INTEGRATING SPECIES DIVERSITY AND FUNCTION INTO RESTORATION MONITORING: WHAT WE'VE LEARNED FROM THE REEDY CREEK RESTORATION PROJECT

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CHARLOTTE
COLLEGE OF LIBERAL ARTS & SCIENCES
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PURDUE
UNIVERSITY
Environmental and
Ecological Engineering

Charlotte-Mecklenburg
STORM
WATER
Services

REEDY CREEK
stream restoration

Acknowledgements

- Many graduate and undergraduate students
  - Sara Henderson, MS Earth Science 2015
  - Rebecca Black , MS Earth Science 2019
  - Jackie Hartman, MS Earth Science 2021

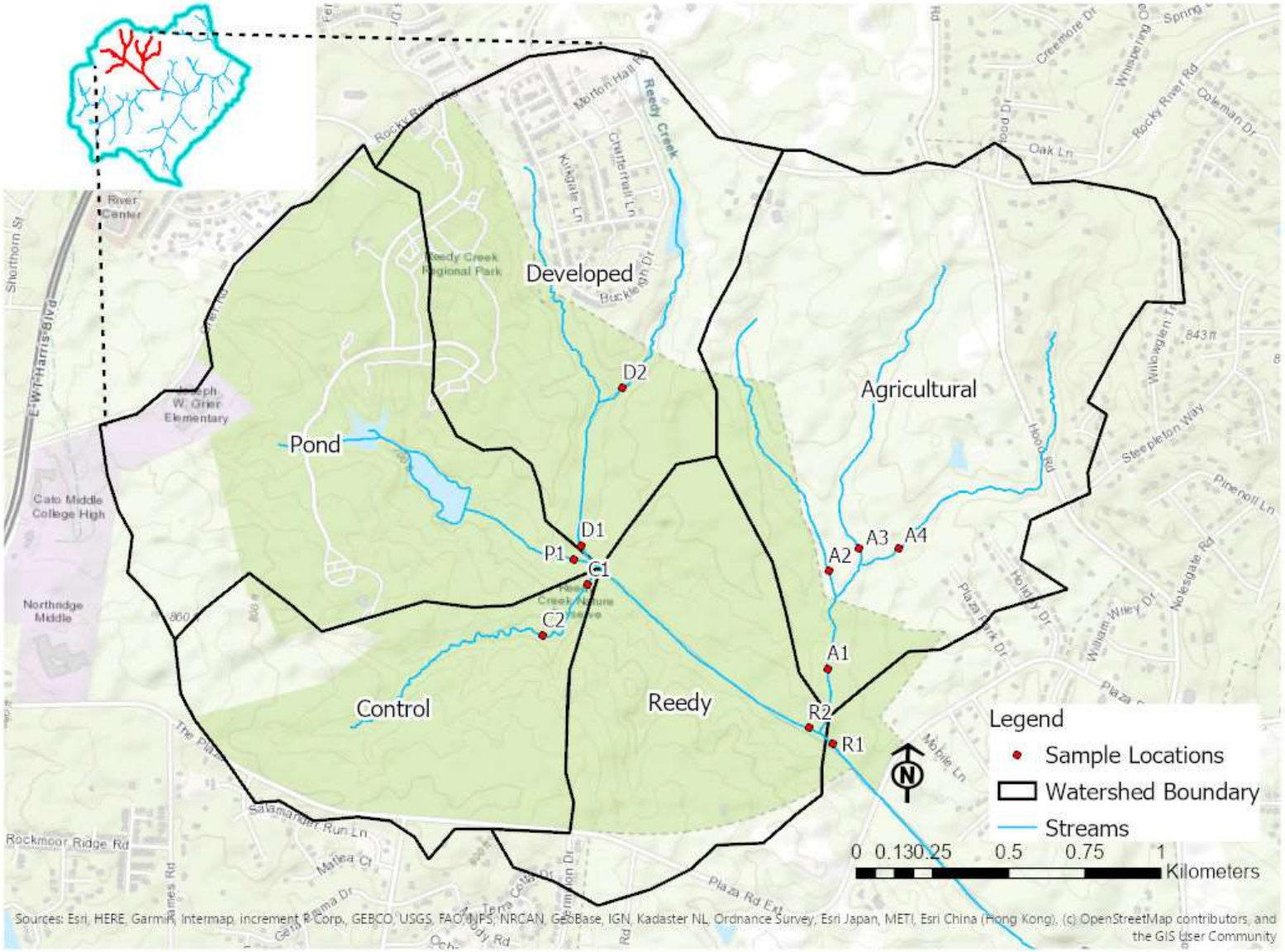
- City of Charlotte
- Wildlands Engineering
- Anthony Roux, Mecklenburg County Land Use and Environmental Services Agency

Why don’t macroinvertebrates recover in urban restored streams?

- Small scale of projects (< 2 km)
- Stormwater inputs upstream
- Disruption of food sources
- Lack of colonists

Reedy Creek Restoration Project

- Large scale restoration project
- Primarily forested
- “Excellent” (NCBI) <2 km from restored sites



Site	Area (km^2)
D2	0.27
D1	1.15
P1	1.18
C1	0.77
C2	0.68
A4	0.55
A3	0.60
A2	0.48
A1	1.90
R2	3.69
R1	5.70

BUCKLEIGH BRANCH
BEFORE
CONSTRUCTION
AFTER
CONSTRUCTION

REEDY CREEK
BEFORE
CONSTRUCTION

AFTER
CONSTRUCTION

Methods

- **11 sites sampled seasonally Fall 2012 – Summer 2020**

- Modified NC Qual 4 (no kick net)
- Samples placed in 90% ethanol in the field and 70% ethanol in the lab
- Taxa identified to lowest taxonomic level possible
  - Chironomidae (TV =7)

