The Impacts of Abandoned Mine Drainage on Freshwater Ecosystems

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What is Abandoned Mine Drainage (AMD)?

“Abandoned mine drainage is water that is polluted from contact with mining activity, and normally associated with coal mining.”

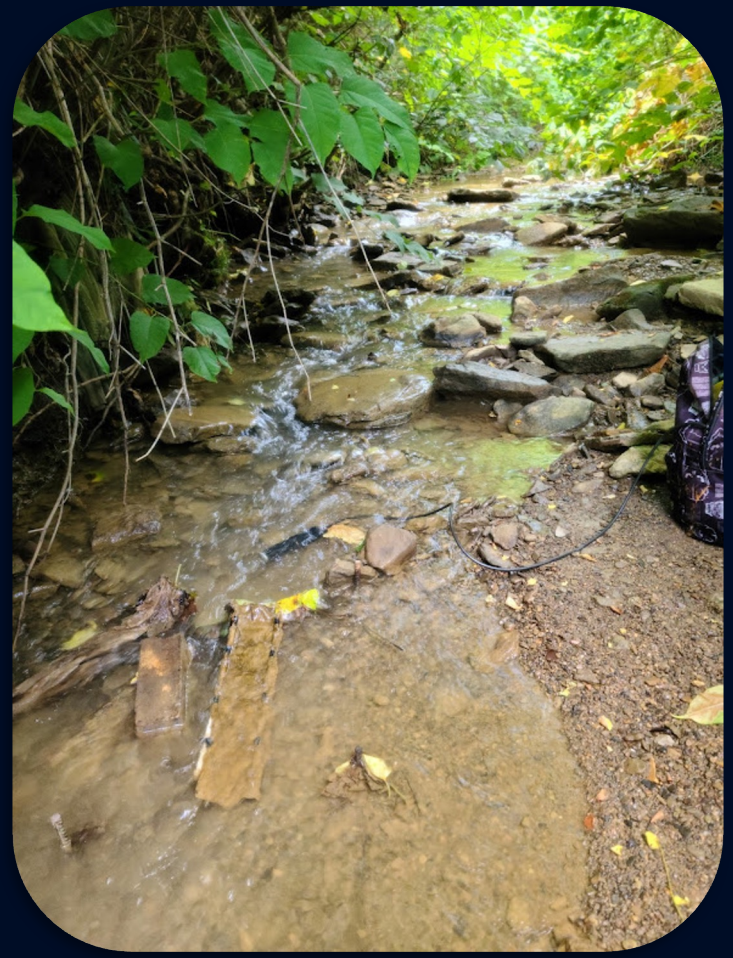
– Environmental Protection Agency

Abandoned Mine Drainage | US EPA

Purpose

To determine how the addition of AMD impacts:

- Rate of decomposition on organic materials
  - Labile (leaves)
  - Recalcitrant (wood)
- Microbial community
  - Identification of bacteria and fungi
  - Changes in community structure and concentration

