Case Study: Marylea Farm Stream Restoration Site Biological Monitoring

by: Mike Fowler and Carolyn Lanza

WILDLANDS
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Creating ecological solutions through innovative engineering

→ **Founded in 2007 in Charlotte, North Carolina**

→ **Specialize *exclusively* in mitigation, ecological restoration, watershed planning, and water quality management**

→ **92 employees**

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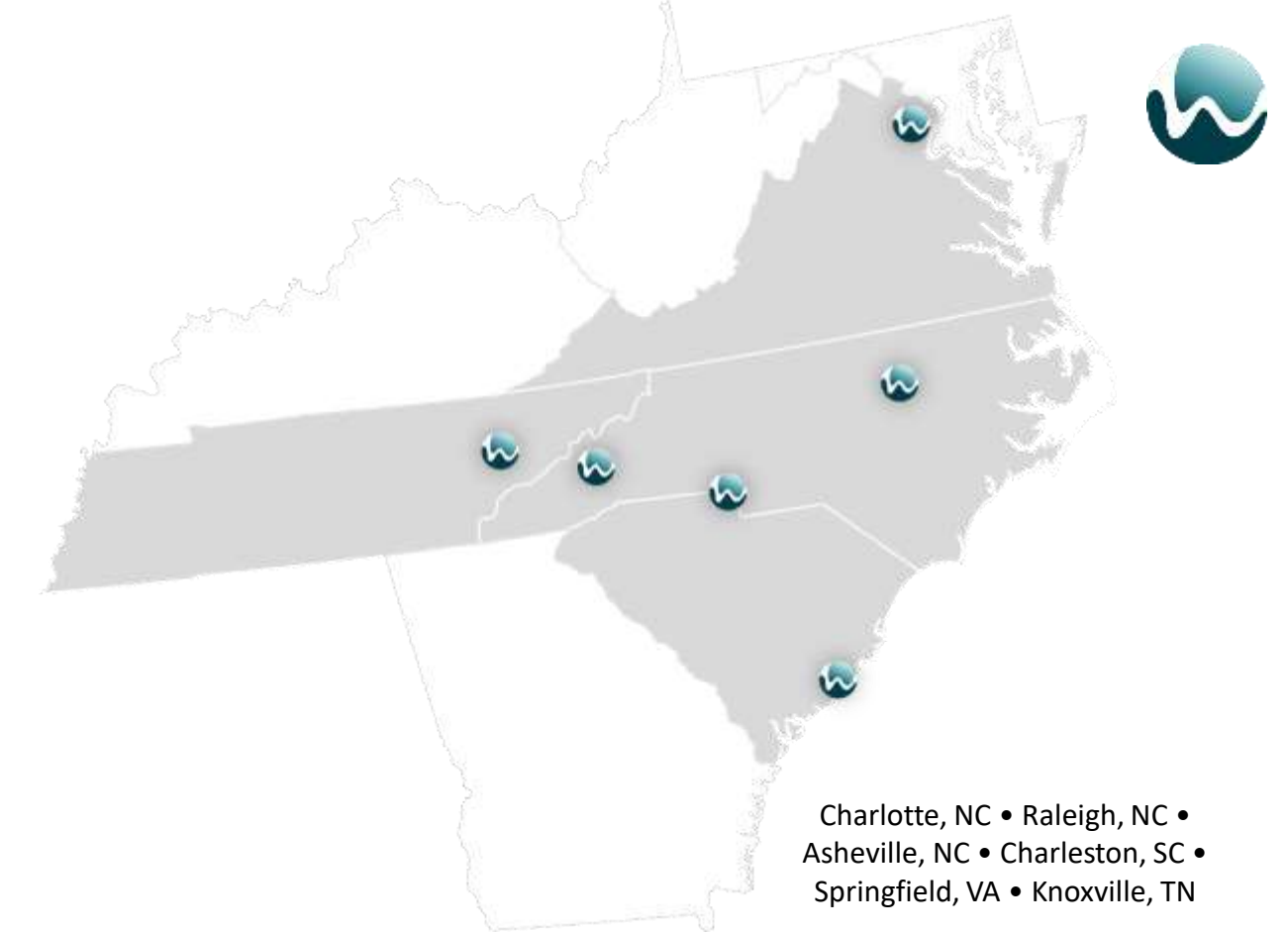
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Project Timeline

