CORRELATING SPECIES DIVERSITY, TAXA TRAITS AND STREAM HABITAT QUALITY TO BETTER INFORM RESTORATION PRACTICES

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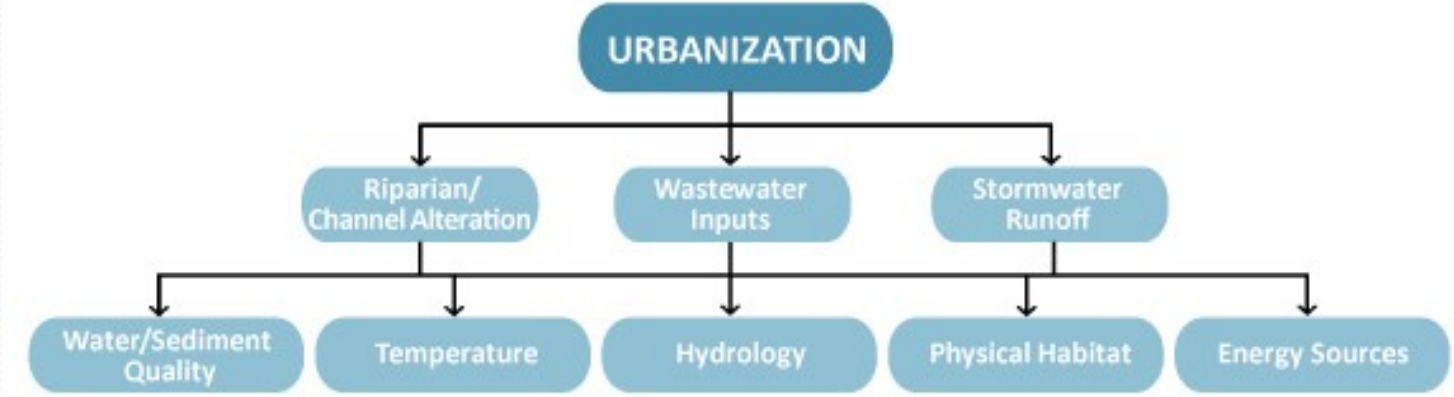
25 YEARS Charlotte-Mecklenburg STORM WATER Services

UNC CHARLOTTE

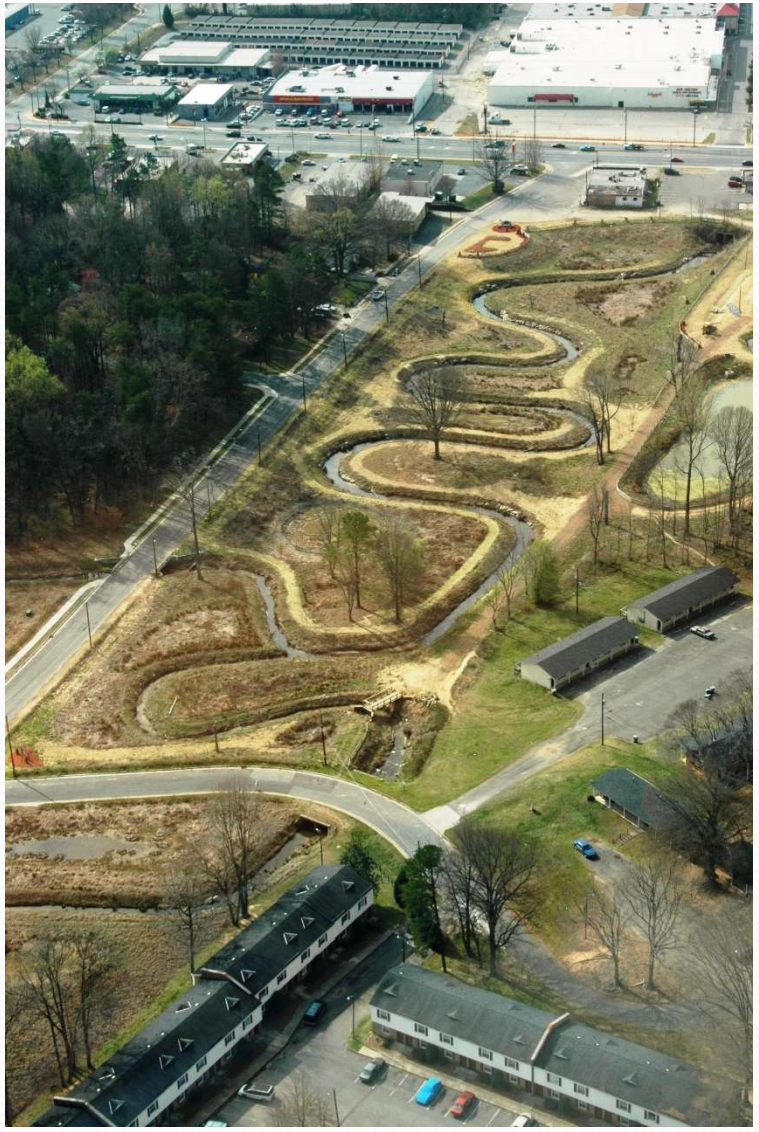
Introduction

- Stream habitat quality and benthic macroinvertebrate community diversity are negatively impacted by urbanization – Urban Stream Syndrome



Introduction

- Watershed managers respond to urban stream degradation by repairing degraded streams using stream restoration techniques;
- However most natural channel design approaches do not result in an uplift of the benthic macroinvertebrate community diversity and function.



Little Sugar Creek – Hidden Valley – Mecklenburg County SWS

Introduction – Study Objectives

- Benthic macroinvertebrate taxa richness has been shown to increase with habitat complexity. The diversity of taxa traits is expected to reflect the diversity of microhabitats in the stream channel.

- This study examines the relationship between stream habitat quality and benthic macroinvertebrate community diversity and function by:

  - Evaluating 30 streams in the Piedmont, North Carolina, spanning a gradient of excellent to poor habitat
  - Examining how taxa and taxa traits are correlated to in-stream microhabitats

Introduction – Taxa Traits

- Taxa traits - characteristics unique to each taxa (genus or species) reflecting their position in the stream ecosystem.

- Taxa traits have been used to:
  - characterize the functional composition of benthic macroinvertebrate communities
  - predict changes in species assemblages within a biological community along environmental gradients in terms of traits that are sensitive to local environmental conditions.

