Influence of Water Quality and Sediment Transport on Biological Recovery Downstream of Lime Dosers

Comparative Study of Four Lime Doser Systems

Presented by

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Introduction

- Acid Mine Drainage (AMD) is the legacy of pre-regulation mining in southeastern Ohio.
- Lime Dosers - Active Remediation strategy when space limitation exists and where passive system would not be effective .
- Used in high acid loading streams.

Lime Doser Installation and Water Quality

Four Dosers were installed in four watersheds to treat heavy acid loading streams.

Doser Location	Year Installed	Stream Remediated	Sub-Watershed	WaterShed
Carbondale	2004	Carbondale Seeps	Hewett Fork	Raccoon Creek
Job's Hollow	2004	Job's Hollow		Monday Creek
Pine Run	2012	Pine Run	West Branch	Sunday Creek
Thomas Fork	2012	Thomas Fork Seeps	Thomas Fork	Leading Creek

(Bowman and Johnson, 2013)

Carbondale Doser, Hewett Fork

Job's Hollow Doser Monday Creek

Intro cont'd

- Installation of the dosers led to chemical and biological improvement.

- In Raccoon Creek and Monday Creek, biological, acidity, pH and metal targets are both met 7 miles downstream of the doser. (Bowman and Johnson, 2013)
- In Sunday Creek, acidity, pH and metal targets are met 3.5 miles downstream of the doser, biological targets are not met until 7 miles downstream of the doser. (Bowman and Johnson, 2013)
- In Leading Creek, while the pH goal is met 1.5 miles downstream; acidity, metal and biological targets are not met.

- **pH values downstream of dosers in Raccoon and Monday Creeks vary between 5.5 to 8.0 up to January, 2013.**
- **pH values downstream of dosers in Sunday and Leading vary from 6 to 6.5.**

Thomas Fork Doser, Leading Creek

Intro cont'd

- Previous studies in Hewett Fork (Raccoon Creek Watershed) demonstrated the influence of stream geomorphology and natural alkalinity sources in the biological recovery of macro-invertebrates and fishes(Kruse et al, 2013).
- The study led to the "partition" of the zones downstream of doser into 3: Impaired, Transition and Improved Zones to reflect the level of biological recovery.

- Studies in Pennsylvania also showed episodic AMD discharges were positively correlated with dissolved metal concentrations and specific conductivity. However, they were negatively correlated with MAIS scores (MacCausland & McTammany, 2007)

Objectives of Study

The purpose of this study is to investigate the factors that contribute to biological recovery in the downstream reaches of lime doser systems.

Specific Objectives of the study are the following:

- To explore differences in biological recovery downstream of dosers systems.
- To examine the aqueous water chemistry trends to identify correlations with biological recovery.
- To assess the influence of reduction in sediment load, precipitation of dissolved metals and additional alkalinity loads downstream of the doser treatment on biological improvement.

Methods

- Total study duration will be 12 months.
- Study commenced in February 2014 and will continue until January 2015.
- Eight to eleven miles downstream of dosers will be sampled for analysis.

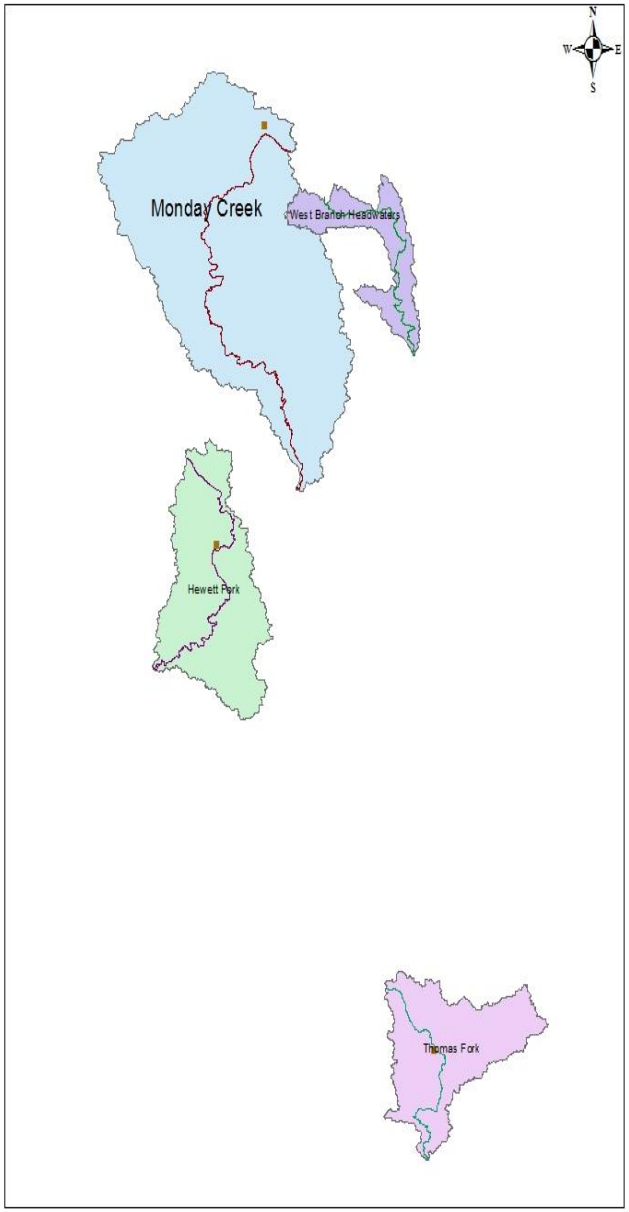
Physical / Chemical Analysis

- Field Parameters and Flow
- Alkalinity – Acidity Budget
- Water Quality Laboratory
- Sediment Chemistry and Grain Size

