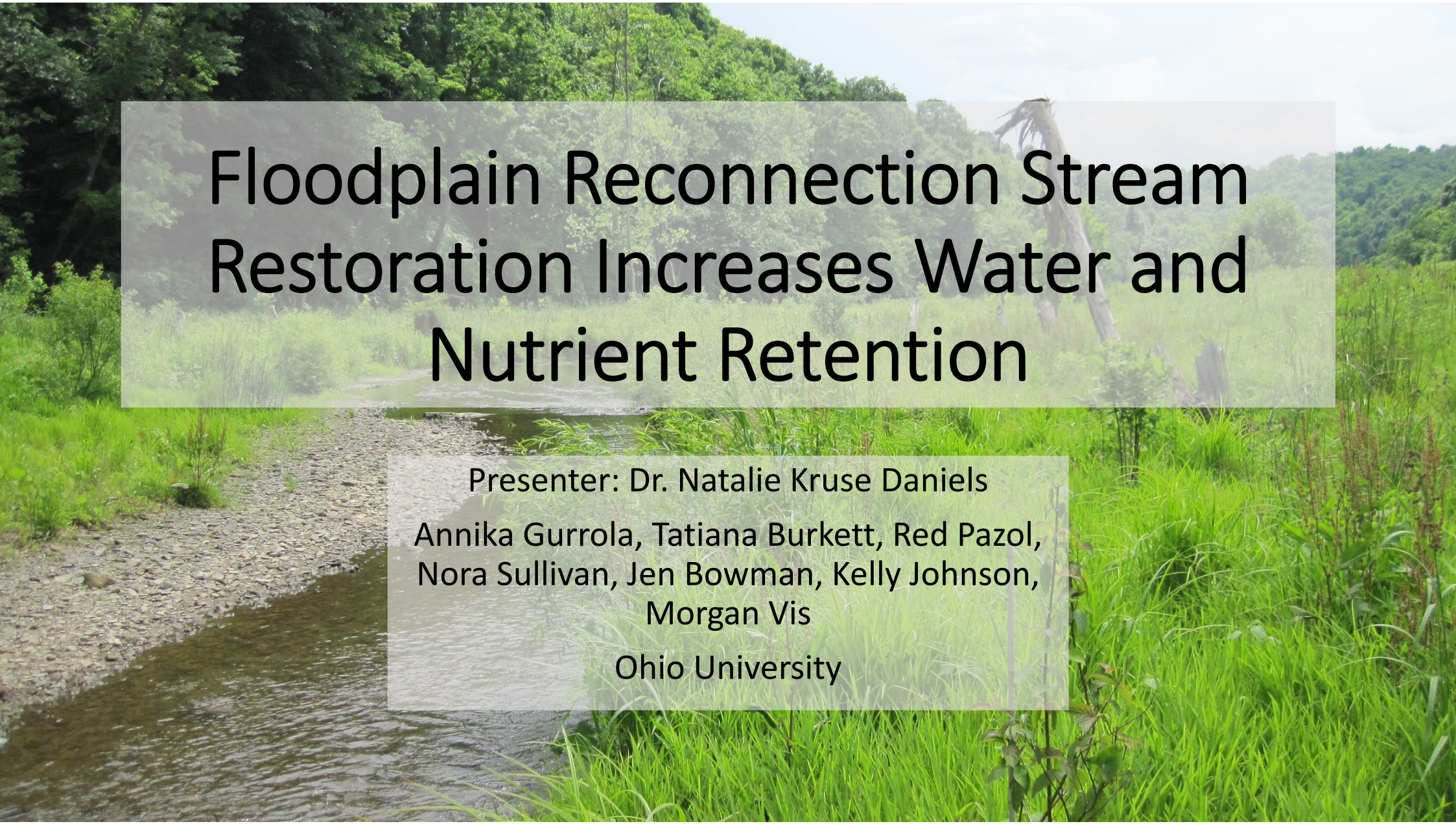


Floodplain Reconnection Stream Restoration Increases Water and Nutrient Retention

Presenter: Dr. Natalie Kruse Daniels

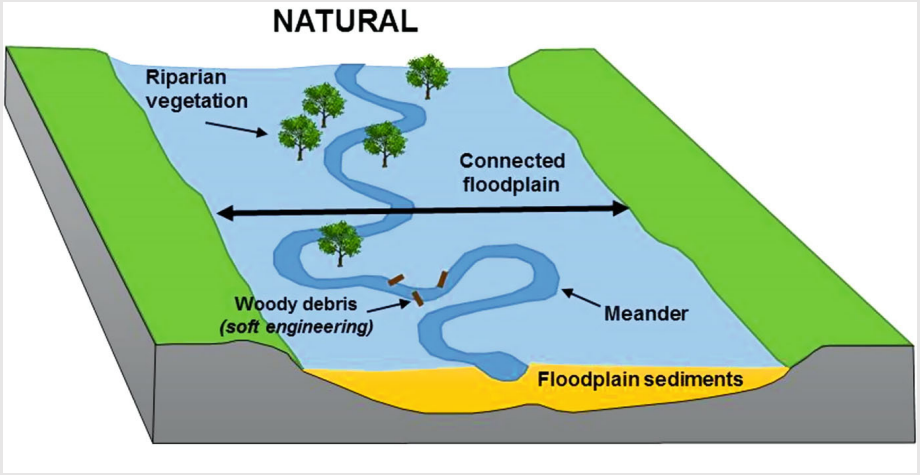
Annika Gurrola, Tatiana Burkett, Red Pazol, Nora Sullivan, Jen Bowman, Kelly Johnson, Morgan Vis

Ohio University

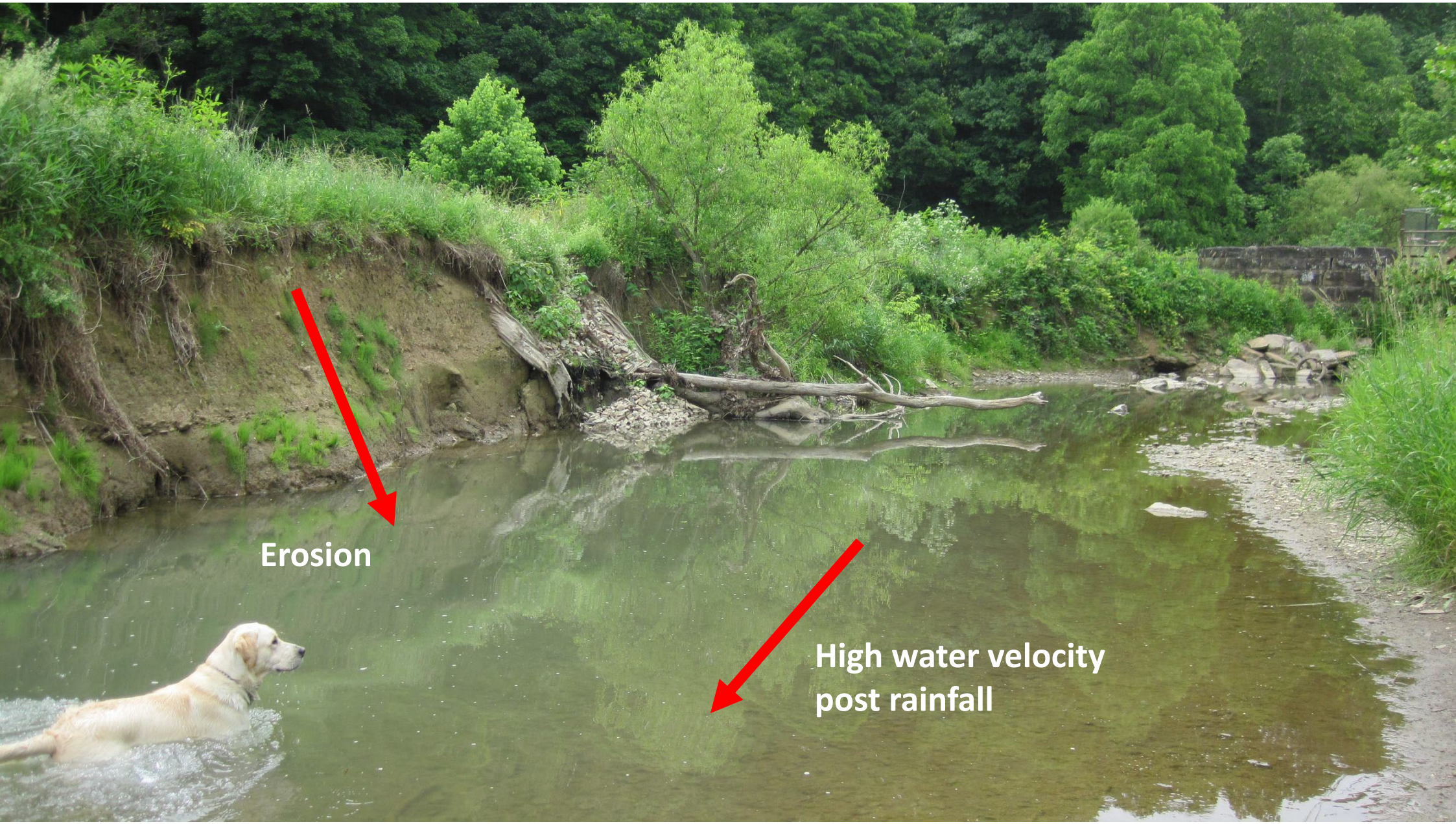
Floodplain Reconnection and Restoration

- Purpose
  - To establish a connection between stream channel and the surrounding terrestrial environment
- Why we're using it
  - Manage stream loss from longwall mining
  - Mitigation for mining & oil and gas:
    - Increased water storage
    - Increased nutrient storage
    - Increased resilience to flooding
    - Reduced erosion

Historically, streams in this area behaved this way.