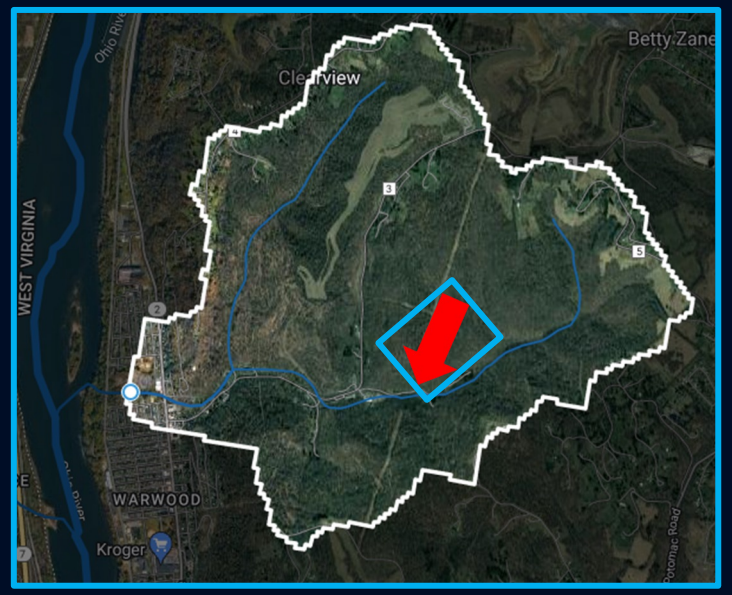


Without AMD

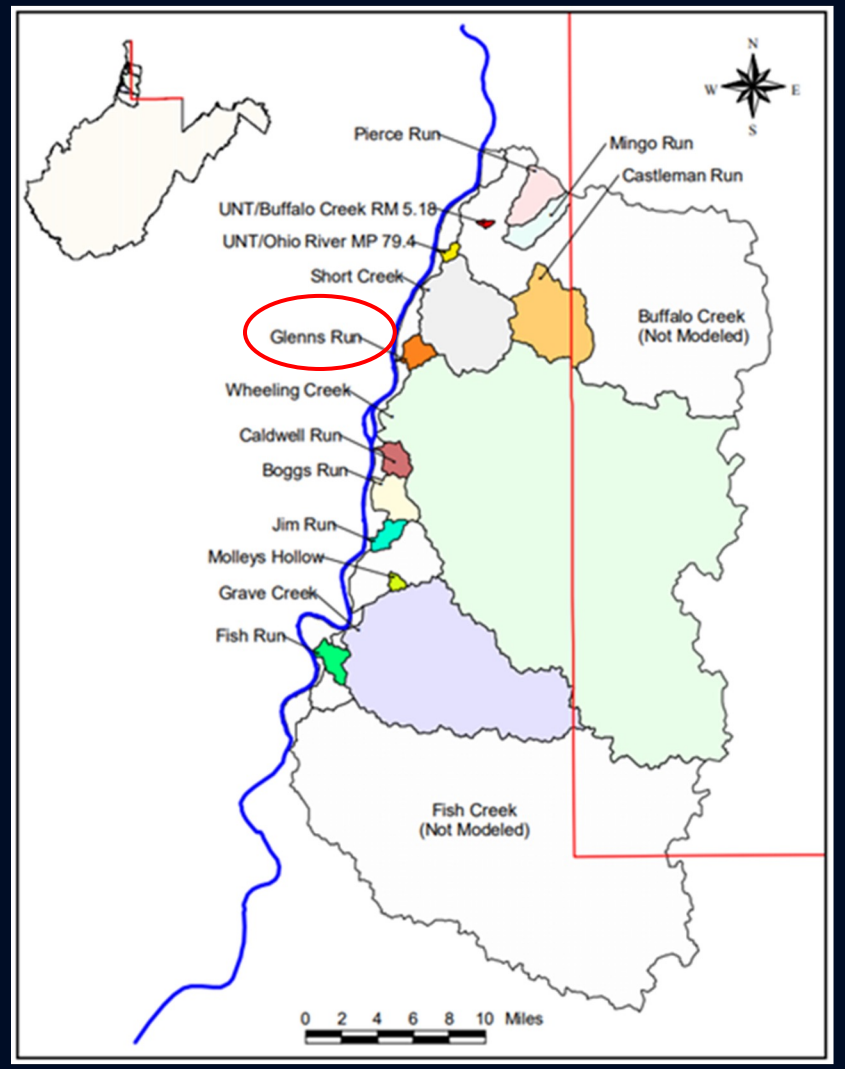
With AMD

Glenns Run

- **AMD input** (photo, bottom)
- **Impairments**
  - **Aluminum (Al)**
  - **Iron (Fe)**
  - **Manganese (Mn)**
  - **pH**
- **Stressors**
  - **Metal toxicity, Al**
  - **Flocculation, Fe**
  - **pH toxicity**



Glenns Run Watershed, West Virginia, USA.
Image Credit: ModelMyWatershed.org, May 2023.



