

MONITORING EMERGING WATER QUALITY ISSUES: ACROSS TIME AND SPACE

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Regional Monitoring Across Time and Space

- Tracking Contaminant Sources and Hot Spots
- Evaluating Watershed Management and BMPs
- Diagnosing Freshwater Salinization Syndrome

Regional Monitoring Across Time and Space

- **Tracking Contaminant Sources and Hot Spots**
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How Can We Track Contaminant Sources?

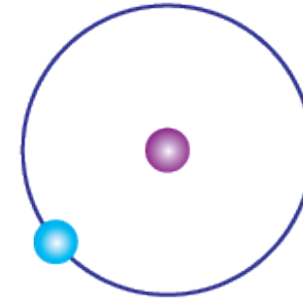


Tracking Contaminant Sources Is Like Detective Work

Fingerprint



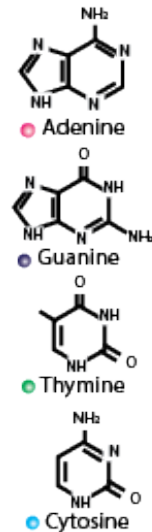
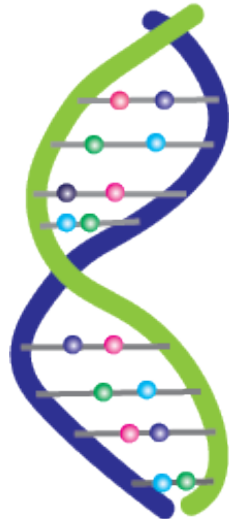
Isotopes



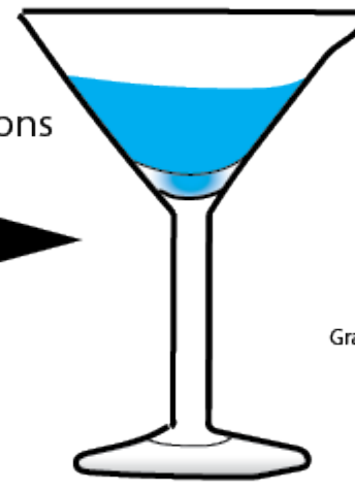
Unique Signatures



DNA



Chemical Cocktails



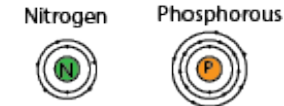
Unique Combinations of Elements



Trace Metals



Nutrients



Organic Matter



Major Ions



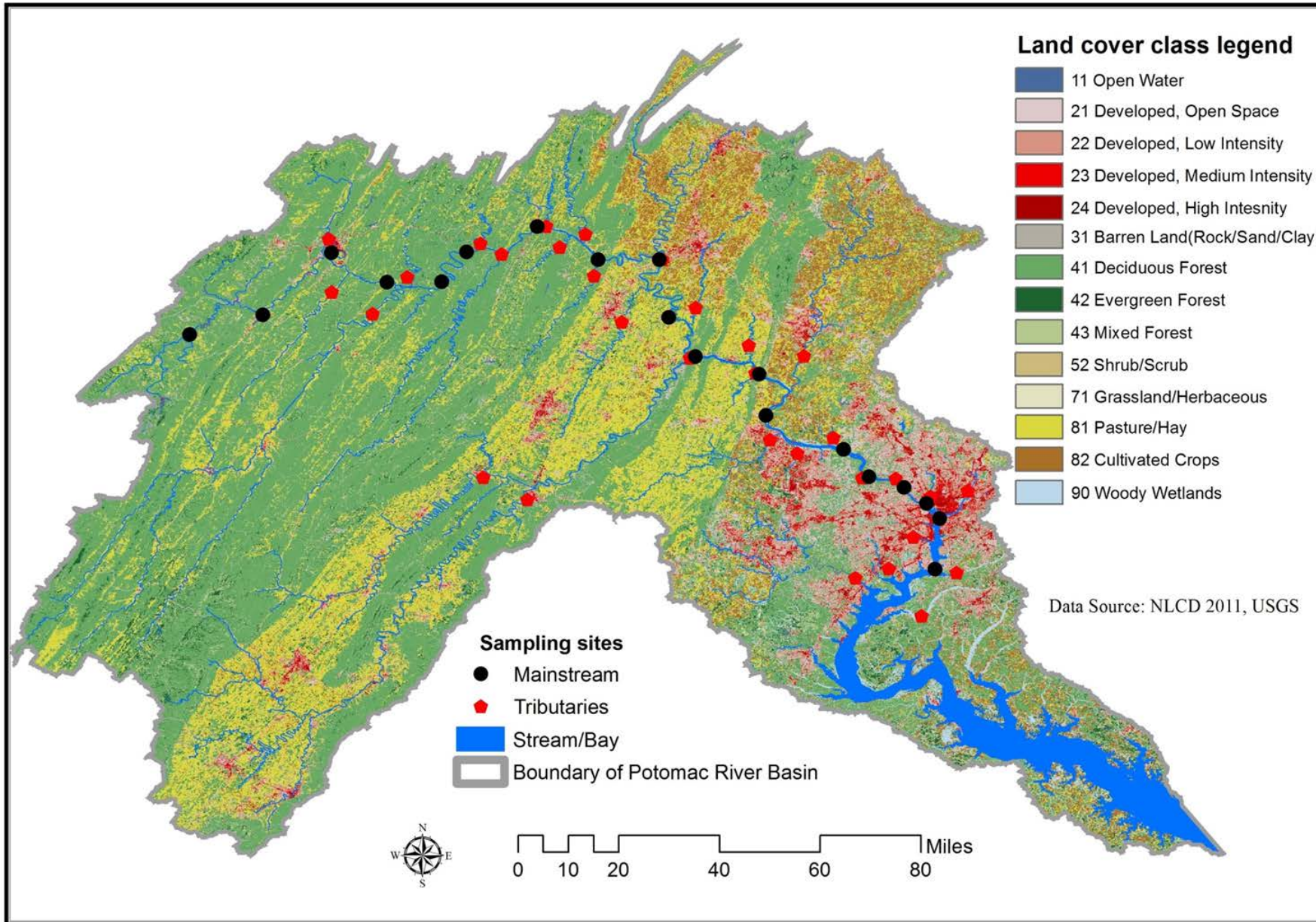
Courtesy: Jenna Reimer

Kaushal...Reimer et al. (Accepted)
Applied Geochemistry

Potomac River Represents Diverse Land Use and Contaminant Sources

19 main stem sites
31 sub-watershed sites

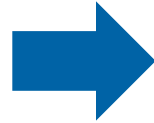
Sub-Watersheds:
F1-F11: Forested
A1-A11: Agricultural
U1-U8: Urban/Suburban
W1-W2: Wetland



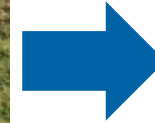
Tracking Contaminant Hot Spots Across Land Use