Maryland State Highway Admin. Request for Proposals

Pre-construction biological sampling

Post-construction biological sampling

2018

2020

2017

2019

2023

Marylea Farm Stream Restoration Site contract executed

Construction completed
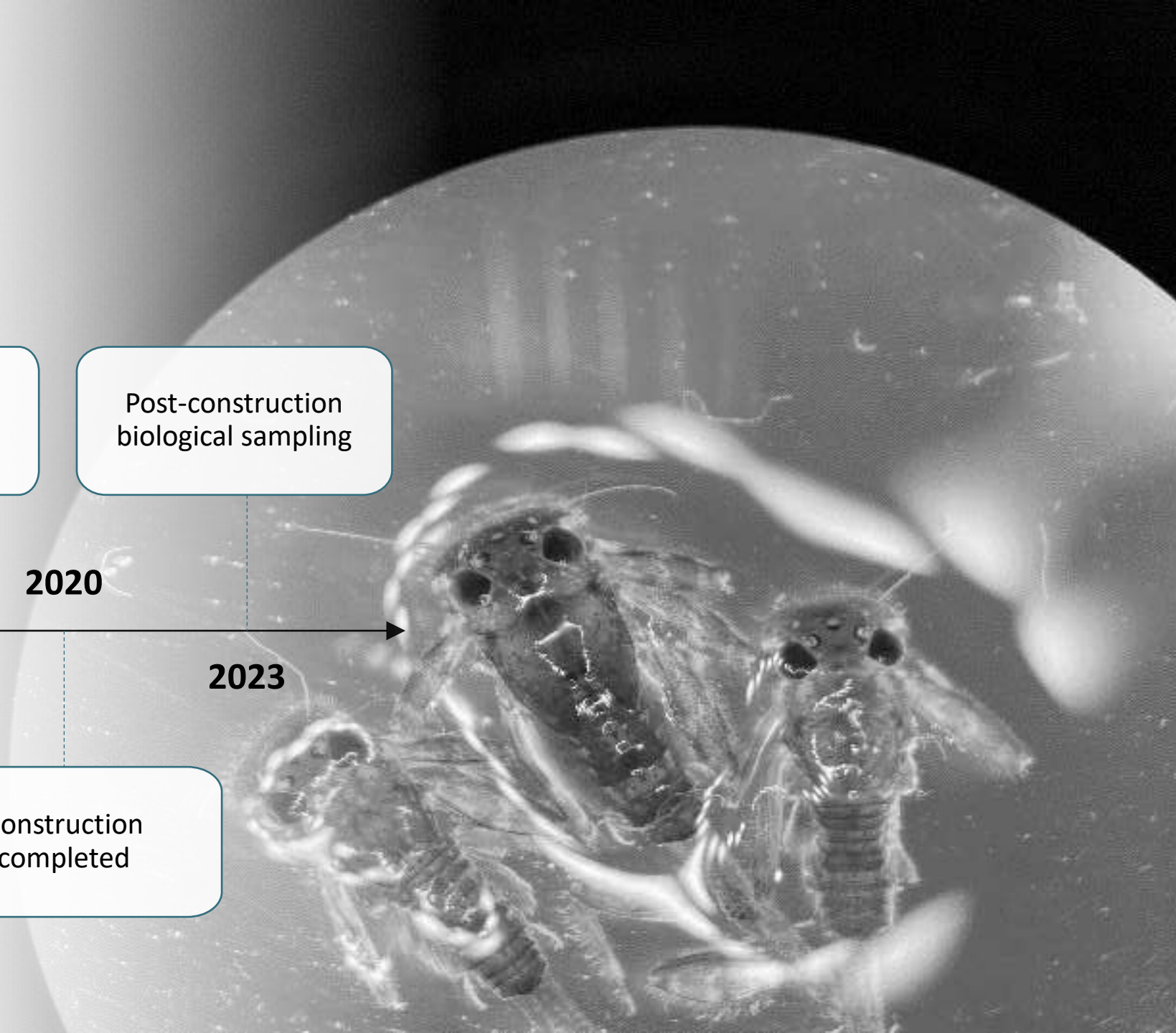
Project Overview

- **LOCATION**: Bel Air, Maryland

- **RIVER BASIN**: Susquehanna

- **ECOREGION**: Piedmont Uplands

- **WATERSHED SIZE**: 5.8 sq. miles