Biological Recovery

- MAIS and IBI

Study Watersheds



Study Sites

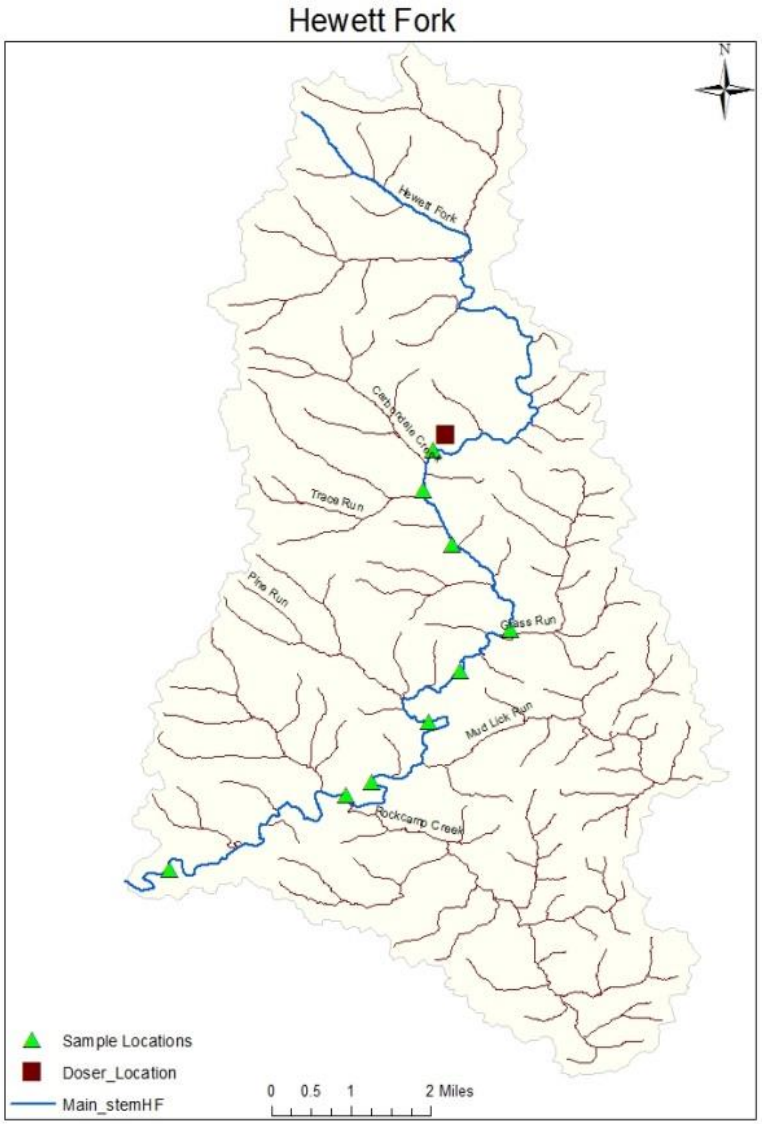


Fig 1

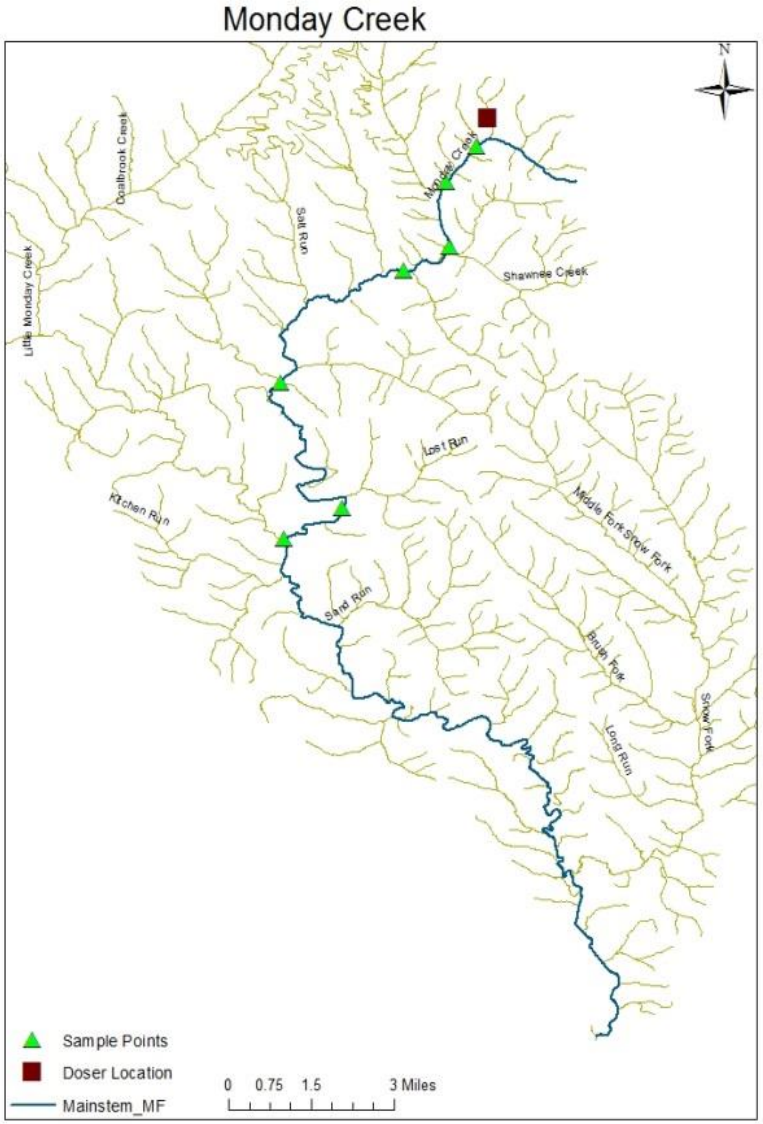


Fig 2

Study Sites Cont'd

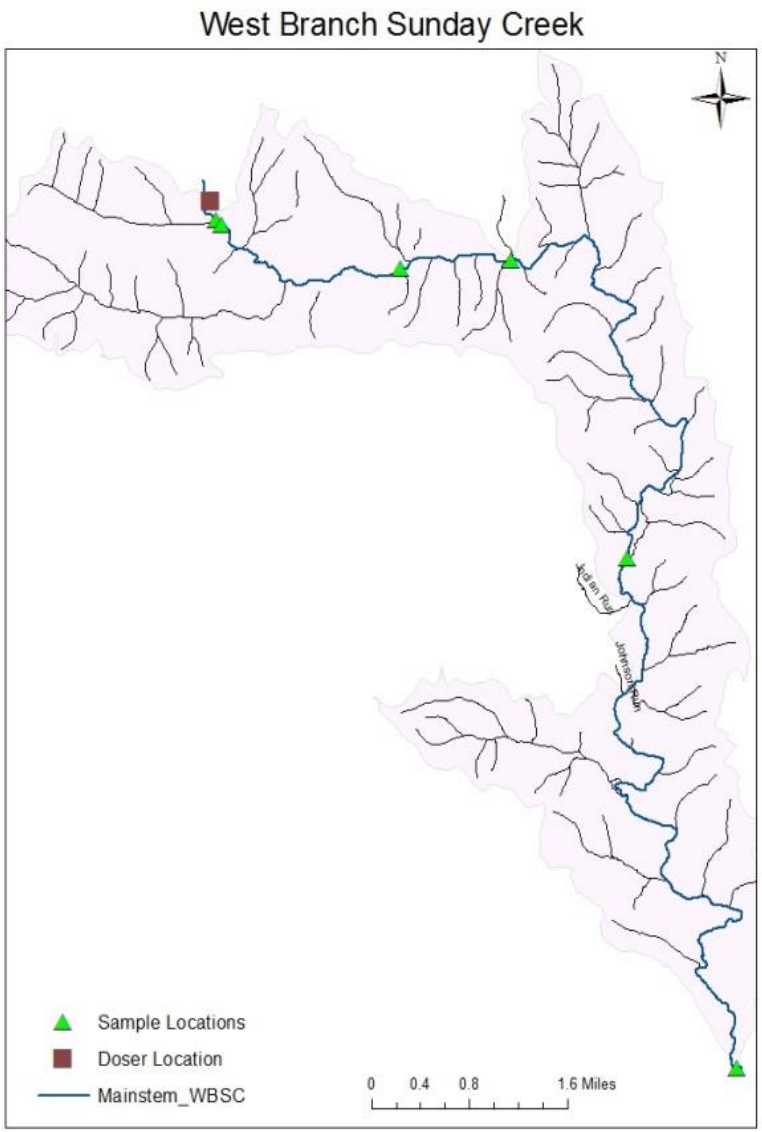


Fig 3

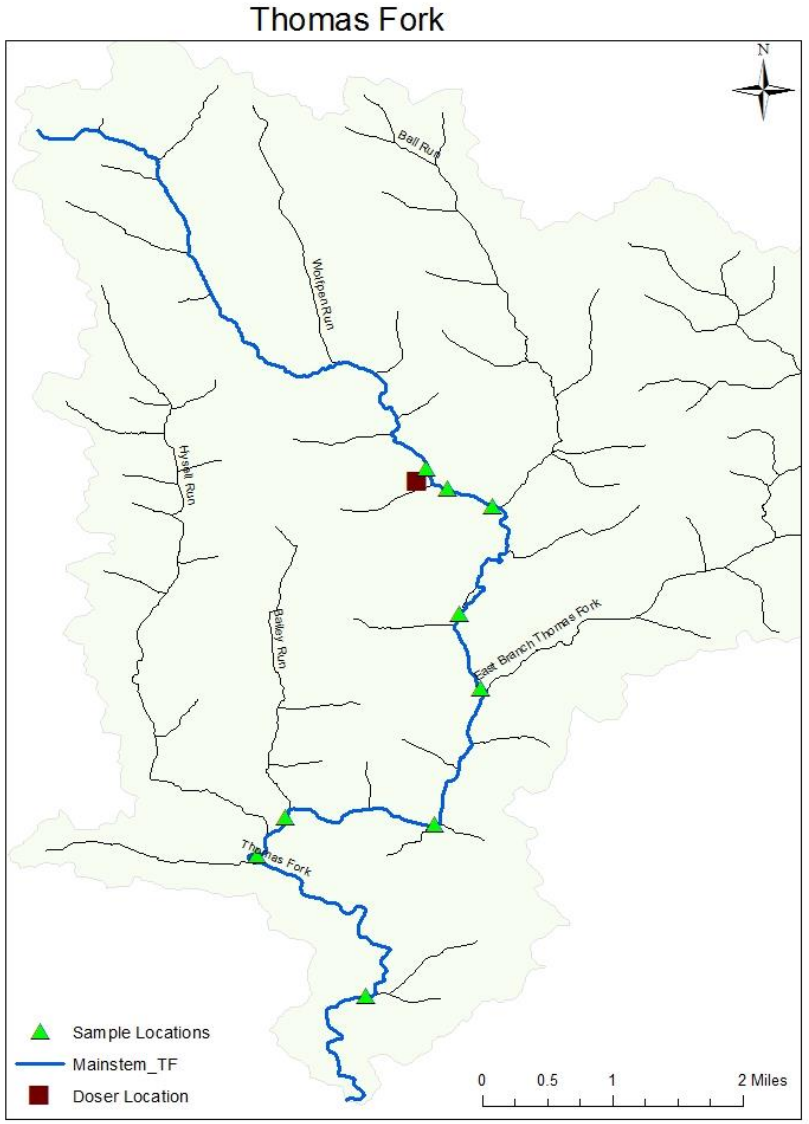


Fig 4

Table 2. Proposed sampling sessions at Study Sites

Activity	No of Sites	Rationale	Sampling Frequency	Issues
Water Quality / Field Parameters/Flow	37	Changes in water quality	2 - 3 x/ year	Doser should be working optimally
		Seasonal patterns		
		Discharge		
Field Parameters / Flow or Velocity	37	For metal, acid and alkalinity loads quantification	Monthly	
Alkalinity Budget	80	Alkalinity and Acidity Profile of Streams	2x /year High Flow (Late March – Early June) & Low Flow (Aug - Late September)	
