TREE TRADE-OFFS IN STREAM RESTORATION PROJECTS: IMPACT ON RIPARIAN GROUNDWATER QUALITY

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Outline

- Overview/ Key Questions
- Methods/ Study Sites
- Results/ Discussion
- Management Implications

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Motivation

- Trees in riparian zones provide key water quality functions
- Trees can be removed from riparian zones during stream restoration
- There is a lack in our understanding of the effects of tree removal on water quality


How does removing trees affect groundwater quality?
Courtesy Gwen Sivirichi

Research Questions

- What is the impact of riparian tree removal during stream restoration and subsequent recovery (if any) on groundwater quality across restored, degraded, and forested reference sites in Maryland?

- Which type of broadly available data are best suited to predict (through the development of a user friendly tool) both the nominal and cumulative impacts of riparian zones with various history of tree dynamics / disturbance on water quality at the watershed scale?

Experimental Design

- Chronosequence of restoration up to 20 years
- Variety of stream restoration types
- Paired riparian zones with undisturbed trees and with trees removed in same watershed
- Measure concentrations of common plant nutrients and contaminants in ground water

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Characteristics of Study Sites

Site	Year(s) Restored	Latitude & Longitude	Area of Tree Removal During Restoration m^2	Geology	Soils	Depth to bedrock	Vegetation Present Today
Campus Creek	Planned	38°59'42.3"N, 76°56'45.3"W	Planned	Quaternary gravel and sand	Fine Loam	201 ft	Mature Trees (Maple, Holly, Beech)
Paint Branch	2014	38°59'43.6"N, 76°55'59.1"W	13,958	Quaternary gravel and sand	Fine Loam	201 ft	Herbaceous near river, Mature trees upland (Tulip Magnolia, Maple, etc.)
Stony Run	2009	39°21'22.2"N, 76°37'49.3"W	6,089	Late Precambrian to early paleozoic gabbro and norite	Fluvial	201 ft, 25 ft	Young/relatively smaller trees (Redbud, Beech, etc.)
Scotts Level Branch	2014	39°22'25.7"N, 76°47'41.5"W	9,703	Late Precambrian quartz-feldspar schist and granulite	Fine Loam	201 ft	Transect A: Herbaceous Transect B: Mature trees (Hickory, Oak, etc.)
Minebank Run - Upstream	1999	39°24'43.0"N, 76°33'12.5"W	No imagery available	Late Precambrian mica schist and gneiss	Fine Loam	201 ft	Mature trees (Sycamore, Beech, Oak, etc.) & herbaceous ground cover

