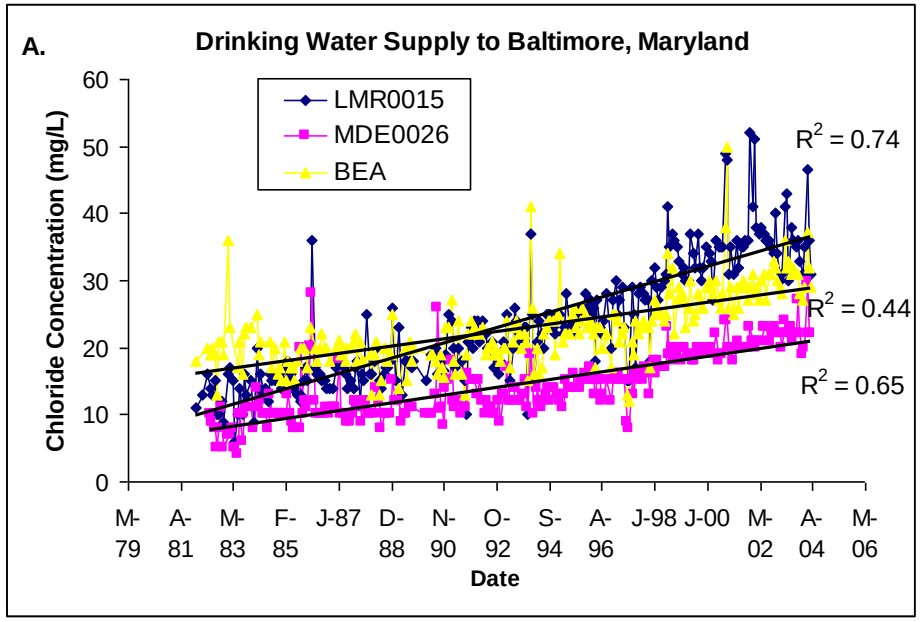
Freshwater Salinization Syndrome: Diagnosing Water Quality Impacts

Sujay S. Kaushal, University of Maryland
Shahan Haq, RMS Consulting
Kelsey Wood, University of Maryland
Joseph Galella, University of Maryland
Gene Likens, Cary Institute of Ecosystem Studies
Michael Pace, University of Virginia
and friends…

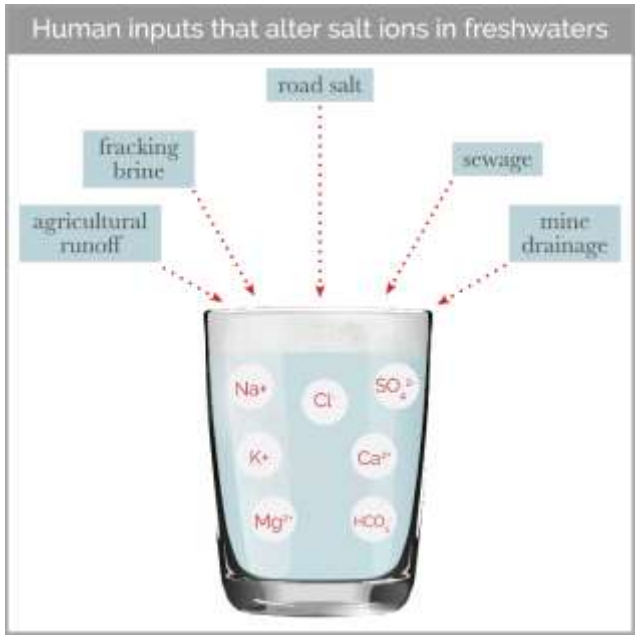
Outline

1. Freshwater Salinization Syndrome (FSS)
2. Chemical Cocktails as a Consequence of FSS
3. Regional Monitoring and Data Gaps

