Montana AWRA
October 12, 2023

Pathways of nitrate processing across agricultural riparian corridors characterized through geochemical analyses of water from shallow aquifers and streams.

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Pathways of nitrate processing through geochemical analyses

Why is this research important?

Why is our study site relevant?

What does the data tell us?

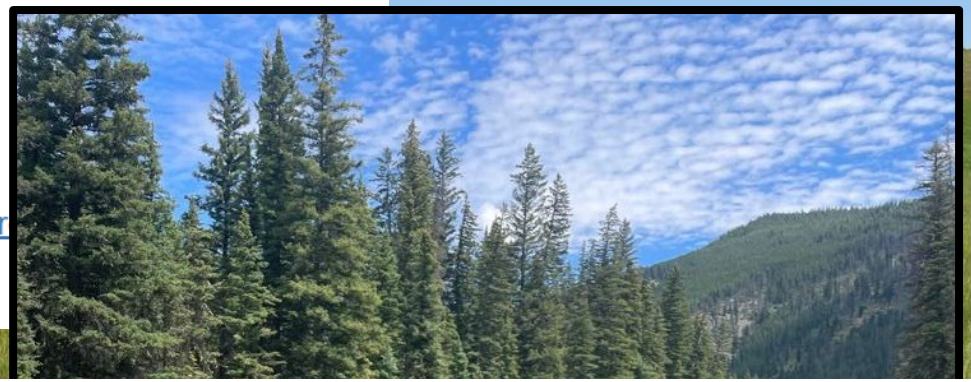
Why do we care?

Why is this research important?

Int J Environ Res Public Health. 2018 Jul; 15(7): 1557.
PMCID: PMC6068531
Published online 2018 Jul 23. doi: 10.3390/ijerph15071557

Drinking Water Nitrate and Human Health: An Updated Review

Mary H. Ward,[1,*] Rena R. Jones,[1] Jean D. Brender,[2] Theo M. de Kok,[3] Peter J. Weyer,[4] Bernar
Cristina M. Villanueva,[6,7,8,9] and Simone G. van Breda[3]



Nutr Cycl Agroecosyst (2023) 126:1–20
https://doi.org/10.1007/s10705-023-10263-3

ORIGINAL ARTICLE

Using spatially variable nitrogen application and cr responses to evaluate crop nitrogen use efficiency