Sediment Chemistry & Grain Size	16	Characterize and quantify the constituents of sediment	1x/year Summer (June/July highly anticipated)	
MAIS	25	Biological Recovery	1x/year (July highly anticipated)	
IBI	9	Biological Recovery	1x/year (Sept highly anticipated)	

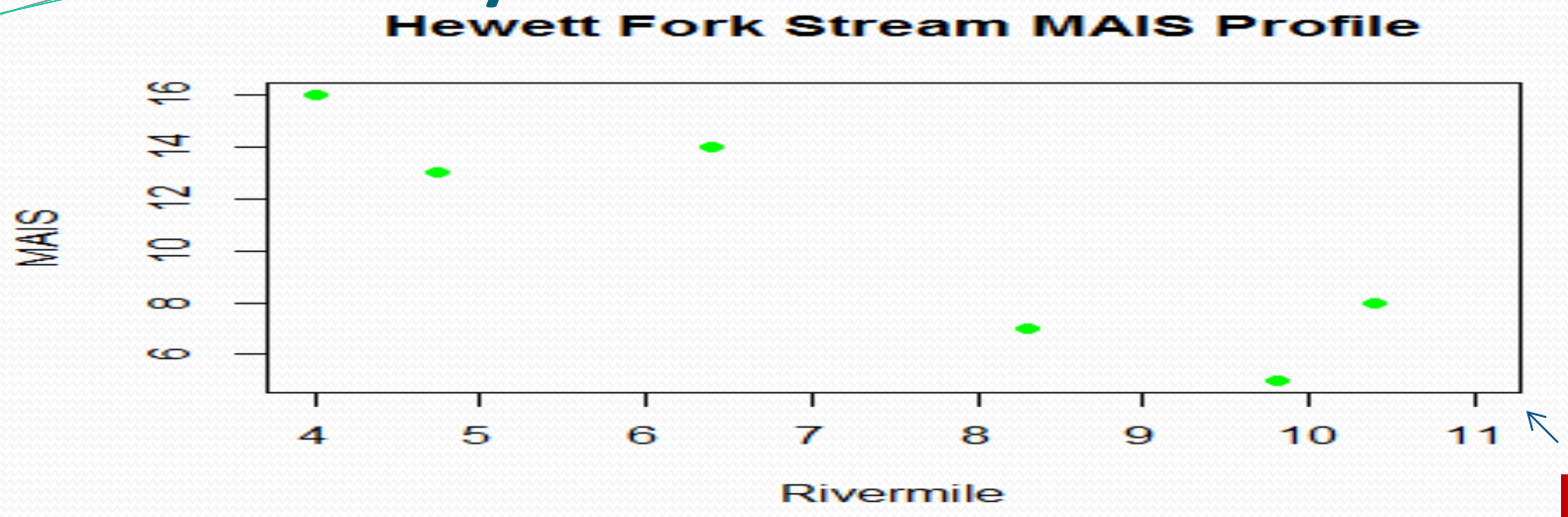
Table 3: Breakdown of sampling sites and volume (per Study Site)

		Location/ No of Sites			
Activity	Total No of Sites	Monday Creek / Downstream Jobs Hollow Doser	West BranchSunday Creek / Downstream Pine Run Doser	Thomas Fork / DownstreamThomas Fork Doser	Hewett Fork / Downstream Carbondale Doser
Water Quality / Field Parameters/Flow	37	7	9	11	11
Field Parameters / Flow or Velocity	37	7	9	11	11
Alkalinity Budget	80	21	20	21	18
Sediment Chemistry & Grain Size	16	4	4	4	4
MAIS	25	6	7	5	7
IBI	9	-	6	-	3