1. Freshwater Salinization Syndrome

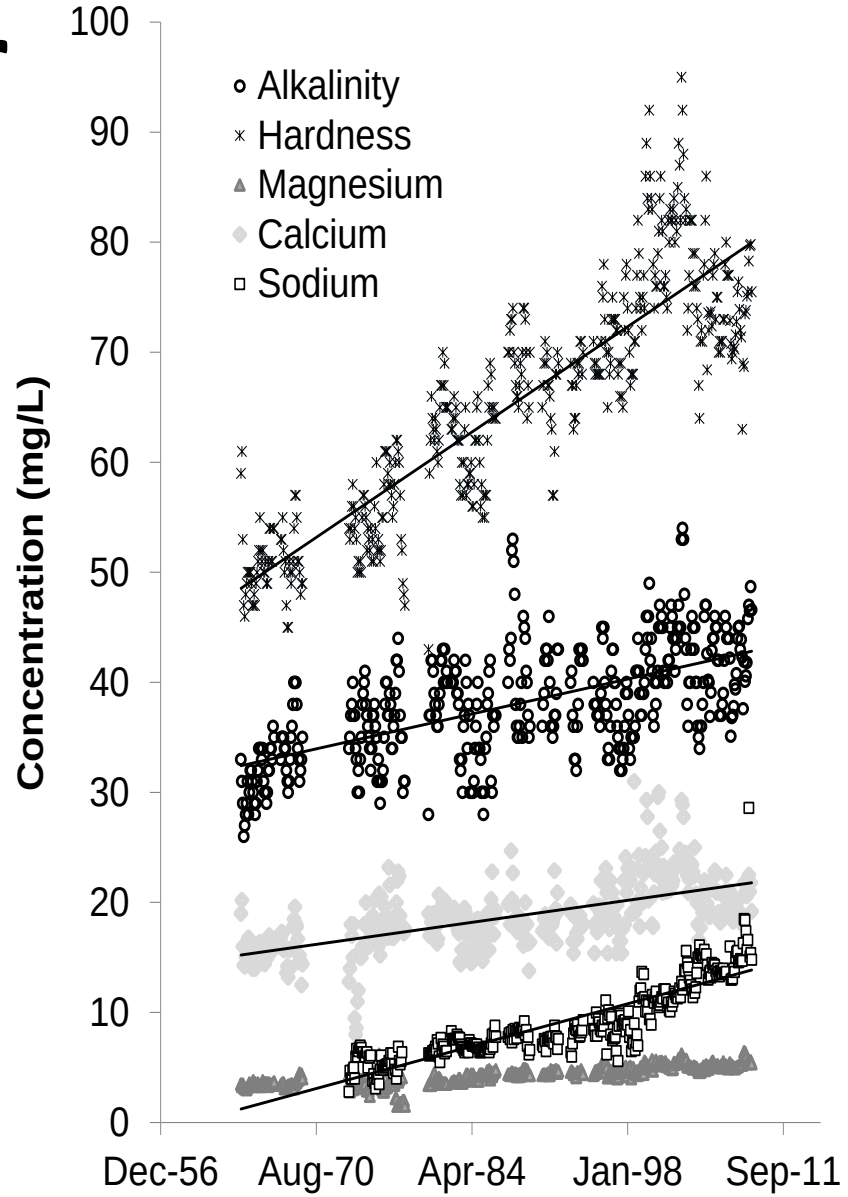


Kaushal et al. (2005) *PNAS*

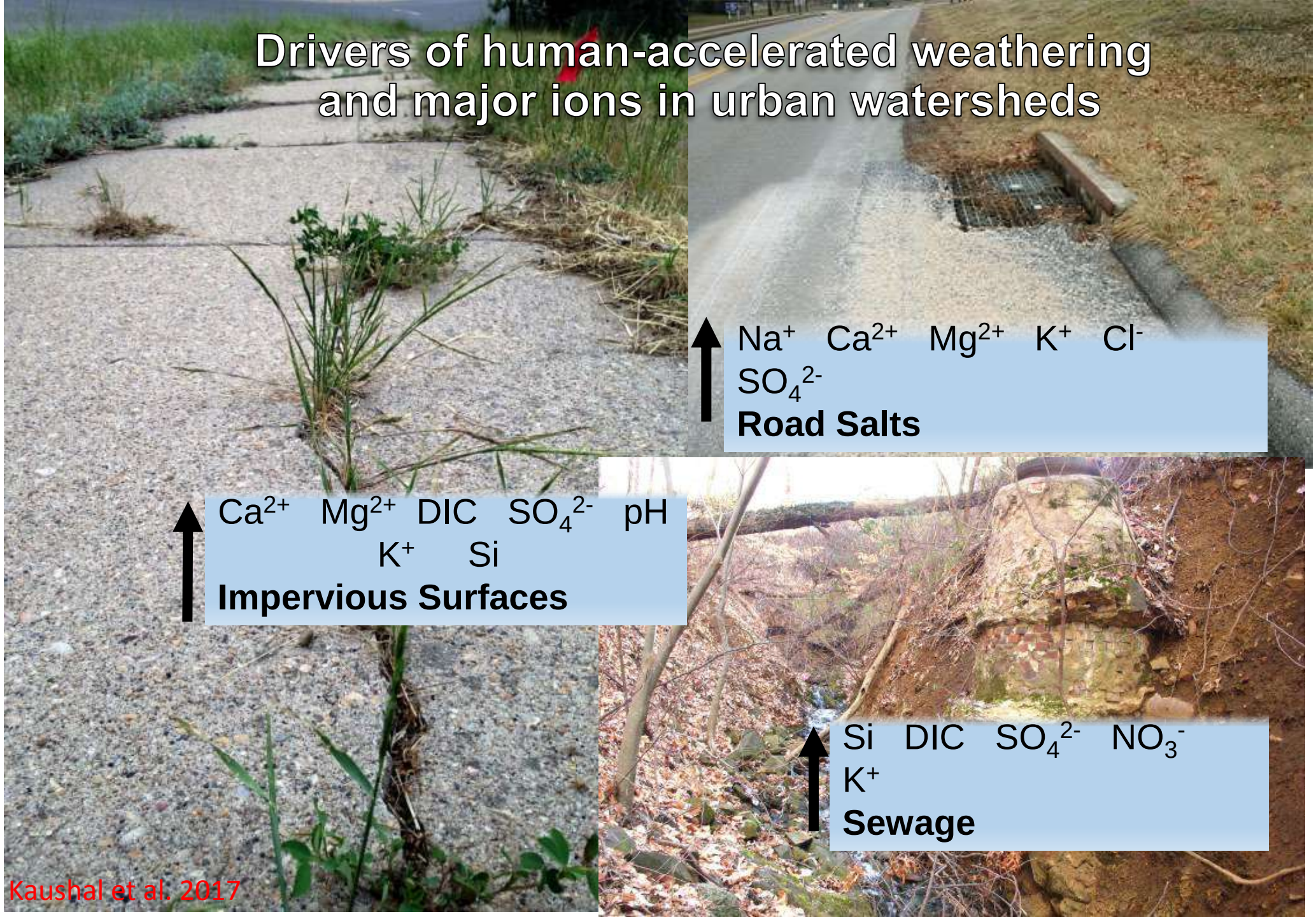


L. Quillen (2018) FSS Press Release

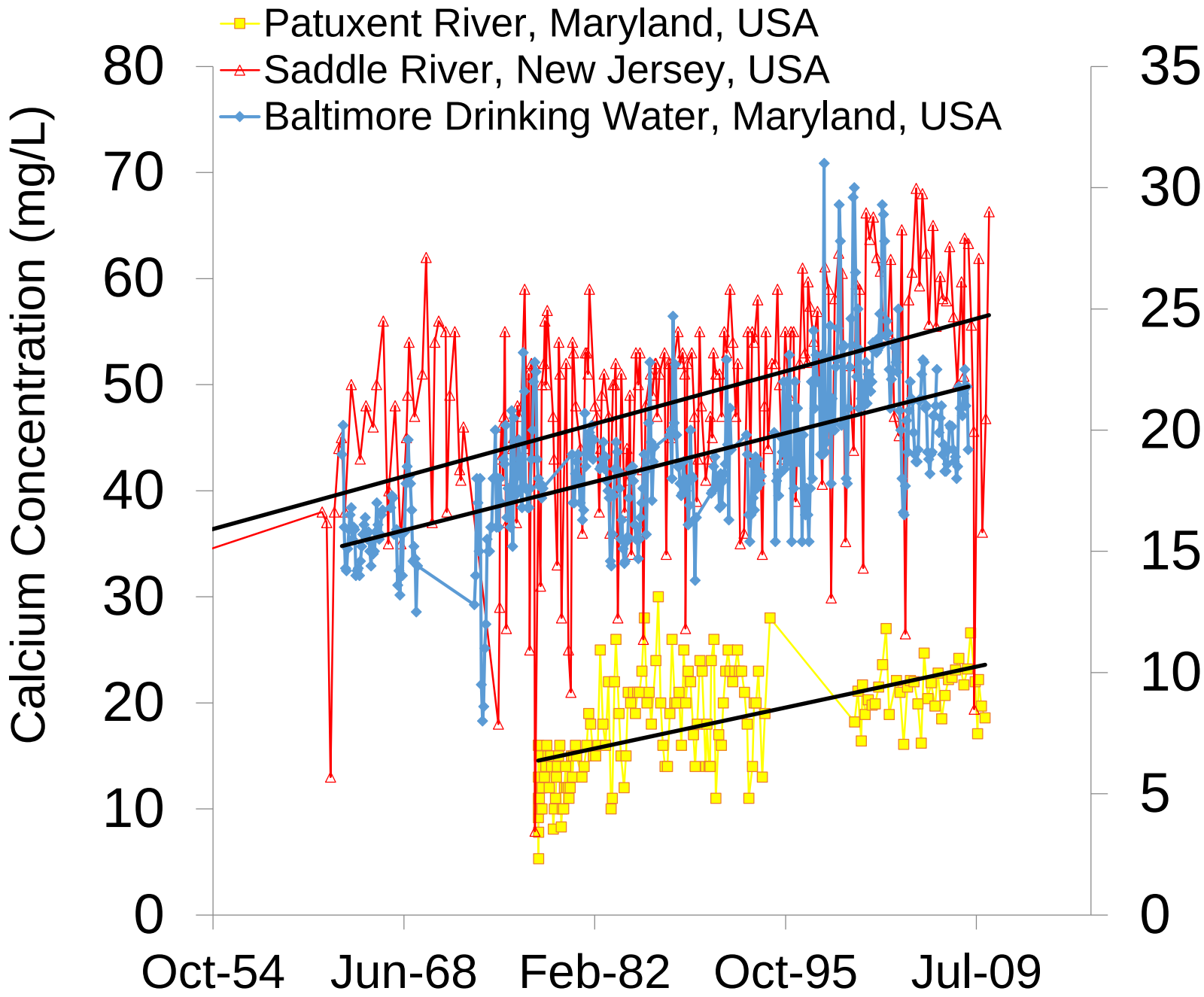
Baltimore's Drinking Water

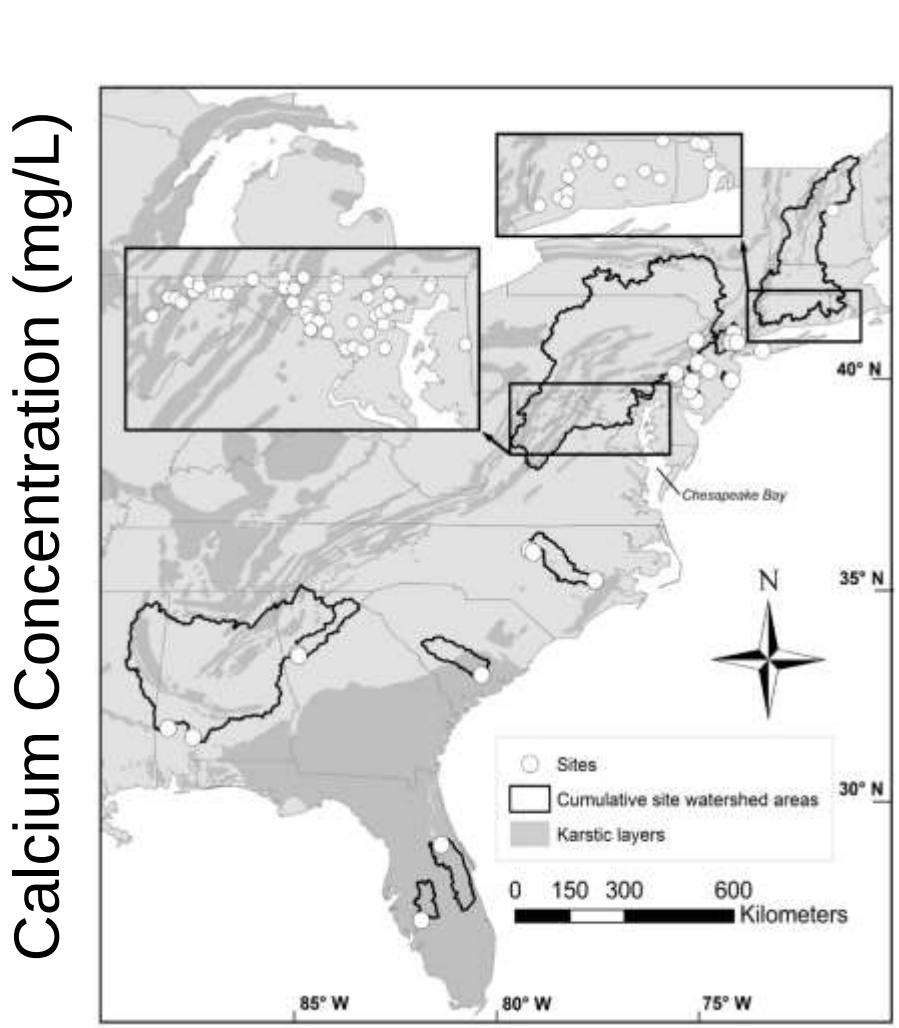


Kaushal et al. (2017) *Appl. Geochem*


Drivers of human-accelerated weathering and major ions in urban watersheds
Na^+ Ca^{2+} Mg^{2+} K^+ Cl^- SO_4^{2-}
Road Salts
Ca^{2+} Mg^{2+} DIC SO_4^{2-} pH K^+ Si
Impervious Surfaces
Si DIC SO_4^{2-} NO_3^- K^+
Sewage
Kaushal et al. 2017

Human-Accelerated Weathering and River Alkalinization





Kaushal et al. (2013 *ES&T*, 2014 *Biogeochemistry*)

Human-Accelerated Weathering

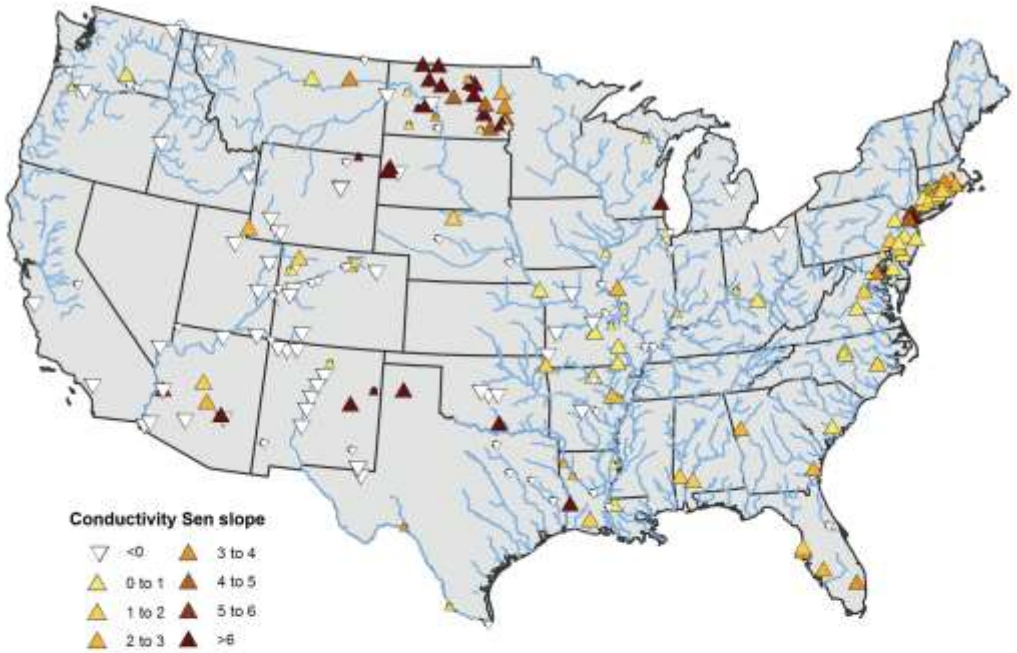
Photo Courtesy: Colin Delzel

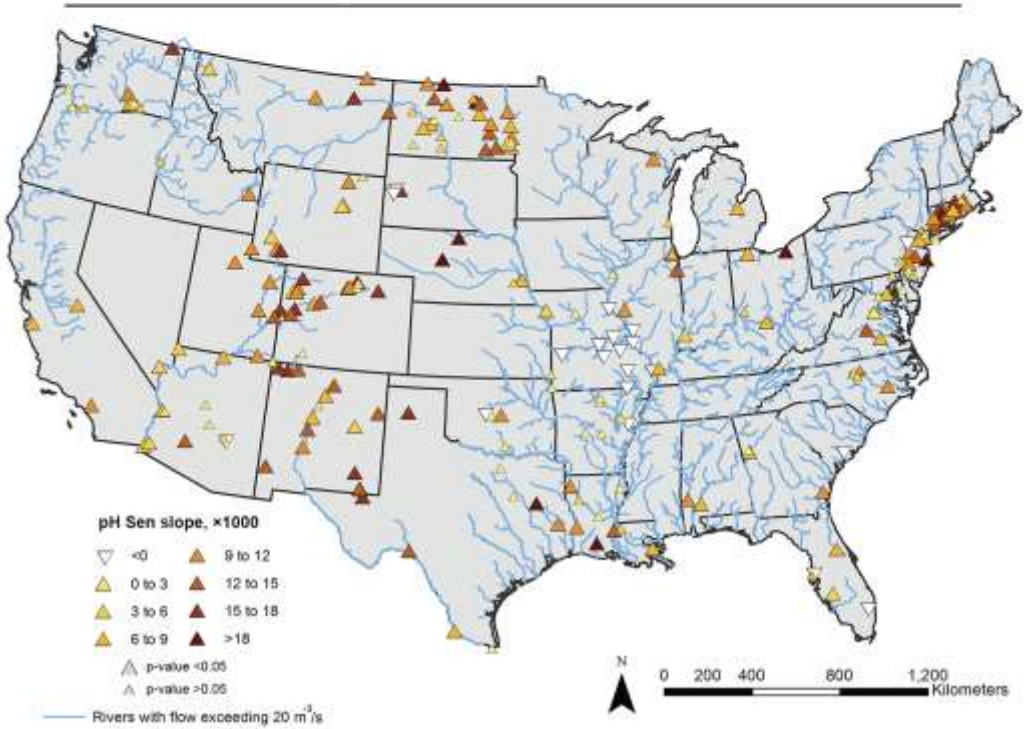
Evolving Weathering in Urbanized Watersheds Over Time

Cities create a distinct urban geology

Weathering of “urban karst”

Kaushal and Belt (2012)
Kaushal et al. (2014, 2015)



