An evaluation of forest impacts compared to benefits associated with stream restoration

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Overall Research Question

- What are the impacts of stream restoration on the biological communities currently found on the floodplain ?

Specific Research Questions

- Does the reconnection of the floodplain to the stream alter the functional composition and diversity of plant communities?
- Do invasive species increase or decrease after the floodplain is hydrologically reconnected to the stream?
- Are soil nutrients stocks in the floodplain altered in response to the reconnection to the stream ? Or changes in plant functional composition ?

Plant Functional Groups - Definition

- How does restoration impact ecosystem function?

- Functional groups are defined as “groupings of species which perform similarly in an ecosystem based upon a set of common biological attributes” (Lavorel et. al, 1997)

Plant Functional Groups

- **C_3 grasses** – perennial grasses with a more “primitive” carbon pathway during photosynthesis. These plants are adapted to cool season establishment and grow in either dry or wet environments. Examples include: sedges, fescues, rushes, cattails.

- **C_4 grasses** – perennial grasses with a more complicated carbon pathway. They are adapted to warm or hot season conditions, with higher temperature and light requirements and have a higher productivity than C_3 grasses. Examples include: Japanese stilt-grass (invasive), little bluestem , switchgrass

- **Forbs** – herbaceous plants that are not grasses. Compared to grasses, forbs produce a more persistent seed bank and tend to be heartier species. Examples include: milkweed, boneset, dandelions, goldenrod.

- **Legumes** – herbaceous plants that are important due to their symbiotic relationship with nitrogen-fixing bacteria that contribute nitrogen to the surrounding soil. Legumes produce a pod as their fruit. Examples include: clovers, kudzu (invasive), vetches.

- **Woody Plants** – plants that produce wood as their structural tissue – usually trees or shrubs. Woody plants may enhance productivity and participate in carbon storage in an ecosystem.

Study Design-Site Selection

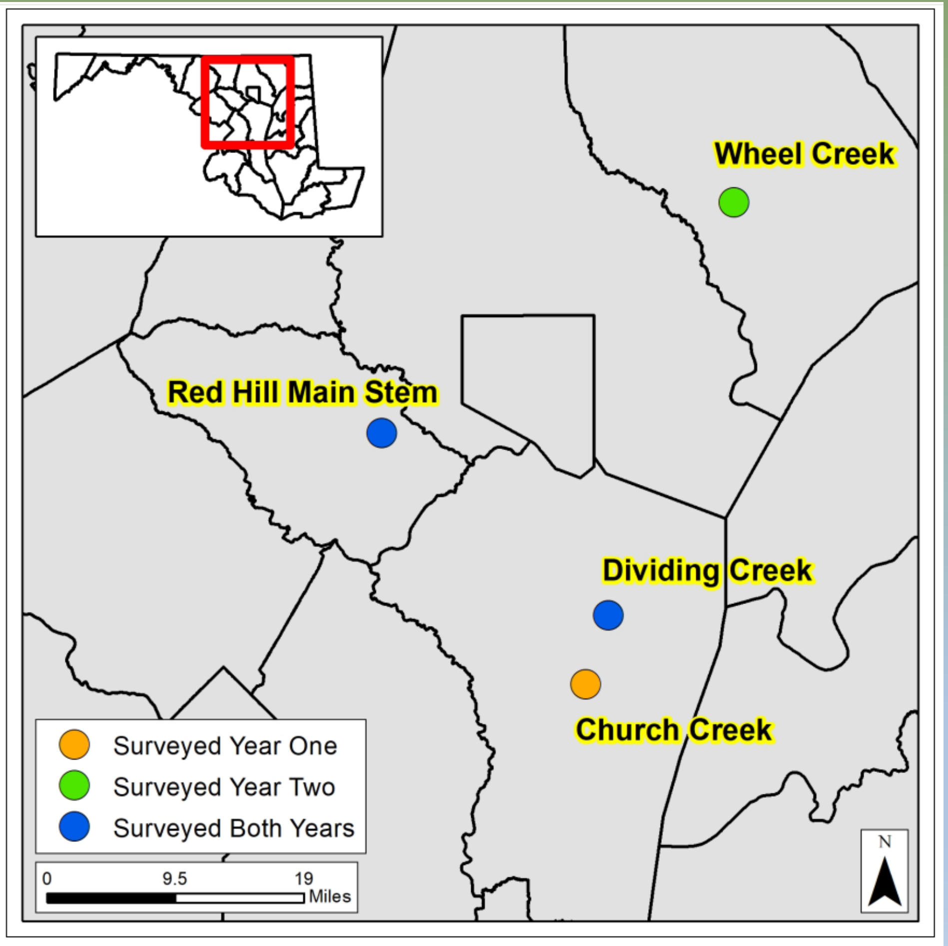
- Site Selection Criteria
  - Restoration must provide reconnection to floodplain
  - Floodplain must be wide enough to place study plots
  - Restoration must have nearby reference and control sites