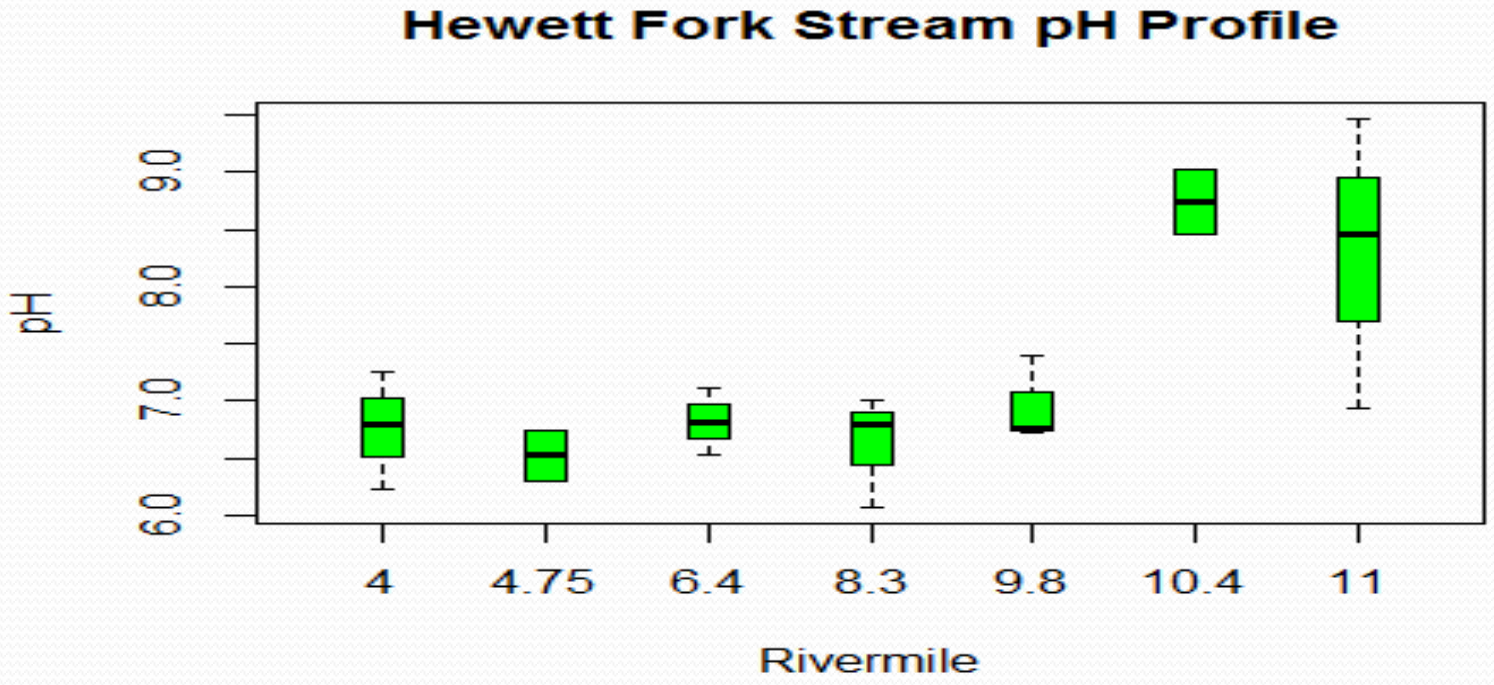
Statistical Analysis

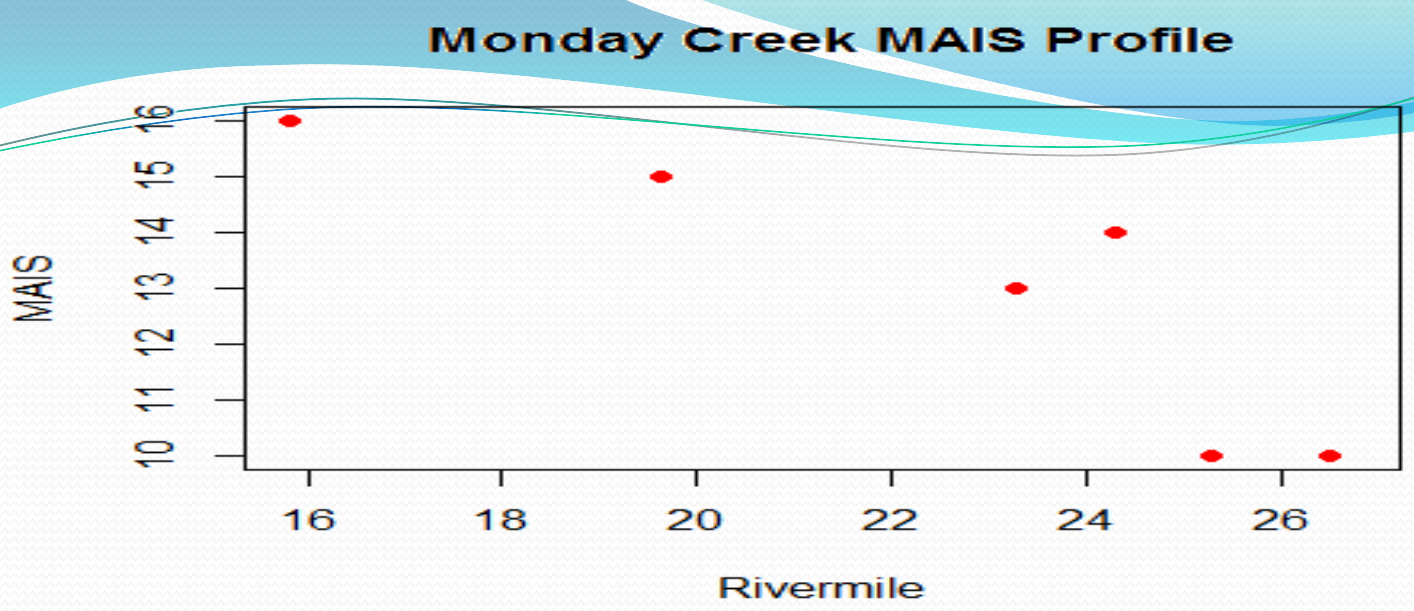
- Correlation and Regression analysis of data will be conducted using R and Excel employing parametric and non-parametric approaches.
- Sampling results will be compared to MAIS and IBI results to find the best correlation that describes the factors that enhance biological recovery.
- Downstream reaches field parameters and water quality profile for the dosers will be analyzed and compared to assess differences in biological recovery.