Paul B. Hegedus · Stephanie A. Ewing · Clain Jones · Bruce D. Maxwell

The Nature Conservancy

WHAT WE DO ABOUT US GET INVOLVED MEMBERSHIP & GIVING

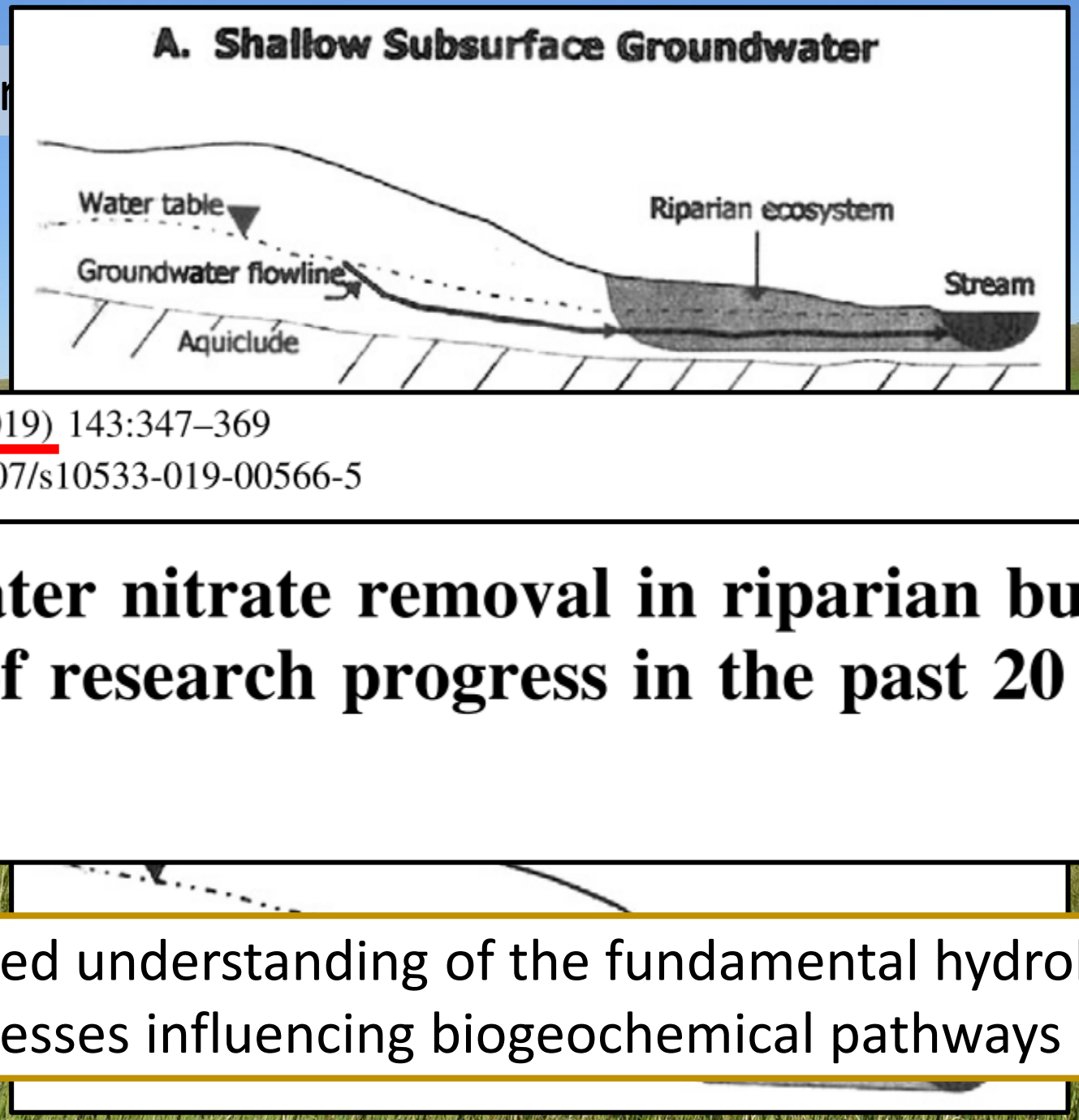
STORIES IN ILLINOIS

Small Wetlands, Big Benefit: How to Harness Nature to Filter Agriculture Runoff

A long-term study of constructed wetlands in Illinois shows a nearly 50% reduction of excess nutrients in agricultural runoff that can damage wildlife habitat and impact drinking water quality.

August 29, 2022

Why is this resear