- **LENGTH**: ~9,800 LF of stream restoration

- **GOAL**: Reduce sediment and nutrient inputs to the Chesapeake Bay
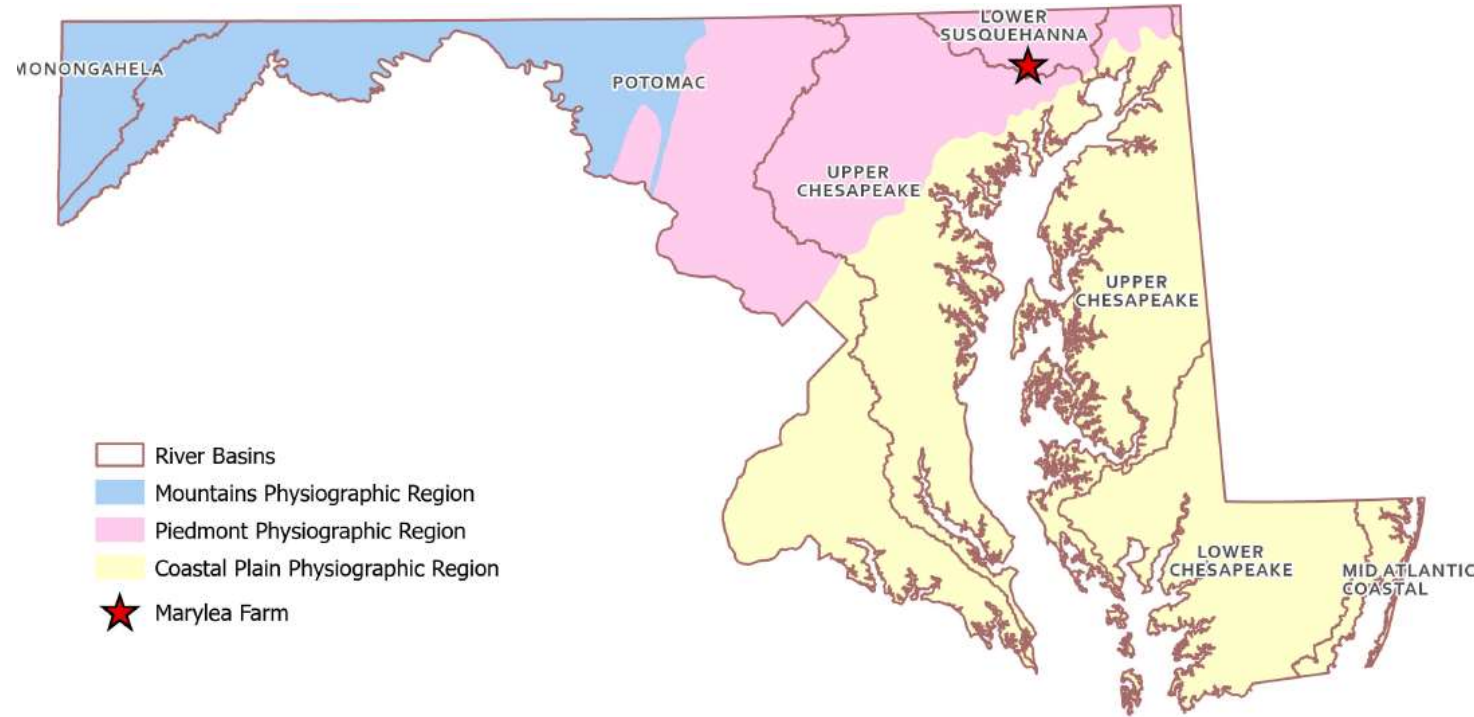
How does stream restoration impact the biological community?

Existing Conditions

- Extensive channelization

- Mass wasting and severe erosion in meandering sections

- Unvegetated banks and complete lack of riparian buffer

- Moderate to severe incision

How does stream restoration impact the biological community?