The Upper Ohio South Watershed, WV and PA, USA.
Image credit: The Upper Ohio South Watershed: TMDL Report, 2009, EPA.

Locations


Site 1
Site 2
Site 3
Site 4
Mine Discharge
Glenns Run
Site 2
Mine Discharge
Site 4
Site 3
WARWOOD
TERRACE
Garden Park
WARWOO
Site 5
N. 24th Street Park
Ohio River

Method

Arrays

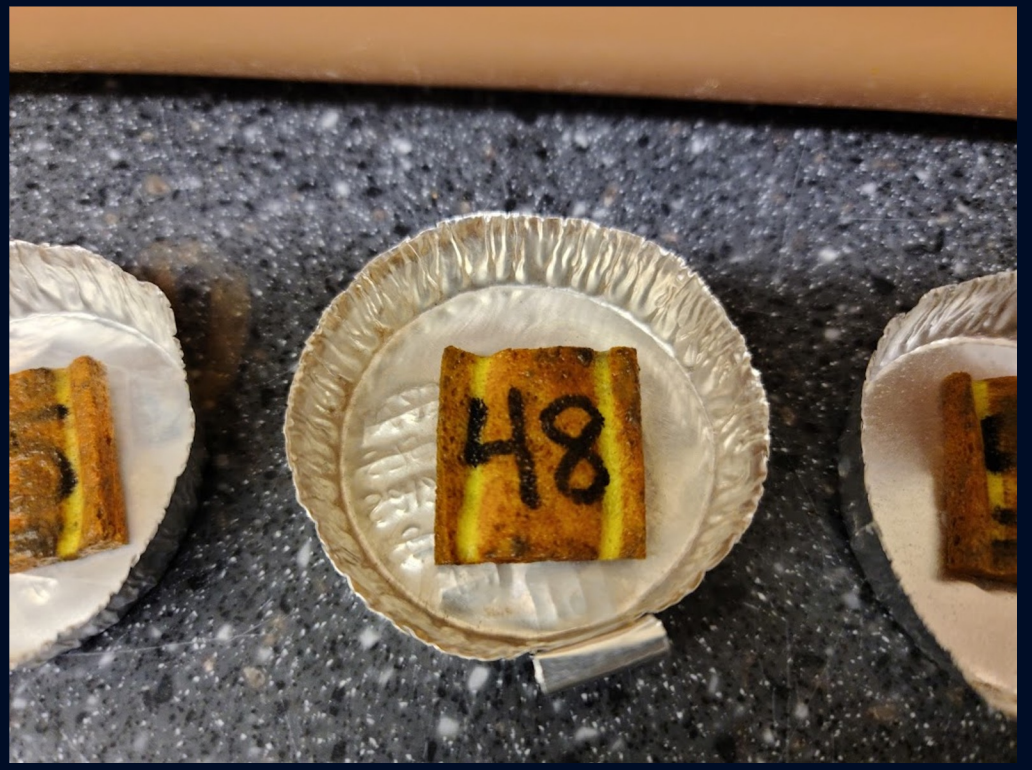
- **Plastic gutters**
- **Cellulose sponges (leaf matter)**
- **Wooden veneers (woody debris)**
- **Screen to prevent insect activity**