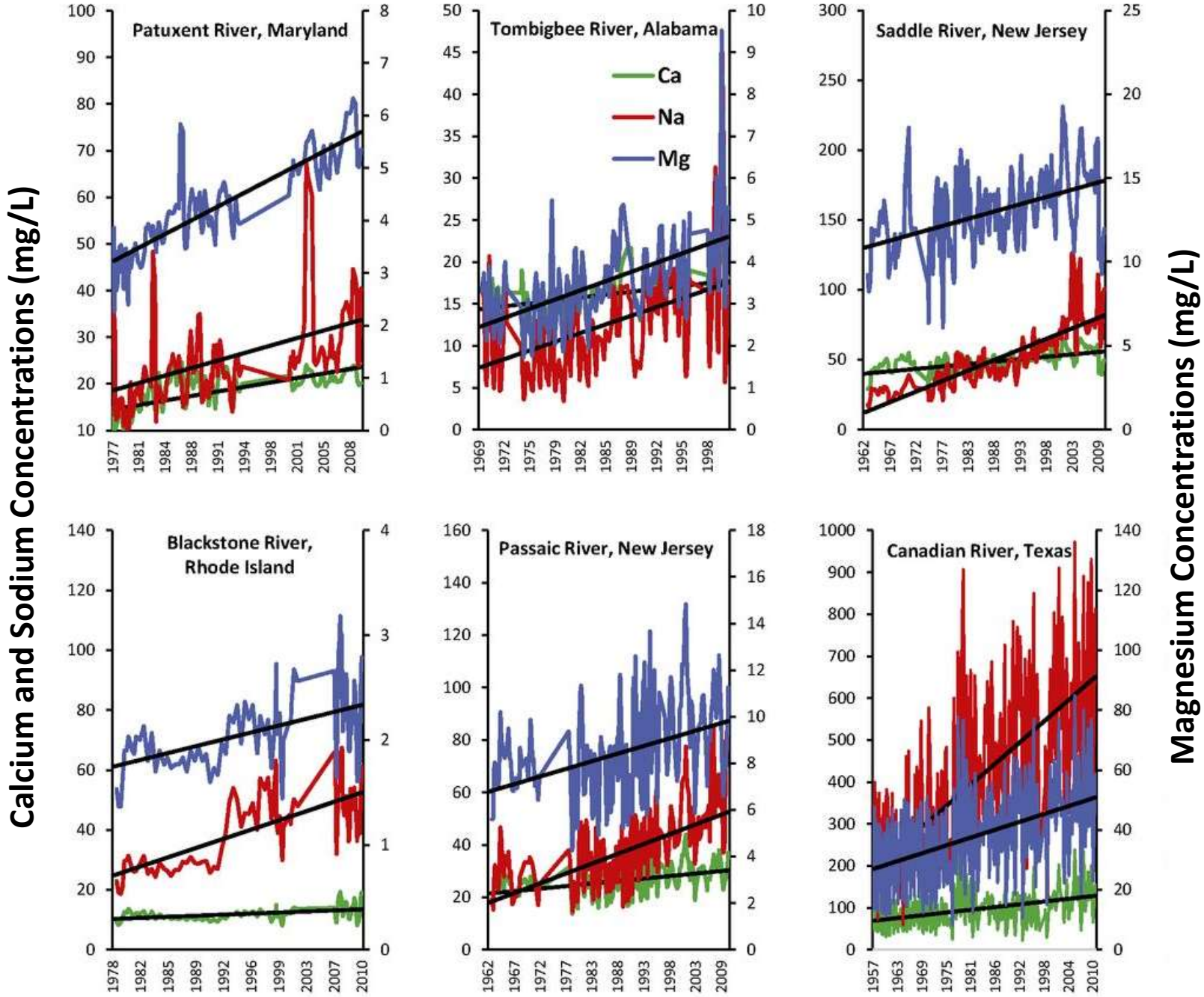


Freshwater Salinization Syndrome on a Continental Scale?

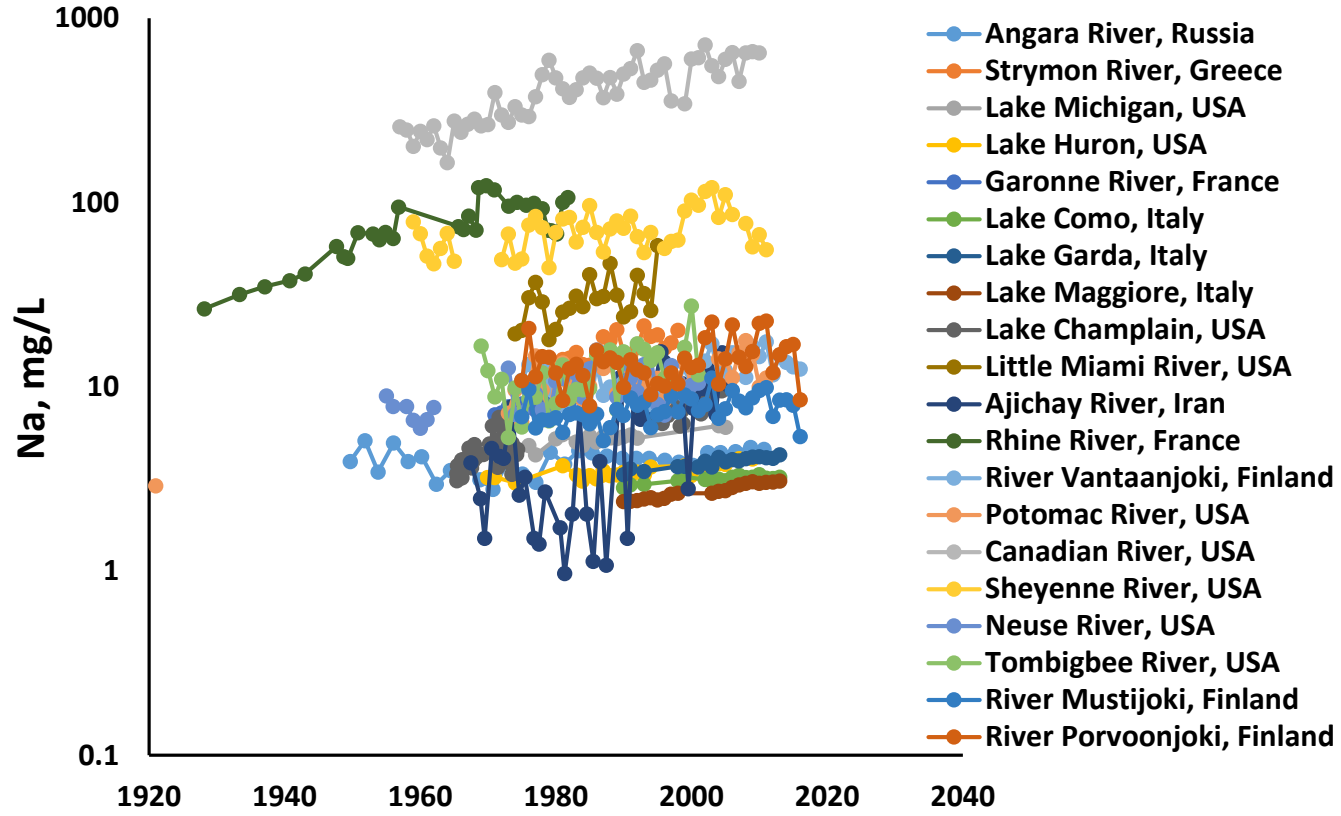
Increased pH and specific conductance over 50 years

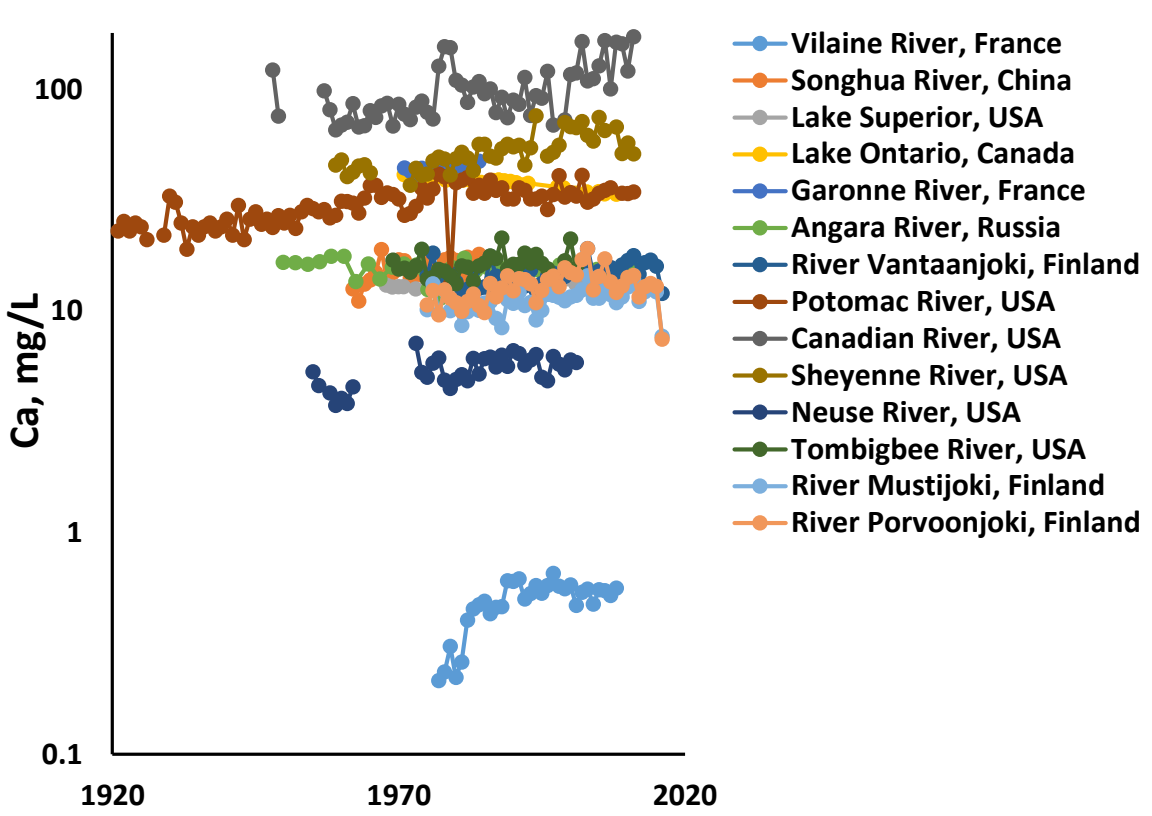
Kaushal et al. (2018a) *PNAS*

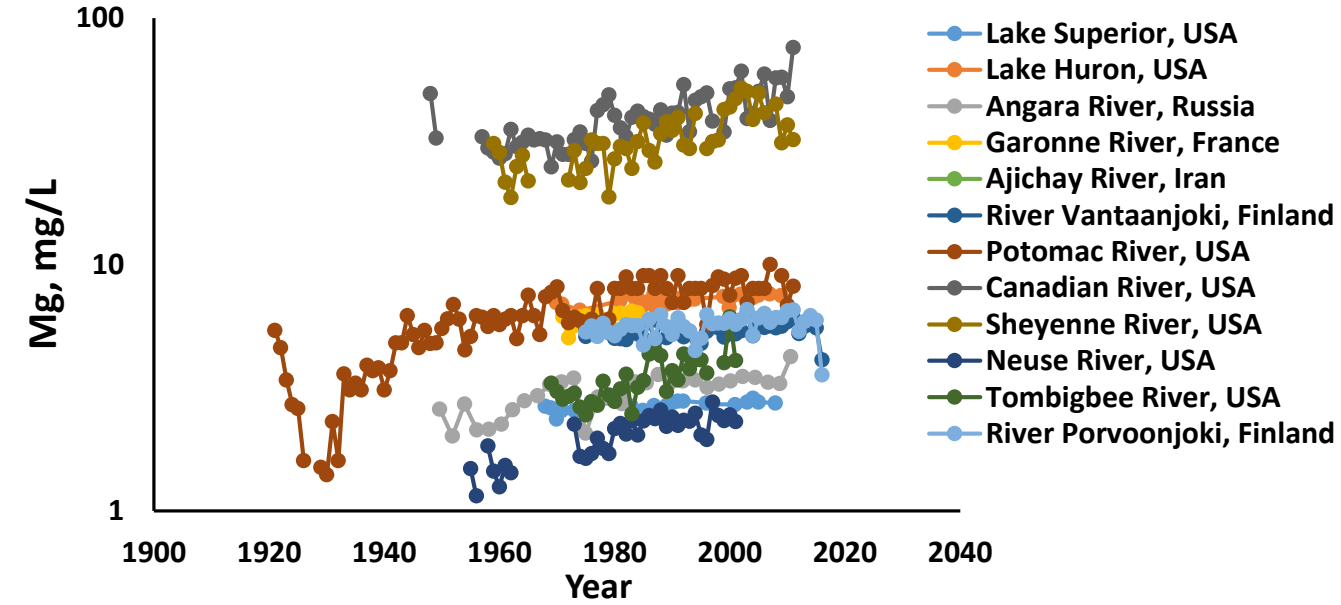
Freshwater Salinization Syndrome- Major Ions on a Continental Scale