Functional Category	Pre-Construction	Post-Construction
Aquatic Biology	Not Functioning	Functioning at Risk
Physiochemical	Not Rated	Not Rated
Geomorphology	Not Functioning	Functioning
Hydraulic	Not Functioning	Functioning
Hydrology	Functioning at Risk	Functioning at Risk

Maryland Biological Criteria

- Marylea permits did not require biological sampling at the time of permit review in 2019

- Now benthic macroinvertebrate pre-construction sampling on all perennial streams required to receive joint permit application

- Sampling not required post-construction per monitoring requirements

Methods

Proper benthic macroinvertebrate Maryland Biological Stream Survey training and Scientific Collection Permits for fish

MBSS: Round Four Field Sampling Manual (MD DNR, 2019)

Water quality parameters for benthic sampling: DO, pH, temperature, conductivity

IDs completed by a licensed taxonomist and certified fisheries professional

Benthic Sampling
Pre- and Post-construction Comparison
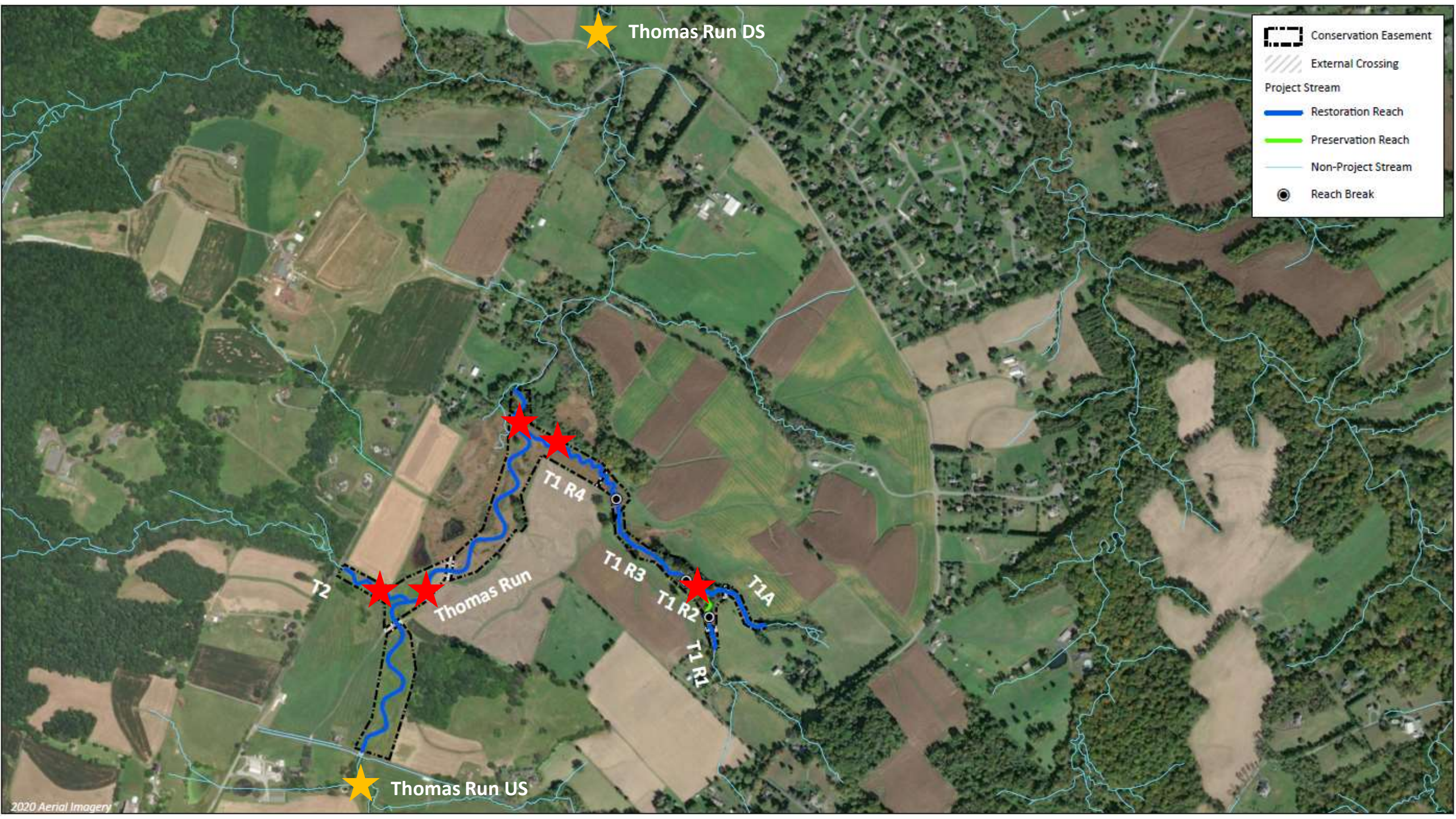
Maryland Benthic Index of Biotic Integrity:
Piedmont

