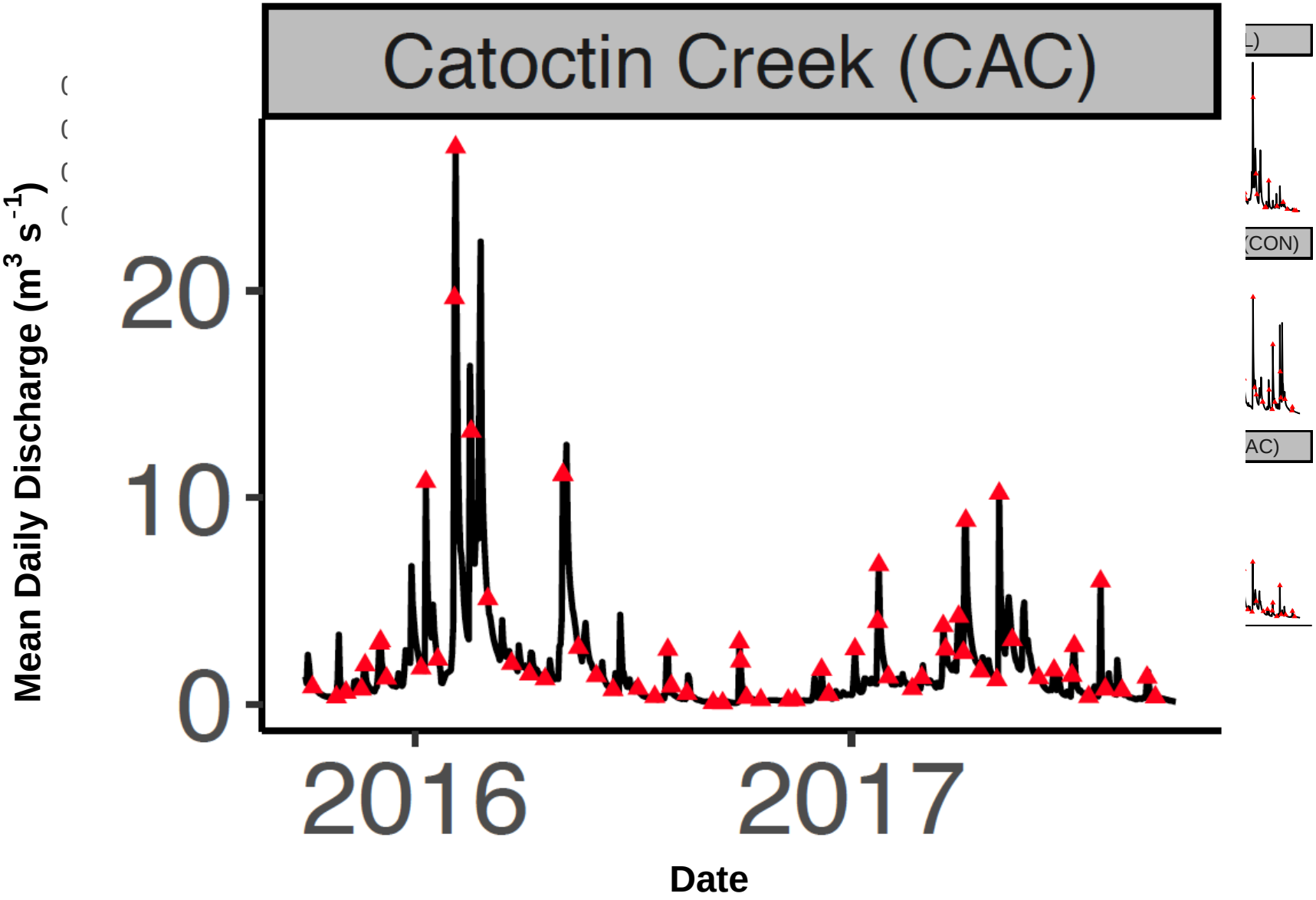


Watershed Land Use



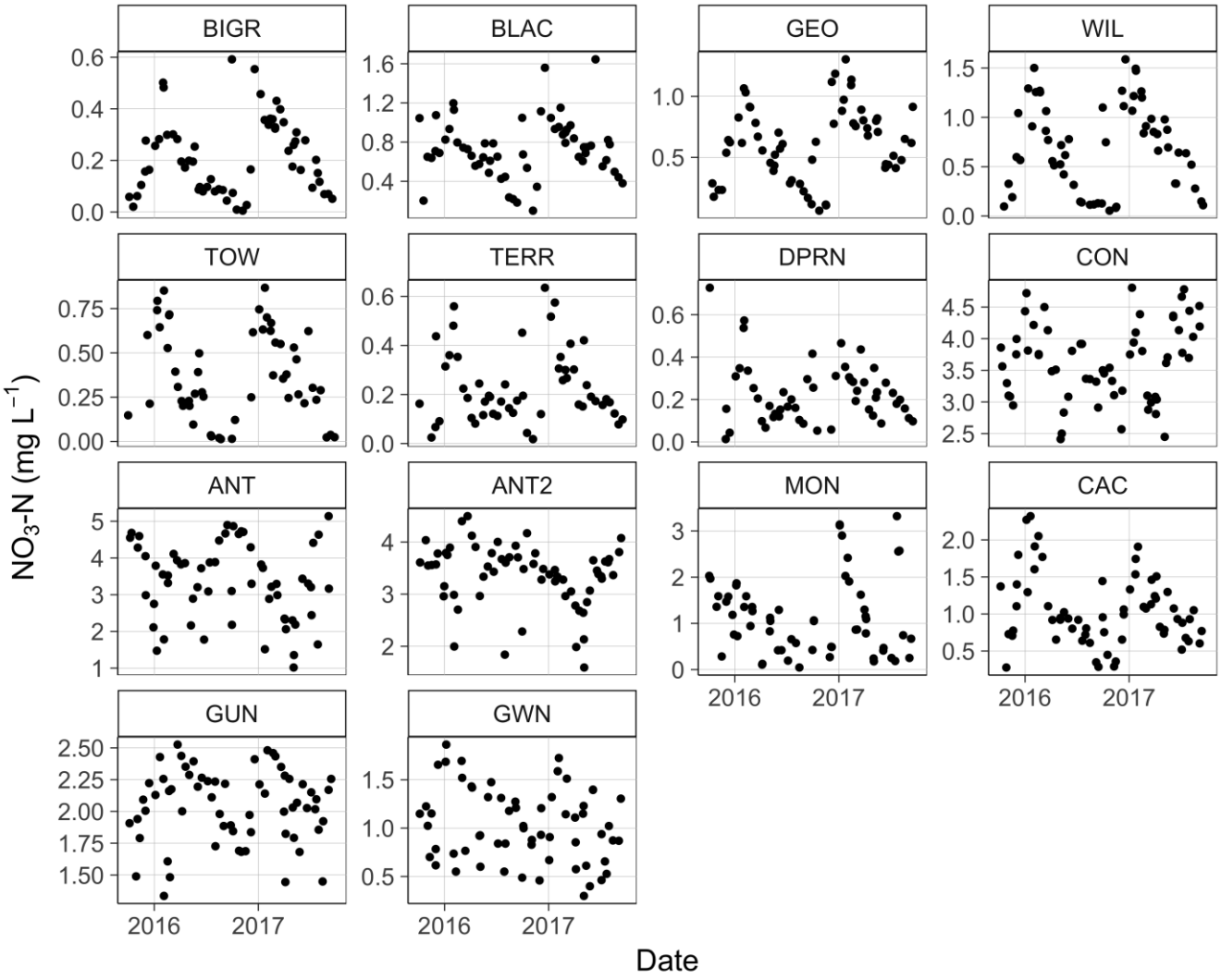


Stream Sampling

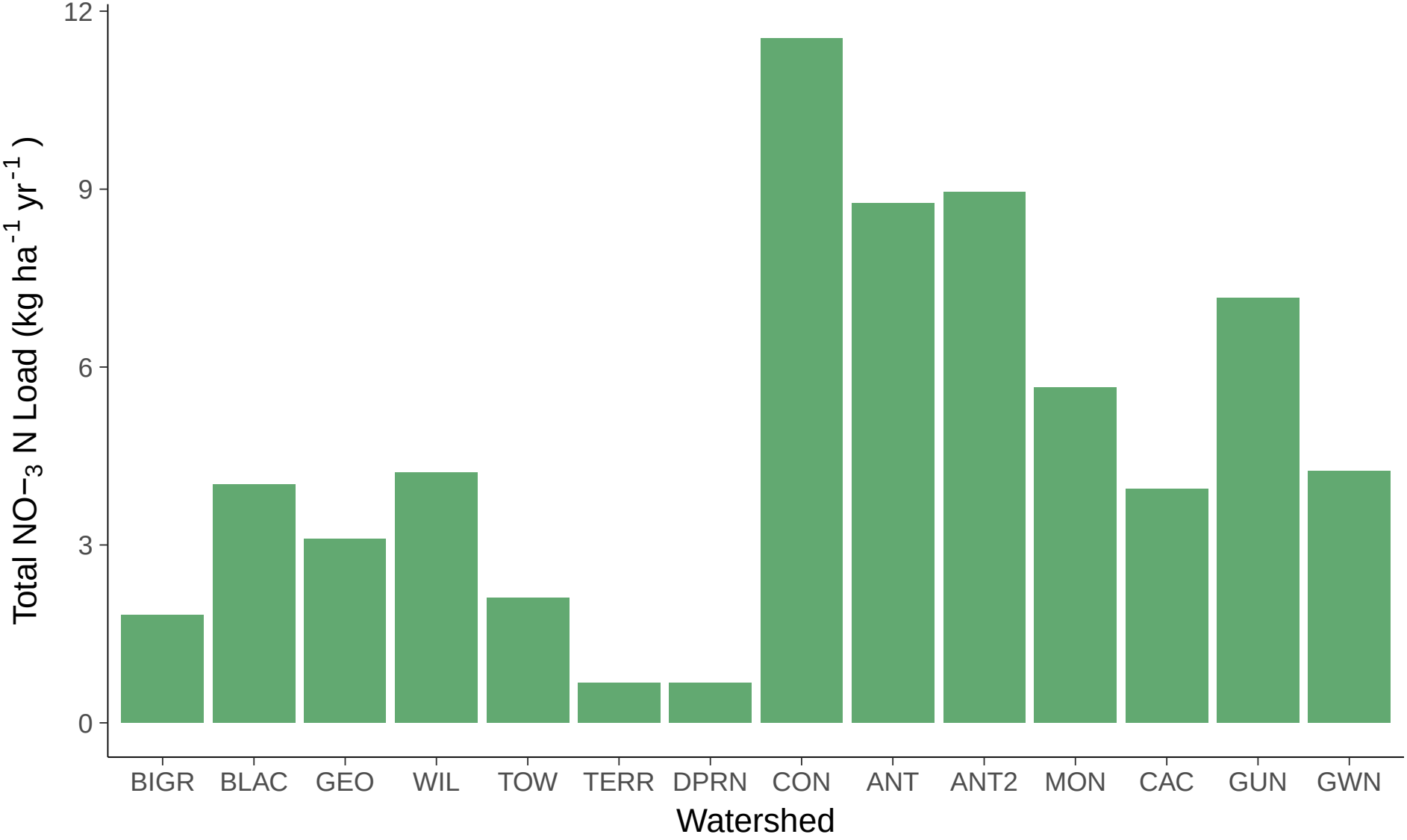


RESULTS