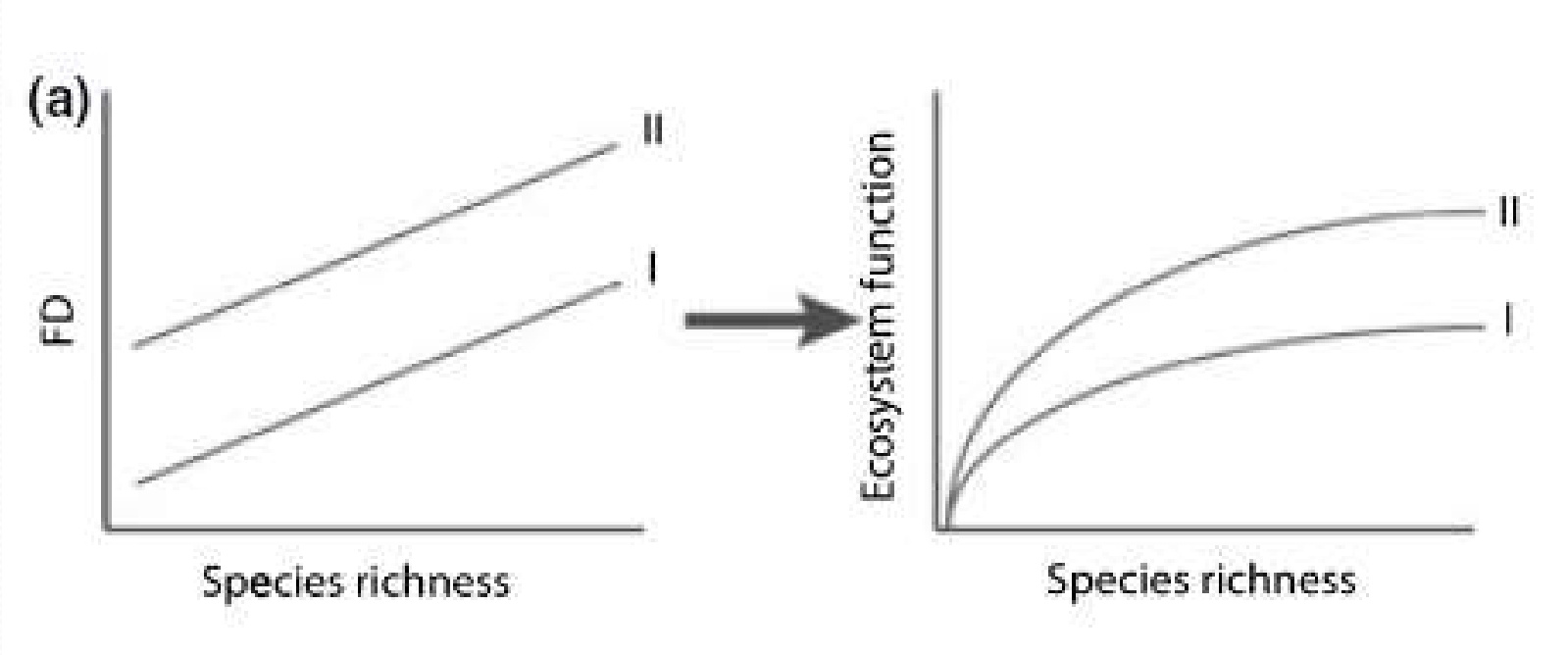
- Trait categories include:
  - Life History – rate of development, adult life span
  - Mobility – crawling rate, swimming ability, flying strength
  - Morphology – shape, size, respiration strategy
  - Ecology – feeding, thermal, habit preferences

Biodiversity and Stream Function

- *Biodiversity* is a measure of the variety of organisms present in different ecosystems. In streams – *Taxa Richness*

- *Ecosystem Function* refers to the structural components of an ecosystem, such as vegetation, water, soil, atmosphere and biota, and how they interact with each other, within ecosystems and across ecosystems. In streams – *Taxa Traits*

Biodiversity and Stream Function



Cadotte et al. 2011

- Functional Diversity has been shown to be correlated to Species Richness (Biodiversity) in plant communities
- Threats to Biodiversity in streams include pollution and habitat impairment that are often the result of urbanization

Stream Habitat Assessment

- Mecklenburg Habitat Assessment Protocol (MHAP) – used to assess stream habitat quality at each site.
- MHAP based on EPA Rapid Bioassessment Stream Assessment Protocol (score 0 – 200)

Mecklenburg County Stream Habitat Assessment Protocol (MHAP)

MHAP Stream Parameter	Stream Condition Measured
1. Instream Cover	Diversity of microhabitats
2. Epifaunal Substrate	Riffle condition
3. Embeddedness	Degree to which substrate impacted by sediment
4. Channel Alteration	Man made changes to the stream channel
5. Sediment Deposition	Deposition of sediment and formation of sand bars
6. Frequency of Riffles	Estimation of the frequency of riffles in sample reach
7. Channel Flow Status	Estimation of flow status
8. Bank Vegetative Protection (Left/Right Bank)	Estimation of amount of stream bank vegetation cover
9. Bank Stability (Left/Right Bank)	Estimation of amount of unstable stream bank present
10. Vegetated Buffer Zone Width (Left/Right Bank)	Estimation of riparian buffer width and condition