Preliminary Results

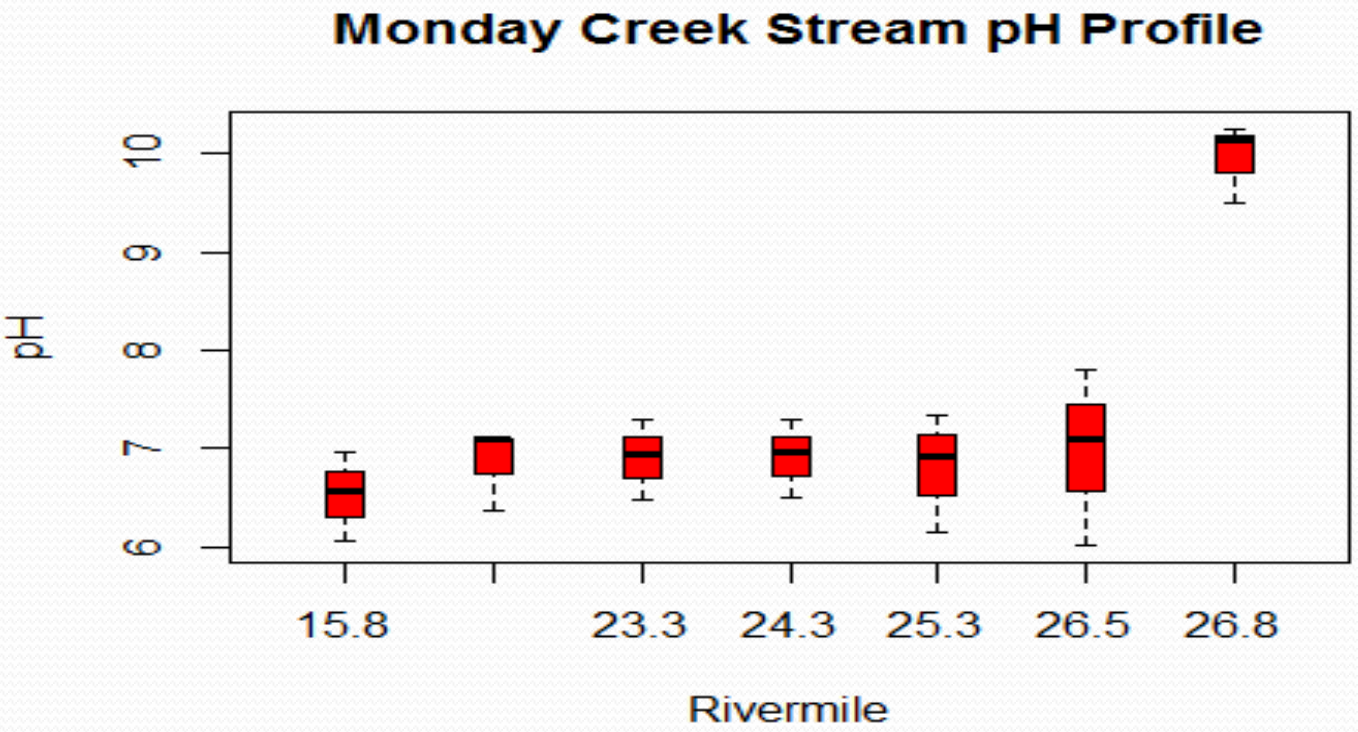


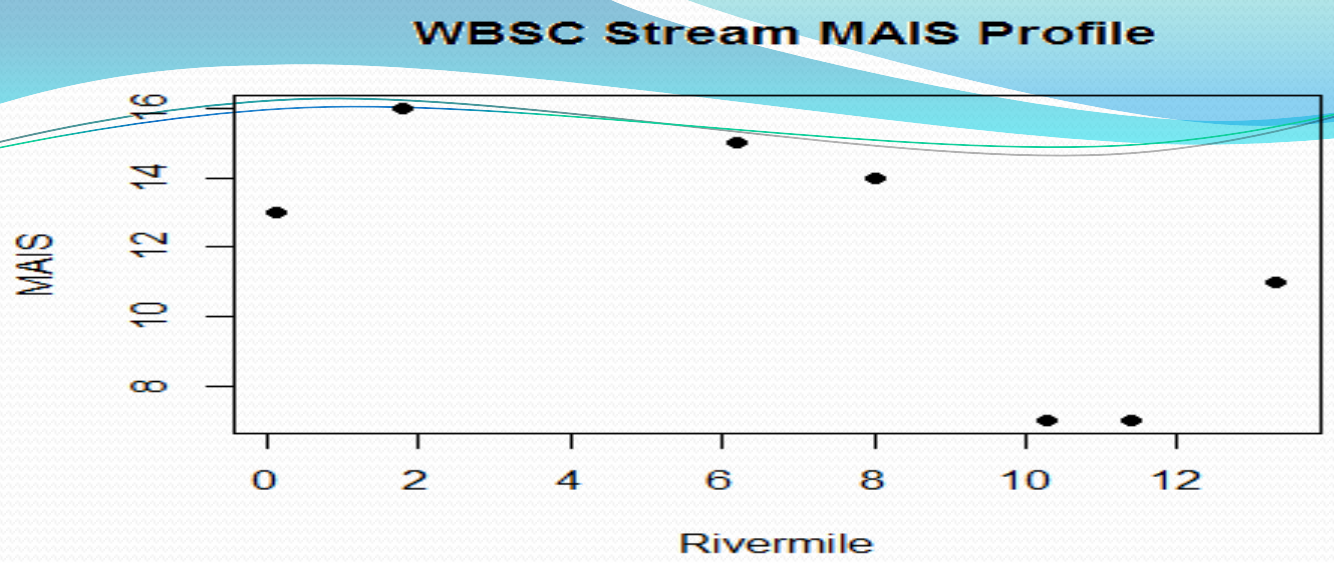
DOSER



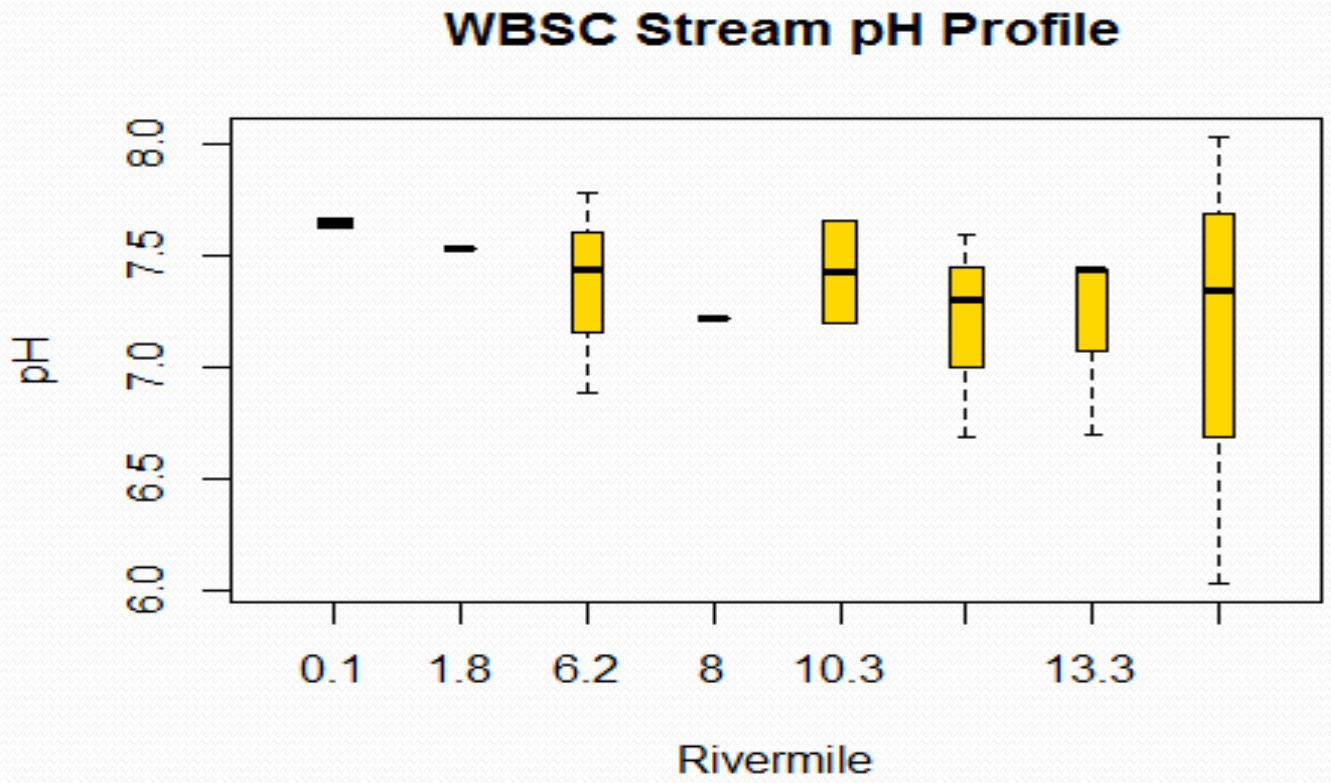

Monday Creek MAIS Profile
MAIS
10
11
12
13
14
15
16
16
18
20
22
24
26
Rivermile

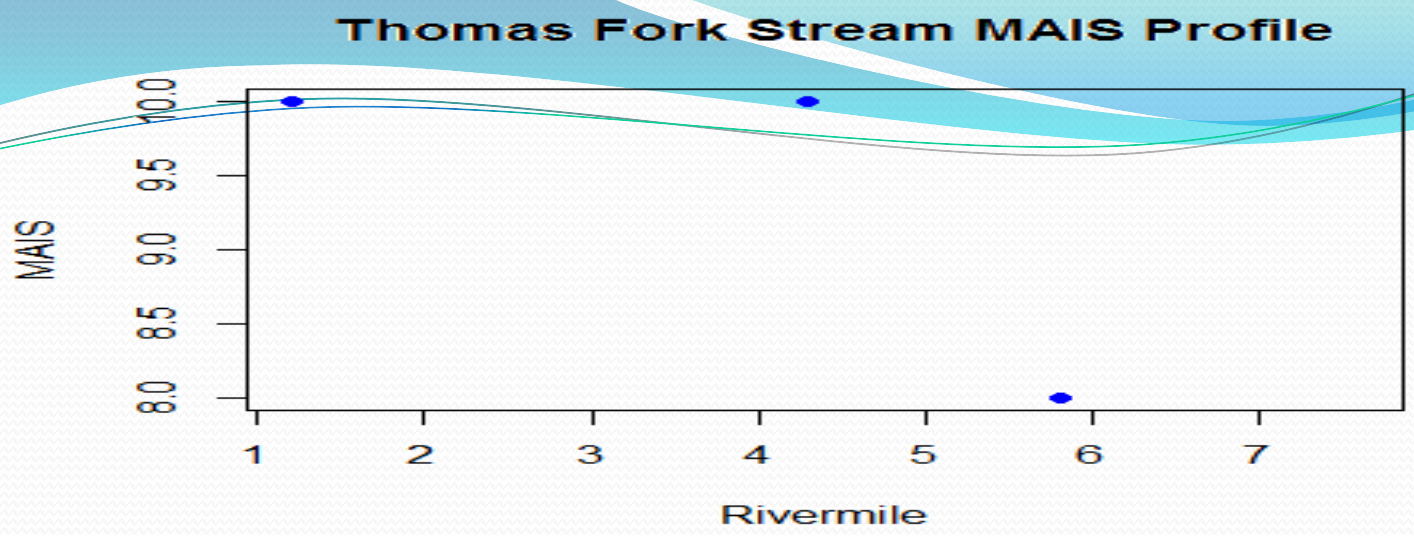
DOSER


Monday Creek Stream pH Profile
pH
6
7
8
9
10
15.8
23.3
24.3
25.3
26.5
26.8
Rivermile