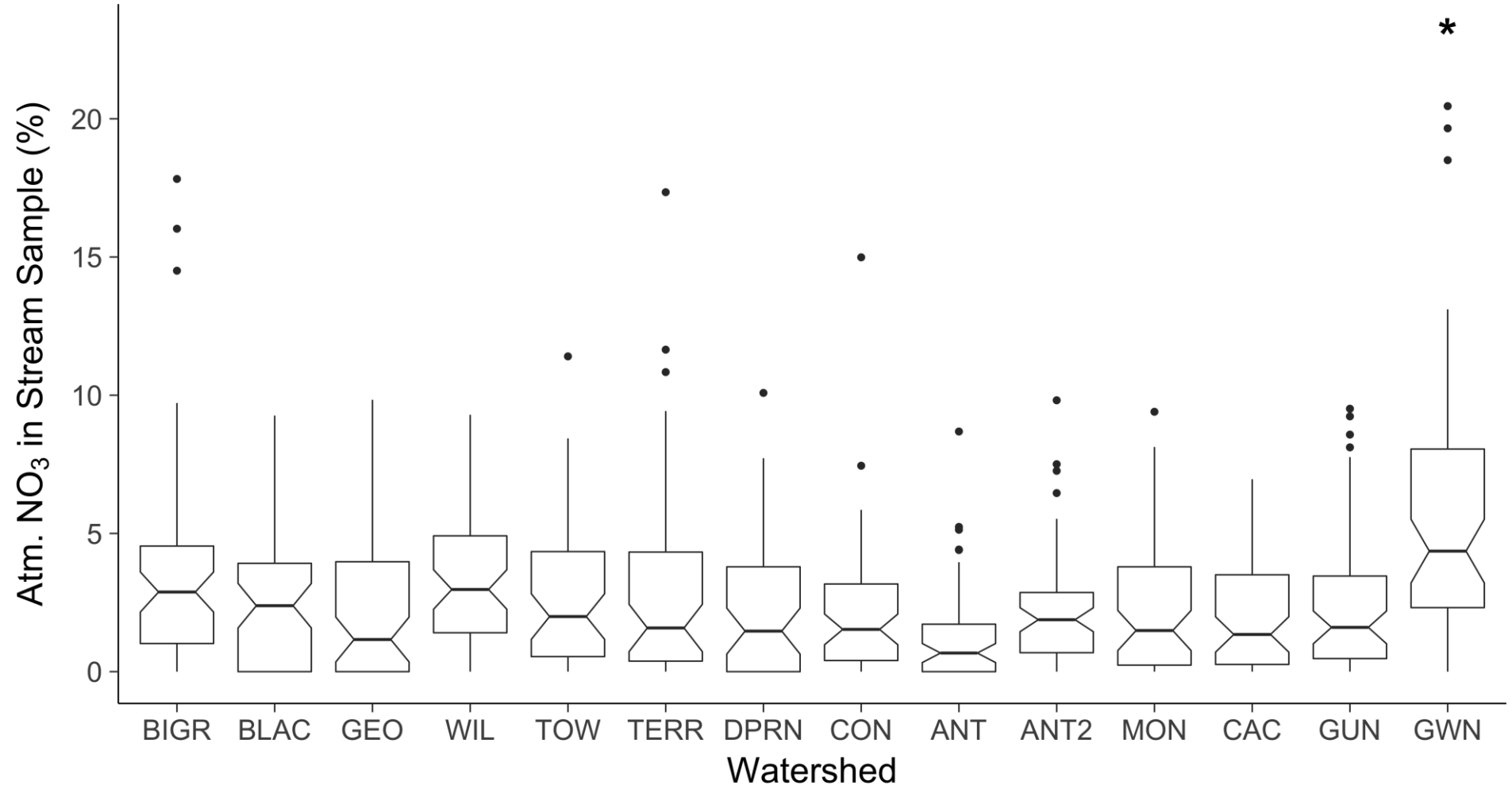
Total NO_3 Concentrations



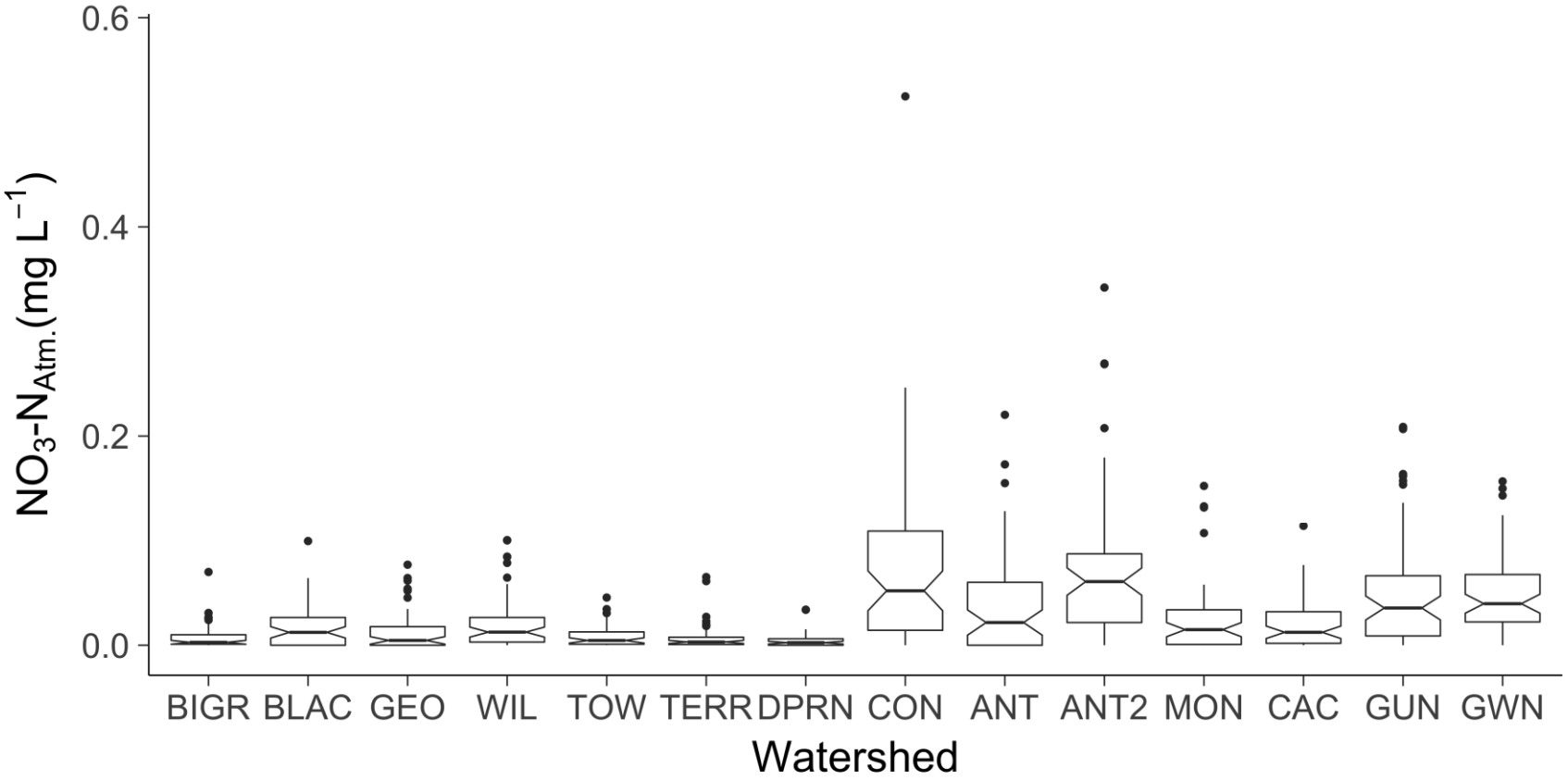
Total NO_3 Loads



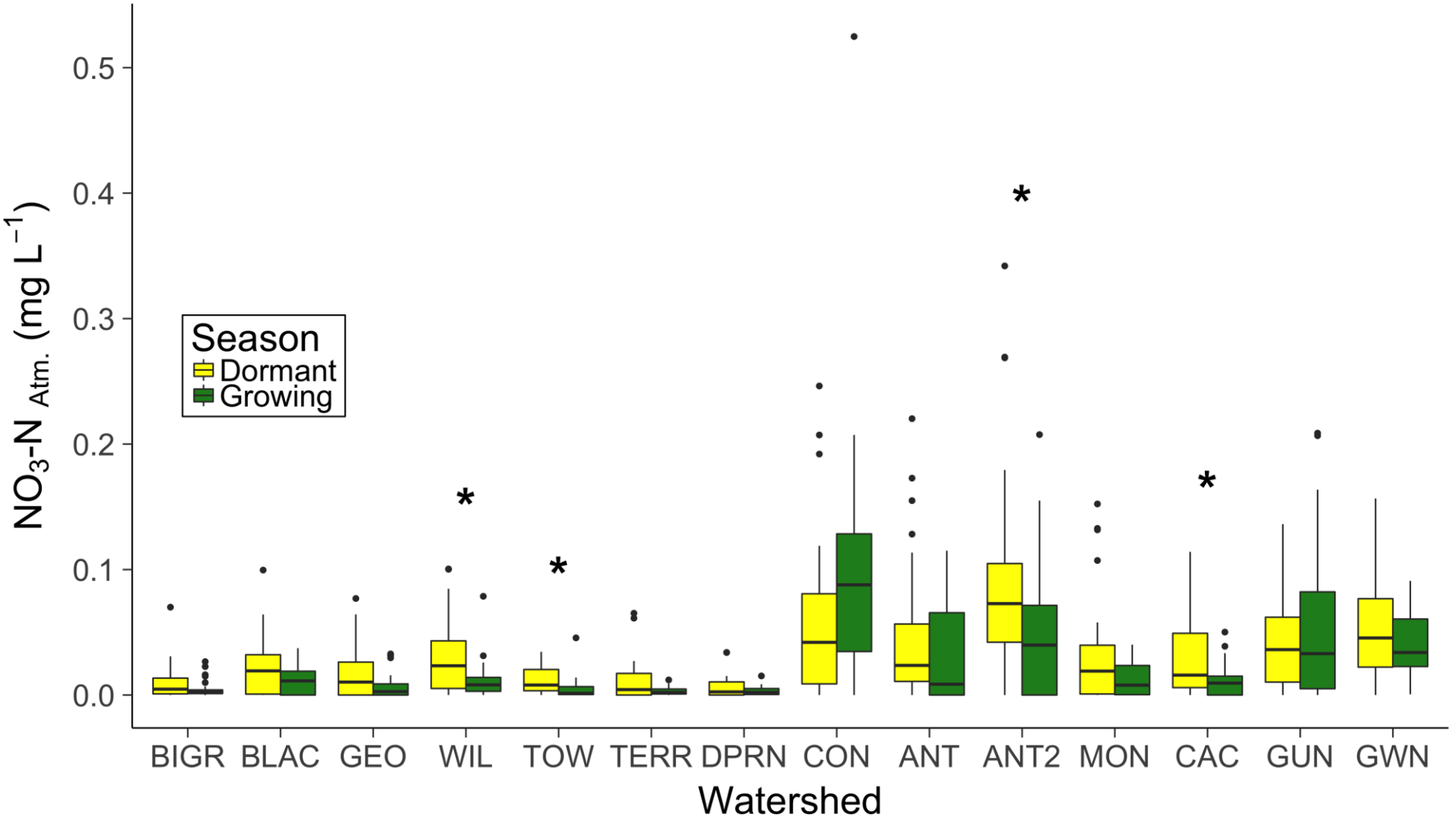
Atmospheric NO_3 in Stream Samples (%)