- **Metrics calculated**
  - Taxa richness
  - EPT richness
  - NCBI score

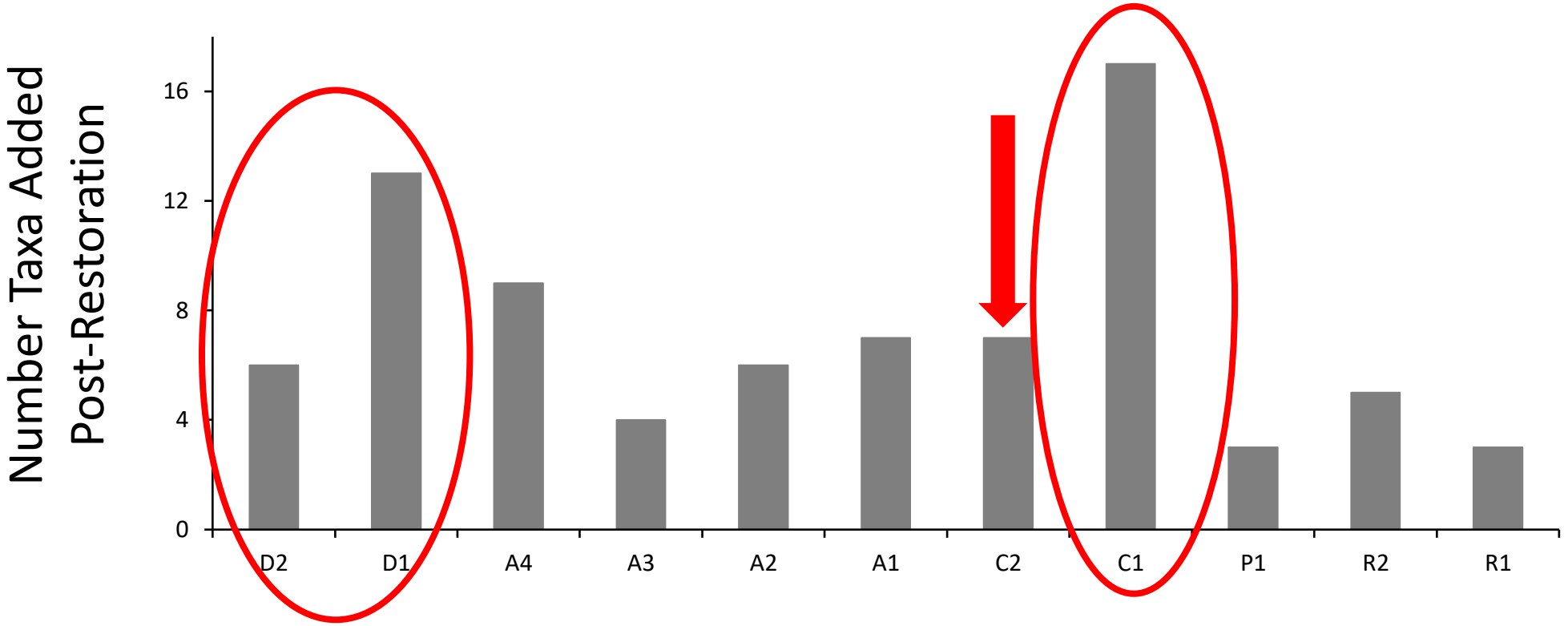
Questions:

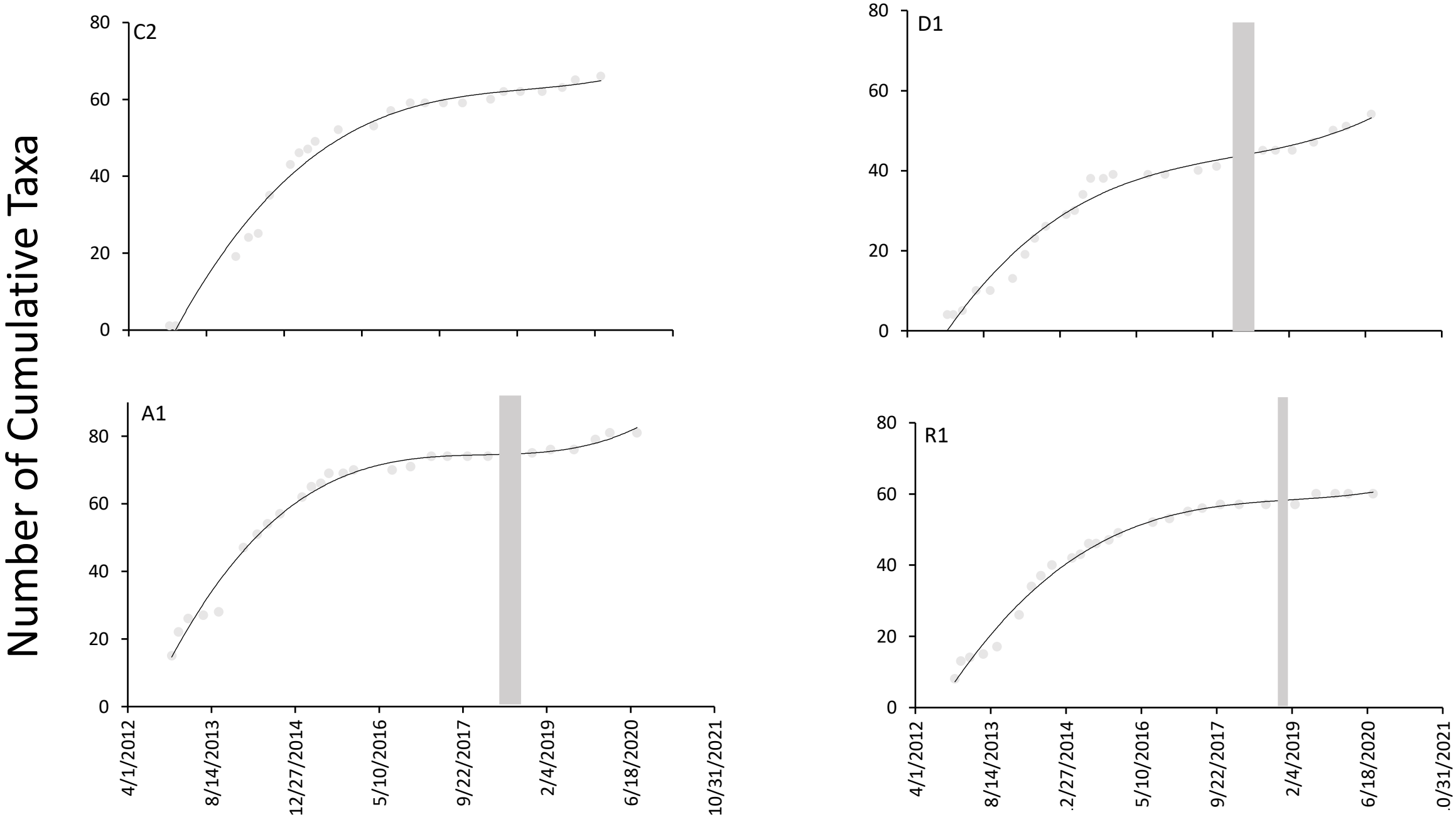
1. **How quickly are new taxa added and how does this recovery relate to land use?**

2. How do key metrics (richness, NCBI) change pre/post restoration? How do these metrics and recovery vary across land use?