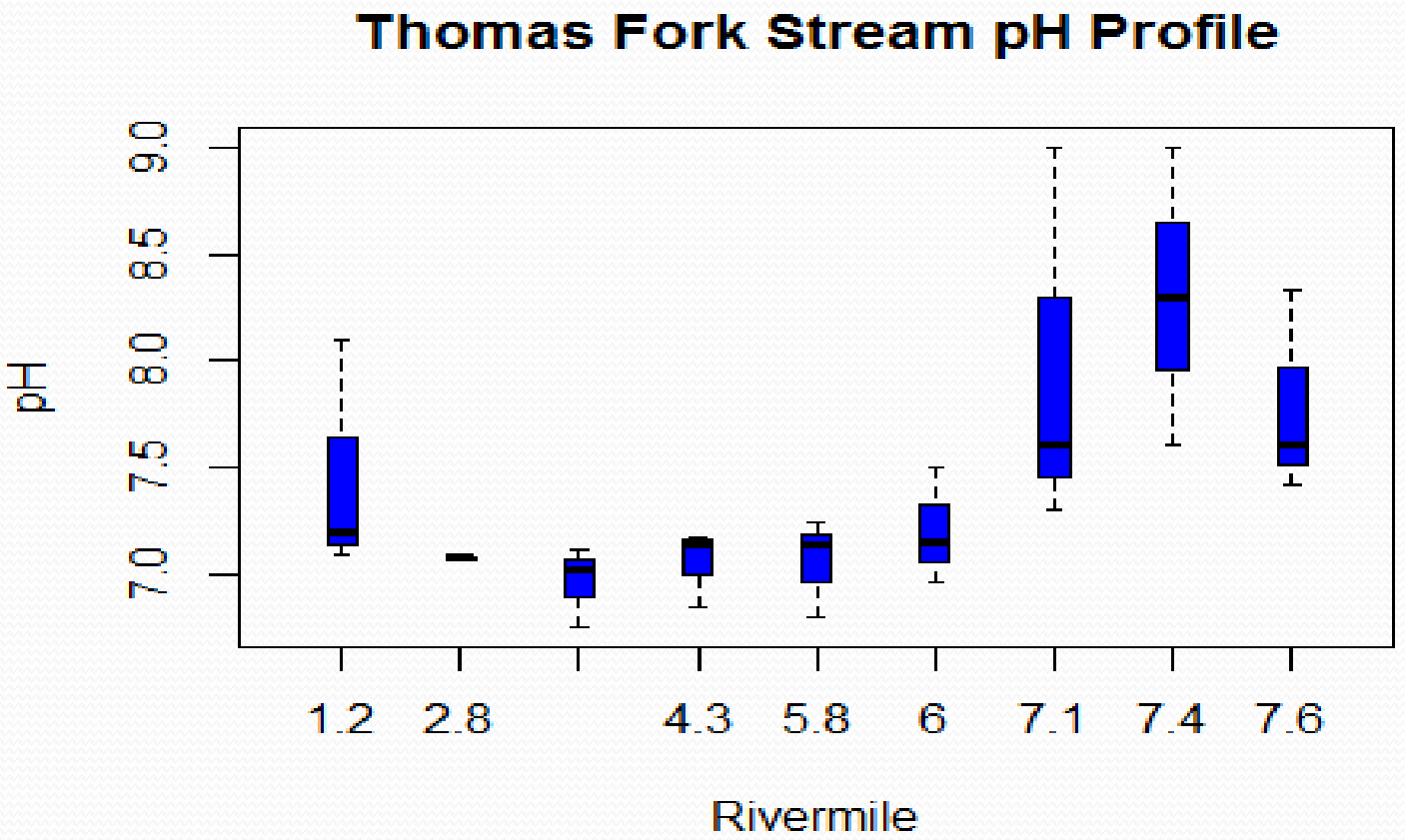

WBSC Stream MAIS Profile
MAIS
8
10
12
14
16
0
2
4
6
8
10
12
Rivermile

DOSER

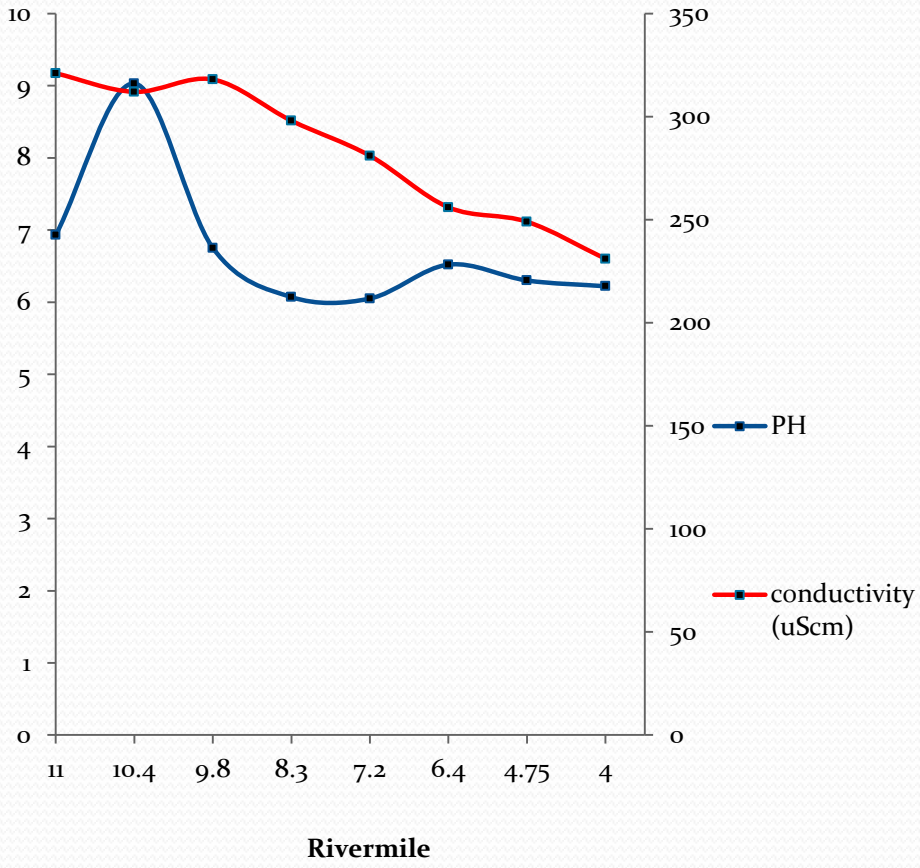

WBSC Stream pH Profile
pH
6.0
6.5
7.0
7.5
8.0
0.1
1.8
6.2
8
10.3
13.3
Rivermile

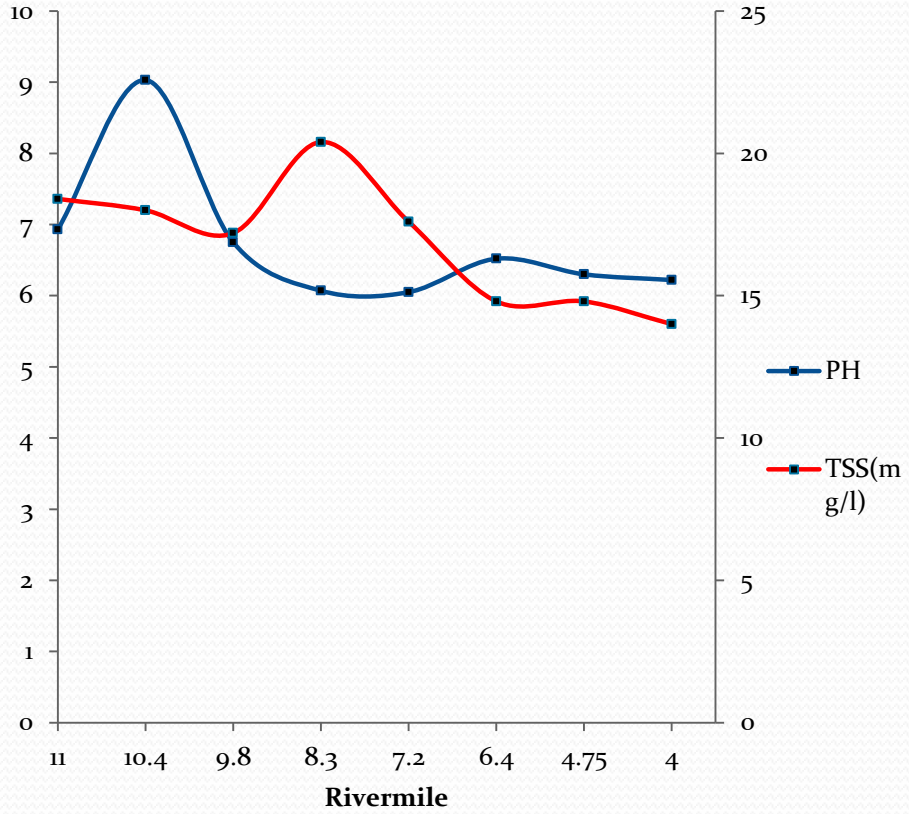

Thomas Fork Stream MAIS Profile
MAIS
8.0
8.5
9.0
9.5
10.0
1
2
3
4
5
6
7
Rivermile