Benthic Macroinvertebrate Sampling Techniques

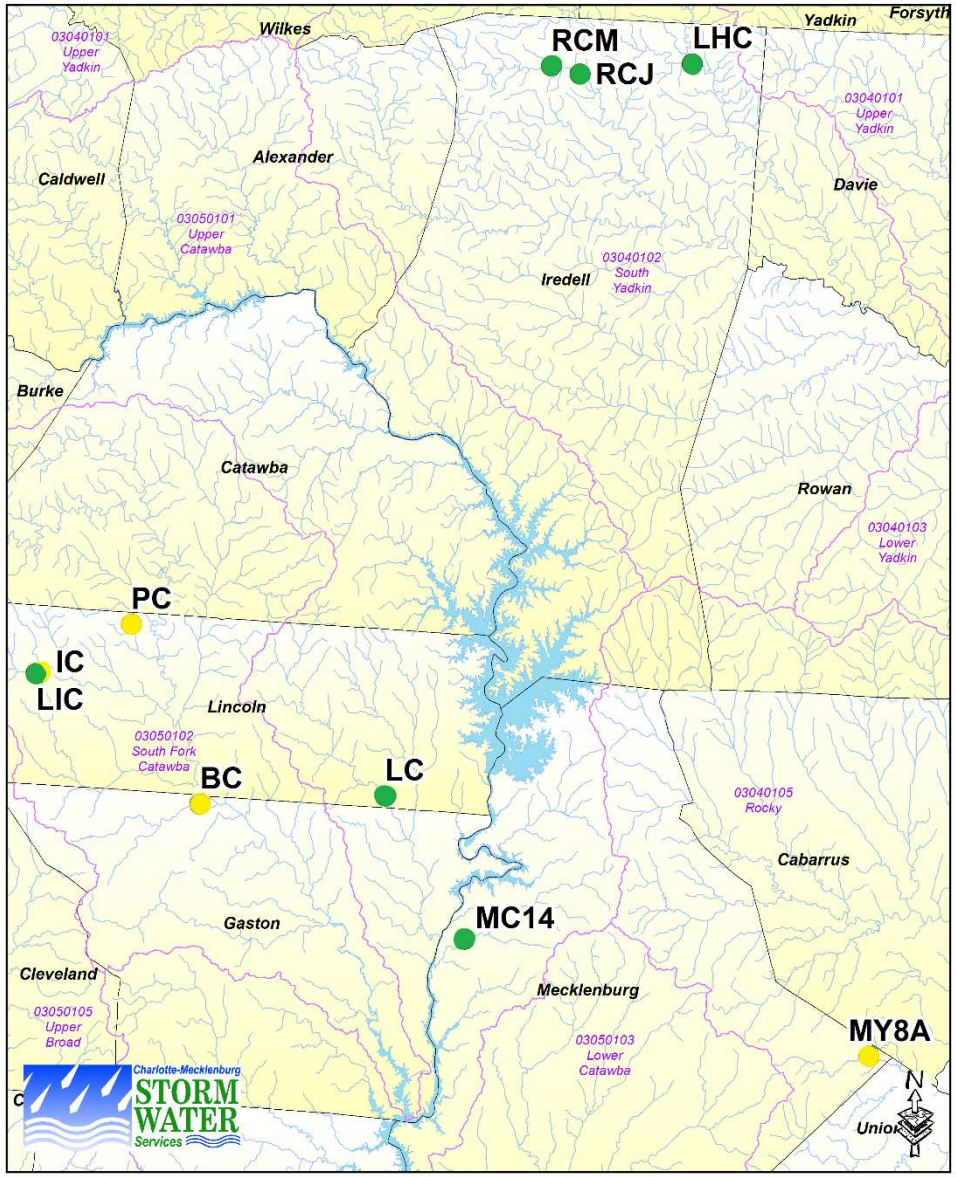
- Collected benthic macroinvertebrates using Standard Qualitative Method developed by North Carolina Division of Water Resources Biological Assessment Unit
- In the 10 streams with Good MHAP scores, benthic macroinvertebrates were collected quantitatively from 8 microhabitats, including riffles, root wads, undercut banks, woody debris, leaf packs, backwater, sandy and macrophyte bed areas to correlate taxa and taxa ecological traits with each microhabitat

Study Sites

- Urban stream watersheds that span a gradient of MHAP Scores:
  - Supporting (>160; green)
  - Partially Supporting (110-159; yellow)
  - Impaired (60-109; Red)
  - Degraded (<60; Orange)

- Rural stream watersheds north and west of Mecklenburg County:
  - Supporting and Partially Supporting