3. How does restoration impact the community (all taxa and EPT) pre/post restoration?

Increase in number of taxa 2 y post-restoration




Number of Cumulative Taxa
C2
D1
A1
R1
0
20
40
60
80
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021

Lesson #1: It is challenging to determine if we added new taxa post-restoration

- Important to have pre-restoration data
- Rate of taxon detection varies between “good” versus “poor” sites
- Adding 1-2 taxa/year after >10 years in local monitoring programs
- Restoration studies often comparing to “good” sites but not all sites are monitored for decades

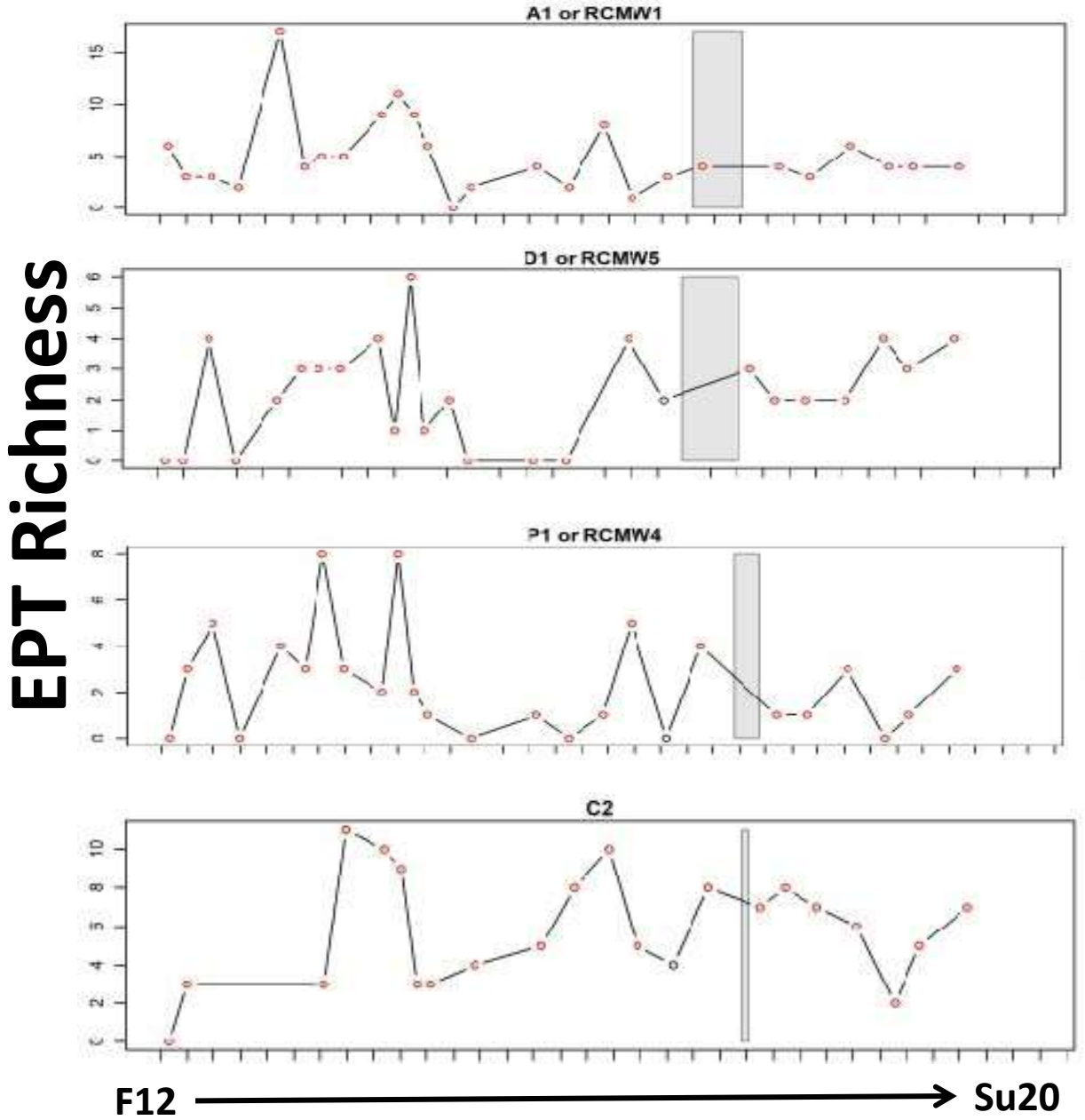
Questions:

1. How quickly are new taxa added and how does this recovery relate to land use?

2. **How do key metrics (richness, NCBI) change pre/post restoration? How do these metrics and recovery vary across land use?**

3. How does restoration impact the community (all taxa and EPT) pre/post restoration?

Key Metrics – Pre and Post Restoration



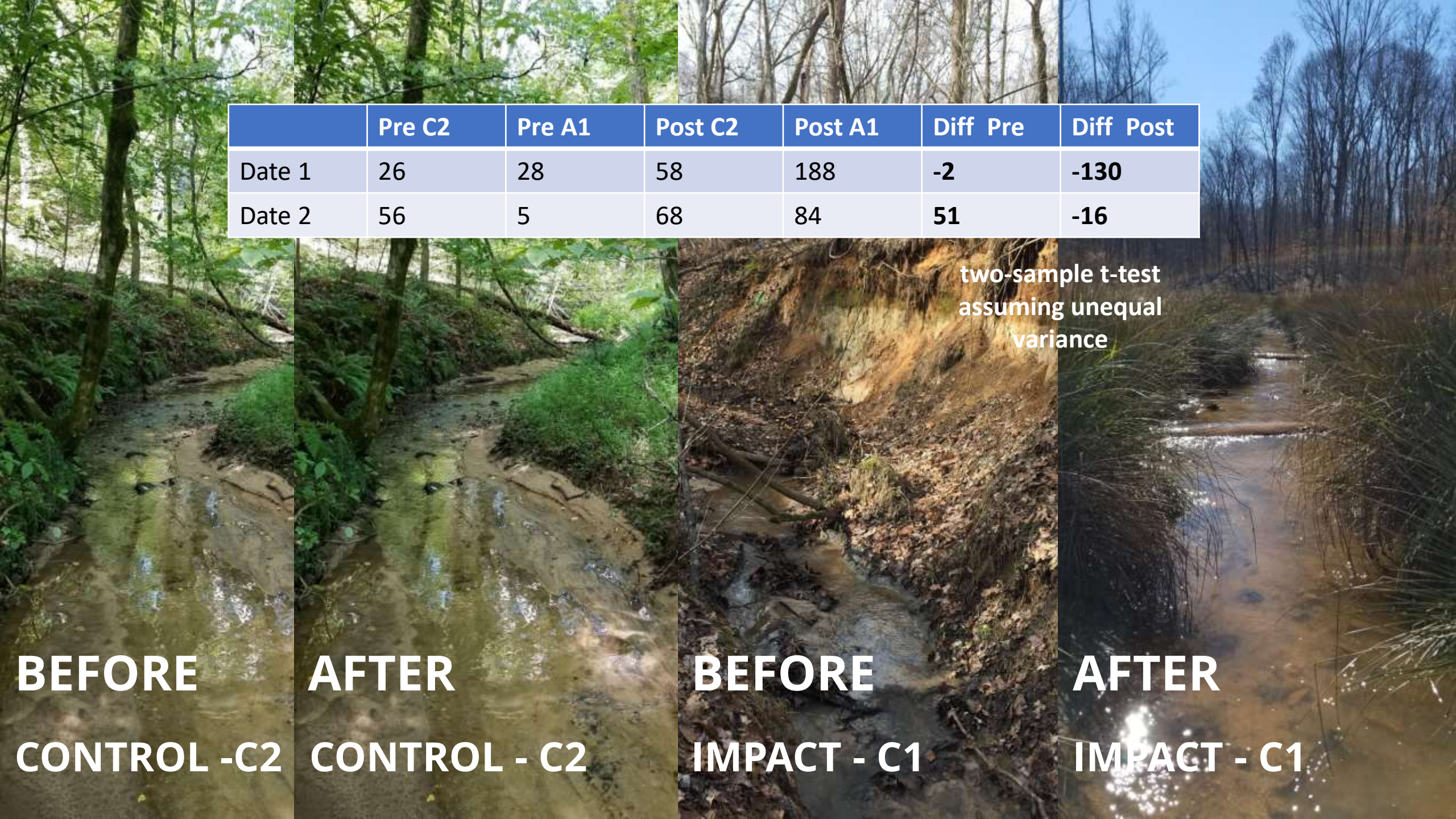
We have 2 years post-restoration data

Compare 2 yrs pre with 2 yrs post

- t-test
- **Mann-Whitney test**

Before-After-Control-Impact (BACI)