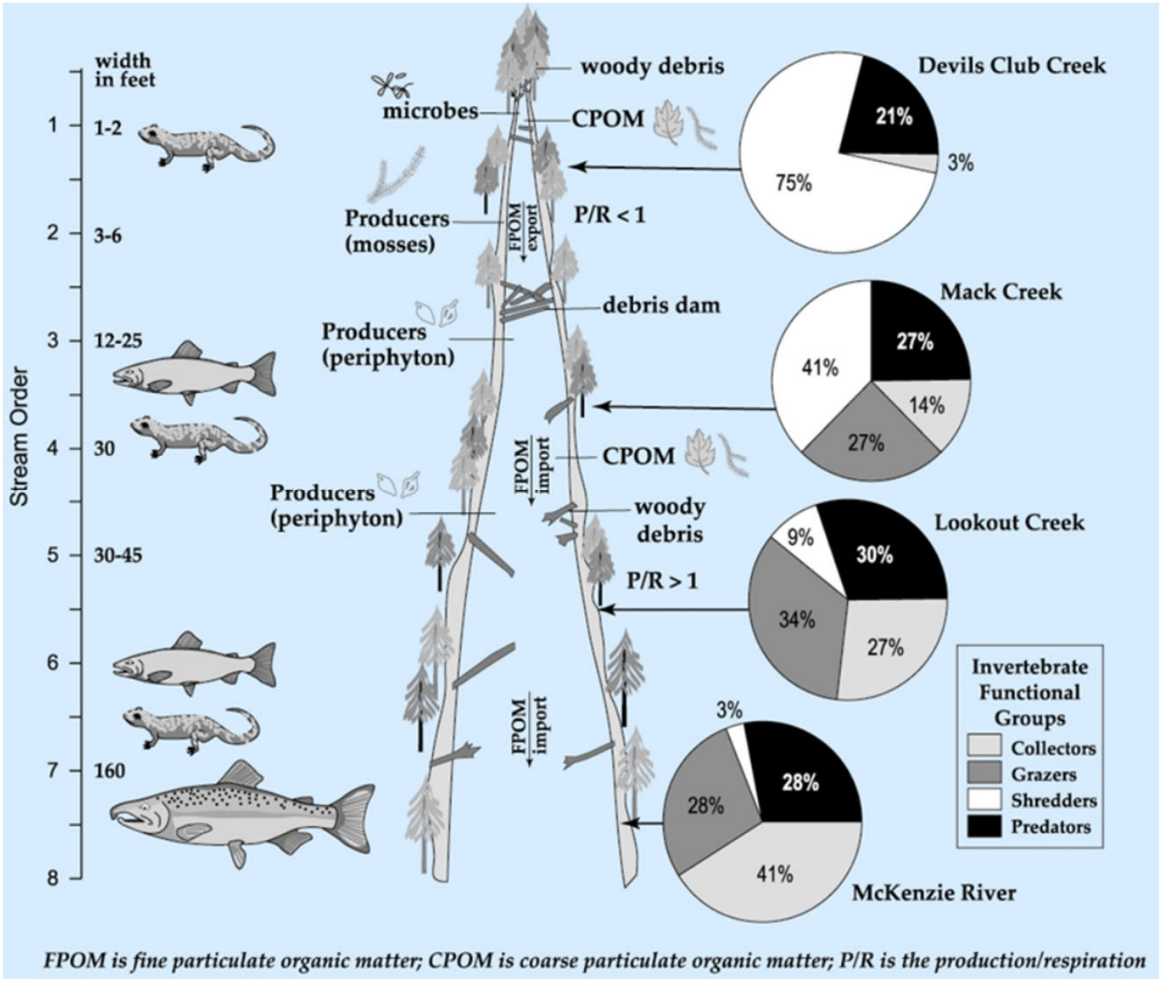


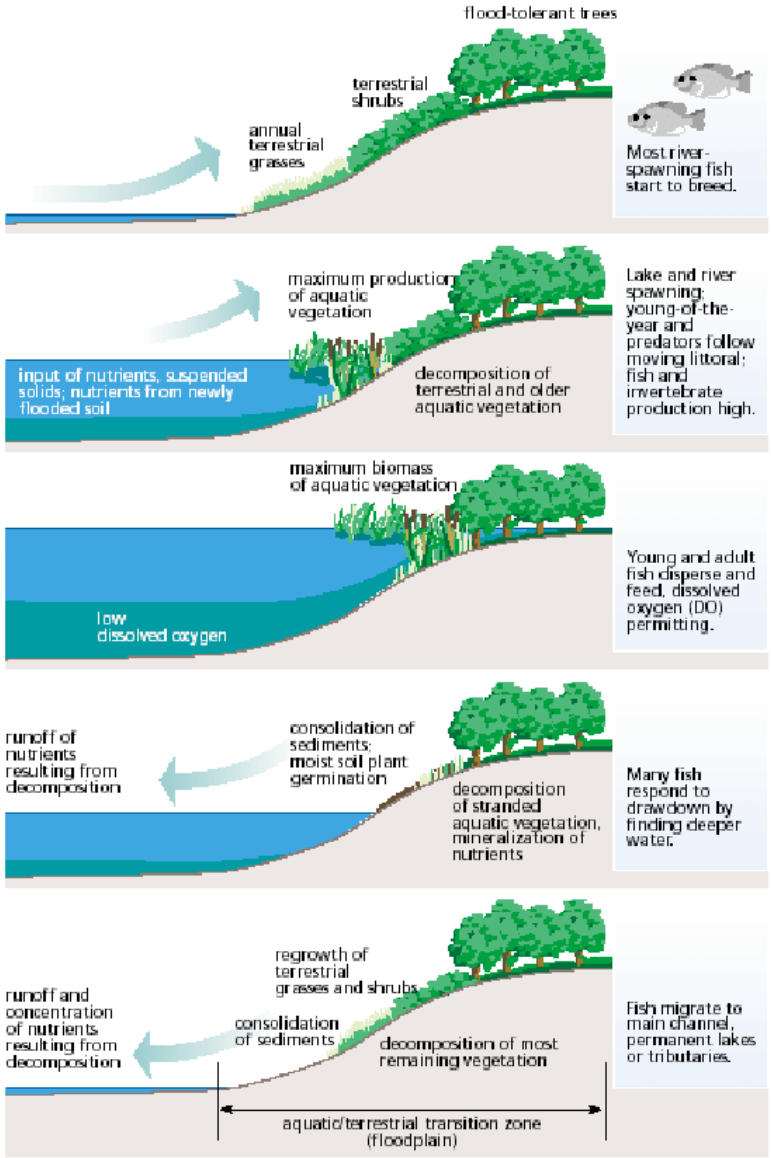
Cooper, Hiscock, & Lovett, 2019


Erosion
High water velocity
post rainfall


Increased water storage
Reduced sediment flux into channel
Less SW nutrient export DS
Less sediment export DS

Ecosystem Concepts





Sediment Dynamics

Excess sediment can cause: turbid water, habitat destruction, lower biodiversity

Sediment can harbor excess nutrients

Velocity and volume of water moves sediment at different rates

Nutrient Cycling

Nutrients are vital for ecosystem health, but too much or too little can be harmful to biodiversity

Many different biotic and hydrologic factors control rates of nutrient retention, removal, and release

McMillan and Noe note that nutrient processing rates were primarily controlled by physical channel features

Simplified channel structure does not lead to a connected system like varied, natural streams do

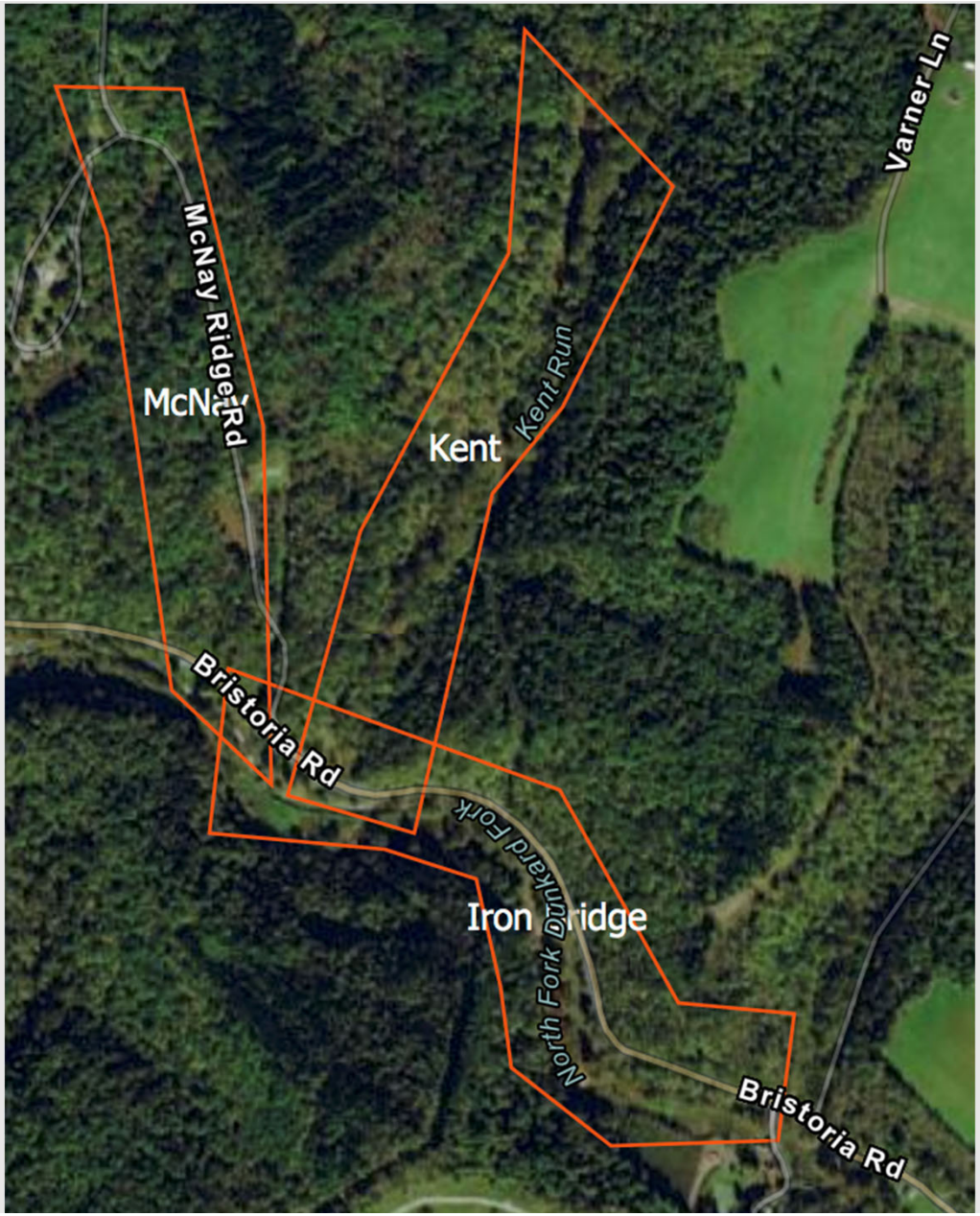
Objectives

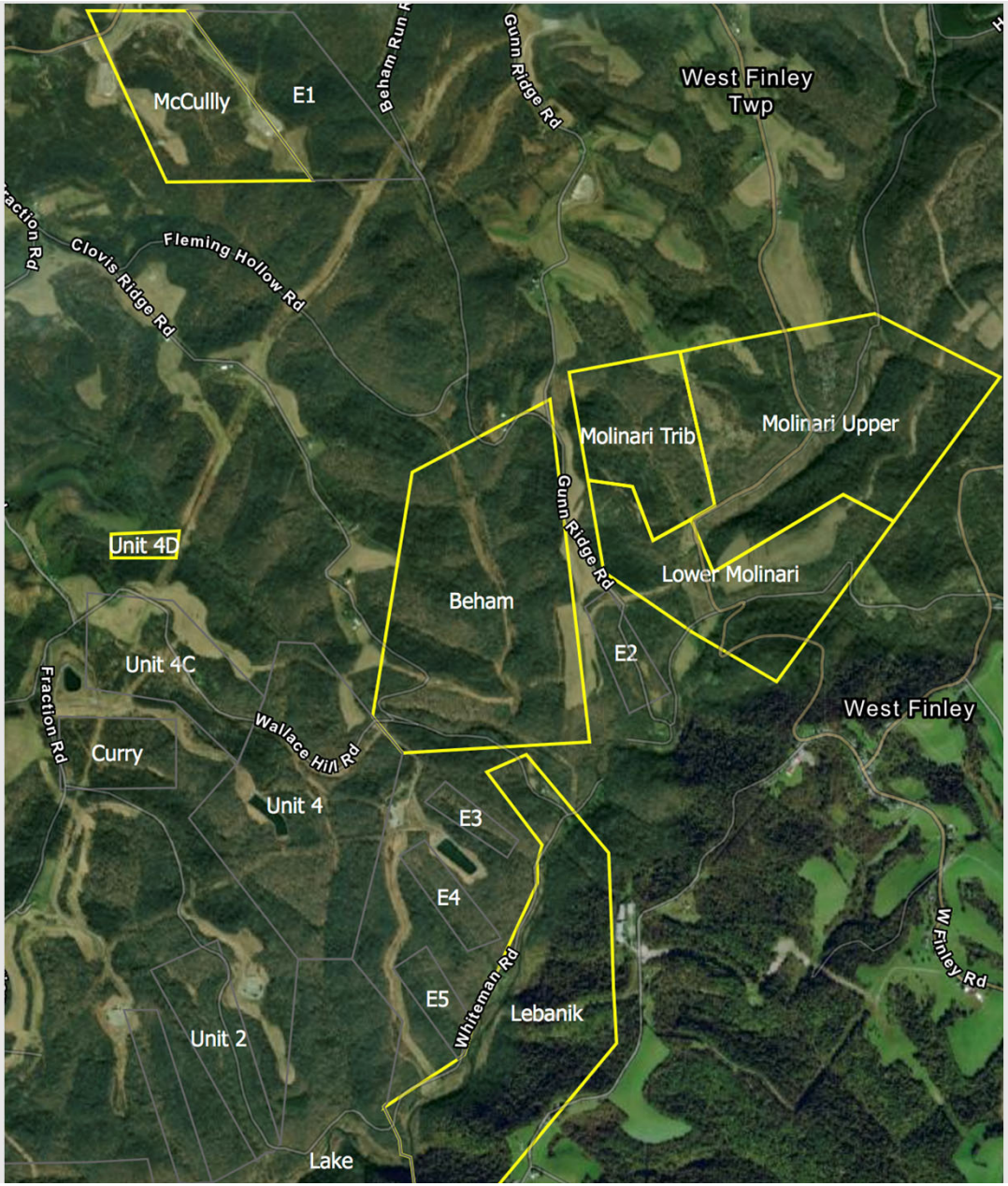
Characterize impact of the floodplain reconnection method in longwall mined watersheds by comparing the following characteristics of restored and unrestored sites