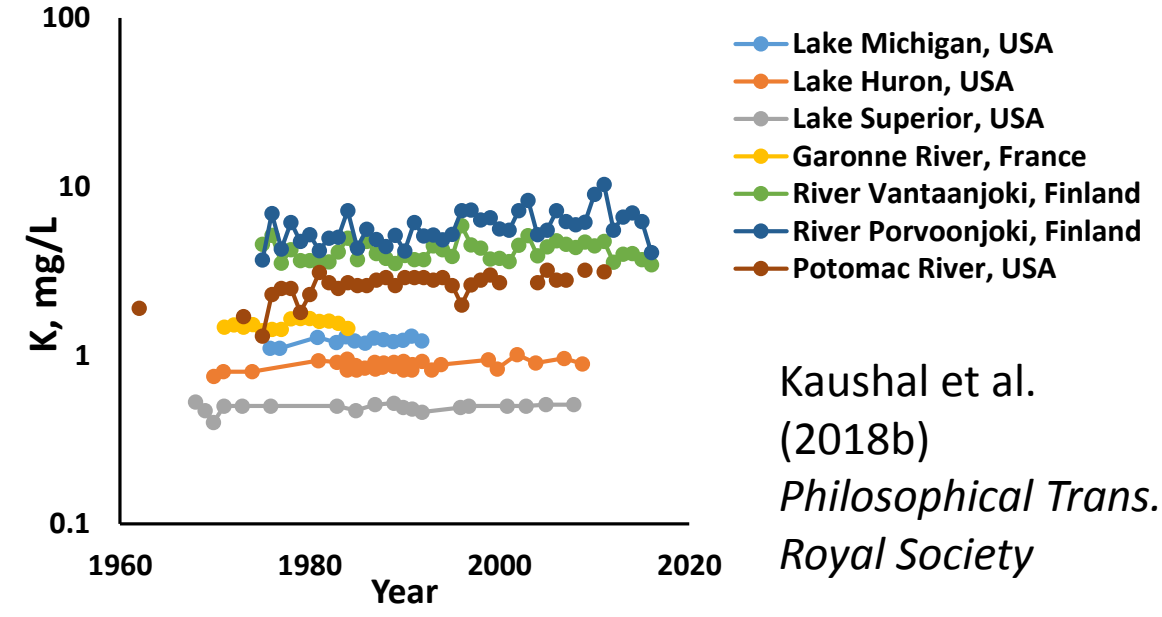


Kaushal et al. (2018a) *PNAS*

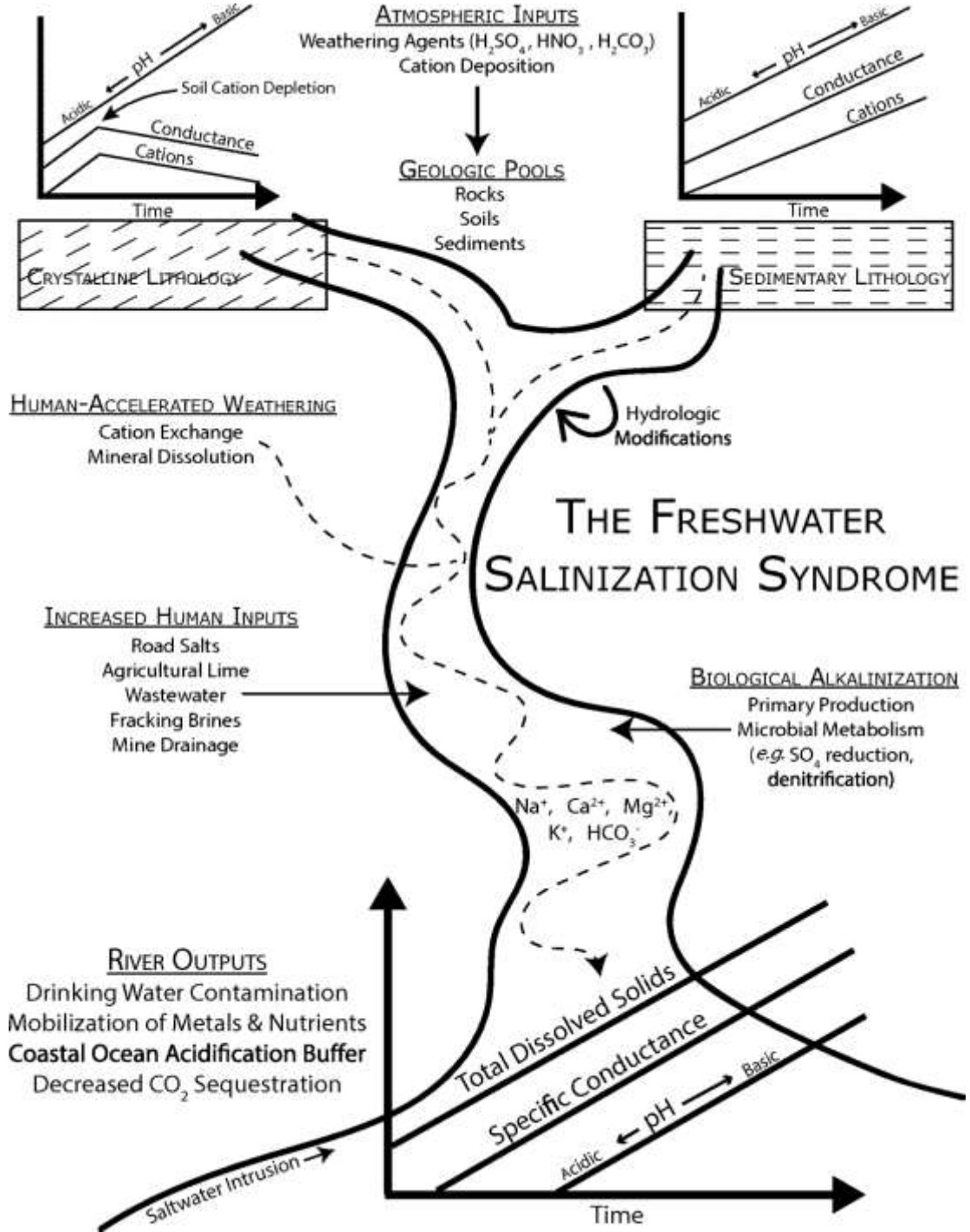








Kaushal et al. (2018b) *Philosophical Trans. Royal Society*



Kaushal et al. (2018a) *PNAS*

Outline

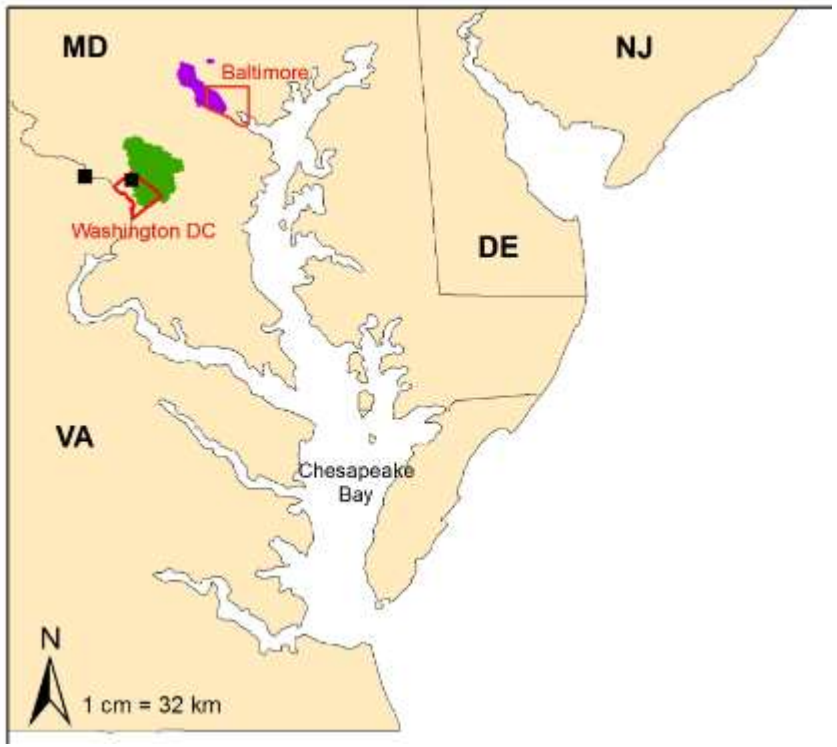
1. Freshwater Salinization Syndrome (FSS)
2. Chemical Cocktails as a Consequence of FSS
3. Regional Monitoring and Data Gaps

Which other chemicals are mobilized by salts – other effects?

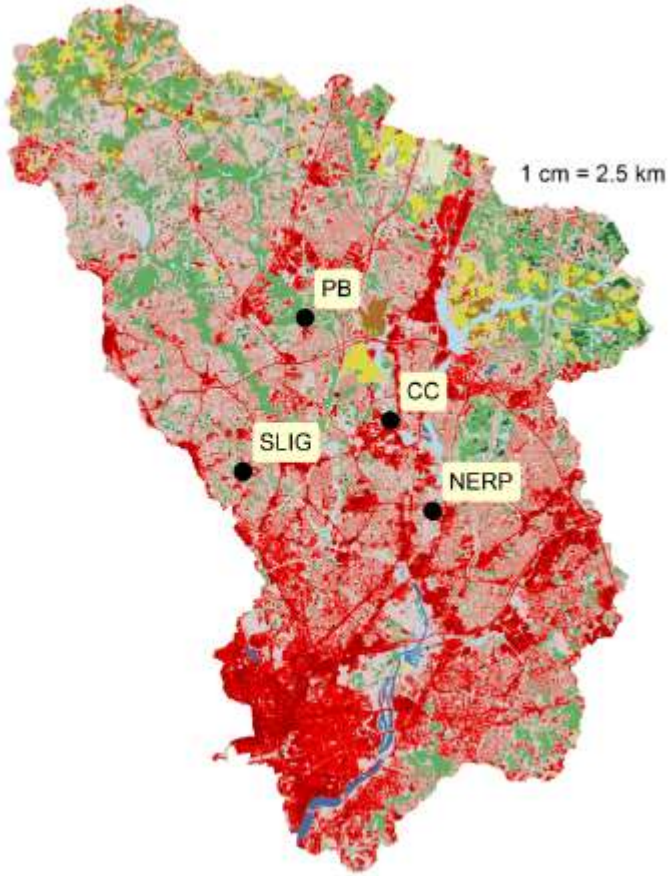
Photos Courtesy: S. Kaushal

Photo Courtesy: J. Galella

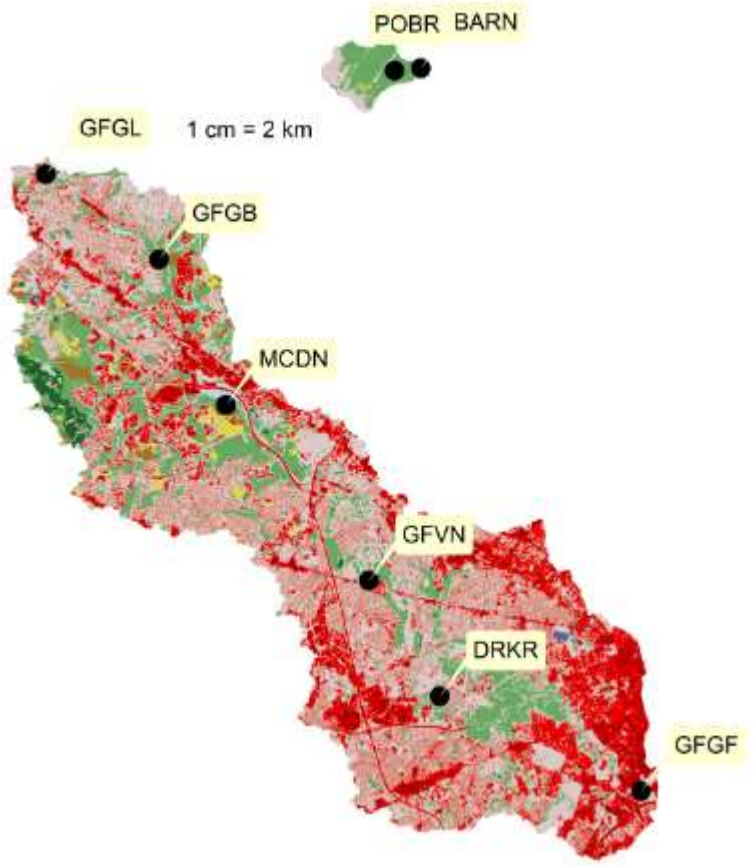
2. Chemical Cocktails as Consequence of FSS Experimental Salinization Experiments