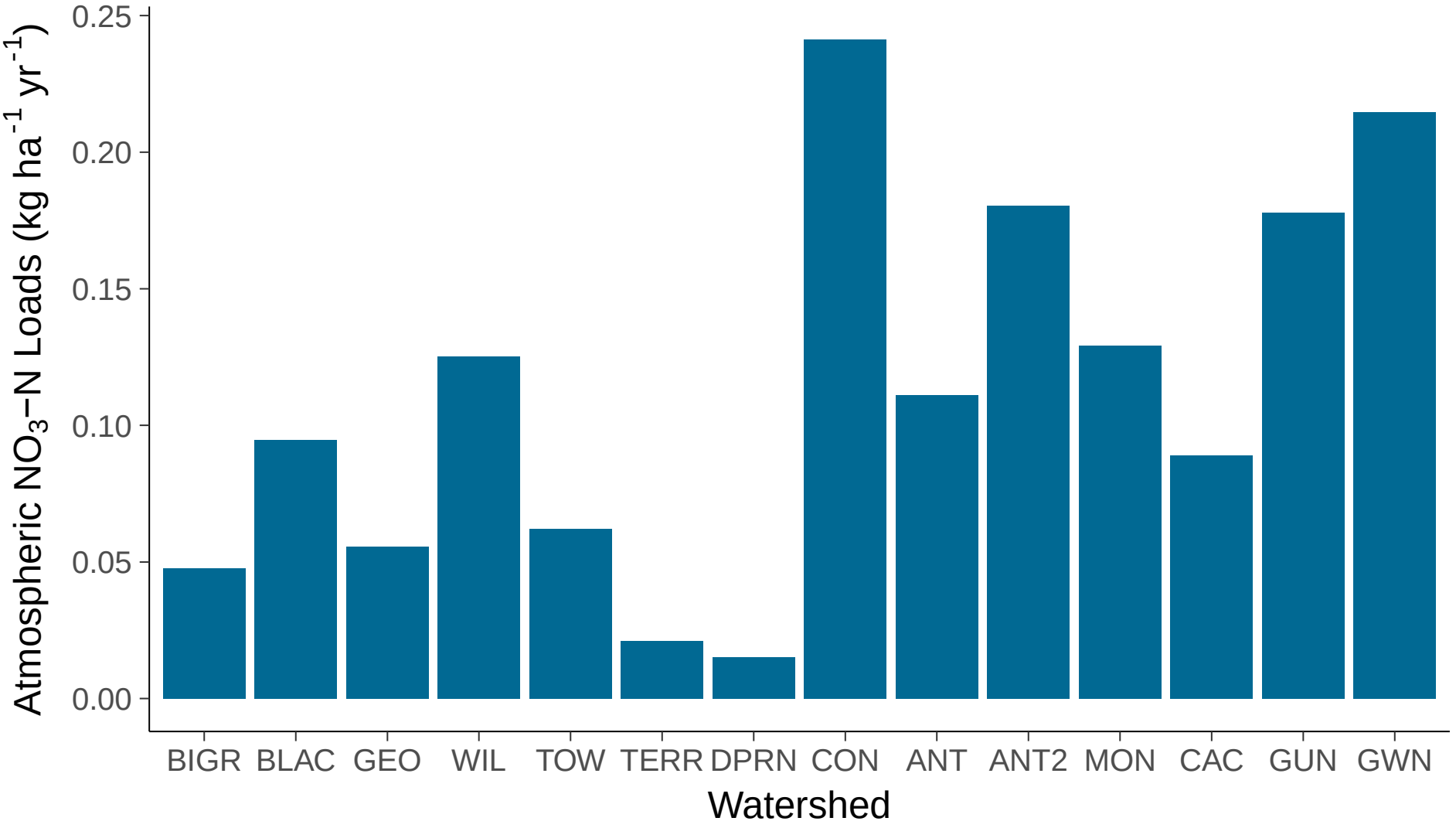
Atmospheric NO_3 Concentrations



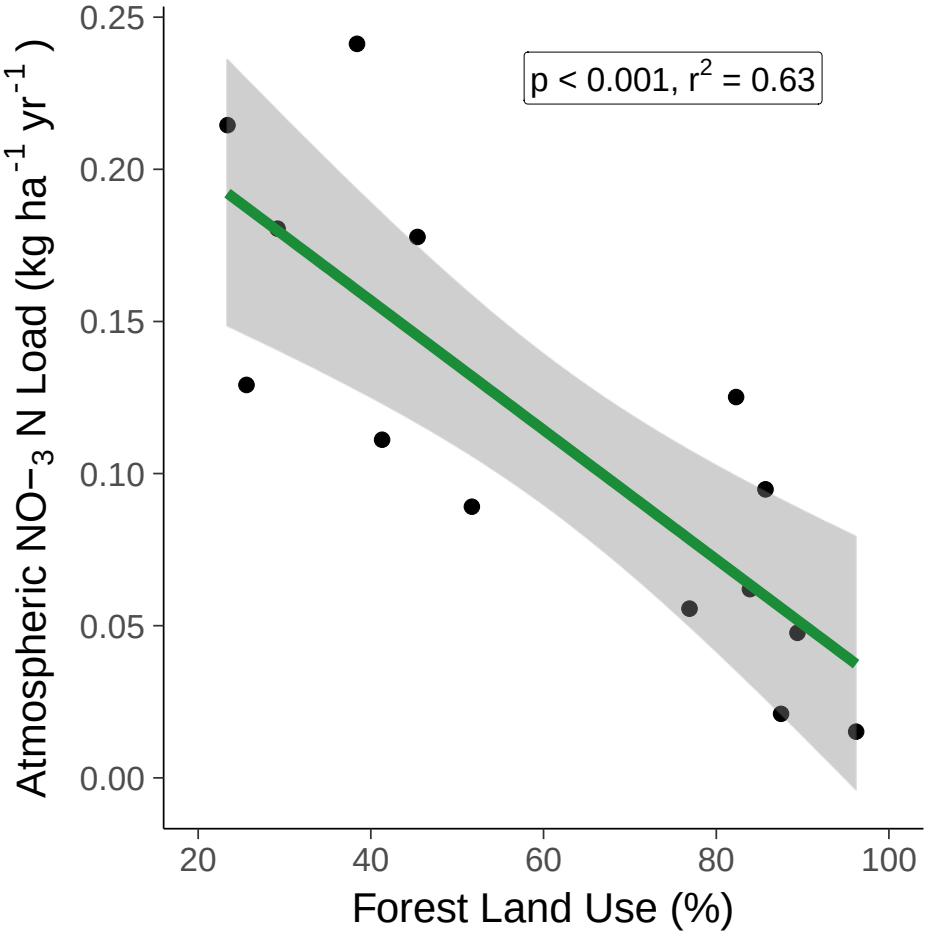
Seasonal Atm. NO_3

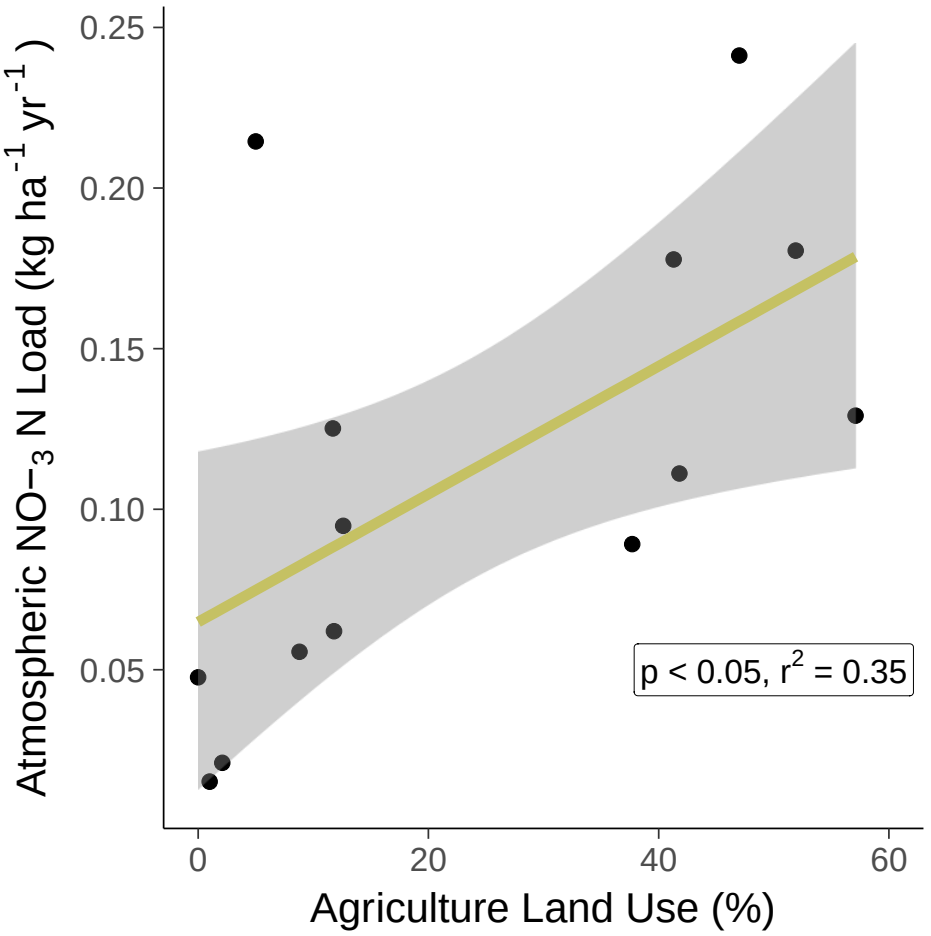


Atmospheric NO_3 Loads



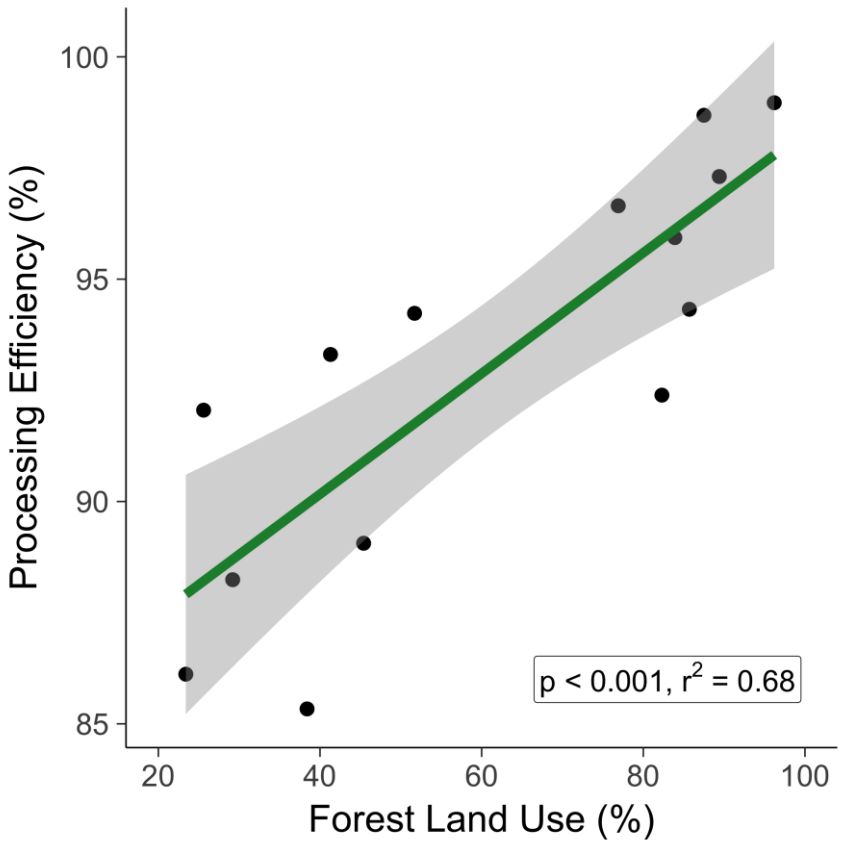
Atmospheric NO_3 Loads and Land Use

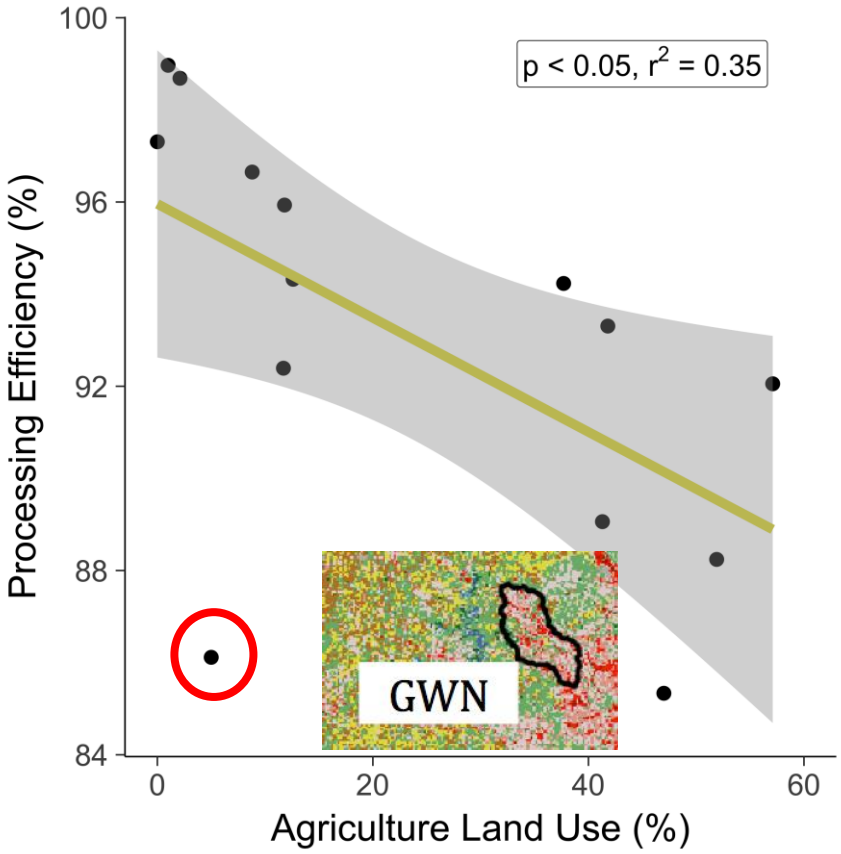




Processing Efficiency and Land-Use