Upper Potomac: **Forest**

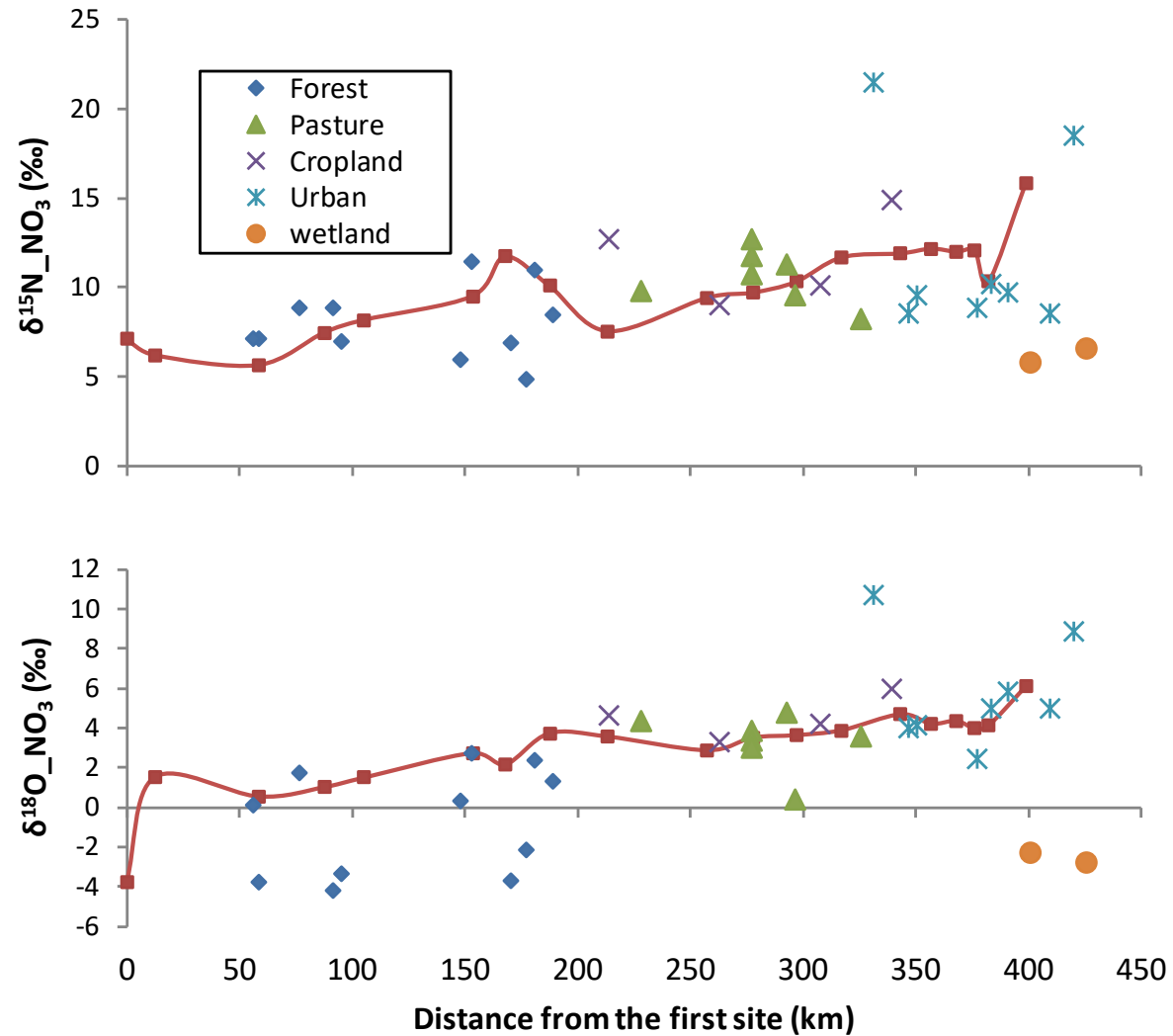


Middle Potomac: **Agriculture**

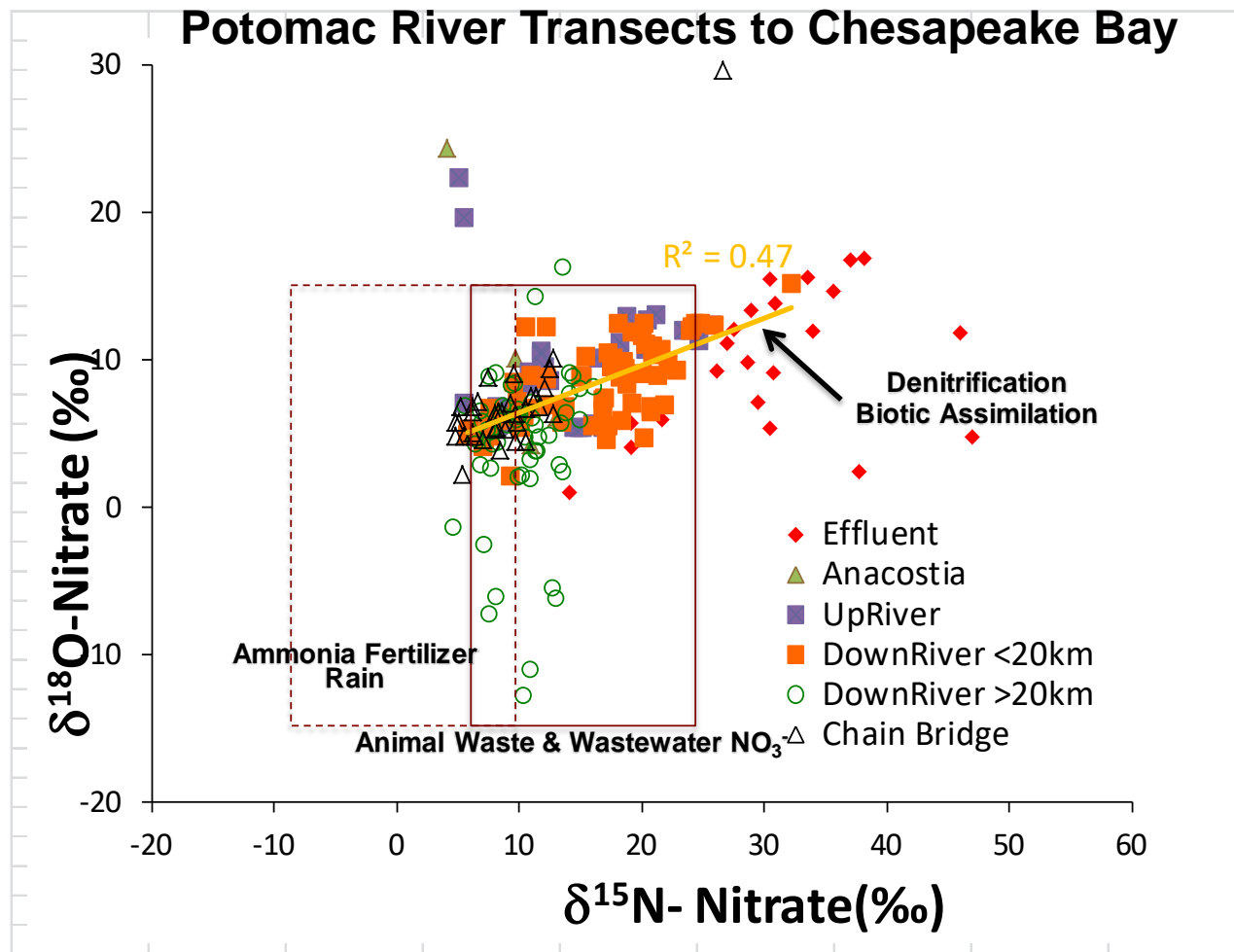


Lower Potomac: **Urban**

N Sources Shift to Manure and Wastewater Downstream



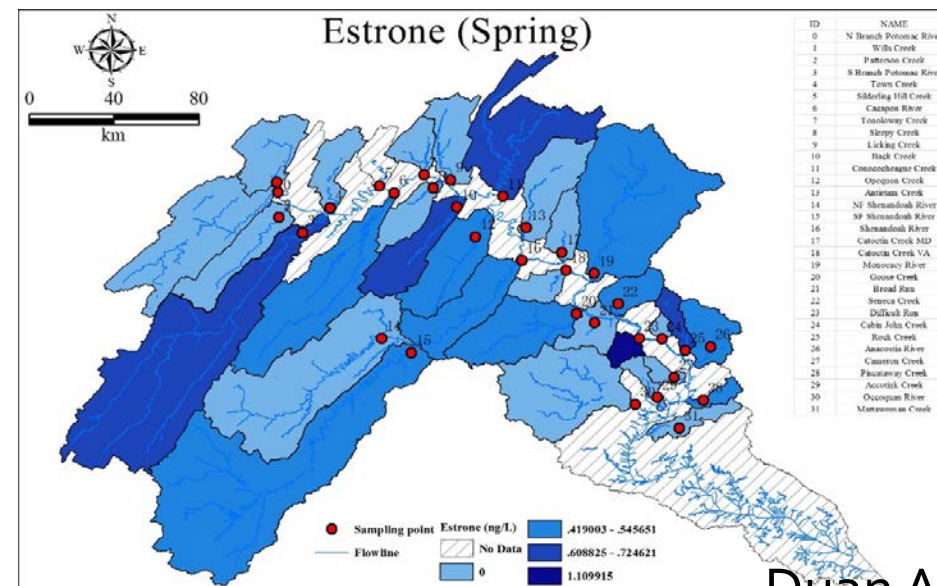
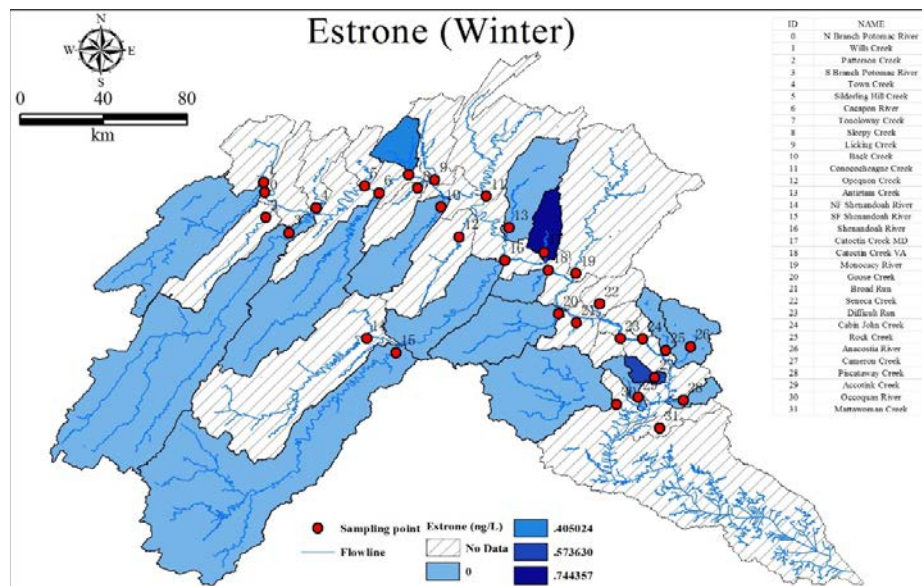
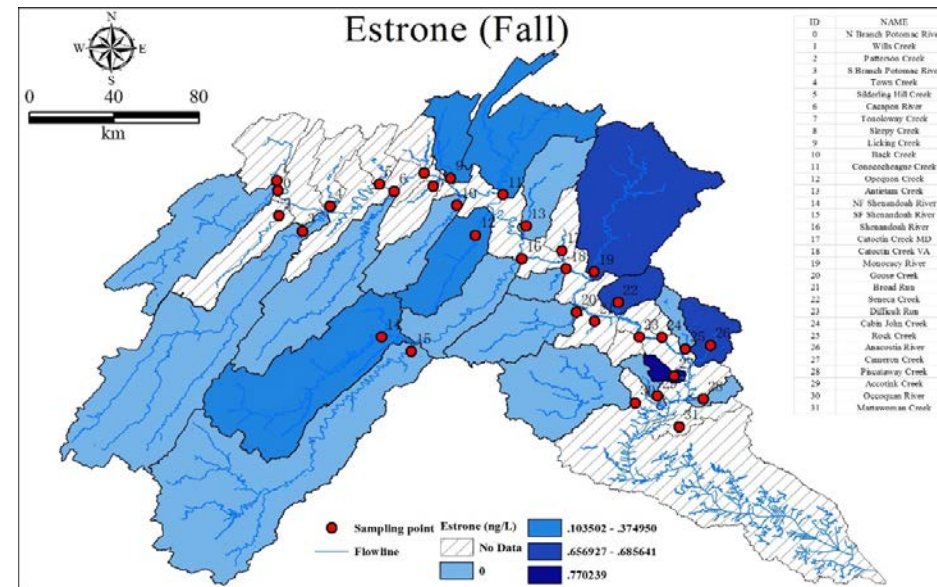
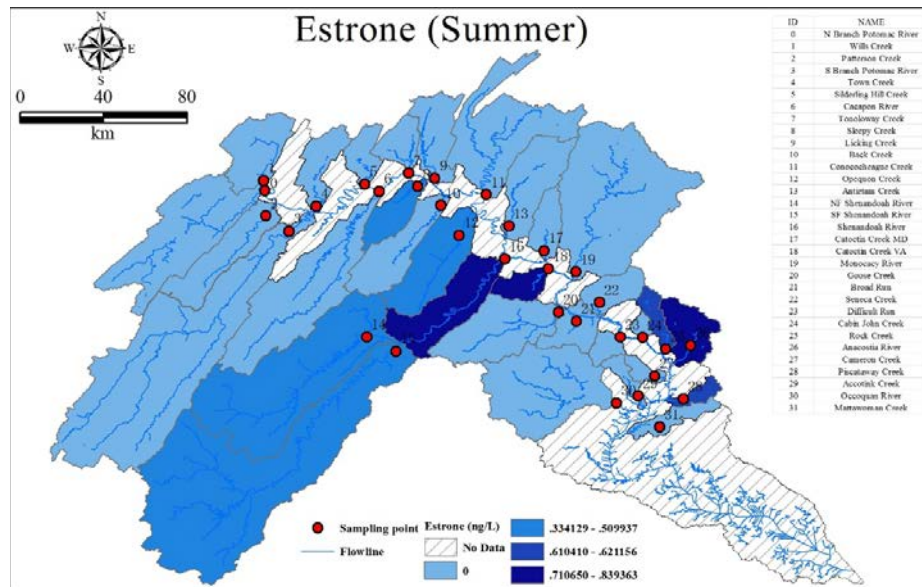