Stream Bioassessment Reference Sites

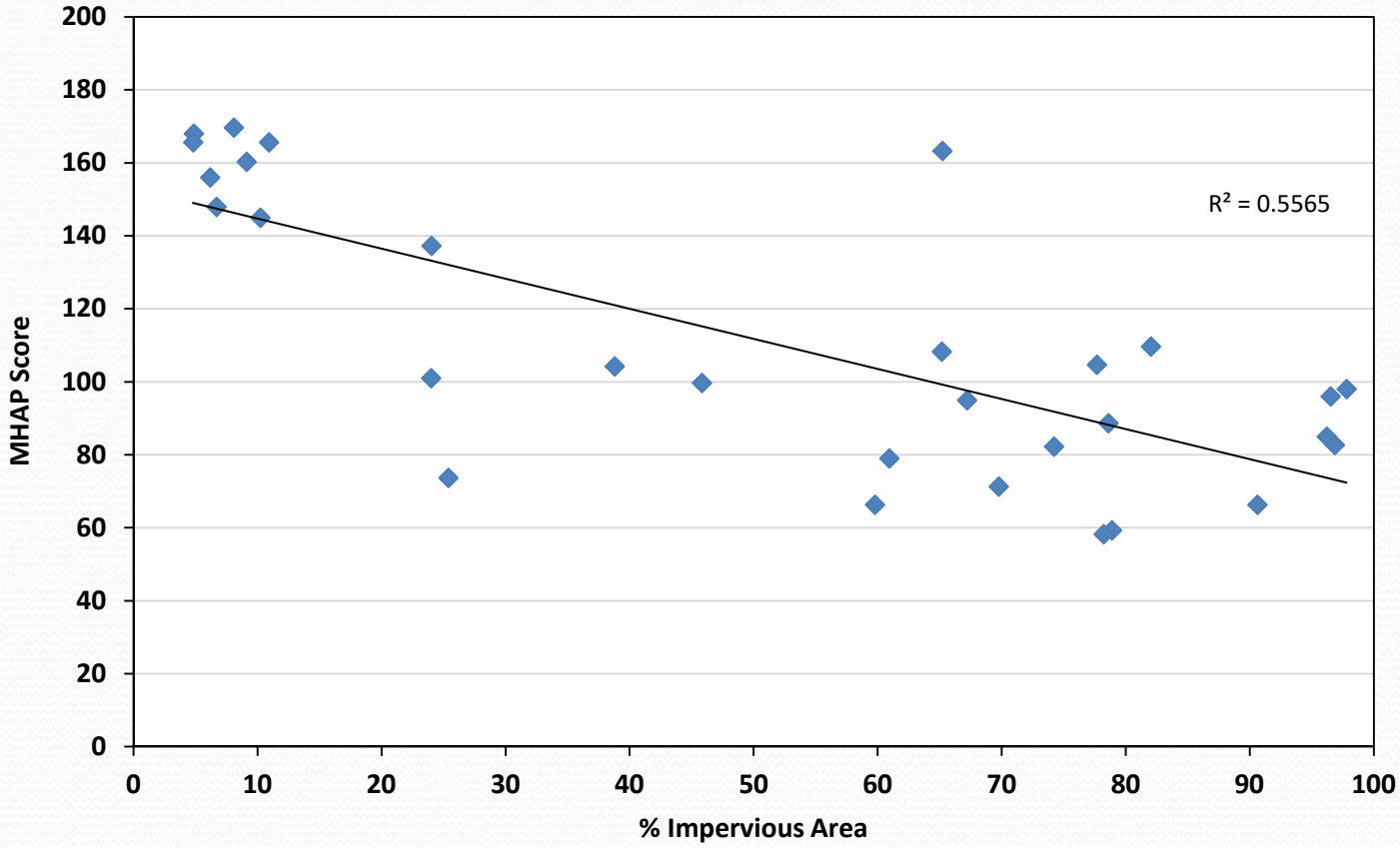


Rocky Creek - MHAP: 168 EPT: 37

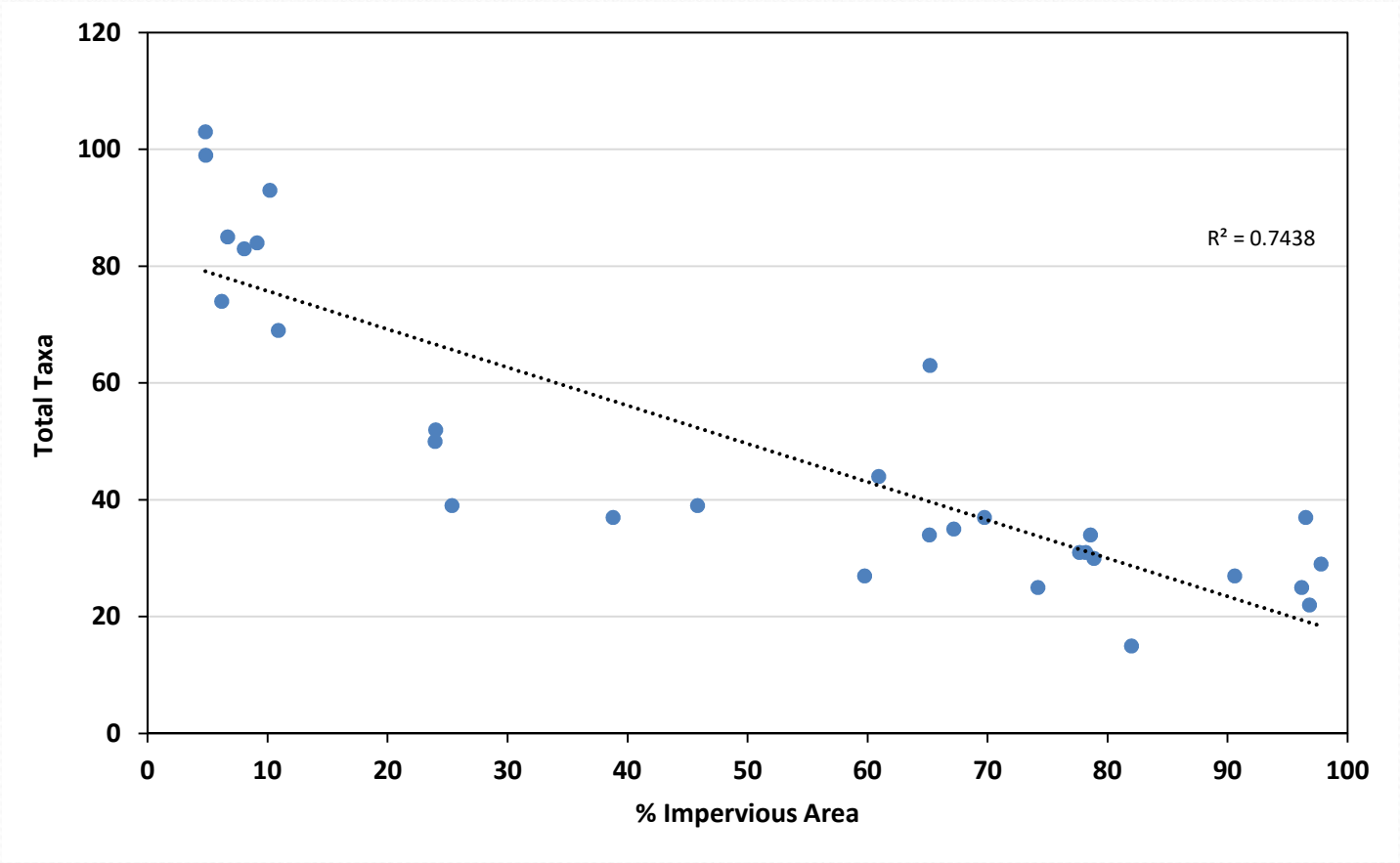
Steele Creek - MHAP: 104.7 EPT: 7

Paw Creek - MHAP: 58.3 EPT: 5

Results – Relationship Between % Impervious Area and Stream Habitat Assessments (MHAP)