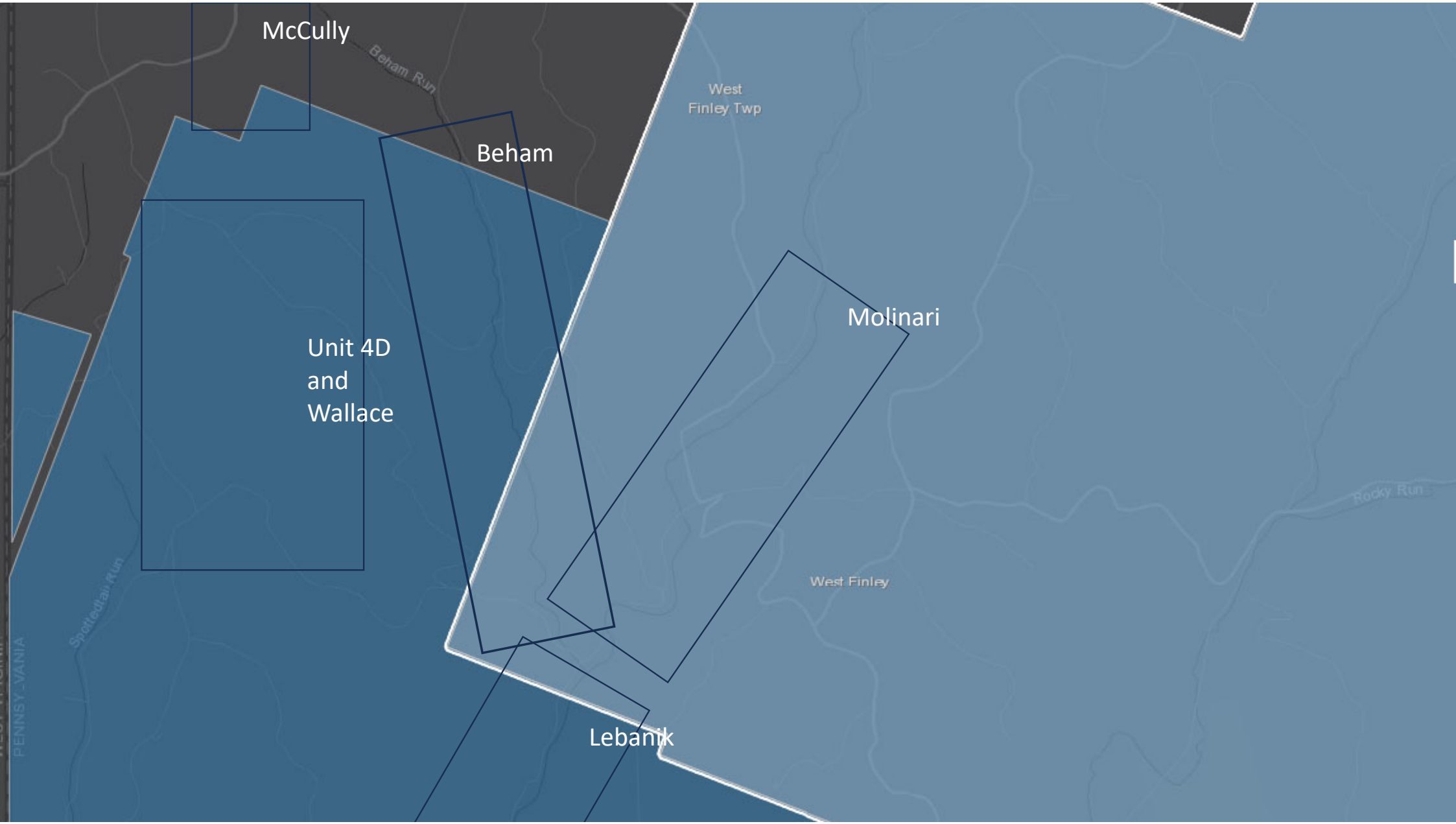
- Water storage
- Sediment retention and export
- N and P retention and export in the sediment and surface water
- Carbon accumulation and retention

Methods

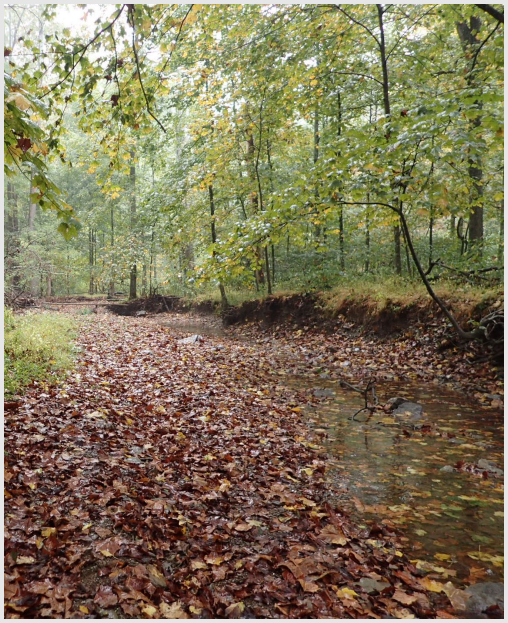
- Flow and Water Level
- Water and Sediment Chemistry
  - Nutrients
  - Carbon
  - Pore Water
- Carbon Inputs


McNay Ridge Rd
McN
Kent
Kent Run
Varner Ln
Bristoria Rd
Iron
ridge
North Fork Dunkard Fork
Bristoria Rd


McCullly
E1
Beham Run
Gunn Ridge Rd
West Finley
Twp
Clovis Ridge Rd
Fleming Hollow Rd
Molinari Trib
Molinari Upper
Unit 4D
Gunn Ridge Rd
Lower Molinari
Beham
E2
Unit 4C
Fraction Rd
Curry
Wallace Hill Rd
West Finley
Unit 4
E3
E4
W Finley Rd
E5
Whiteman Rd
Lebanik
Unit 2
Lake


McCully
Beham Run
Beham
West
Finley Twp
Molinari
Unit 4D
and
Wallace
Rocky Run
West Finley
Spottedtail Run
PENNSY_VANIA
Lebanik

Study Sites



Primary headwaters

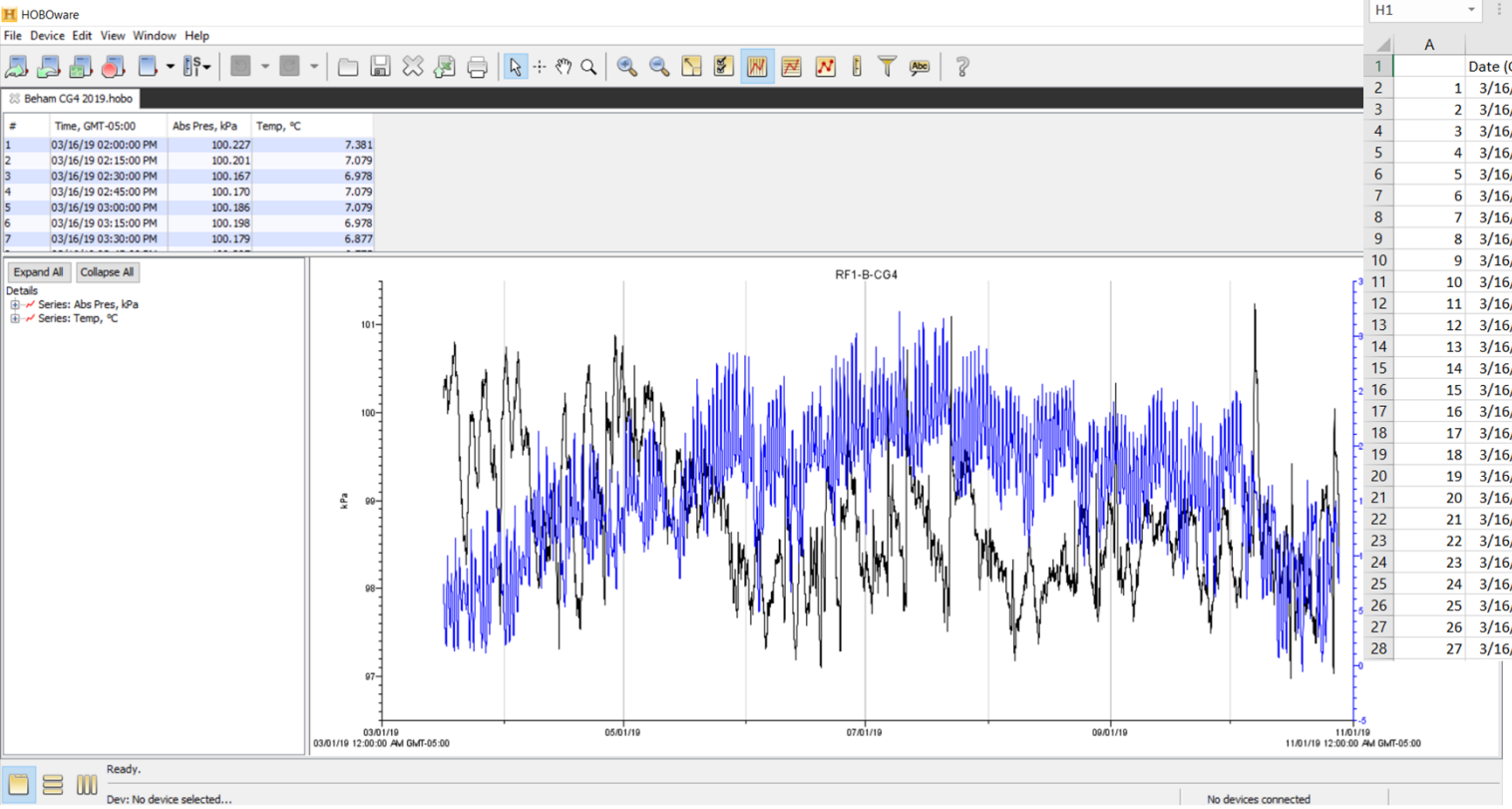
Headwaters

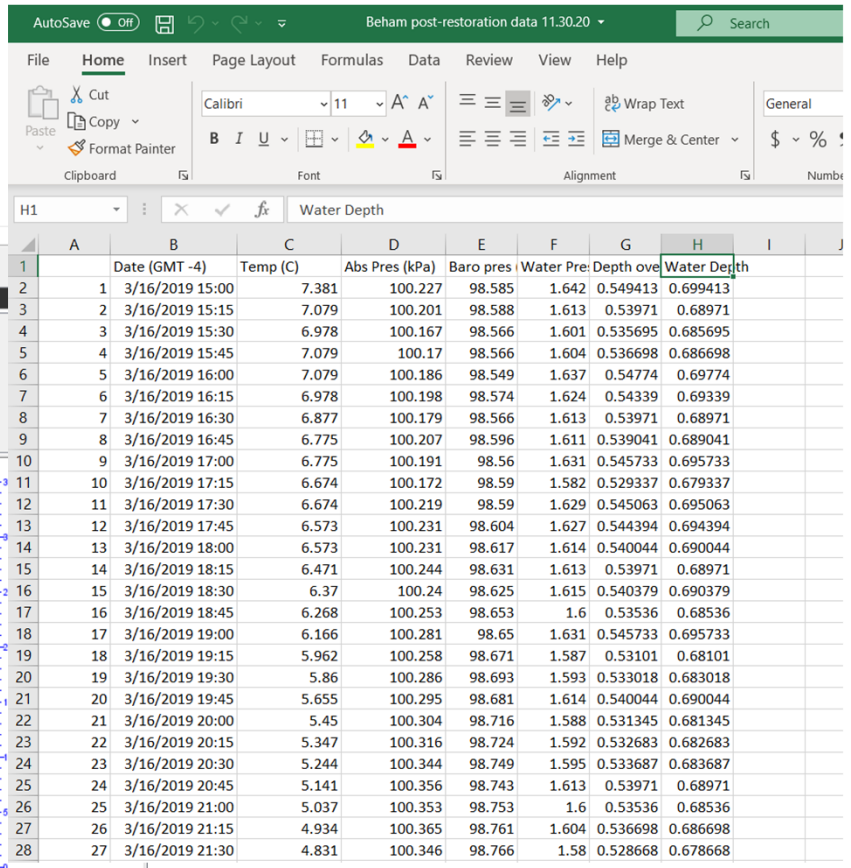
Wadeable

Flow and Water Storage

- Channel flow with flume, SonTek, or pygmy meter
- Salt tracing to measure transient flow with YSI meter

Water Level Monitoring





	A	B	C	D	E	F	G	H	I
1		Date (GMT -4)	Temp (C)	Abs Pres (kPa)	Baro pres	Water Pre	Depth ove	Water Depth	
2	1	3/16/2019 15:00	7.381	100.227	98.585	1.642	0.549413	0.699413	
3	2	3/16/2019 15:15	7.079	100.201	98.588	1.613	0.53971	0.68971	
4	3	3/16/2019 15:30	6.978	100.167	98.566	1.601	0.535695	0.685695	
5	4	3/16/2019 15:45	7.079	100.17	98.566	1.604	0.536698	0.686698	
6	5	3/16/2019 16:00	7.079	100.186	98.549	1.637	0.54774	0.69774	
7	6	3/16/2019 16:15	6.978	100.198	98.574	1.624	0.54339	0.69339	
8	7	3/16/2019 16:30	6.877	100.179	98.566	1.613	0.53971	0.68971	
9	8	3/16/2019 16:45	6.775	100.207	98.596	1.611	0.539041	0.689041	
10	9	3/16/2019 17:00	6.775	100.191	98.56	1.631	0.545733	0.695733	
11	10	3/16/2019 17:15	6.674	100.172	98.59	1.582	0.529337	0.679337	
12	11	3/16/2019 17:30	6.674	100.219	98.59	1.629	0.545063	0.695063	
13	12	3/16/2019 17:45	6.573	100.231	98.604	1.627	0.544394	0.694394	
14	13	3/16/2019 18:00	6.573	100.231	98.617	1.614	0.540044	0.690044	
15	14	3/16/2019 18:15	6.471	100.244	98.631	1.613	0.53971	0.68971	
16	15	3/16/2019 18:30	6.37	100.24	98.625	1.615	0.540379	0.690379	
17	16	3/16/2019 18:45	6.268	100.253	98.653	1.6	0.53536	0.68536	
18	17	3/16/2019 19:00	6.166	100.281	98.65	1.631	0.545733	0.695733	
19	18	3/16/2019 19:15	5.962	100.258	98.671	1.587	0.53101	0.68101	
20	19	3/16/2019 19:30	5.86	100.286	98.693	1.593	0.533018	0.683018	
21	20	3/16/2019 19:45	5.655	100.295	98.681	1.614	0.540044	0.690044	
22	21	3/16/2019 20:00	5.45	100.304	98.716	1.588	0.531345	0.681345	
23	22	3/16/2019 20:15	5.347	100.316	98.724	1.592	0.532683	0.682683	
24	23	3/16/2019 20:30	5.244	100.344	98.749	1.595	0.533687	0.683687	
25	24	3/16/2019 20:45	5.141	100.356	98.743	1.613	0.53971	0.68971	
26	25	3/16/2019 21:00	5.037	100.353	98.753	1.6	0.53536	0.68536	
27	26	3/16/2019 21:15	4.934	100.365	98.761	1.604	0.536698	0.686698	
28	27	3/16/2019 21:30	4.831	100.346	98.766	1.58	0.528668	0.678668	