Metric	5	3	1
Number of Taxa	≥ 25	15 - 24	< 15
Number of EPT Taxa	≥ 11	5 - 10	< 5
Number of Ephemeroptera Taxa	≥ 4	2 - 3	< 2
Percent Intolerant Urban	≥ 51	12 - 50	< 12
Percent Chironomidae	< 24	24 - 63	> 63
Percent Clingers	≥ 74	31 - 73	< 31

Benthic Analysis: Overall Results

Pre-Construction - 2019	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
Raw Scores				Raw Scores			
Total Number of Taxa	21	30	24	20	26	23	15
Number of EPT Taxa	6	11	7	7	11	11	6
Number Ephemeroptera Taxa	3	2	3	1	6	3	1
Percent Intolerant Urban	6.8	14.3	12.7	19.5	12.3	37.5	2.5
Percent Chironomidae	60.0	55.8	75.8	69.2	58.3	31.7	44.2
Percent Clingers	37.2	44.1	31.3	40.7	38.8	84.1	49.2
BIBI Scores				BIBI Scores			
Total Number of Taxa	3	5	3	3	5	3	3
Number of EPT Taxa	3	5	3	3	5	5	3
Number Ephemeroptera Taxa	3	3	3	1	5	3	1
Percent Intolerant Urban	1	3	3	3	3	3	1
Percent Chironomidae	3	3	1	1	3	3	3
Percent Clingers	3	3	3	3	3	5	3
BIBI Score	2.7	3.7	2.7	2.3	4.0	3.7	2.3
Narrative Rating	poor	fair	poor	poor	good	fair	poor

Post-Construction - 2023	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
Raw Scores				Raw Scores			
Total Number of Taxa	38	36	23	30	36	33	27
Number of EPT Taxa	13	7	4	12	10	13	9
Number Ephemeroptera Taxa	5	1	1	4	4	4	2
Percent Intolerant Urban	22.9	9.9	10.9	49.6	24.0	53.1	26.0
Percent Chironomidae	32.1	60.3	56.5	36.0	48.8	14.7	43.1
Percent Clingers	60.3	46.4	27.5	58.4	49.6	83.2	55.3
BIBI Scores				BIBI Scores			
Total Number of Taxa	5	5	3	5	5	5	5
Number of EPT Taxa	5	3	1	5	3	5	3
Number Ephemeroptera Taxa	5	1	1	5	5	5	3
Percent Intolerant Urban	3	1	1	3	3	5	3
Percent Chironomidae	3	3	3	3	3	5	3
Percent Clingers	3	3	1	3	3	5	3
BIBI Score	4.0	2.7	1.7	4.0	3.7	5.0	3.3
Narrative Rating	good	poor	very poor	good	fair	good	fair

Benthic Analysis: Thomas Run at T2 Results

Pre-Construction - 2019	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
Raw Scores							
Total Number of Taxa	21	30	24	20	26	23	15
Number of EPT Taxa	6	11	7	7	11	11	6
Number Ephemeroptera Taxa	3	2	3	1	6	3	1
Percent Intolerant Urban	6.8	14.3	12.7	19.5	12.3	37.5	2.5
Percent Chironomidae	60.0	55.8	75.8	69.2	58.3	31.7	44.2
Percent Clingers	37.2	44.1	31.3	40.7	38.8	84.1	49.2
BIBI Scores							
Total Number of Taxa	3	5	3	3	5	3	3
Number of EPT Taxa	3	5	3	3	5	5	3
Number Ephemeroptera Taxa	3	3	3	1	5	3	1
Percent Intolerant Urban	1	3	3	3	3	3	1
Percent Chironomidae	3	3	1	1	3	3	3
Percent Clingers	3	3	3	3	3	5	3
BIBI Score	2.7	3.7	2.7	2.3	4.0	3.7	2.3
Narrative Rating	poor	fair	poor	poor	good	fair	poor