Duan et al. (In Preparation)

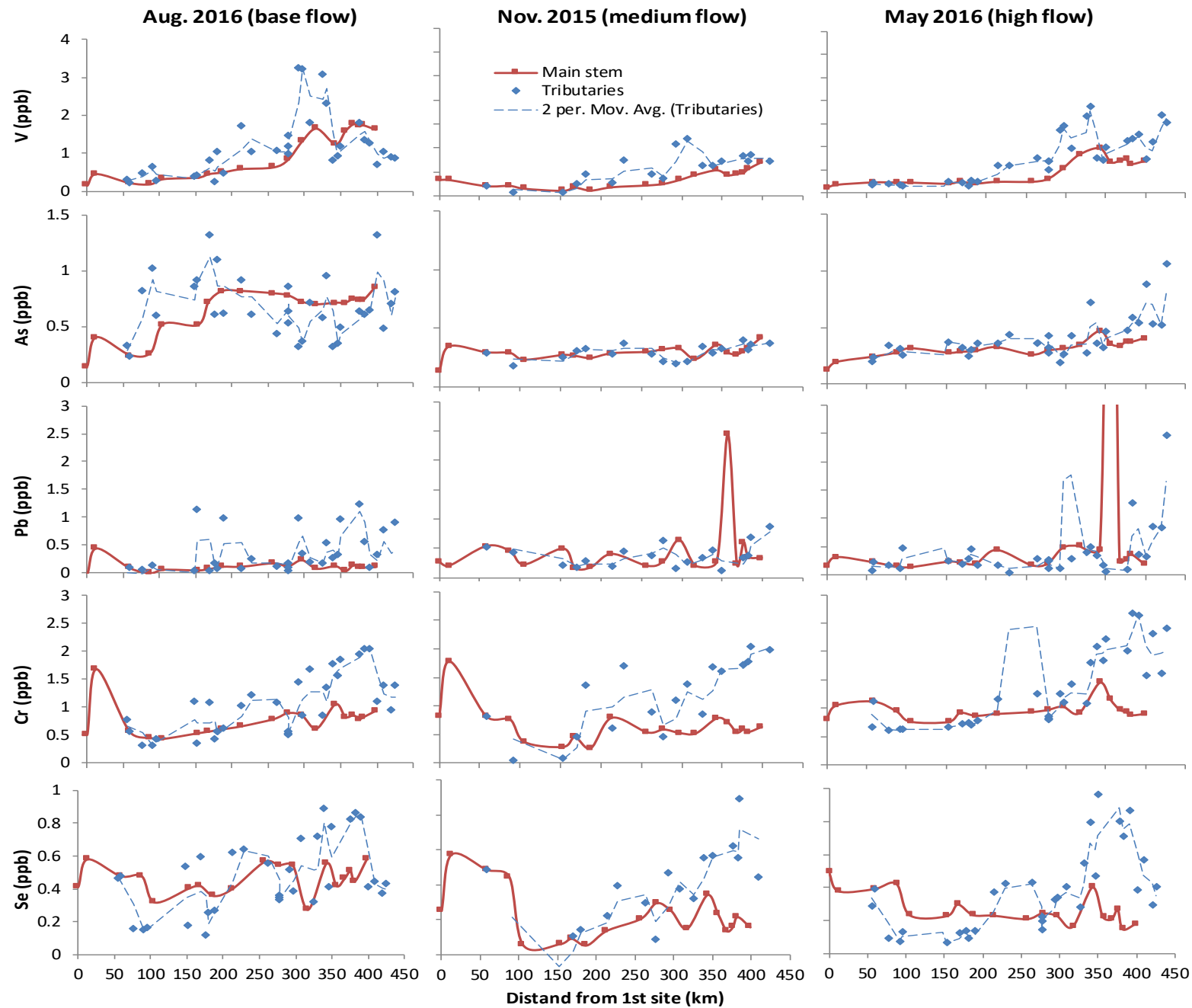


N Sources Also
Change Along the
Estuary Based on
Seasons and
Streamflow

Pennino, Kaushal...Blomquist
et al., 2016, *Biogeosciences*

Tracking Hormone Hot Spots





Trace Elements Reveal Clues to the Sources and Hot Spots of Contaminants

How Have Nitrogen Sources Changed Over Time?