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Tree Removal Area

Paint Branch

2012 vs. 2014

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Well installation

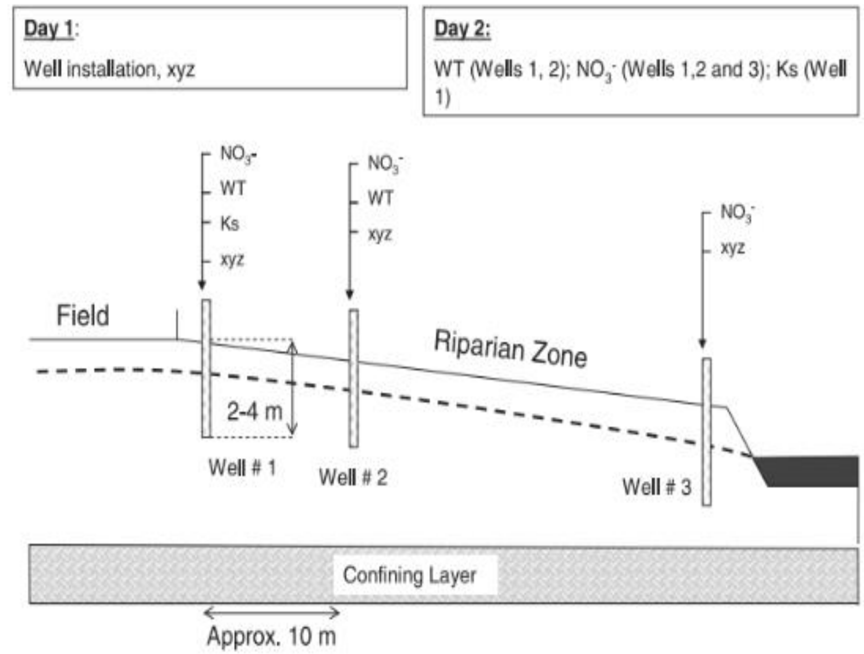


FIGURE 1. Schematic Diagram of the Field Layout and Summary of Measurements for the Simplified Method (NO_3^-, nitrate concentration measurement; WT, water table elevation measurement; Ks, saturated soil hydraulic conductivity measurement; xyz, measurement of relative distances and elevations between wells). The dashed line indicates the water table.

Vidon, Philippe and Michael G. Dosskey, 2008. Testing a Simple Field Method for Assessing Nitrate Removal in Riparian Zones. *Journal of the American Water Resources Association* (JAWRA) 44(2):523-534. DOI: 10.1111/j.1752-1688.2007.00155.x

Sampling Wells Routine Monthly

Measure depth to the water table.

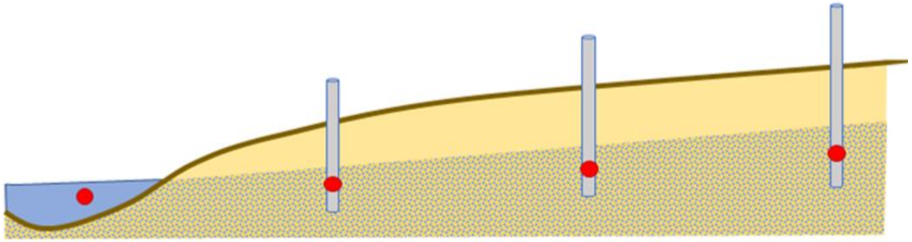
Collect ~200mL water sample from each well and the open channel

Lab Analyses

Filtered through 0.7µm glass fiber filter

Analyzed on a Shimadzu TOC-L for total nitrogen (TN), dissolved inorganic carbon (DIC), and non-purgeable organic carbon (NPOC).

Aliquot acidified with ultra-pure nitric acid and analyzed on a Shimadzu Ion Coupled Plasma Optical Emission Spectrometer (ICP-OES) for elemental and/or ionic composition of:
Ca, K, Mg, Na, S, Al, Cr, Zn, Cu, B, Fe, Mn, Ni, Pb, P, etc.