- Before = Pre
- After = Post
- Control = C2 unrestored
- I = all other sites

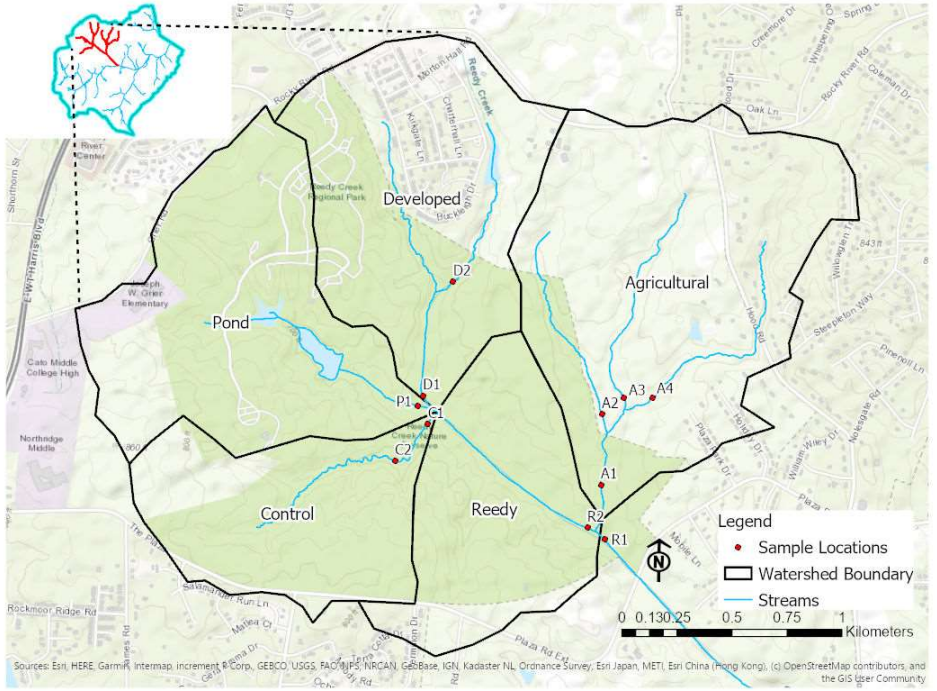


	Pre C2	Pre A1	Post C2	Post A1	Diff Pre	Diff Post
Date 1	26	28	58	188	**-2**	**-130**
Date 2	56	5	68	84	**51**	**-16**

two-sample t-test assuming unequal variance

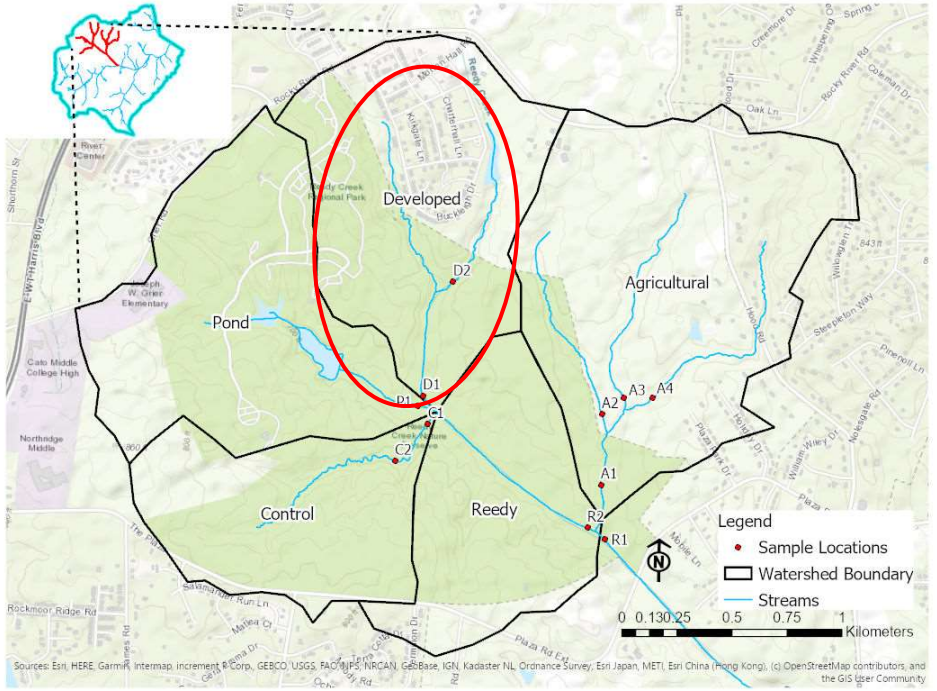
Key Metrics – Pre and Post Restoration

	Mann-Whitney				BACI		
	Taxa Richness	EPT Richness	NCBI Score		Taxa Richness	EPT Richness	NCBI Score
D2							
D1							
A4							
A3							
A2							
A1							
C2							
C1							
P1							
R2							
R1							



