

2025 Periodic Report on the Bioassessment of Savannah River Site Streams

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SRNS-STI-2025-00558

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Savannah River
Ecology Laboratory
UNIVERSITY OF GEORGIA

Integrator Operable Units

- Integrator Operable Unit (IOU) program
 - Used to understand how contaminants from SRS locations could influence the ecology of local environments
 - Contaminants from legacy and ongoing SRS activities can be transported into water bodies by overland and subsurface water flow
 - Watersheds become an “integrator” of disturbances arising from land use within the catchments

Bioassessments for Stream Health

- Taxa differ in their sensitivity to pollution and other environmental disturbances
- Integrate the effects of that exposure over time
- Evaluate biological stream communities to understand longer term ecological effects of disturbances in waterbodies
- Indicates stream ecological health
 - Demonstrates potential for different trophic levels (primary and secondary consumers) to persist in an environment

Objectives

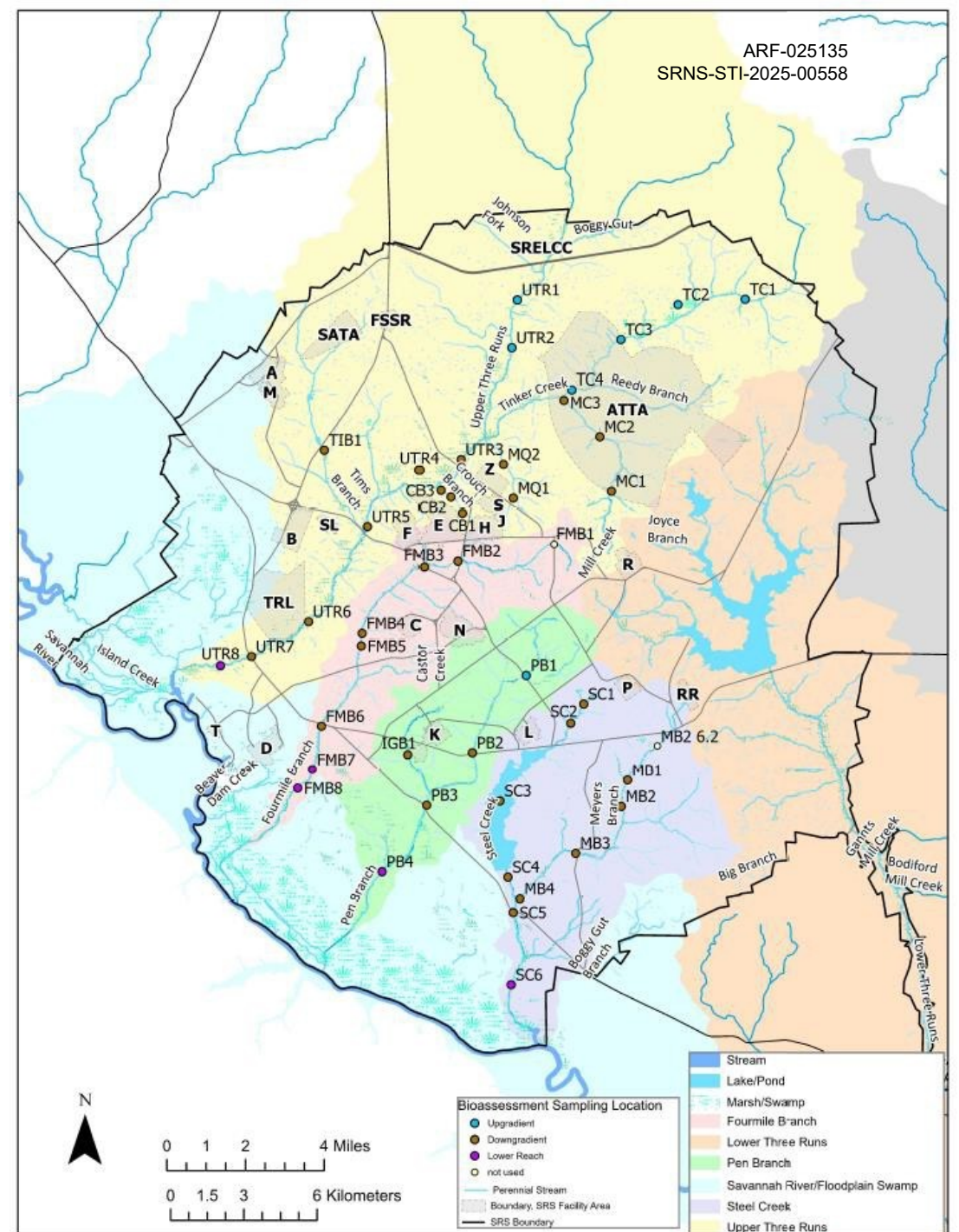
1. Update stream reach designation categories to reflect ongoing SRS activities
2. Present results from bioassessment sampling completed since 2019
3. Assess changes in stream biotic health since the previous reporting period
4. Compare biotic integrity among SRS streams
5. Present modifications to the implementation of bioassessment monitoring

Study sites

- Integrator Operable Units
 - Upper Three Runs
 - Fourmile Branch
 - Pen Branch
 - Steel Creek
 - Lower Three Runs (not included)
- Redefine stream reach categories
 - Relative to industrial and waste areas and measured contamination
 - Upgradient
 - Downgradient
 - Lowest Reaches
 - Led to few upgradient sites

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Figure 3 of Scoping Summary

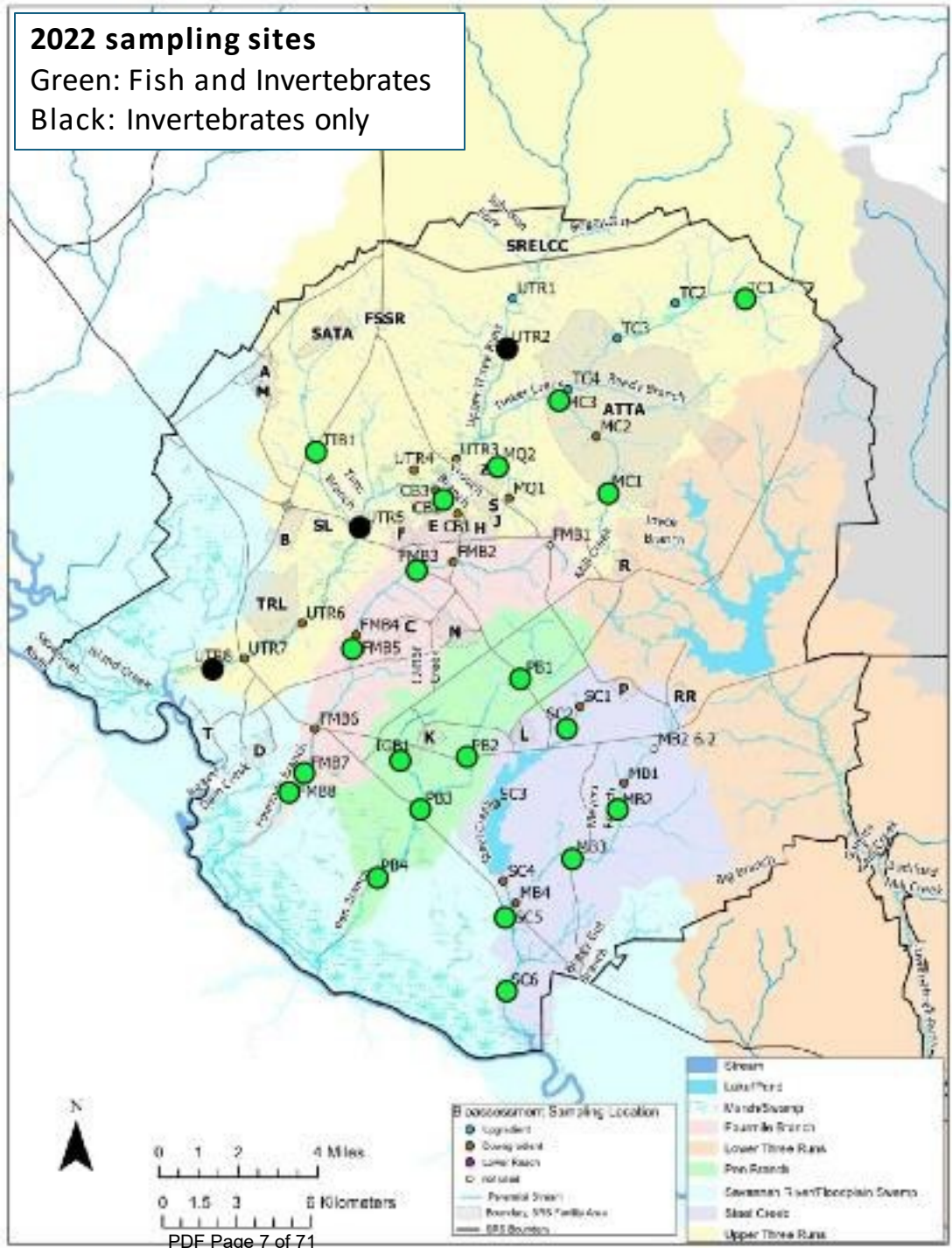


Study sites sampled 2022

2022 sampling sites
Green: Fish and Invertebrates
Black: Invertebrates only

- 20 Fish Sites and 23 Macroinvertebrate Sites

- Fish collected:
 - June – September 2022
- Macroinvertebrates collected:
 - MHSP November 2022 – January 2023
 - Hester-Dendy Samplers April – May 2023

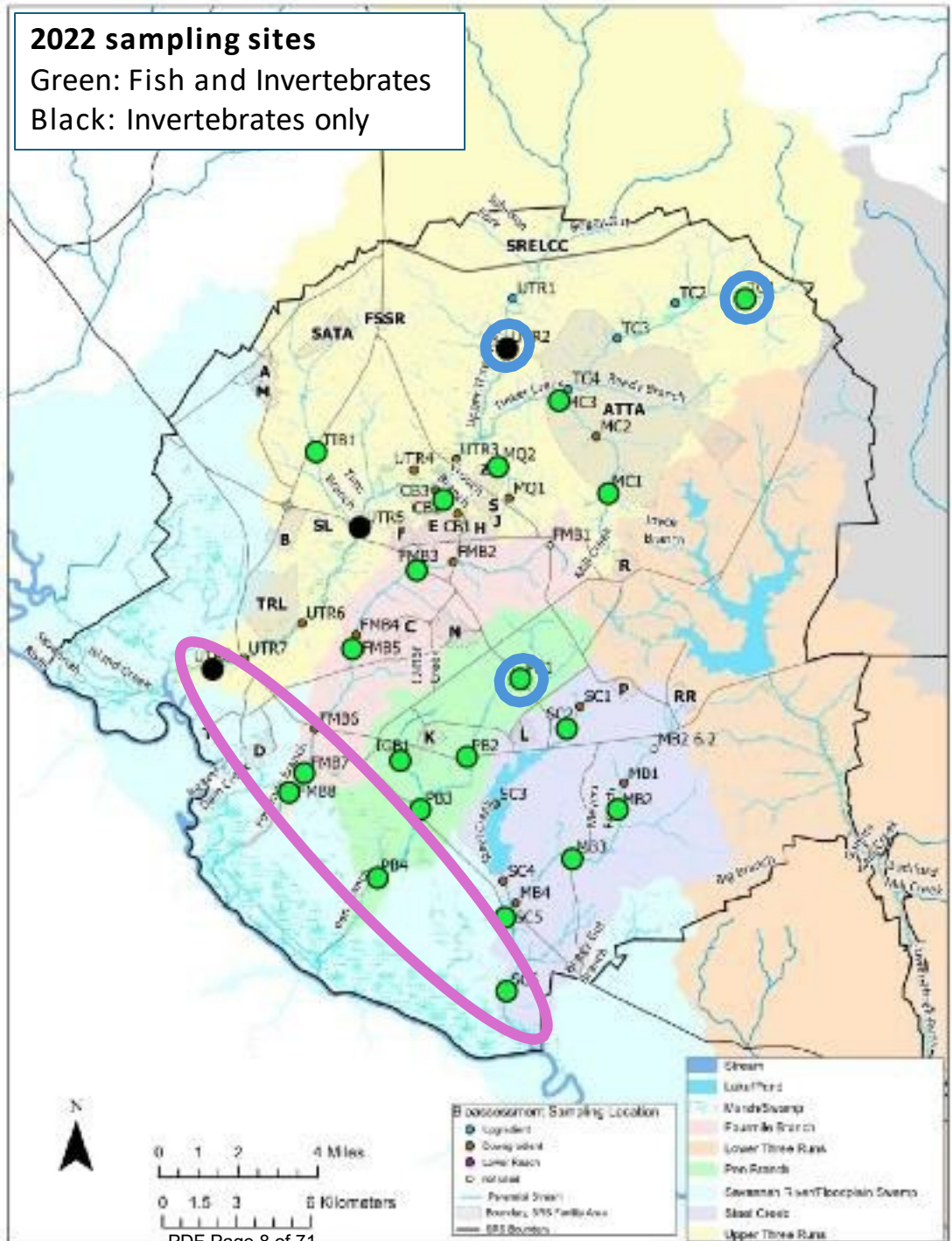


Study sites sampled 2022

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Green: Fish and Invertebrates
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- 20 Fish Sites and 23 Macroinvertebrate Sites

- Fish collected:
 - June – September 2022
- Macroinvertebrates collected:
 - MHSP November 2022 – January 2023
 - Hester-Dendy Samplers April – May 2023
- Site Designations
 - Upgradient
 - Downgradient (not highlighted)
 - Lowest Reaches



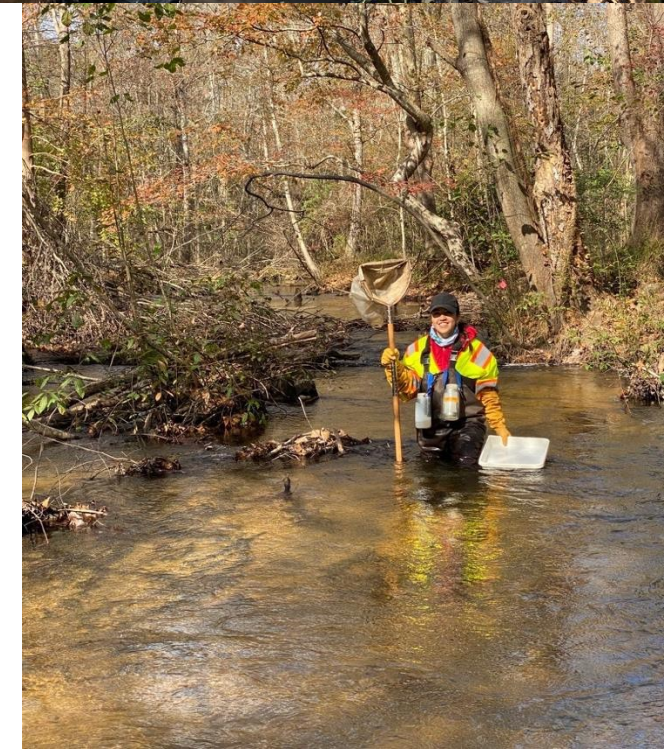
Methods

- Fish communities
 - Index of Biotic Integrity (IBI)
 - 20 locations
 - backpack electrofishing
 - 3 passes
 - Collect, ID and count all fish



Methods

- Fish communities
 - Index of Biotic Integrity (IBI)
- Macroinvertebrate communities (23 locations)
 - SCDES Multi-Habitat Sampling Protocol (MHSP)
 - Timed assessment, focuses on collecting as many unique species as possible from 100 m
 - Uses kicknet, D-frame dipnet, sieves, fine mesh samplers, forceps, and visual inspection free sampling
 - Qualitative
 - Yields EPT Score and Biotic Integrity Score <- averaged to get MHSP score
 - EPT score corrected for stream width



EPT Taxa

Ephemeroptera



(mayfly)

Plecoptera



(stonefly)

Trichoptera



(caddisfly)

Methods

- Fish communities
 - Index of Biotic Integrity (IBI)
- Macroinvertebrate communities (23 locations)
 - SCDES Multi-Habitat Sampling Protocol (MHSP)
 - Hester-Dendy multiplate samplers
 - Focuses on quantitative comparison using a common, artificial substrate deployed for 28 days
 - Prior studies finds this works best for EPT indicator taxa, but not other taxa
 - Yields Biotic Integrity Number, mean number EPT, and mean number taxa



Methods

- Fish communities
 - Index of Biotic Integrity (IBI)
- Macroinvertebrate communities
 - SCDES Multi-Habitat Sampling Protocol (MHSP)
 - Hester-Dendy multiplate samplers
- Habitat assessments
 - EPA *Revisions to Rapid Bioassessment Protocols for Use in Streams and Rivers*
 - Low-gradient coastal plain ecoregion
 - SC Aquatic Biology Section assessment (ABS)



Analysis

- Upgradient benchmark
 - Exclude lowest 5 % of points
 - Ranges
 - 95 % Confidence Intervals
- Temporal analysis (all years)
 - Linear models of sites with at least 3 points
- Spatial analysis (two most recent collections)
 - Used 2022 and 2017 data
 - Pairwise comparisons of upgradient category with downgradient streams

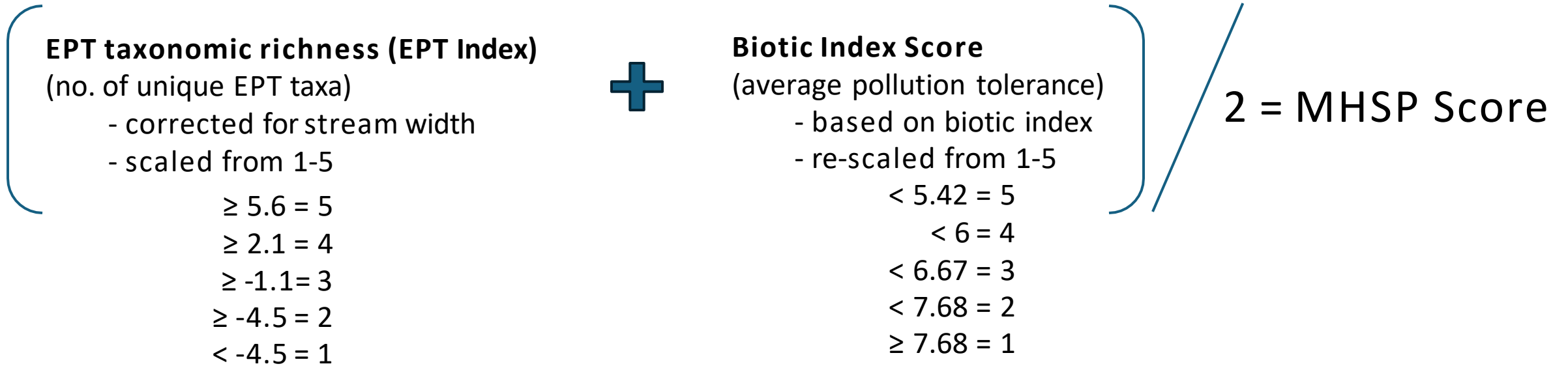


Value ranges and categories: Fish IBI

- 10 metrics scored as 1 = low, 3 = medium, 5 = best; summed with no weighting
- Upgradient range: 36 – 50; 95% CI 41.6 – 46.7

IBI Relative Rating	Poor	Fair	Fair-Good	Good	Excellent
Score	≤ 17	18 – 25	36 – 33	34 – 41	42 – 50

Value ranges and categories: Macroinvertebrates, MHSP



Bioclassifications	Poor	Fair	Good-Fair	Good	Excellent	
Score	1-1.5	1.5-2.4	2.5-3.4	3.5-4.4	4.5-5	Upgradient range: 3-5 Upgradient 95% CI: 3.9-4.6

Value ranges and categories: Macroinvertebrates, Hester-Dendy samplers

EPT taxonomic richness (EPT Index)

(no. of unique EPT taxa)

- NOT corrected for stream width
- NOT scaled

Upgradient range:

small: 1.6-3.8; large: 3.5-10.5

Upgradient 95% CI:

small: 1.3-4.5; large: 4.2-7.5

Biotic Index

(average pollution tolerance)

- abundance weighted SC list of tolerance values
- scaled from 0-10

Upgradient range:

small: 5.5-6.6; large: 3.7-5.7

Upgradient 95% CI:

small: 5.2-6.7; large: 4.3-5.4

**SE Plains-based
 scores
 Bioclassifications**

Poor Fair Good-Fair Good Excellent

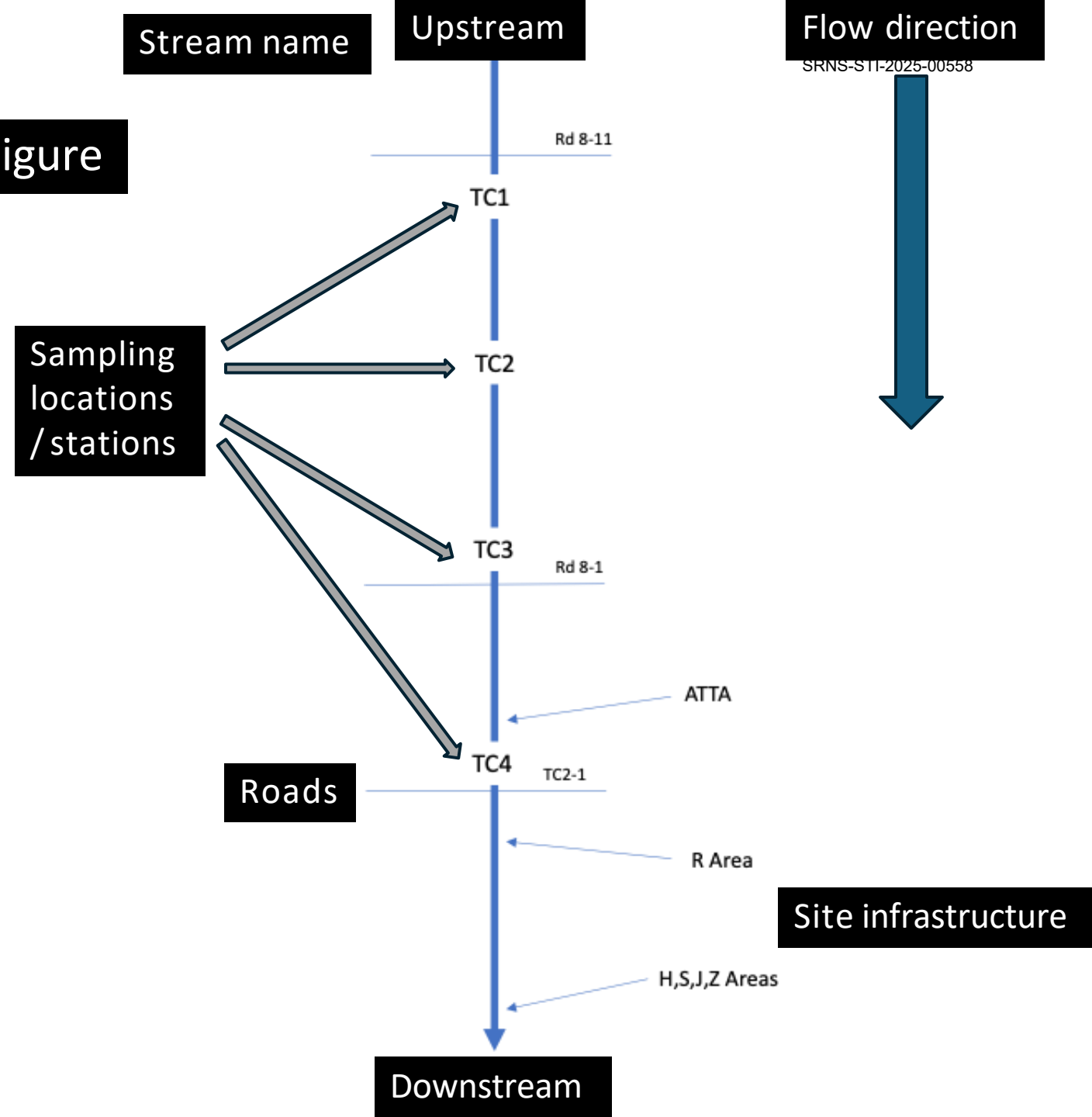
Score

1-1.5 1.5-2.4 2.5-3.4 3.5-4.4 4.5-5

Results

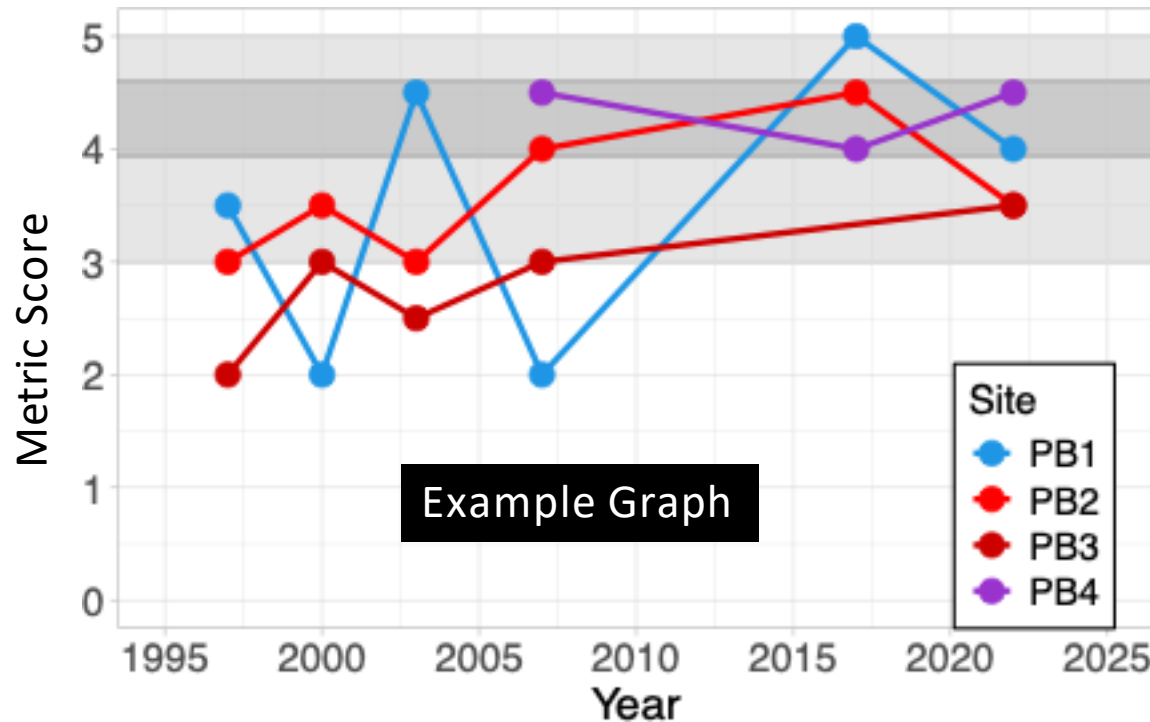
- Conceptual figure of streams and SRS operations locations

Example Figure



Results

- Graphs of each stream in an IOU subunit
 - Sampling locations kept separate



Upgradient Range Key

Light grey = range of top 95% of upgradient site/year scores (all years)

Dark grey = 95% upgradient site CI

Site Type Key

Blue = upgradient

Red = downgradient

Purple = lowest reaches

Study sites

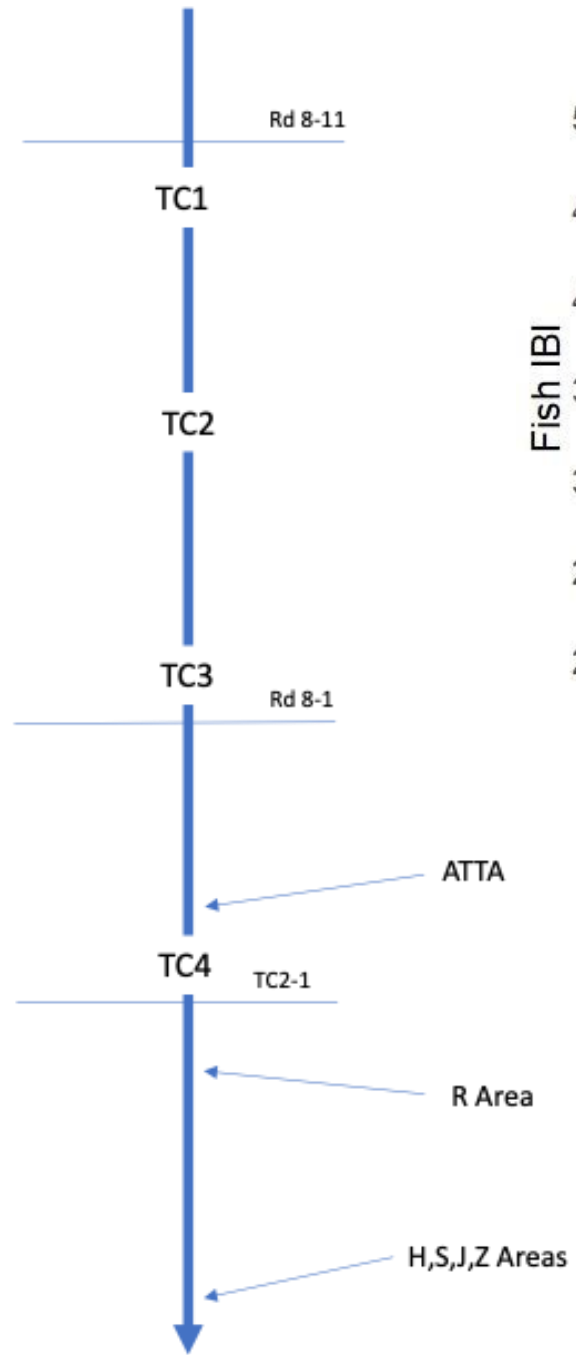
- Upper Three Runs IOU
 - Tinker Creek
 - Mill Creek
 - McQueen Branch
 - Crouch Branch
 - Tims Branch