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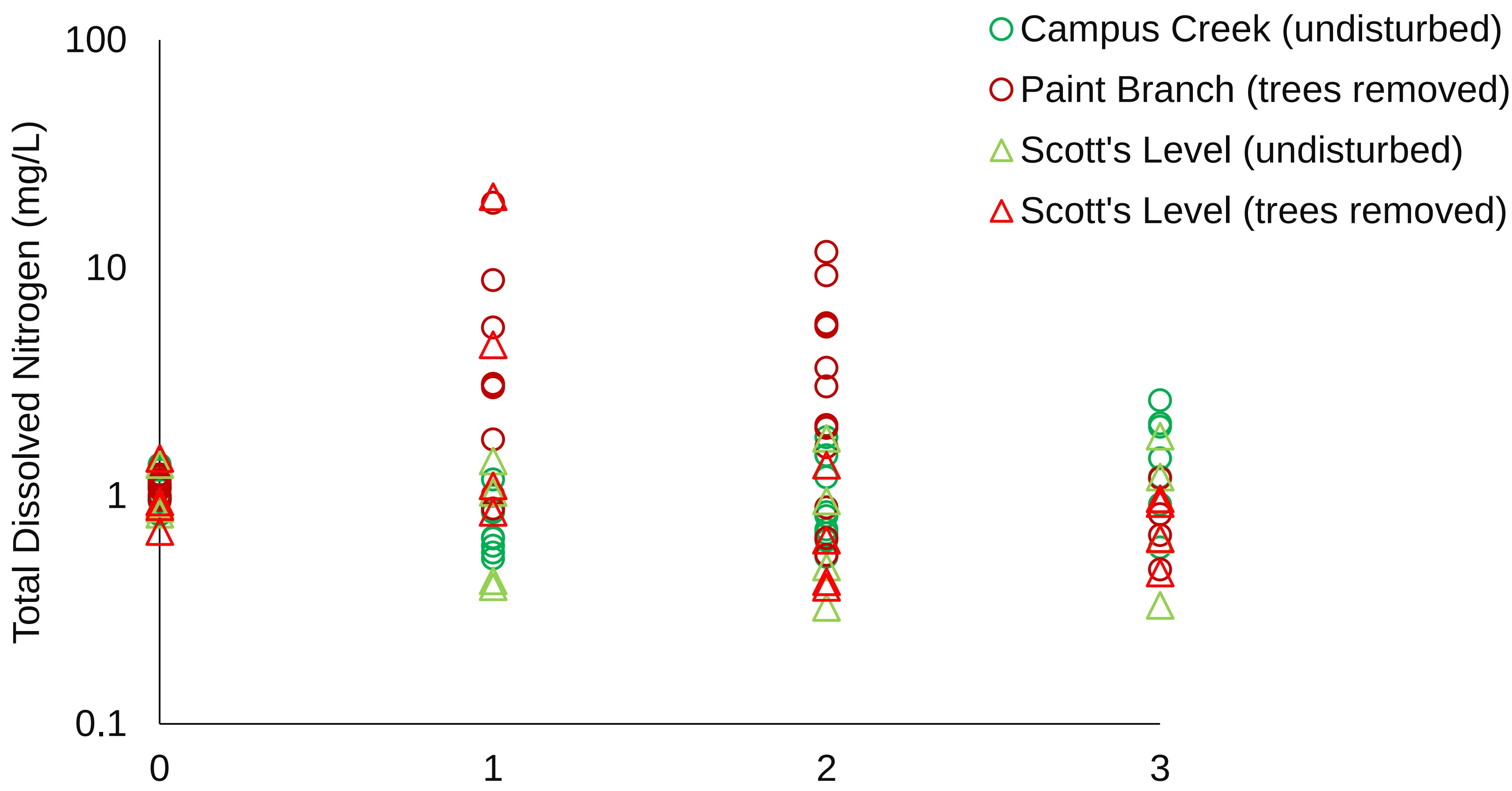
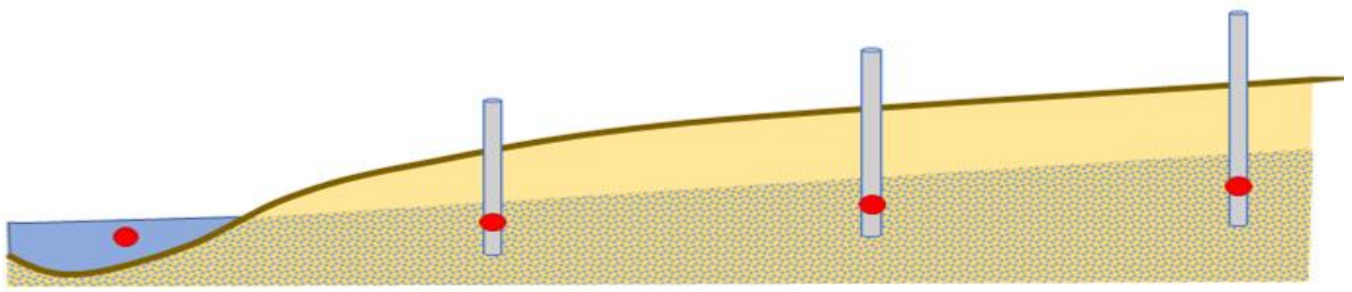
Sites where trees were removed had higher nutrient concentrations than sites where no trees were removed