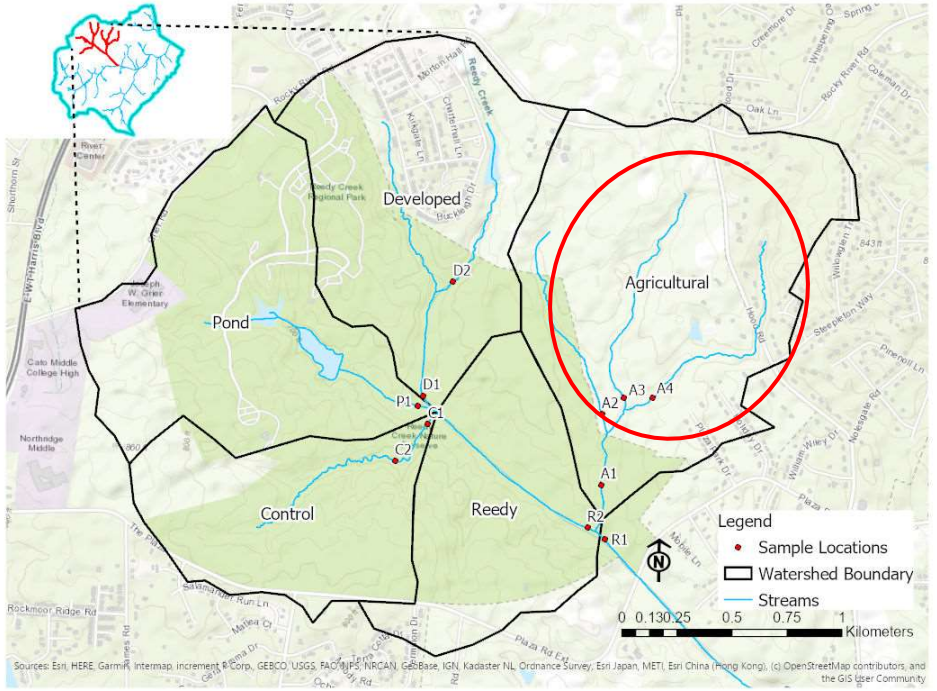
Key Metrics – Pre and Post Restoration

	Mann-Whitney				BACI		
	Taxa Richness	EPT Richness	NCBI Score		Taxa Richness	EPT Richness	NCBI Score
D2	↑	–	↑		↑	–	↑
D1	↑	↑	↑		↑	–	↑
A4							
A3							
A2							
A1							
C2							
C1							
P1							
R2							
R1							



Key Metrics – Pre and Post Restoration

	Mann-Whitney				BACI		
	Taxa Richness	EPT Richness	NCBI Score		Taxa Richness	EPT Richness	NCBI Score
D2							
D1							
A4	↑	–	↑		↓	↓	↑
A3	↓	↓	↑		↓	↓	↑
A2	↓	↓	↑		↓	↓	↑
A1	↓	↓	↑		↓	↓	↑
C2							
C1							
P1							
R2							
R1							



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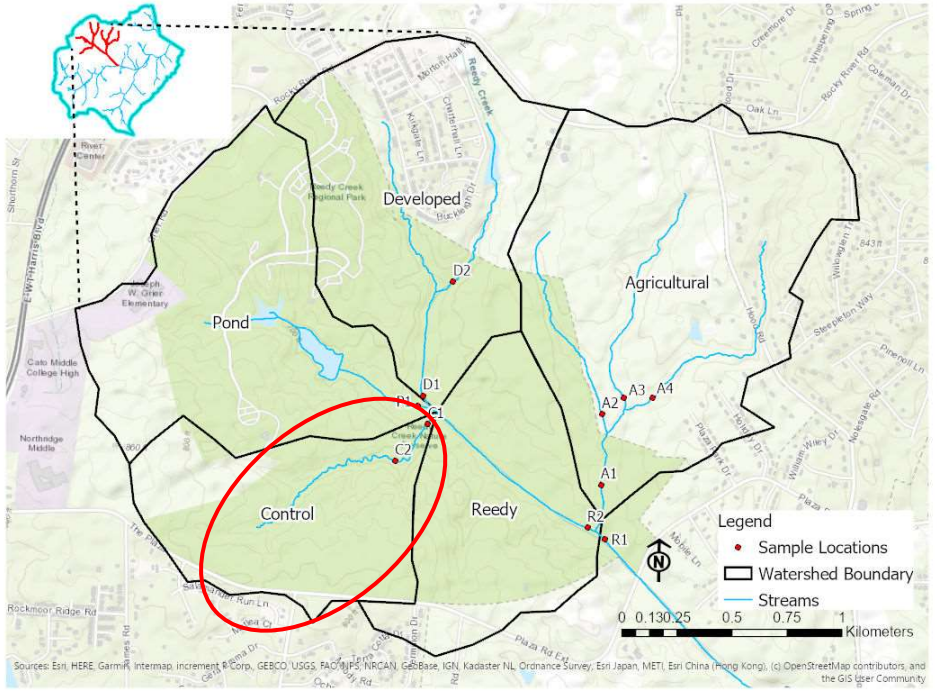
D2							
D1							
A4							
A3							
A2							
A1							
C2	↑	↓	–				
C1	↑	–	–		↑	↓	↑
P1							
R2							
R1							