Long-term Monitoring Program Shows Improving Nitrogen Trends in Maryland's Rivers and Streams



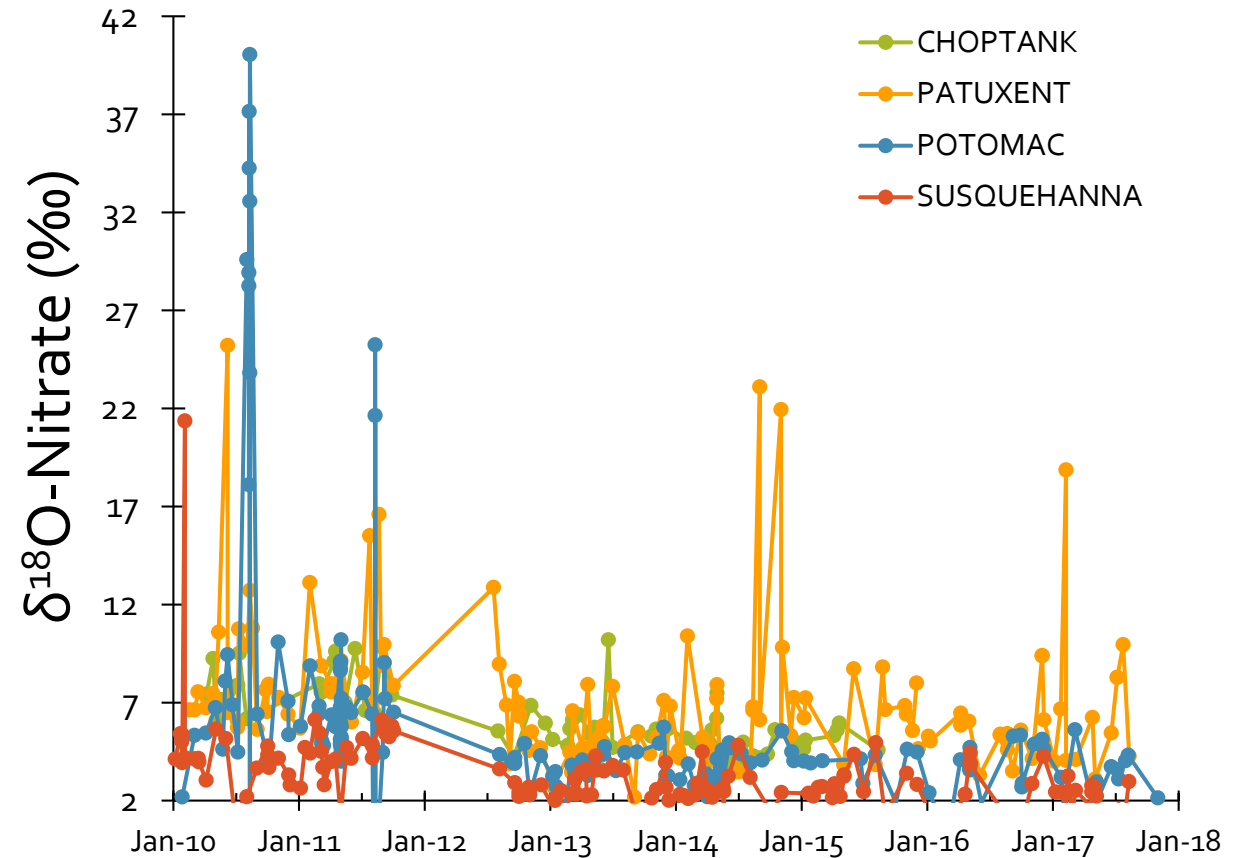
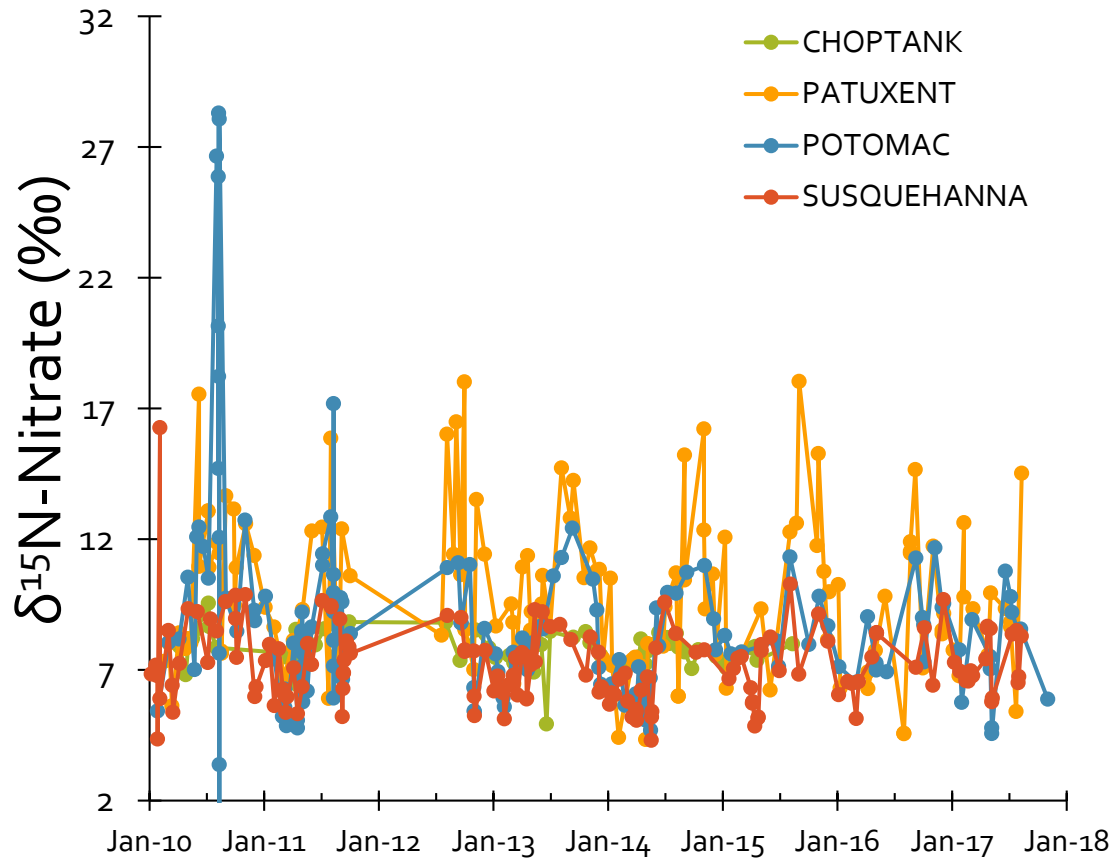
Discovery & Impact

Scientists Mark First Evidence That Dolphins Give Birth in Potomac River

Sources: <https://dnr.maryland.gov/streams/Publications/TNFactsheet2009.pdf>
<https://www.georgetown.edu/news/scientists-mark-first-evidence-that-dolphins-give-birth-in-potomac-river/>