Results – Relationship Between Total Taxa Richness and % Impervious Area



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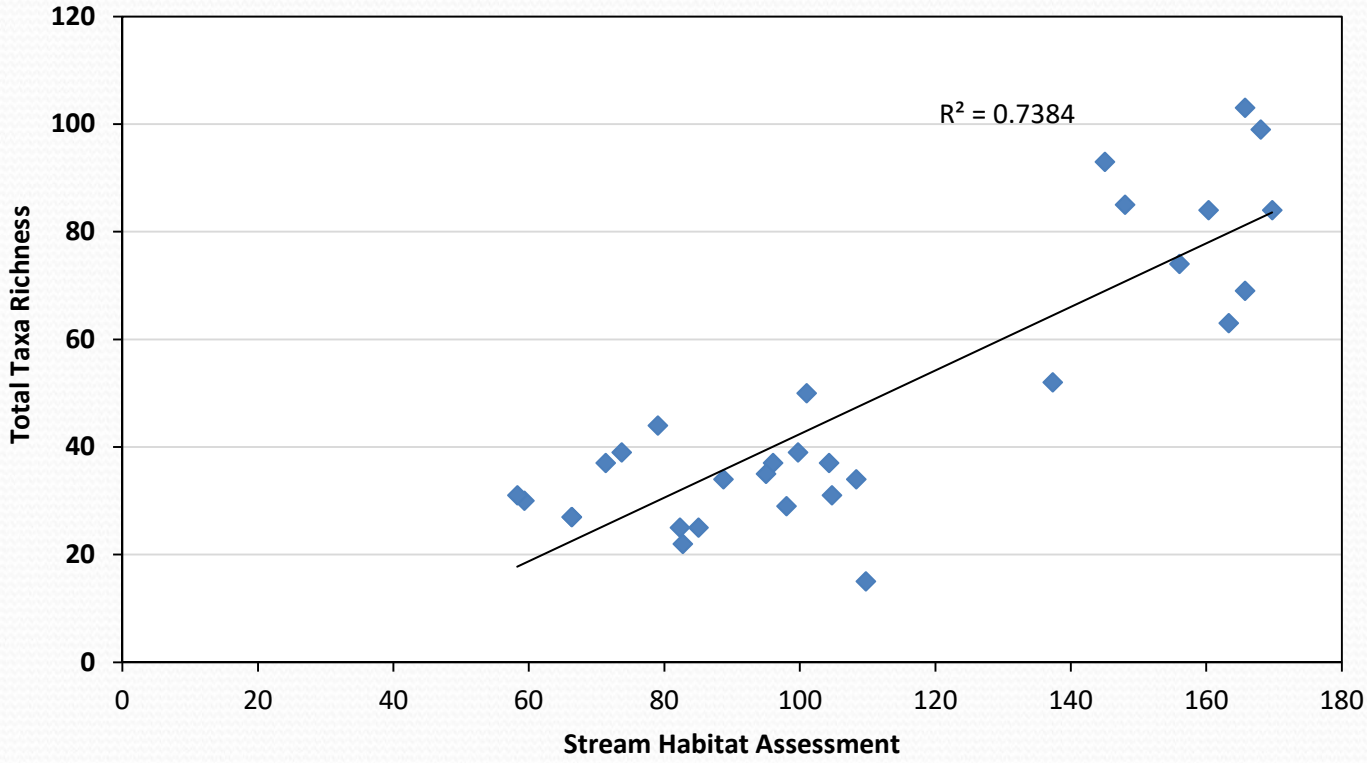


Results – Analysis of Similarity of Functional Feeding Groups Within Microhabitats in Streams with Good Habitat Quality

One-Way Analysis of Similarity (ANOSIM)

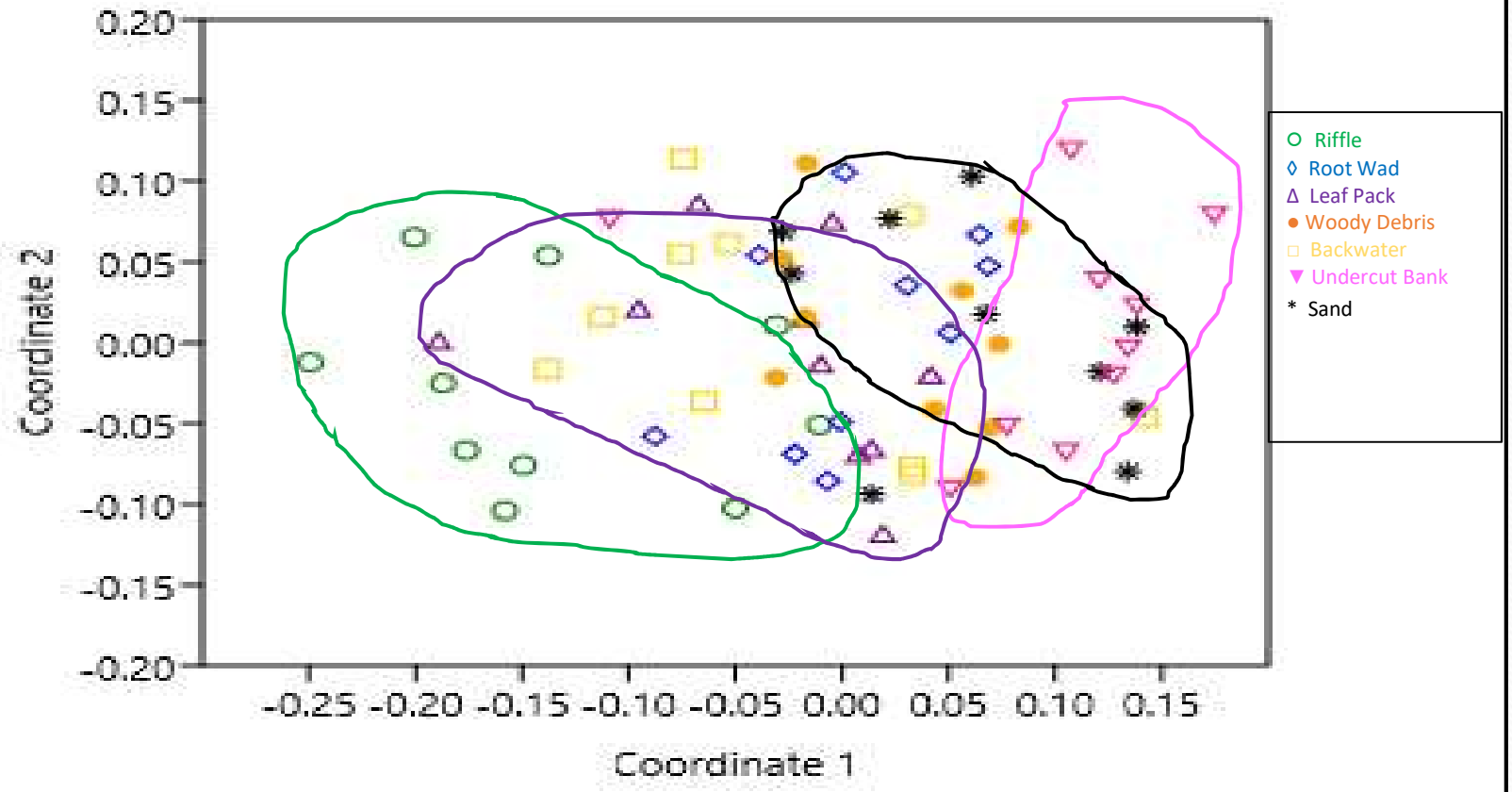
	Riffle	Root Wad	Leaf Pack	Woody Debris	Backwater	Undercut Bank
Riffle						
Root Wad	0.0007					
Leaf Pack	0.3356	0.279				
Woody Debris	0.0004	0.232	0.2974			
Backwater	0.0035	0.0988	0.983	0.0822		
Undercut Bank	0.0004	0.0313	0.0857	0.1949	0.0419	
Sand	0.0001	0.0003	0.0142	0.0327	0.0037	0.5154