Cellulose Sponge 2.5 cm³

Wooden Veneer

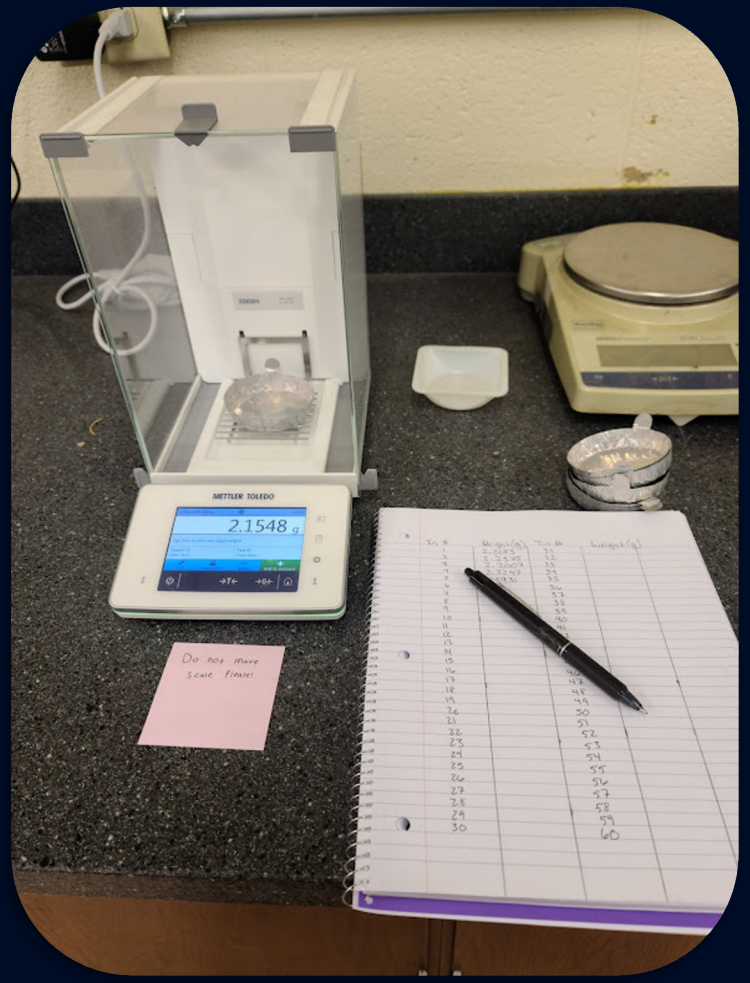
Visual Results

Site 1



Site 5

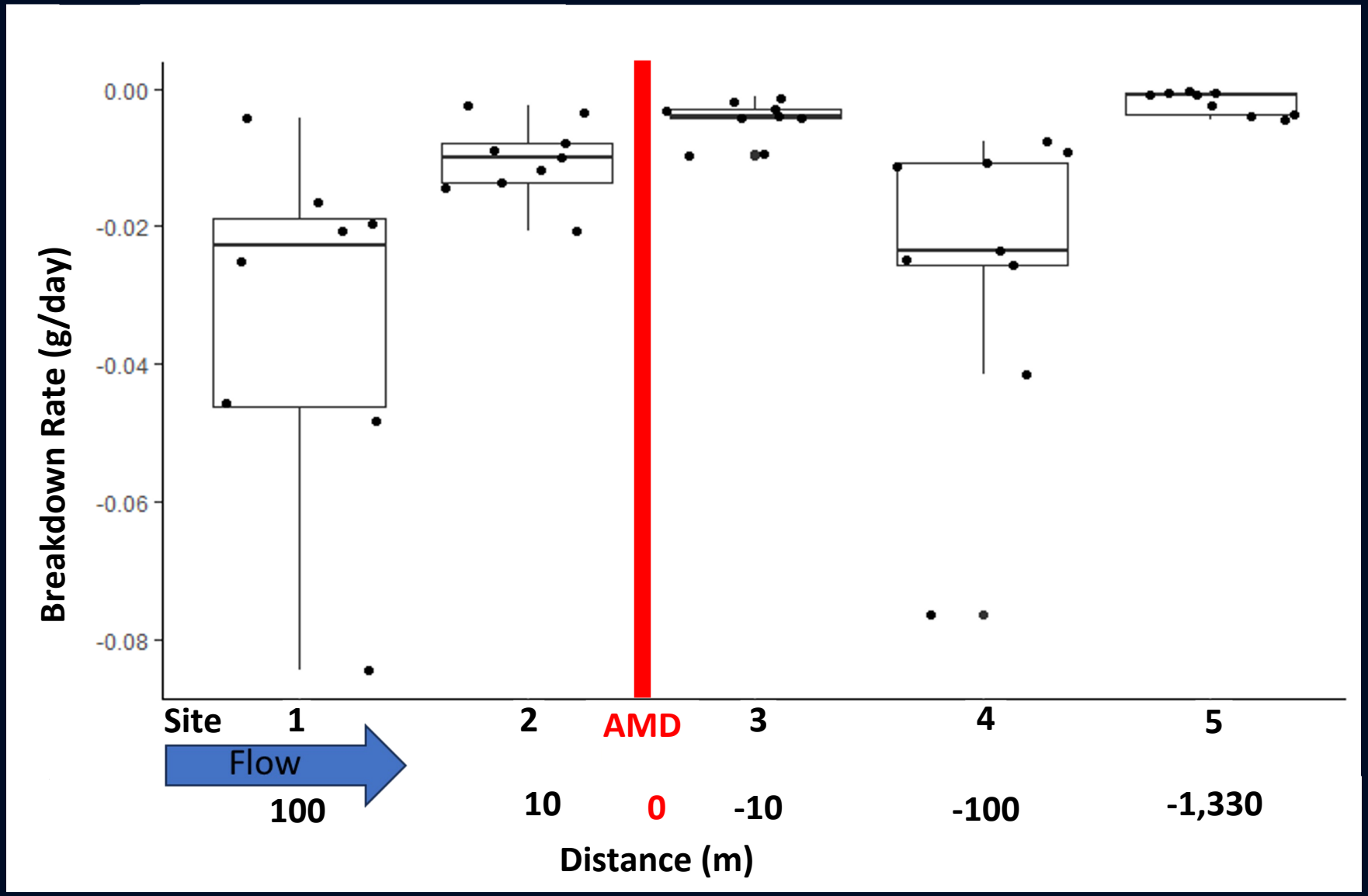
Changes in the Rates of Decomposition



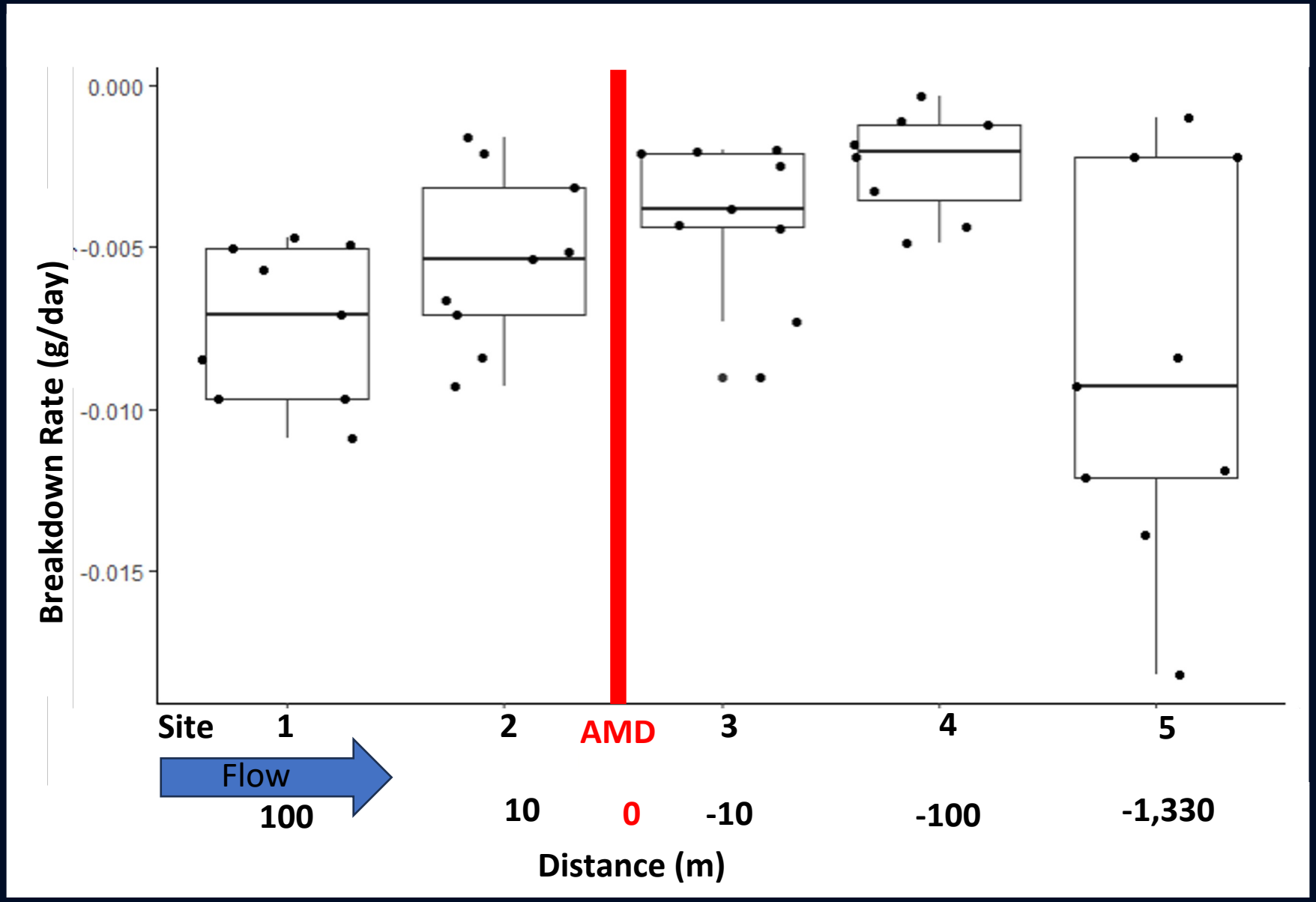
Cellulose Sponge