- Concentrations of common plant nutrients (nitrogen, potassium, and calcium) were elevated in ground water in sites where trees were removed

- Concentrations of common plant nutrients in groundwater decrease downslope in riparian zones with trees, but increase downslope in riparian zones where trees were removed

Higher nitrogen concentrations in riparian ground water where trees were removed





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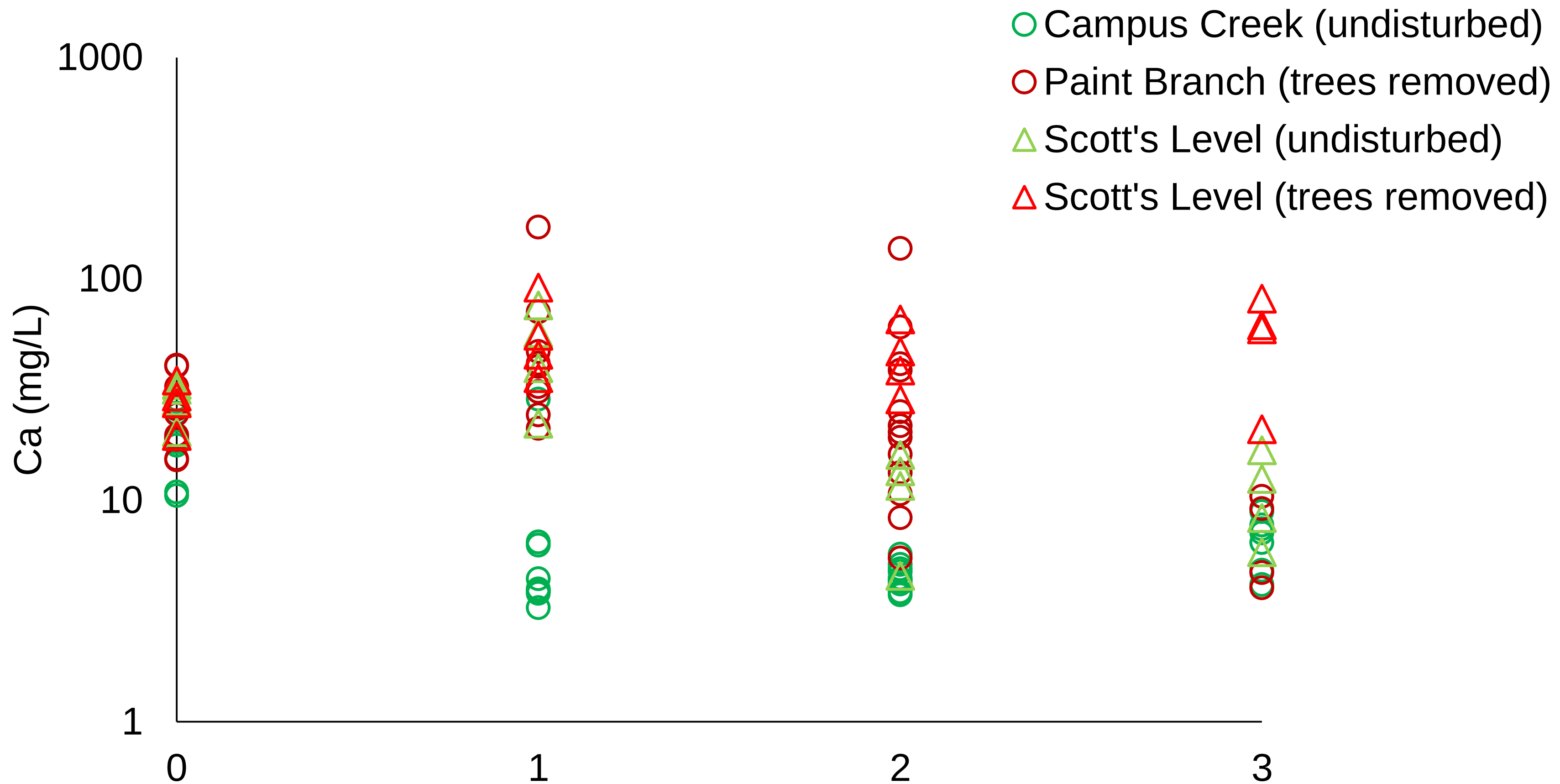
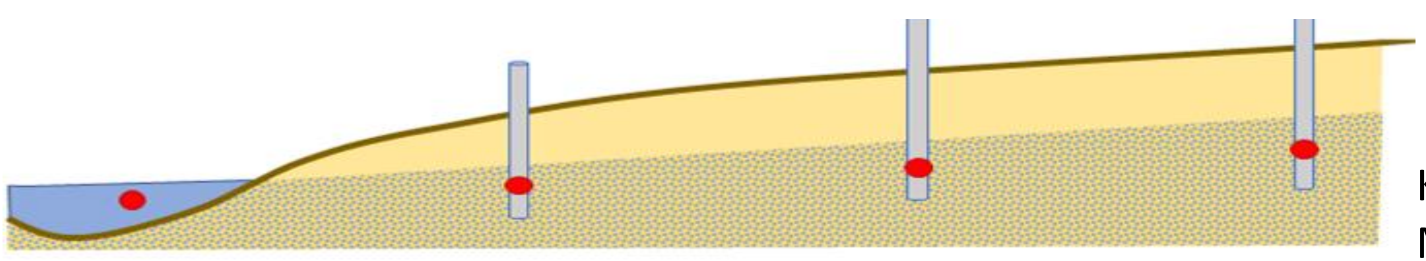
Higher calcium concentrations in riparian ground water where trees were removed