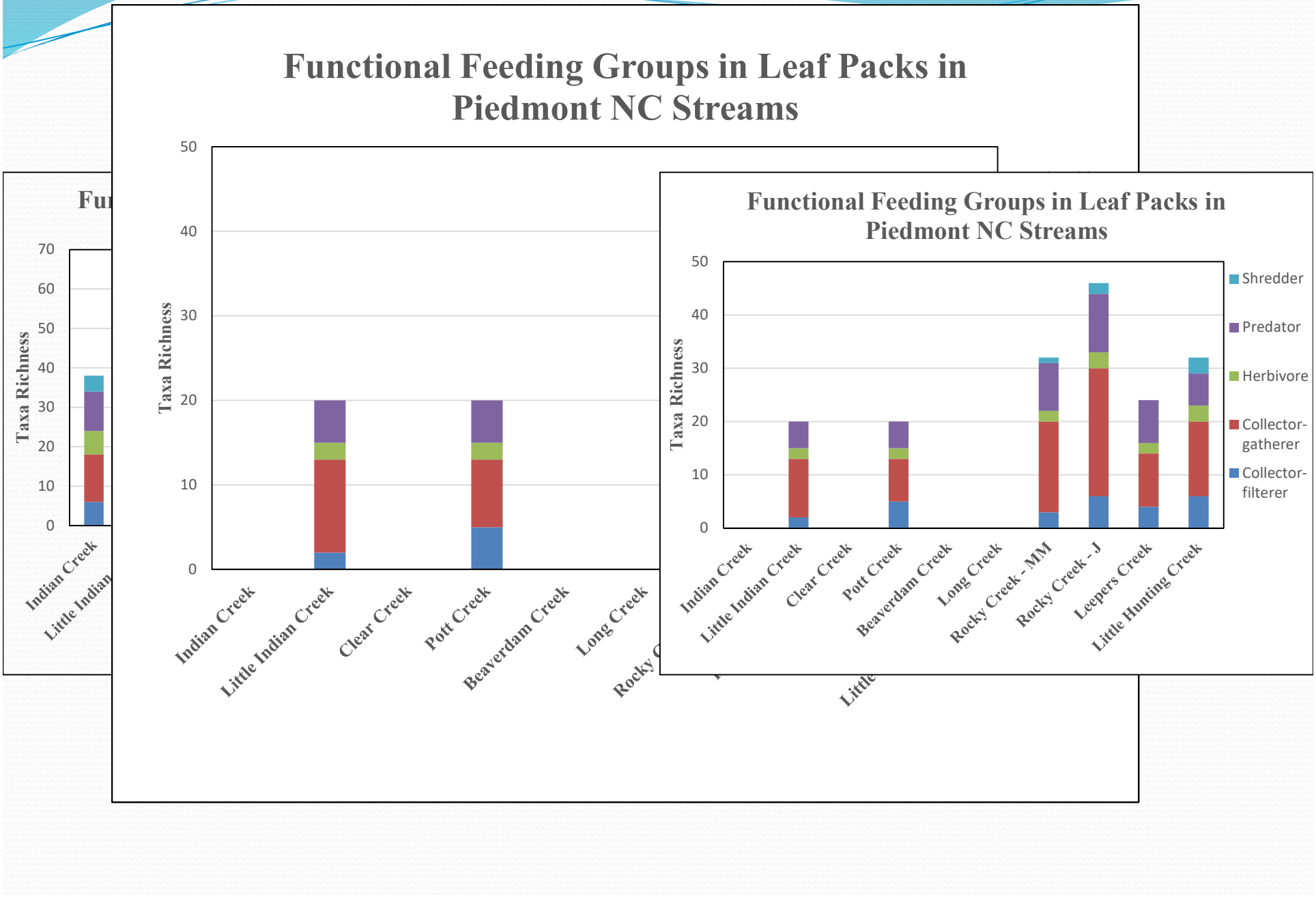
Pink boxes indicate significant differences between diversity in different microhabitats