Figure 4. Scoping Summary

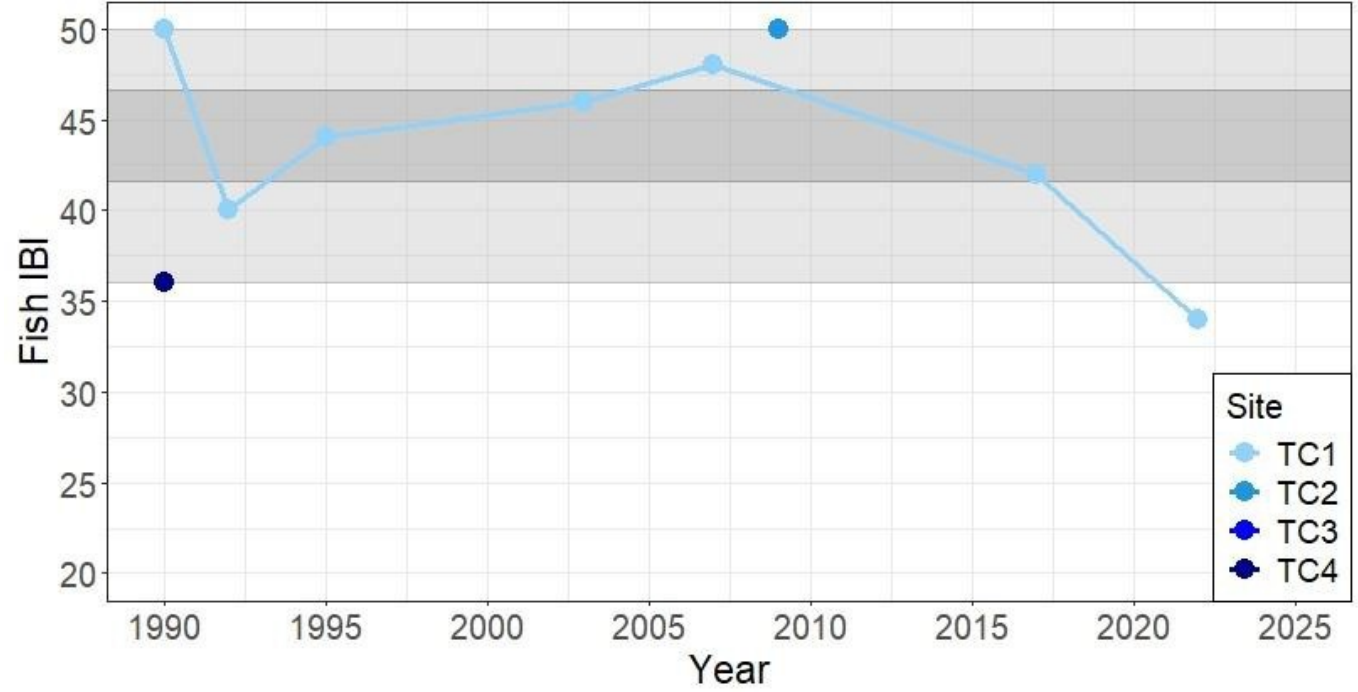
Tinker Creek

IBI Rating:
Good

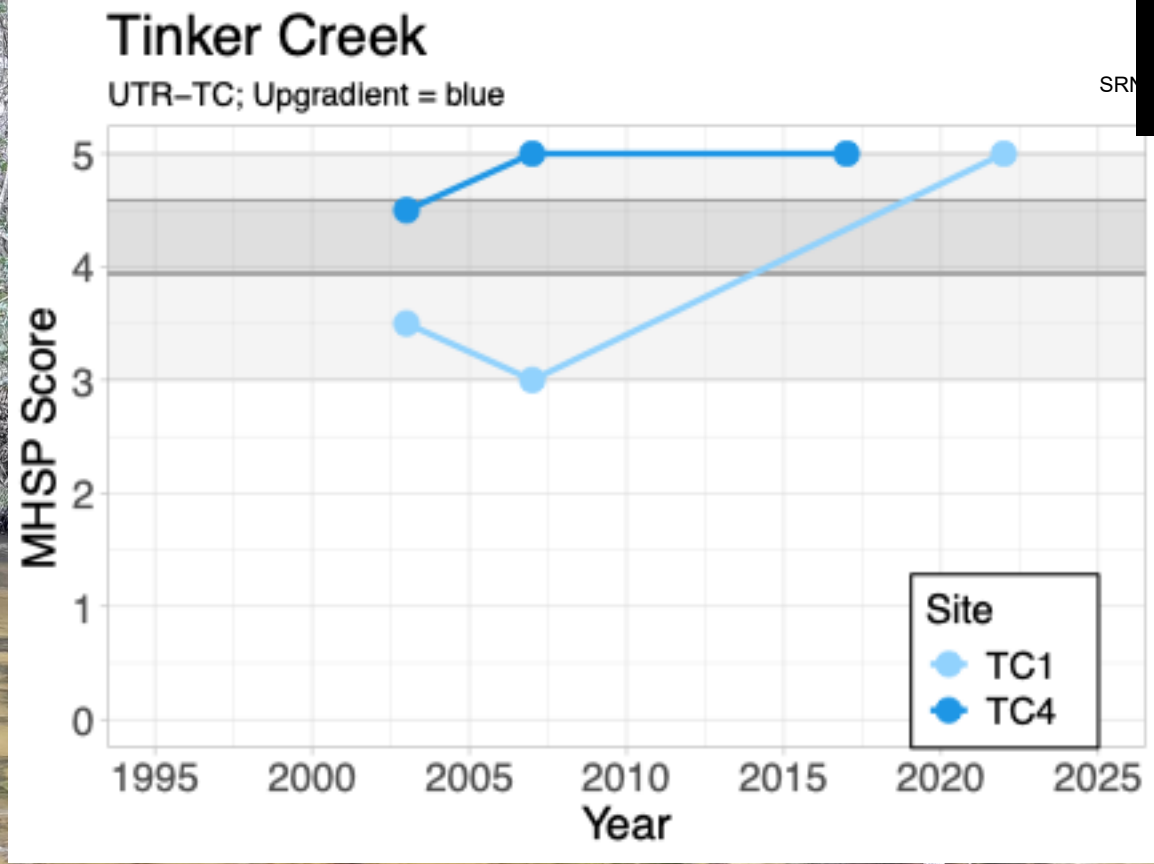
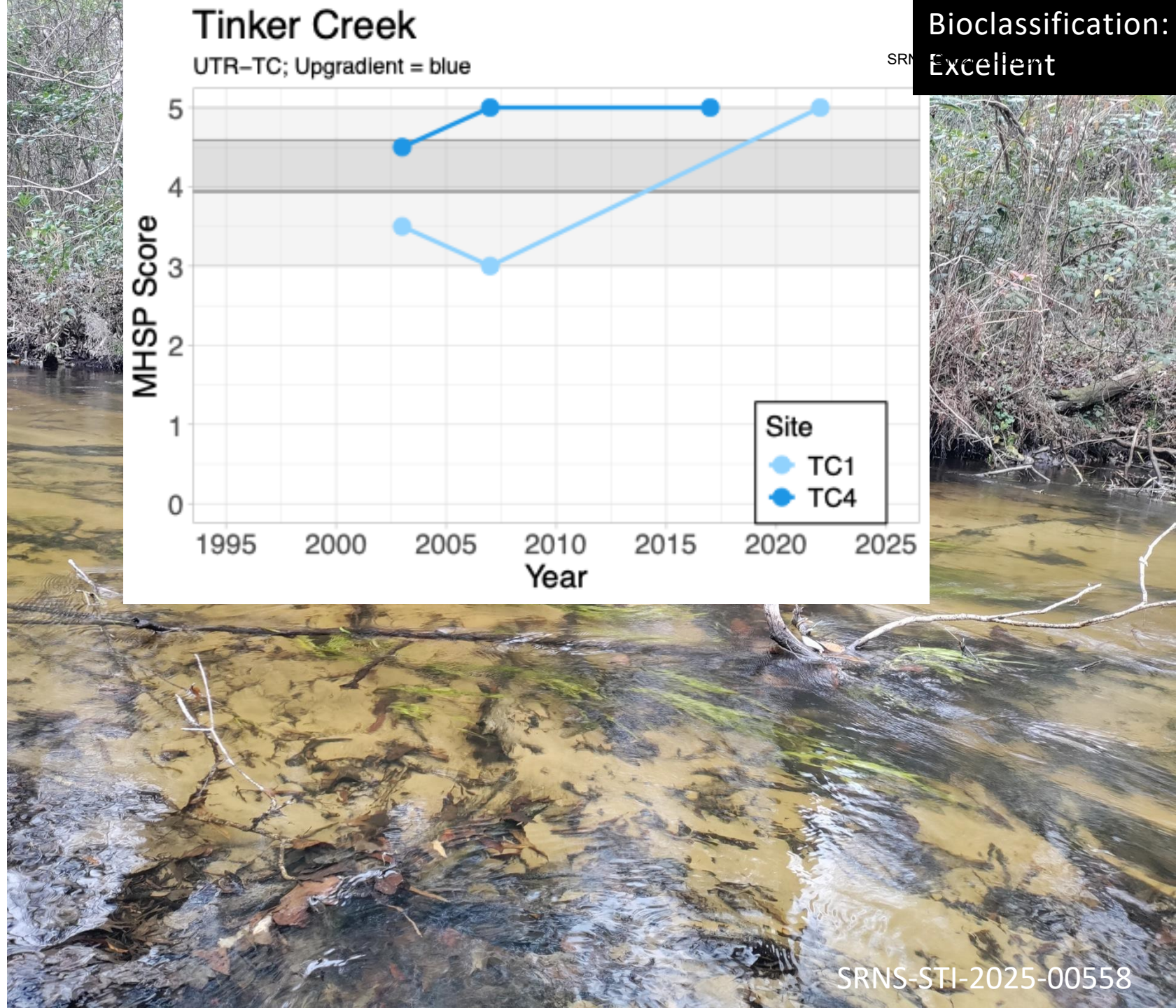
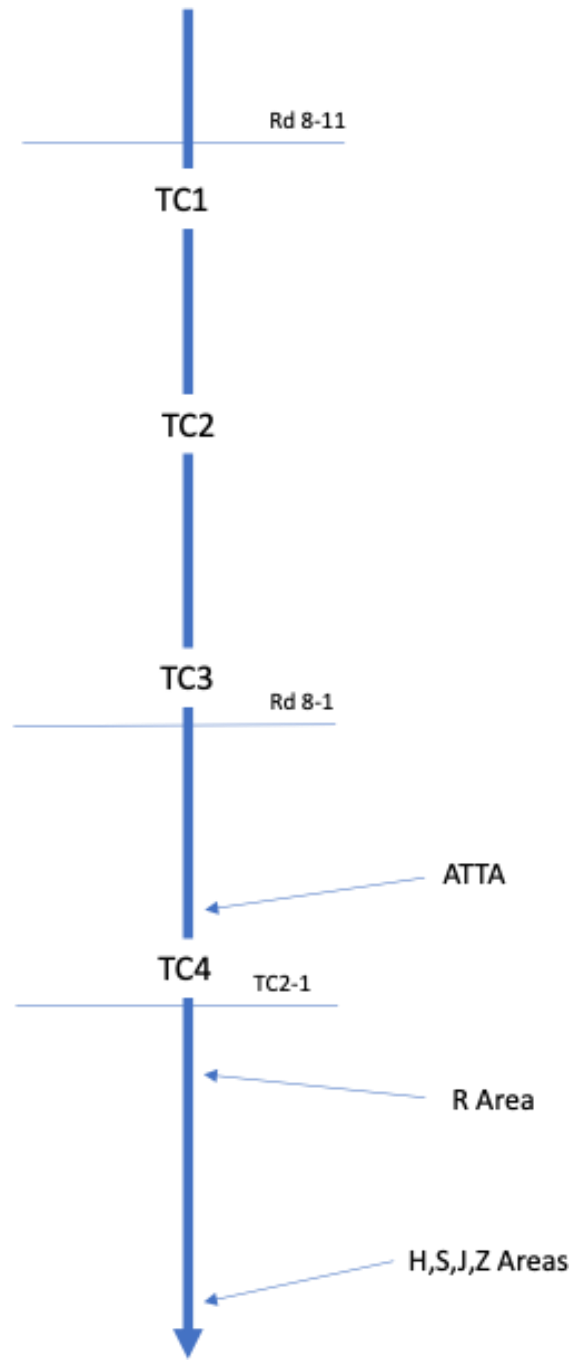


Tinker Creek

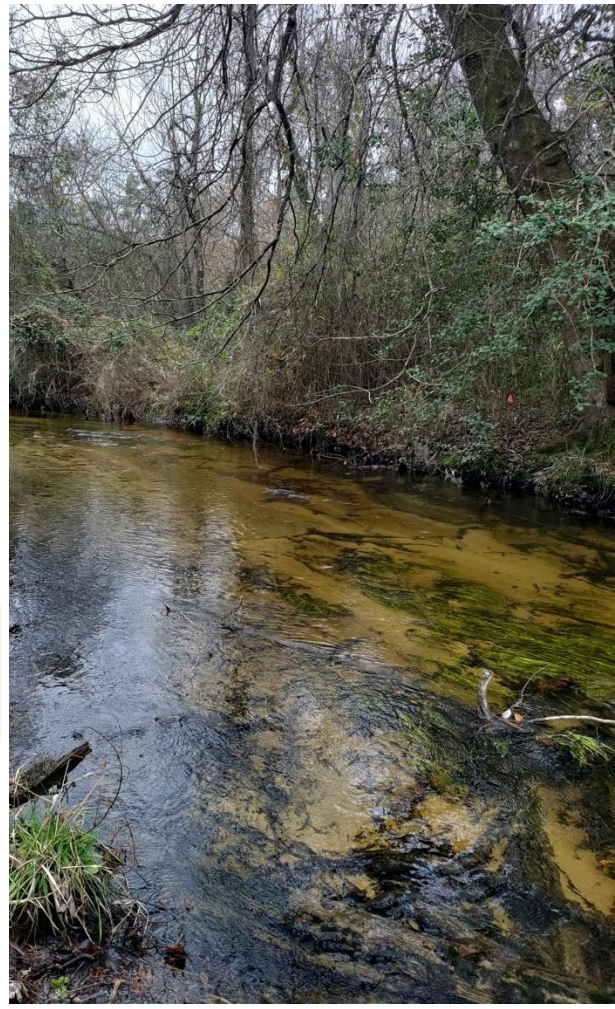
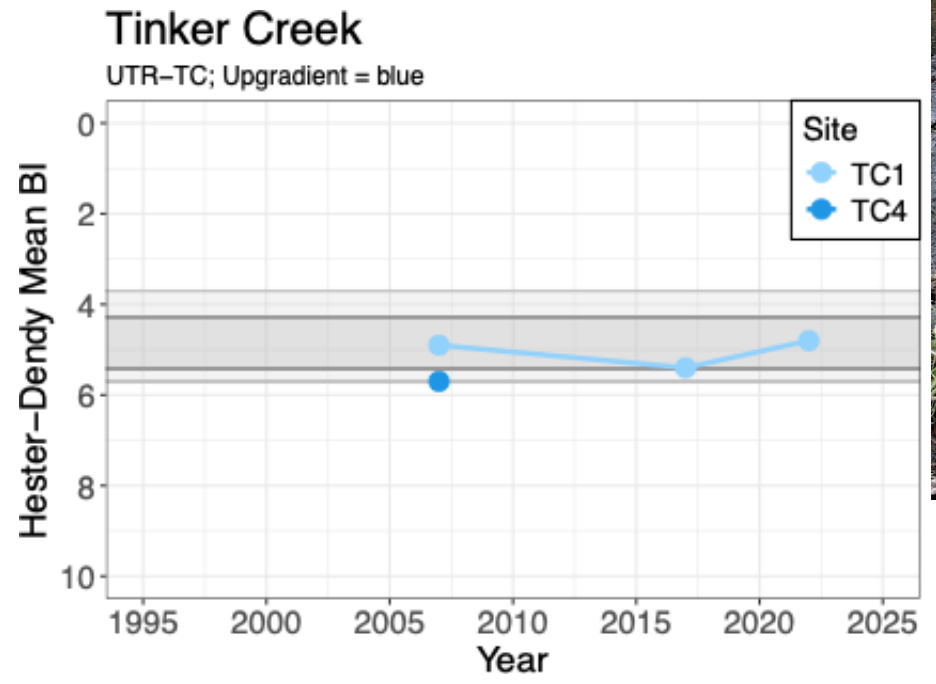
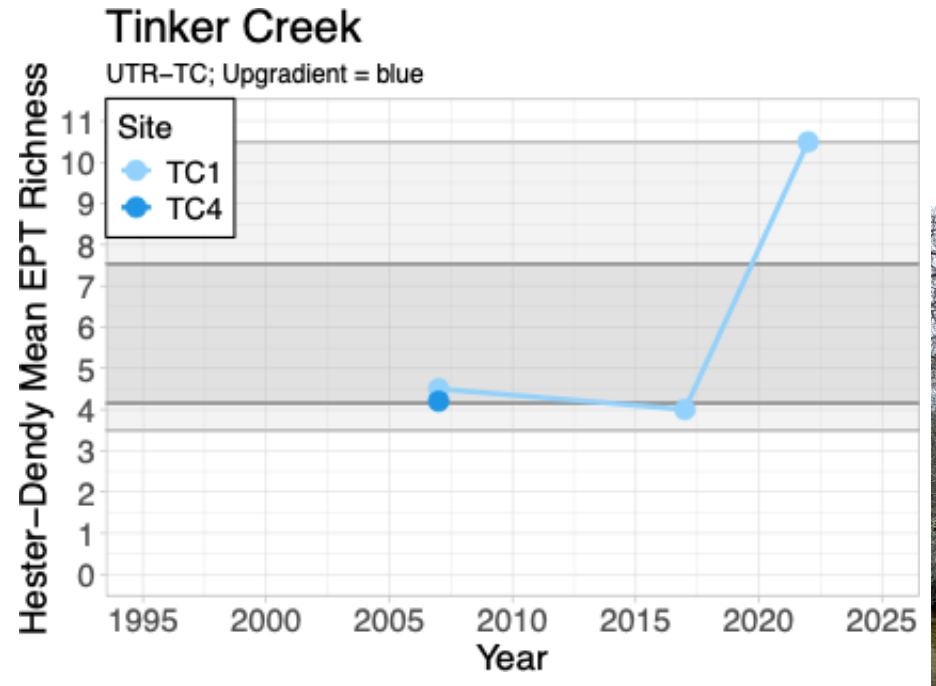
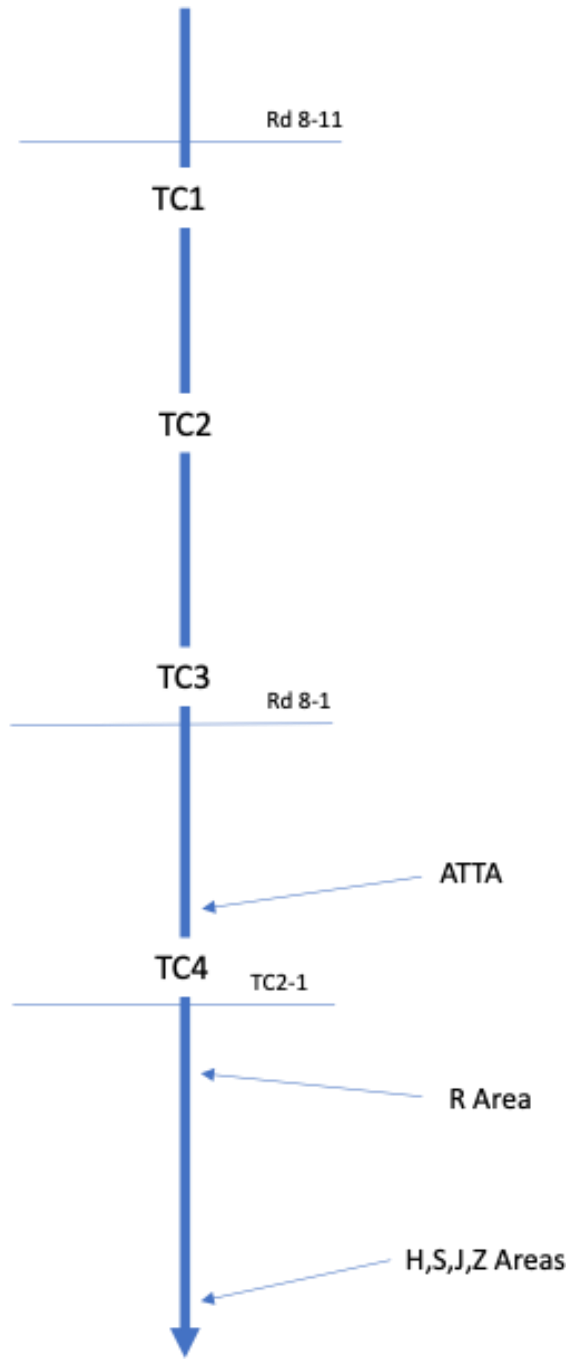
UTR-TC; Upgradient



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Tinker Creek

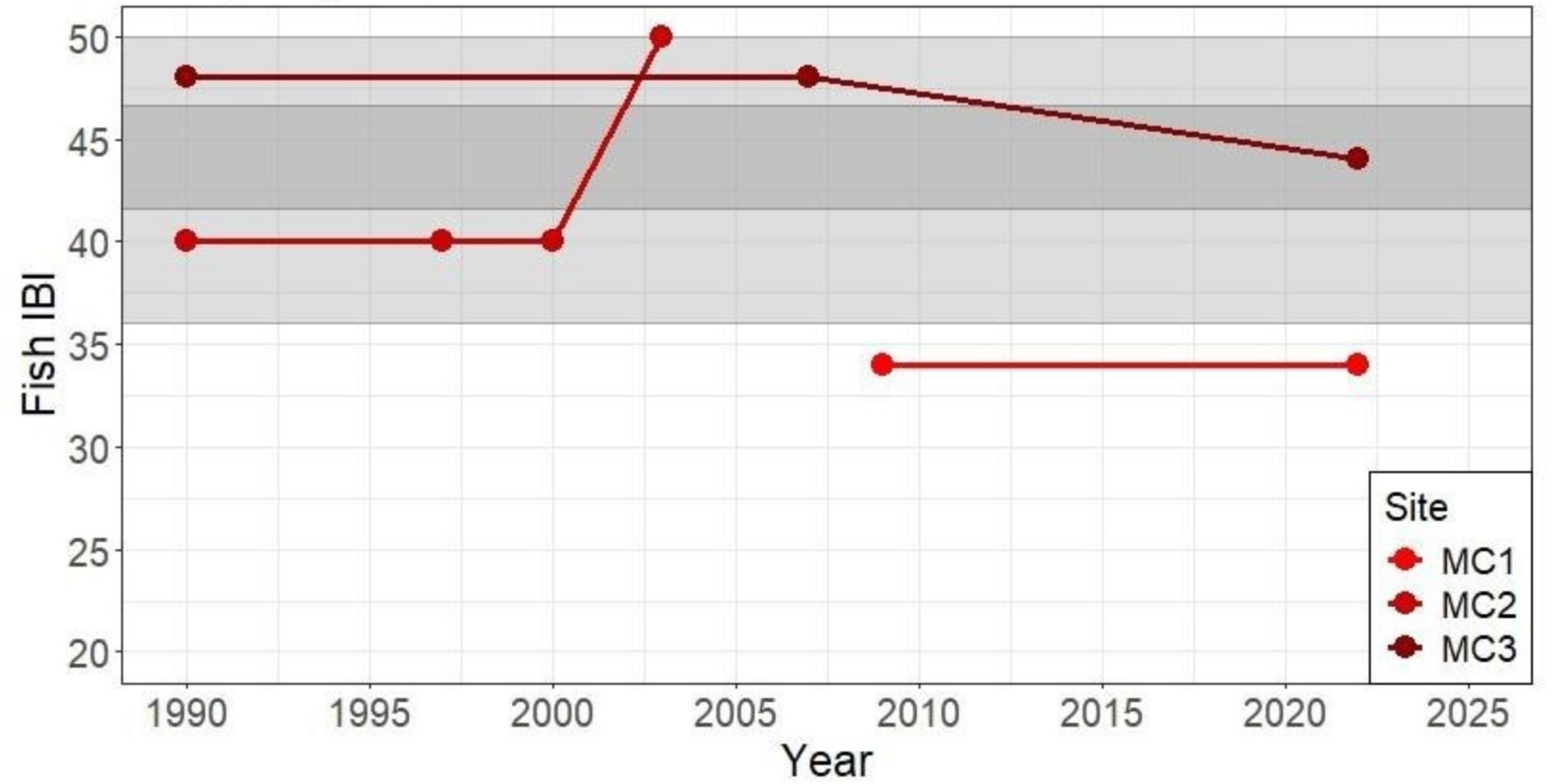
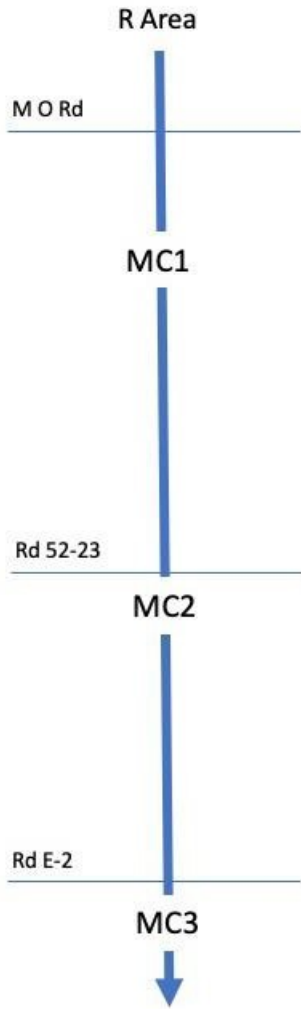


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Mill Creek

UTR-TC; Downgradient

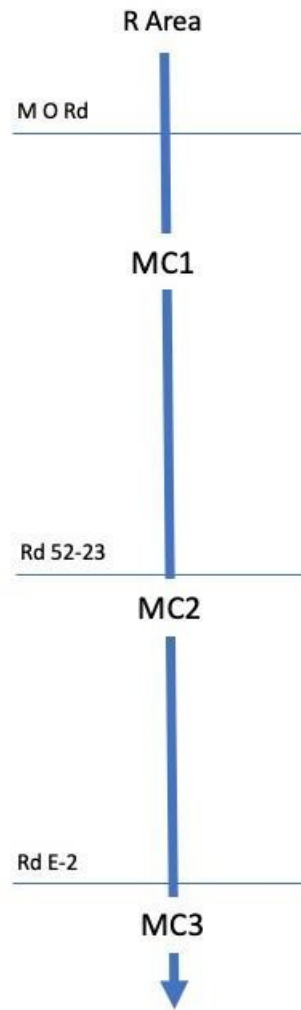
IBI Rating:
Good - Excellent



Mill Creek



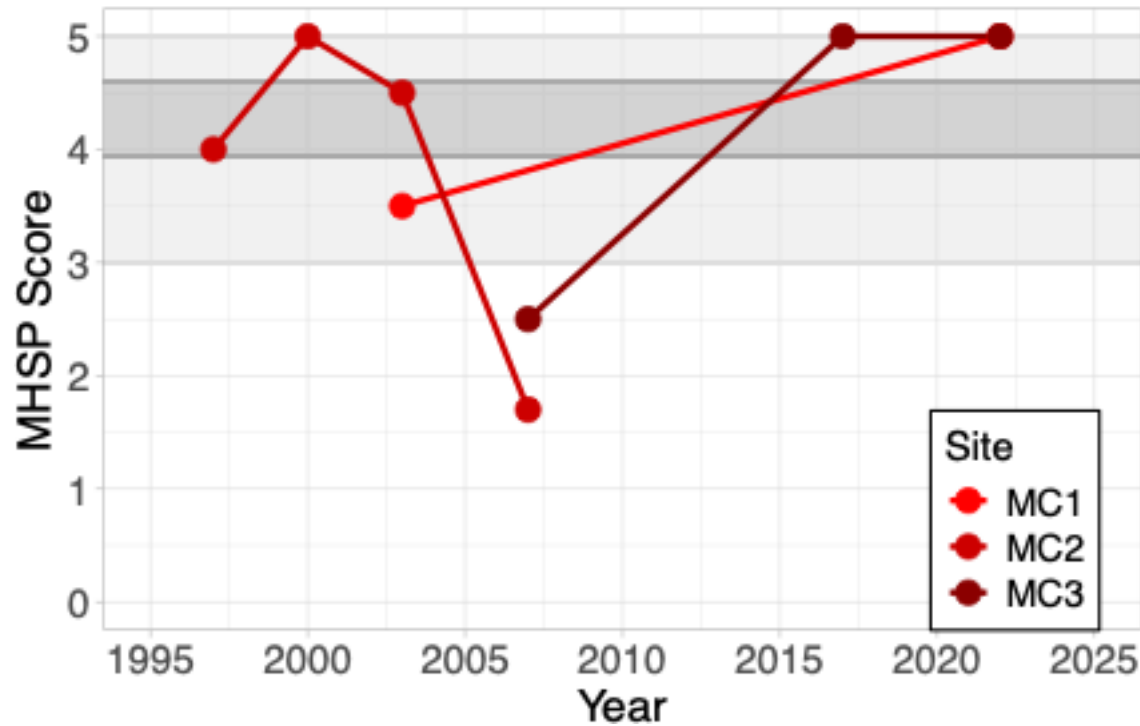
M O Rd = Monroe Owens Road



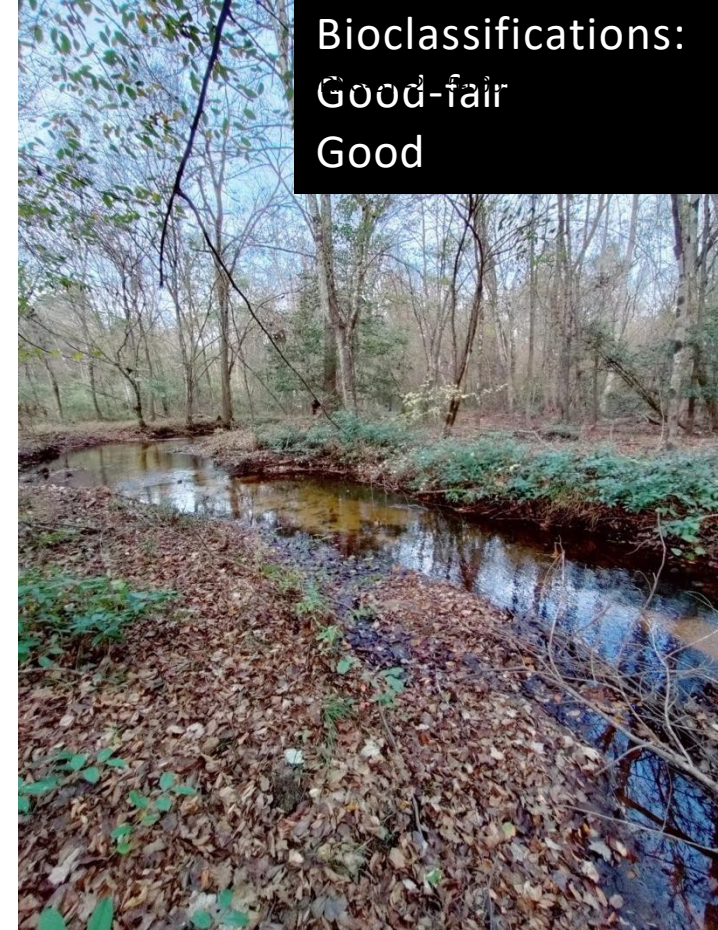
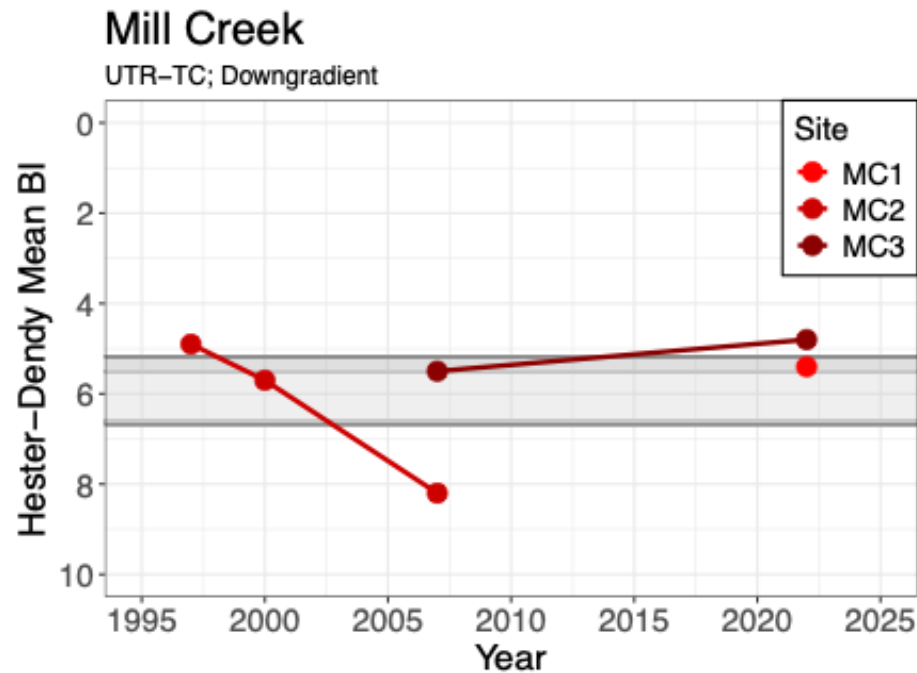
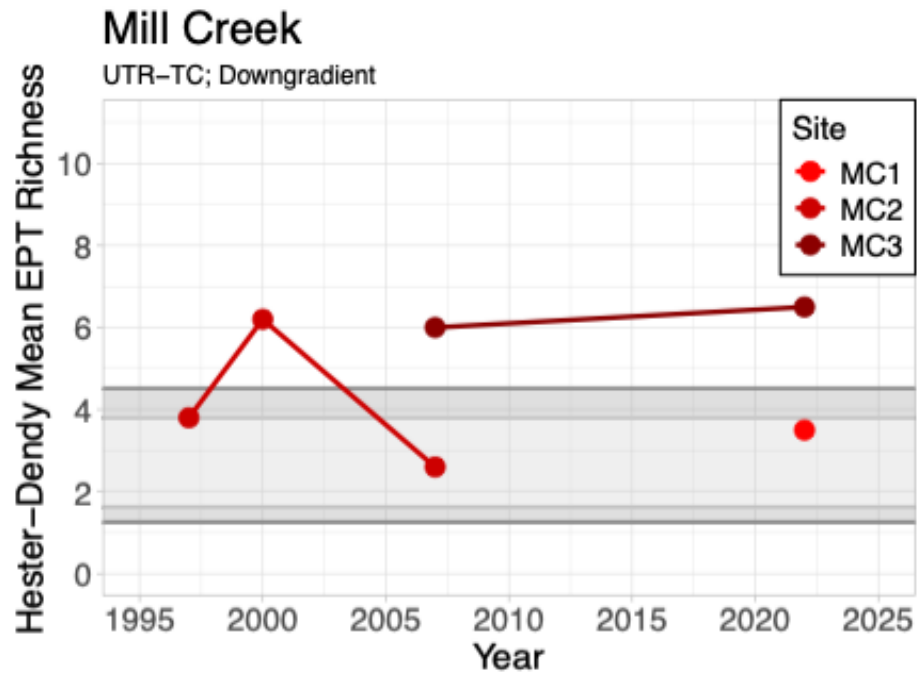
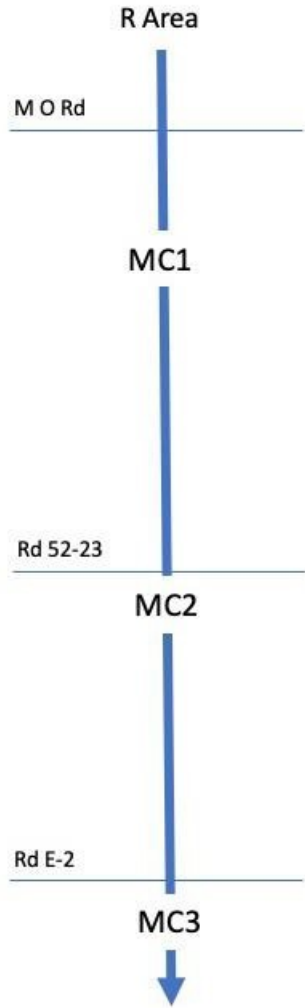
Bioclassification:
S E
Excellent

Mill Creek

UTR-TC; Downgradient



Mill Creek

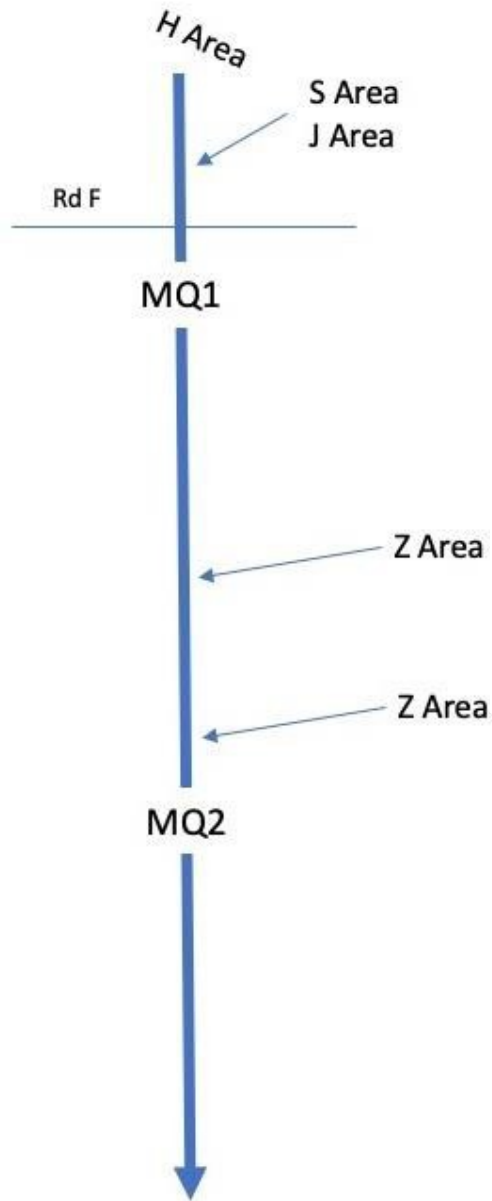


Bioclassifications:
Good-fair
Good

*MC2 only
significant linear
HD-BI trend

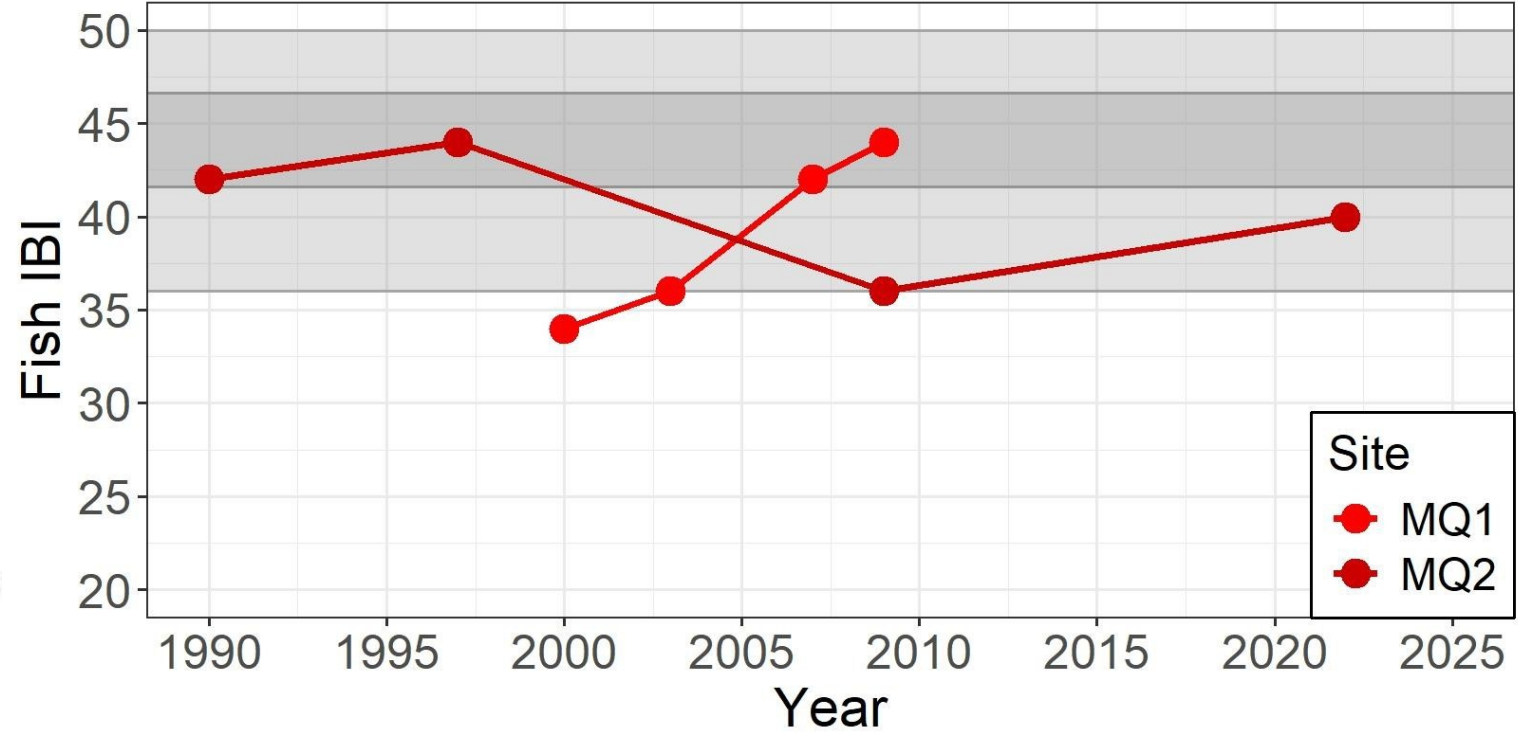
estimate = 0.33
statistic = 16.1
 $p = 0.04$