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



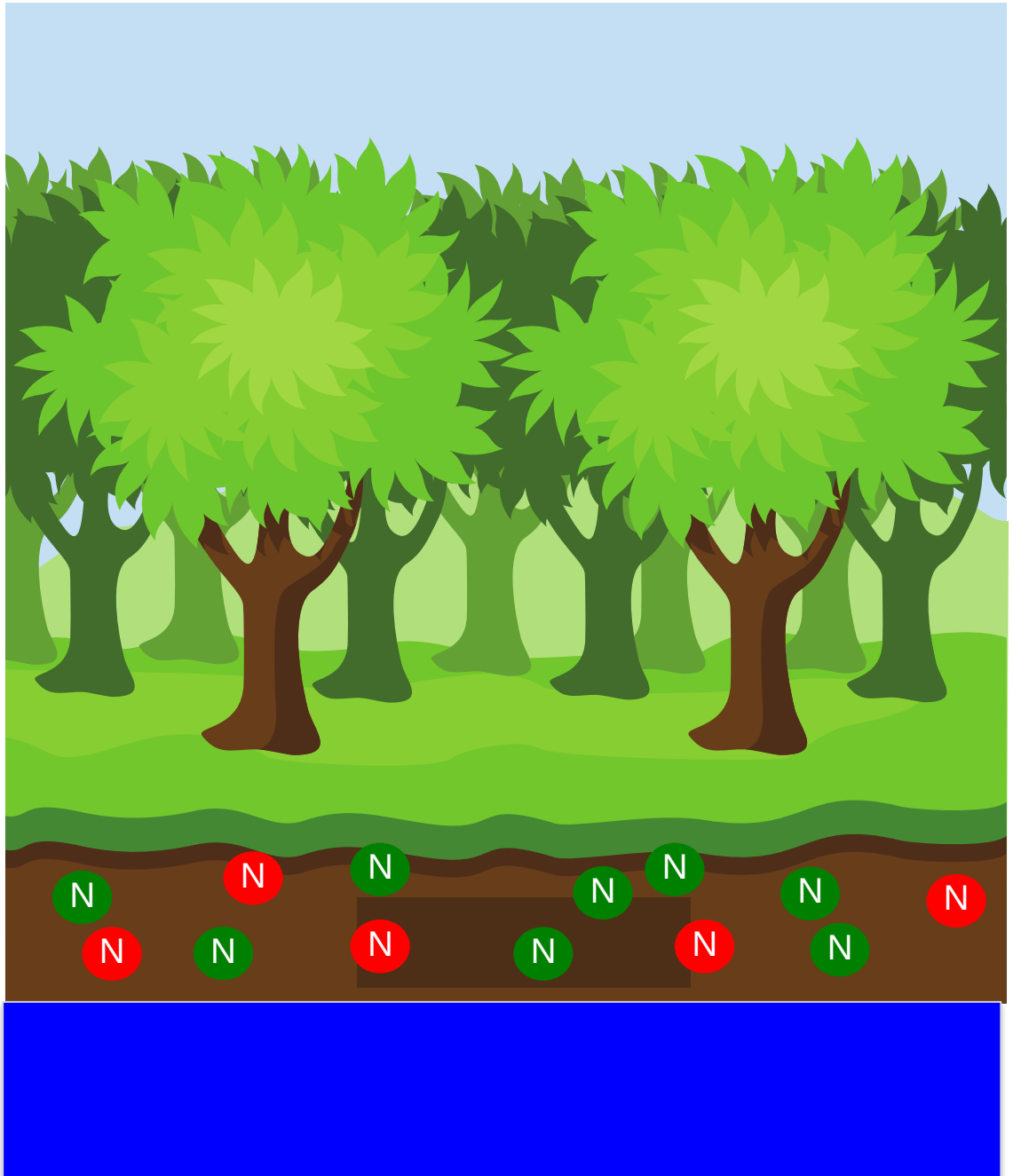


Conclusions

- 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

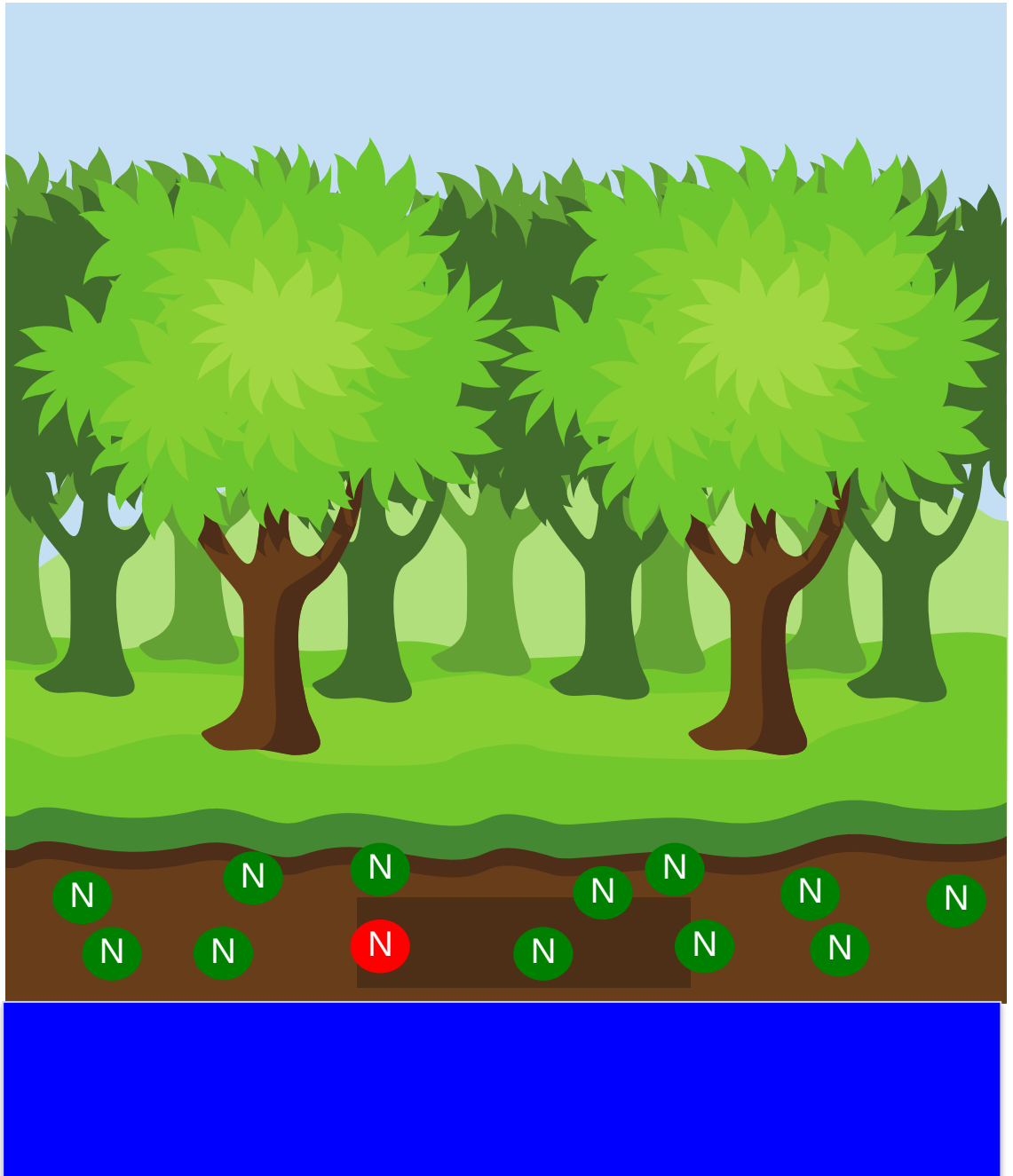
N Atm. NO_3

N Terr. NO_3



N Atm. NO_3

N Terr. NO_3

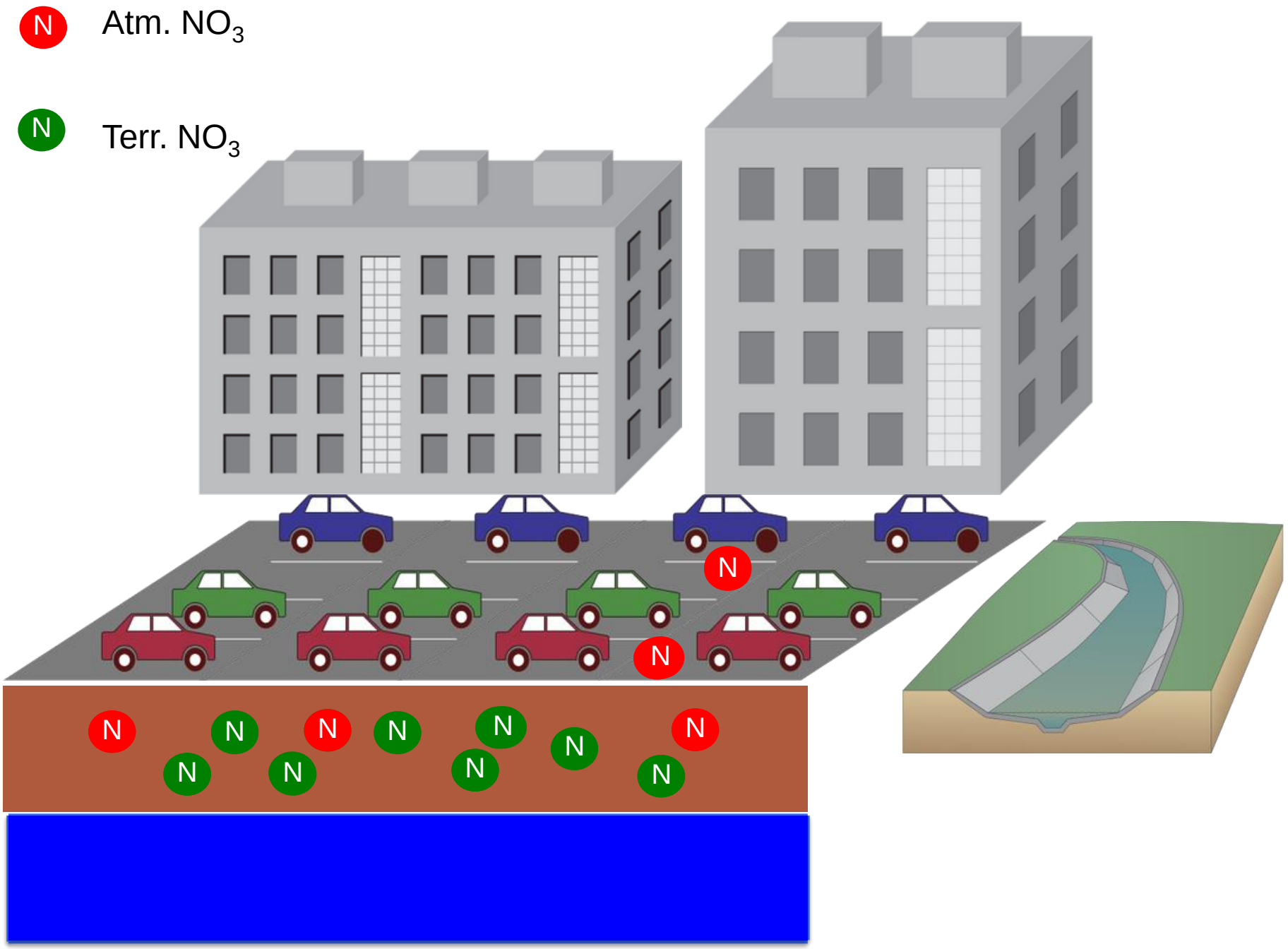


N Atm. NO_3

N Terr. NO_3

N Atm. NO_3

N Terr. NO_3


N
Atm. NO_3