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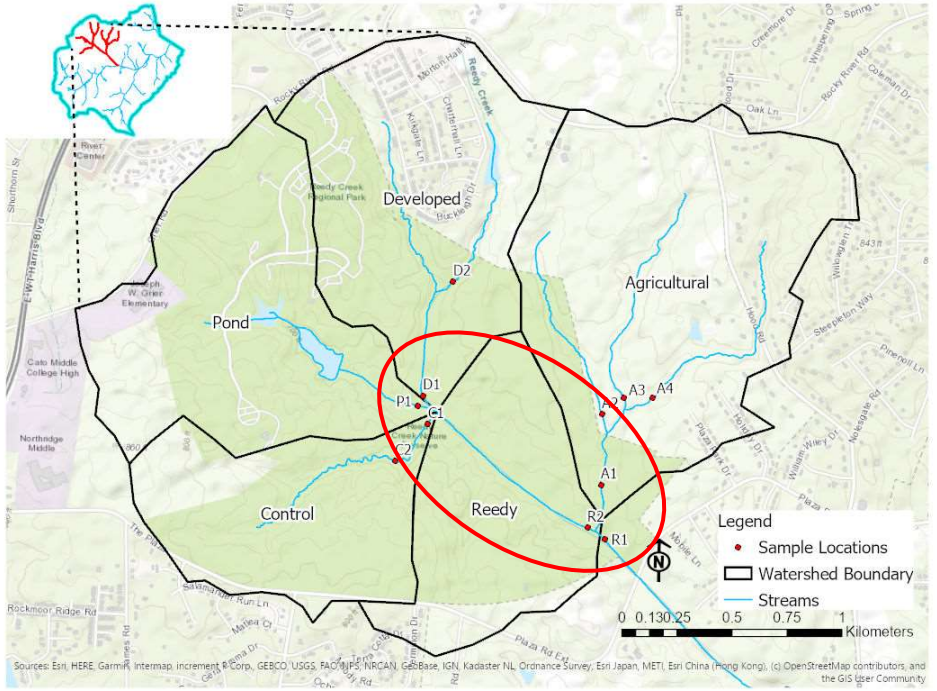
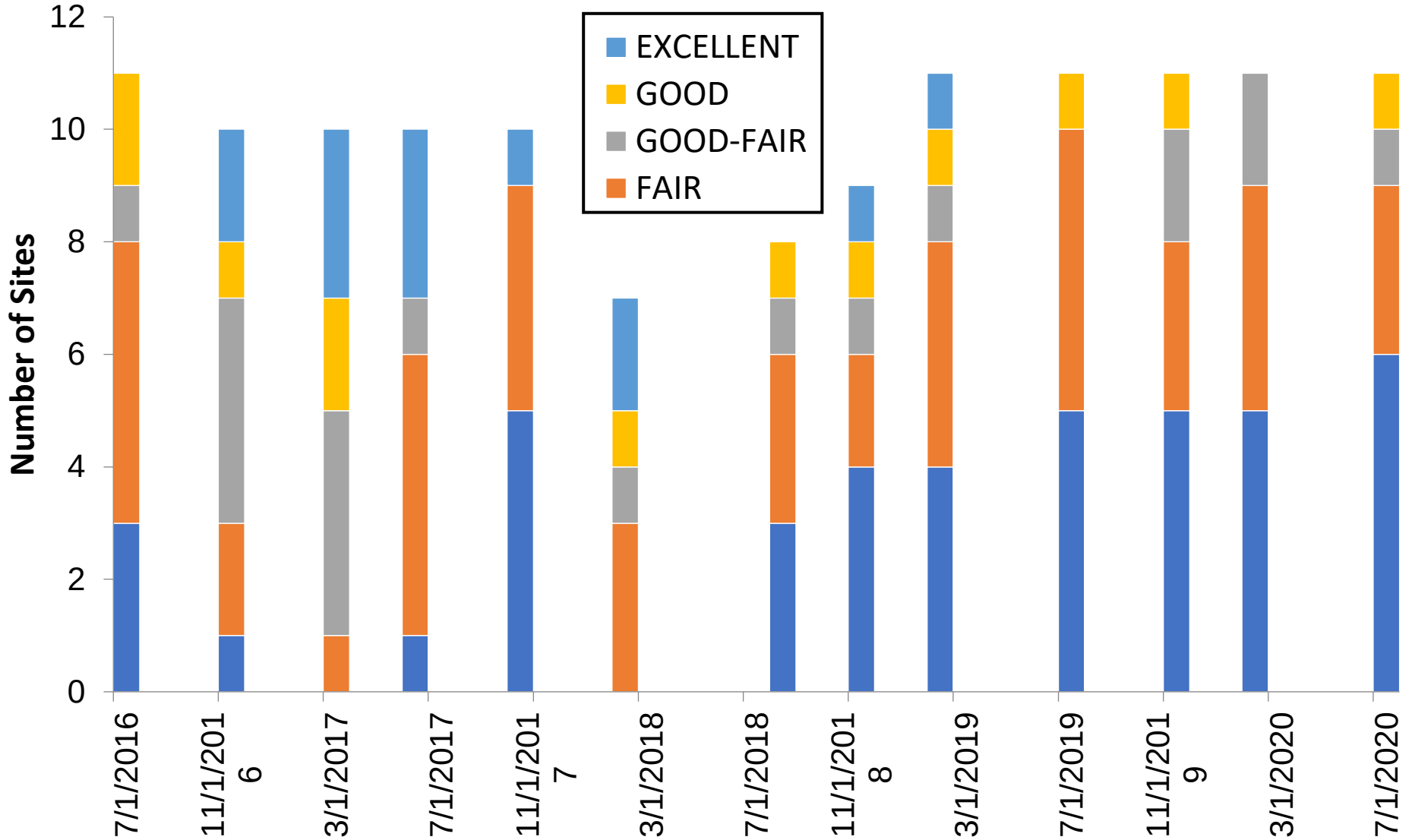
D2							
D1							
A4							
A3							
A2							
A1							
C2							
C1							
P1	–	–	↑		–	–	↑
R2	↑	↑	↑		–	–	↑
R1	–	–	↑		–	–	↑



Number of sites scored “excellent” decrease post-restoration



Lesson #2: Metrics may not capture changes post-restoration

- Metrics based on richness are impacted by which taxon are added
- Metrics based on abundance may not respond if the taxon being added is rare
- Metrics vary seasonally and yearly so long-term data may be needed to see changes

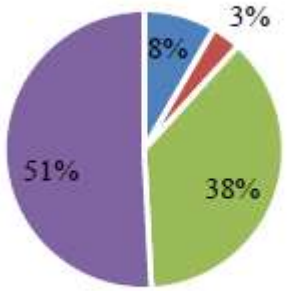
Questions:

1. How quickly are new taxa added and how does this recovery relate to land use?

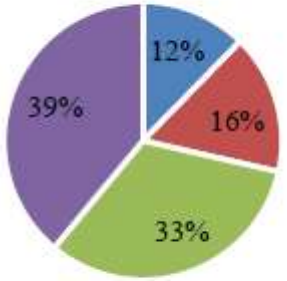
2. How do key metrics (richness, NCBI) change pre/post restoration? How do these metrics and recovery vary across land use?

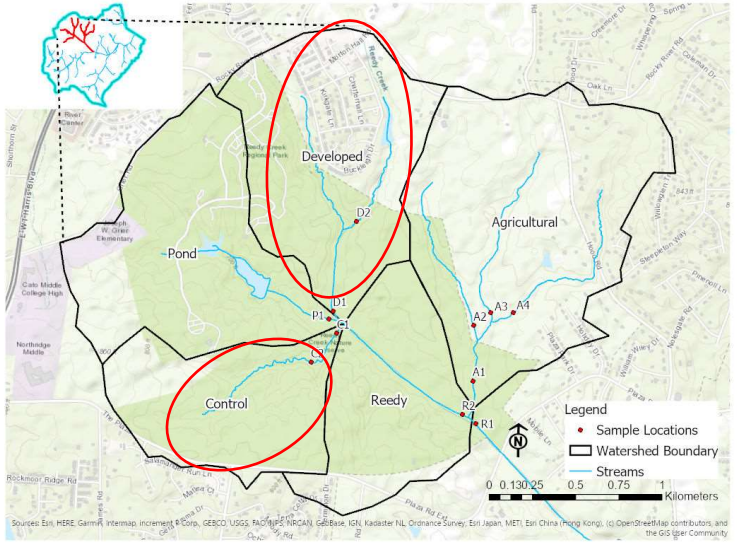
3. **How does restoration impact the community (all taxa and EPT) pre/post restoration?**

C2 Summer Before



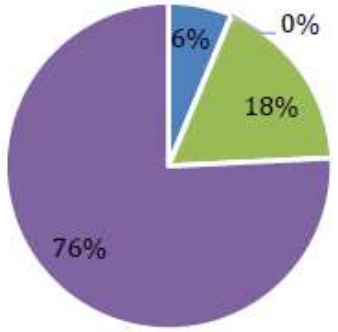
C2 Summer After



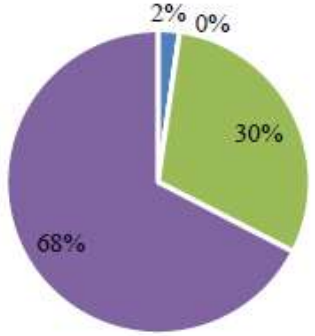


E P T OTHER

D2 Summer Before



D2 Summer After



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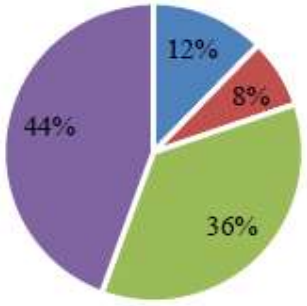