McQueen Branch



McQueen Branch

UTR-TC; Downgradient

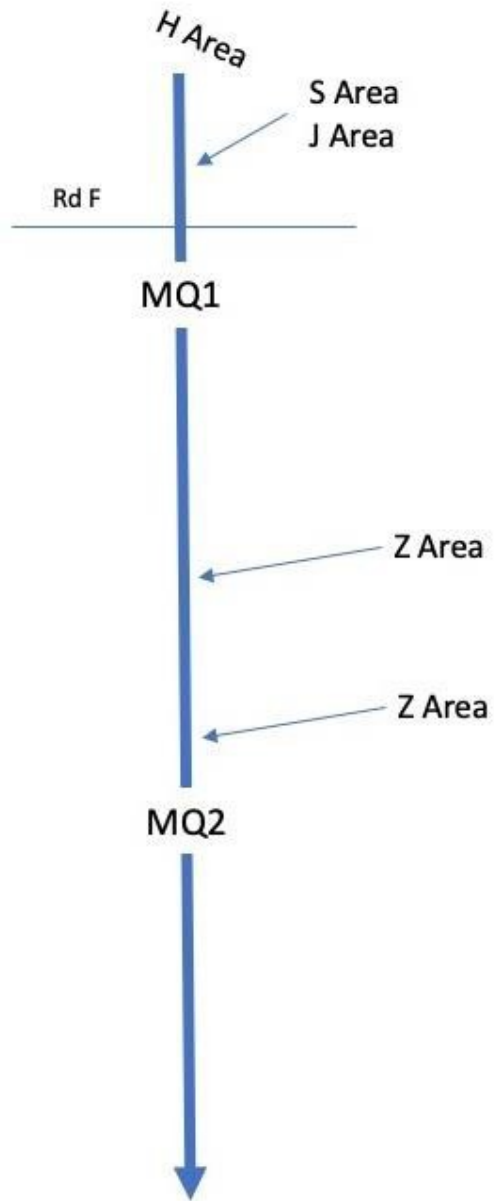


IBI Rating:
Good



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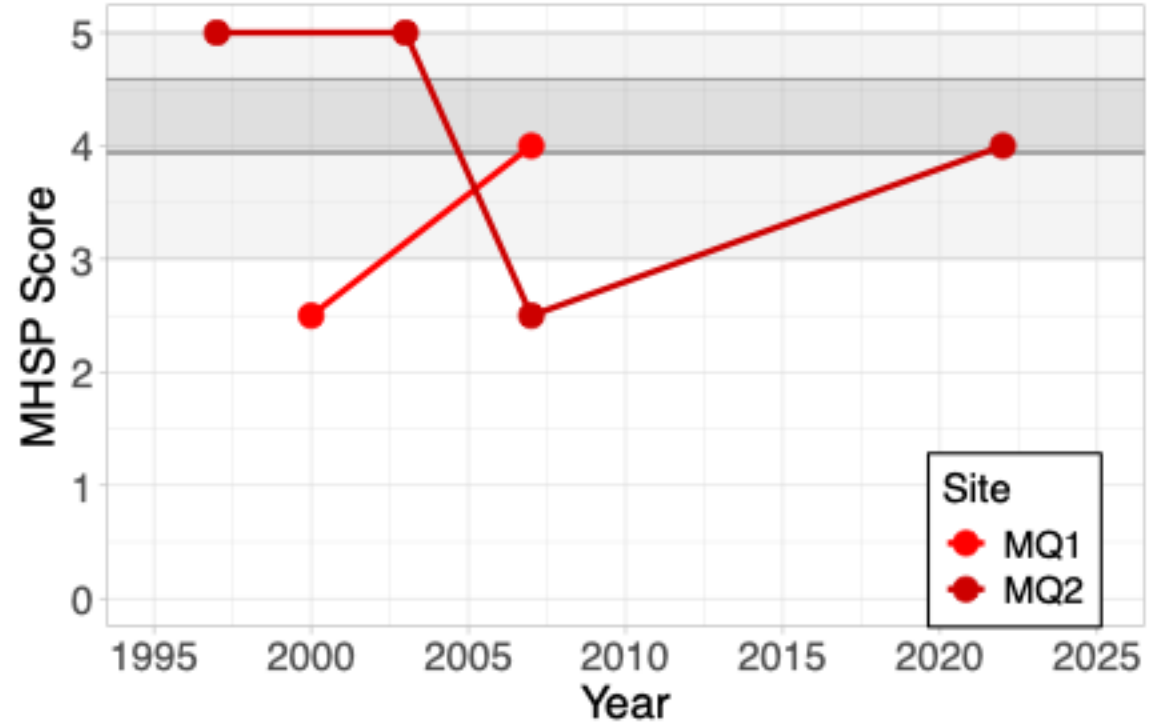
McQueen Branch



McQueen Branch

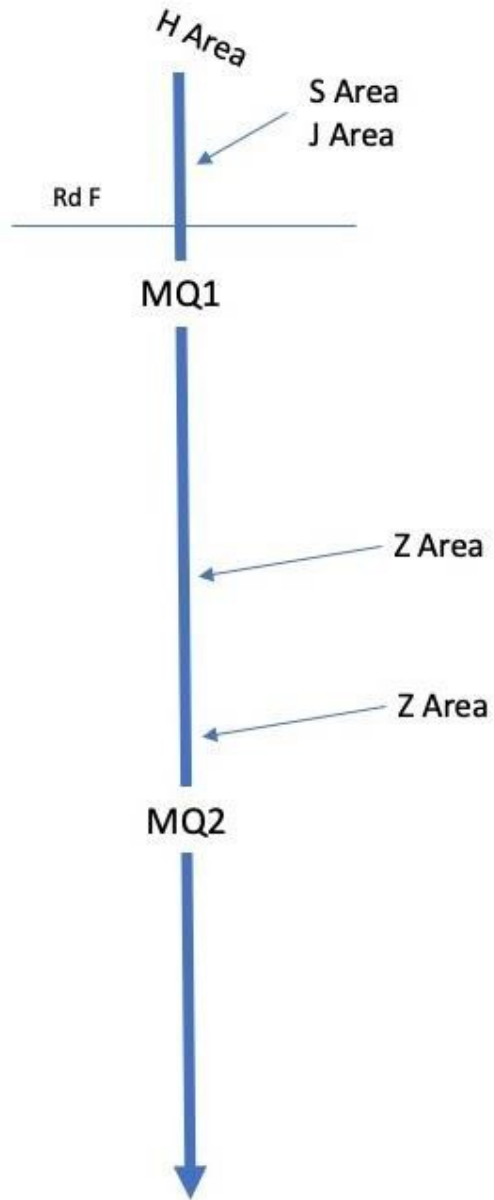
UTR-TC; Downgradient

Bioclassification:
Good



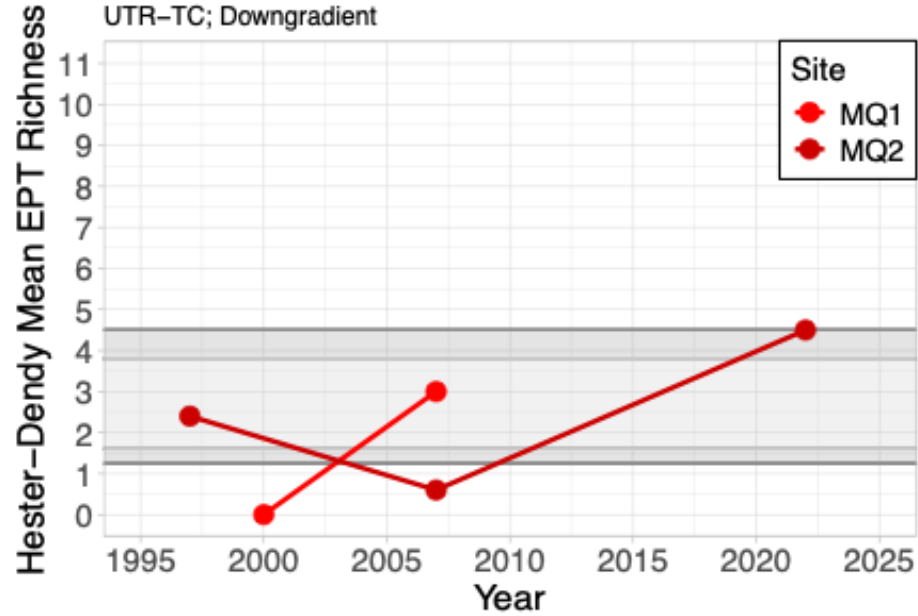
SRNS-STI-2025-00558

McQueen Branch



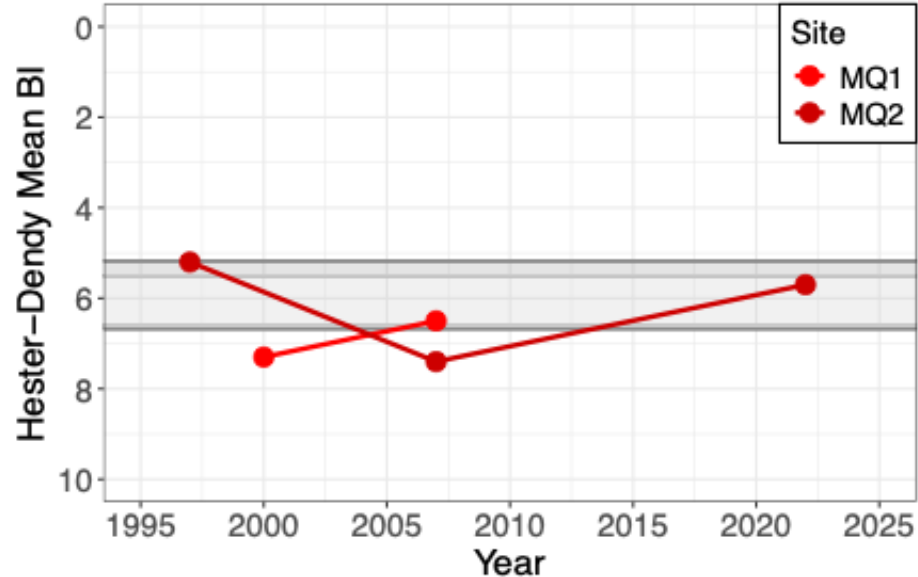
McQueen Branch

UTR-TC; Downgradient



McQueen Branch

UTR-TC; Downgradient



Bioclassification:
Good-fair

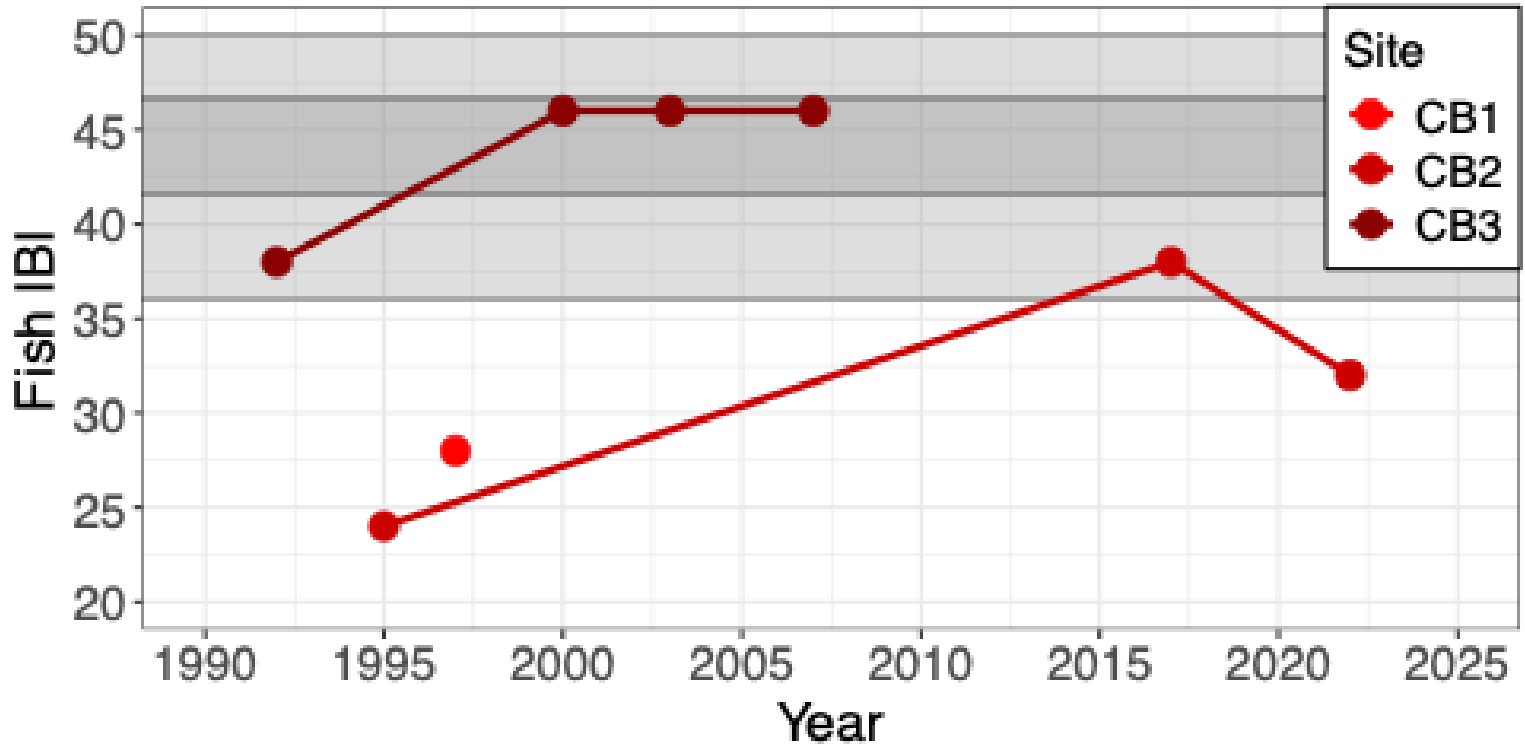
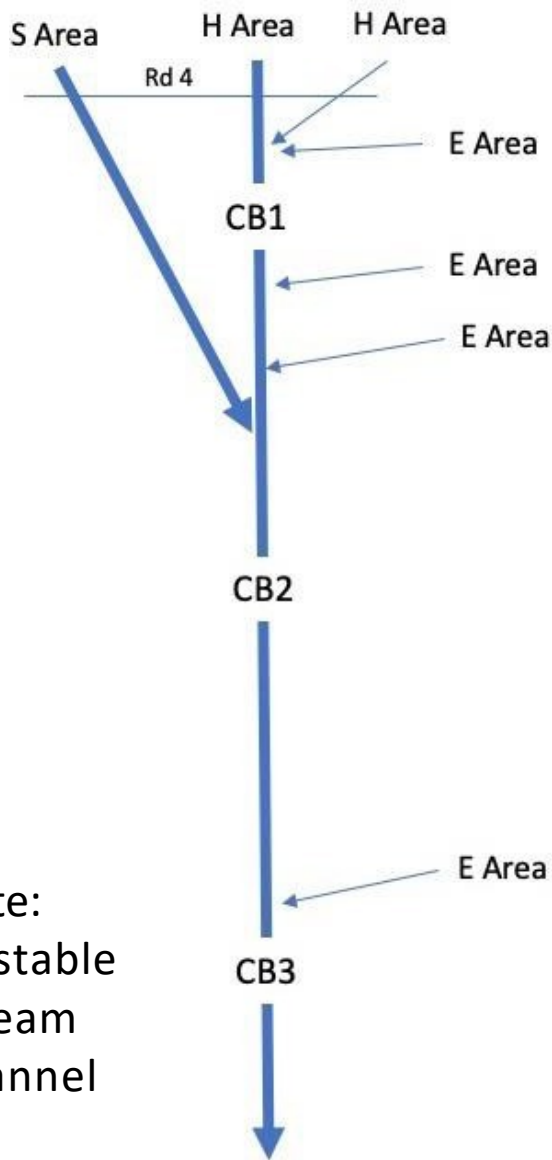


Crouch Branch

Crouch Branch

UTR-middle; Downgradient

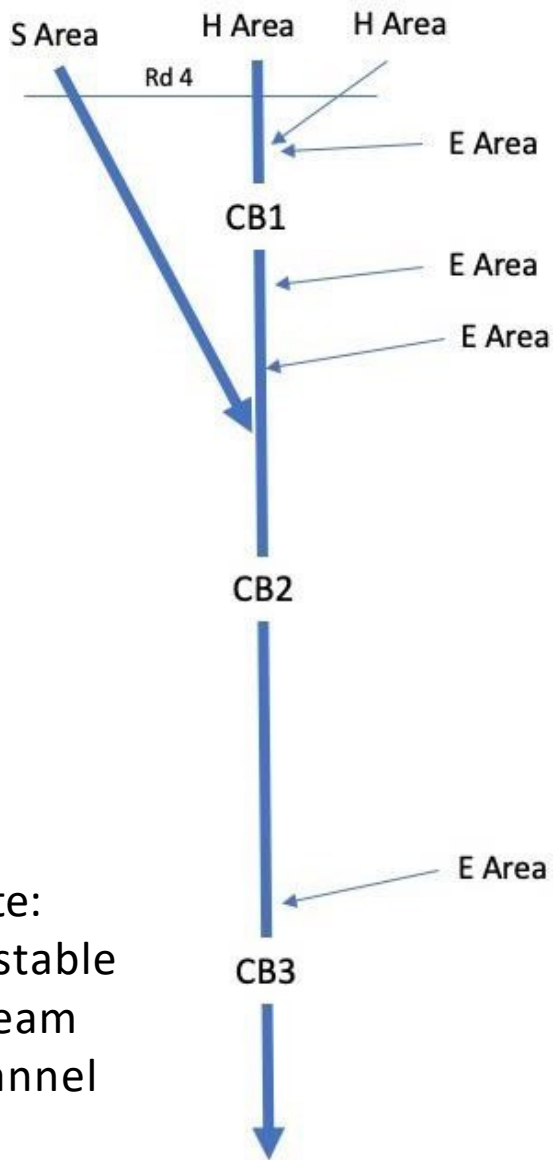
IBI Rating:
Good



Note:
Unstable
stream
channel



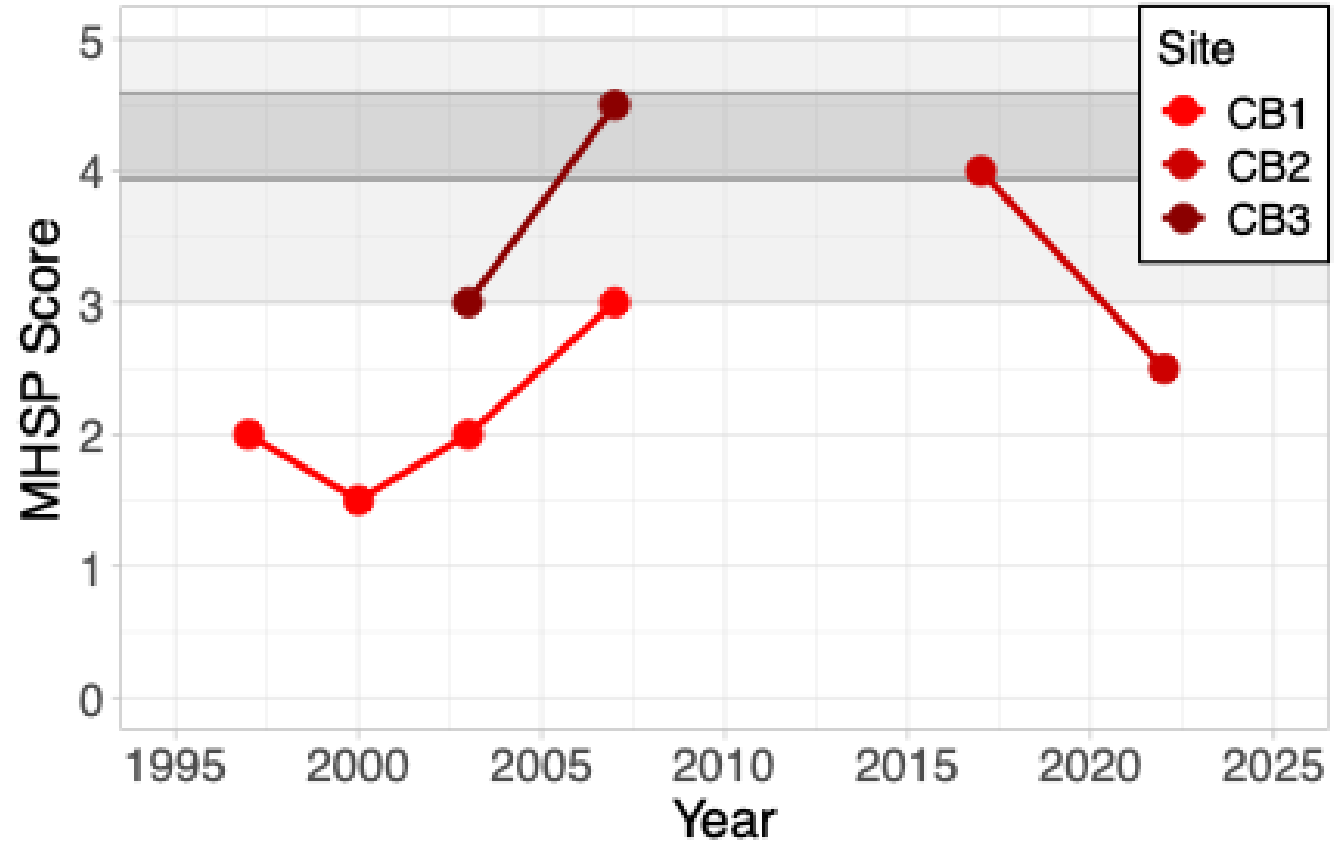
Crouch Branch



Note:
Unstable
stream
channel

Crouch Branch

UTR-middle; Downgradient

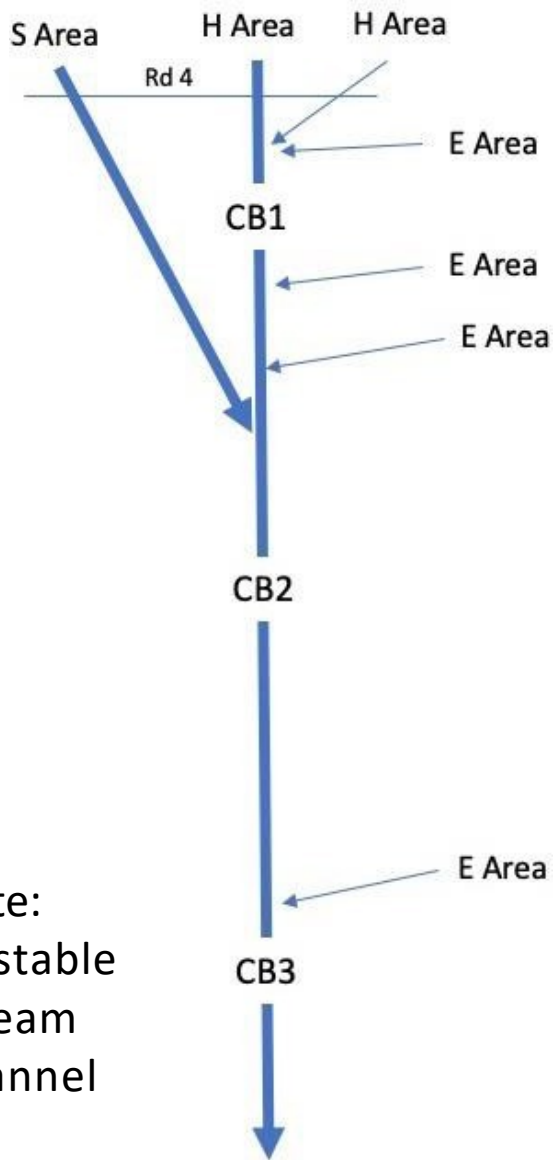


Bioclassification:
Good-fair



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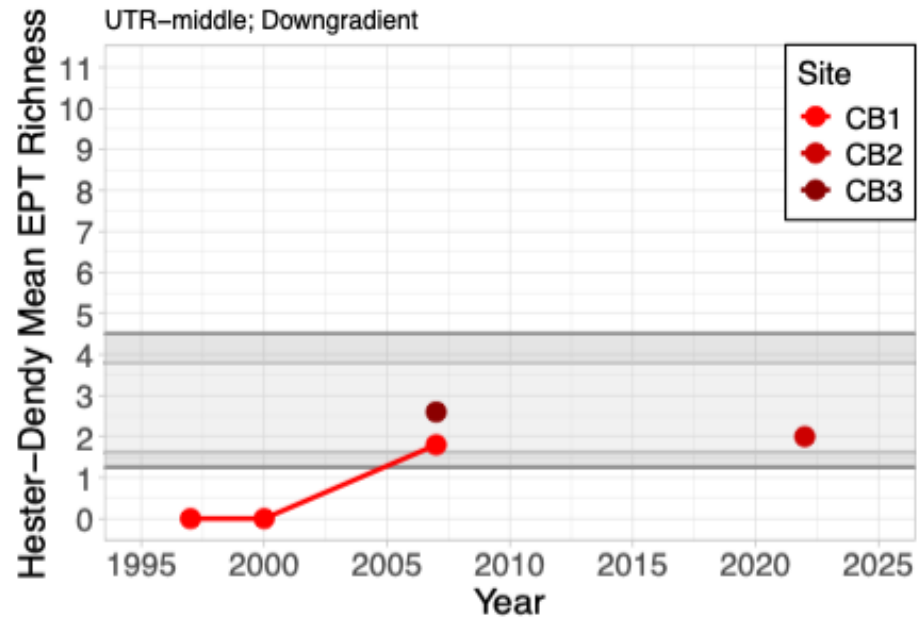
Crouch Branch



Note:
Unstable
stream
channel

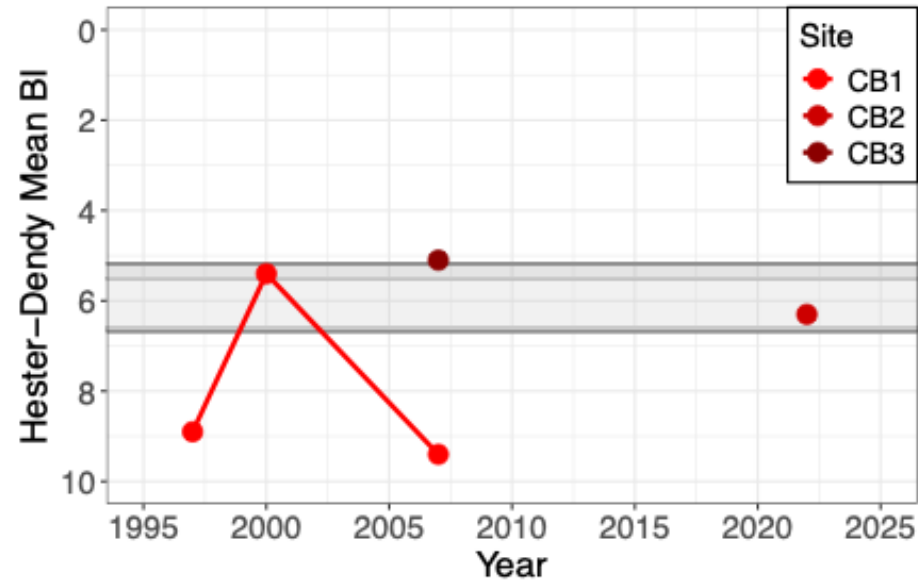
Crouch Branch

UTR-middle; Downgradient



Crouch Branch

UTR-middle; Downgradient

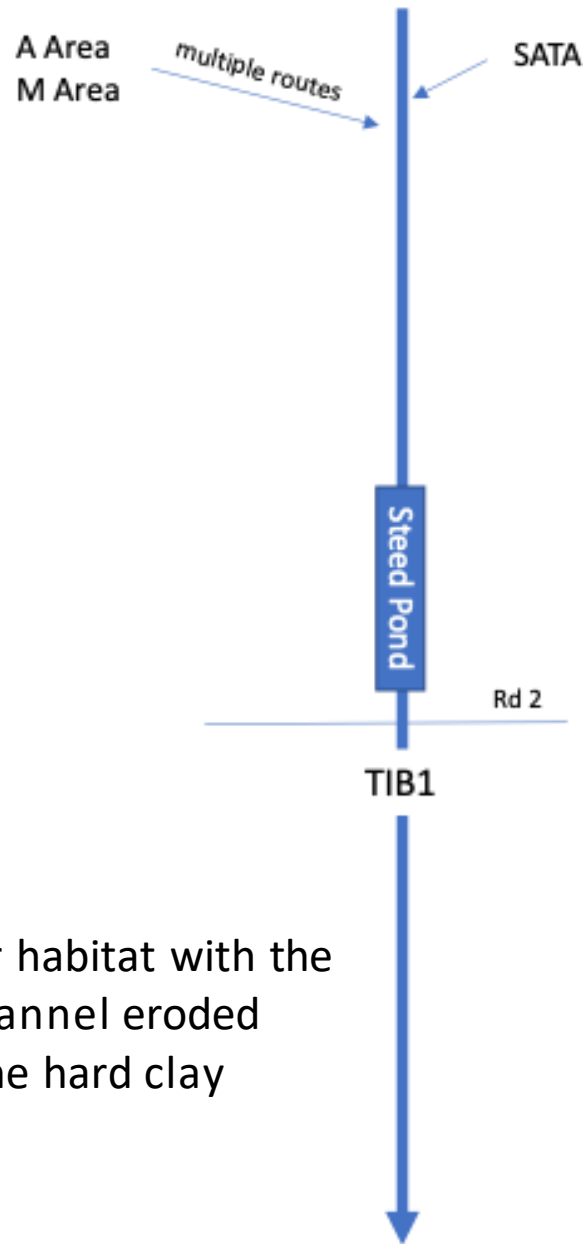


Bioclassification:
Fair



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Tims Branch



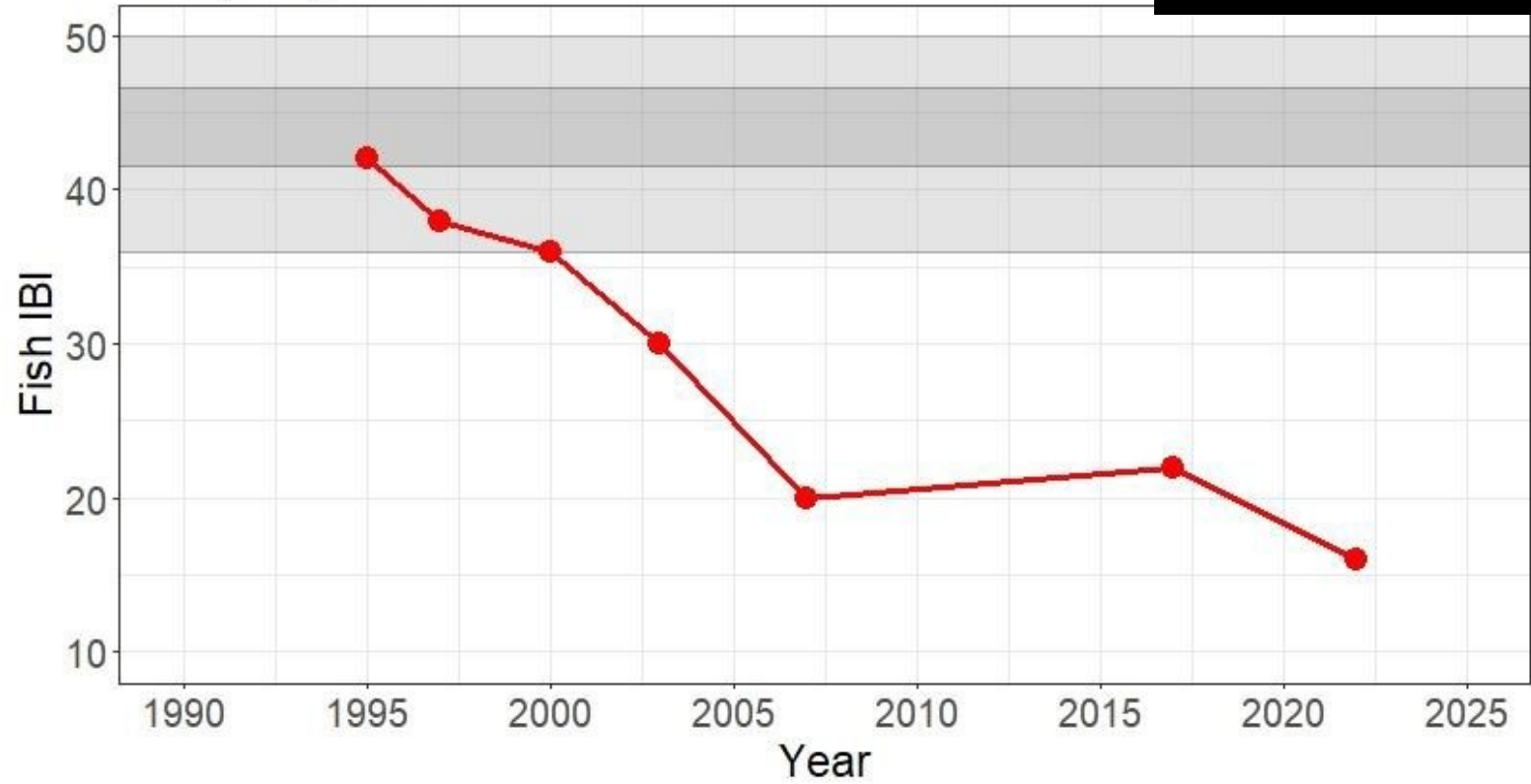
Note: Poor habitat with the stream channel eroded down to the hard clay layer