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Terr. NO_3
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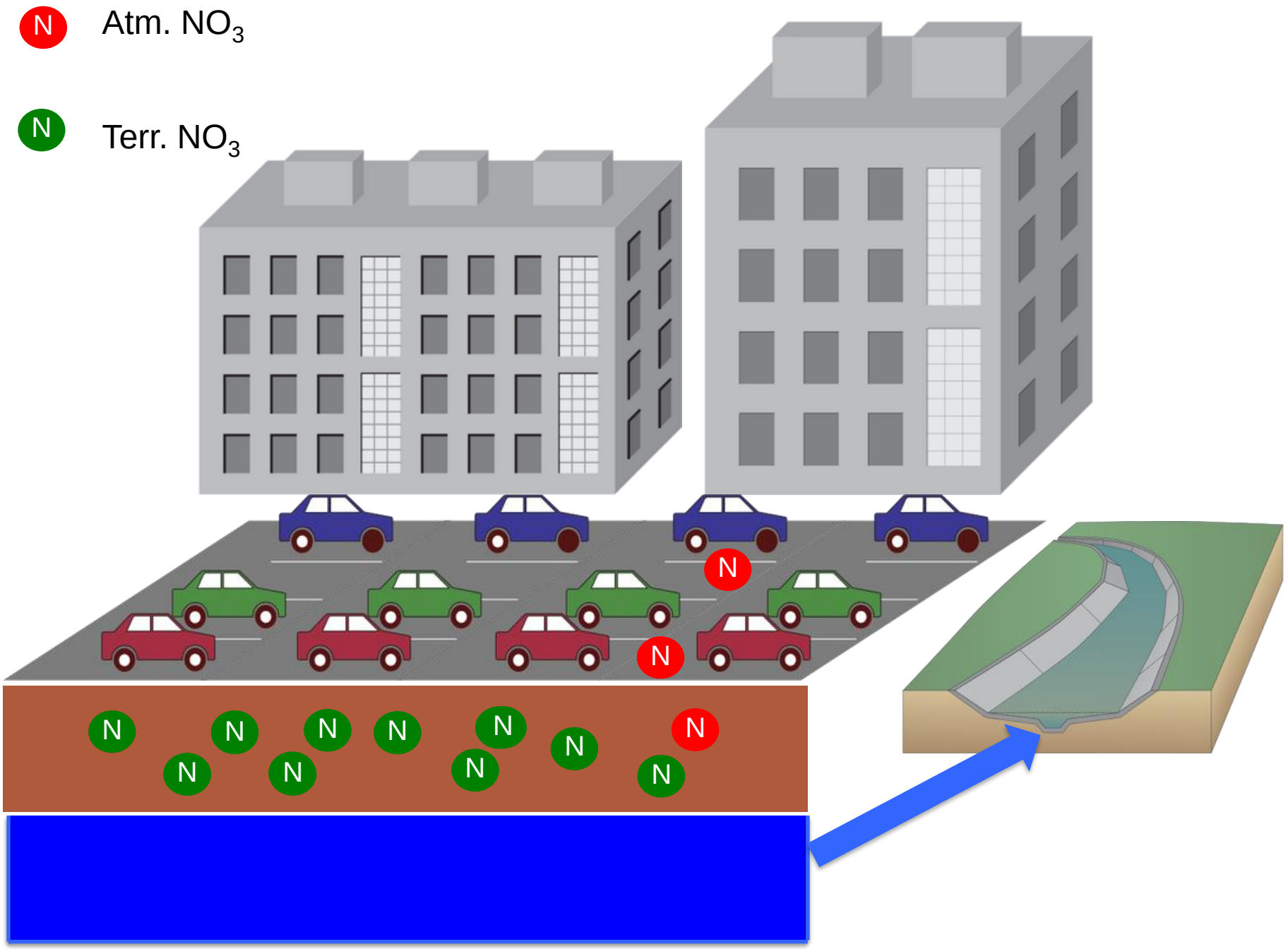
N
Atm. NO_3
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Terr. NO_3
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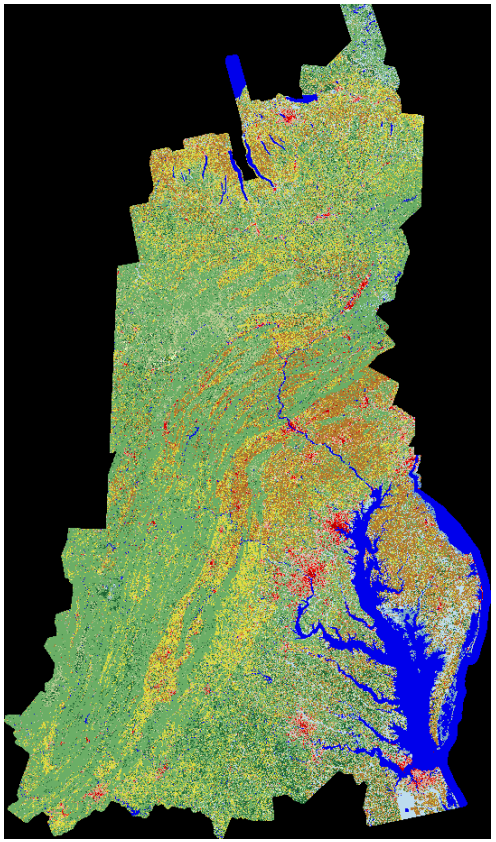
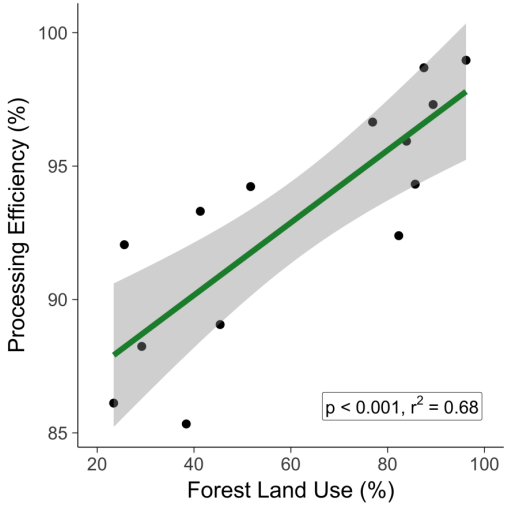