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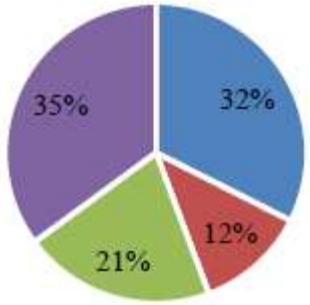

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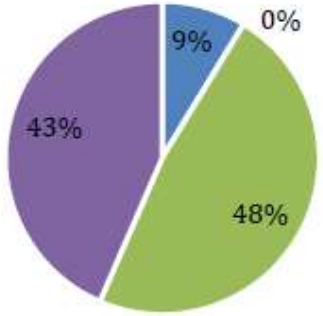

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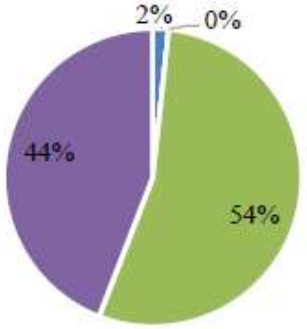

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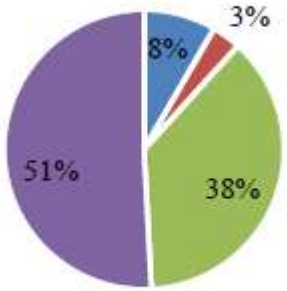

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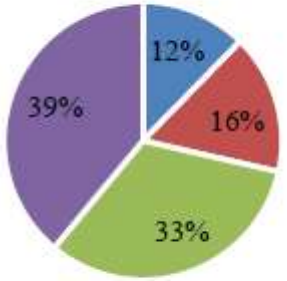
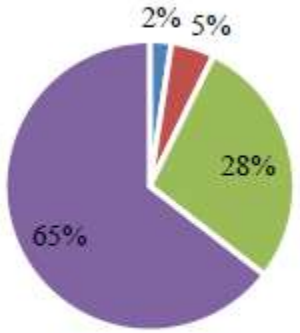
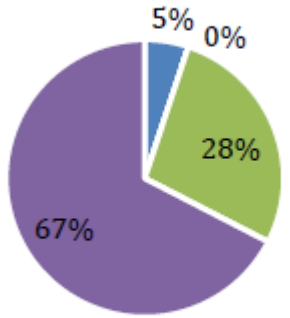
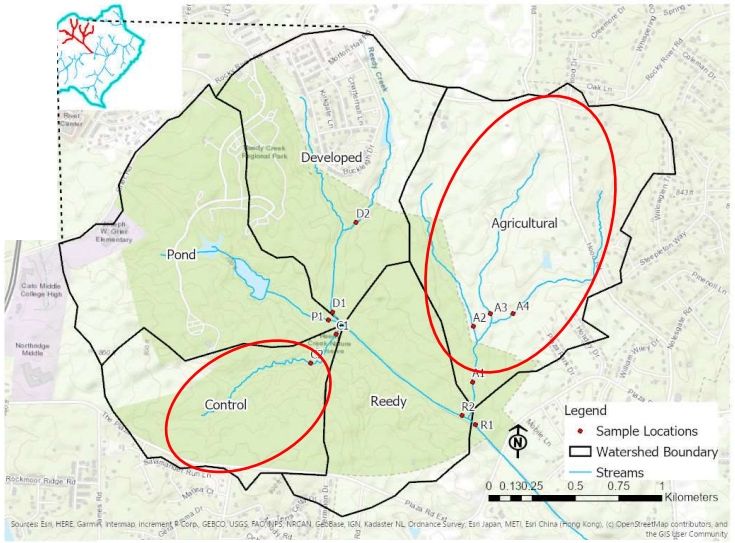


A3 Summer Before



A3 Summer After





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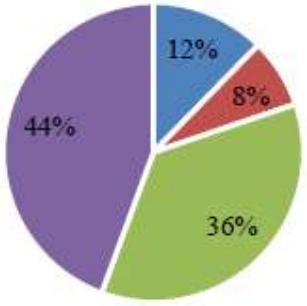

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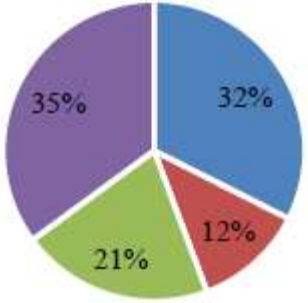

E P T OTHER

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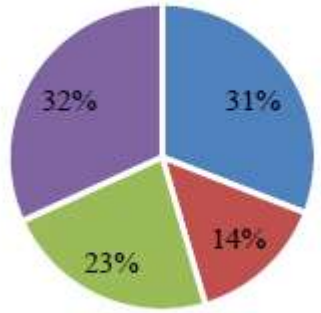
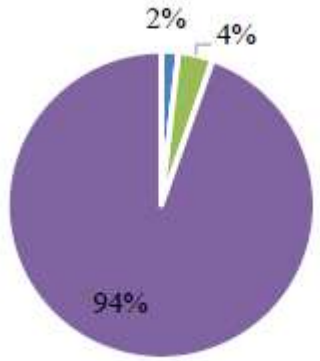


A3 Winter After



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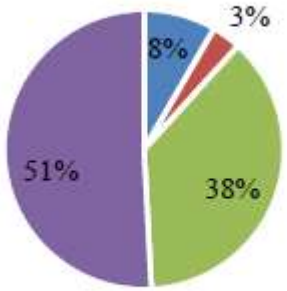

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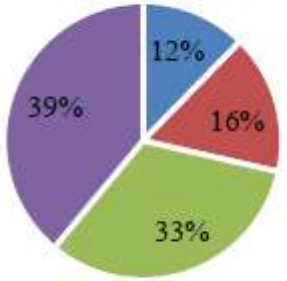
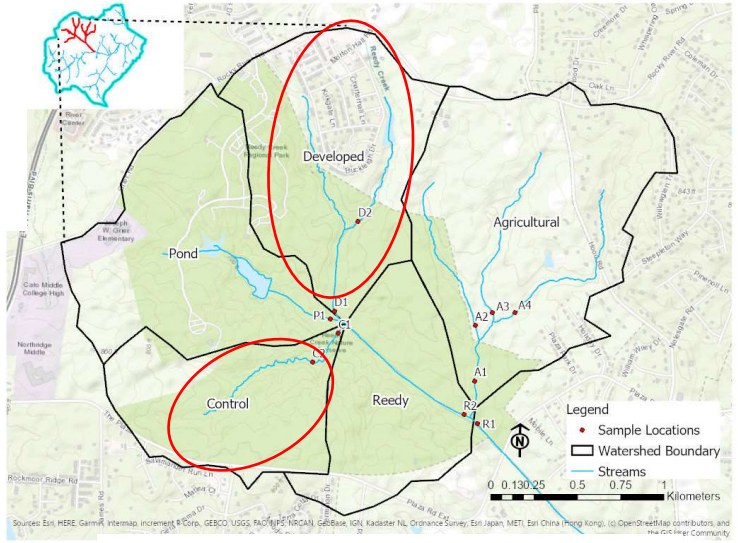
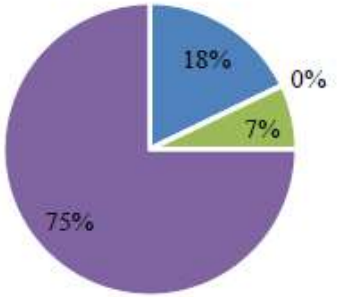