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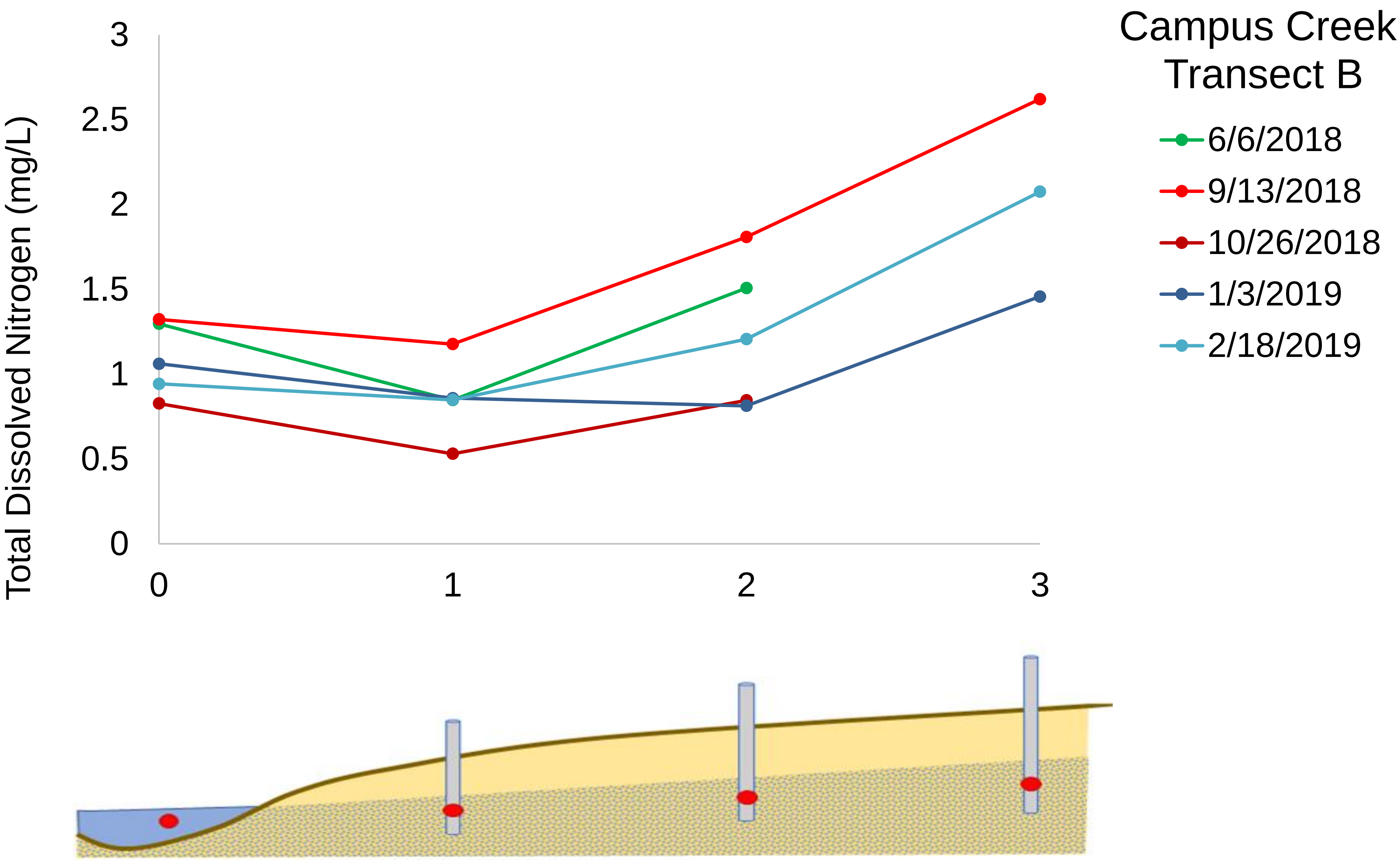
Nitrogen concentrations in groundwater decrease downslope in riparian zones with trees