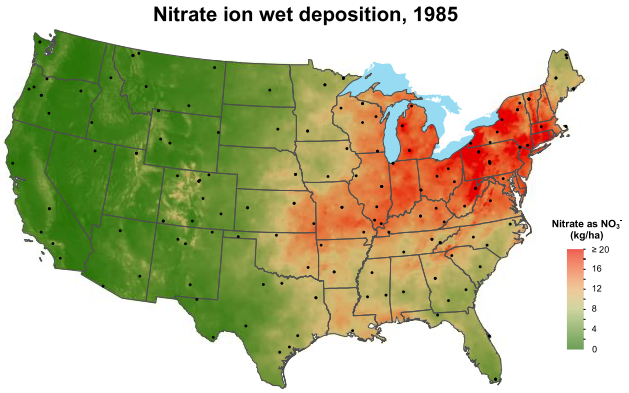
Next Steps

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

1984 CB Land Cover (USGS)







National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu

Next Steps

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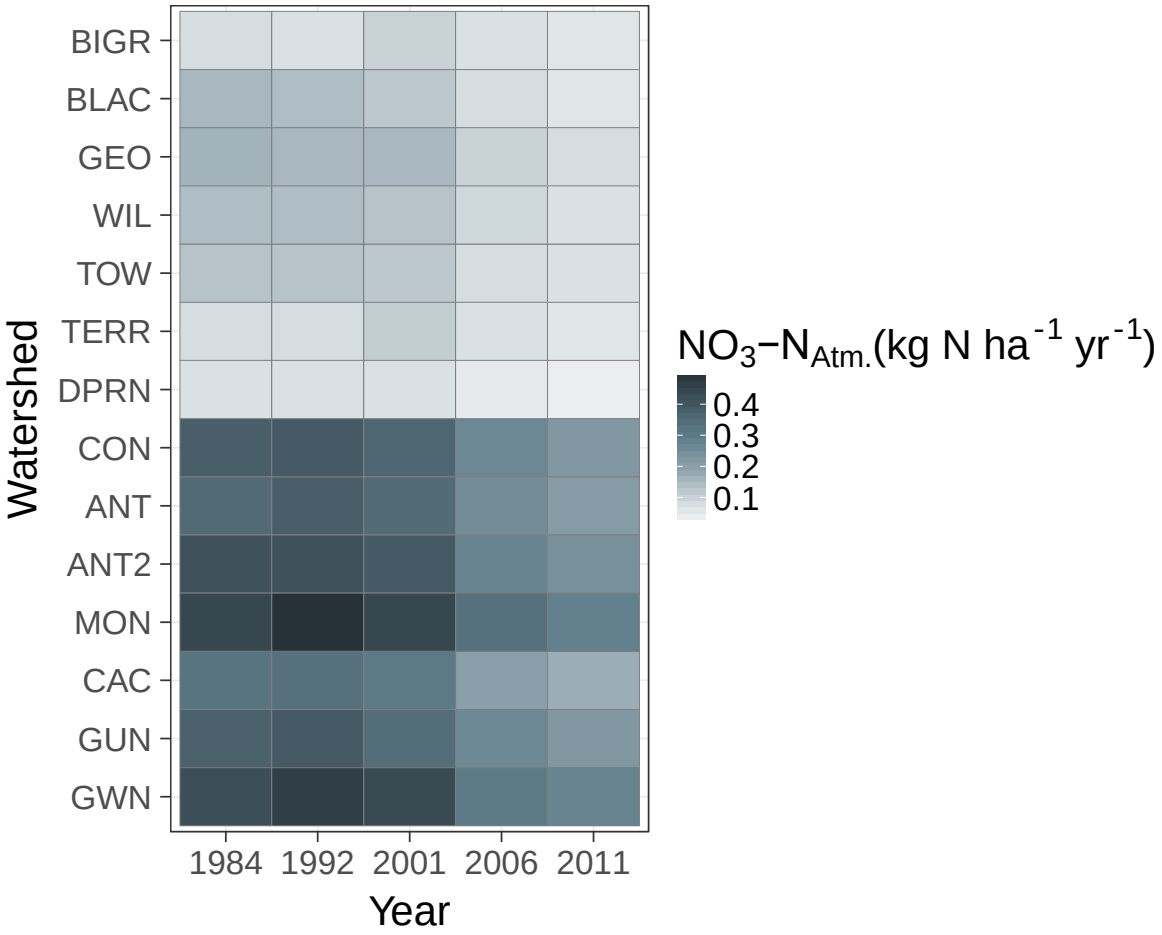
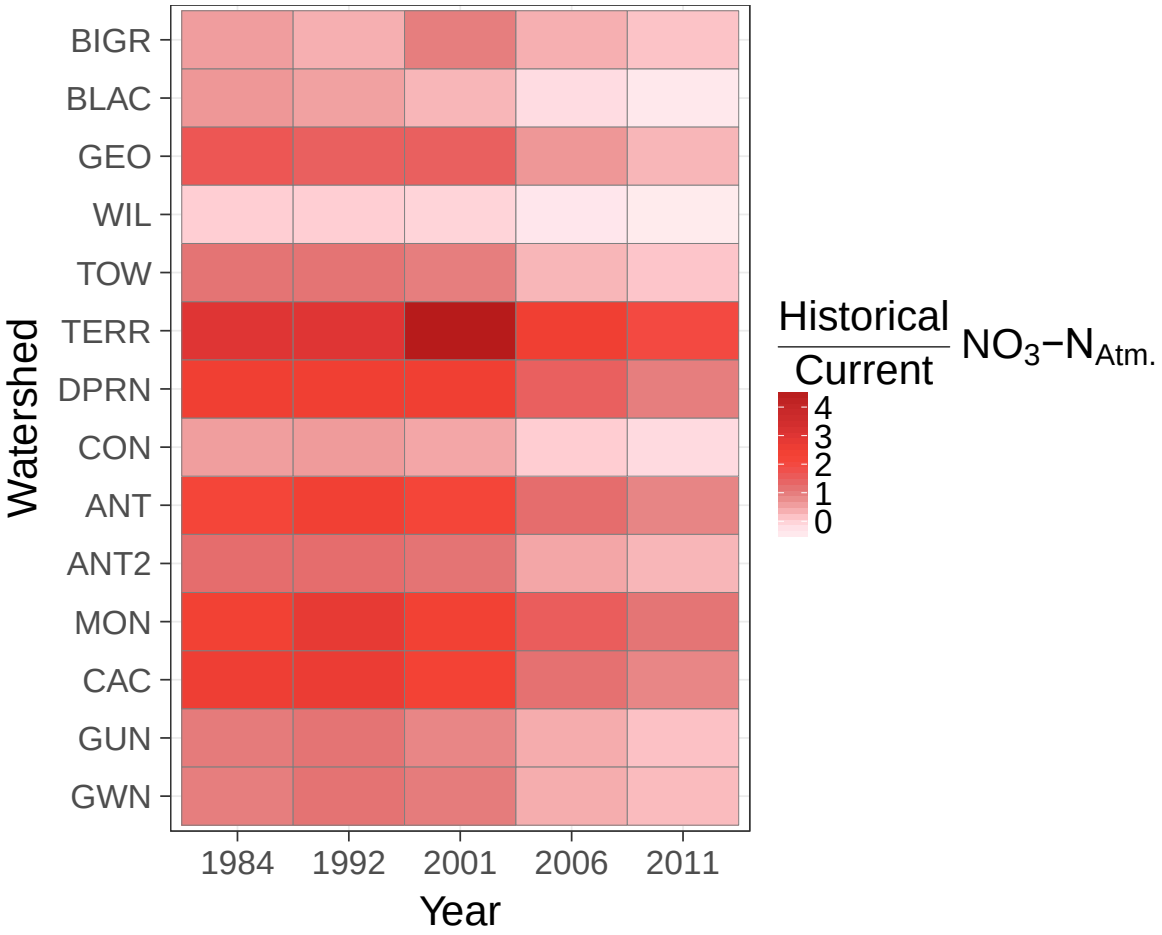
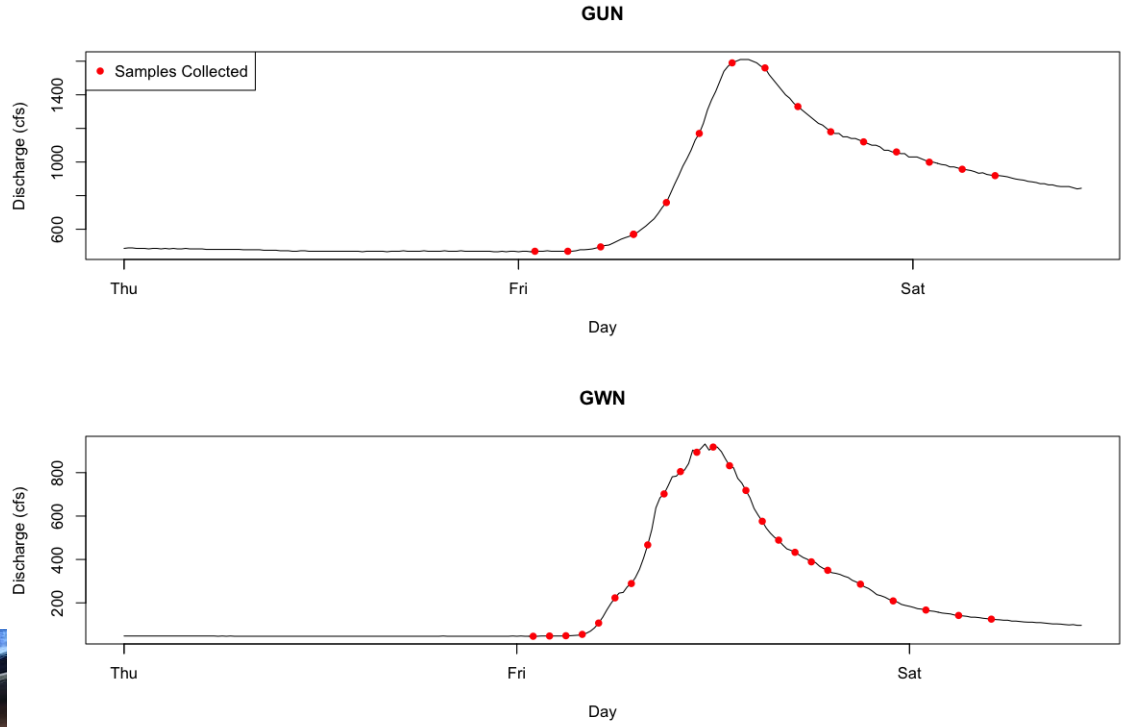