Woode
n
Veneer

Breakdown Rates of Sponges



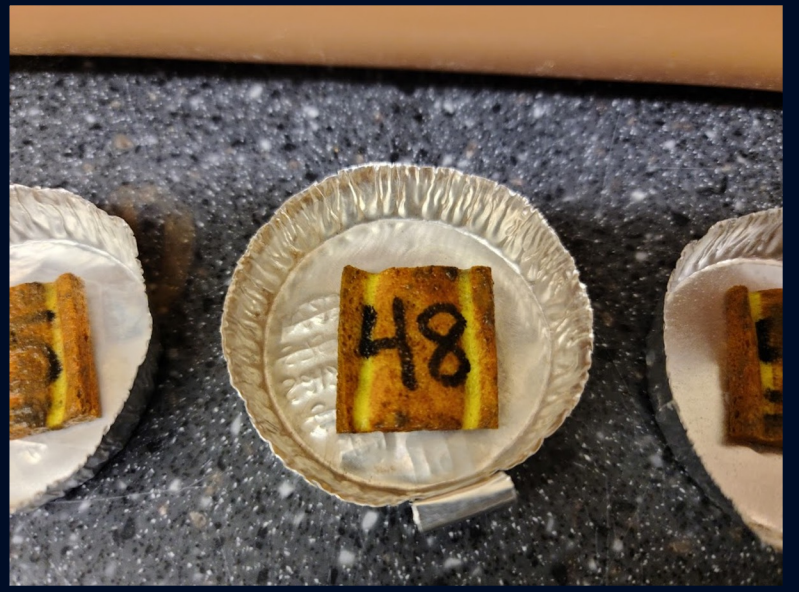
Breakdown Rates of Veneers



Changes in Decomposition

Site Comparison		Breakdown g/day	Comparison Results Site 1 is:
1:2	Sponge	0.0031/0.0054	0.57 x Faster
	Veneer	0.0074/0.0104	0.71 x Slower
1:3	Sponge	0.0331/0.0042	7.88 x Faster
	Veneer	0.0074/0.0042	1.76 x Faster
1:4	Sponge	0.0331/0.0257	1.29 x Faster
	Veneer	0.0074/0.0024	3.08 x Faster
1:5	Sponge	0.0331/0.002	16.55 x Faster
	Veneer	0.00740.0088	0.84 x Slower