Meteorological Data

- Waynesburg, PA Weather Station
- Rainfall Data
- Calculated Antecedent Precipitation Index

Water & Sediment Chemistry

- Grab water samples taken seasonally 2020 - 2024
  - Field parameters
- Biweekly ater TOC summer & fall 2022
- Sediment samples gathered with a trowel seasonally 2020 - 2024
  - C, N, P
  - Grain size

Pore Water

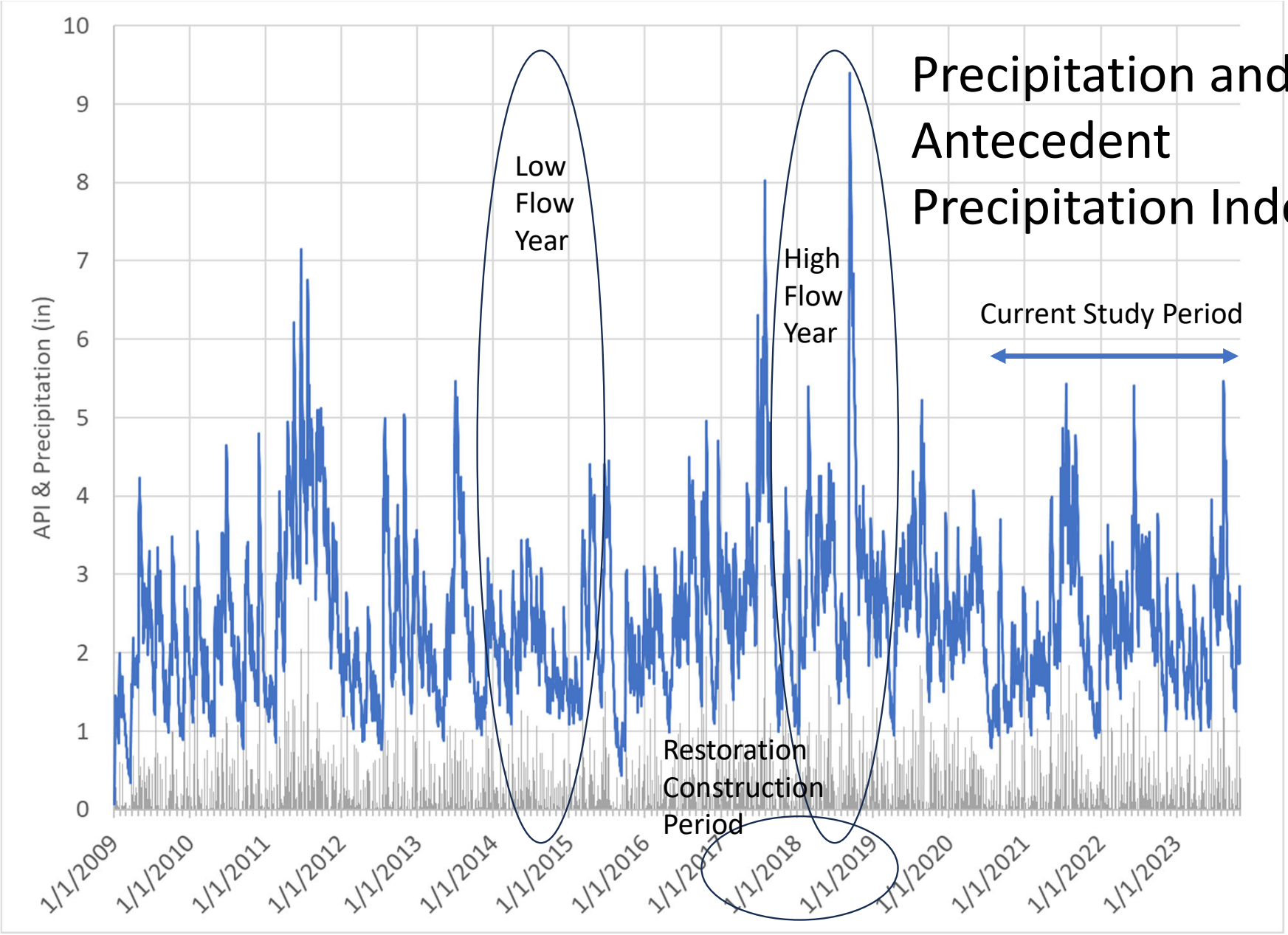
- Measured dissolved N and P concentrations in upper layer
- Micro-rhizon samplers collected water from upper soil layer
- Soil temp, pH, DO, ORP, conductivity, moisture content determined by Orion meter

Carbon Inputs and Stores

- Large Woody Debris index following U.S. Forest Service methodologies
- Leaf Litter Input
- Soil Carbon by Loss on Ignition Method

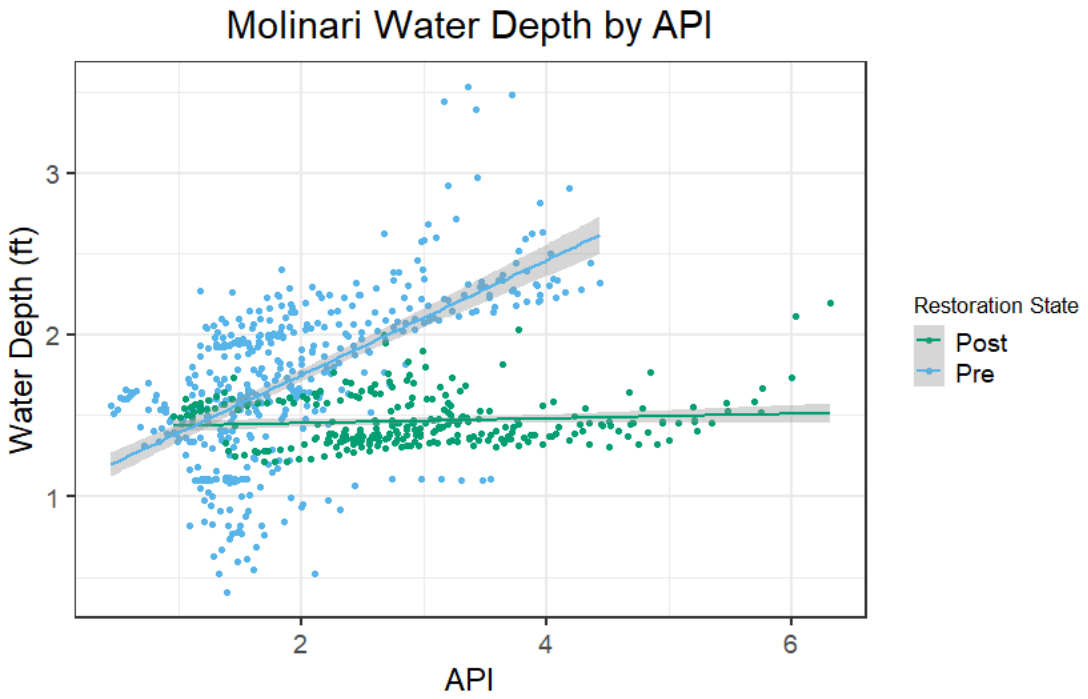
Results

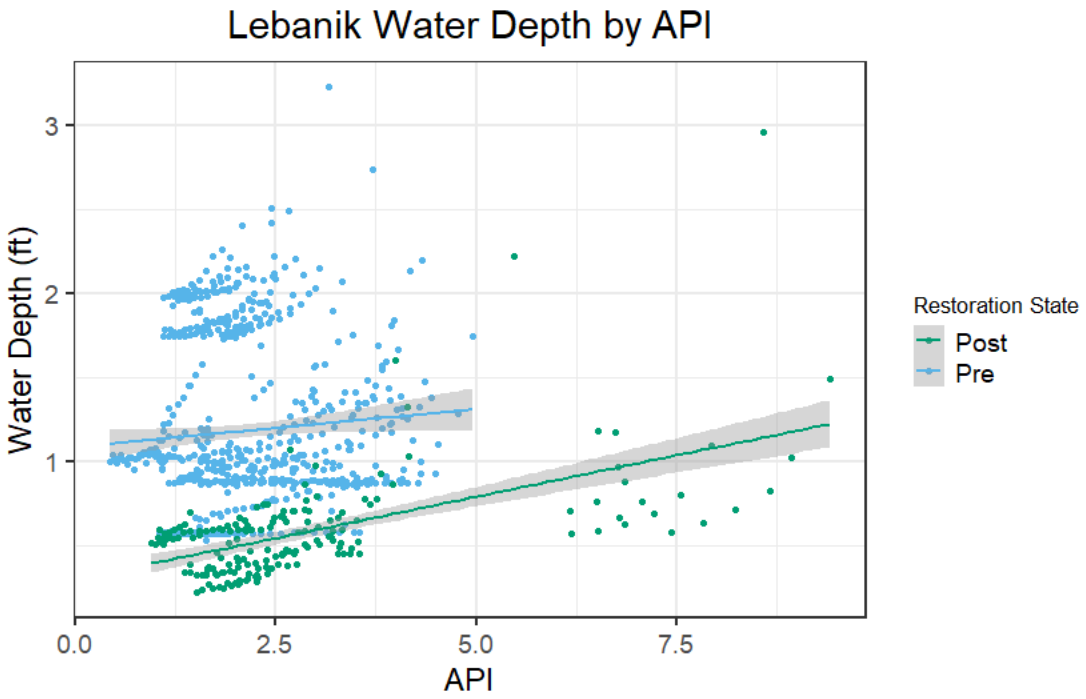
- Rainfall, Flow, Water Storage
- Nutrients in Water, Pore Water, and Sediment
- Carbon Input and Storage


Precipitation and Antecedent Precipitation Index
API & Precipitation (in)
10
9
8
7
6
5
4
3
2
1
0
Low Flow Year
High Flow Year
Current Study Period
Restoration Construction Period
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
1/1/2016
1/1/2017
1/1/2018
1/1/2019
1/1/2020
1/1/2021
1/1/2022
1/1/2023

Water Storage:

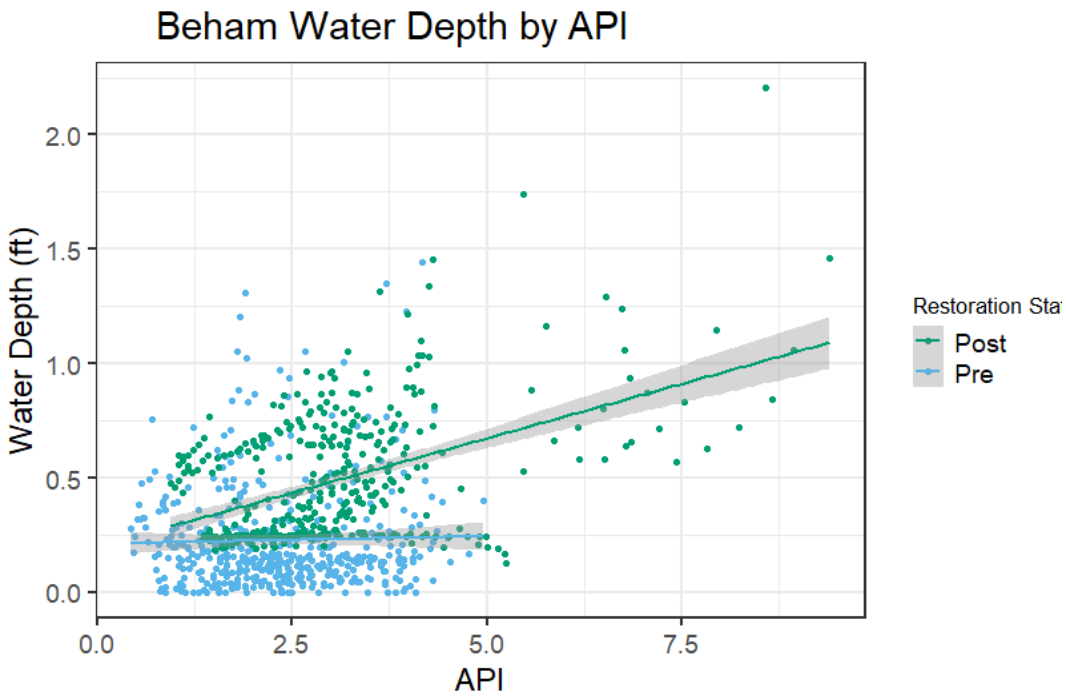
Wadeable Streams

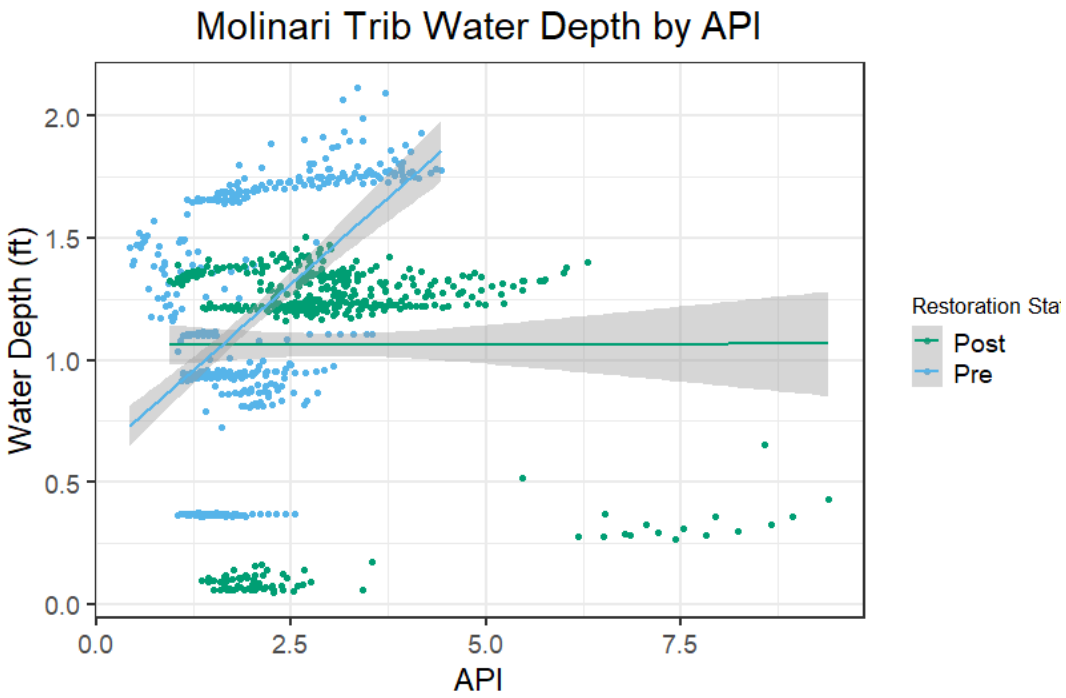




Water Storage:

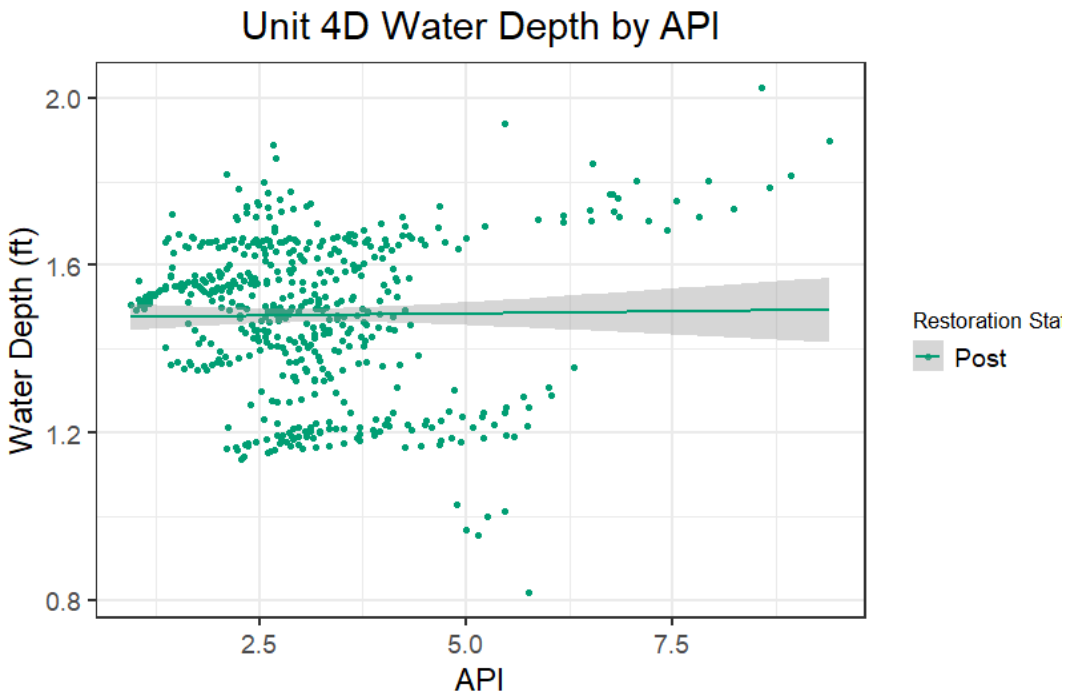
Headwaters Streams

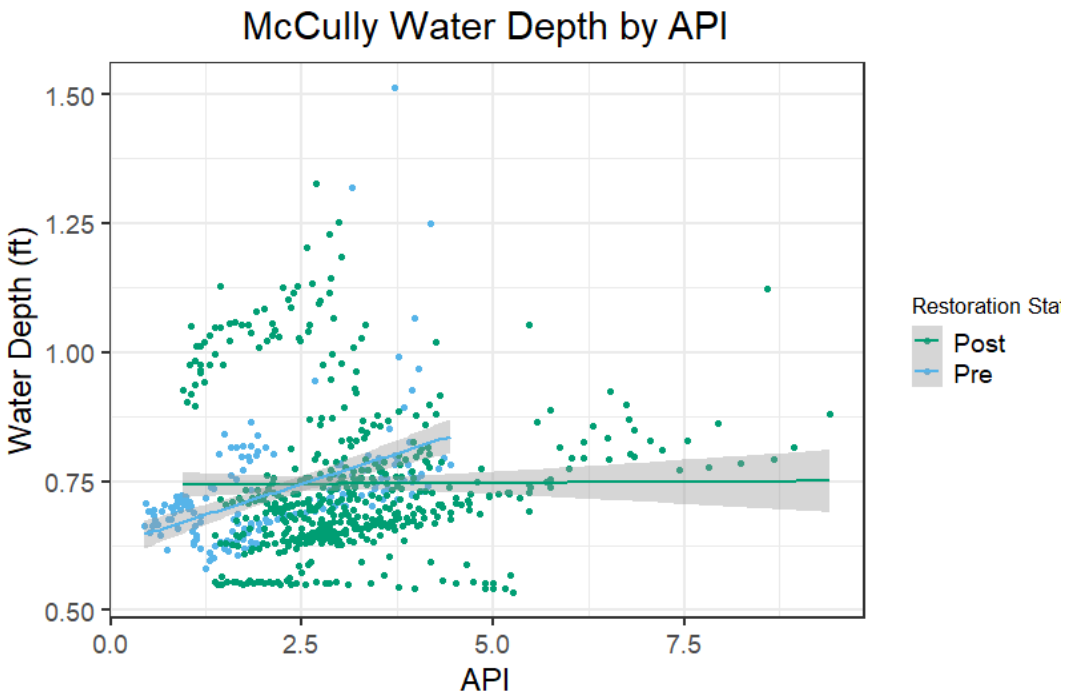




Water Storage:

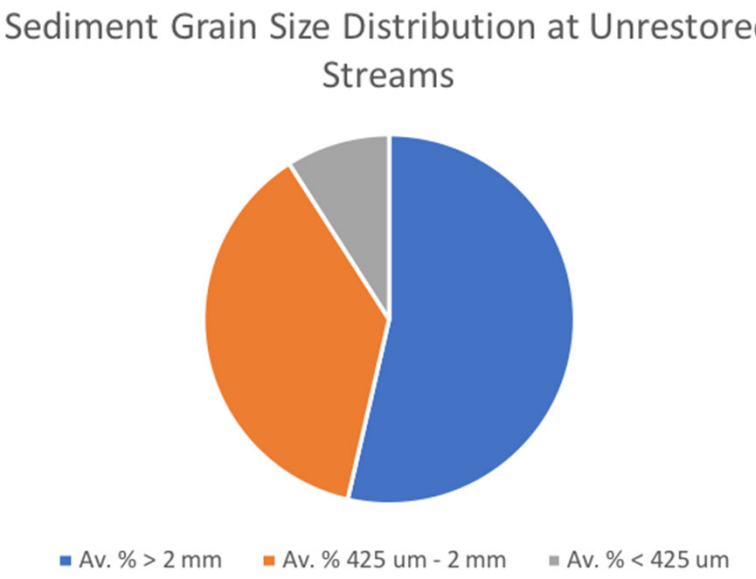
Primary Headwaters Streams

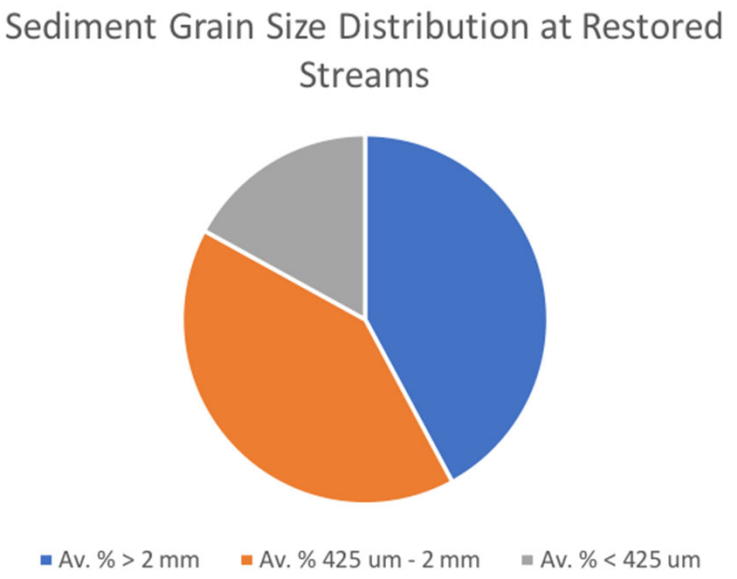




Sediment Dynamics

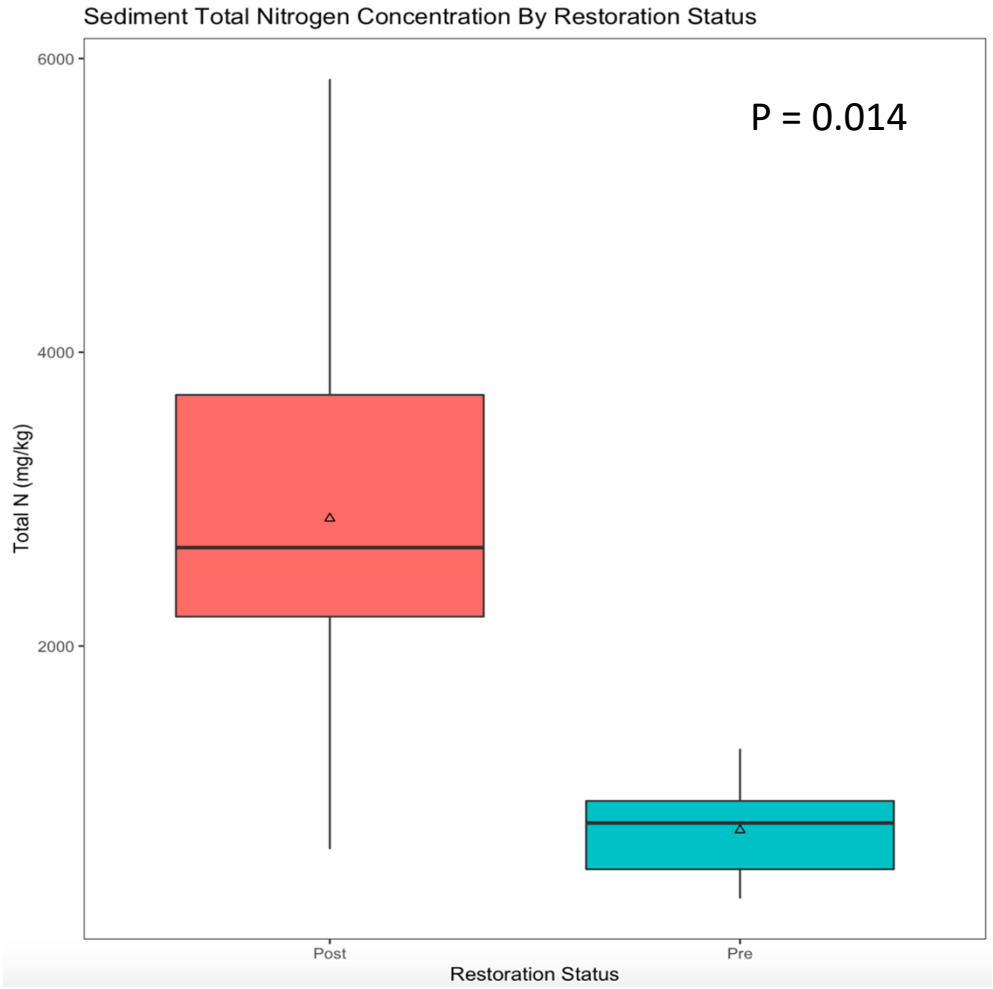
- More fine-grained sediment in restored sites