DOSER

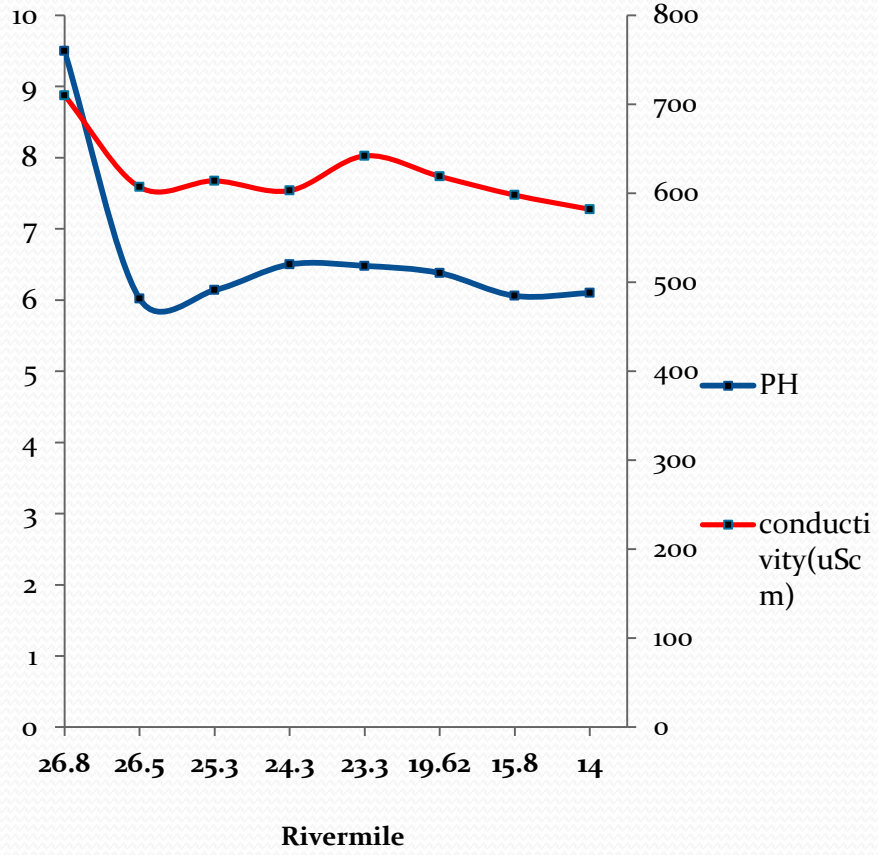

Thomas Fork Stream pH Profile
pH
7.0
7.5
8.0
8.5
9.0
1.2
2.8
4.3
5.8
6
7.1
7.4
7.6
Rivermile

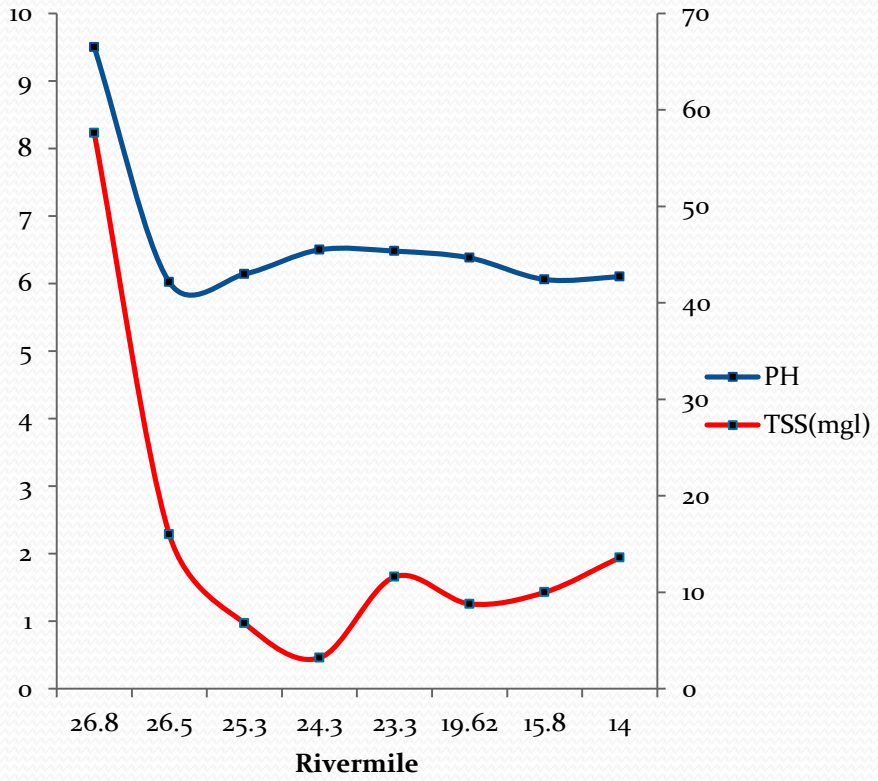
Hewett Fork


10
9
8
7
6
5
4
3
2
1
0
350
300
250
200
150
100
50
0
PH
conductivity (uScm)
11
10.4
9.8
8.3
7.2
6.4
4.75
4
Rivermile

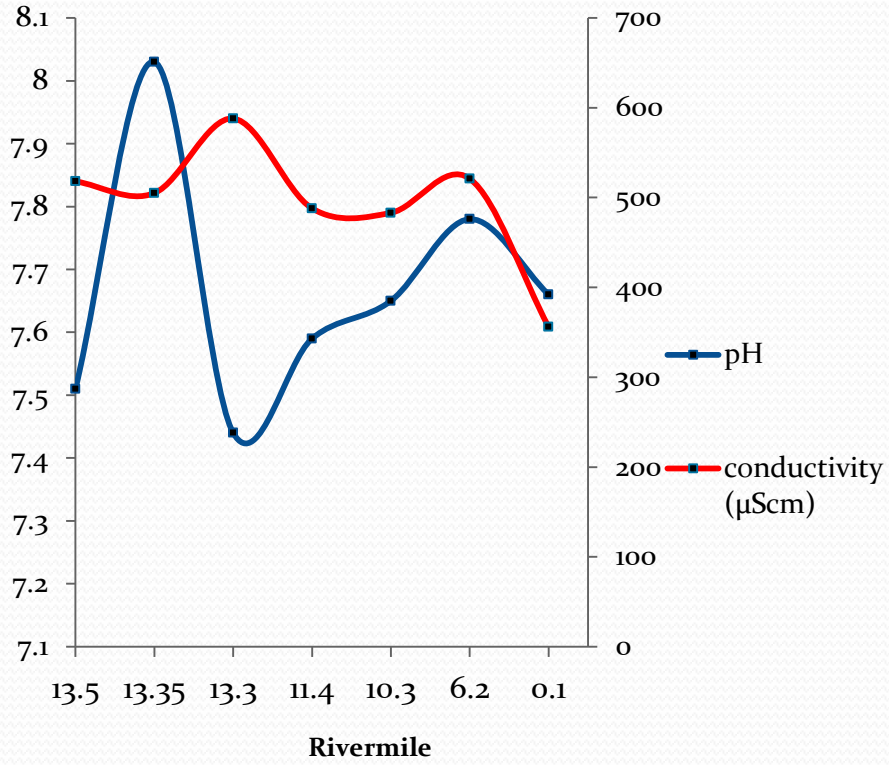

10
9
8
7
6
5
4
3
2
1
0
25
20
15
10
5
0
PH
TSS(mg/l)
11
10.4
9.8
8.3
7.2
6.4
4.75
4
Rivermile