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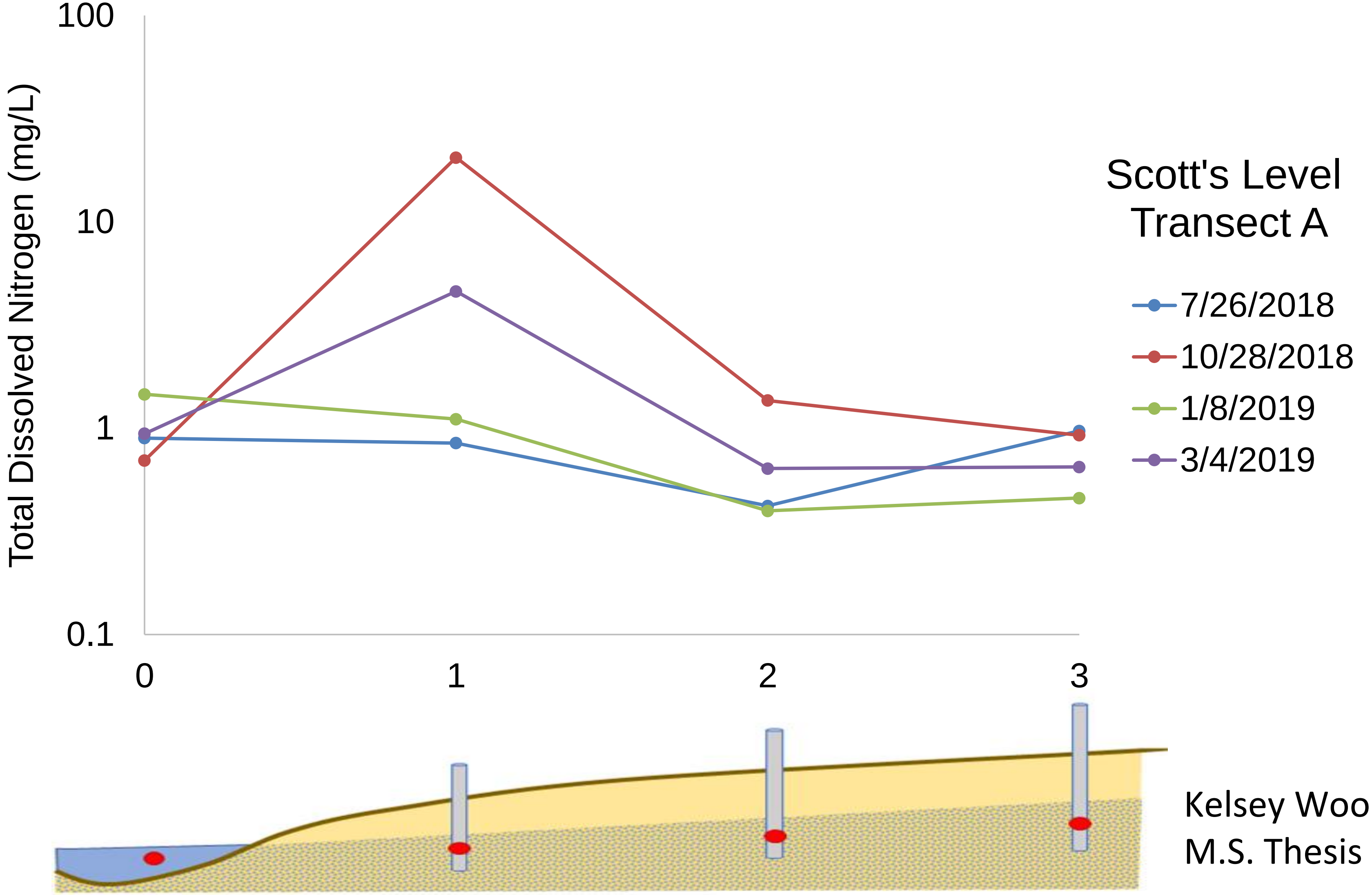
Nitrogen concentrations in groundwater increase downslope in riparian zones where trees were removed