Biogeochemistry (2019) 143:347–369
https://doi.org/10.1007/s10533-019-00566-5

Groundwater nitrate removal in riparian buffer zones: a review of research progress in the past 20 years

Alan R. Hill

limited understanding of the fundamental hydrologic and redox processes influencing biogeochemical pathways in riparian systems

Primary research question:

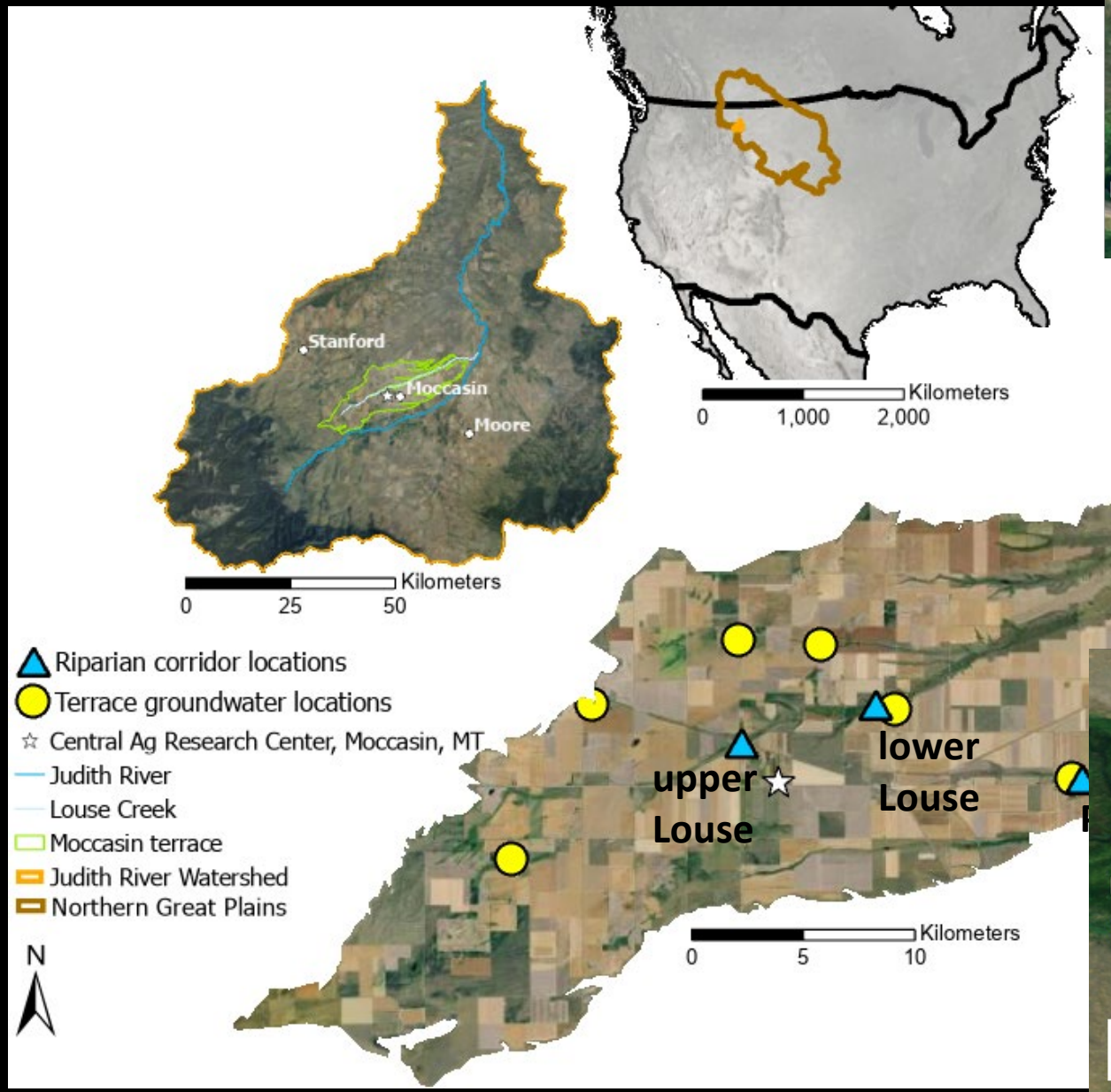
How do riparian corridors control water and solute exchange between upland terrace groundwater and stream channel waters to decrease nitrate exports?