Tims Branch

UTR-TB; Downgradient

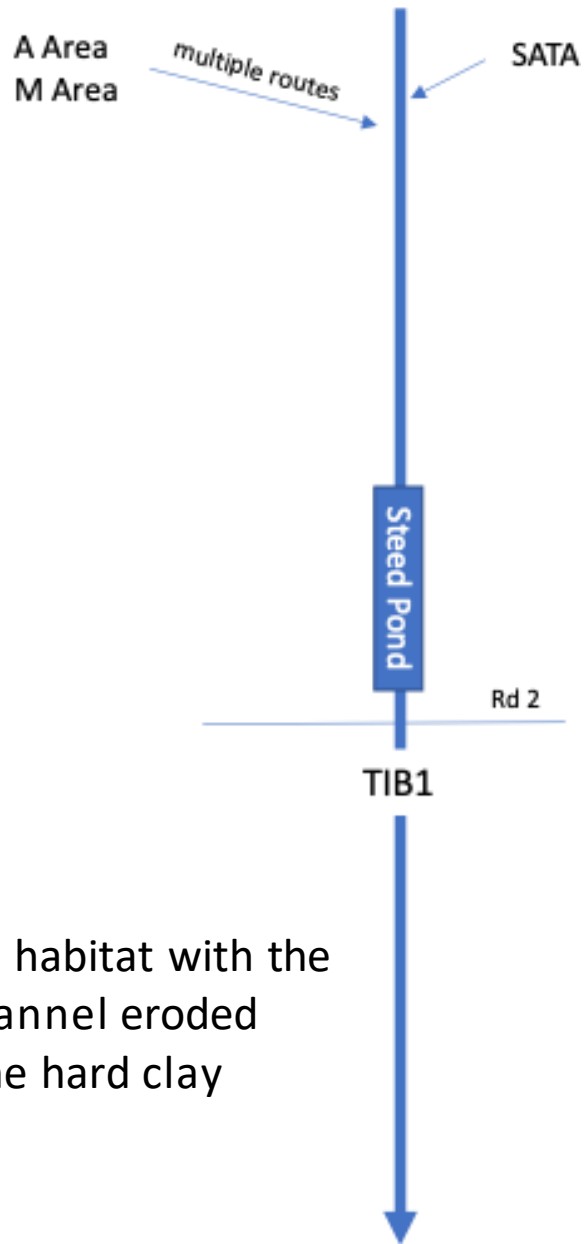
IBI Rating:

Poor



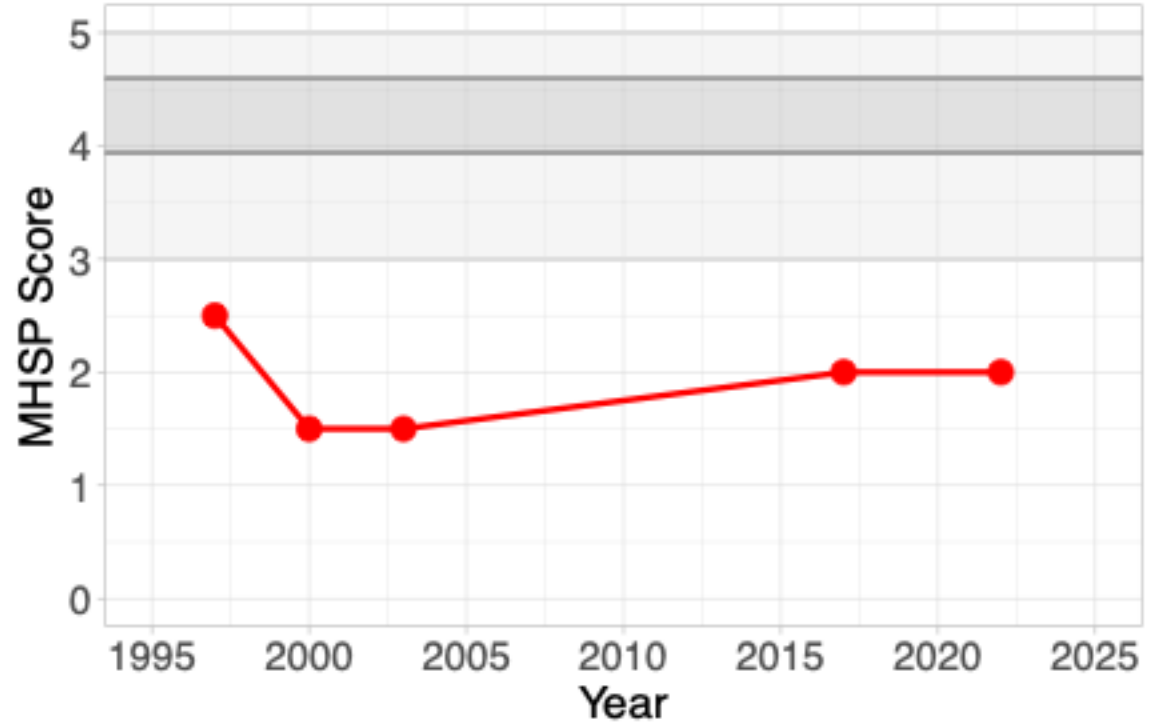
Tims Branch

Bioclassification:
Fair



Tims Branch

UTR-TB; Downgradient

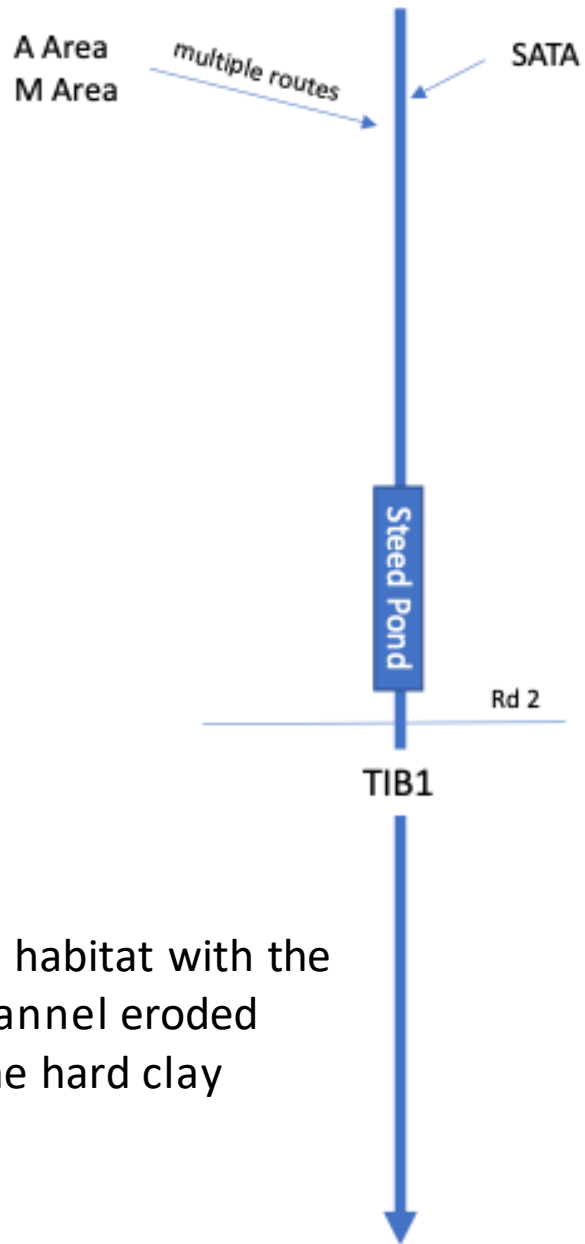


- MHSP scores consistently low



Note: Poor habitat with the stream channel eroded down to the hard clay layer

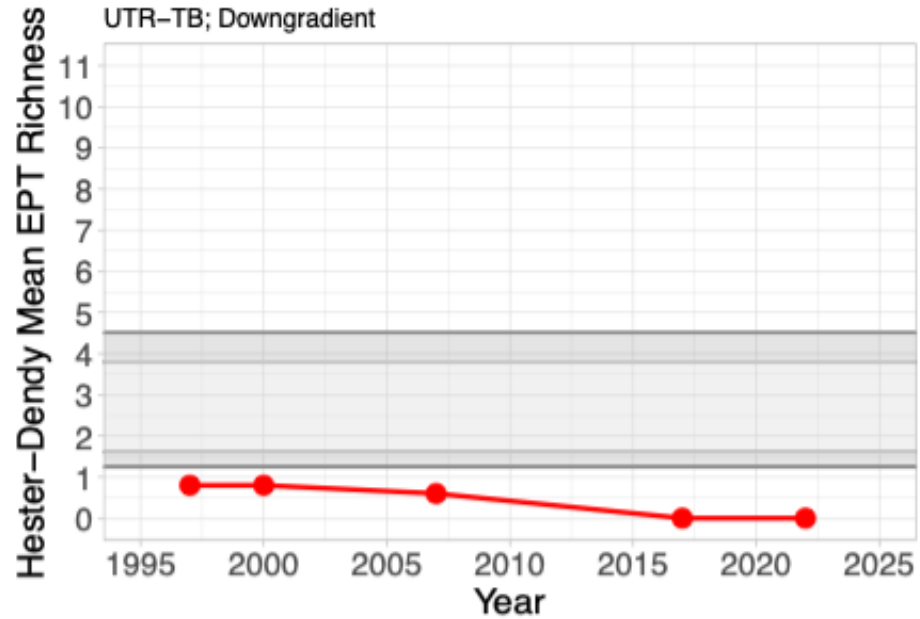
Tims Branch



Note: Poor habitat with the stream channel eroded down to the hard clay layer

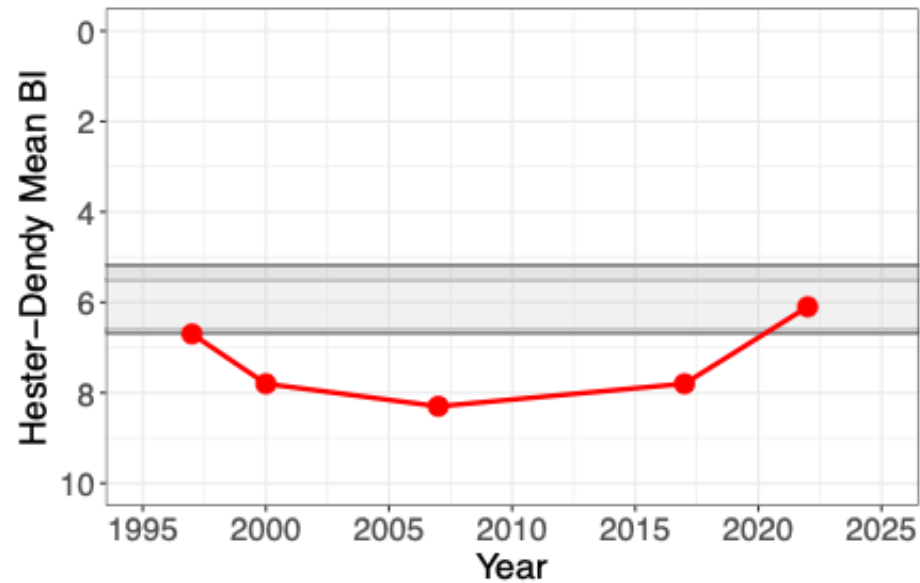
Tims Branch

UTR-TB; Downgradient



Tims Branch

UTR-TB; Downgradient



Bioclassification:

S Fair

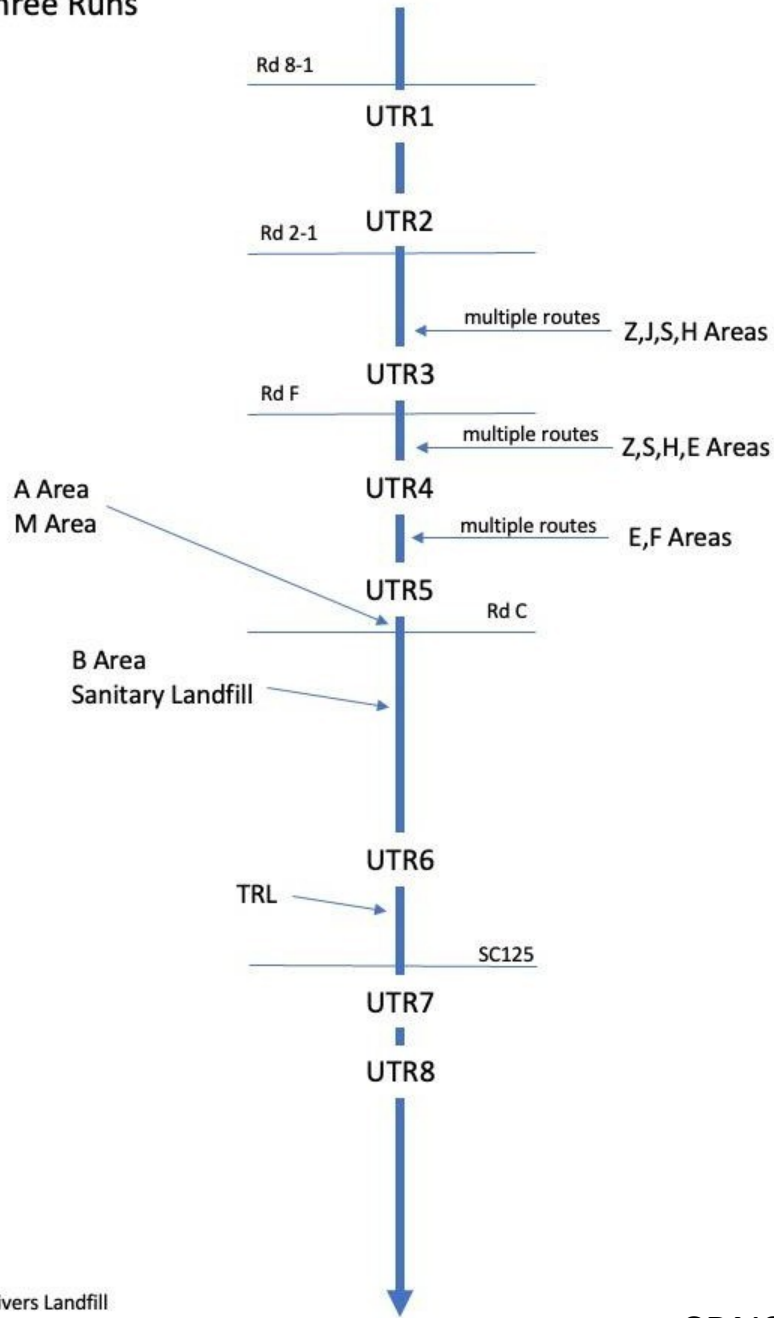
*Only significant linear HD-EPT trend

estimate = -0.037,
 statistic = -7.23,
 $p = 0.006$



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Upper Three Runs

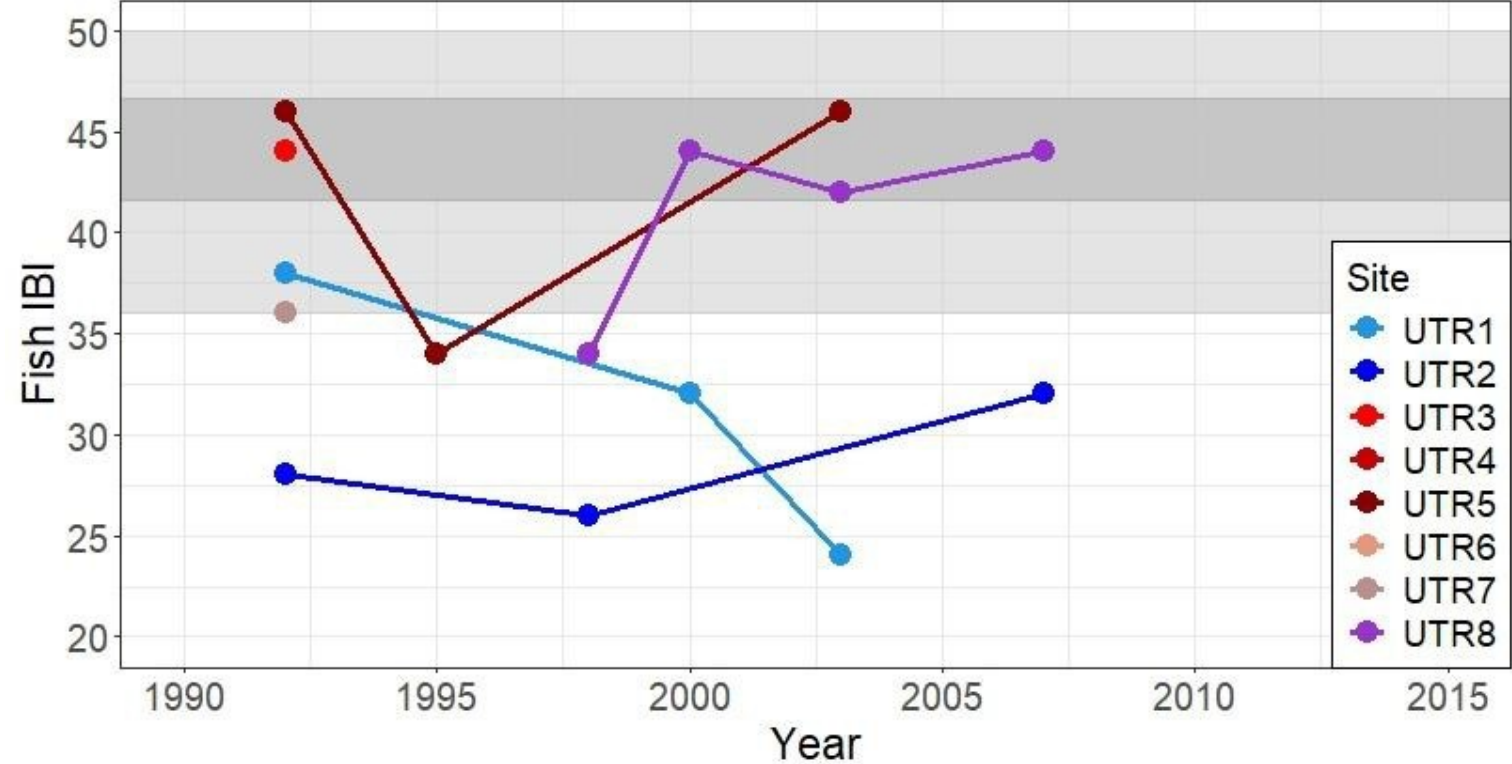


TRL = Three Rivers Landfill

Upper Three Runs

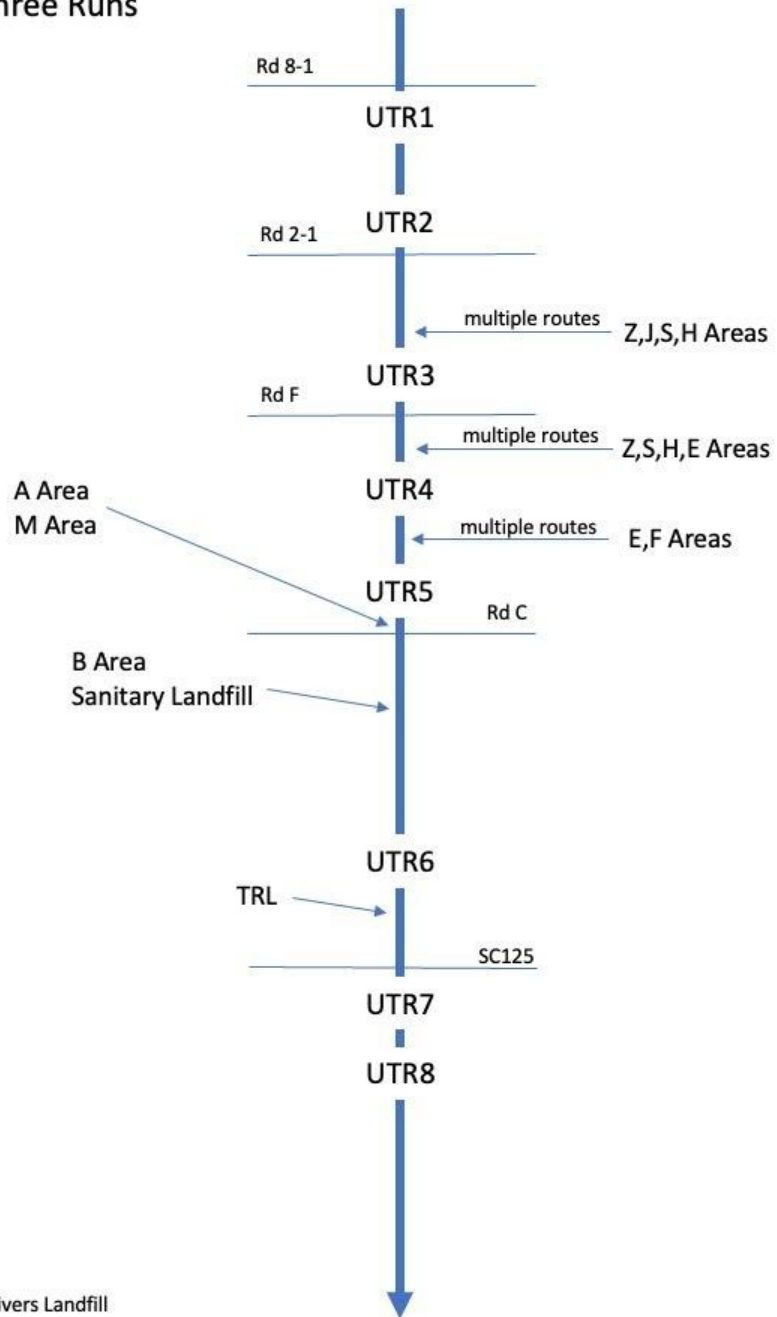
UTR; Upgradient = blue, Downgradient = red, Lowest reaches = purple

IBI Rating:
Good - Excellent



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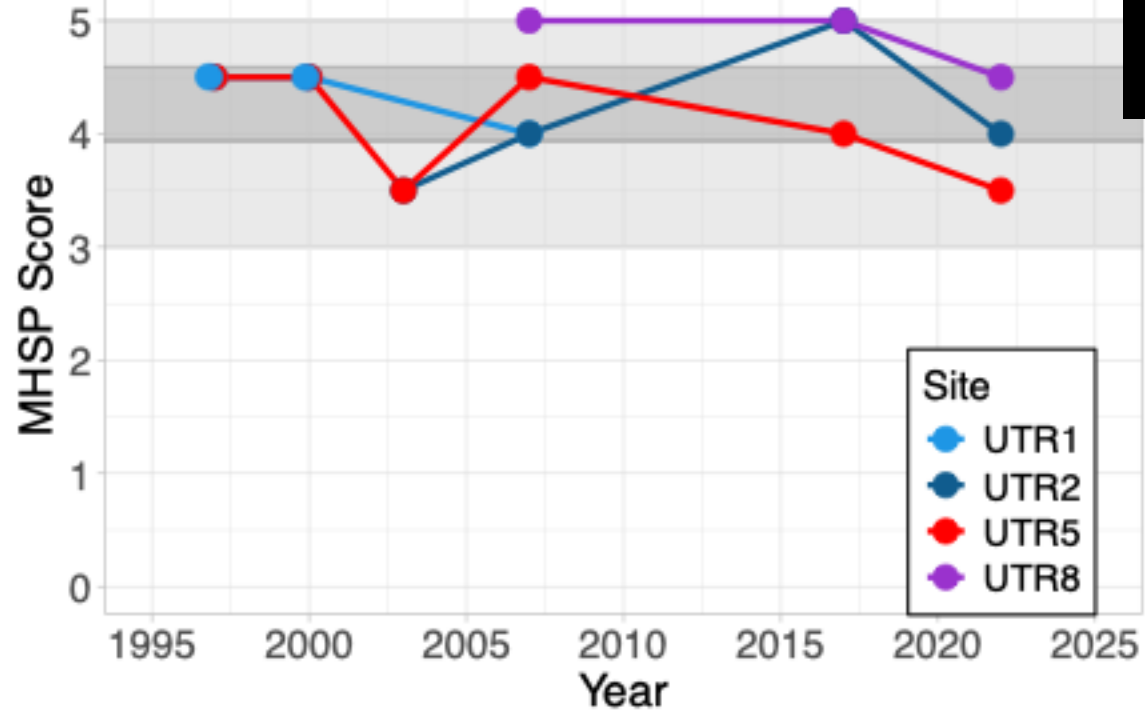
Upper Three Runs



TRL = Three Rivers Landfill

Upper Three Runs

UTR; Upgradient = blue, Downgradient = red, Lowest reaches = purple

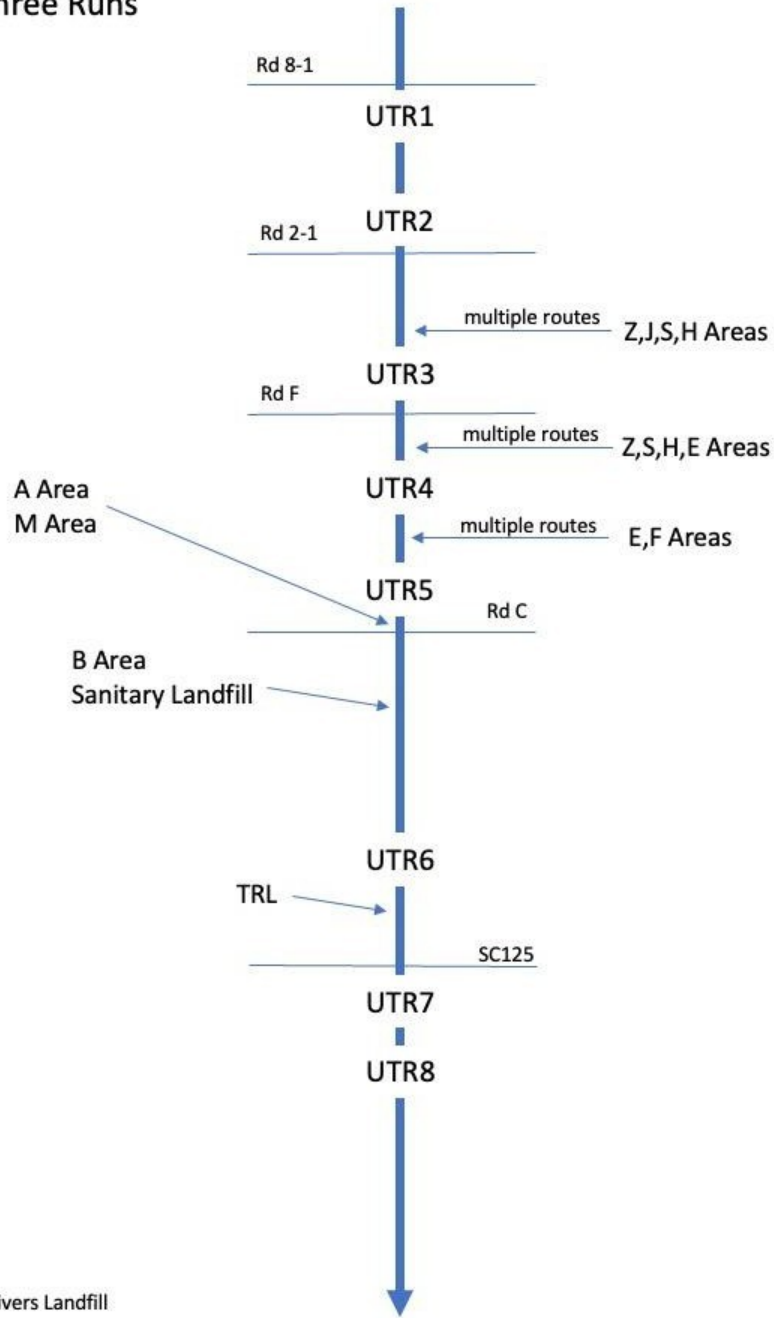


Bioclassifications:
 Good
 Good
 Excellent



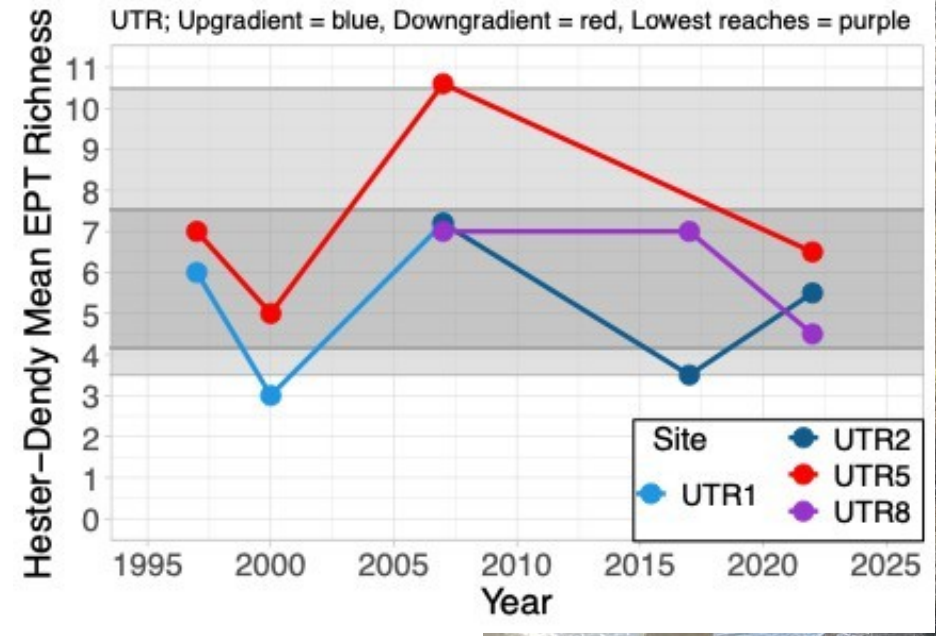
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Upper Three Runs

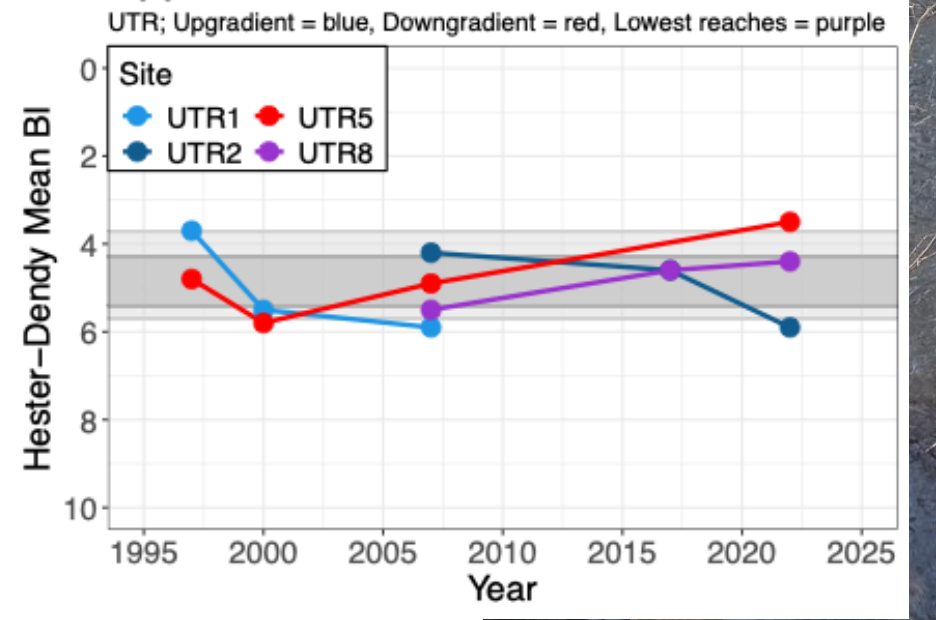


TRL = Three Rivers Landfill

Upper Three Runs



Upper Three Runs



Bioclassifications:
 Good-fair
 Good
 Good



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Study sites

- Fourmile Branch IOU



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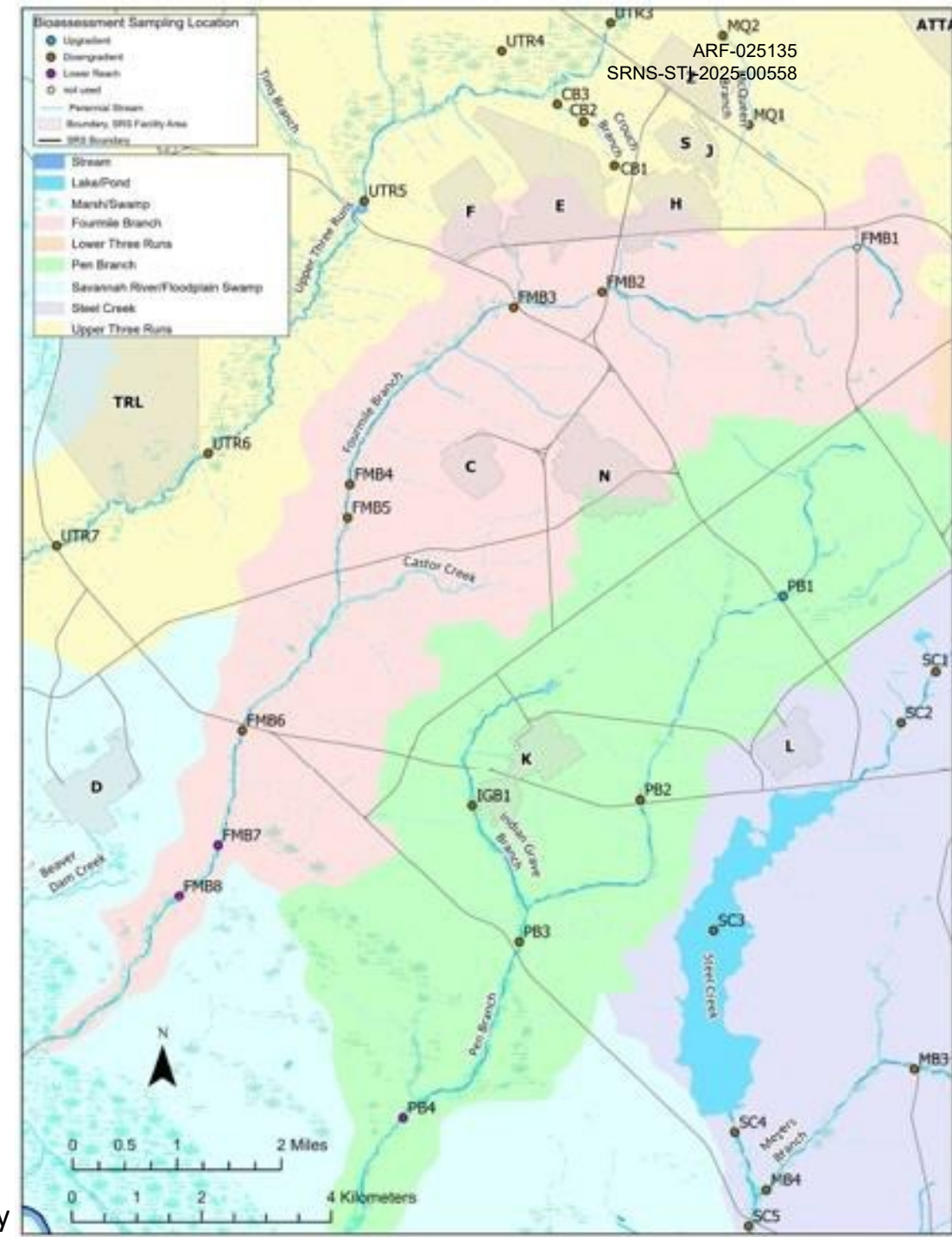
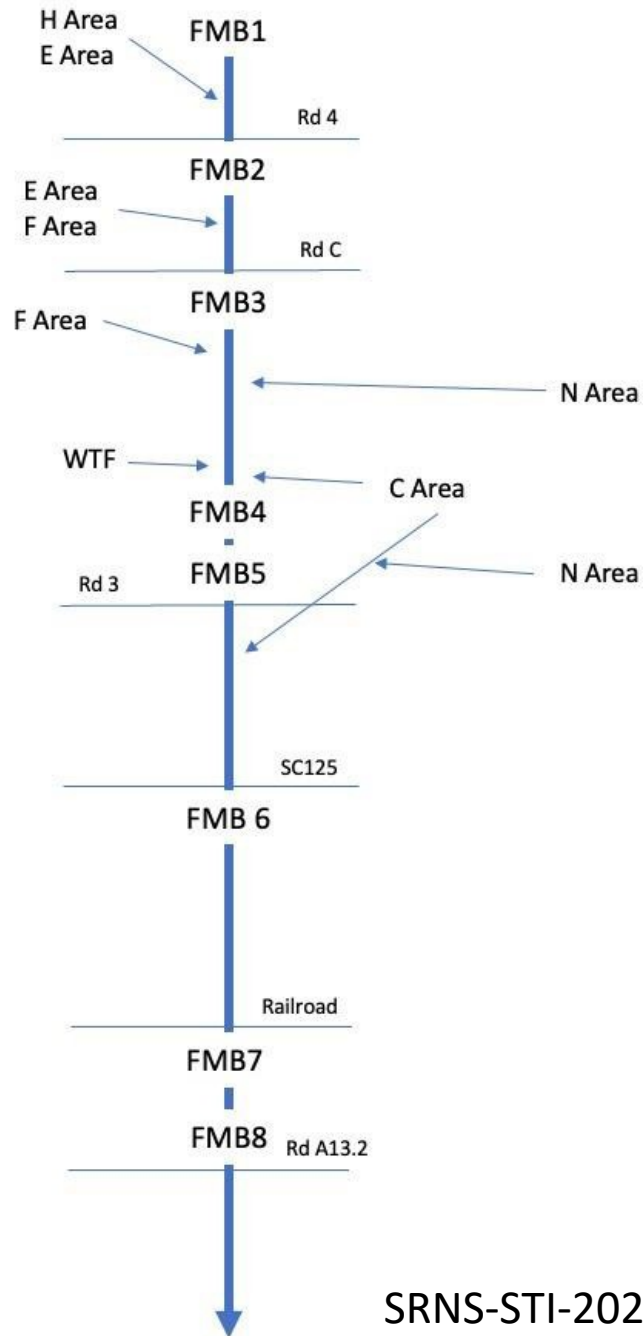