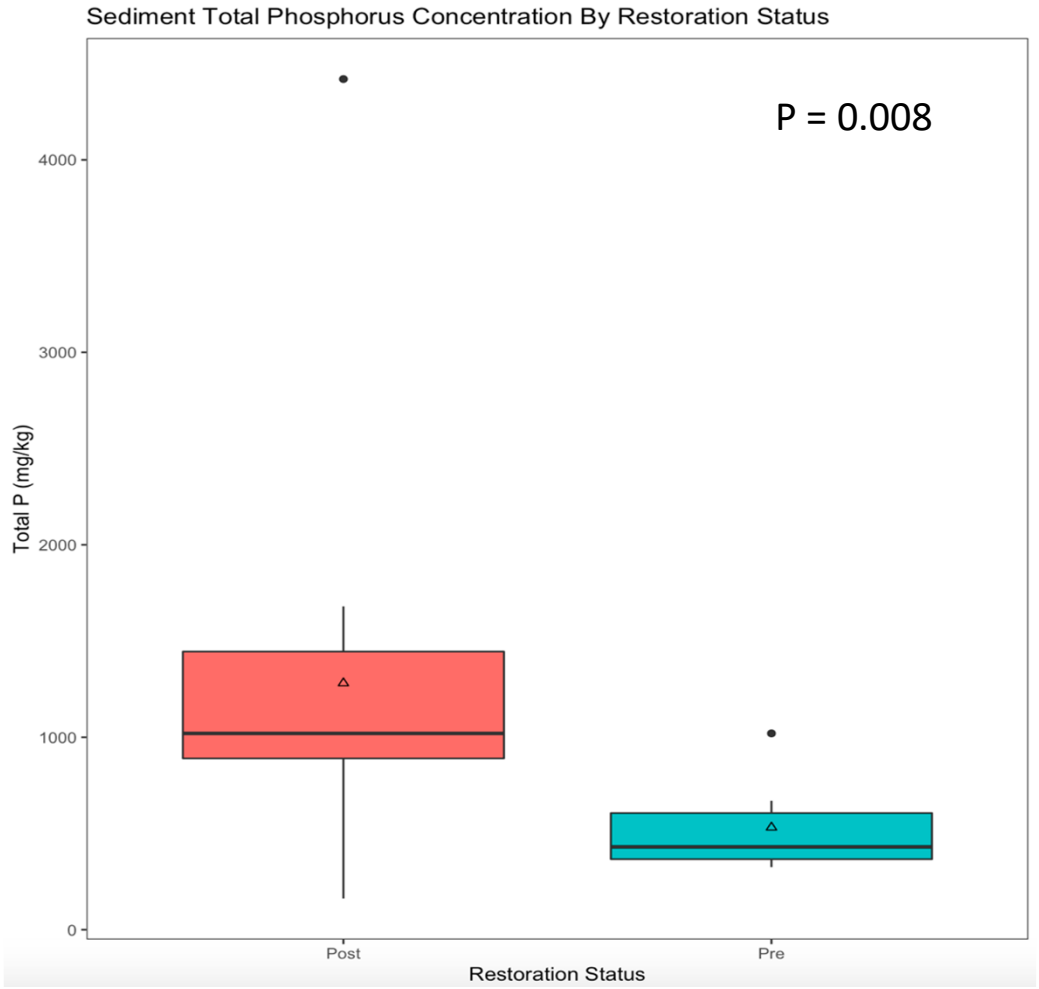




Nutrients

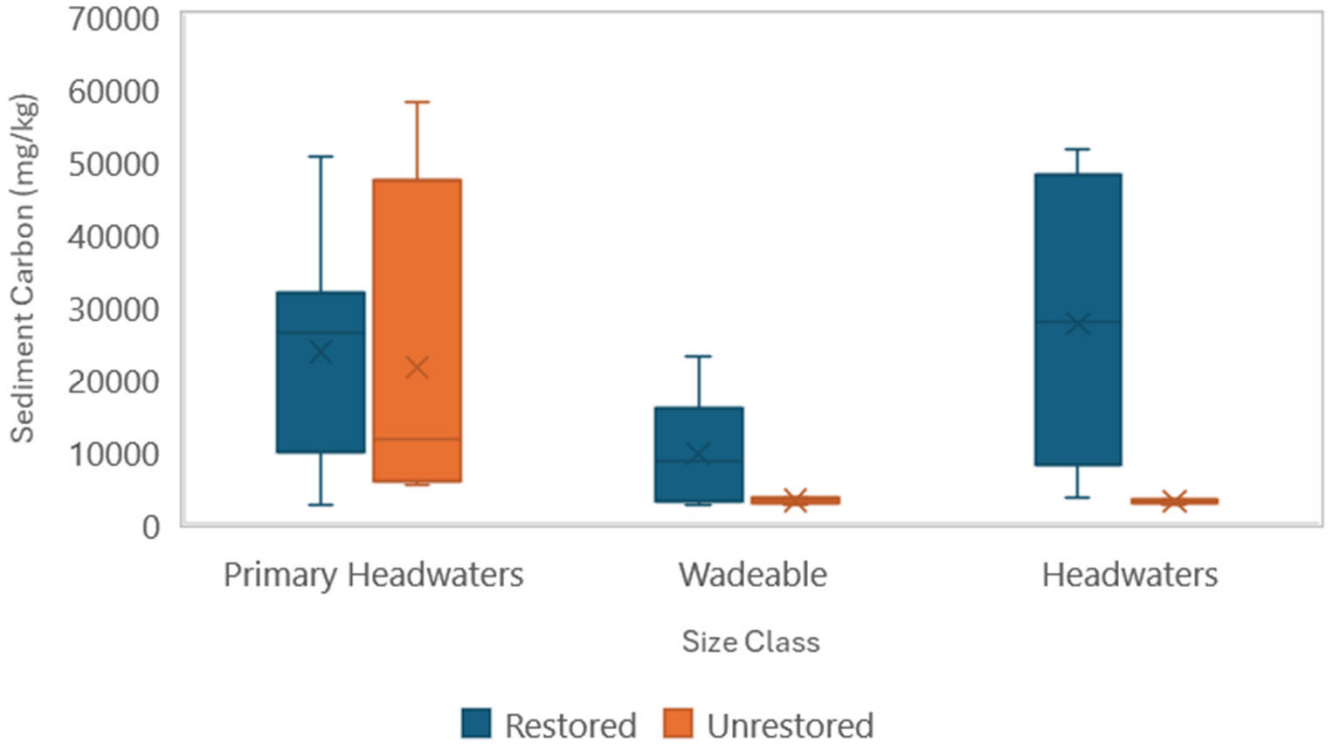
- Sediment
  - More N and P in restored sites