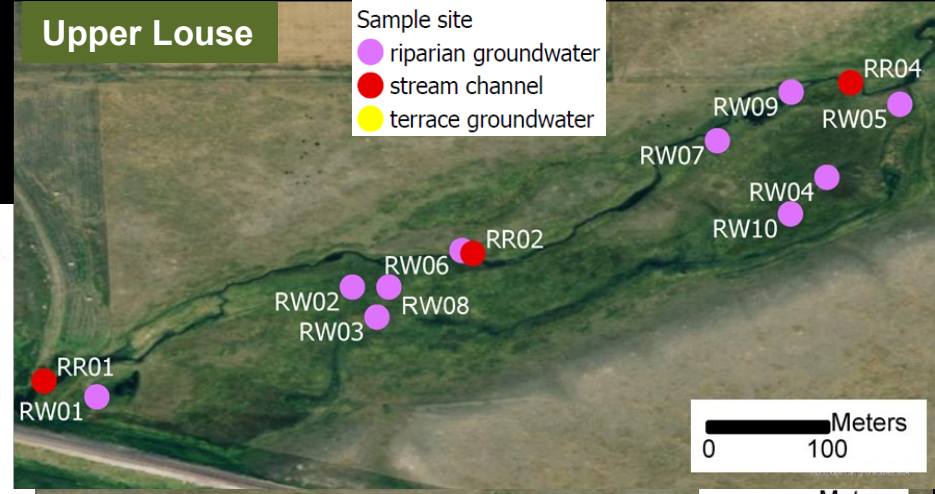
Hypothesis: Riparian soils facilitate nitrate reduction through supplying organic carbon and heterogeneous mineral surface area that influence water residence times and reaction surfaces.

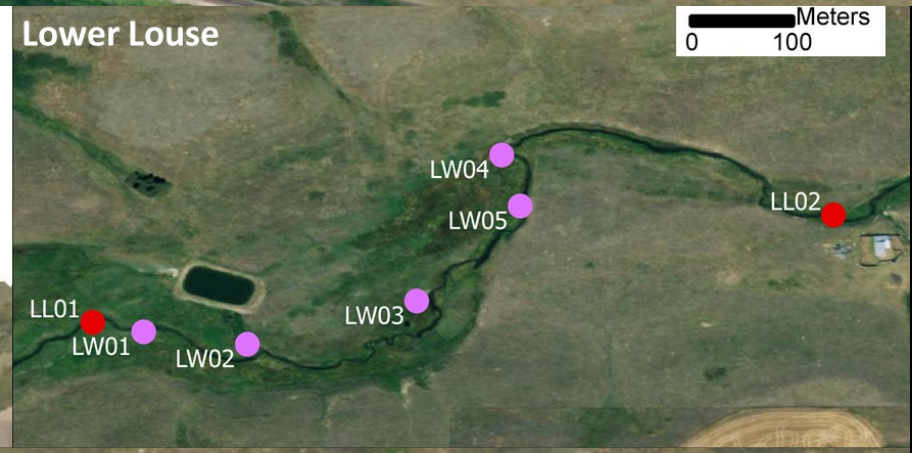
Predictions:

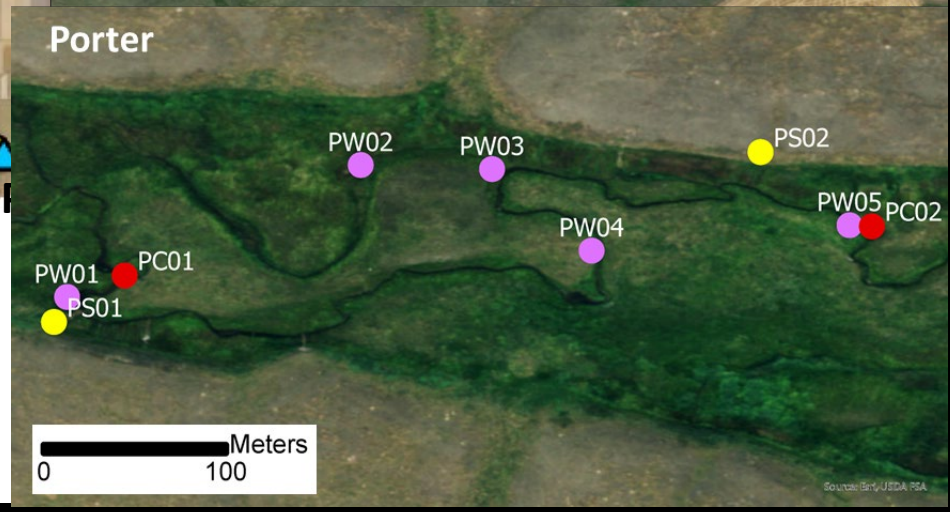
1. Variable nitrate concentrations reflect different reduction pathways.
2. Spatial patterns in riparian water chemistry reflect ecosystem controls on hydrology and reactivity.

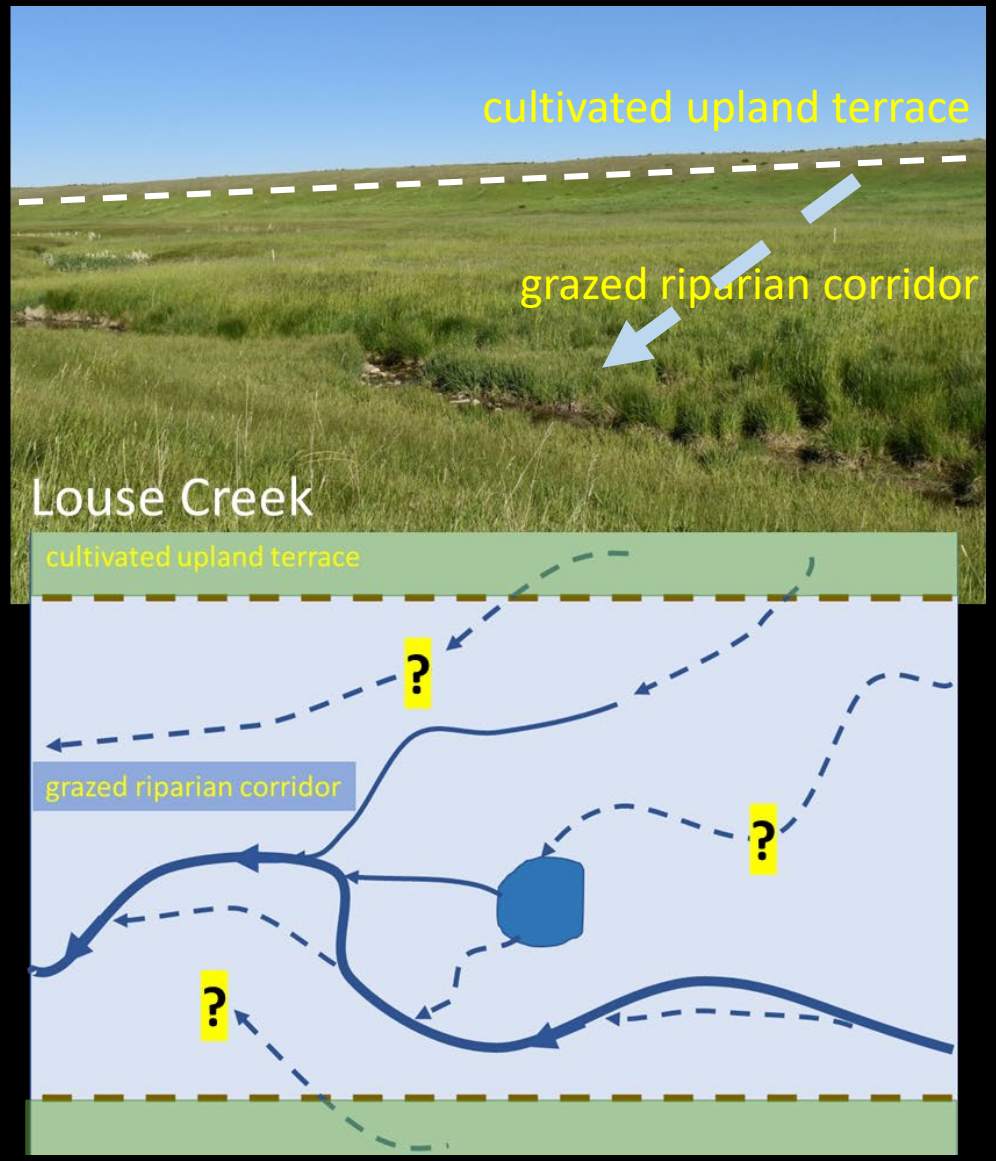
Why is our study site relevant?