Figure 5. Scoping Summary

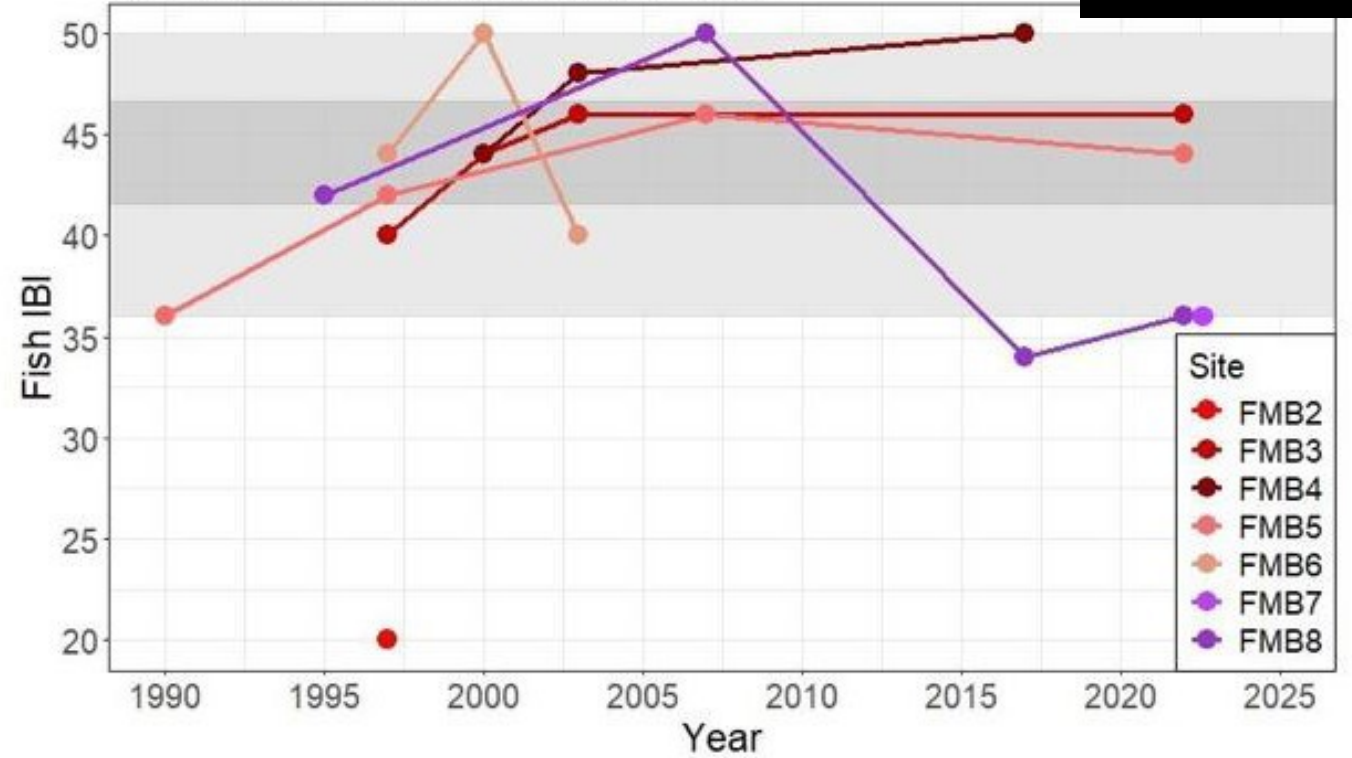
Fourmile Branch



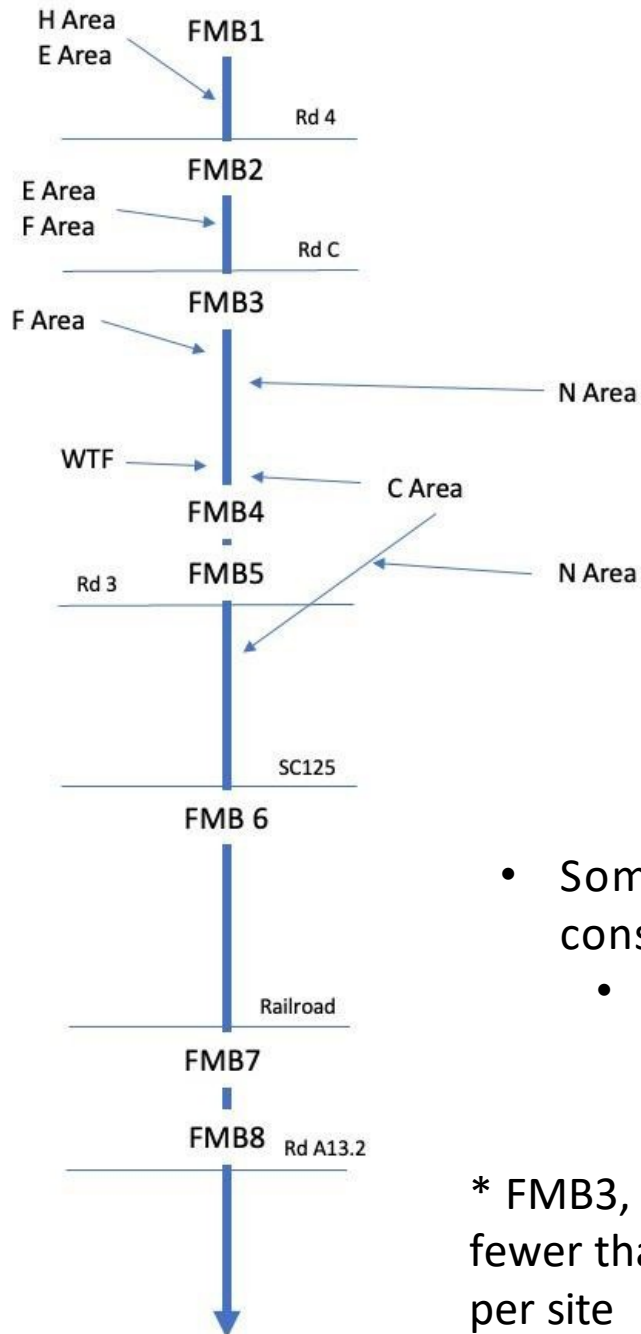
Fourmile Branch

FMB; Downgradient= red/brown, Lowest reaches = purple

IBI Rating:
Good - Excellent

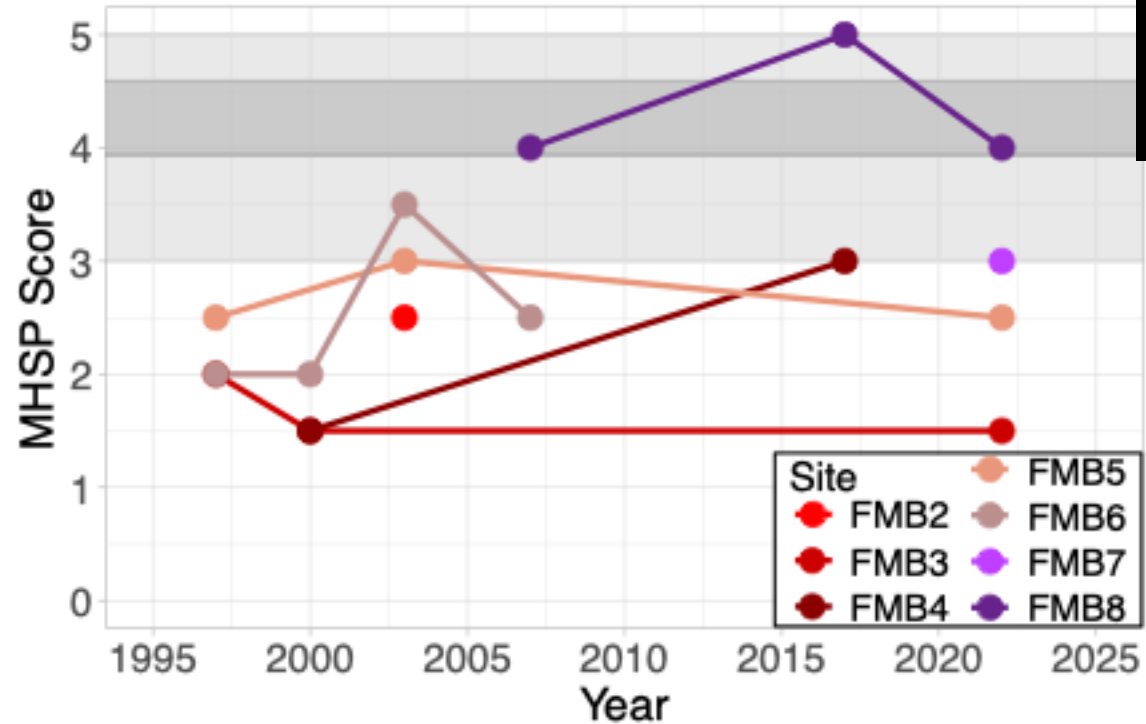


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Fourmile Branch

FMB; Downgradient= red/brown, Lowest reaches = purple



Bioclassifications:
 Poor/Fair
 Good-fair
 Good-fair
 Good

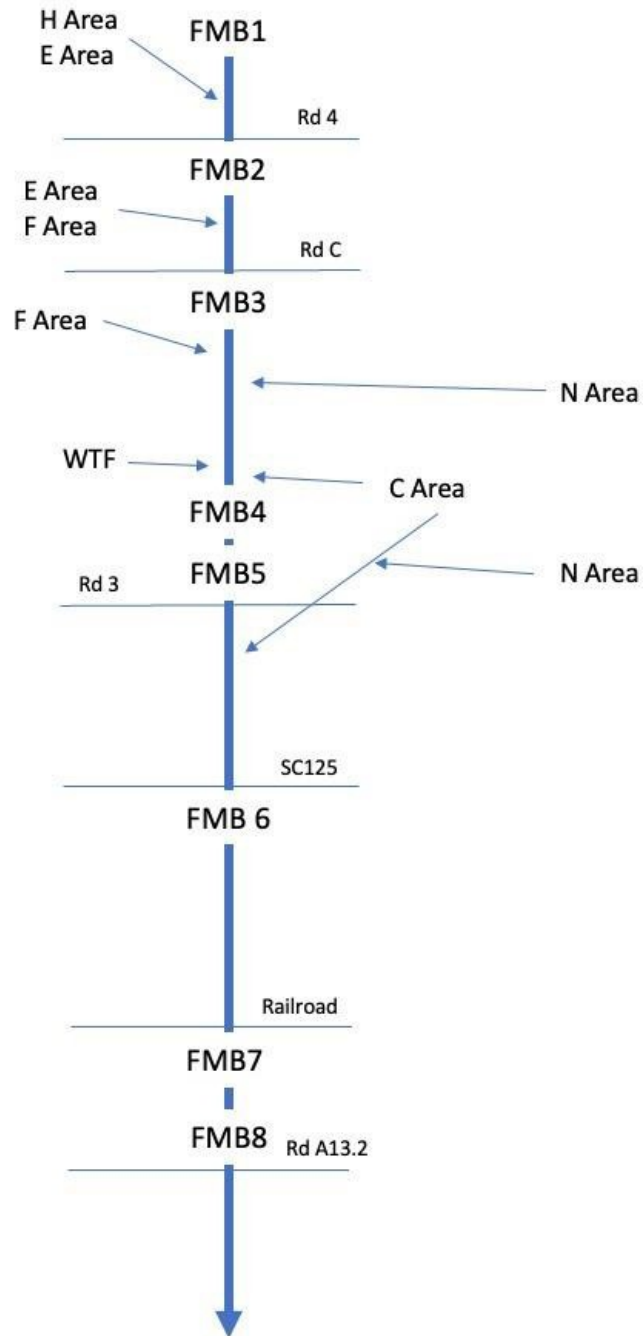
- Some MHSP scores consistently lower
 - (sites FMB3*, FMB4, & FMB5*)

* FMB3, FMB5, FMB7 had fewer than 100 individuals per site



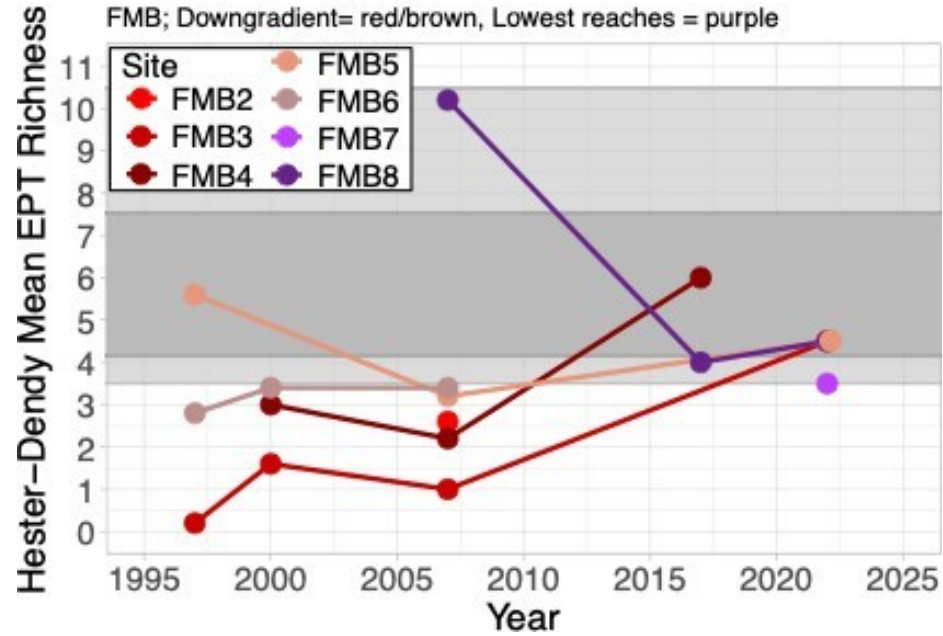
SRNS-STI-2025-00558

Fourmile Branch



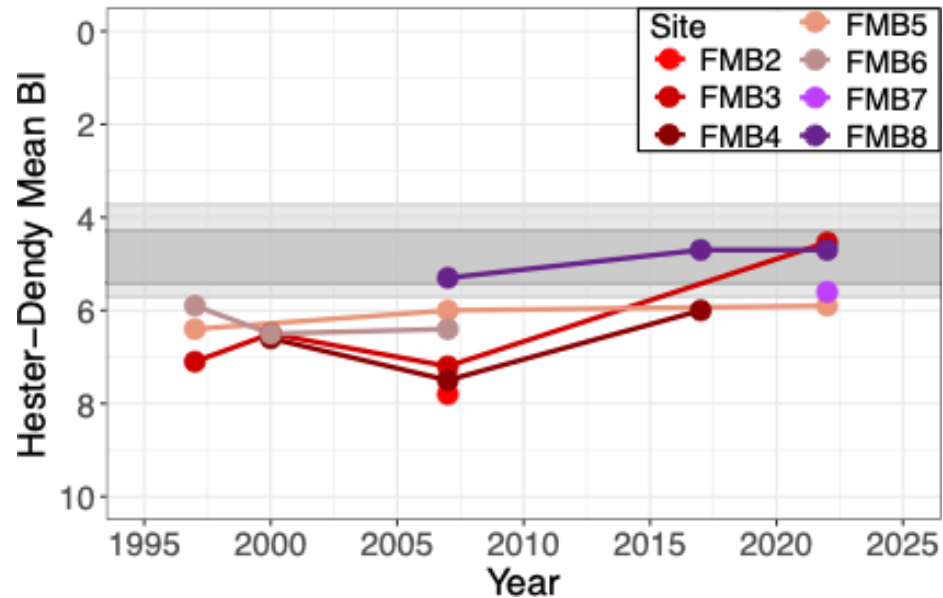
Fourmile Branch

FMB; Downgradient= red/brown, Lowest reaches = purple



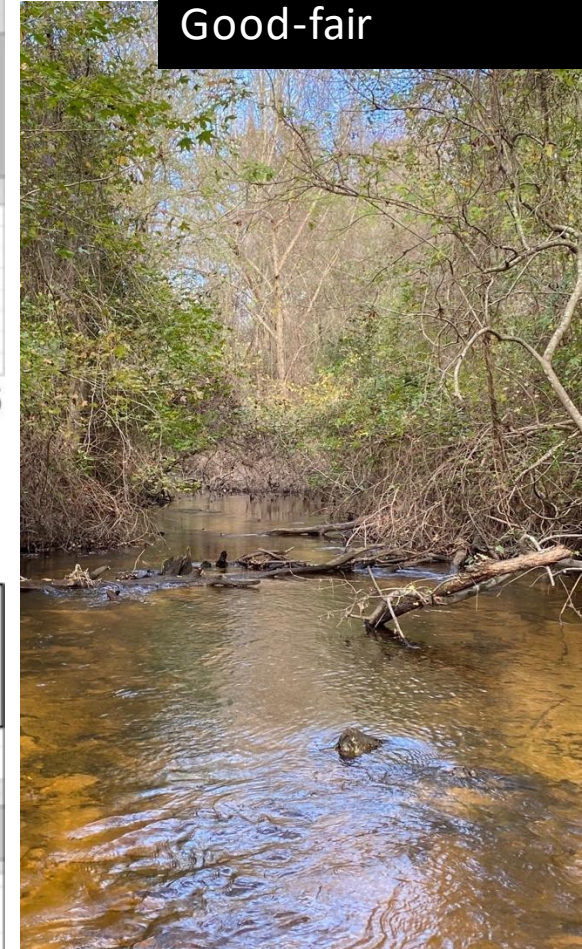
Fourmile Branch

FMB; Downgradient= red/brown, Lowest reaches = purple



Bioclassifications:

- Good
- Good-fair
- Good-fair
- Good-fair



SRNS-STI-2025-00558

Study sites

- Pen Branch IOU
 - Indian Grave Branch

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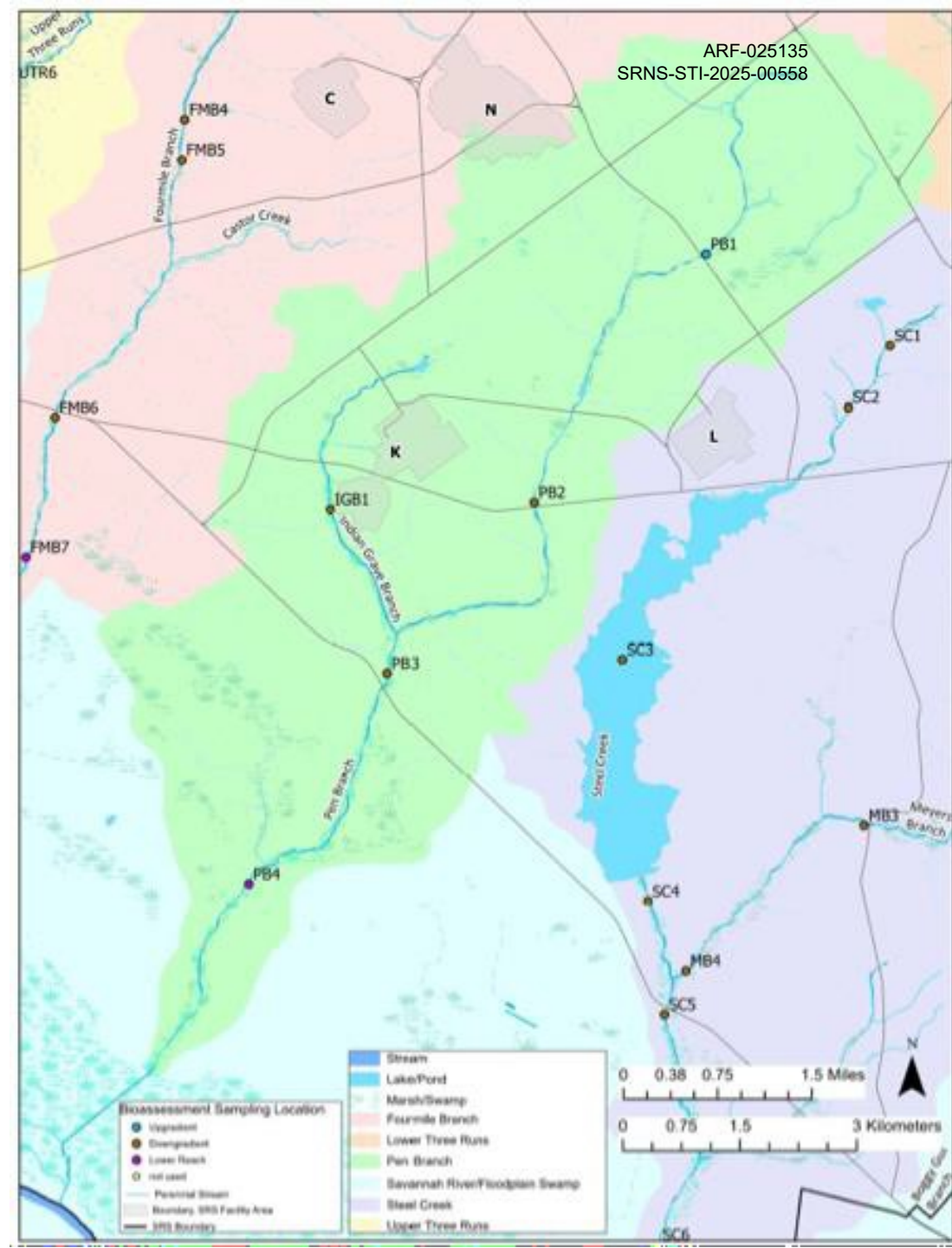
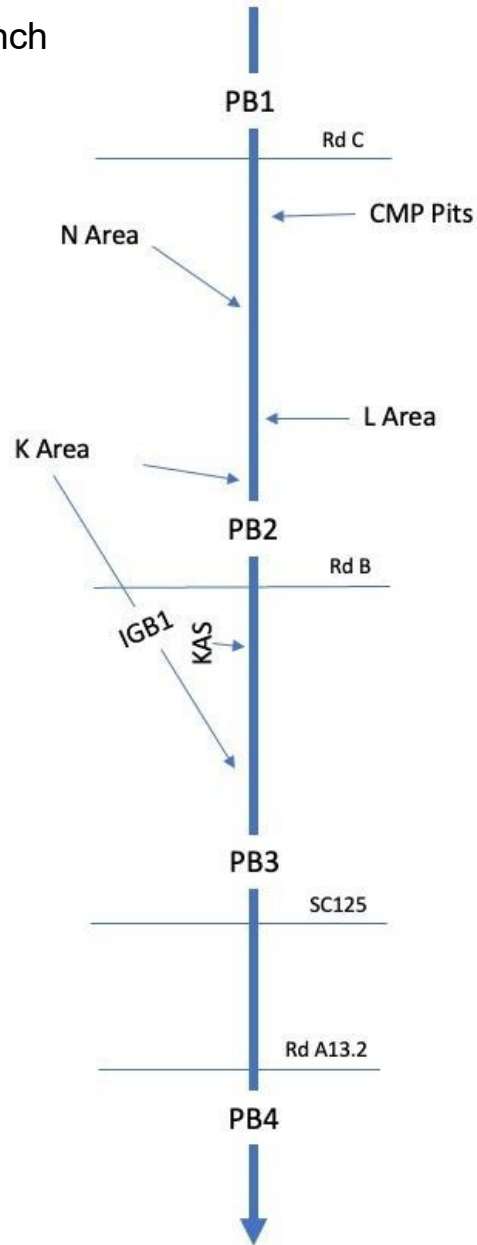


Figure 6. Scoping Summary

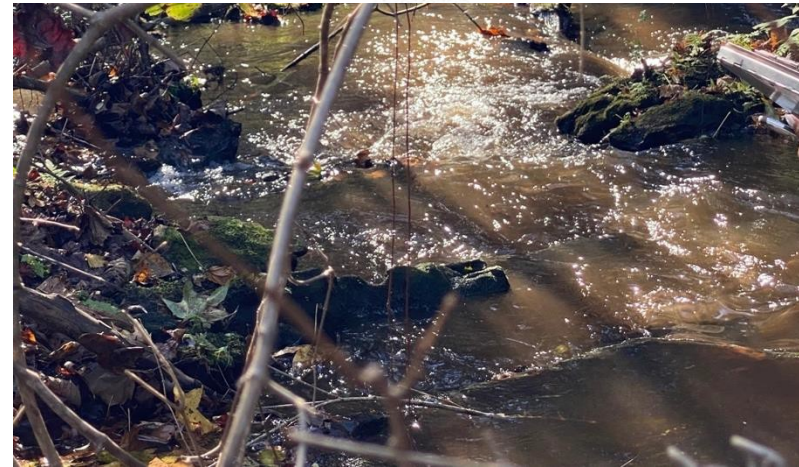
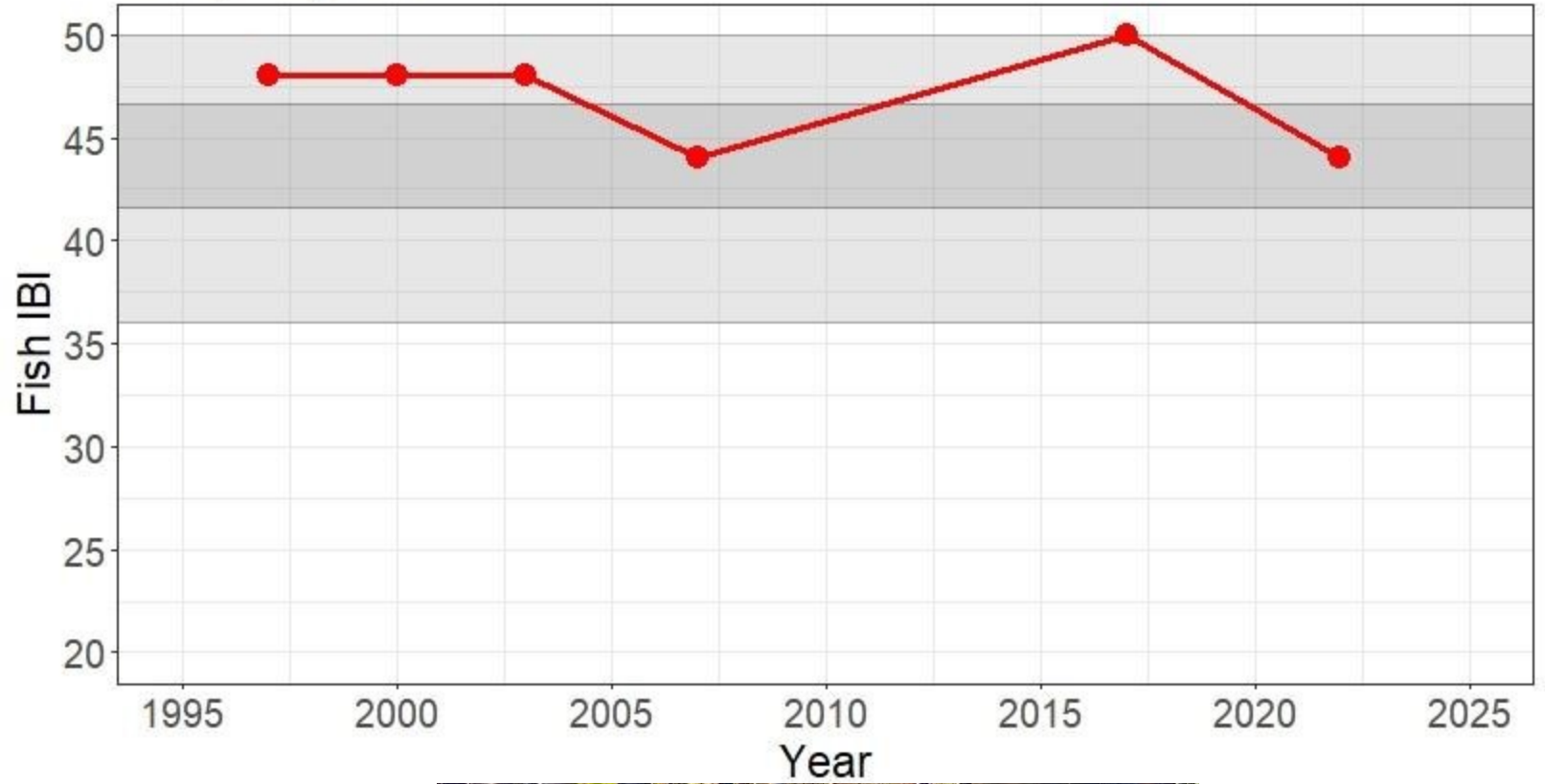
Indian Grave Branch



Indian Grave Branch

PB-IGB; Downgradient

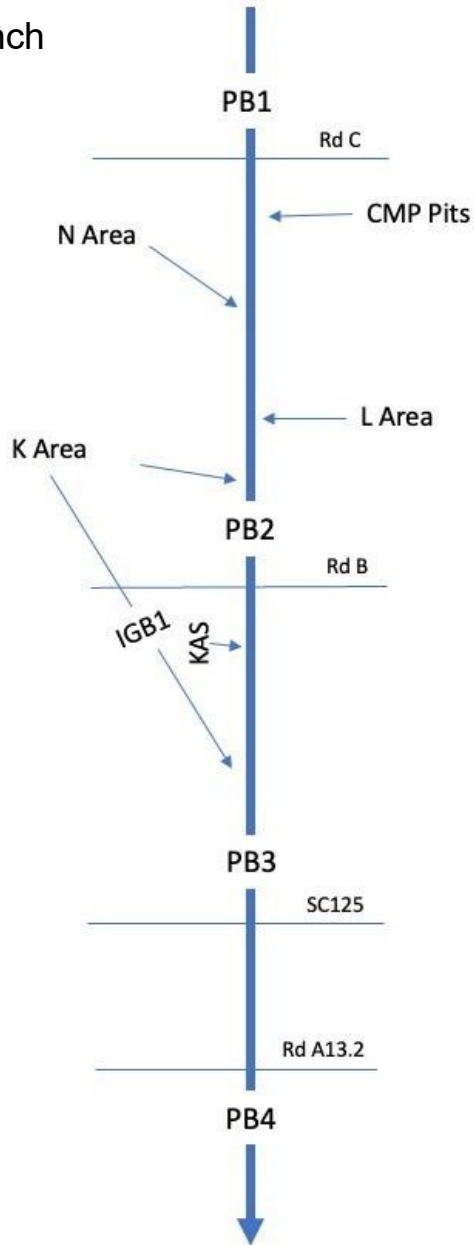
IBI Rating:
Excellent



SRNS-STI-2025-00558

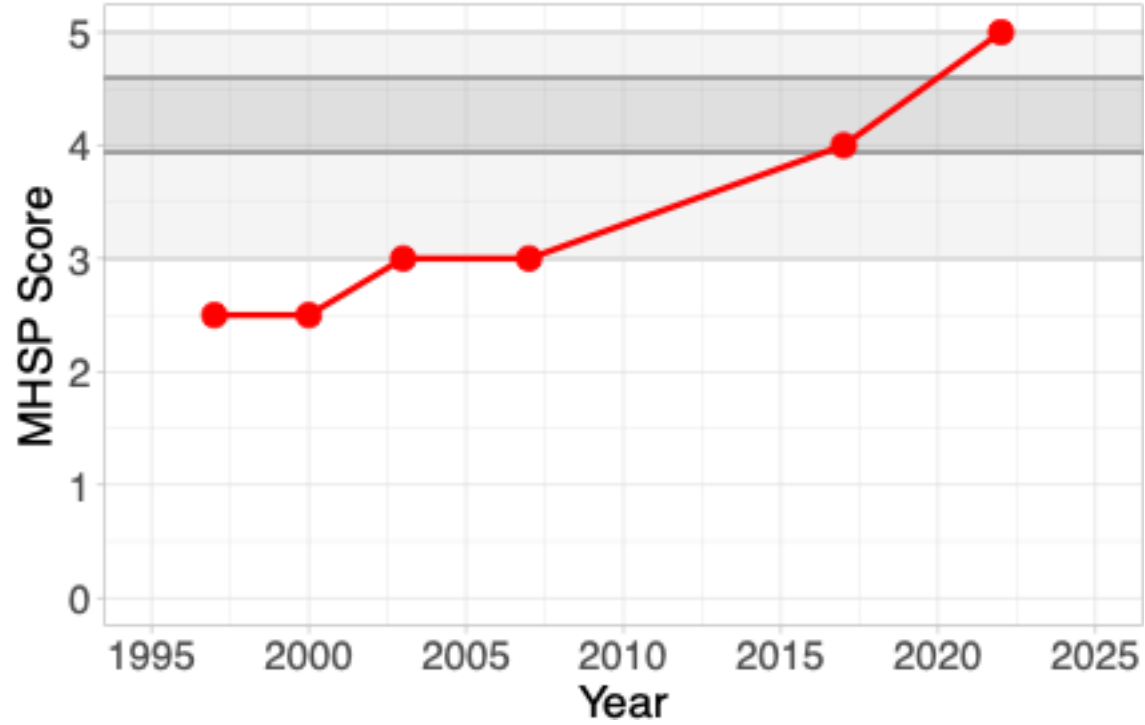
KAS = K Area sludge application site.