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Other studies have shown increased nutrient concentrations after tree removal in watersheds

- Löfgren et al. (2009)
  - Increased consentrations of Na, K, N, Cl, ect.
- Martin and Pierce (1980)
  - Increased concentrations of Ca and N.
- Rusanen et. al. (2004)
  - Increased concentrations of N.
- Likens et al. (1970)
  - Increased concentrations of N, Ca, K, Na, Mg, ect.
- Hewlett et al. (1984)
  - Increased concentrations of N, K, Na, Ca, Mg, ect.
- Feller and Kimmins (1984)
  - Increased concentrations of N, K, Mg, Ca, ect.

Hubbard Brook Ecosystem Study

Summary

- Sites where trees were removed had higher nutrient concentrations than sites where no trees were removed

- Tree removal potentially decreases nutrient uptake along riparian groundwater flowpaths

- Work in progress and continuing sampling and analyses across seasons and hydrologic conditions

Future Work

- Topographic survey
  - -calculate water table gradients
  - -characterize flowpath directions

- Vegetation survey
  - -characterize tree species
  - -estimate tree biomass

- RZ Tradeoffs nutrient model
  - - add a modifying parameter for vegetative disturbance

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Ryan Cole, Maryland Department of Transportation State Highway Administration

What does this mean for me?

- Results confirm that tree removal impacts water quality
- How long does recovery take?
- What types of vegetation cover type (age and species) have the most effect?
- Does the tree removal affect the overall benefit of the stream restoration project?

Acknowledgment Slide

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