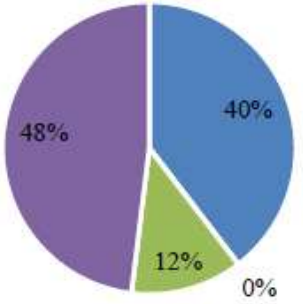


E P T OTHER

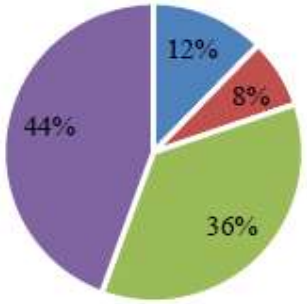
R1 Summer Before



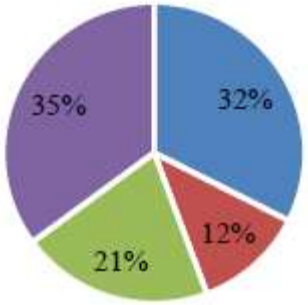
R1 Summer After



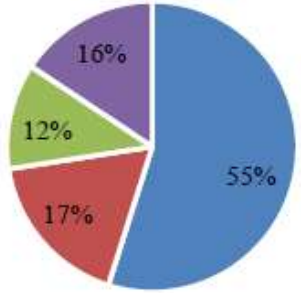
C2 Winter Before



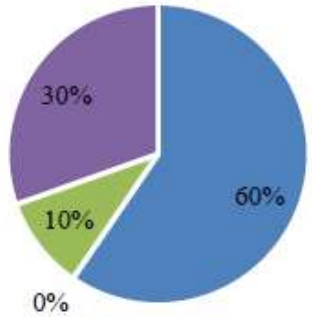
C2 Winter After



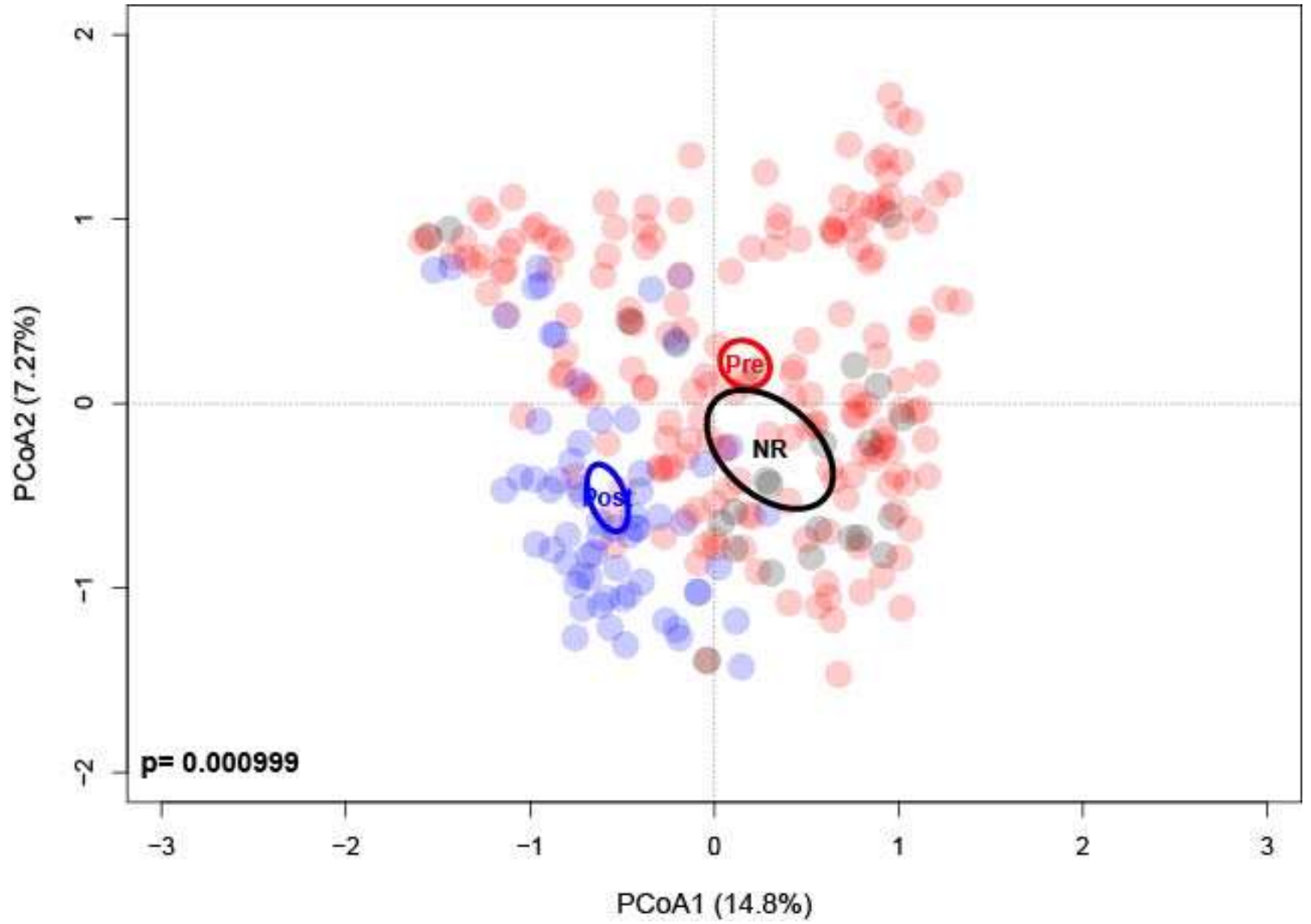
R1 Winter Before



R1 Winter After



There has been an assemblage shift from pre- to 2 y post-restoration



Lesson #3: Community changes are important

- While metrics were not significant we did see changes in the percent composition of the community
  - Decrease in stoneflies but increase in caddisflies post-restoration
- Multivariate analysis indicates that there are different communities pre- and post-restoration
  - Can look at individual taxa to see what is driving these changes
- Need to look at function (long lived species, functional feeding groups)

Overall Summary

- Incredibly rich dataset with a long pre-restoration period
- Differences in how subwatersheds are responding post-restoration

- Challenging to know if we are adding “new” taxa given number of rare taxa still being discovered
- Taxa and EPT richness increased at the worst sites but decreased at the better sites
- 2 y post-restoration there has been a shift in the community across the watershed