Post-Construction - 2023	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
Raw Scores							
Total Number of Taxa	38	36	23	30	36	33	27
Number of EPT Taxa	13	7	4	12	10	13	9
Number Ephemeroptera Taxa	5	1	1	4	4	4	2
Percent Intolerant Urban	22.9	9.9	10.9	49.6	24.0	53.1	26.0
Percent Chironomidae	32.1	60.3	56.5	36.0	48.8	14.7	43.1
Percent Clingers	60.3	46.4	27.5	58.4	49.6	83.2	55.3
BIBI Scores							
Total Number of Taxa	5	5	3	5	5	5	5
Number of EPT Taxa	5	3	1	5	3	5	3
Number Ephemeroptera Taxa	5	1	1	5	5	5	3
Percent Intolerant Urban	3	1	1	3	3	5	3
Percent Chironomidae	3	3	3	3	3	5	3
Percent Clingers	3	3	1	3	3	5	3
BIBI Score	4.0	2.7	1.7	4.0	3.7	5.0	3.3
Narrative Rating	good	poor	very poor	good	fair	good	fair

Benthic Analysis: T1 R4 Results

Pre-Construction - 2019	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
Raw Scores							
Total Number of Taxa	21	30	24	20	26	23	15
Number of EPT Taxa	6	11	7	7	11	11	6
Number Ephemeroptera Taxa	3	2	3	1	6	3	1
Percent Intolerant Urban	6.8	14.3	12.7	19.5	12.3	37.5	2.5
Percent Chironomidae	60.0	55.8	75.8	69.2	58.3	31.7	44.2
Percent Clingers	37.2	44.1	31.3	40.7	38.8	84.1	49.2
BIBI Scores							
Total Number of Taxa	3	5	3	3	5	3	3
Number of EPT Taxa	3	5	3	3	5	5	3
Number Ephemeroptera Taxa	3	3	3	1	5	3	1
Percent Intolerant Urban	1	3	3	3	3	3	1
Percent Chironomidae	3	3	1	1	3	3	3
Percent Clingers	3	3	3	3	3	5	3
BIBI Score	2.7	3.7	2.7	2.3	4.0	3.7	2.3
Narrative Rating	poor	fair	poor	poor	good	fair	poor

Post-Construction - 2023	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
Raw Scores							
Total Number of Taxa	38	36	23	30	36	33	27
Number of EPT Taxa	13	7	4	12	10	13	9
Number Ephemeroptera Taxa	5	1	1	4	4	4	2
Percent Intolerant Urban	22.9	9.9	10.9	49.6	24.0	53.1	26.0
Percent Chironomidae	32.1	60.3	56.5	36.0	48.8	14.7	43.1
Percent Clingers	60.3	46.4	27.5	58.4	49.6	83.2	55.3
BIBI Scores							
Total Number of Taxa	5	5	3	5	5	5	5
Number of EPT Taxa	5	3	1	5	3	5	3
Number Ephemeroptera Taxa	5	1	1	5	5	5	3
Percent Intolerant Urban	3	1	1	3	3	5	3
Percent Chironomidae	3	3	3	3	3	5	3
Percent Clingers	3	3	1	3	3	5	3
BIBI Score	4.0	2.7	1.7	4.0	3.7	5.0	3.3
Narrative Rating	good	poor	very poor	good	fair	good	fair

Running Theories:

Cattails?
Beaver Impoundments?
Soils?