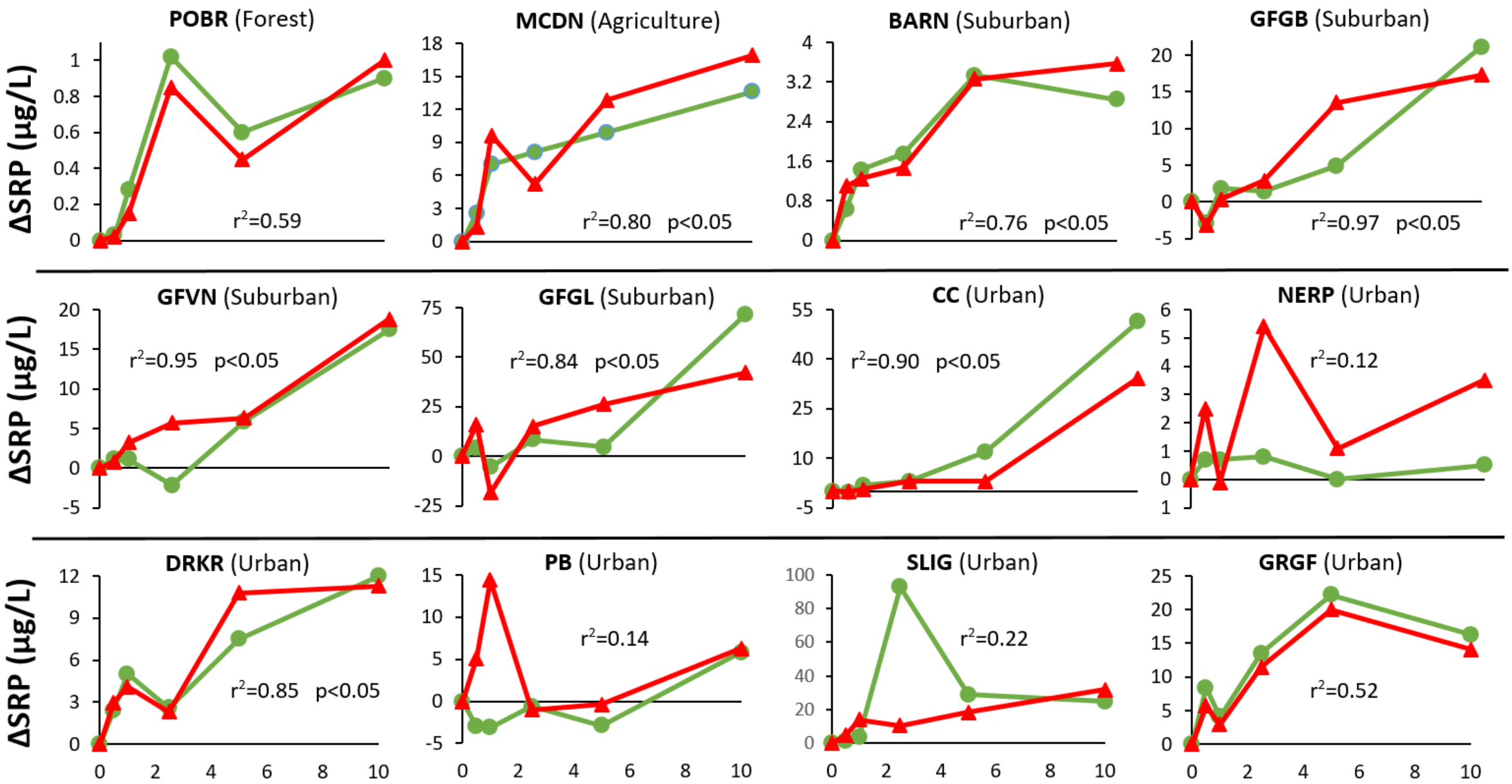
Haq et al. (2018) *Biogeochemistry*



Anacostia River, Washington, DC

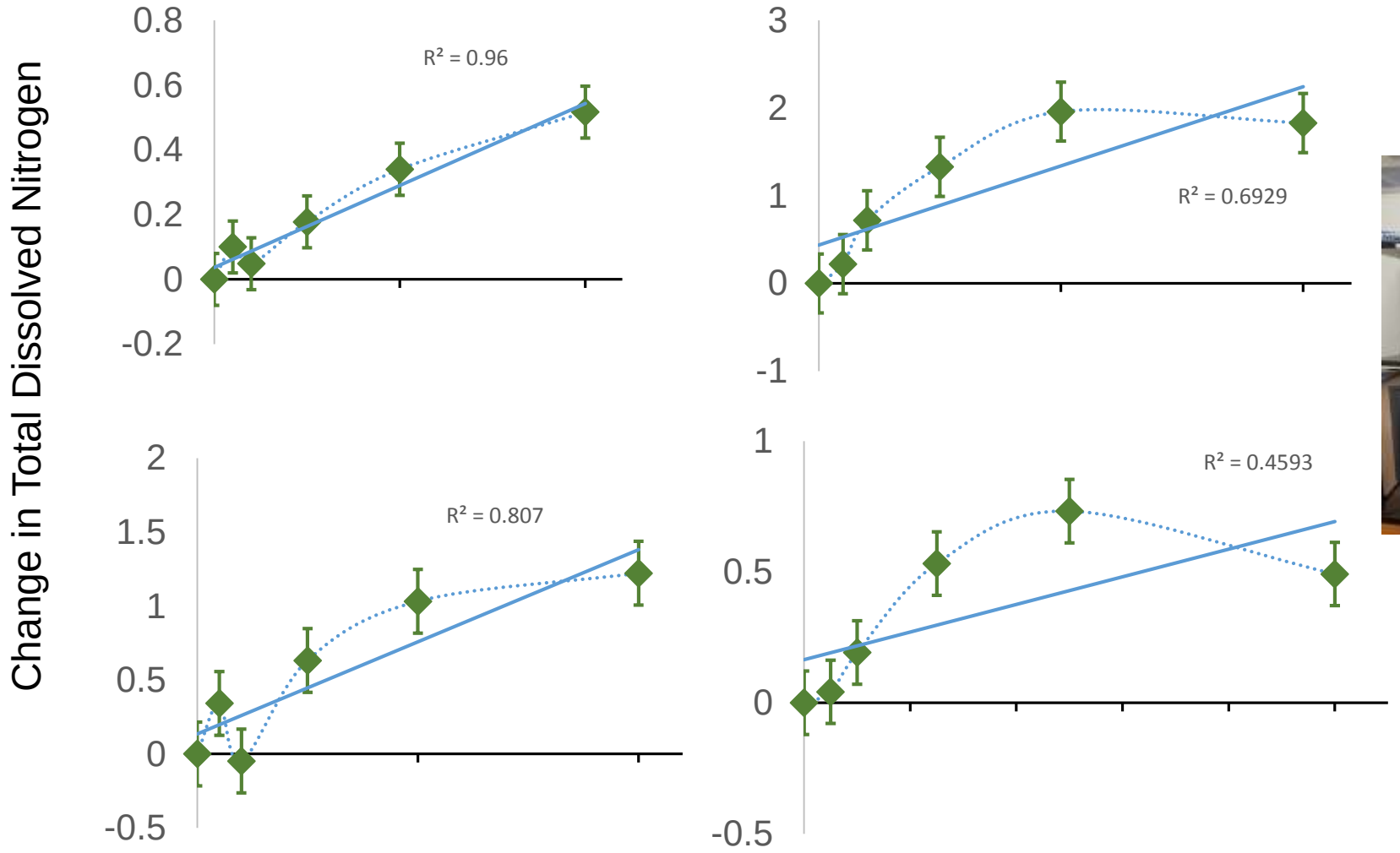


Gwynns Falls, Baltimore LTER, MD



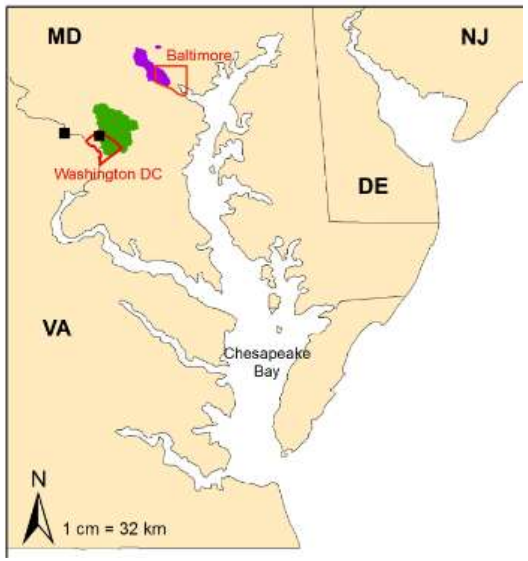
Haq et al. (2018) *Biogeochemistry*
Duan and Kaushal (2015) *Biogeosciences*

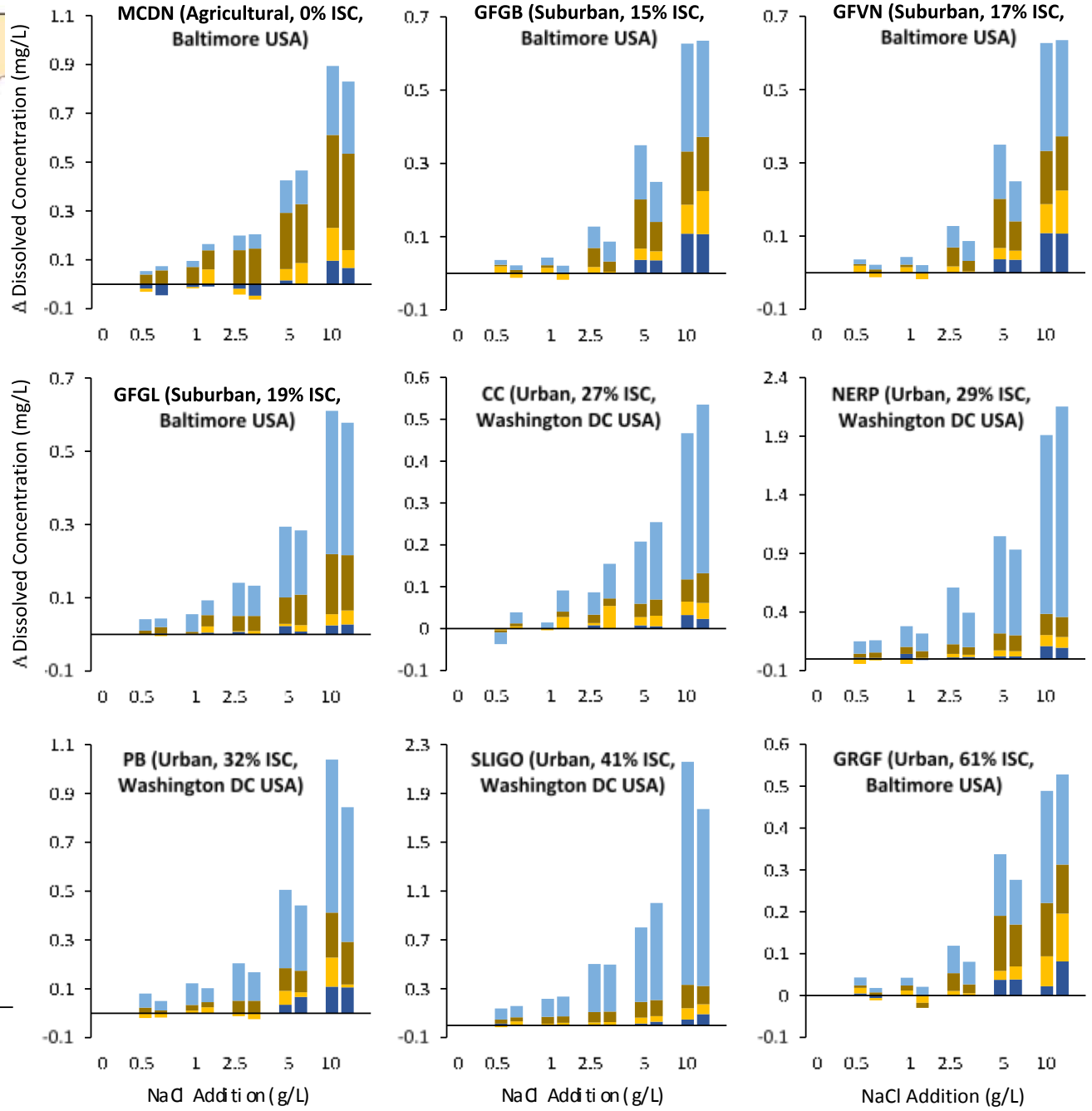
Salinization Mobilizes Nitrogen in Streams