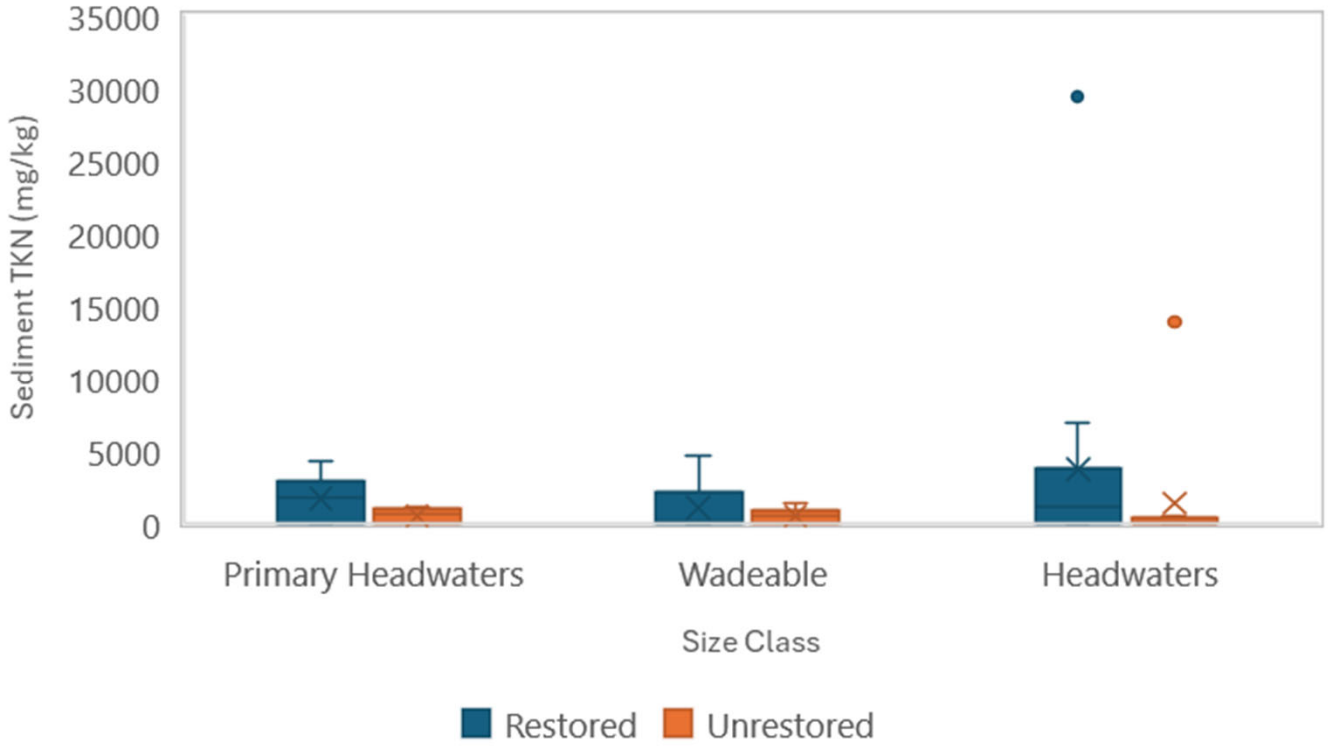
Sediment Carbon

Greater C in larger restored sites



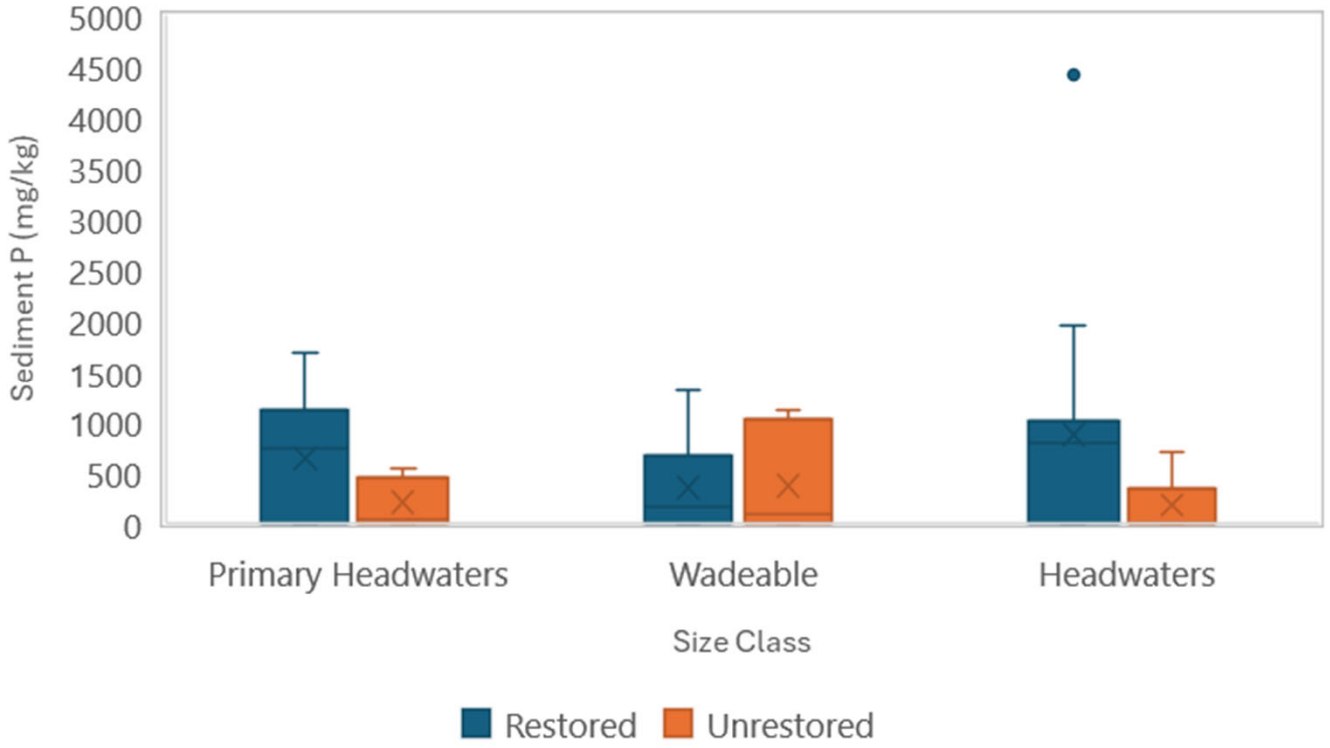
Sediment Nitrogen

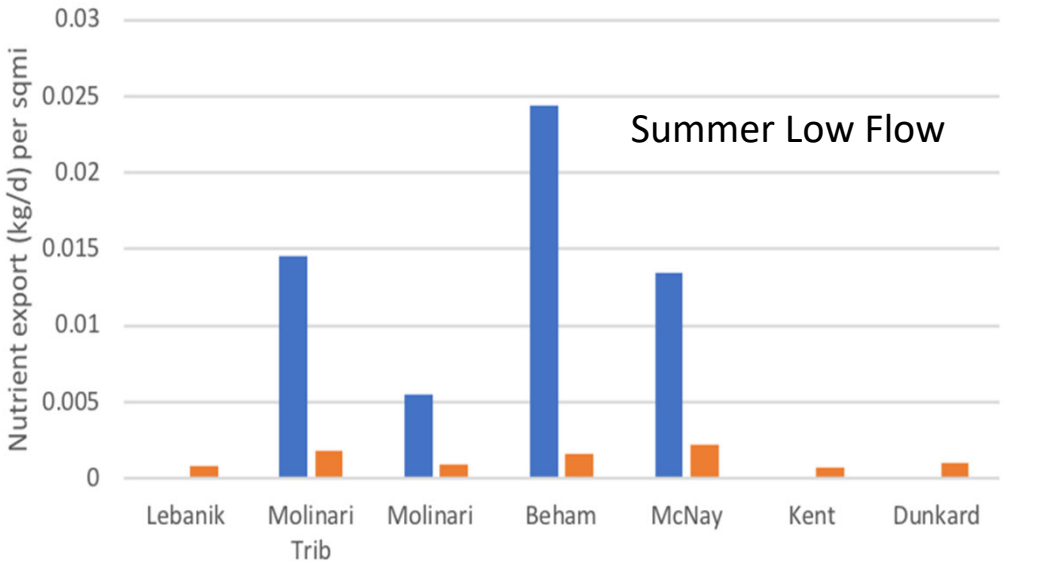
Greater N in restored sites

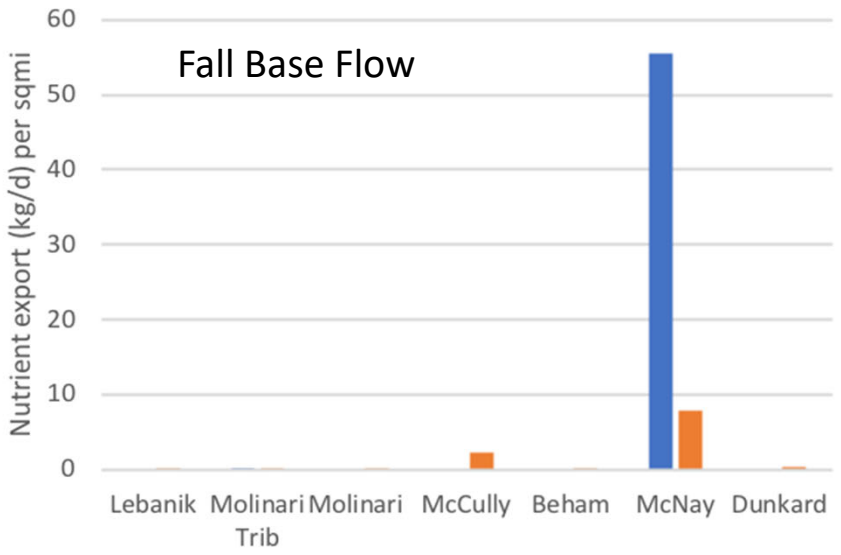


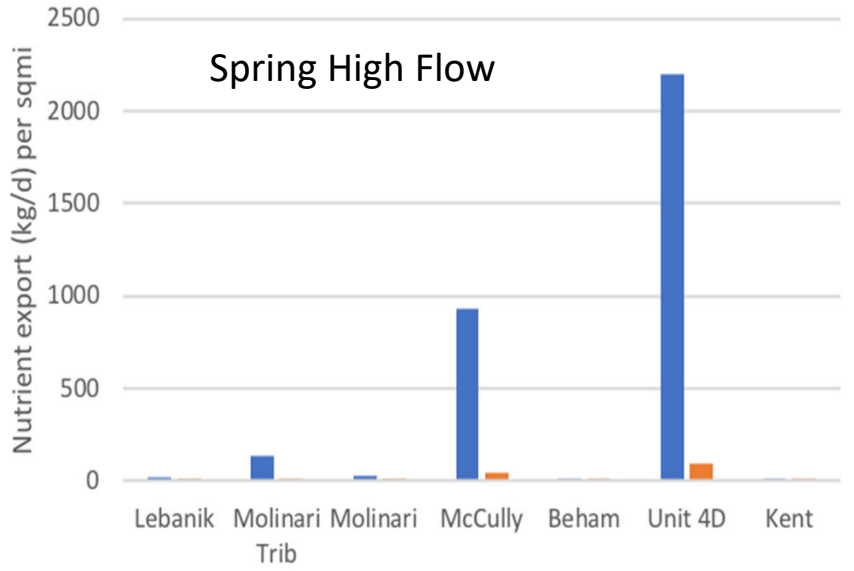
Sediment Phosphorus

Greater P in restored sites







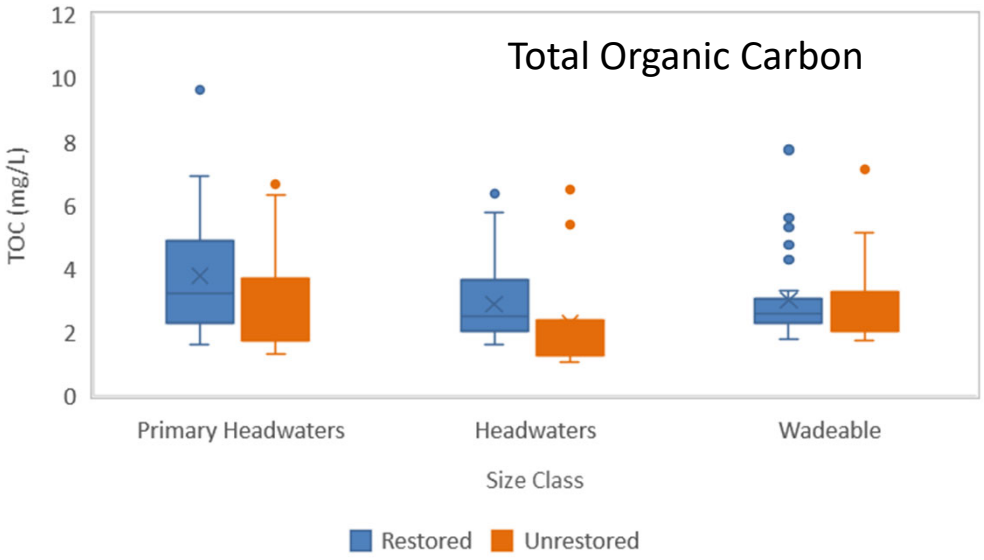


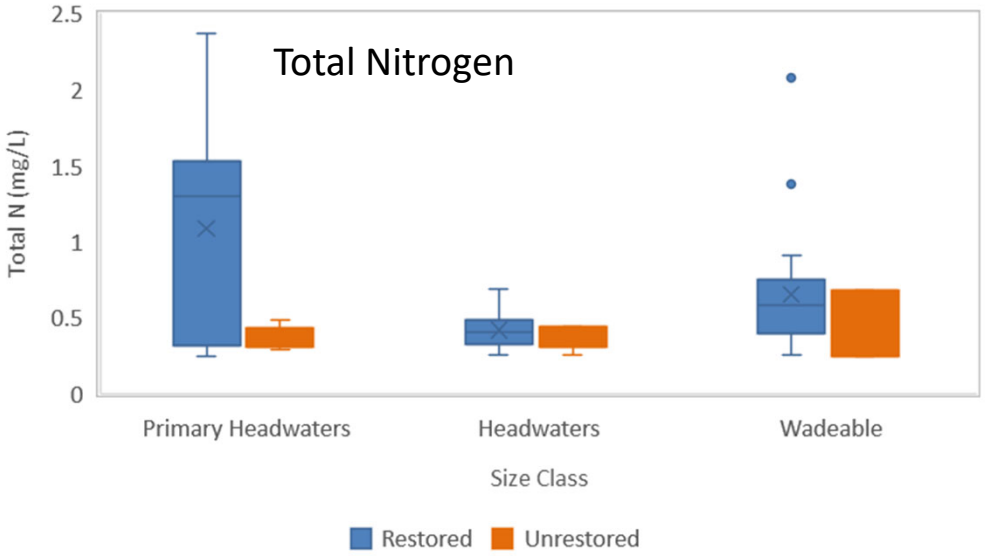
Nutrient Flux

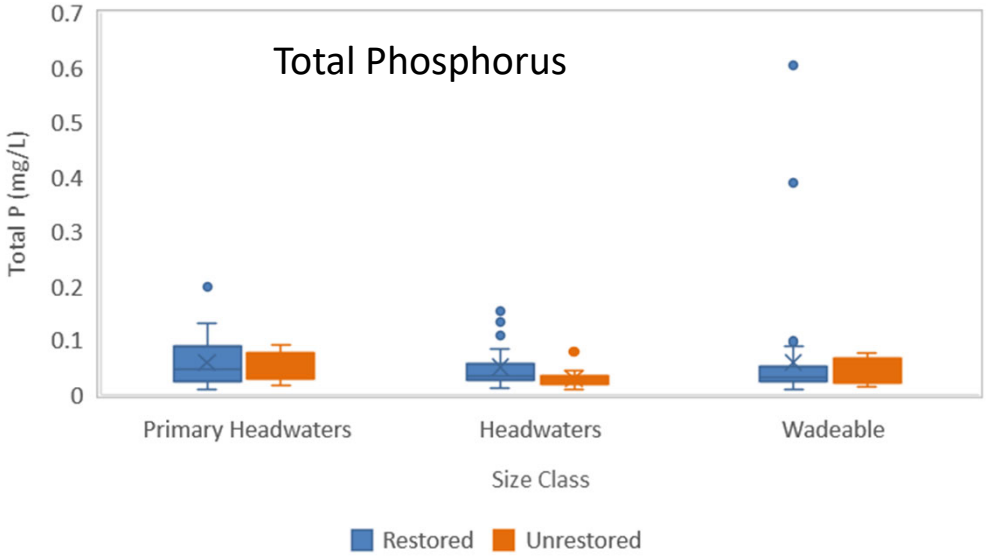
Variable with flow and season, not restoration status

Nutrients in Water:

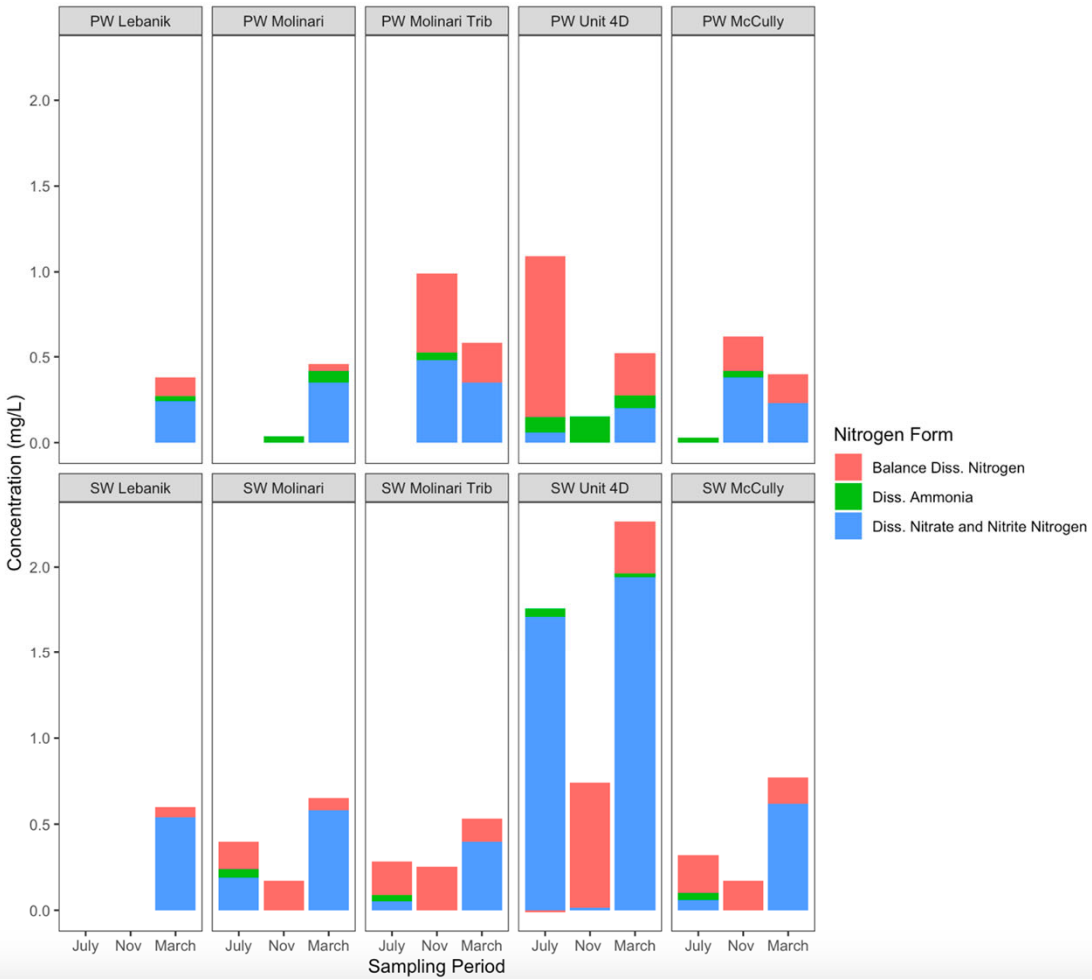
Few differences between restoration or size