# **Benthic Analysis:** Functional Feeding Groups Results

Pre-Construction - 2019	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
FFG	Percentage						
Collector	66%	58%	59%	59%	58%	23%	55%
Filterer	11%	13%	5%	15%	13%	32%	34%
Predator	3%	8%	1%	1%	6%	2%	3%
Scraper	1%	4%	5%	3%	5%	19%	1%
Shredder	17%	9%	12%	13%	7%	16%	6%

Post-Construction - 2023	Thomas Run DS	Thomas Run at T1	T1 R4	T1 R2	Thomas Run at T2	T2	Thomas Run US
FFG	Percentage						
Collector	40%	53%	64%	38%	46%	25%	43%
Filterer	25%	23%	20%	6%	23%	23%	21%
Predator	4%	4%	6%	11%	2%	4%	8%
Scraper	24%	11%	1%	9%	21%	25%	15%
Shredder	7%	7%	4%	35%	3%	22%	11%

Fish Sampling
Pre- and Post-construction Comparison
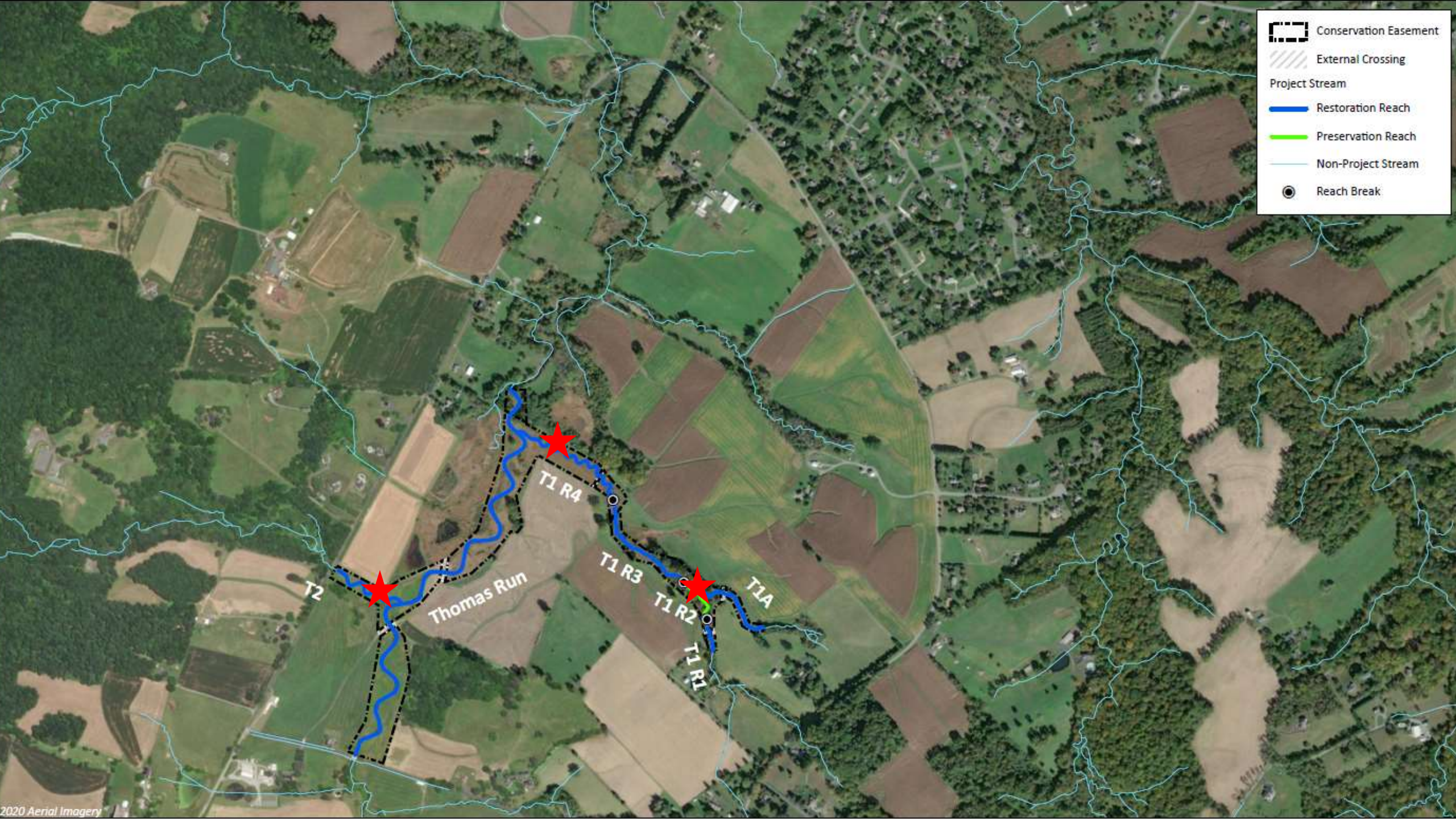
Maryland Fish Index of Biotic Integrity:
Piedmont