Salt Dosing Experiments: 0 g/L, 0.5 g/L, 1 g/L, 2.5 g/L, 5 g/L, 10 g/L of Na Cl

Haq et al. 2018





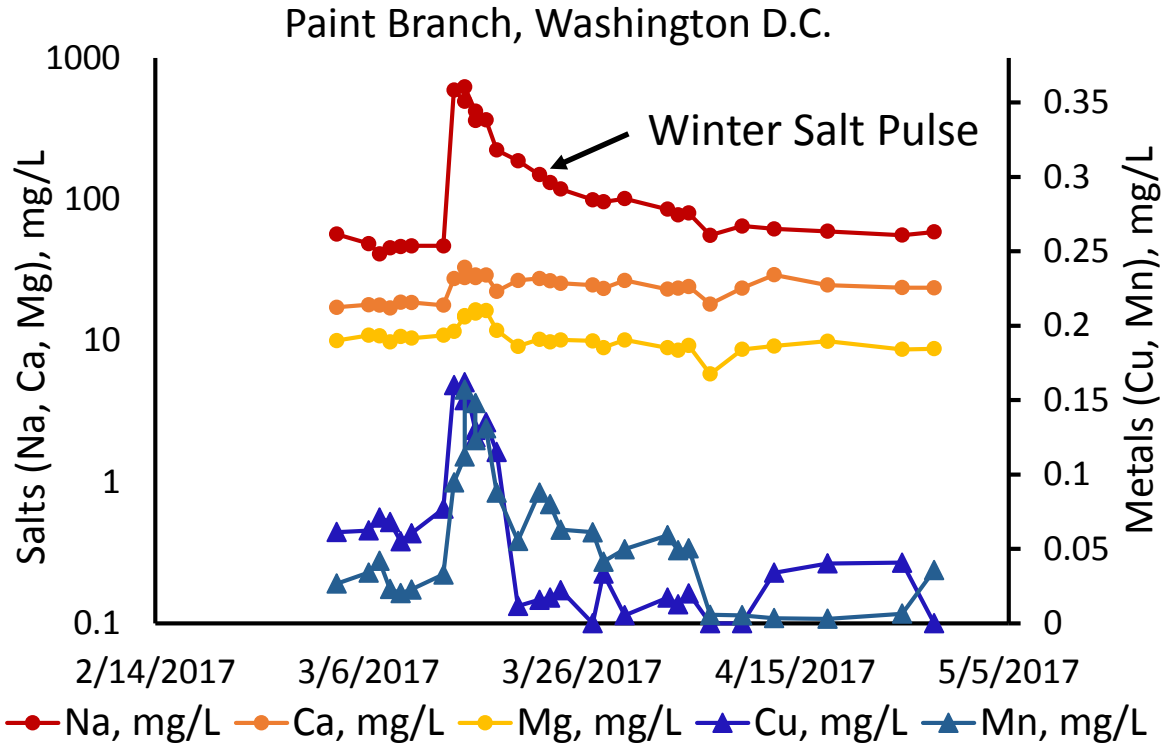
Kaushal et al. (2018b)
Philosophical Trans. Royal Society

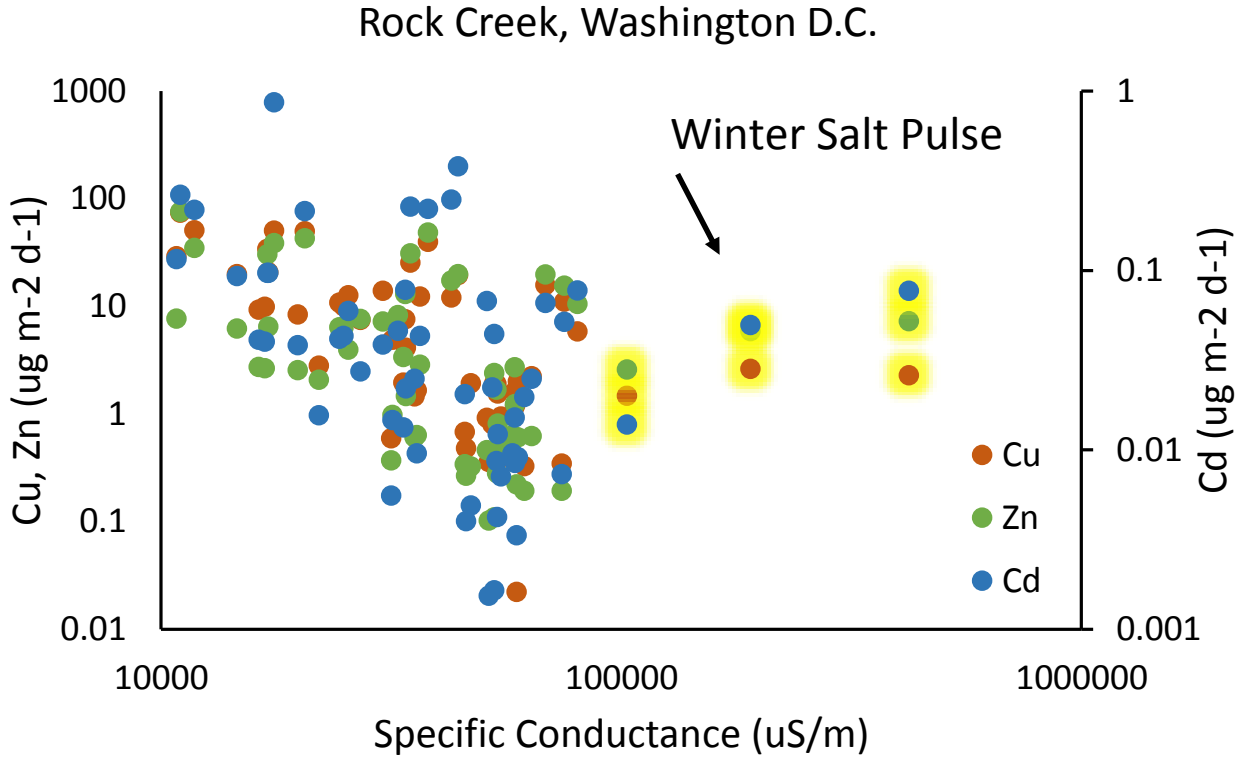
Outline

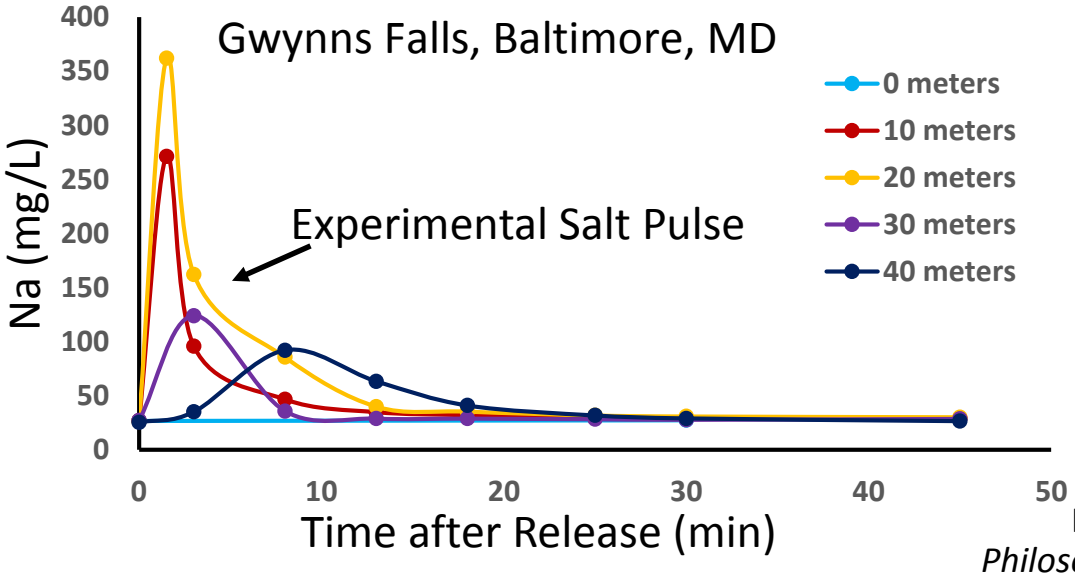
1. Freshwater Salinization Syndrome (FSS)
2. Novel Chemical Mixtures as a Consequence of FSS
3. Regional Monitoring and Data Gaps

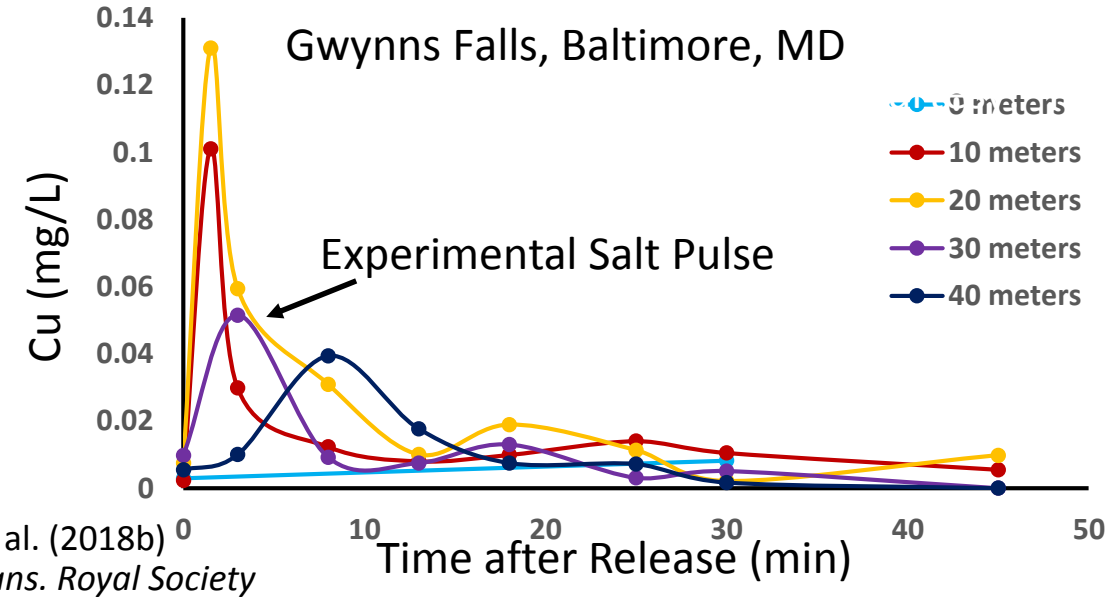
Which Chemical Cocktails Are Mobilized During Snow Events?