Next Steps

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



Next Steps


GUN
Samples Collected
Discharge (cfs)
600
1000
1400
Thu
Fri
Sat
Day
GWN
Discharge (cfs)
200
400
600
800
Thu
Fri
Sat
Day

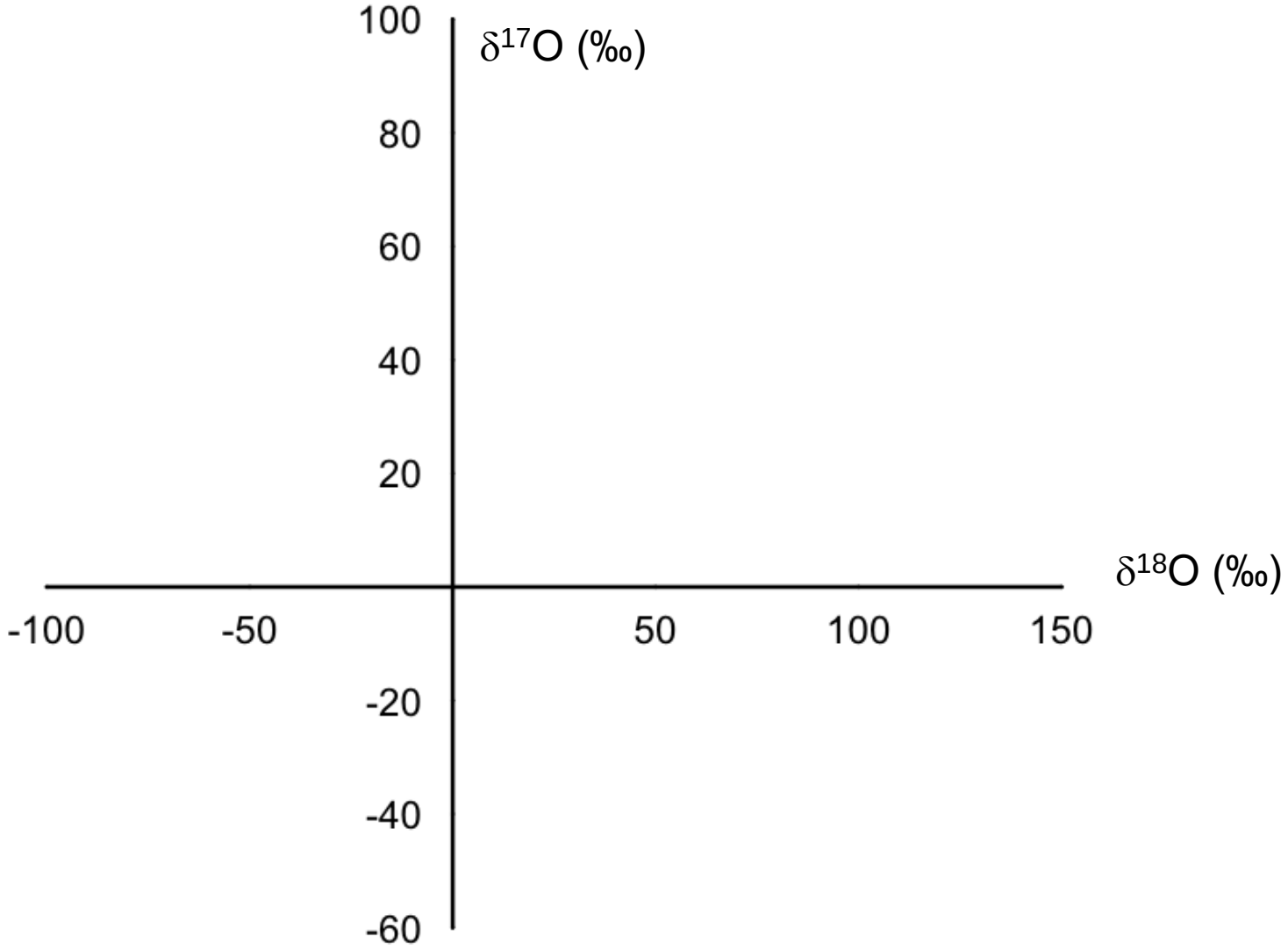
Acknowledgments

-Field Sampling: Maryland DNR

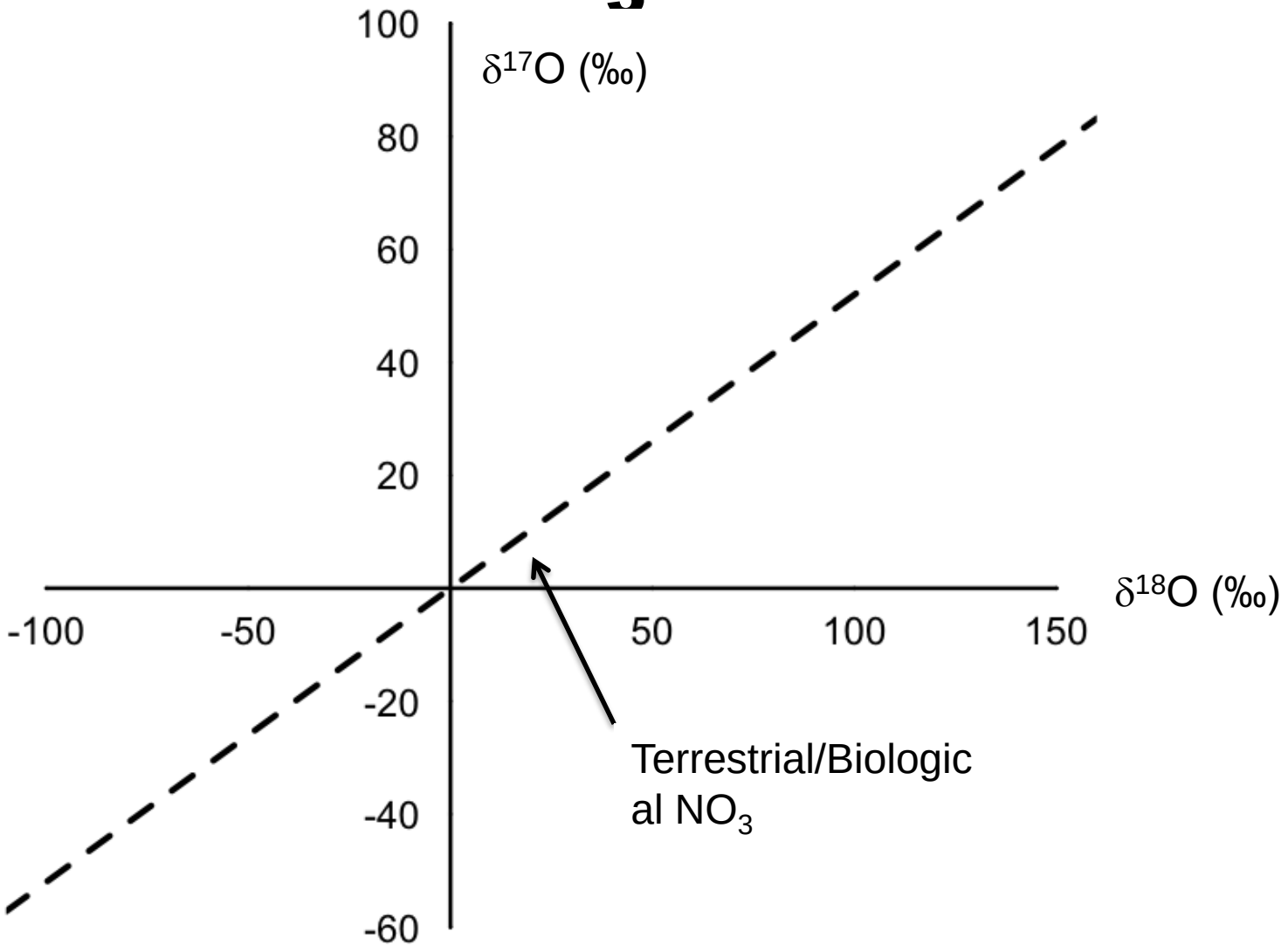
-Lab Assistance: Robin Paulman, Jim Garlitz, Katie Kline, Andrew Schauer