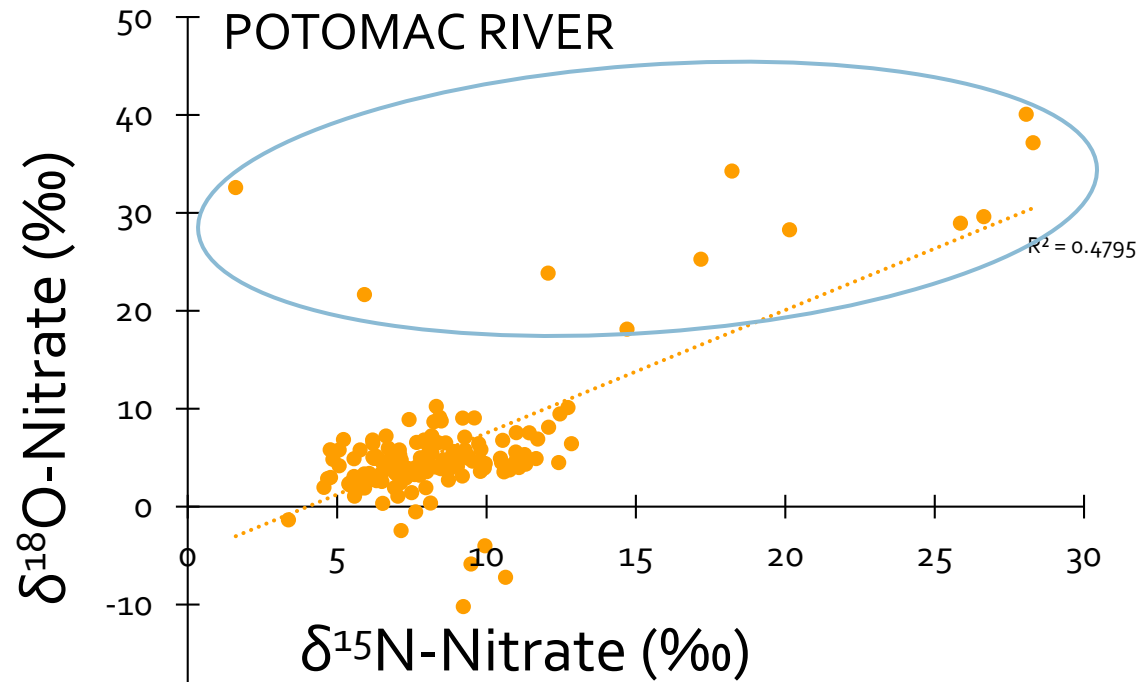
USGS RIM Sites Across Time

Isotope Data from 2010 to 2017

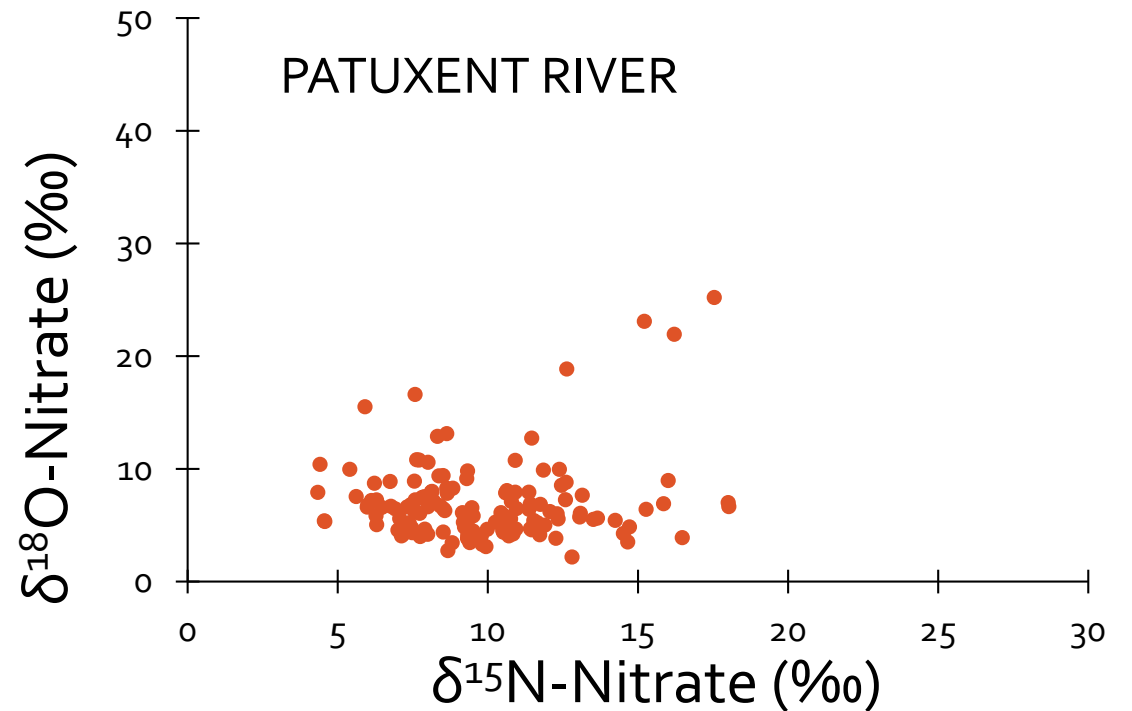


Thank you, Joel Blomquist and RIM Team

Different Rivers have Different Nitrogen Sources



Point Sources vs Non-Point Sources:
Differ Across Streamflow?



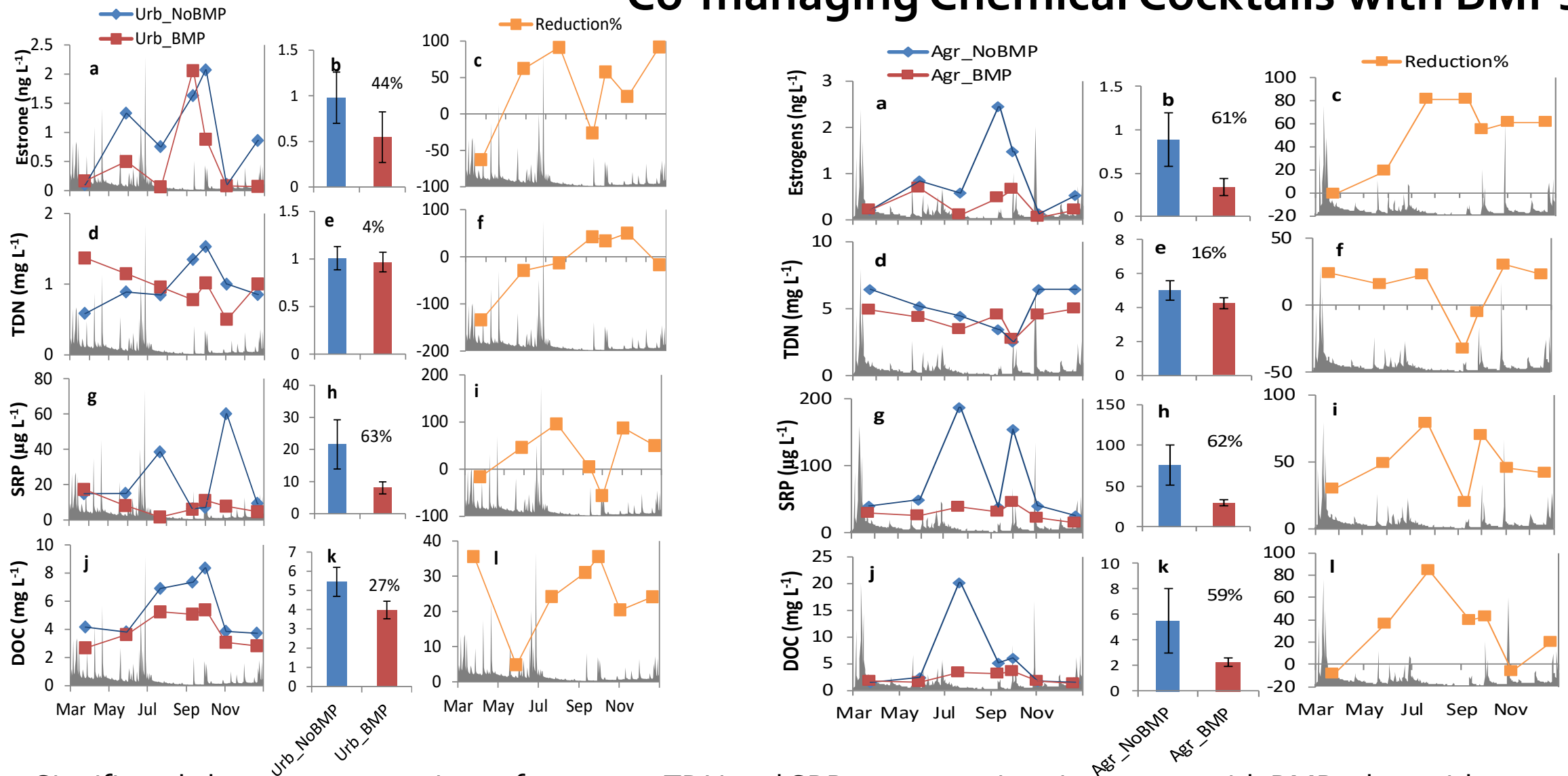
Regional Monitoring Across Time and Space

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Evaluating stream restoration, stormwater BMPs, wastewater treatment



Co-managing Chemical Cocktails with BMPs



Significantly lower concentrations of estrogen, TDN and SRP concentrations in streams with BMPs than without

*Recent EPA project with Adil Godrej and Amelia Flannery expands to VA sites

Duan et al. (In Preparation)

Examples of Previous BMPs Evaluated

Regenerative Stormwater Conveyances (RSCs)

- Duan et al. (2019), Wood et al. (In Progress)

Urban Stormwater Wetlands

- Harrison et al. (2011), Harrison et al. (2012), Harrison et al. (2016), Newcomer Johnson et al. (2014), Pennino et al. (2016a), Smith et al. (2017)

Stream-Floodplain Reconnection

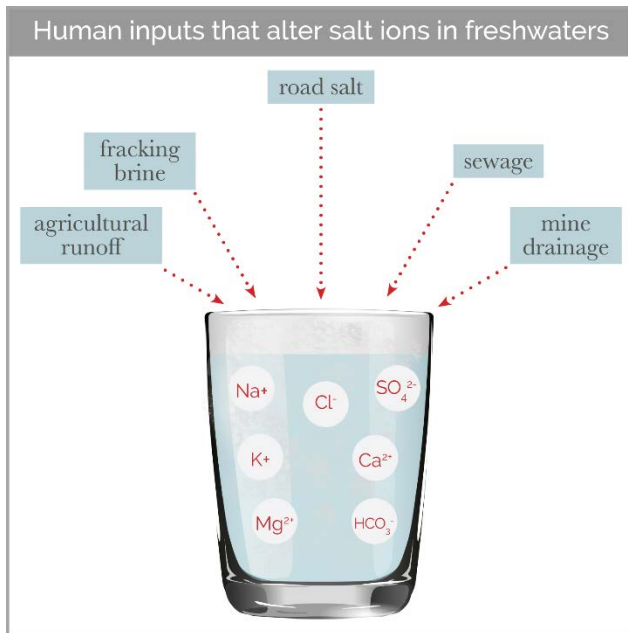
- Newcomer et al. (2012), Newcomer et al. (2014), Newcomer-Johnson et al. (2016), Pennino et al. (2014), Kaushal et al. (2008), Mayer et al. (2010), Klockner et al. (2009)

Examples of Nitrogen Source Tracking: Kaushal et al. (2006), Kaushal et al. (2011), Pennino et al. (2016b), and other studies