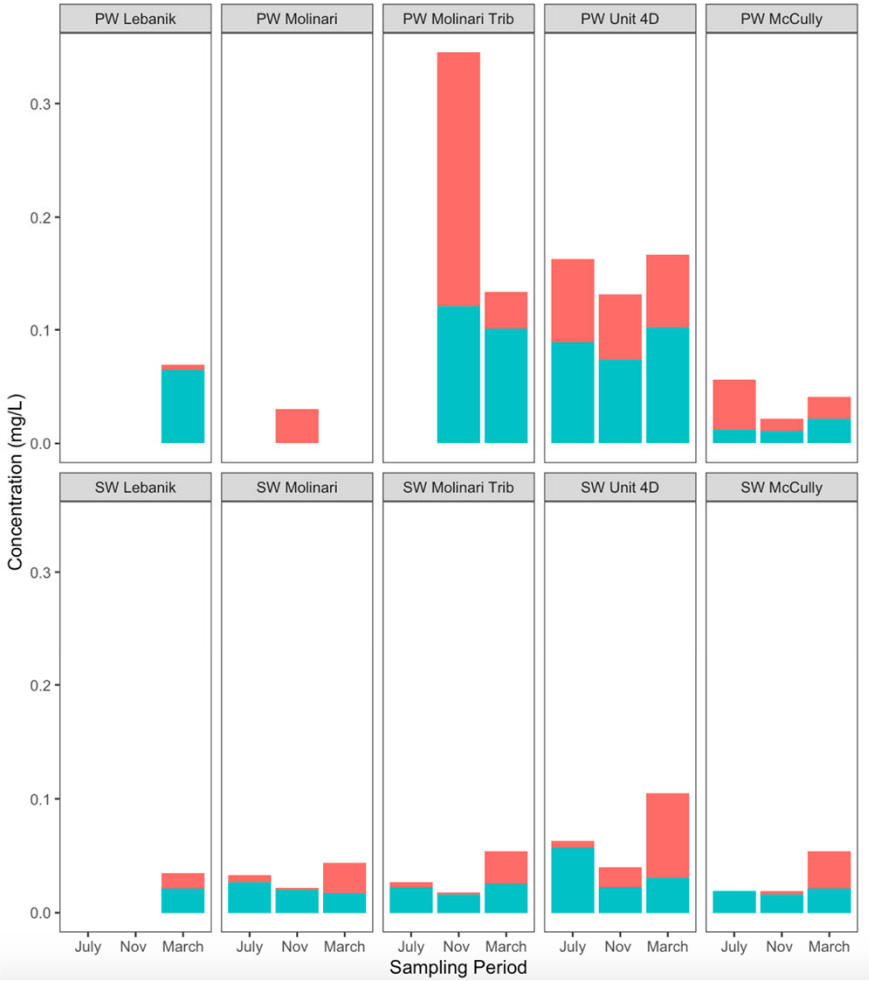






Floodplain Nutrient Interactions: PW and SW

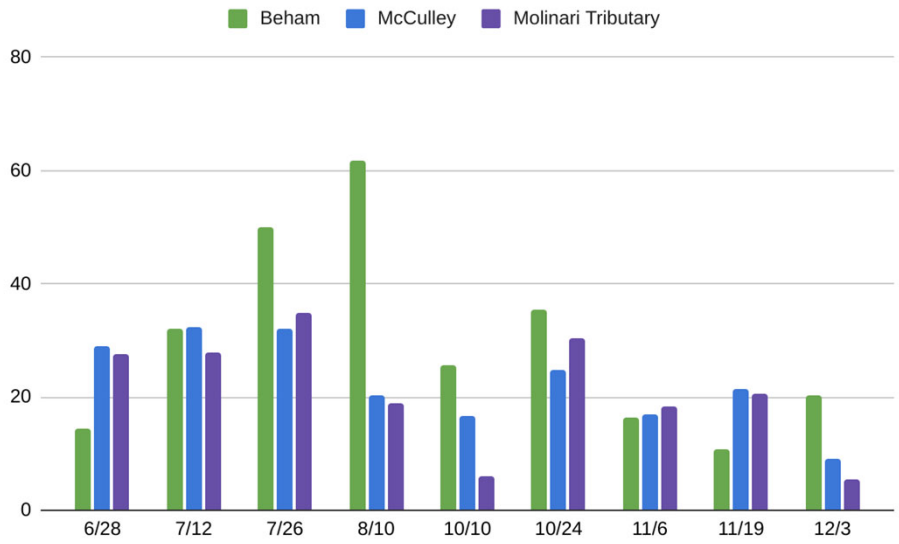




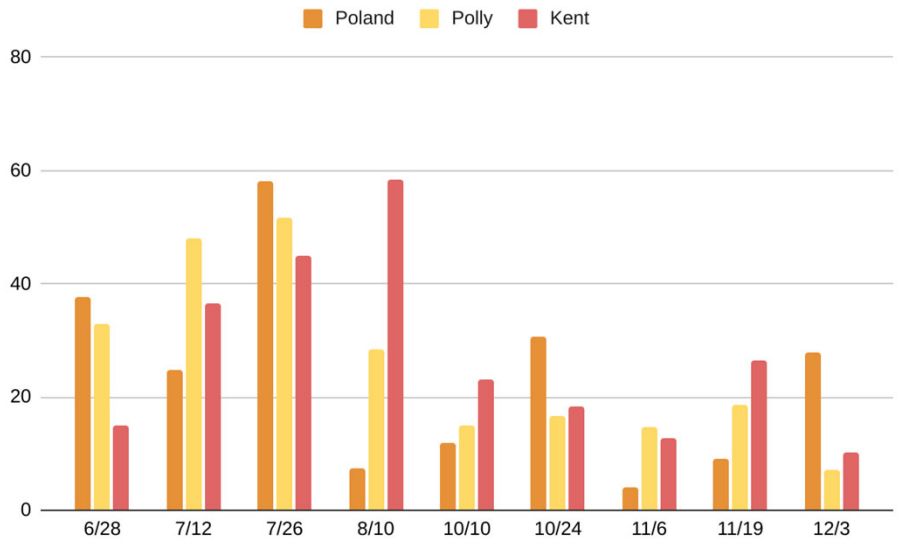
p = 0.017

Total Organic Carbon - Water
Summer and Fall 2022

Restored

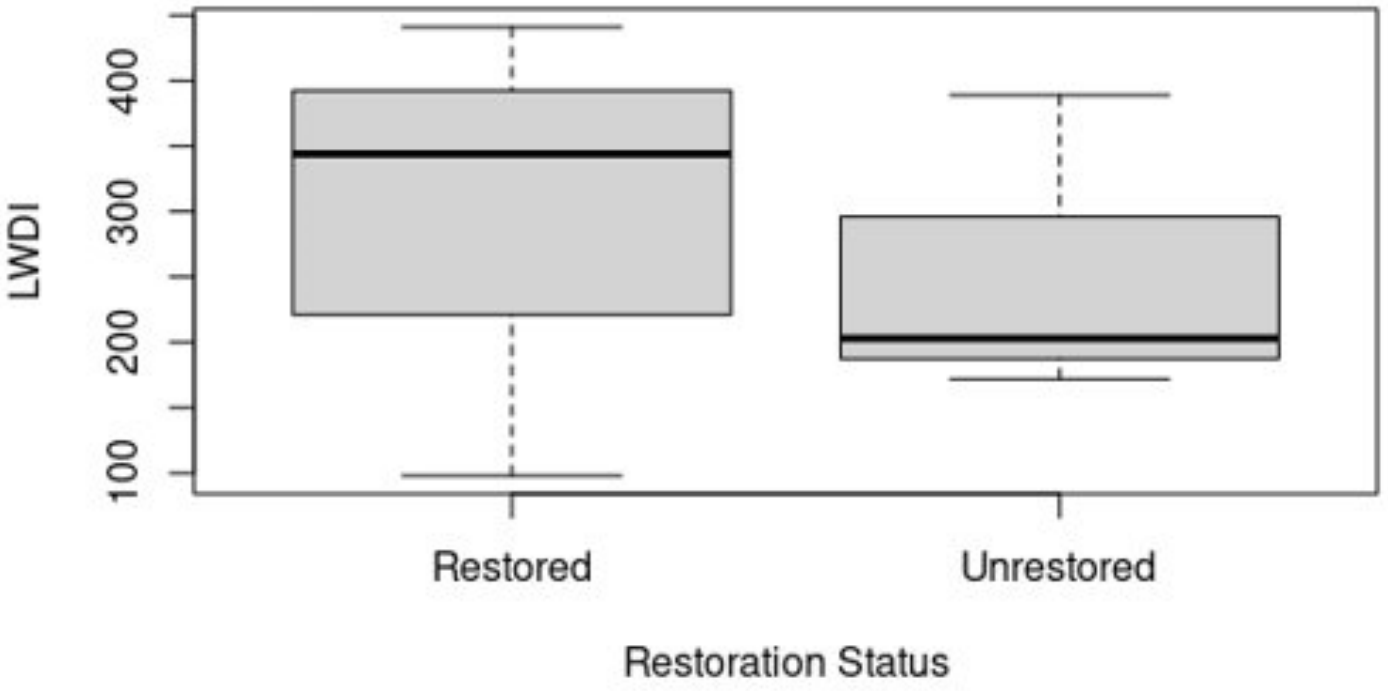


Unrestored



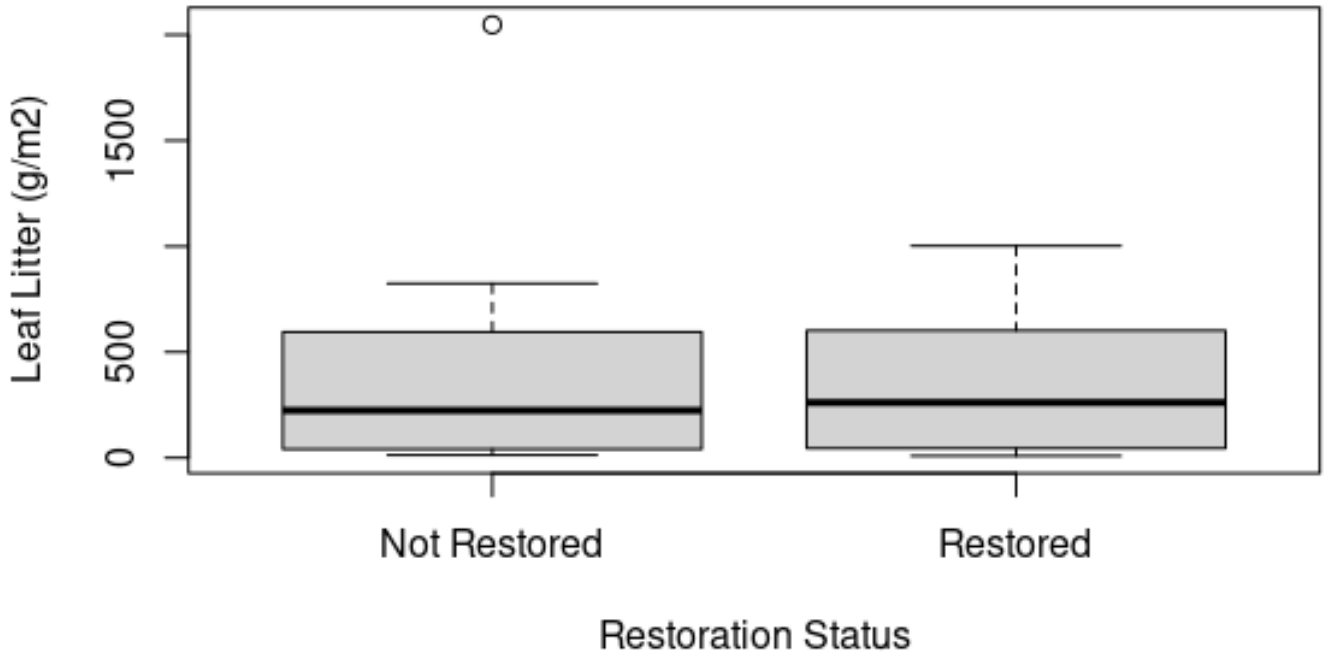
Large Woody Debris Index

No statistical relationship between large woody debris and TOC or Restoration Status



Leaf Litter Input

No statistical relationship between leaf litter input and TOC or Restoration Status



Soil Organic Matter

No statistical relationship between soil organic matter and TOC.

Soil organic matter vs. Restoration status $p<0.05$.

Conclusions

Water storage	Sediment	Nutrients
• Slightly increased in restored sites	• Higher proportion of fine-grained sediment at restored sites • DS TSS load was driven by flow	• Sediment: Richer in N and P in restored sites • Surface water N&P seasonal or flow dependent • P storage in wetlands (pore water)

Conclusions

Total organic carbon	Carbon Input	Soil organic matter
• Dependent upon season (greater in the growing season), not restoration status	• Not significantly different between restoration status	• Greater in restored sites than unrestored

Acknowledgements

PA Department of Environmental Protection

Western Pennsylvania Conservancy


Thank you! Questions?
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krusen@ohio.edu