Indian Grave Branch



Indian Grave Branch

PB-IGB; Downgradient



Bioclassification:
Excellent

Only site with a significant linear trend.

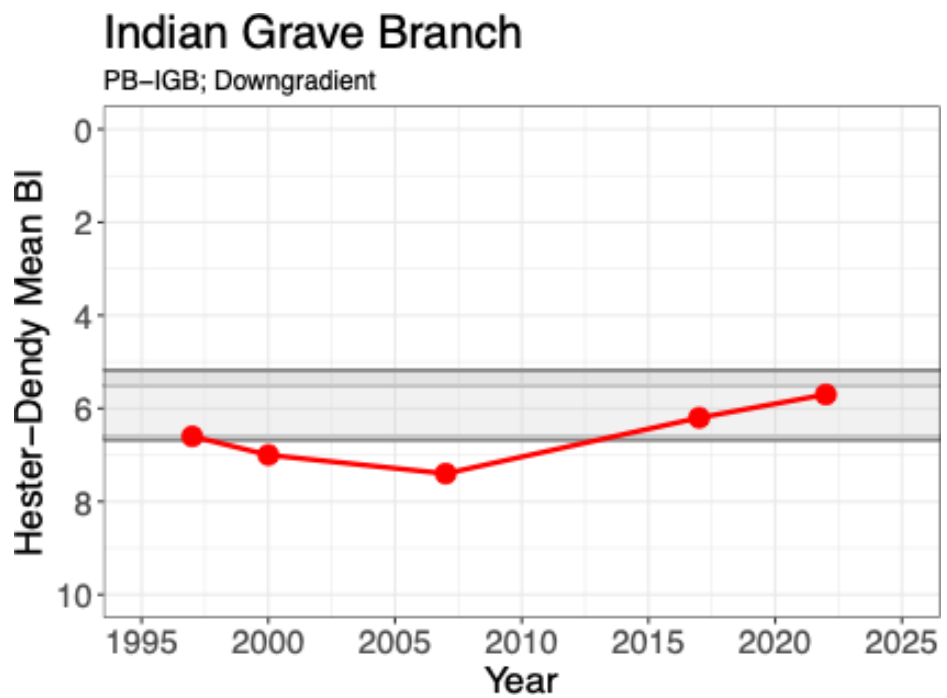
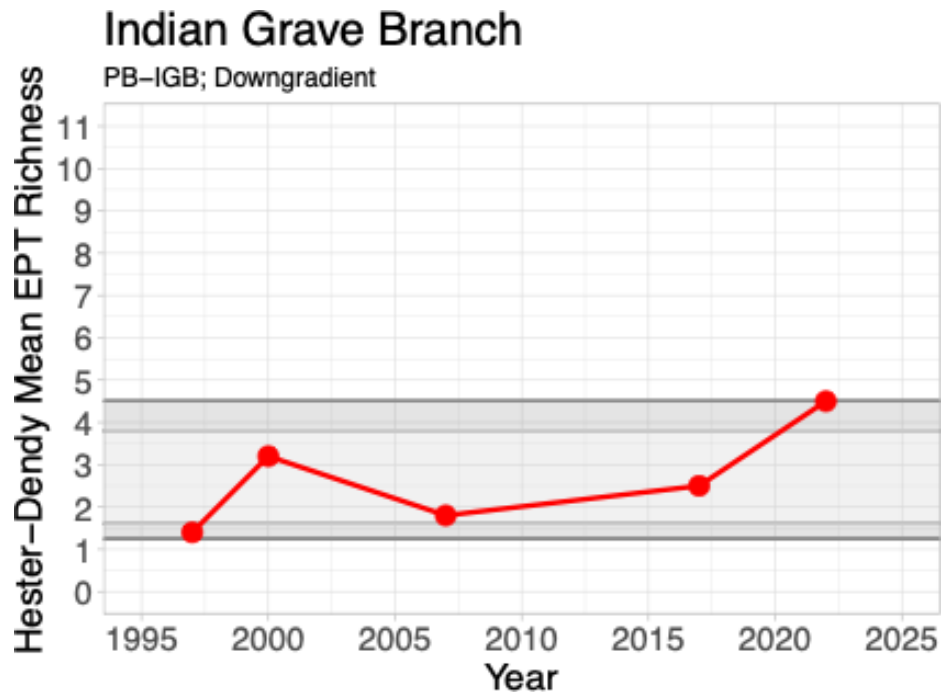
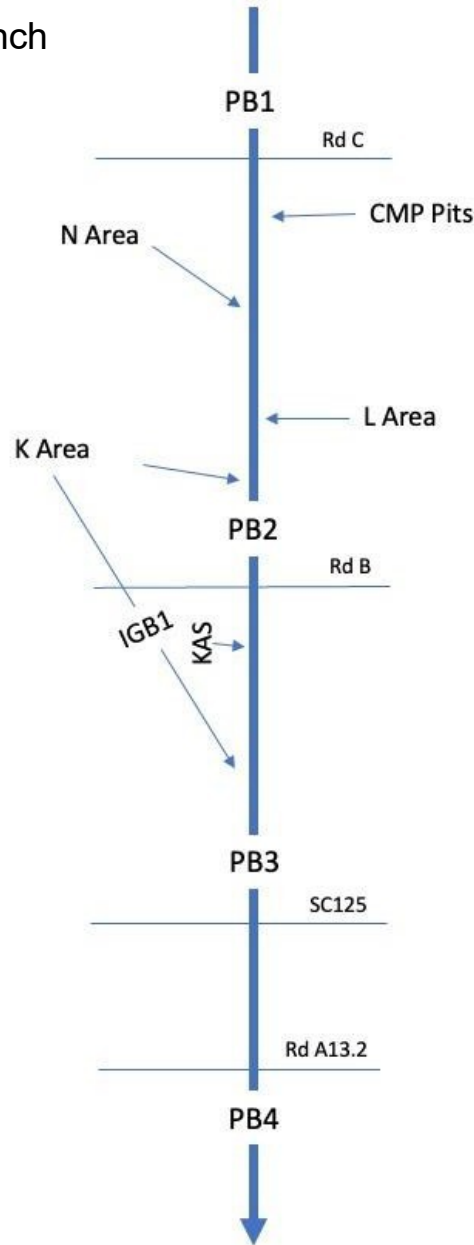
(estimate = 0.1, statistic = 8.25, $p = 0.001$)



SRNS-STI-2025-00558

KAS = K Area sludge application site.

Indian Grave Branch

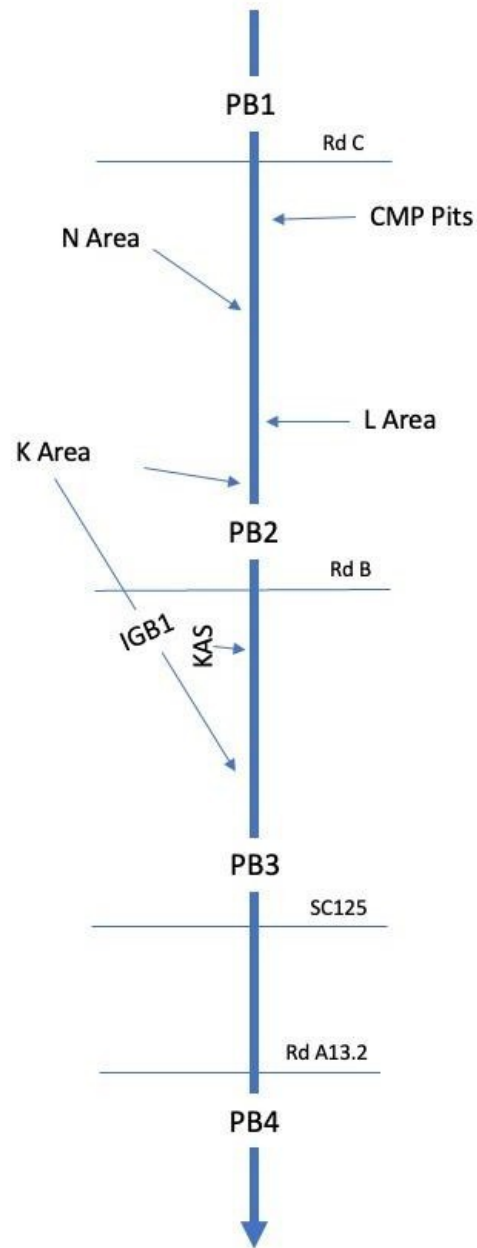


Bioclassification:
Good-fair

SRNS-STI-2025-00558

KAS = K Area sludge application site.

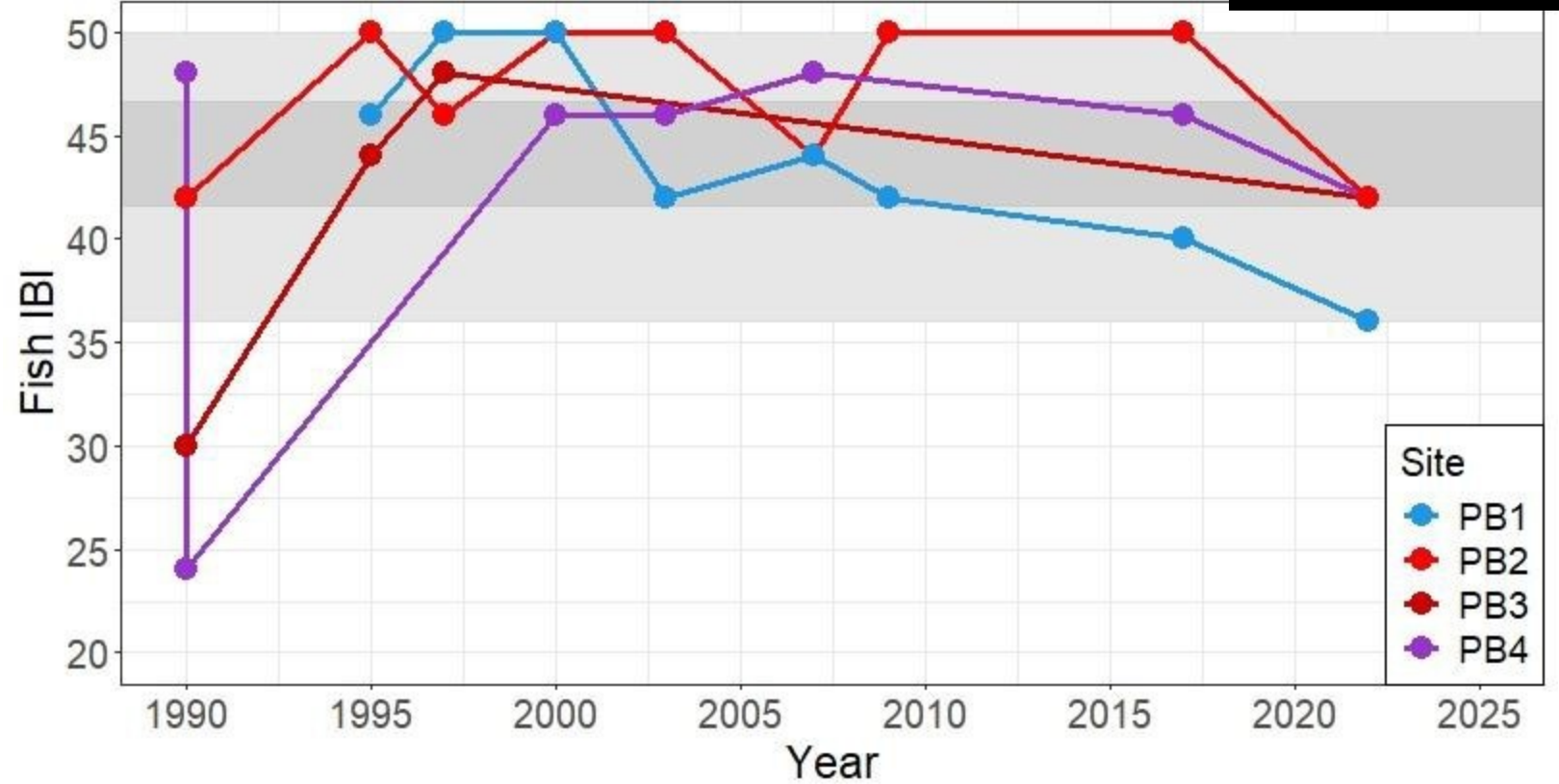
Pen Branch



Pen Branch

PB; Upgradient = blue, Downgradient = red, Lowest reaches = purple

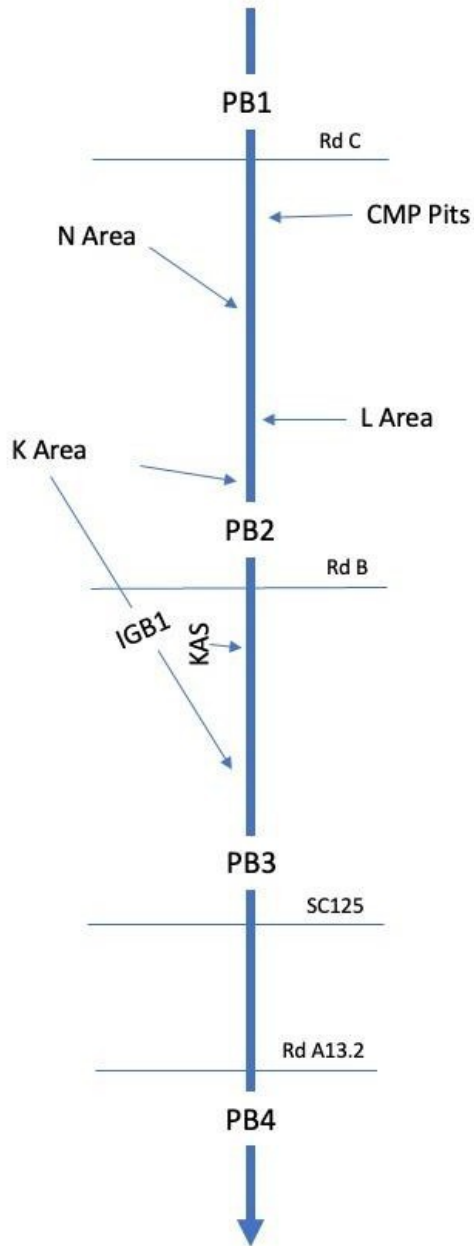
IBI Rating:
Good - Excellent



SRNS-STI-2025-00558

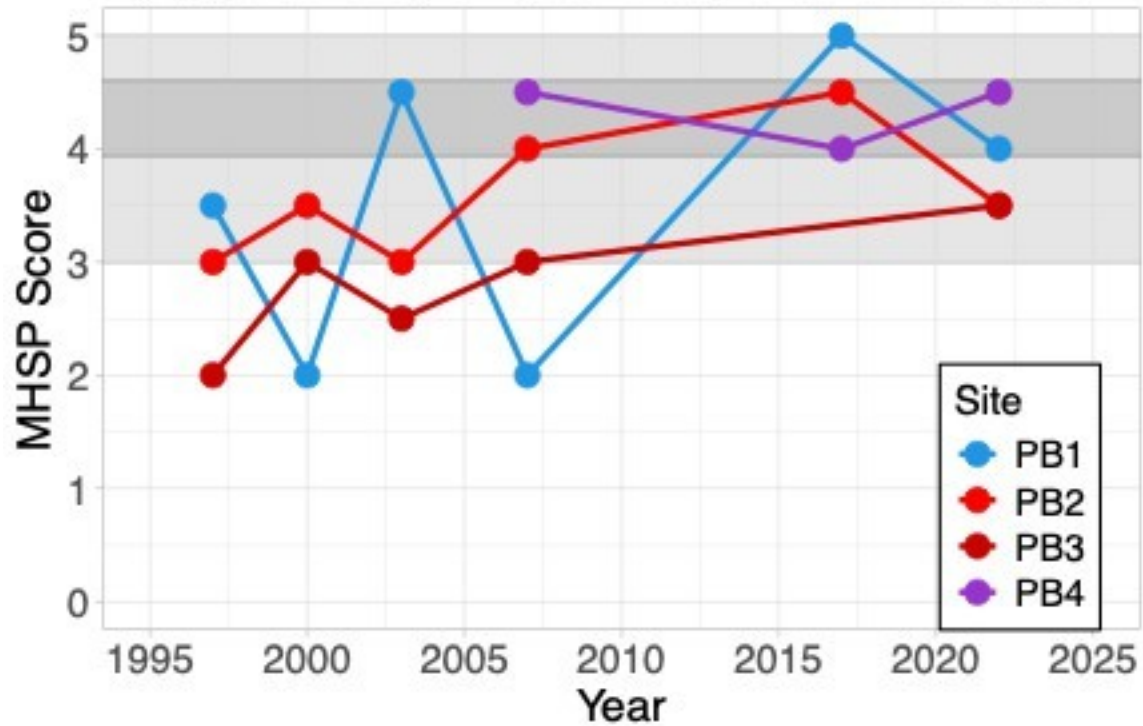
KAS = K Area sludge application site.

Pen Branch



Pen Branch

PB; Upgradient = blue, Downgradient = red, Lowest reaches = purple



Bioclassifications:
 Good
 Good
 Good
 Excellent

Pen Branch (PB3) had a marginally significant increase in MHSP score

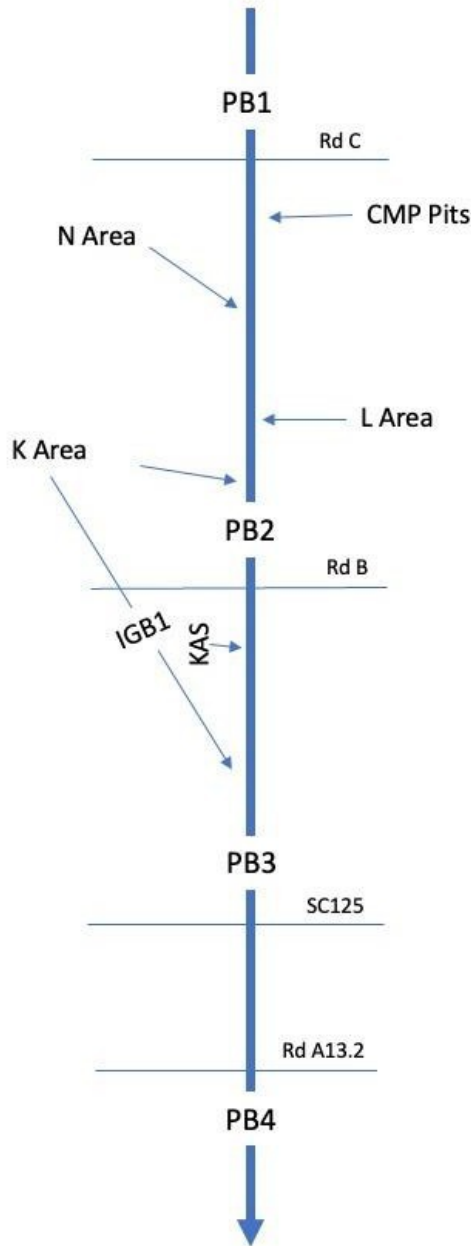
(estimate = 0.5, statistic = 2.48, $p = 0.09$)



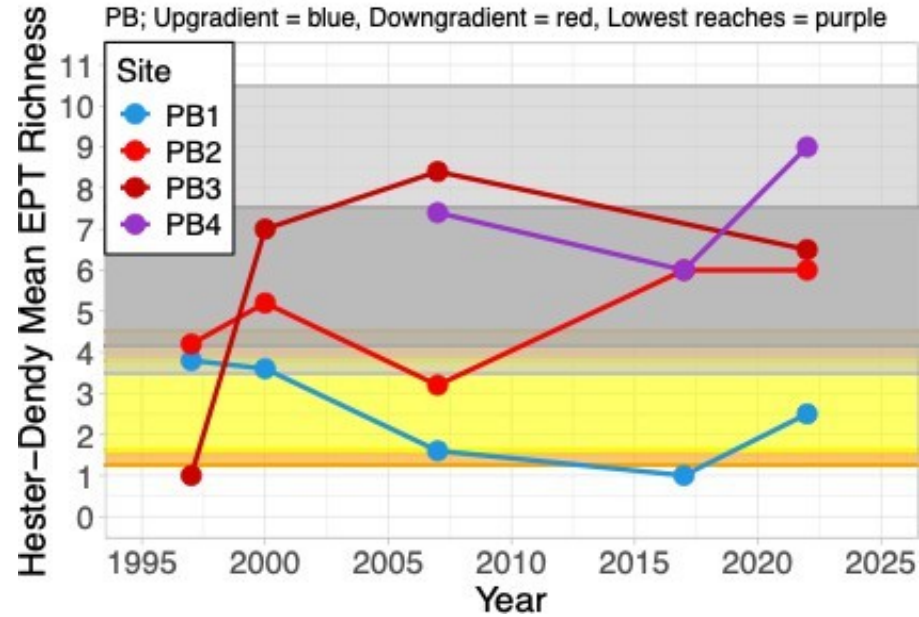
SRNS-STI-2025-00558

KAS = K Area sludge application site.

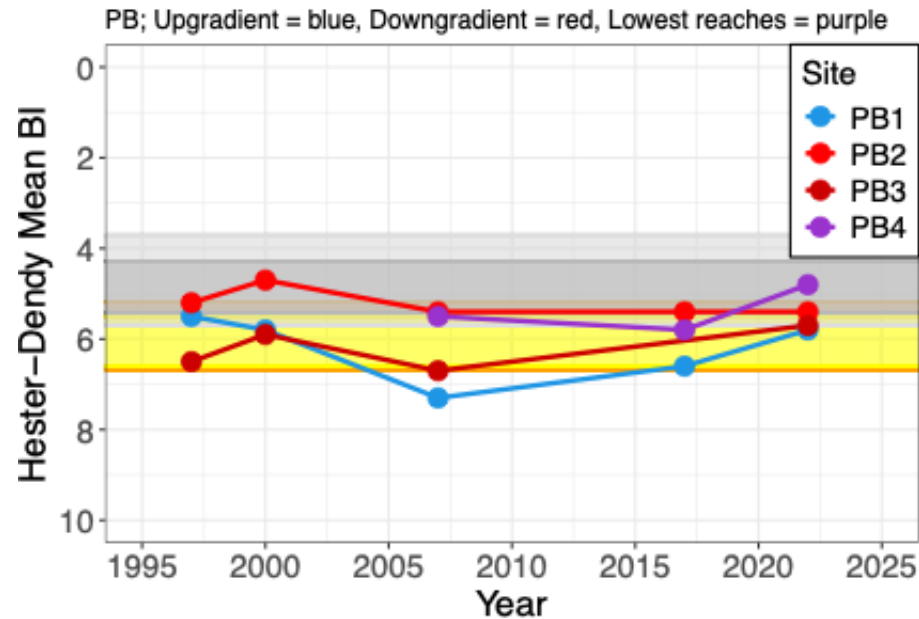
Pen Branch



Pen Branch

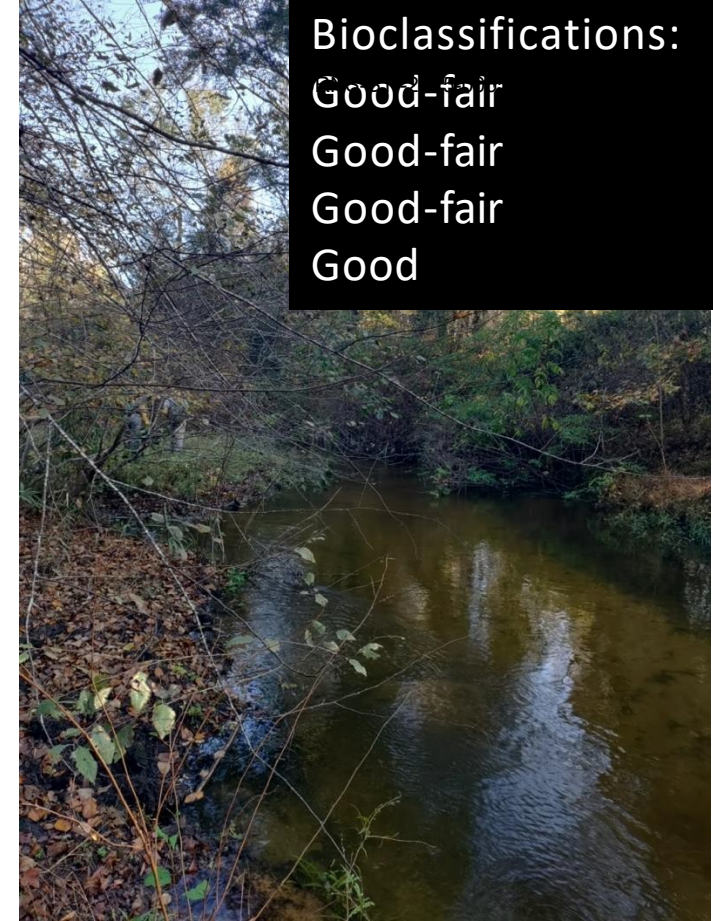


Pen Branch



Bioclassifications:

- Good-fair
- Good-fair
- Good-fair
- Good



Range & 95% CI

- Grey: Large Streams
- Orange & Yellow: Small Streams

SRNS-STI-2025-00558

KAS = K Area sludge application site.

Study sites

- Steel Creek IOU
 - Meyers Branch

SRNS-STI-2025-00558

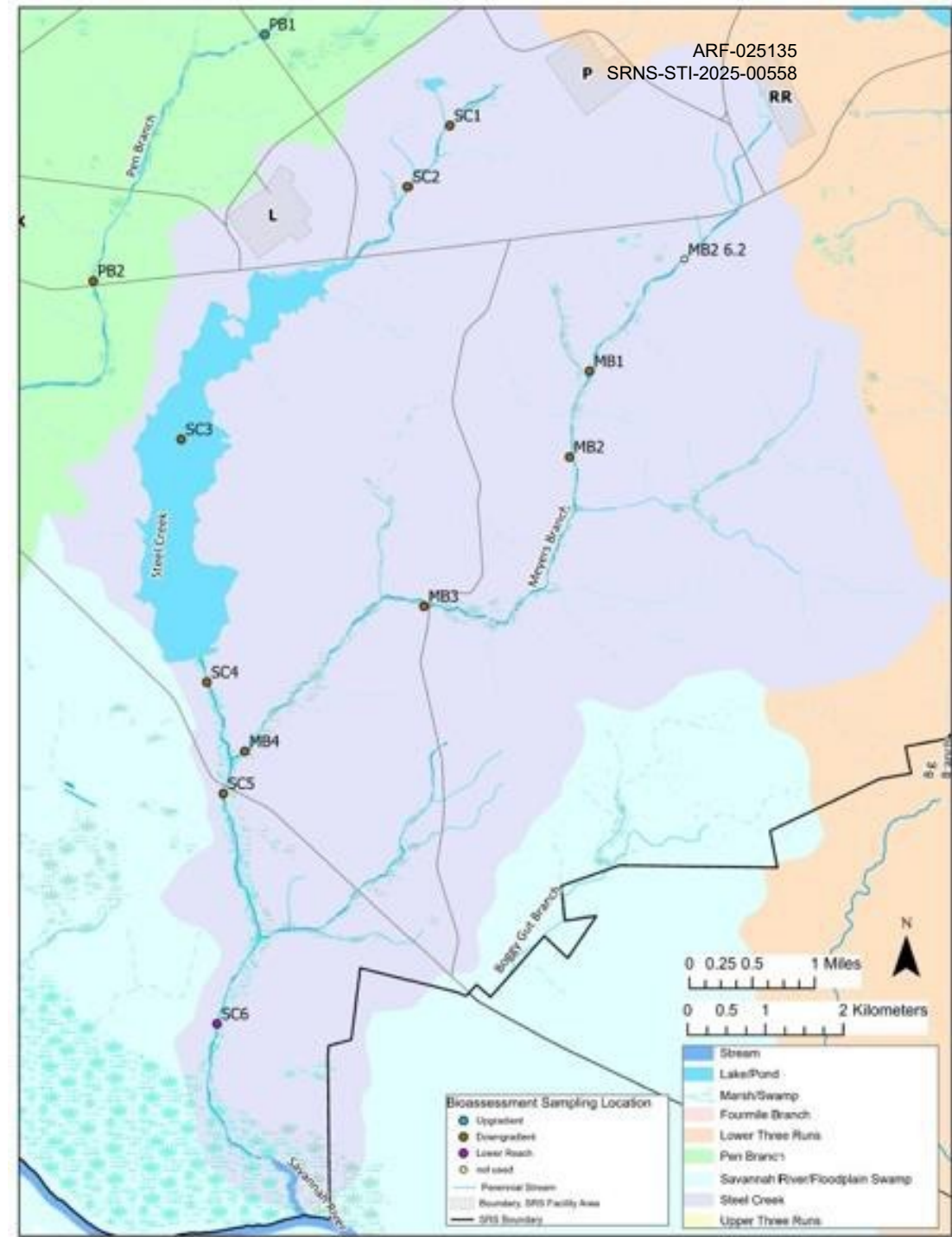
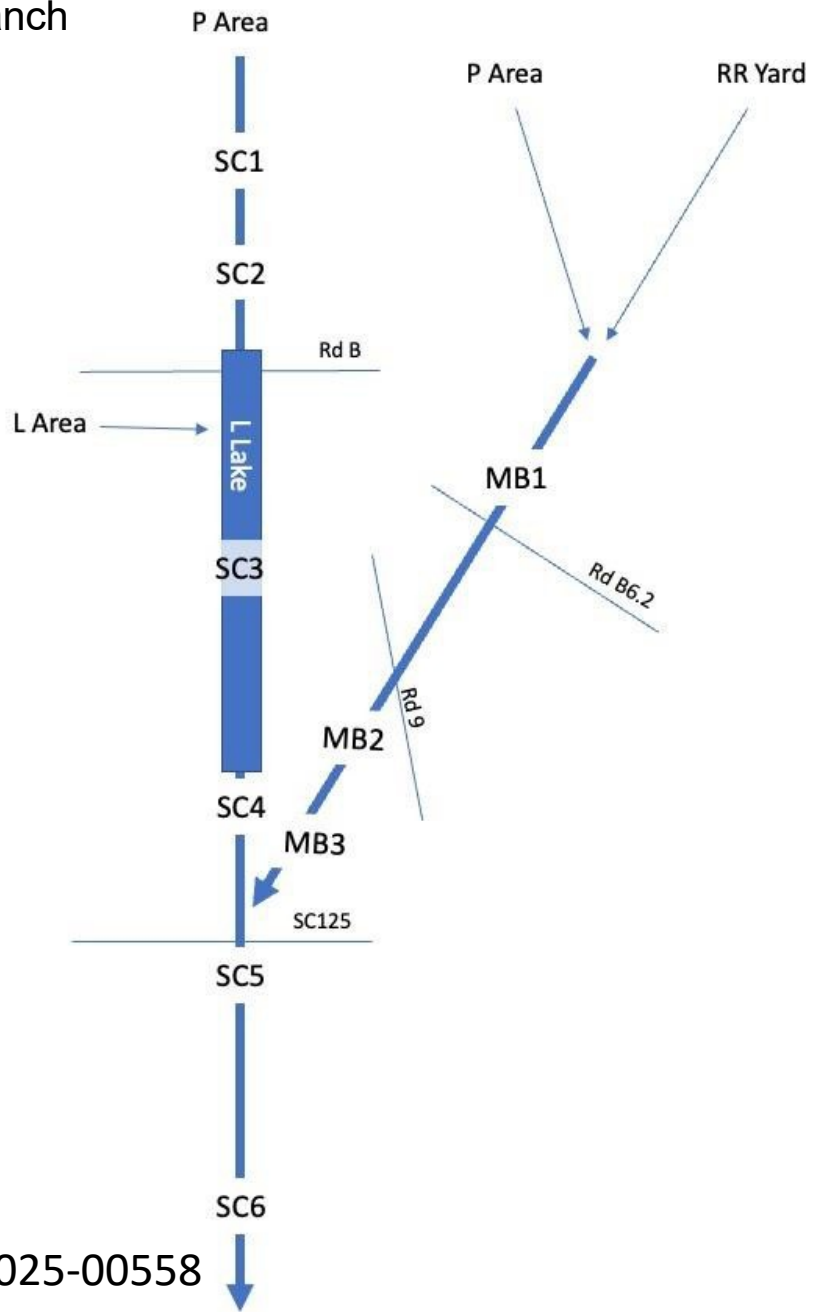