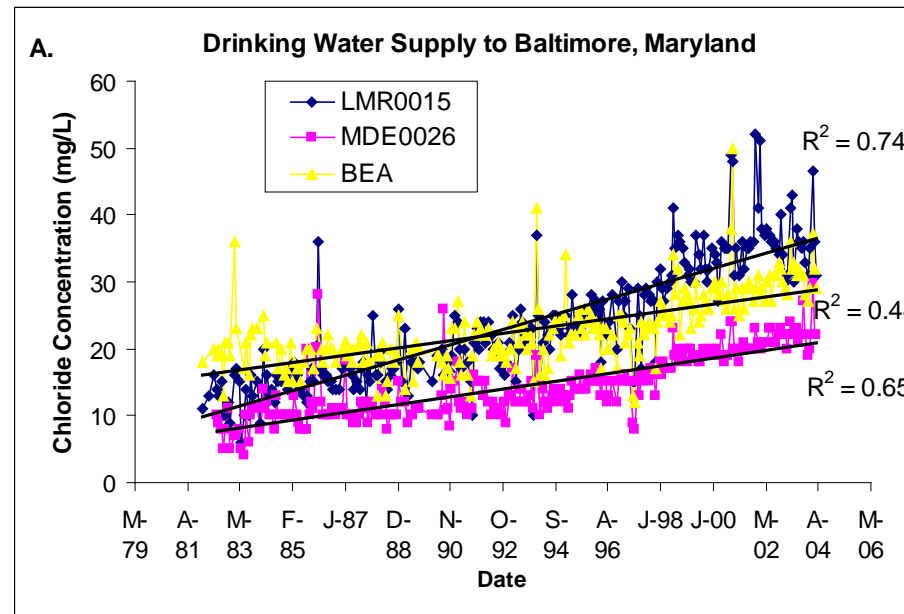
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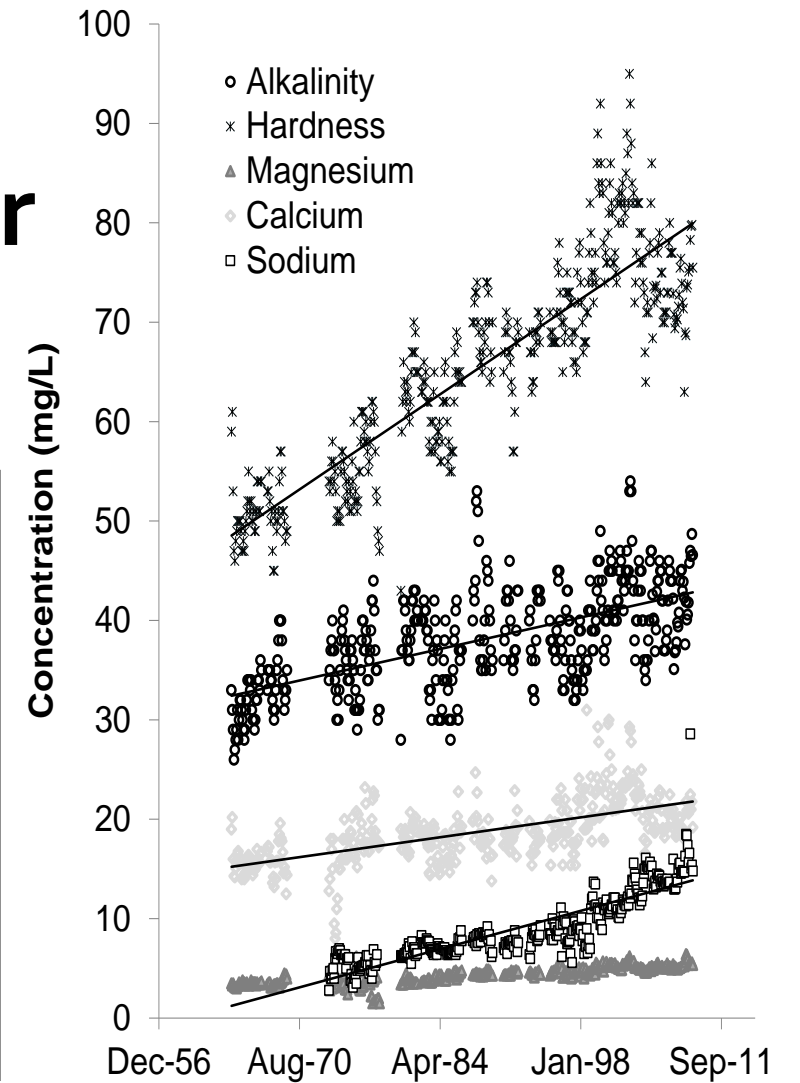
Freshwater Salinization Syndrome Impacts Maryland's Drinking Water



L. Quillen (2018) FSS Press Release

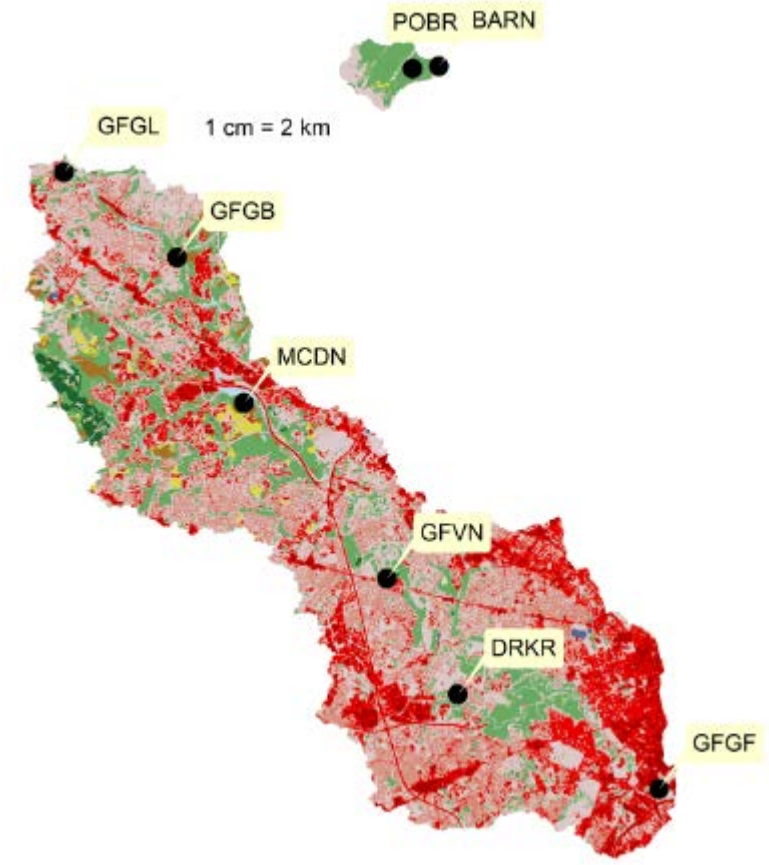
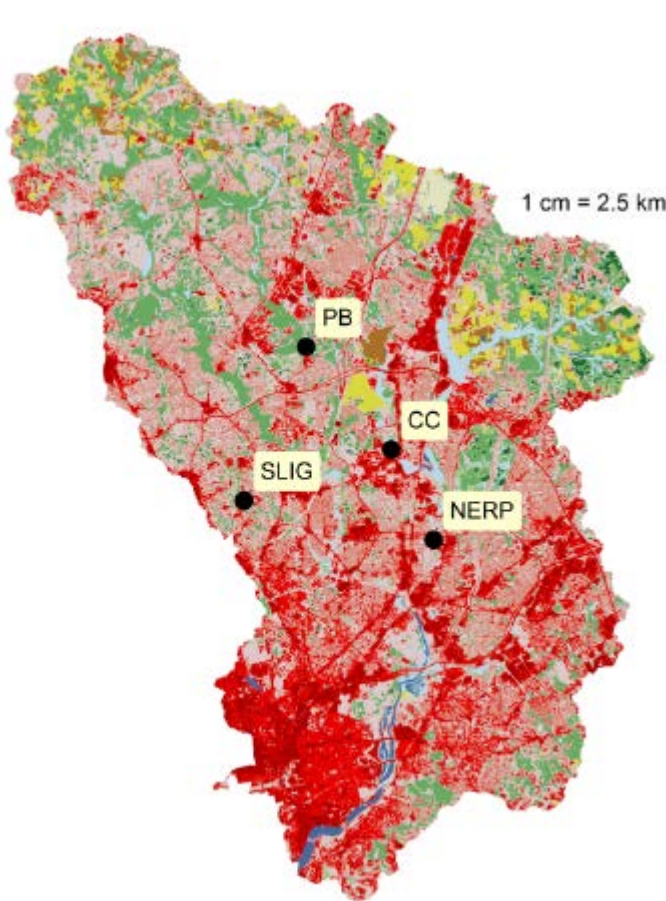
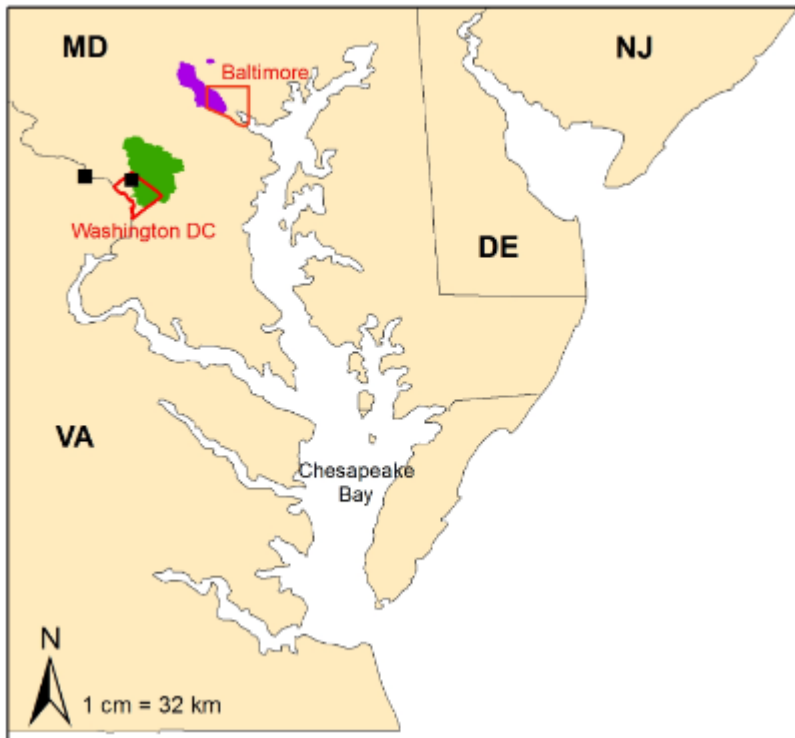