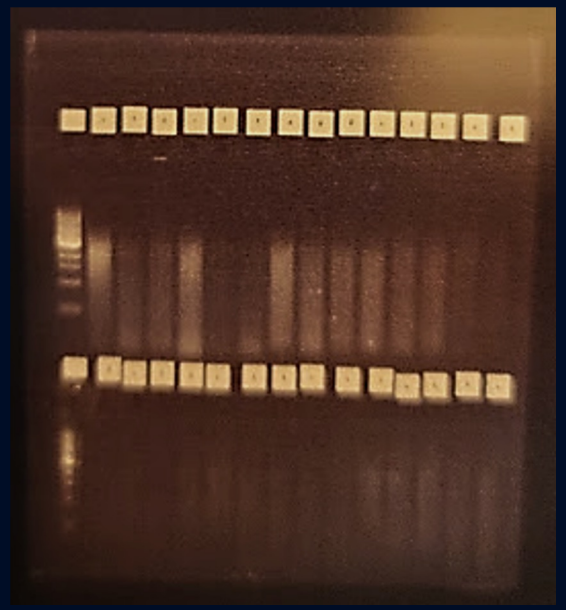
Site 1. 100 meters above AMD input

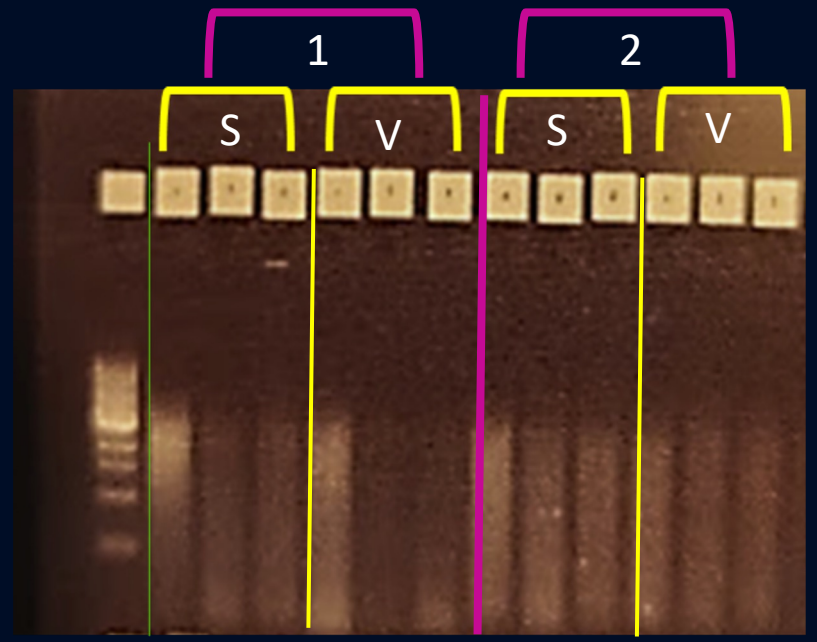


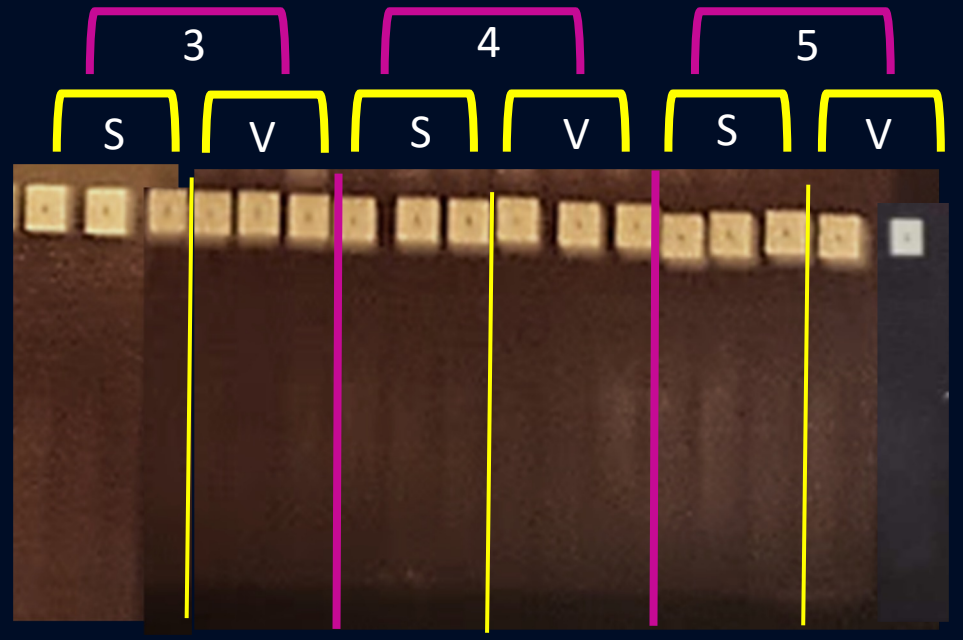
Site 5. 1,330 meters below AMD input

Microbial Community

- DNA isolation for bacterial and fungal analysis
  - 3 veneers/location
  - 3 sponges/location
- Qiagen DNeasy Power Biofilm Kit
- DNA sequencing by Zymo







Water Chemistry

Cation & Anion Analysis (1x)

- **Cations**
  - **Positive charge**
  - **Dissolved metals**
- **Anions**
  - **Negative charge**
  - **Sulfate, nitrate, phosphate**

Water Chemistry (weekly)

- **pH**
- **Temperature**
- **Dissolved oxygen**
- **Specific conductivity**
- **Turbidity**
- **Chloride**

Water Chemistry

Weekly Water Chemistry Averages

Site	Temp C	DO mg/L	SPC uS/cm	pH	Cl- mg/L	Turbidity NTU
1	21.12	7.76	828.17	8.18	29.84	46.28
2	20.85	7.72	840.17	7.70	29.89	50.86
MD	12.38	9.11	8709.67	4.32	83.80	26.92
3	19.97	7.46	1730.17	6.56	88.47	81.04
4	20.05	6.46	1711.67	6.68	95.79	115.87