Figure 7. Scoping Summary

Meyers Branch

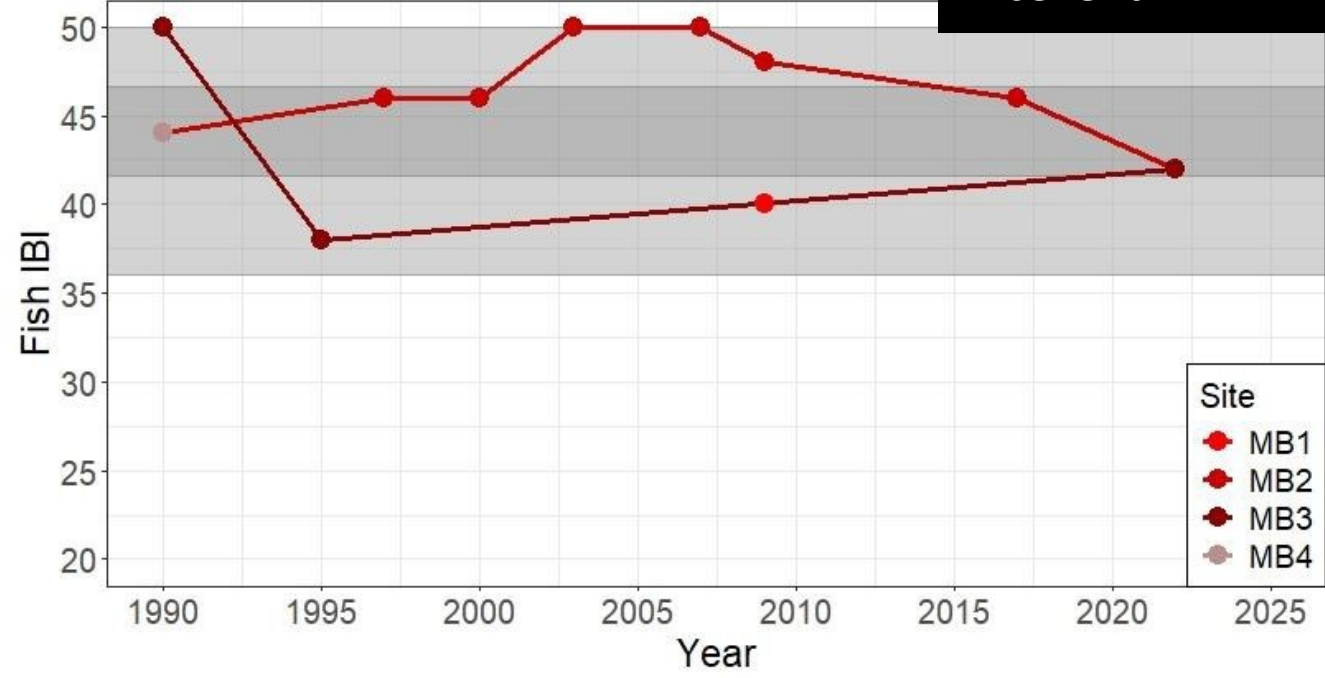


SRNS-STI-2025-00558

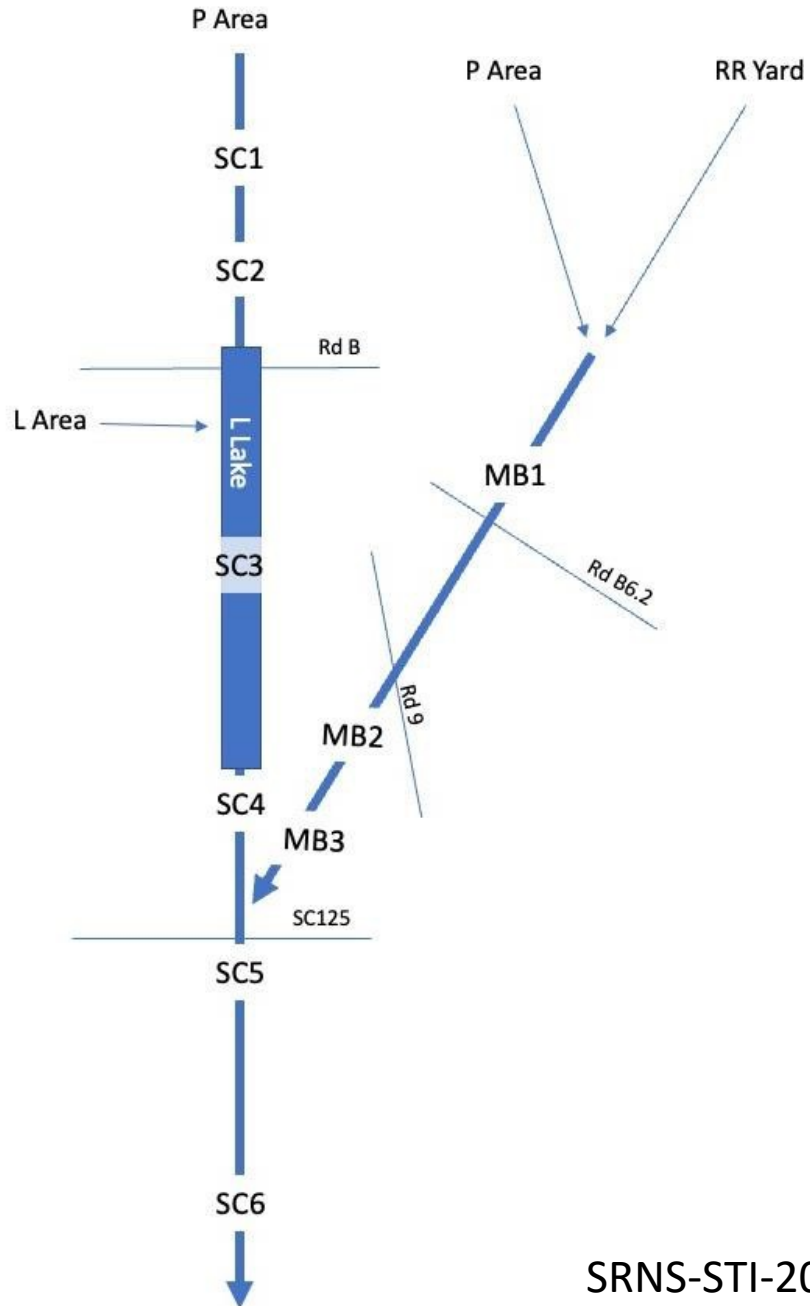
Meyers Branch

SC-MB; Downgradient

IBI Rating:
Excellent

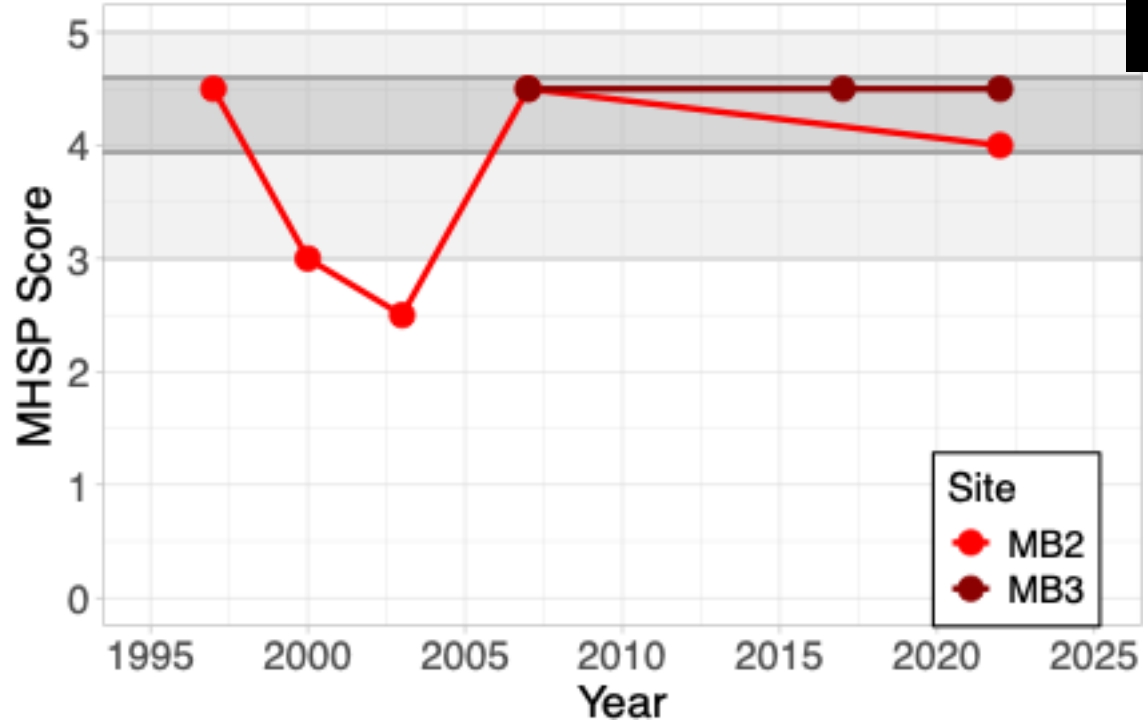


Meyers Branch



Meyers Branch

SC-MB; Downgradient

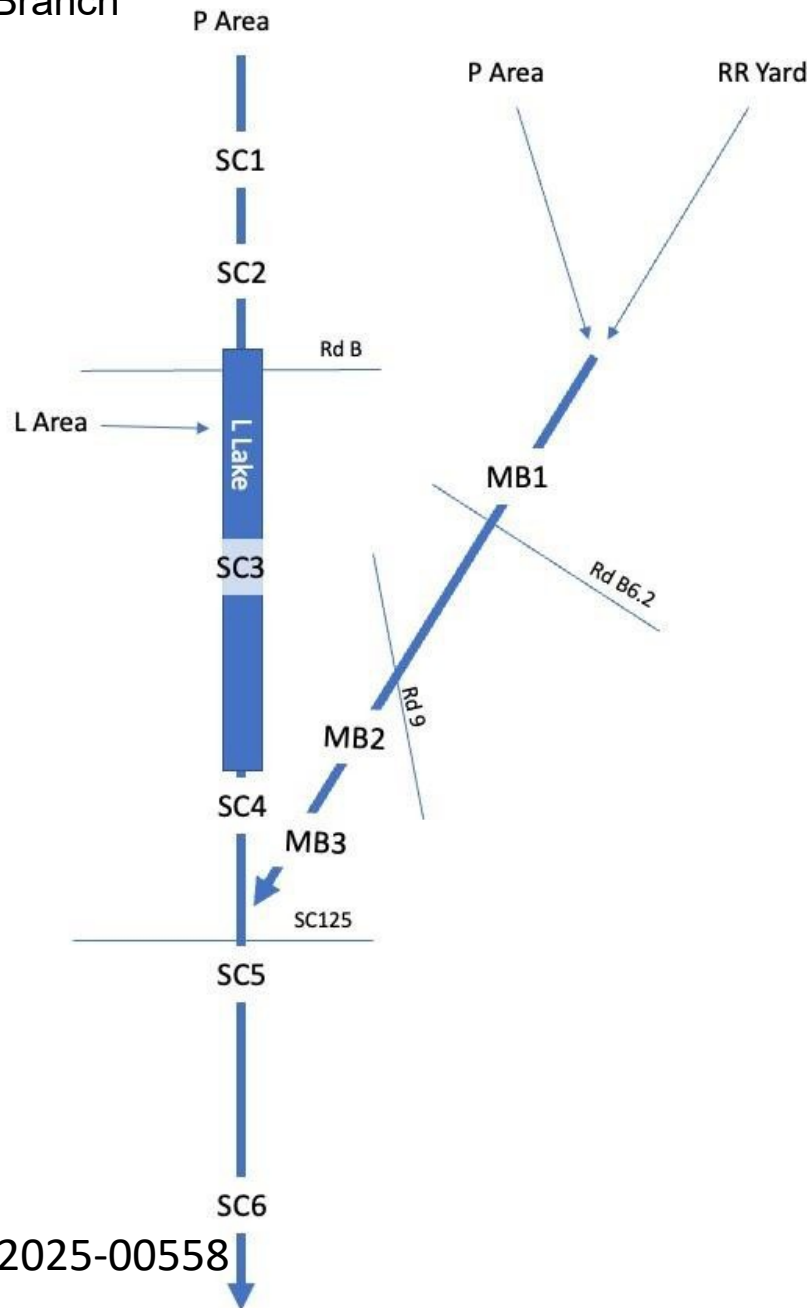


Bioclassifications:
Good
Excellent



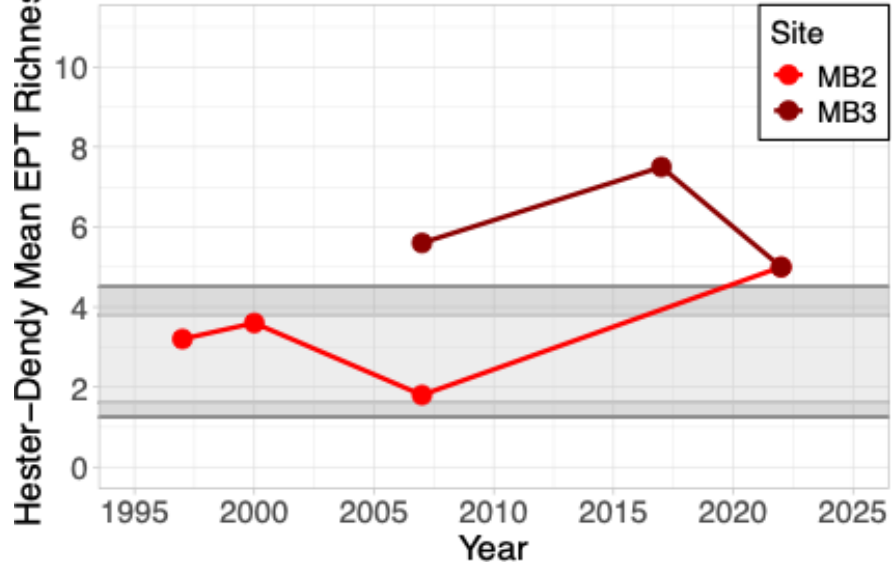
SRNS-STI-2025-00558

Meyers Branch



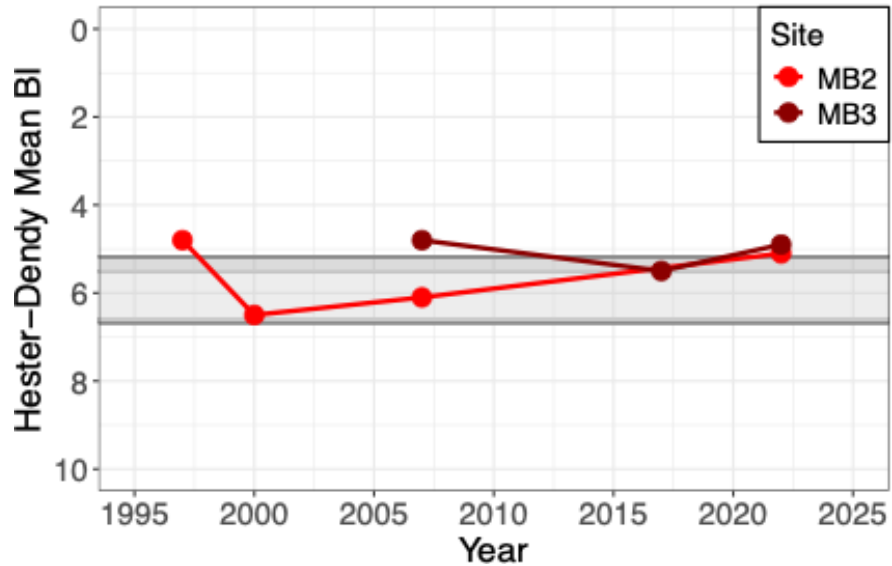
Meyers Branch

SC-MB; Downgradient



Meyers Branch

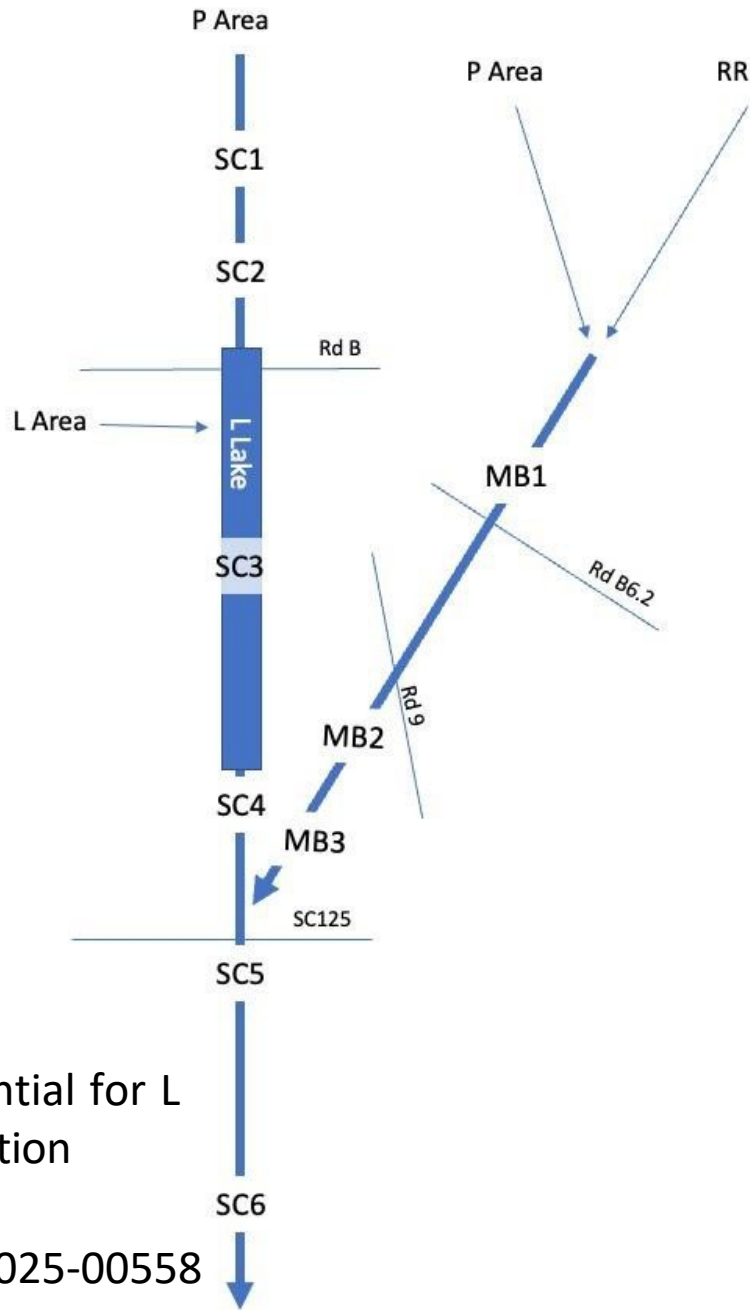
SC-MB; Downgradient



Bioclassifications:
Good-fair
Good-fair



Steel Creek



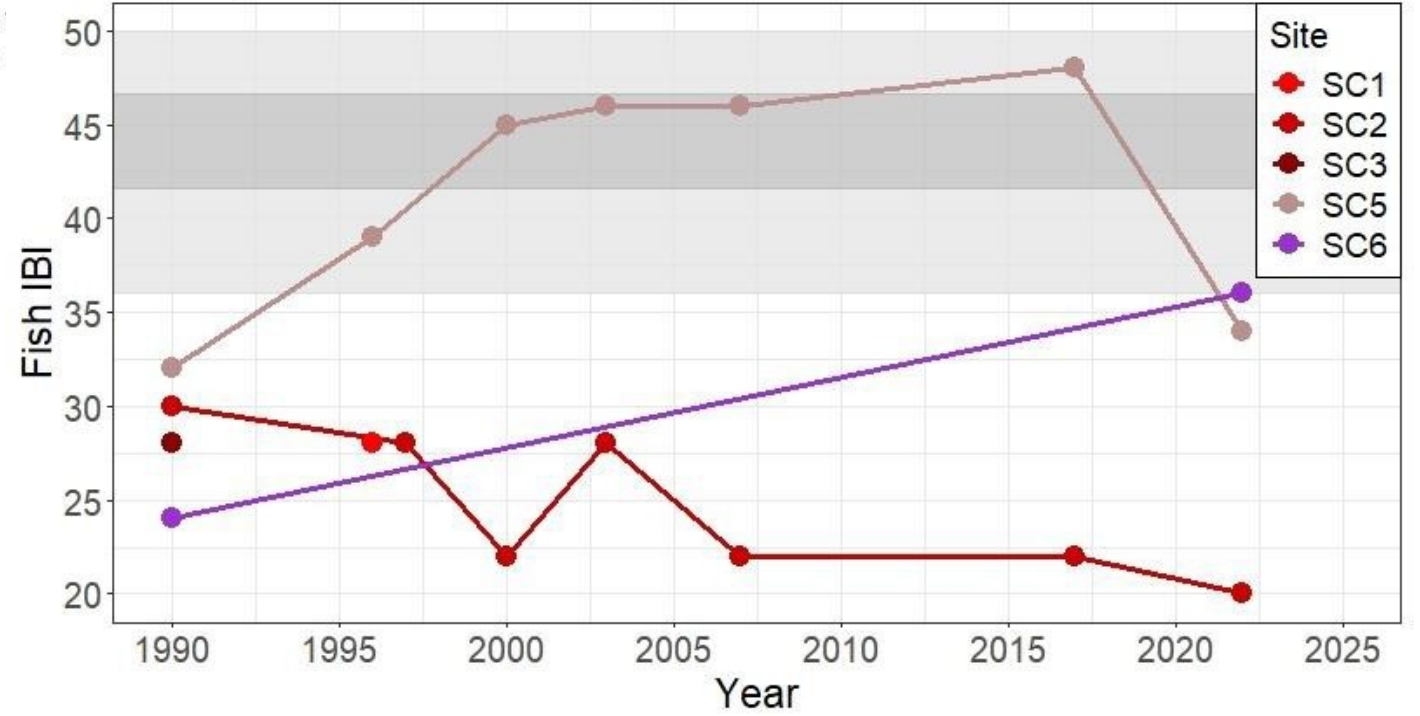
Note: Potential for L
Lake migration
barrier