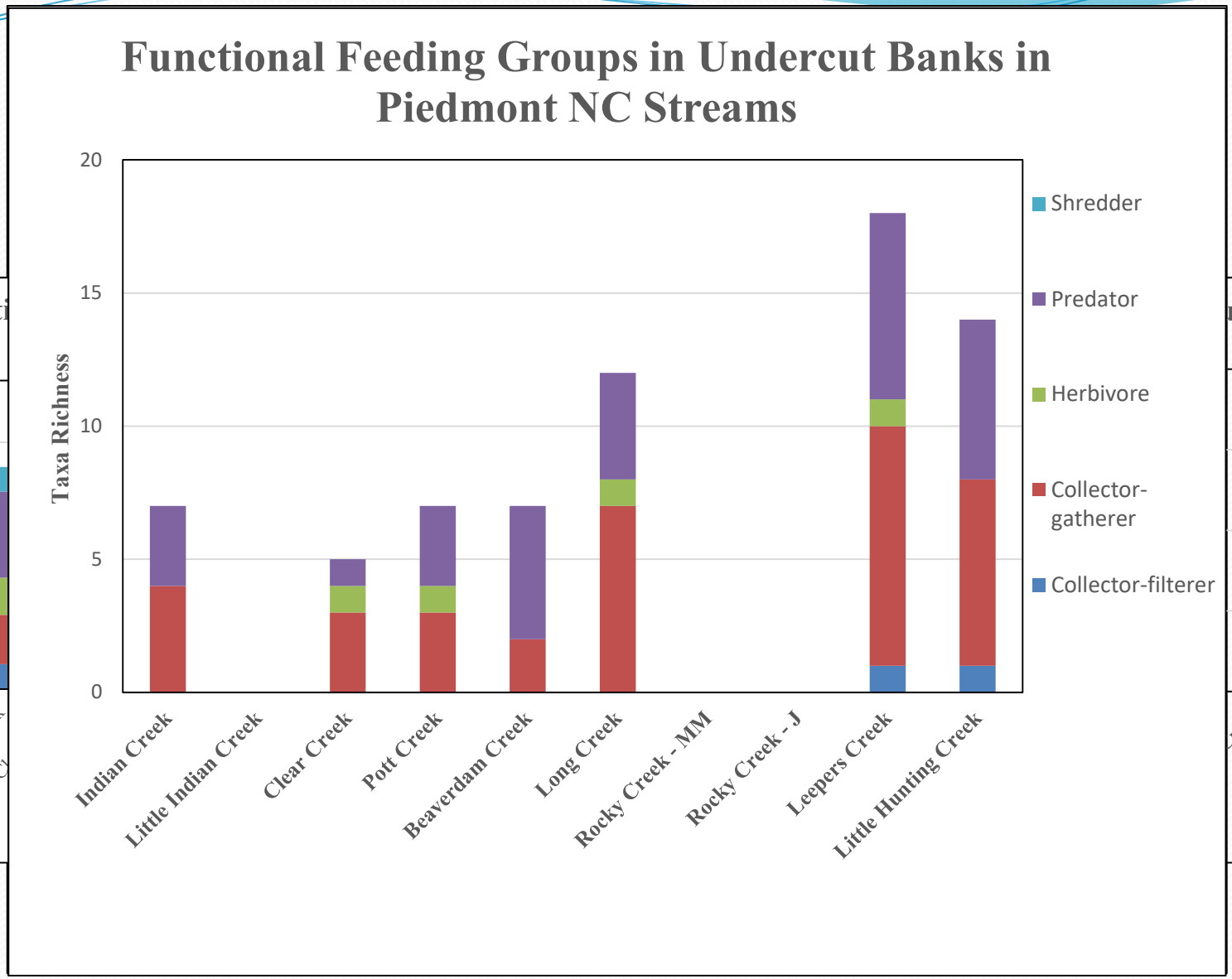
- The FFG diversity in Riffles were similar to the FFG diversity in Leaf Packs, but significantly different from the FFG diversity in the other microhabitats. Pink boxes indicate significant differences between diversity in different microhabitats.

- The FFG Diversity in Sand were similar to the FFG diversity in Undercut Banks.

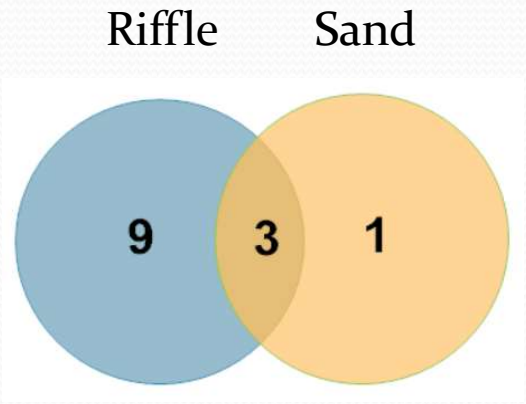
NMDS Plot of Functional Feeding Groups By Microhabitats



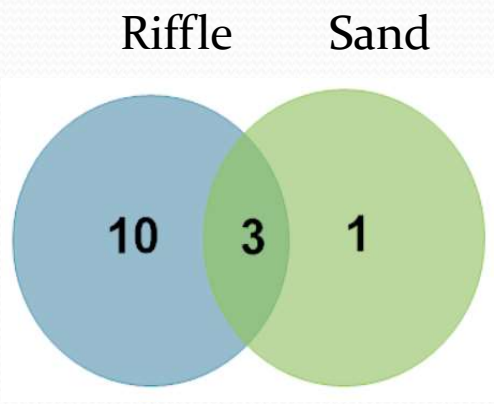

Functional Feeding Groups in Leaf Packs in Piedmont NC Streams
Taxa Richness
50
40
30
20
10
0
Indian Creek
Little Indian Creek
Clear Creek
Pott Creek
Beaverdam Creek
Long Creek
Functional Feeding Groups in Leaf Packs in Piedmont NC Streams
Taxa Richness
50
40
30
20
10
0
Indian Creek
Little Indian Creek
Clear Creek
Pott Creek
Beaverdam Creek
Long Creek
Rocky Creek - MM
Rocky Creek - J
Leepers Creek
Little Hunting Creek
Shredder
Predator
Herbivore
Collector-gatherer
Collector-filterer


Functional Feeding Groups in Undercut Banks in Piedmont NC Streams
Taxa Richness
20
15
10
5
0
Indian Creek
Little Indian Creek
Clear Creek
Pott Creek
Beaverdam Creek
Long Creek
Rocky Creek - MM
Rocky Creek - J
Leepers Creek
Little Hunting Creek
Shredder
Predator
Herbivore
Collector-gatherer
Collector-filterer

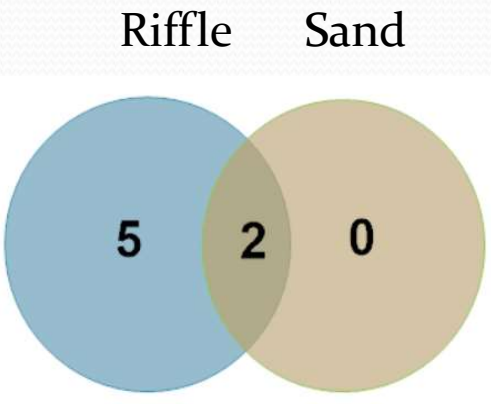
Venn Diagrams Showing Number of Taxa in Common Between the Riffle and Sand Microhabitats