5	20.95	8.28	1362.33	8.05	34.44	318.88

Cation & Anion

Site	Nitrate ug/L	Sulfate mg/L
1	1171.8	231.1
2	1095.2	230.9
MD	145	7988.4
3	881.2	1041.5
4	1165.4	1060.3
5	2022.4	852.7

Metal	Al	Mn	Fe	As
standard in PPM= mg/L	**0.05-0.2**	**0.0500**	**0.3000**	**0.0100**
Site 1	0.1058	0.0580	1.4726	0.1505
Site 2	0.0843	0.0486	1.1556	0.2713
MD	49.3456	2.8300	1196.5100	0.0031
Site 3	5.2289	0.3496	125.8032	0.0045
Site 4	60.6489	3.6983	1161.3825	bdl
Site 5	2.9414	0.2715	42.2713	bdl

Impacts

Overall Results Thus Far

- Microbial communities are altered
  - Bacterial and fungal communities are reduced and/or altered by AMD presence
  - Microbial communities are primarily responsible for decomposition of organic materials (leaf litter, wood)
- Functionality is decreased
  - Decomposition of organic materials is reduced
  - Carbon sequestration will be impacted by reduced availability of decayed organic matter
  - Nutrient transfer to other waterways is impacted
- Pollutants are transferred into additional waterways

Thank You!