-Funding: Maryland Sea Grant, National Science Foundation

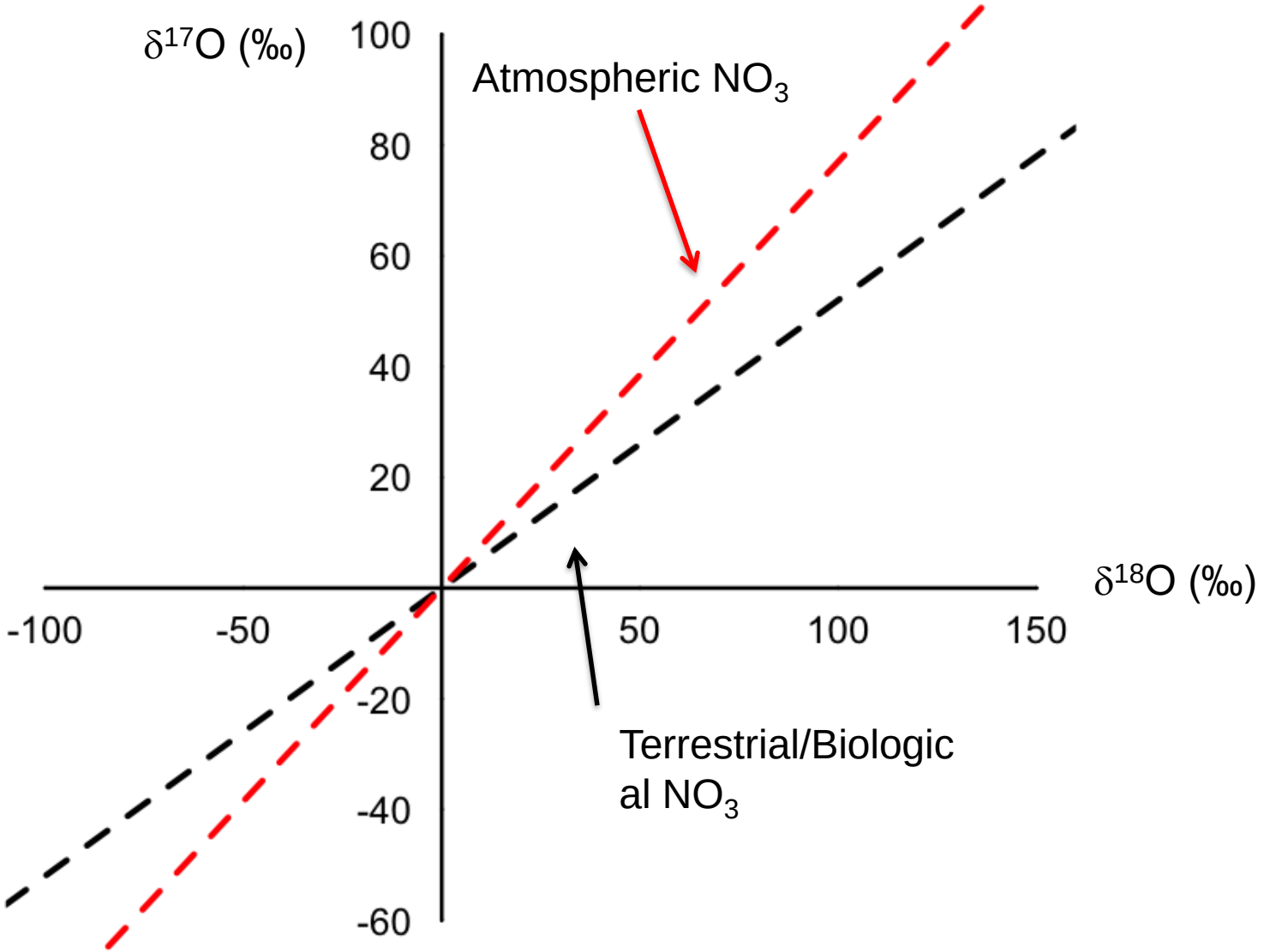
Isotopes and Atmospheric NO_3



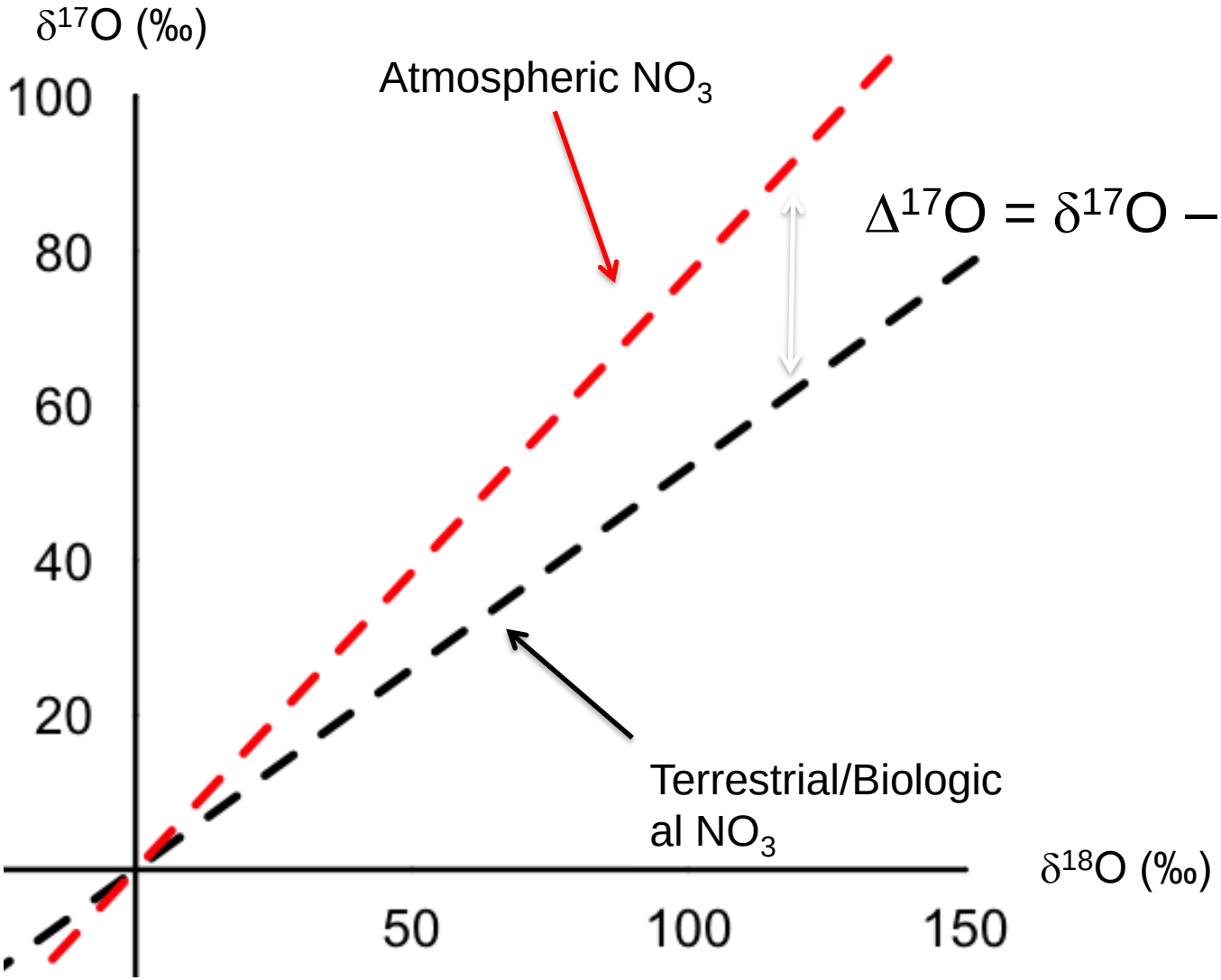
Isotopes and Atmospheric NO_3



Isotopes and Atmospheric NO_3



Isotopes and Atmospheric NO_3



$\Delta^{17}O = \delta^{17}O - 0.52 \times \delta^{18}O$

Isotopes and Atmospheric NO_3

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

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

Fraction of total NO_3 that is atmospheric NO_3

$$\text{Fraction Atm. } NO_3 = \frac{D^{17}O - NO_{3\text{-}Sample}}{D^{17}O - NO_{3\text{-}Deposition}}$$

- Concentration of atmospheric NO_3 in stream sample:

$$NO_{3\text{-}Atm.} = \frac{D^{17}O - NO_{3\text{-}Sample}}{D^{17}O - NO_{3\text{-}Deposition}} \times NO_3$$