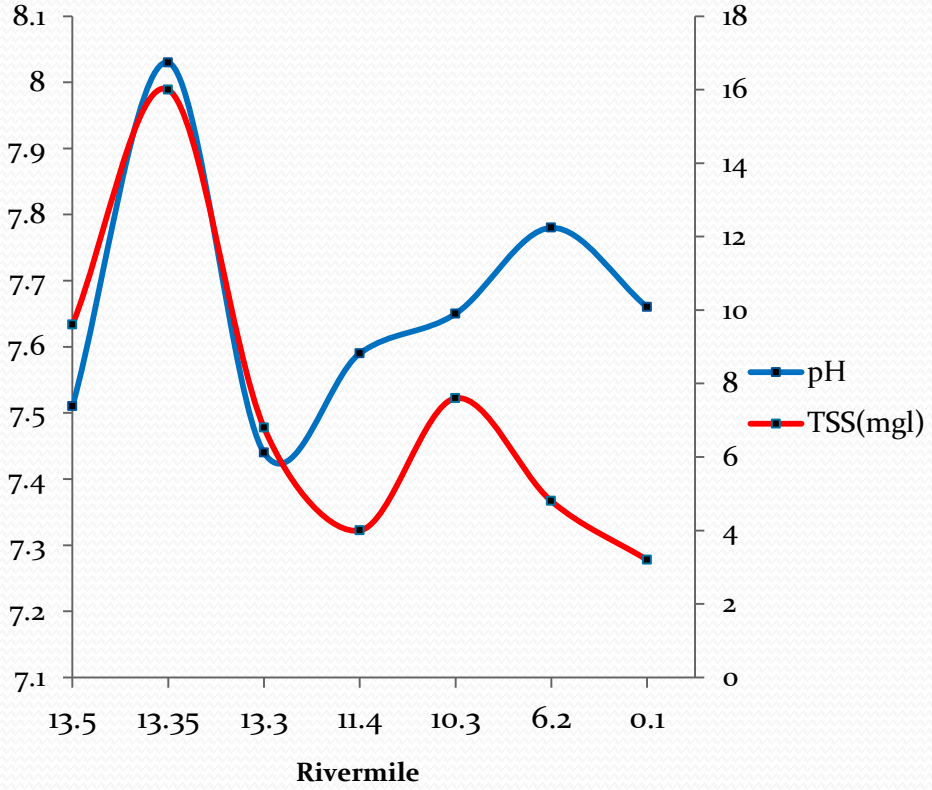
Monday Creek



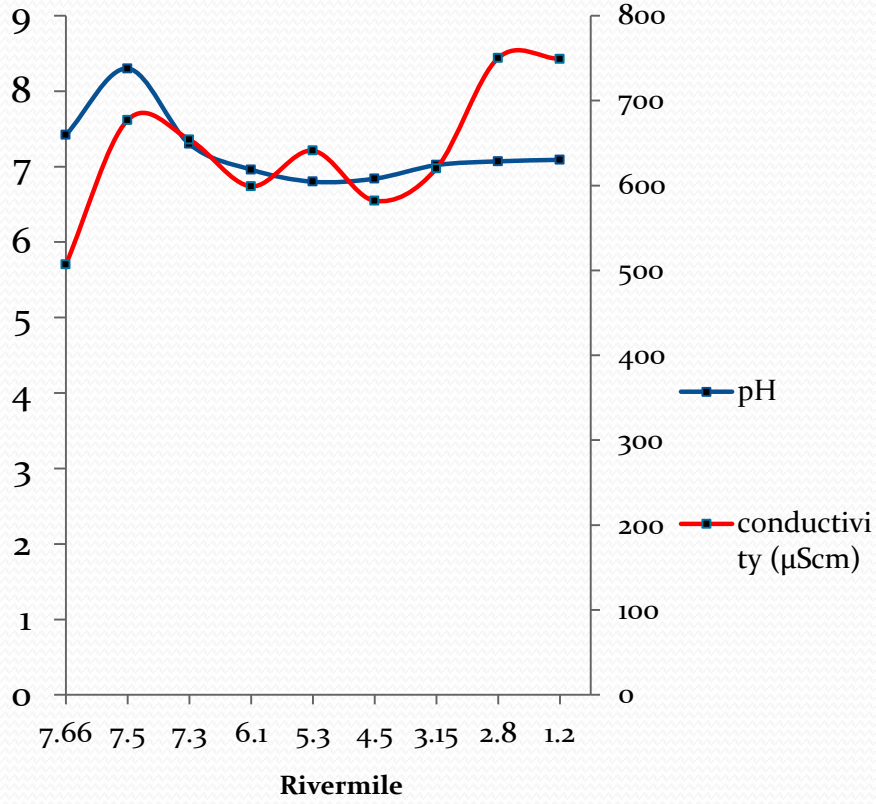


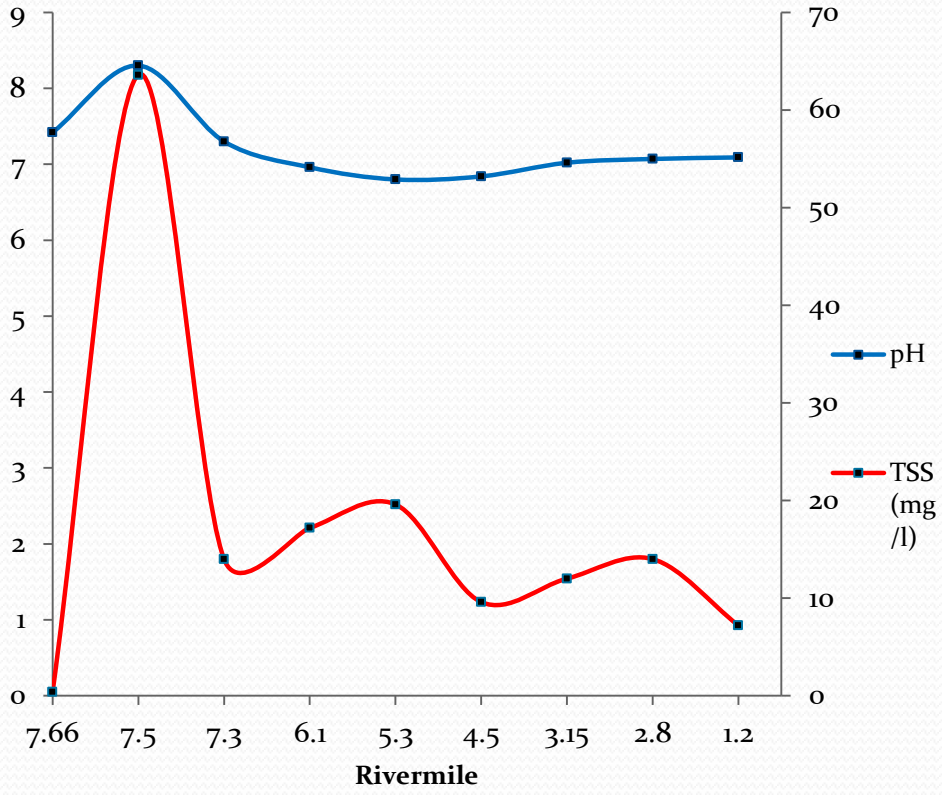
West Branch Sunday Creek





Thomas Fork


9
8
7
6
5
4
3
2
1
0
800
700
600
500
400
300
200
100
0
7.66
7.5
7.3
6.1
5.3
4.5
3.15
2.8
1.2
Rivermile
pH
conductivity (µScm)


9
8
7
6
5
4
3
2
1
0
70
60
50
40
30
20
10
0
7.66
7.5
7.3
6.1
5.3
4.5
3.15
2.8
1.2
Rivermile
pH
TSS (mg /l)

Insight gained from the study will enable us to accomplish two important goals.

- First it will allow us to update the remediation model in the doser systems.

- Second, it will allow us to expand our understanding of the dynamics in doser response, water chemistry, sediment quantity and deposition in biological recoveries in the four watersheds..

Thank You!