Metric	5	3	1
Abundance per Square Meter	≥ 1.25	0.25 – 1.24	< 0.25
Number of Benthic Species	≥ 0.26	0.09 – 0.25	< 0.09
Percent Tolerant	≤ 45	46 – 8	> 68
Percent Generalist, Omnivores, Insectivores	≤ 80	81 – 91	100
Biomass per Square Meter	≥ 8.6	4.0 – 8.5	< 4.0
Percent Lithophilic Spawners (Silt Intolerant)	≥ 61	32 – 60	< 32

Fish Analysis: Overall Results

Pre-Construction - 2019	T1 R4	T1 R2	T2
Raw Scores		Raw Scores	
Abundance per Square Meter	0.7	0.3	3.7
Number of Benthic Species	1.9	3.5	2.9
Percent Tolerant	74.6	81.2	73.5
Percent Generalist, Omnivores, Invertivores	78.0	82.6	82.0
Biomass per Square Meter	1.2	1.2	10.5
Percent Lithophilic Spawners (Silt Intolerant)	23.7	23.2	28.0
BIBI Scores		BIBI Scores	
Abundance per Square Meter	3	3	5
Number of Benthic Species	5	5	5
Percent Tolerant	1	1	1
Percent Generalist, Omnivores, Invertivores	5	3	3
Biomass per Square Meter	1	1	5
Percent Lithophilic Spawners (Silt Intolerant)	1	1	1
FIBI Score	**2.7**	**2.3**	**3.3**
Characterization	poor	poor	fair

Post-Construction - 2023	T1 R4	T1 R2	T2
Raw Scores		Raw Scores	
Abundance per Square Meter	0.8	0.3	3.4
Number of Benthic Species	3.8	3.5	1.9
Percent Tolerant	45.1	87.4	59.0
Percent Generalist, Omnivores, Invertivores	91.5	87.4	87.0
Biomass per Square Meter	10.9	0.6	11.9
Percent Lithophilic Spawners (Silt Intolerant)	35.2	12.6	42.3
BIBI Scores		BIBI Scores	
Abundance per Square Meter	3	3	5
Number of Benthic Species	5	5	5
Percent Tolerant	3	1	3
Percent Generalist, Omnivores, Invertivores	3	3	3
Biomass per Square Meter	5	1	5
Percent Lithophilic Spawners (Silt Intolerant)	3	1	3
FIBI Score	**3.7**	**2.3**	**4.0**
Characterization	fair	poor	good

Next Steps:

- Expand number of internally sampled sites within Wildlands' Maryland projects.
- Establish internal, consistent, long-term data collection methods and standardize data analysis.
- Find well established reference reaches.
- Compare restored data to internal reference sites using an expected: observed ratio.
- Discuss how we define ecological uplift as restoration practitioners and mitigation providers.

POST-CONSTRUCTION YEAR 2

POST-CONSTRUCTION YEAR 4

Overall Research Question:

Can we demonstrate long-term ecological uplift of Wildlands restoration projects using pre- and post-construction data?

References

MD DNR. 2019. Maryland Biological Stream Survey: Round Four Sampling Manual. Maryland Department of Natural Resources. January 2019.

MD DNR. 2005. Maryland Biological Stream Survey 2000-2004: New Biological Indicators to Better Assess the Condition of Maryland Streams. Maryland Department of Natural Resources. December 2005.

Harman, W. R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. *A Function Based Framework for Stream Assessment and Restoration Projects.* US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006.

POST-CONSTRUCTION YEAR 1

POST-CONSTRUCTION YEAR 2

POST-CONSTRUCTION YEAR 3

POST-CONSTRUCTION YEAR 4

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