SRNS-STI-2025-00558

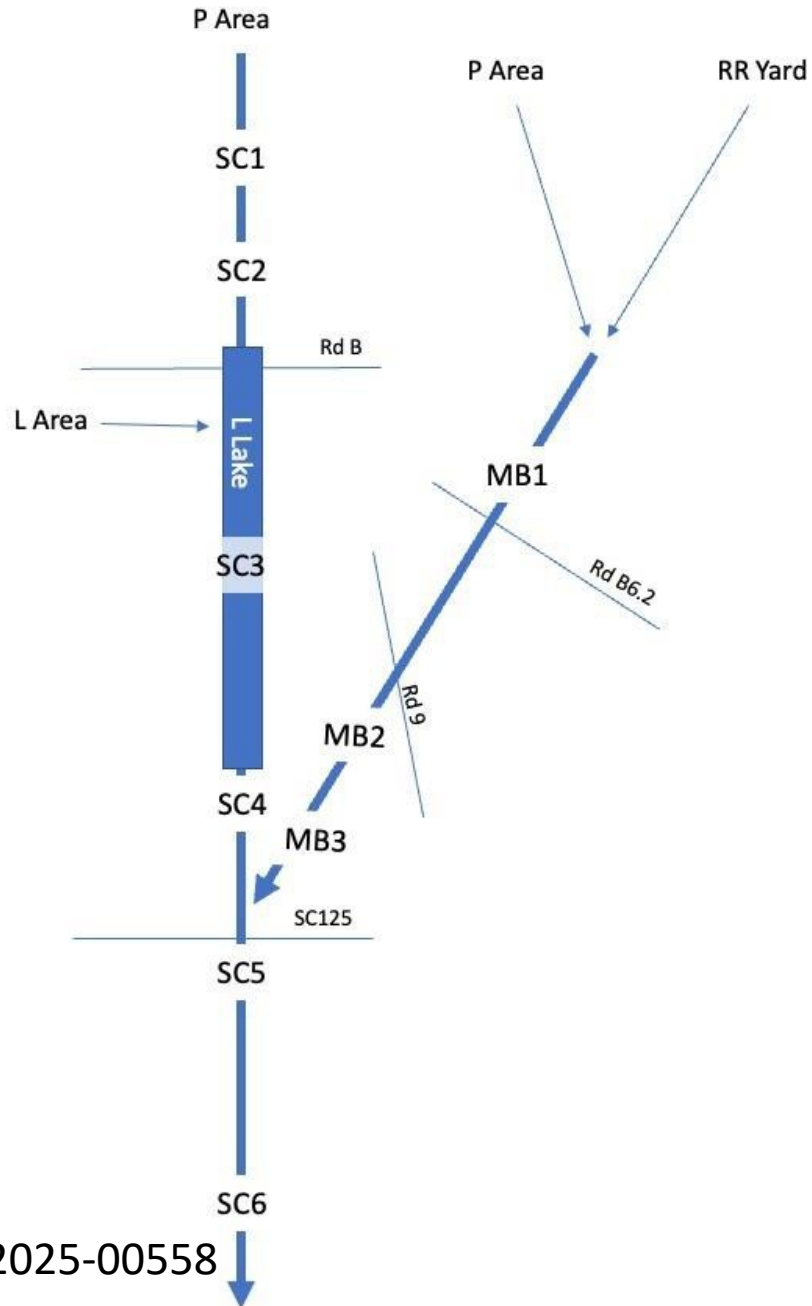
Steel Creek

SC; Downgradient = red, Lowest reaches = purple

IBI Rating:
Poor; Good

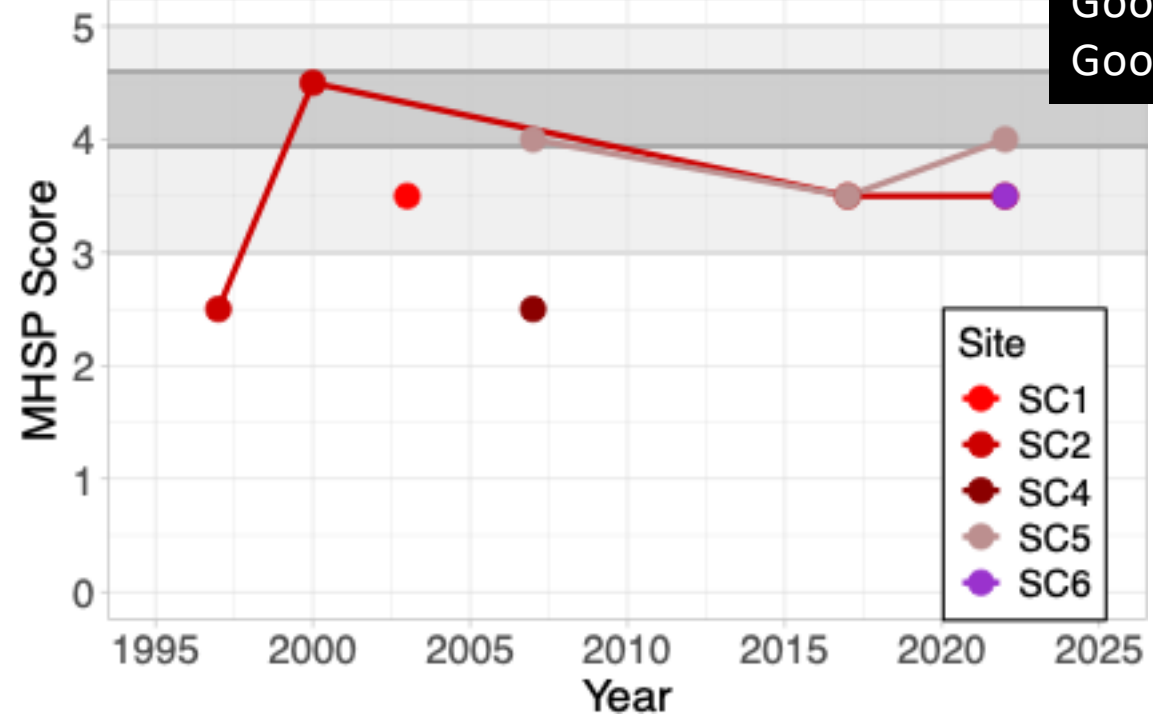


Steel Creek



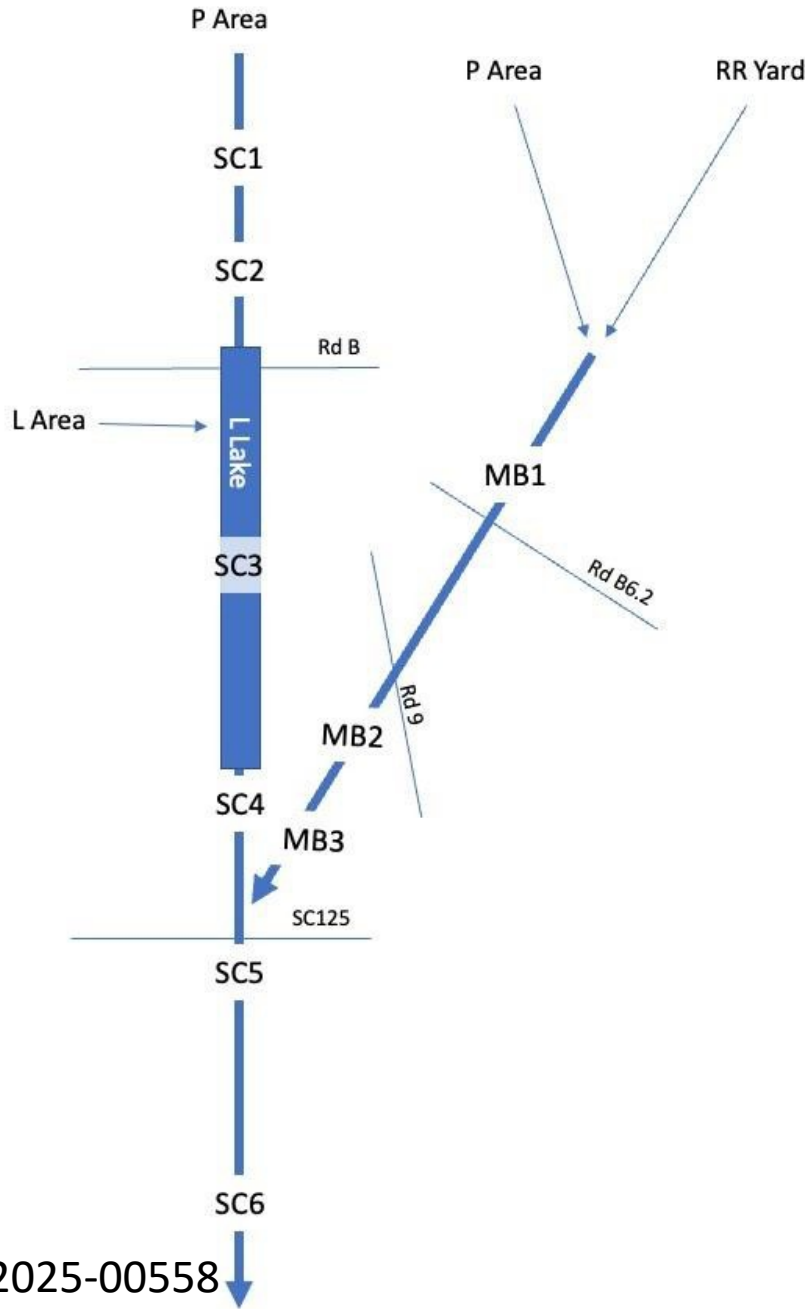
Steel Creek

SC; Downgradient = red, Lowest reaches = purple

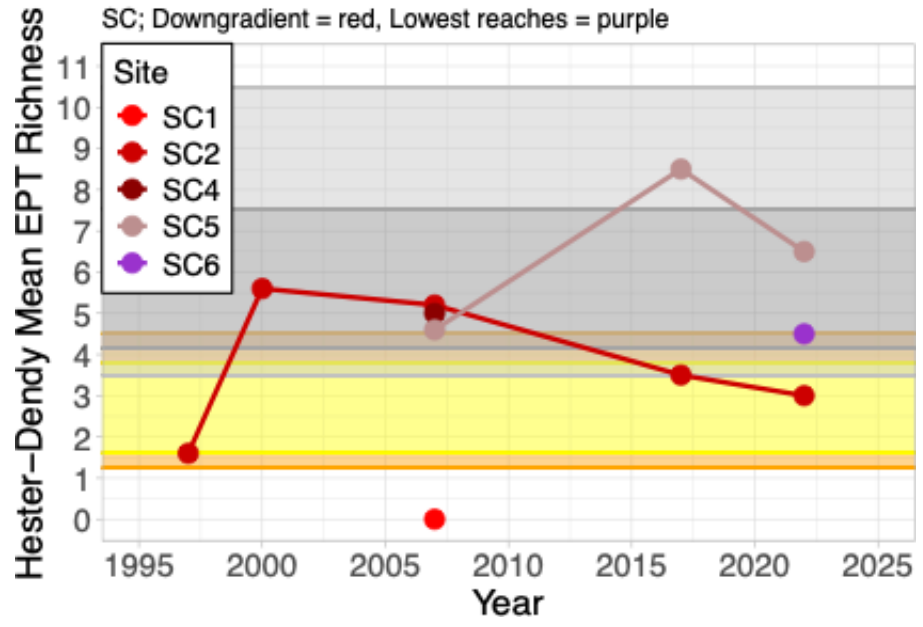


Bioclassifications:
 Good
 Good
 Good

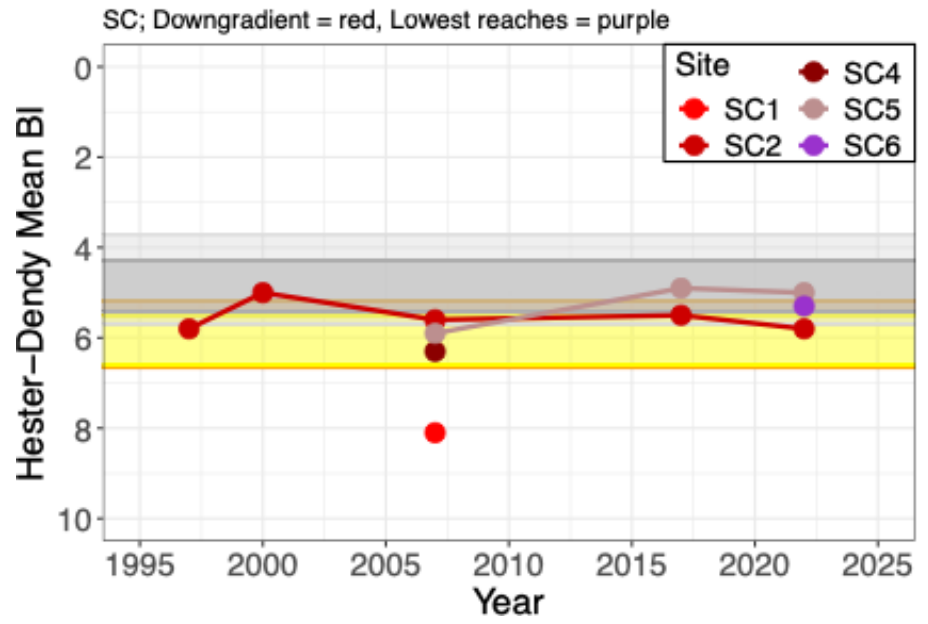




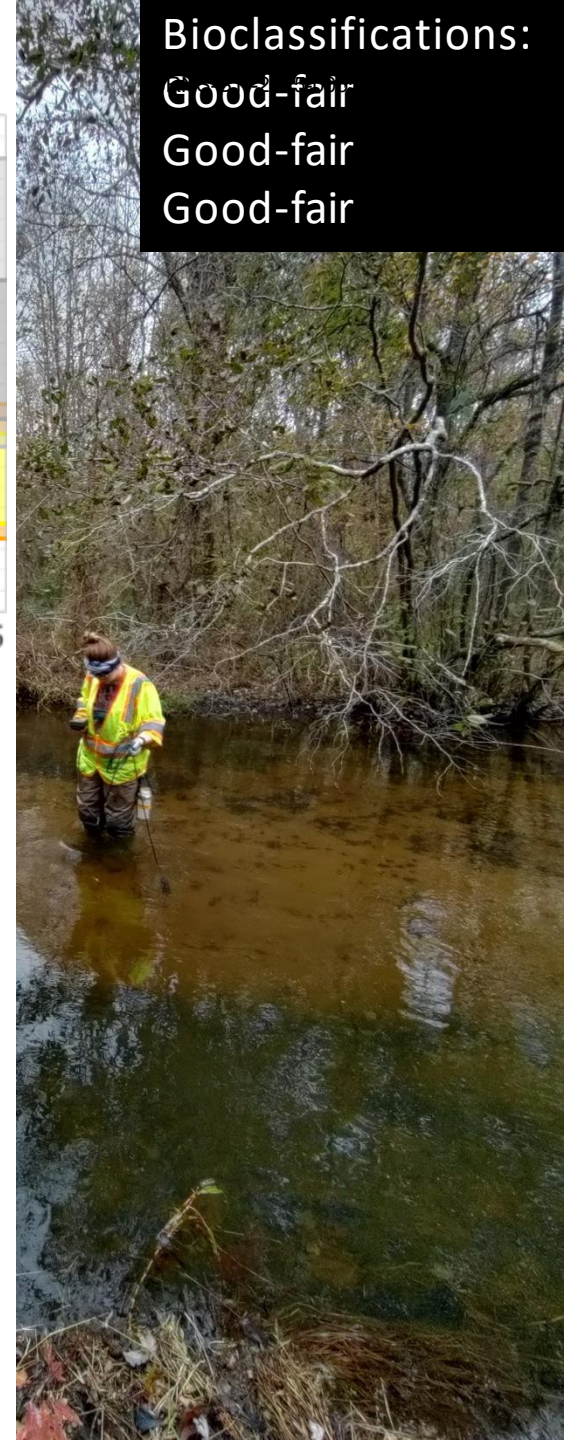
Steel Creek



Steel Creek

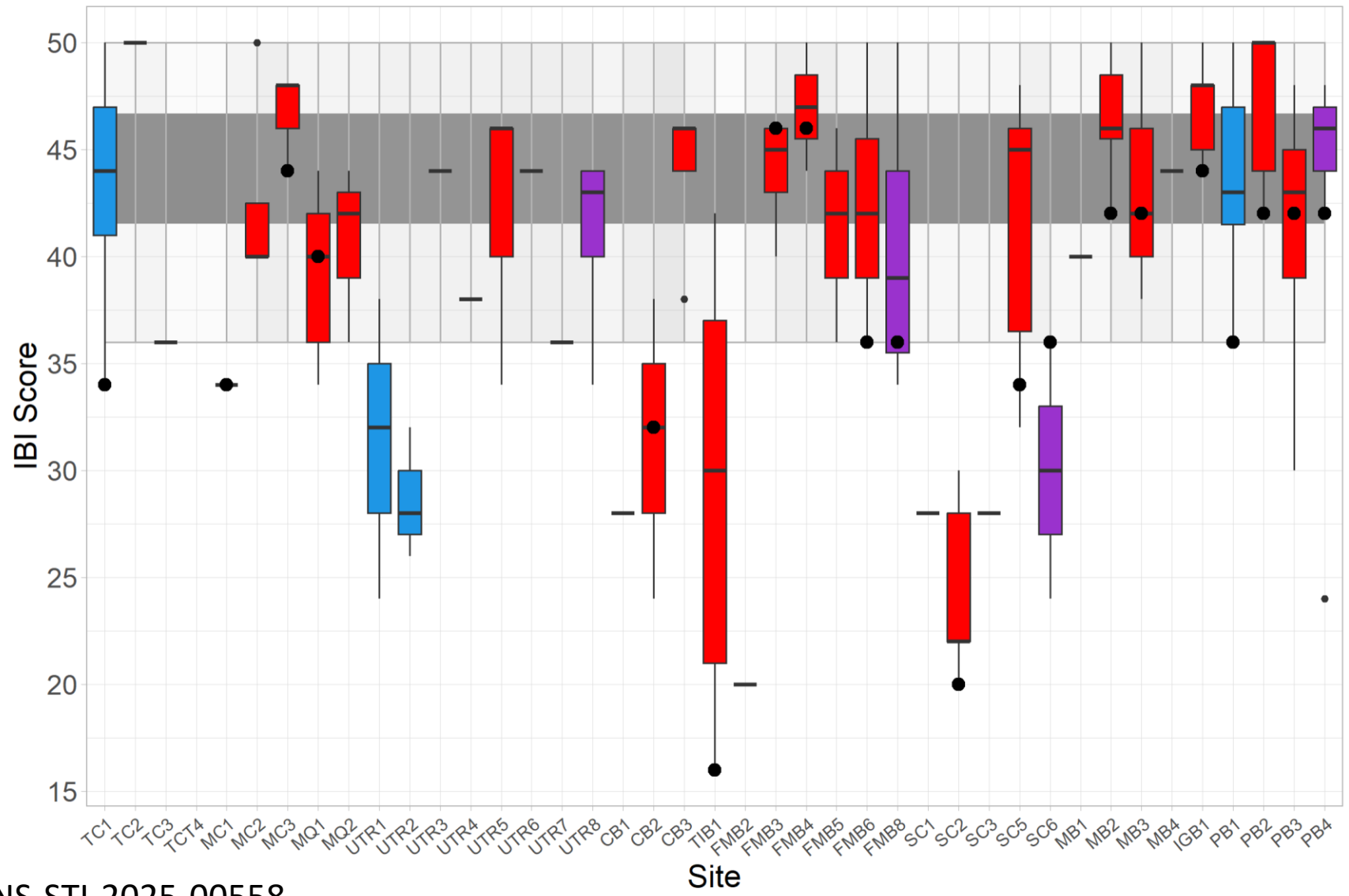


Bioclassifications:
 Good-fair
 Good-fair
 Good-fair



Fish IBI Values in SRS Streams

1990-2022



Site
Upgradient
Downgradient
Lowest Reaches
Year
● 2022

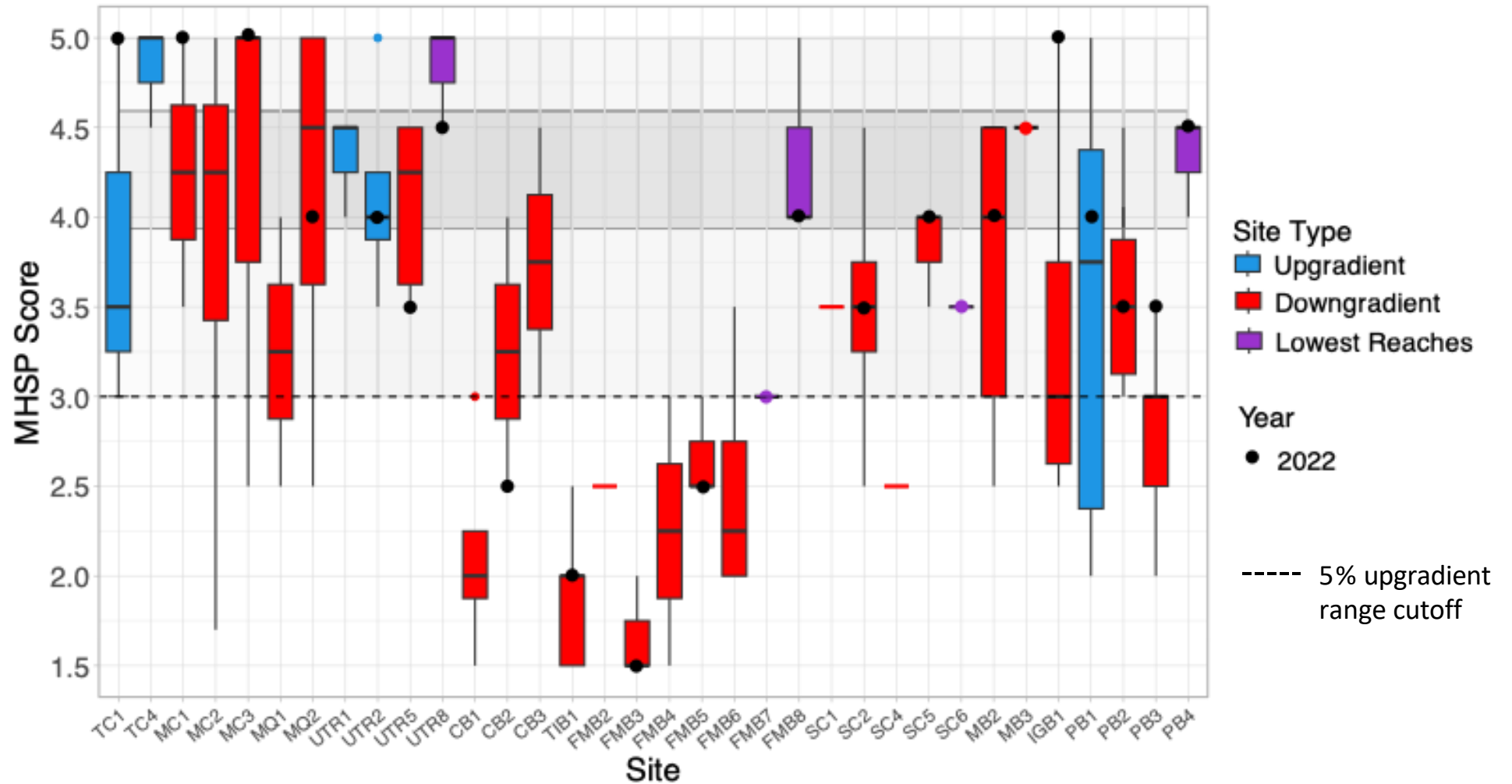
Dark Grey:
95% CI
Light Grey:
Upgradient Range

Tims and Fourmile Br. MHSP values (2017 & 2022) differed from upgradient streams

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Average MHSP Scores in SRS Streams

1997-2022



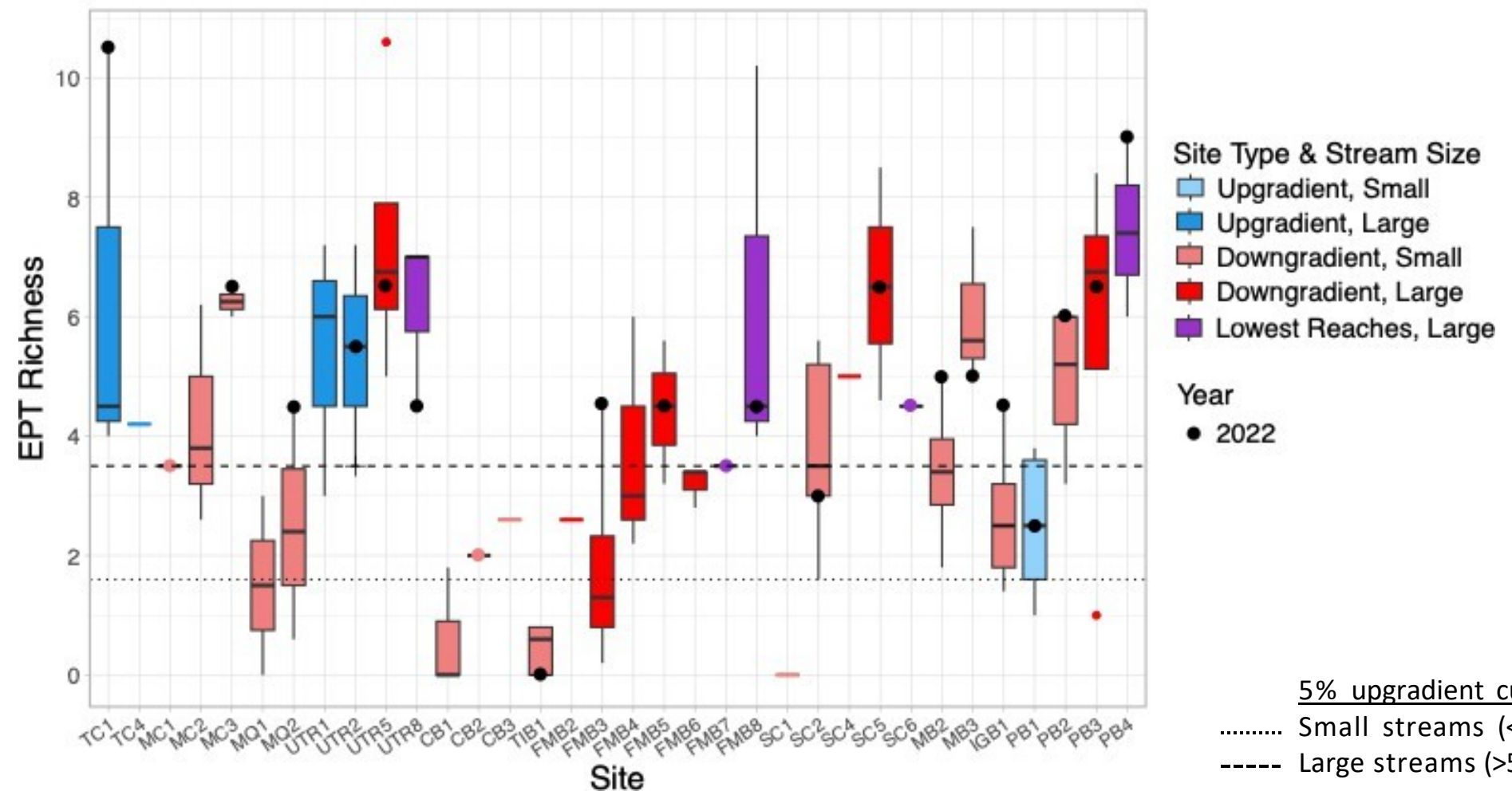
- 2022: Tims Branch (TIB1), Crouch Branch (CB2), and two sites on Fourmile Branch (FMB3*, FMB5*) fell below upgradient range

* FMB3, FMB5, FMB7 had fewer than 100 individuals per site

Tims Br.: Dunn's test, $n = 2$, z value = -2.962 , p adj. = 0.040
 Fourmile Br.: Dunn's test, $n = 4$, z value = -3.230 , p adj. = 0.017

No Hester-Dendy EPT values from 2017 & 2022 differed from the upgradient streams

Average Hester-Dendy EPT Richness in SRS Streams
1997-2022



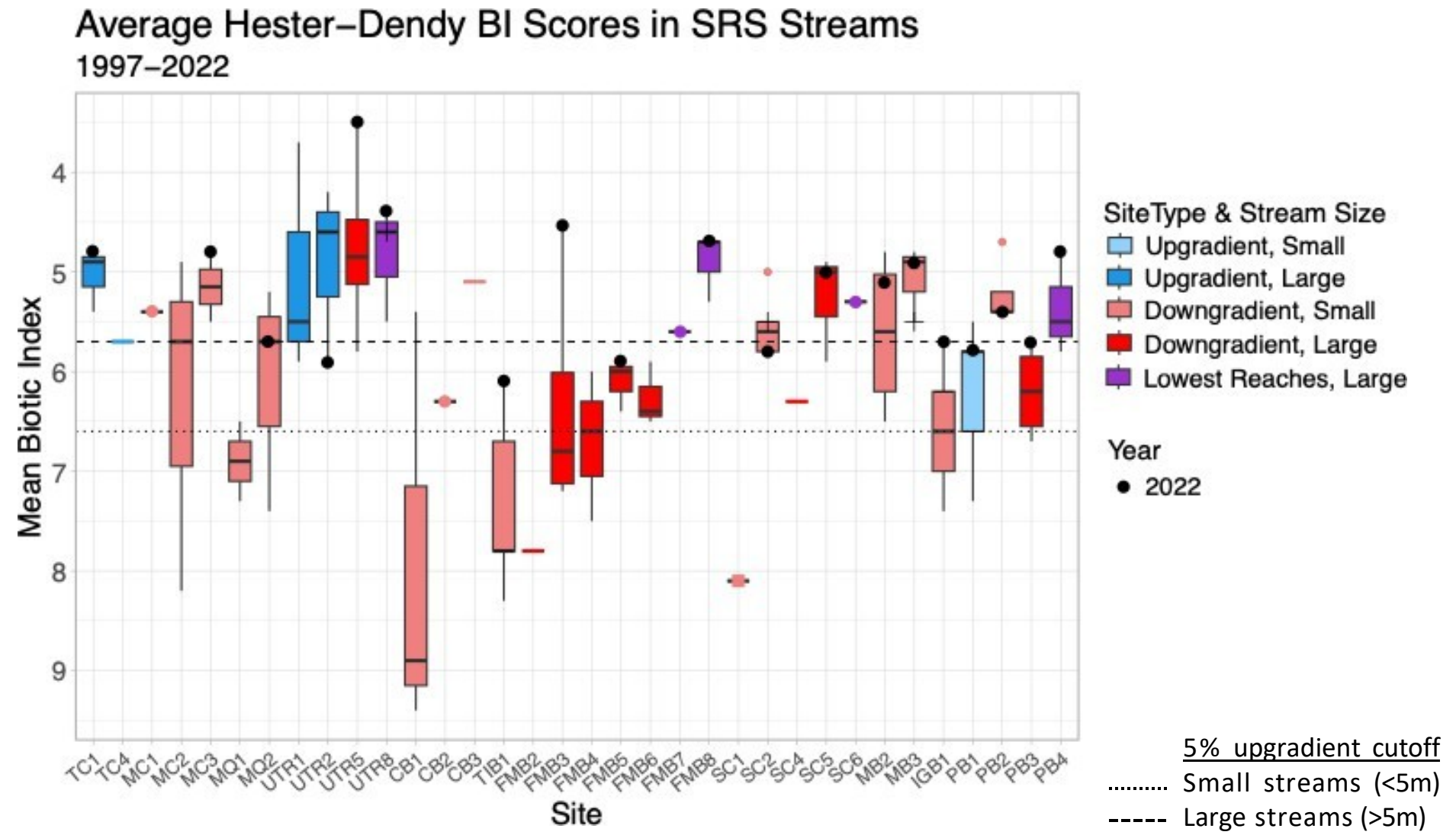
- 2022: Tims Branch (TIB1) had zero EPT; Fourmile Branch (FMB7) met lower upgradient range

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(small streams: Chi-square = 12.5, df = 8, $p = 0.129$; large streams: Chi-square = 8.9, df = 8, $p = 0.351$)

No Hester-Dendy BI values from 2017 & 2022 differed from the upgradient streams

- 2022: Fourmile Branch site (FMB5) & lower Pen Branch site (PB3) did not surpass upgradient threshold (5.7)



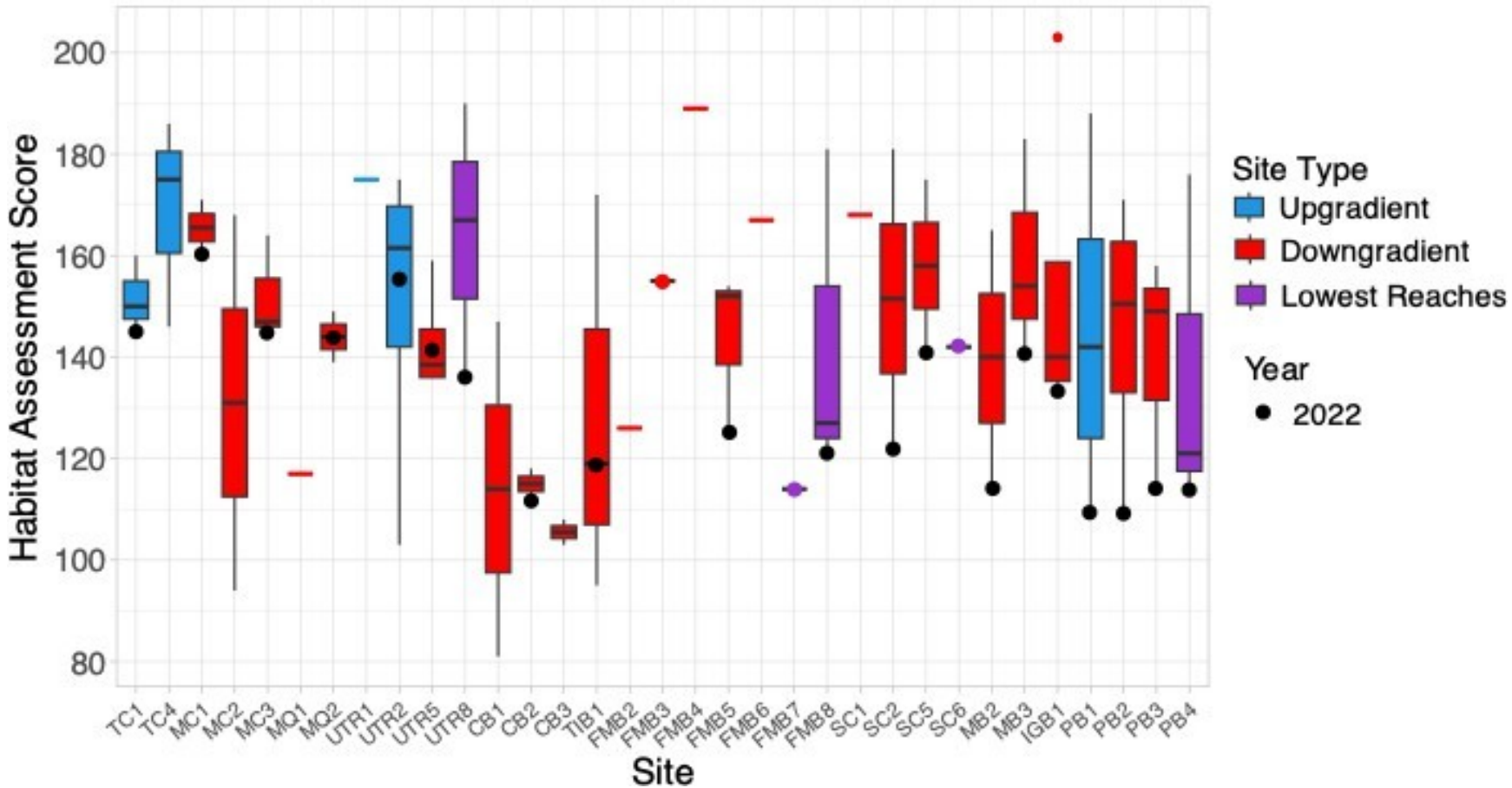
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(small streams: Chi-square = 13.4, df = 8, $p = 0.10$; large streams: Chi-square = 8.34, df = 8, $p = 0.401$)

Assessment scores from all pairwise comparisons differed except for 2003 vs 2007

EPA Low Gradient Stream Habitat Scores in SRS Streams

1997-2022



Difference in scores driven by:

- Vegetative protection

Also:

- Channel flow status & alteration
- Channel sinuosity
- Bank stability

Average scores:

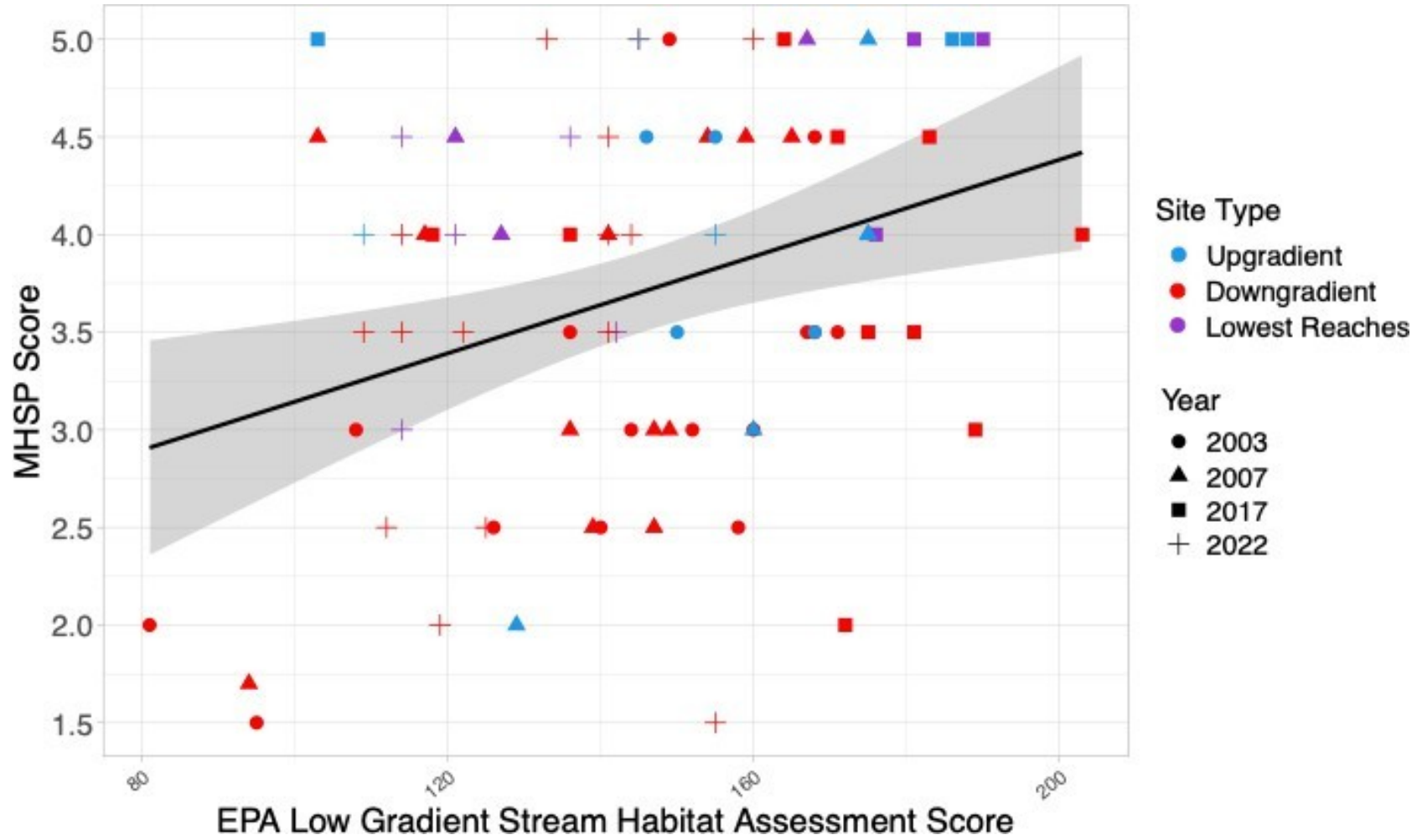
2022 (130 ± 3.4)

2017 (164 ± 7.5)

2007 144 (± 5.0)

2003 145 (± 5.4)

Habitat assessment scores correlated with only MHSP



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No correlations with only 2022 data

$S = 55,602, r = 0.30, p = 0.008$

Conclusions

- Many SRS streams have improved in biotic quality since the early 1990's



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ARF-025135
SRNS-STI-2025-00558

Conclusions

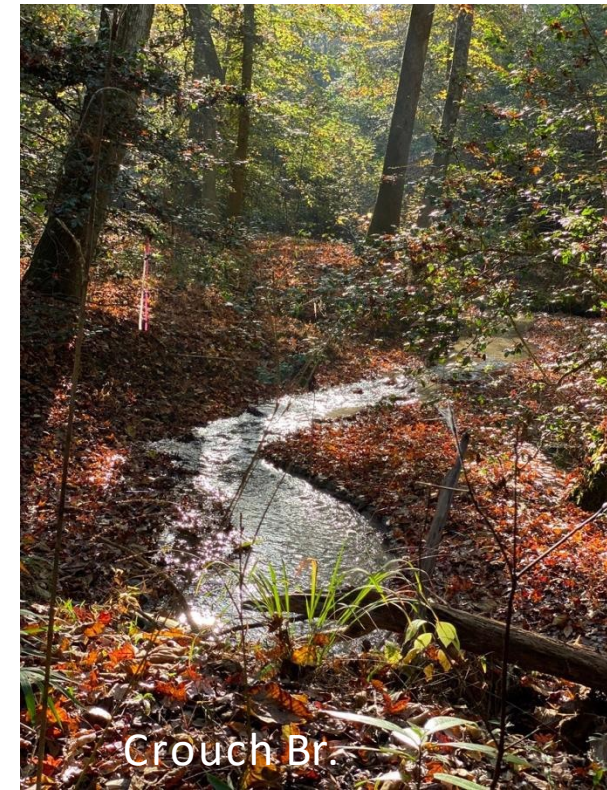
- Many SRS streams have improved in biotic quality since the early 1990's
- Tims Branch, upper Steel Creek, Crouch Branch, and Fourmile Branch indicated impairment based on fish indices, macroinvertebrate indices, or both
 - Tims Branch: poor habitat quality may be the main driver
 - Upper Steel Creek: L Lake may be a barrier to fish colonization
 - Crouch Branch: habitat instability may be the main driver
 - Fourmile Branch: impairment reflected in macroinvertebrates but shows trajectory of improvement



Tims Branch

Future Work

- Meyers Branch, McQueen Branch, and Crouch Branch interpretations would be improved with additional and consistent samples



Future Work

- Meyers Branch, McQueen Branch, and Crouch Branch interpretations would be improved with additional and consistent samples
- Additional upgradient sample locations would strengthen the confidence of biotic recovery targets
 - Potential for Mill Creek, Meyers Branch, and Tinker Creek tributaries to provide additional upgradient sites

Future Work

- Meyers Branch, McQueen Branch, and Crouch Branch interpretations would be improved with additional and consistent samples
- Additional upgradient sample locations would strengthen the confidence of biotic recovery targets
- Fish metrics that consider the distribution, ecology, and conservation value of species

Future Work

- Meyers Branch, McQueen Branch, and Crouch Branch interpretations would be improved with additional and consistent samples
- Additional upgradient sample locations would strengthen the confidence of biotic recovery targets
- Fish metrics that consider the distribution, ecology, and conservation value of species
- **Modifications to standardize macroinvertebrate sampling**

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- McKenzie Cromer
- Tucker Stonecypher
- Adam McFall
- Kelly Holland
- Elise Webb
- Jon Skaggs
- Padraic Robinson
- Carson Pakula
- Vienna Cartwright
- Chris Smaga
- Cody Whitlock
- Ezmie Trevarrow



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SRNS-STI-2025-00558

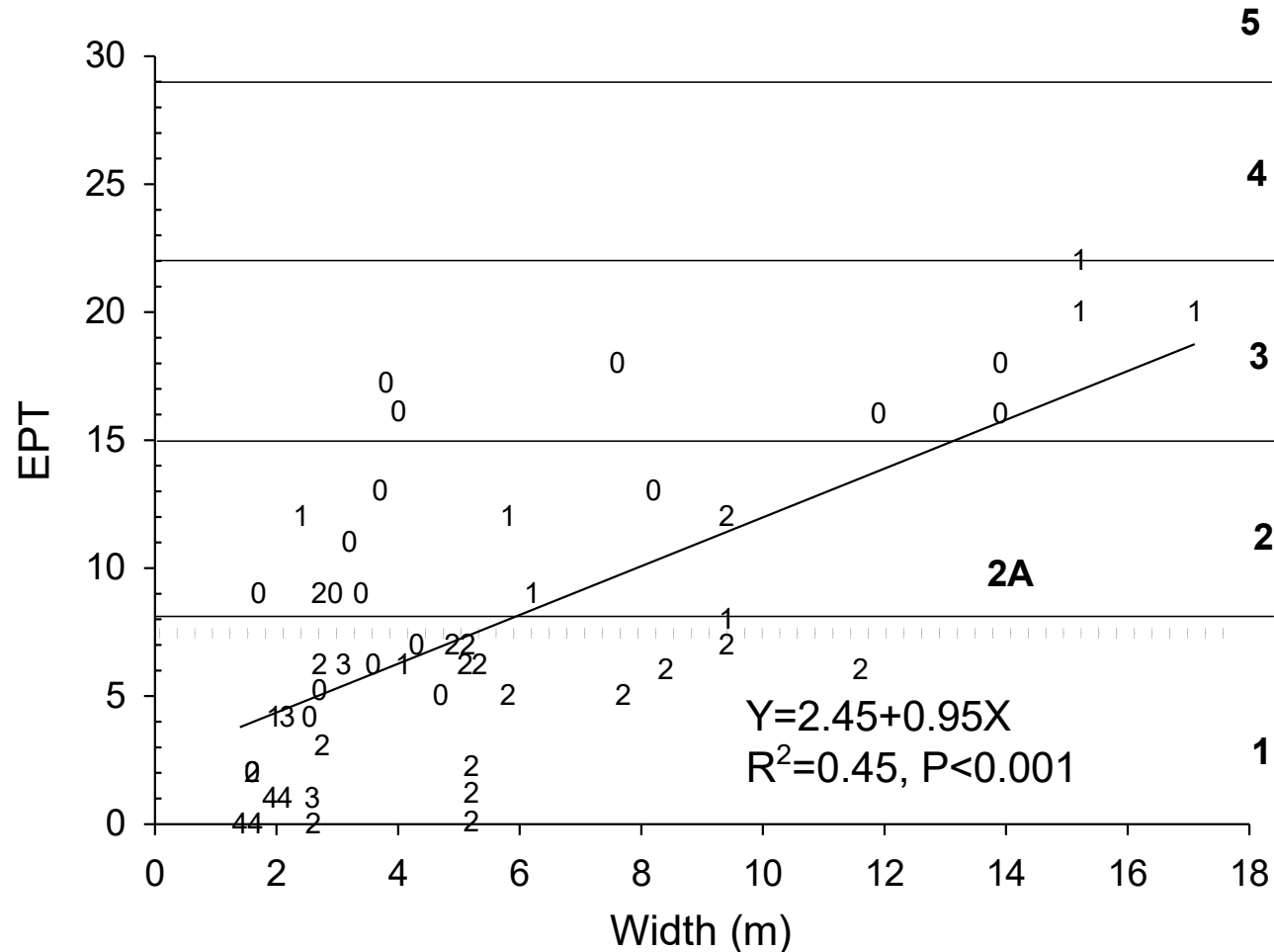


**Savannah River
Ecology Laboratory**
UNIVERSITY OF GEORGIA

2022 Samples: Macroinverts MHSP

- Stream width corrections

Regression of EPT on stream width.
 Dotted line represents the average EPT for all sites.
 Taken from Paller et al. (2007).



Unadjusted MHSP scores for EPT (SCDHEC 1998)

2022 Samples: Macroinverts MHSP

- Stream width corrections

Distribution of EPT residuals (derived from the regression of EPT on stream width) divided into five scoring intervals after excluding the upper 5% (shown by dashed line).

Taken from Paller et al. (2007).