Photos Courtesy: K. Wood

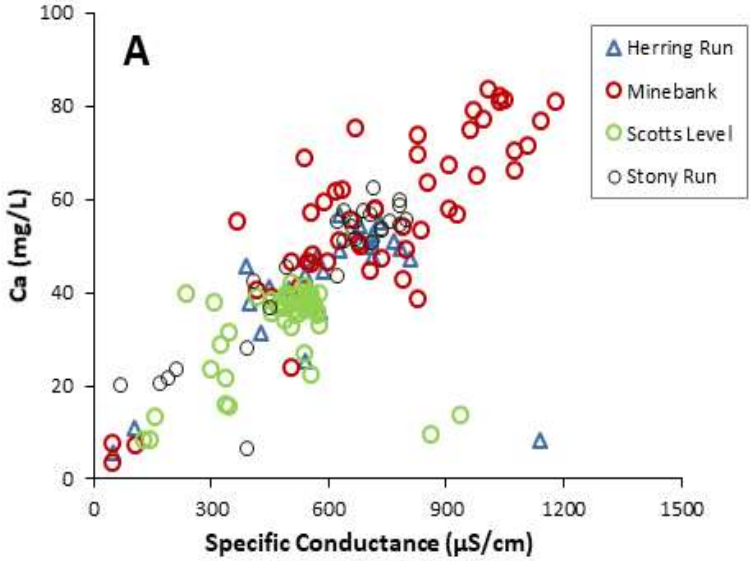


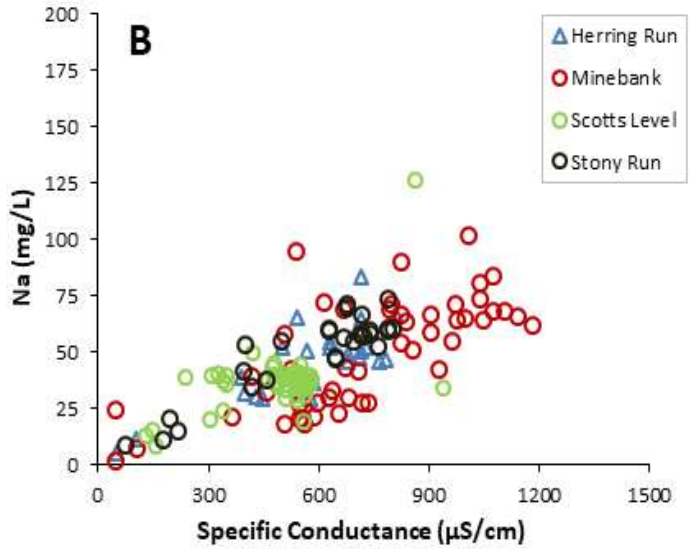


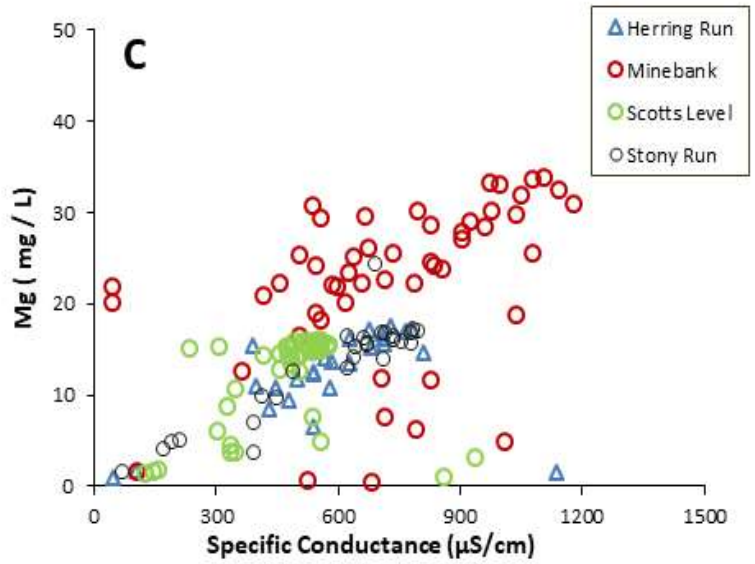


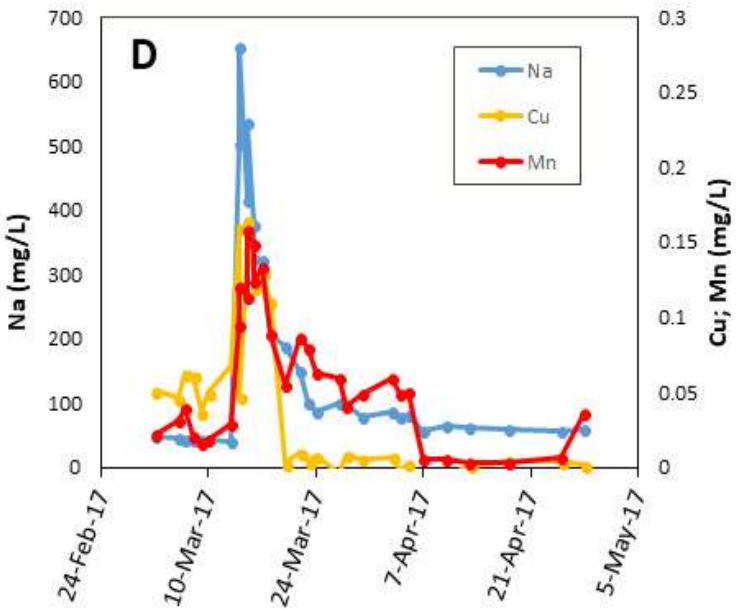


Kaushal et al. (2018b)
Philosophical Trans. Royal Society





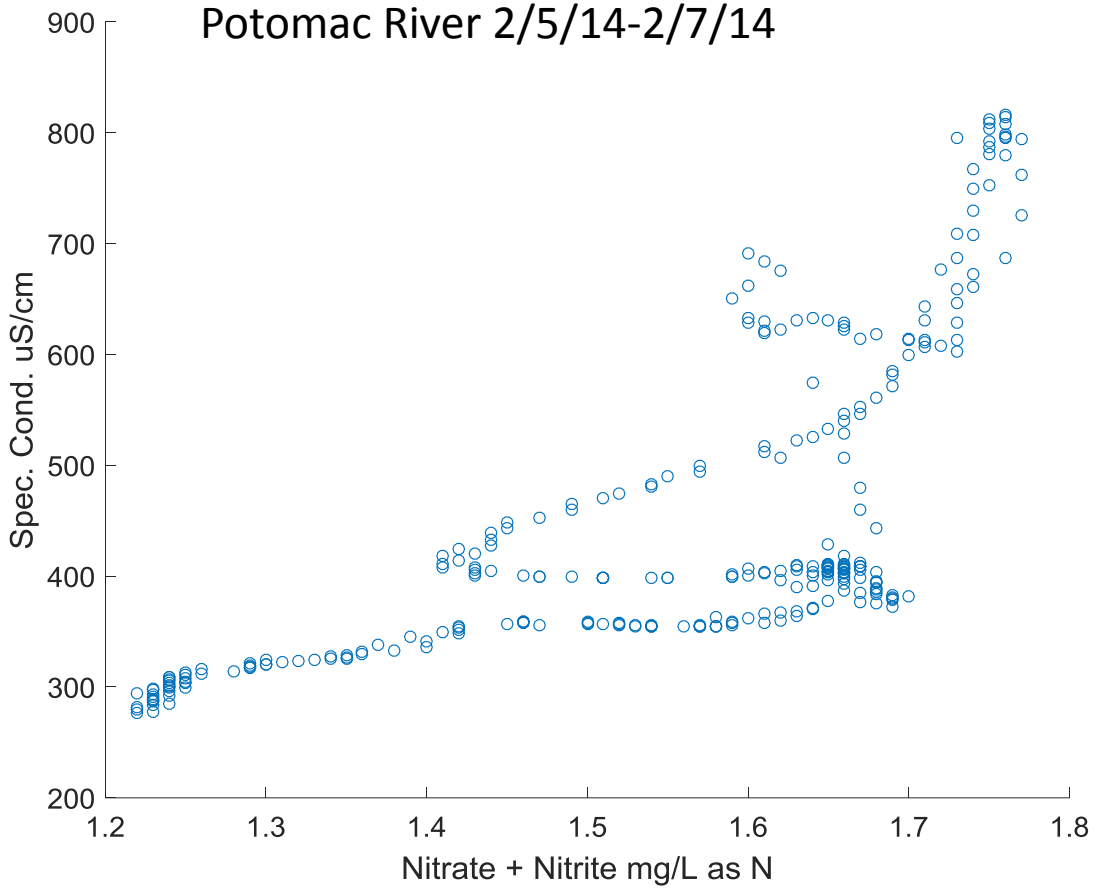


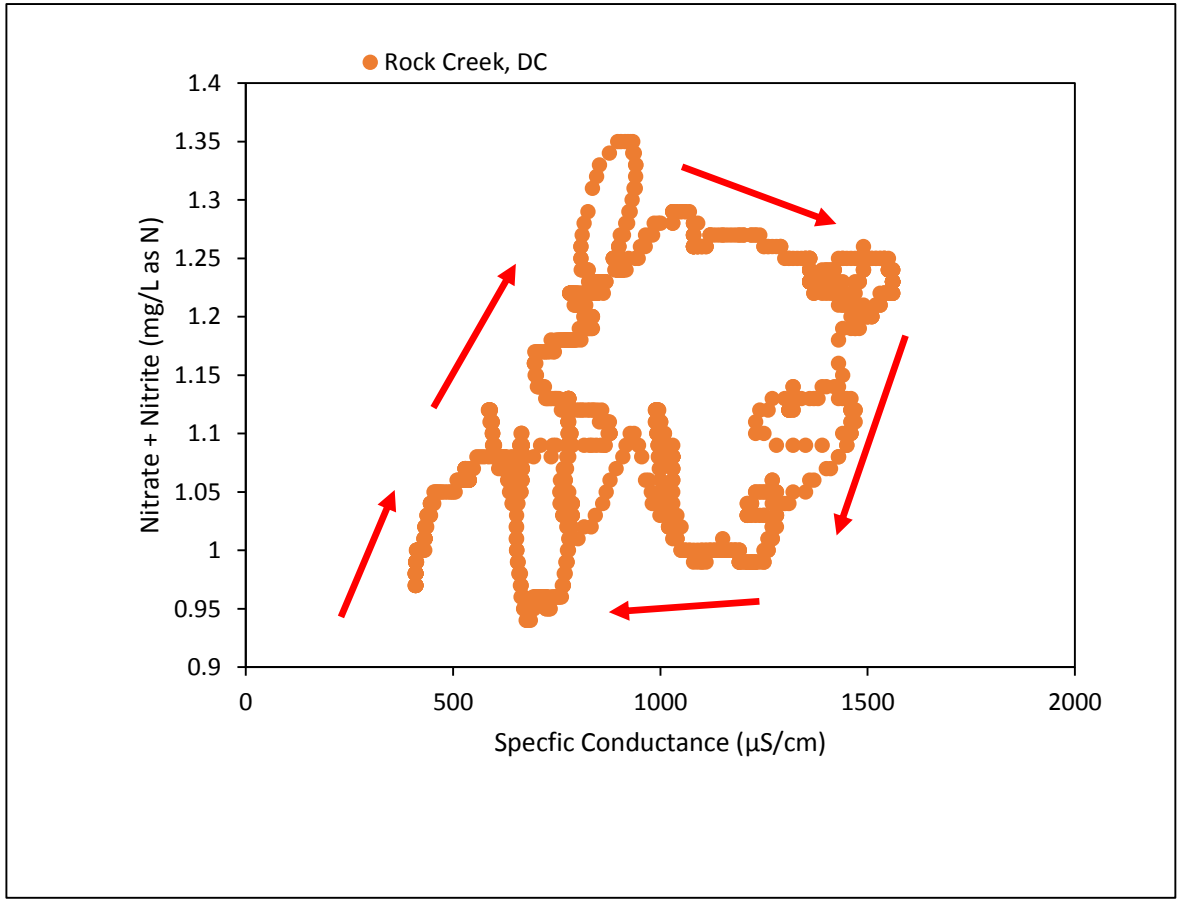


Developing Proxies for Chemical Cocktails: Using Sensors for Detecting Water Quality Exceedances?

Kaushal et al. (2018c)
Biogeochemistry

Sources of Nitrate Flushing during Snow Events?