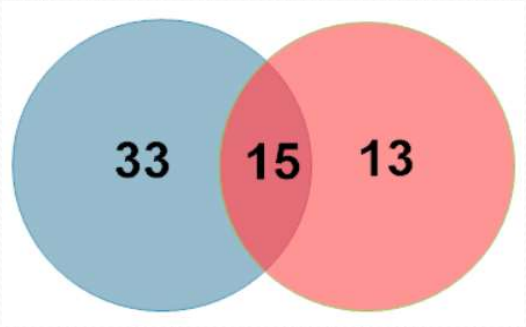
Collector-Filterer



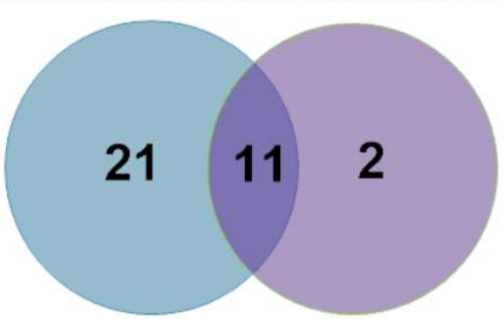
Herbivores



Shredders



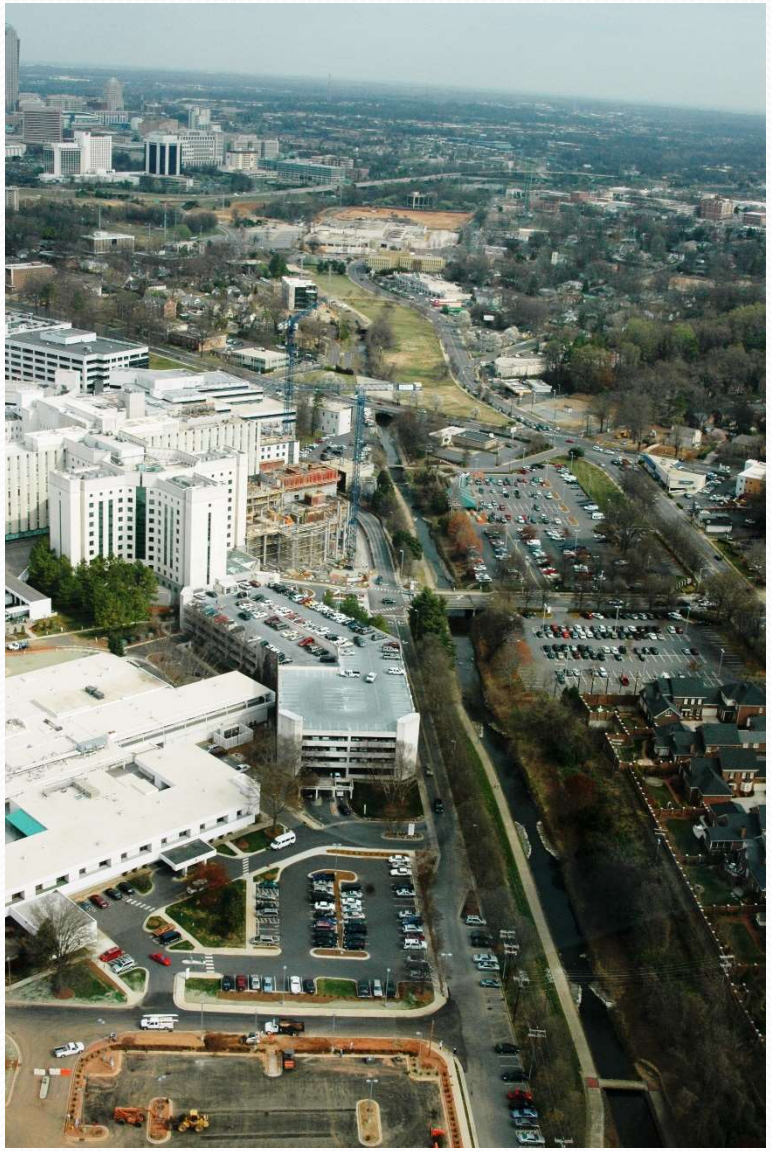
Collector-Gatherer



Predators

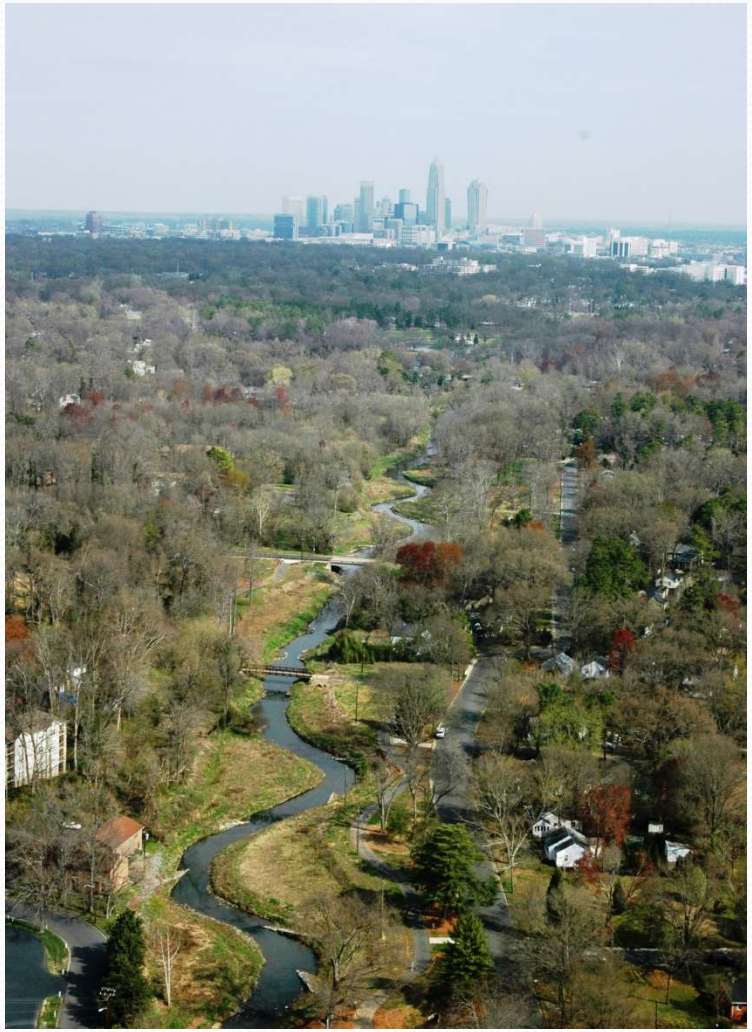
Stream Restoration as a Watershed Management Tool

- Stream restoration is an attempt to restore damaged stream channels to a more natural condition
- Based on the knowledge of the distribution of taxa traits over the stream microhabitats:
  - Stream restoration design and implementation can be improved to provide greater support for improving stream function
  - Bioassessment results of restored stream can be better interpreted



Acknowledgements

- Mecklenburg County Water Quality Bioassessment Team
- Charlotte-Mecklenburg Storm Water Services
- Members of the Clinton lab at UNCC



Little Sugar Creek – Westfield – Mecklenburg County SWS

Questions?