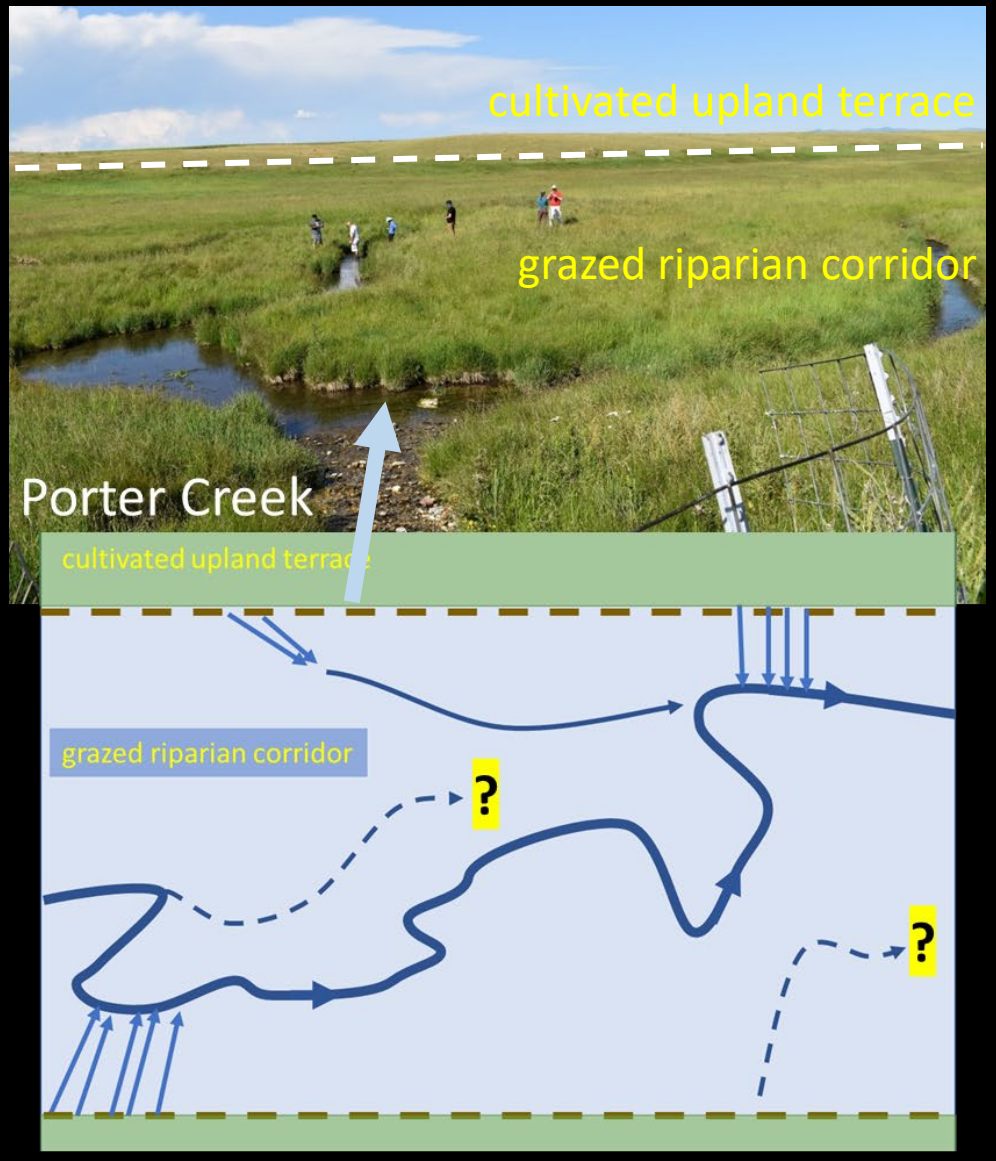








Flow through riparian substrate



Direct discharge into stream

What do the data tell us?

Heterotrophic nitrate reduction: $5CH_3COO^- + 8NO_3^- + 13H^+ \rightarrow 10CO_{2(g)} + 14H_2O + 4N_2$

Dissolution and dissociation of inorganic carbon species: $CO_{2(g)} + H_2O \leftrightarrow H_2CO_3 \rightarrow H^+ + HCO_3^-$

pH 7-8

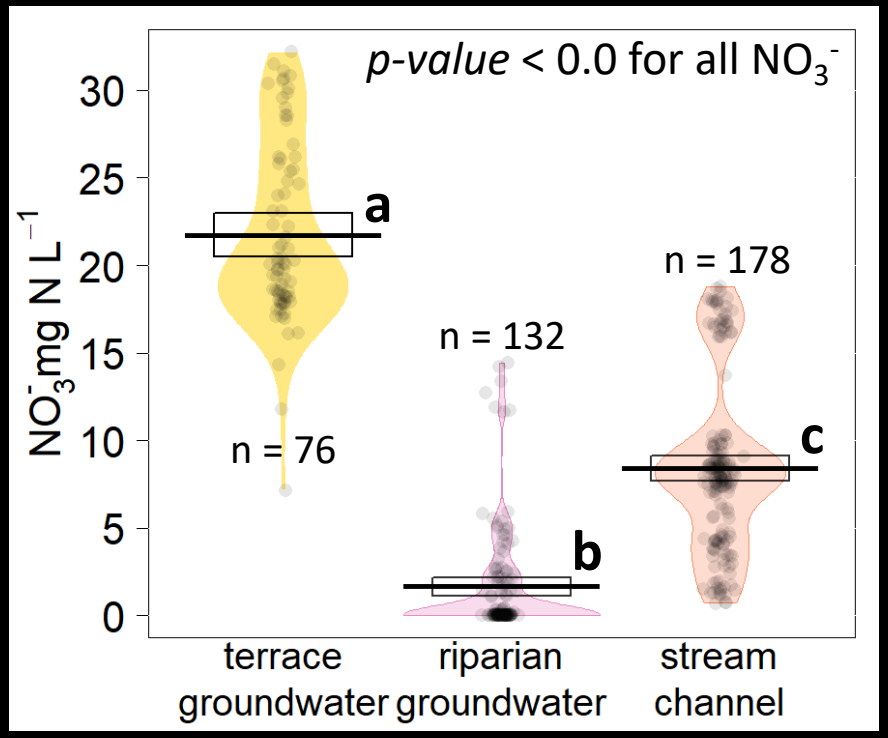
Heterotrophic sulfate reduction: $2CH_2O + SO_4^{2-} \rightarrow H_2S + 2HCO_3^-$

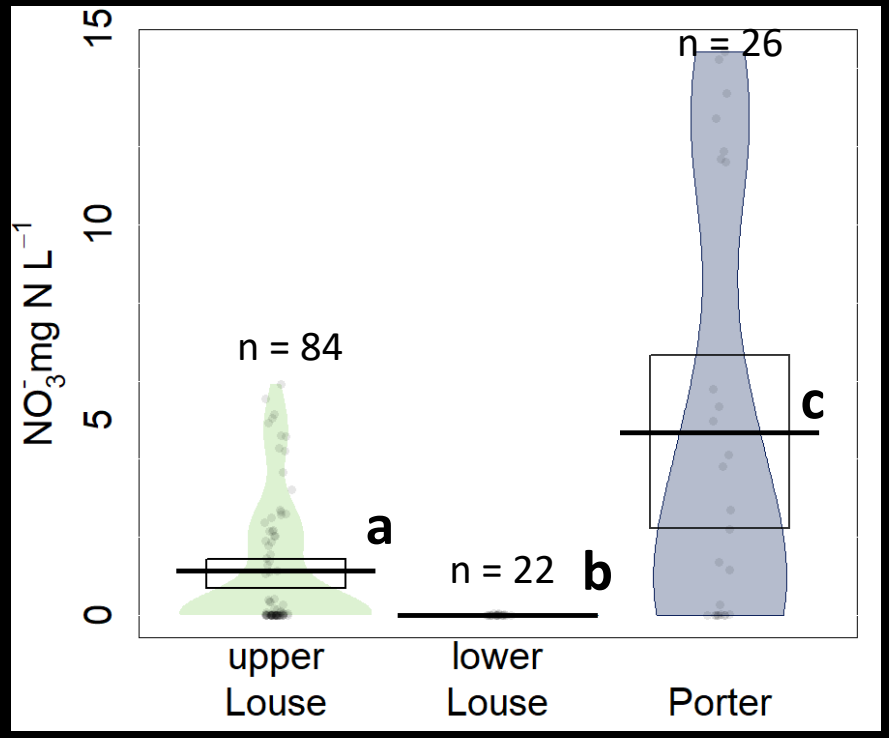
What do the data tell us?