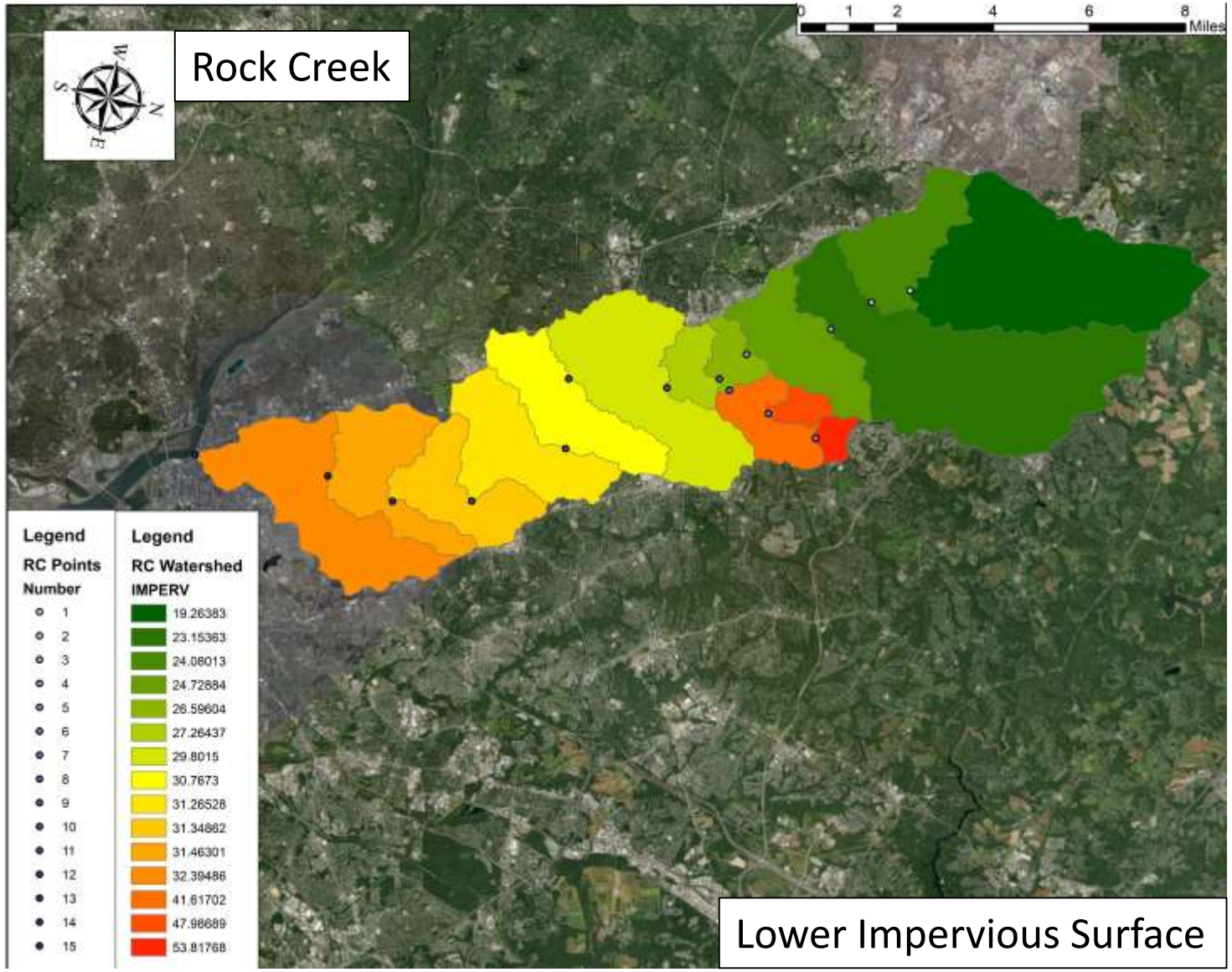


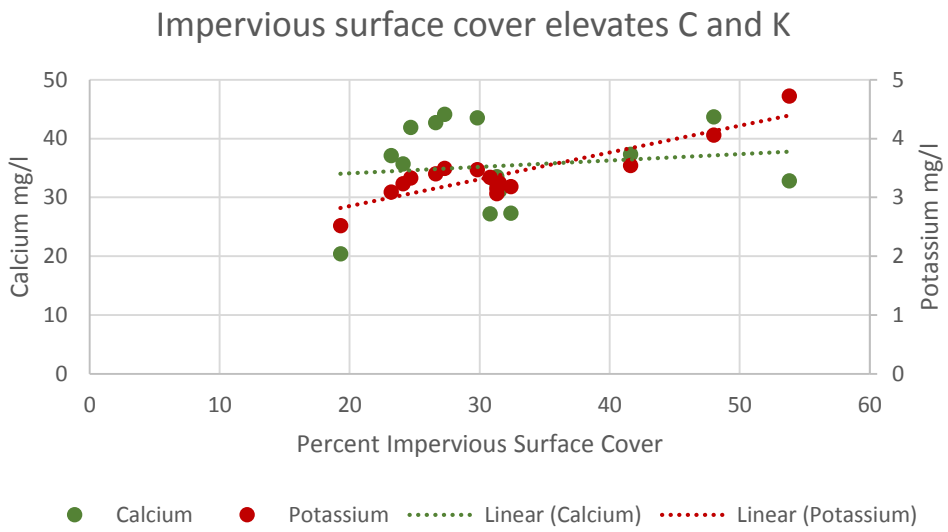


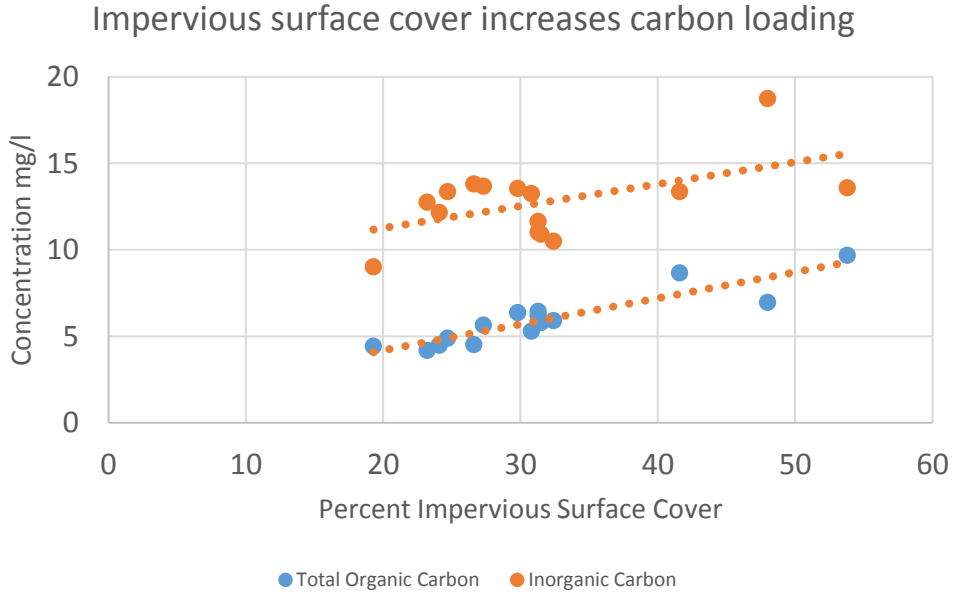
Kaushal et al. (2019)
Phil. Transactions of the Royal Society

Kaushal et al. (2018b)
Biogeochemistry

Salt Accumulation Along Watersheds: Stream "Salty Spots"







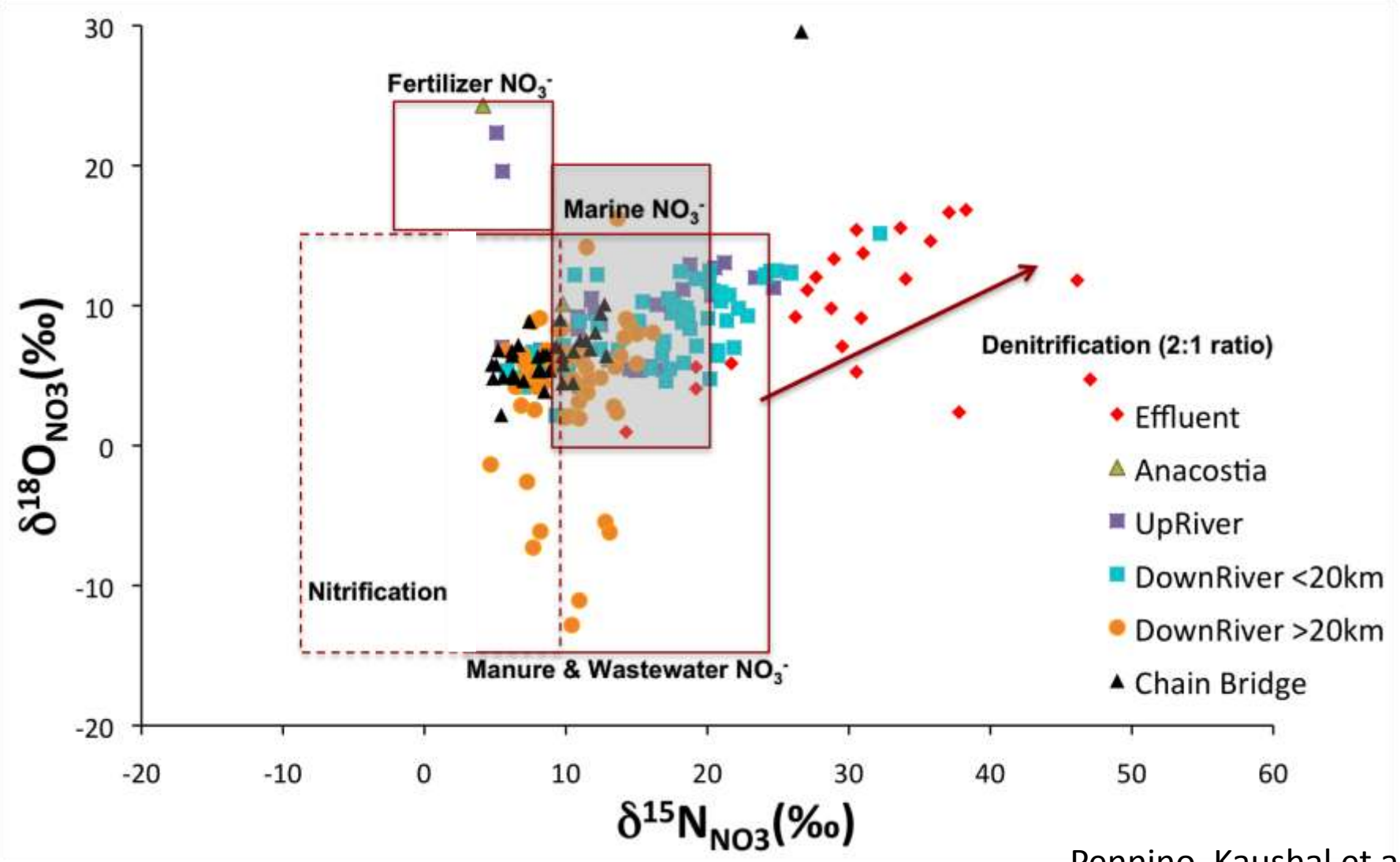
Conclusions

1. Freshwater Salinization Syndrome (FSS) emerges across local, regional, and continental scales

2. Chemical cocktails are a consequence of FSS

3. Mobilization of chemical cocktails across time and space in watersheds?

What are major sources of N?



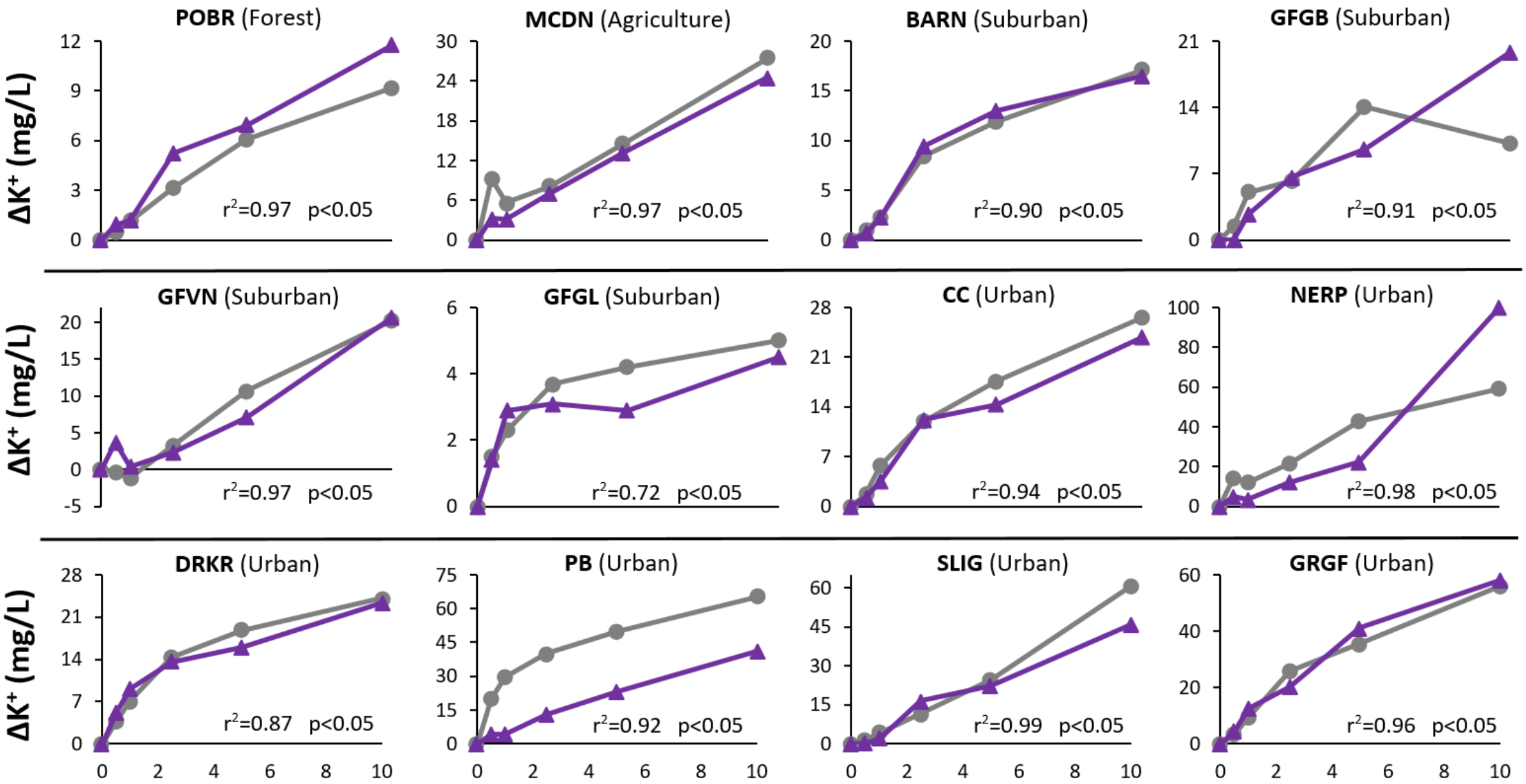
Pennino, Kaushal et al. (2016)

Freshwater Salinization Syndrome: An Introduction

by Matthew Wright

- https://www.youtube.com/watch?v=y-VCYHwpHmE&feature=youtu.be

Photo Courtesy: K. Belt



Haq et al. (2018) *Biogeochemistry*