Kaushal et al. (2005) *PNAS*



Kaushal et al. (2017) *Appl. Geochem*

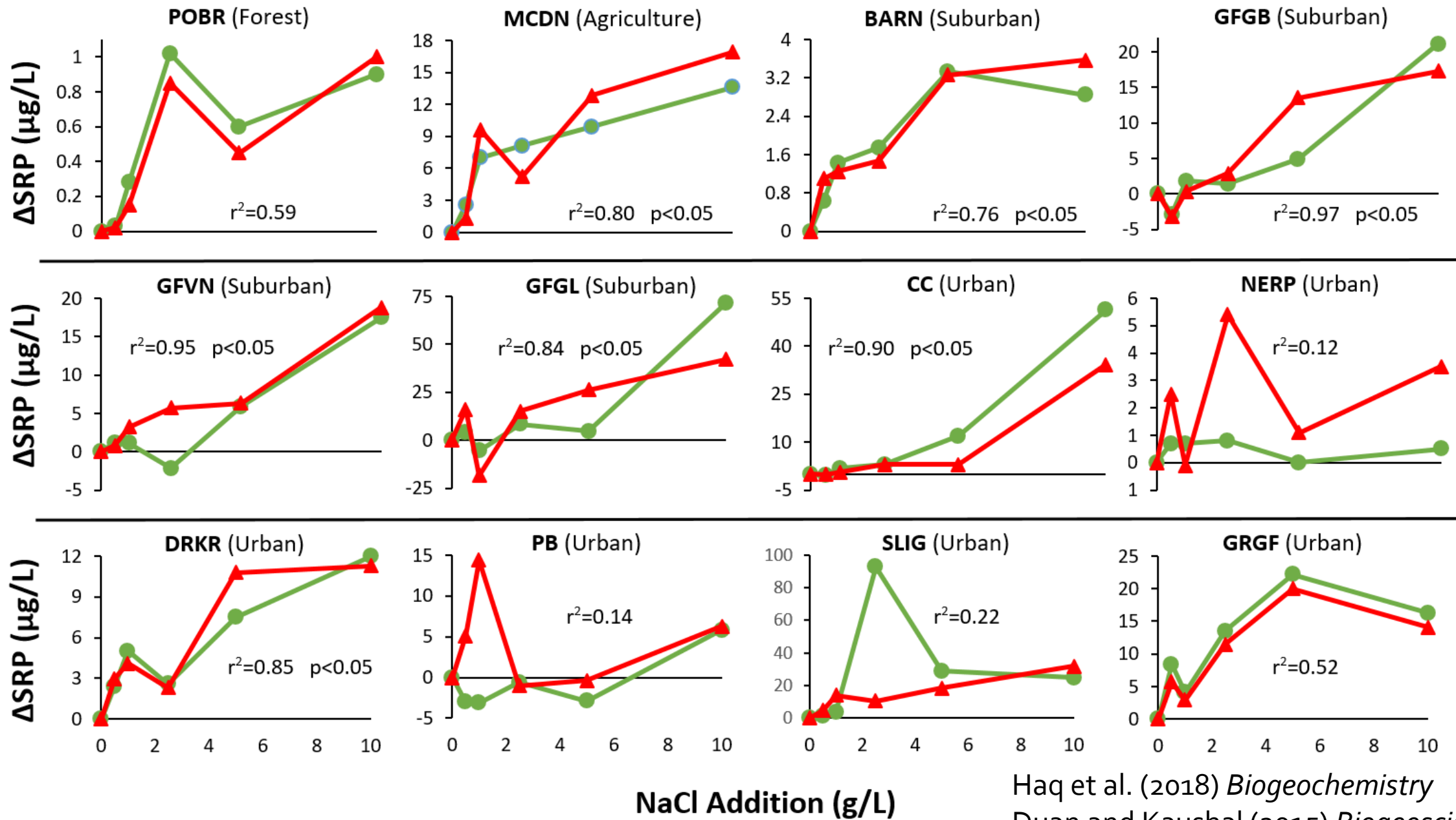
Novel Chemical Cocktails Are a Consequence of Freshwater Salinization Syndrome

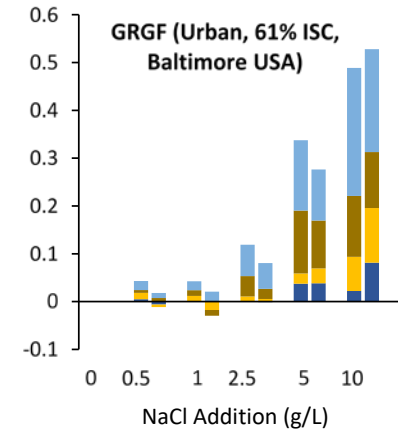
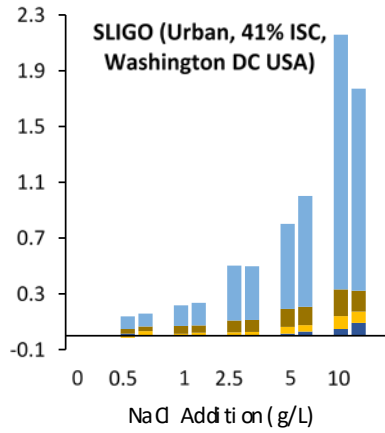
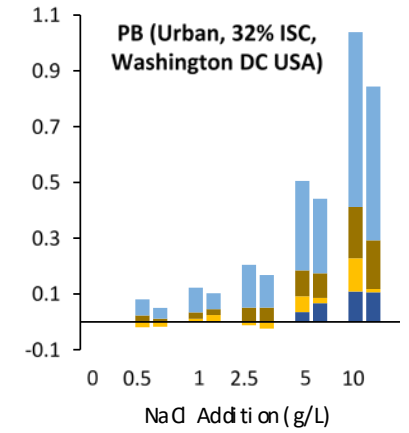
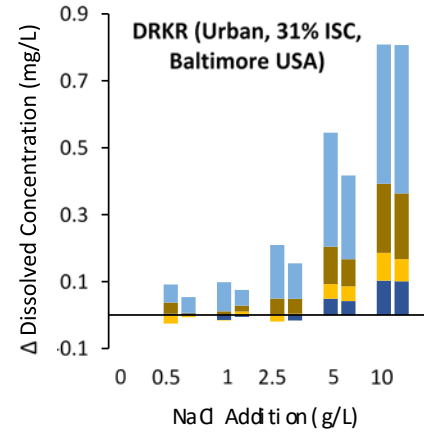
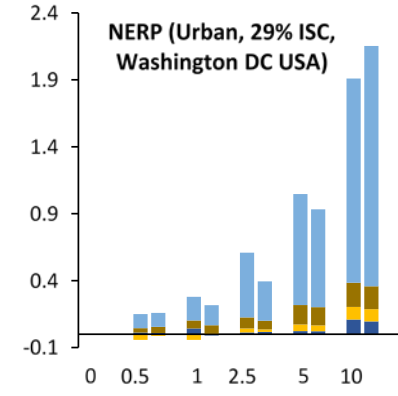
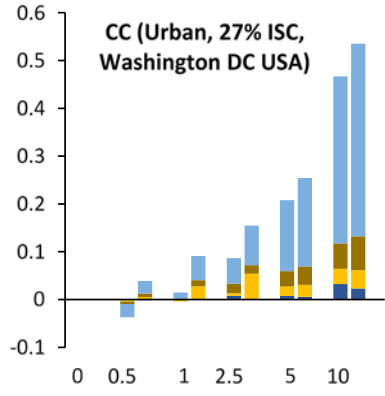
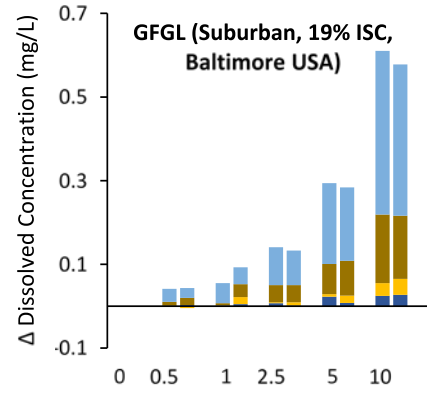
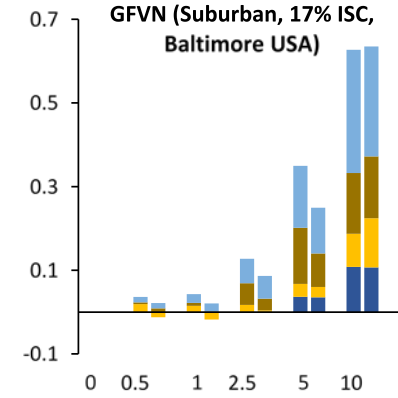
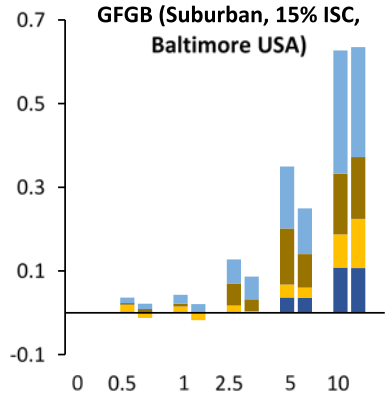
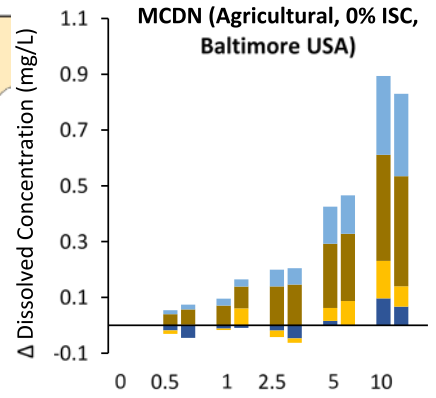
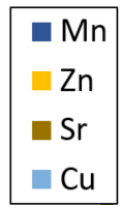
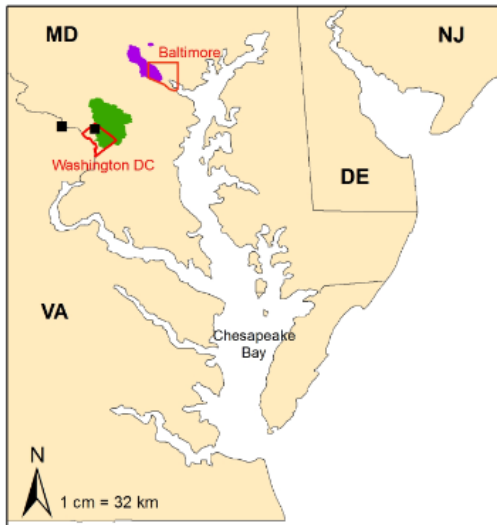