Heterotrophic nitrate reduction: $\downarrow NO_3^- \;\&\; \uparrow HCO_3^-$

Heterotrophic sulfate reduction: $\downarrow SO_4^{2-} \;\&\; \uparrow HCO_3^-$

Nitrate reduction occurs in riparian corridors, but varies within and across riparian ecosystems





Analytical uncertainty:
NO_3^- = 5%
else= 10%

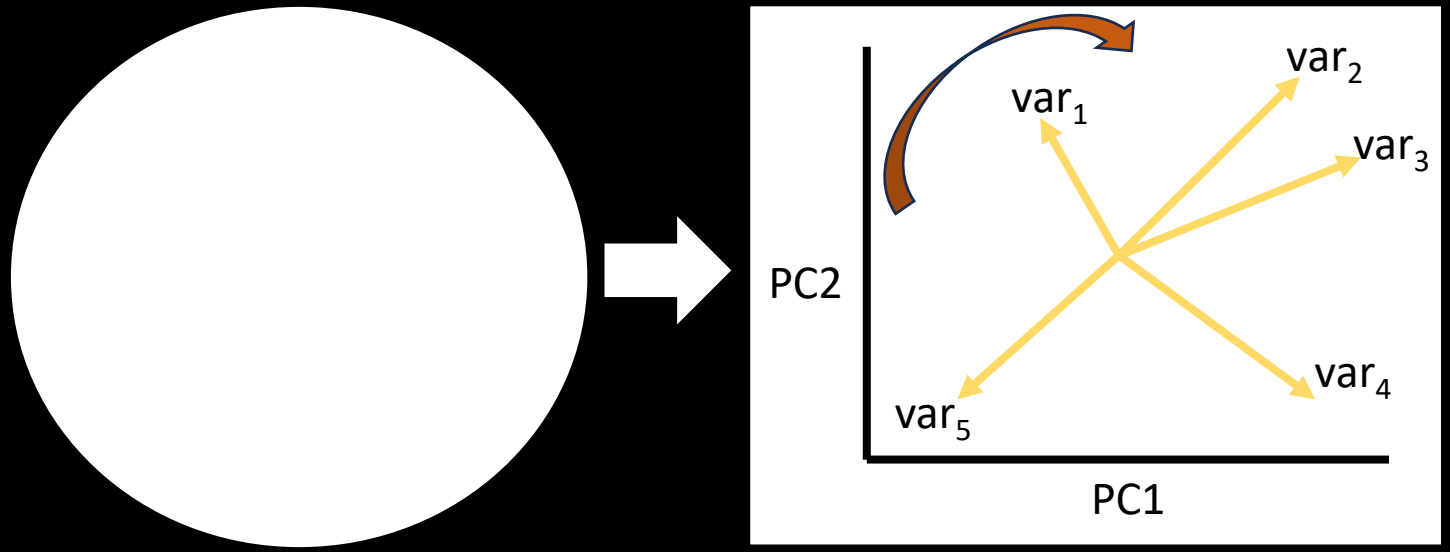
2021-2022
Terrace groundwater:
2013-2016 (Sigler et al., 2018), **2021-2022**

What do the data tell us?