Haq et al. (2018) *Biogeochemistry*

Anacostia River, Washington, DC

Gwynns Falls, Baltimore LTER, MD





New Chesapeake Bay Trust Grant

- What are critical thresholds in concentrations of different road salt ions (Na^+ , Ca^{2+} , Mg^{2+}) which can mobilize nutrients and metals to surface waters across varying stormwater BMPs?
- What are the concentrations and loads of different road salt ions and associated metals and nutrients in nearby stream outfalls before, during, and after deicing events



Preliminary Experimental Design

Stormwater BMP	Number of Sites	Lab Reps	Number of Salt types	Number of Salinity Levels	Total samples/BMP
Bioretention	3	3	4	3	108
Legacy Pond	3	3	4	3	108
Infiltration	3	3	4	3	108
Floodplain Reconnection	3	3	4	3	108
Forested Reference	2	3	4	3	72
				Grand total	504



Examples of Candidate Sites: Anacostia Watershed



Campus Creek: Mobilization of Metals in Response to Freshwater Salinization Syndrome

W. Nguyen: Senior Thesis

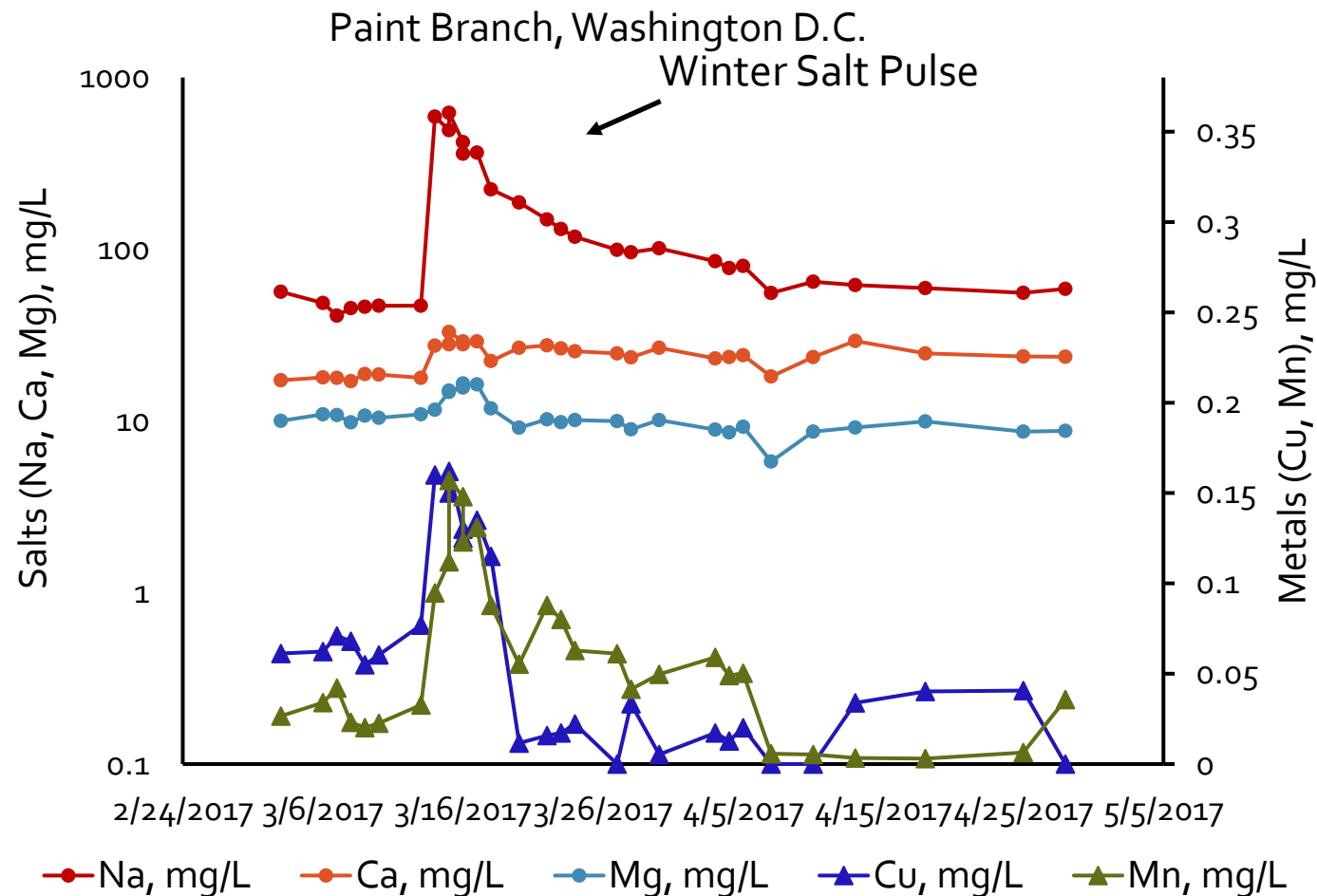
Special acknowledgements: Kelsey Wood, Joseph Gallela, and Jenna Reimer

Examples of Monitoring Sites: Anacostia Watershed



Photos Courtesy: Kelsey Wood

Snowstorm Monitoring: Peaks and Persistence of Freshwater Salinization Syndrome?



Special Thanks:
Kelsey Wood Collected Past Data
Jenna Reimer and Students Collecting
Present Data

Kaushal et al. (2018b) *Philosophical Trans. Royal Society*



Thanks to students in
our lab.

Conclusions – How to Monitor Moving Targets?

Past Findings

- Sources and Hot Spots of Contaminants Shift Across Space and Time

Questions Raised

- Can Sources, Hot Spots, and Chemical Cocktails Be Accurately Tracked and Co-Managed?

Future Research Needs

- Higher-Resolution Tracking of Sources and Hot Spots Across Space and Time (Nutrients, Salts, Metals, E. coli)
- Contaminant Mobilization: Regional Vulnerability to Freshwater Salinization
- Potential Co-management of Chemical Cocktails in BMPs
- Monitoring Sources and Hot Spots in Managed vs. Unmanaged Watersheds