Heterotrophic nitrate reduction: ↓ NO_3^- & ↑ HCO_3^-

Heterotrophic sulfate reduction: ↓ SO_4^{2-} & ↑ HCO_3^-

Principal Component Analysis:



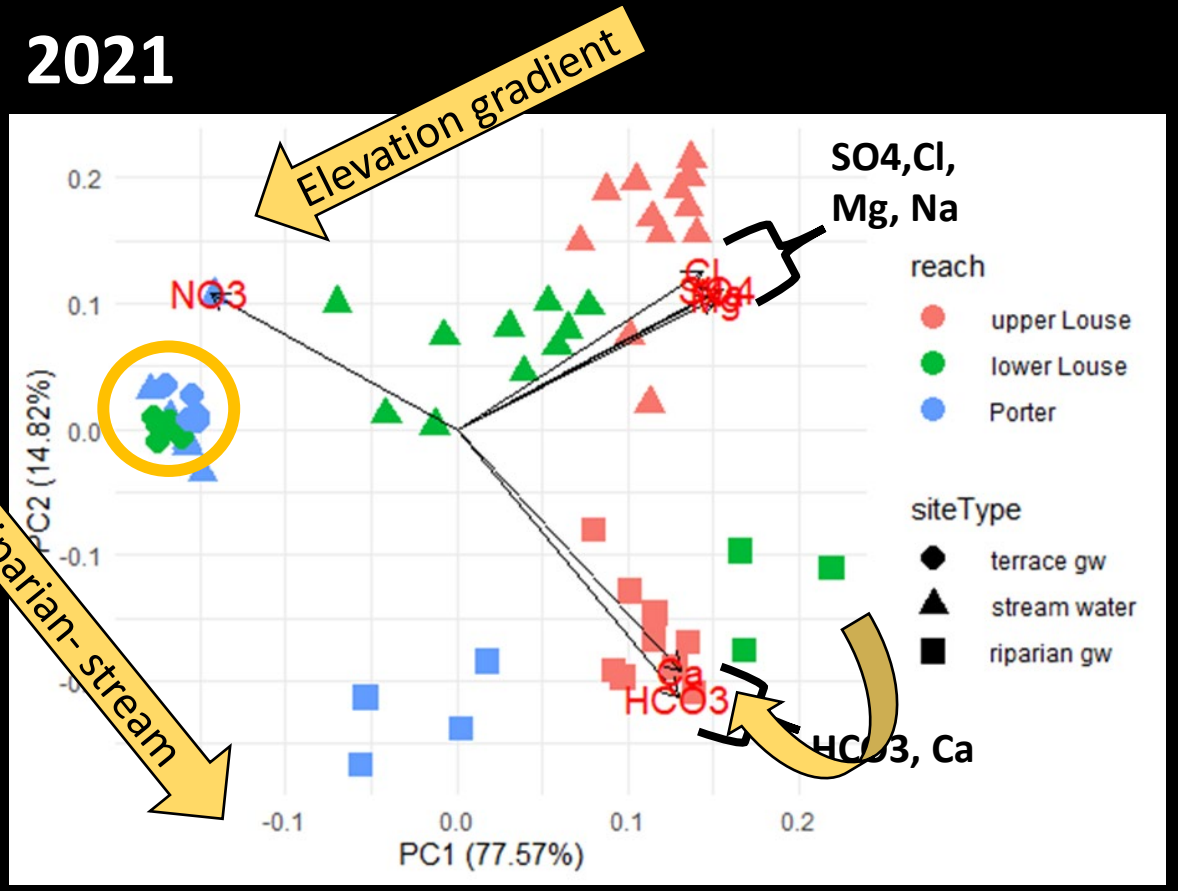
What do the data tell us?

Heterotrophic nitrate reduction: $\downarrow NO_3^-$ & $\uparrow HCO_3^-$

Heterotrophic sulfate reduction: $\downarrow SO_4^{2-}$ & $\uparrow HCO_3^-$

Terrace groundwater: 20 mg N L^{-1}

2021



- Heterotrophic nitrate reduction processes exist within **riparian corridors**
- Sulfate production is likely driven by soil weathering, most evident in **stream water**.
- Temporal variation within **corridors**

Why do we care?

Primary research question: **How do riparian corridors control water and solute exchange between upland terrace groundwater and stream channel waters to decrease nitrate exports?**

- Variations in solute concentrations within and across reaches indicate even though heterotrophic nitrate reduction processes occur, alternate novel pathways for nitrate reduction exist and are important (e.g., sulfur, methane, and/or iron coupled with nitrogen cycling)
  - Microbial composition and function (DOE funded N-DAMO research)
  - Isotopic composition of nitrate and sulfate

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Thank you

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Dr. Robert Payn
Dr. Kelsey Jencso
Dr. Ann Marie Reinhold
Dr. Jean Dixon

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Madison Boone
Dr. Adam Sigler
Simon Fordyce
Dr. Paul Hegedus
Zoe Durkin
Madeline Beck
Madisynn Weber
Rachel Anderson
Sean Williams
Kendall Wojcik

Sunrise over the Moccasin Range