- Dividing Creek, Anne Arundel Community College

  Anne Arundel County WPRP
- Church Creek, Annapolis

  South River Federation
- Red Hill Branch, Columbia

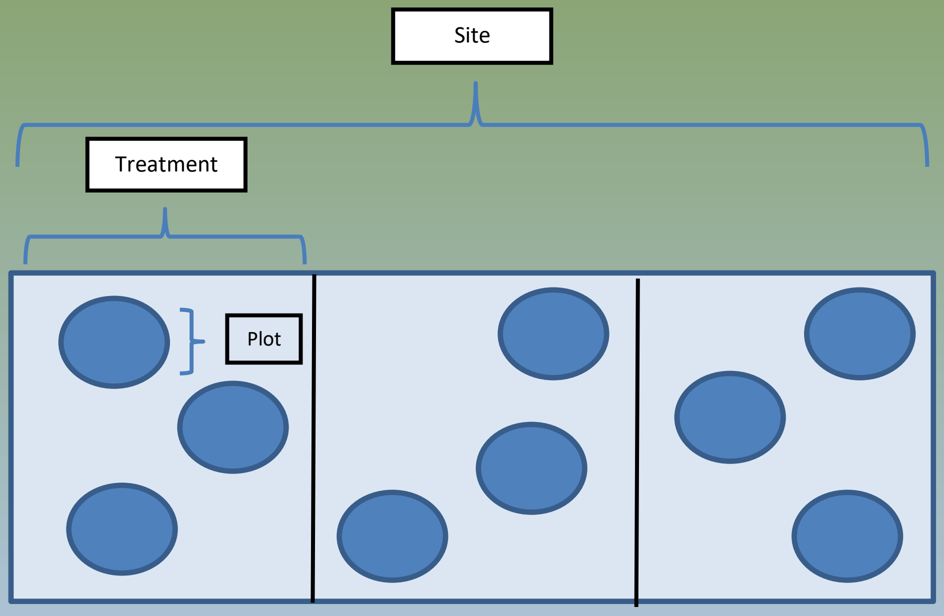
  Howard County DPW
- Wheel Creek, Harford County



Study Design-Experimental Design

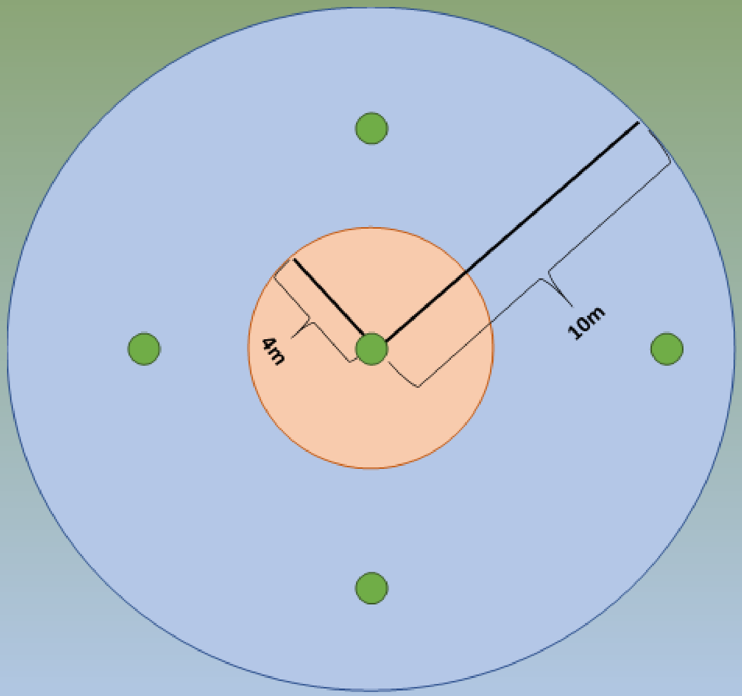
- Each site has three treatments
  - Restored
  - Reference
  - Control (non-restored)

- Each treatment has three sample “ subplots” for a total of nine plots at each sample location



Field Data Collection

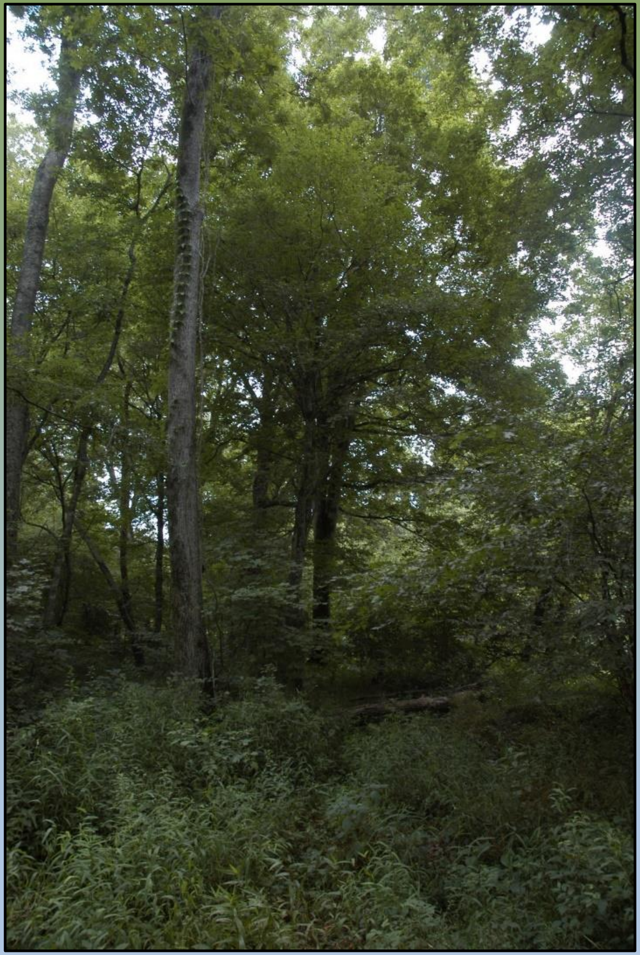
- 4 meter subplot:
  - ID every herbaceous plant to species; estimate percent vegetative cover
  - Woody plants < 5cm DBH, ID to species
  - Woody plants >= 5cm DBH, ID to species, DBH, height measurements using clinometer
- 10 meter subplot:
  - Trees >= 5cm DBH, ID to species, DBH, height
- Six soil samples from each plot homogenized to obtain a single sample to be analyzed for N, P, C
- Tree cores for every species encountered at plot
- Identify any herpetofauna encountered



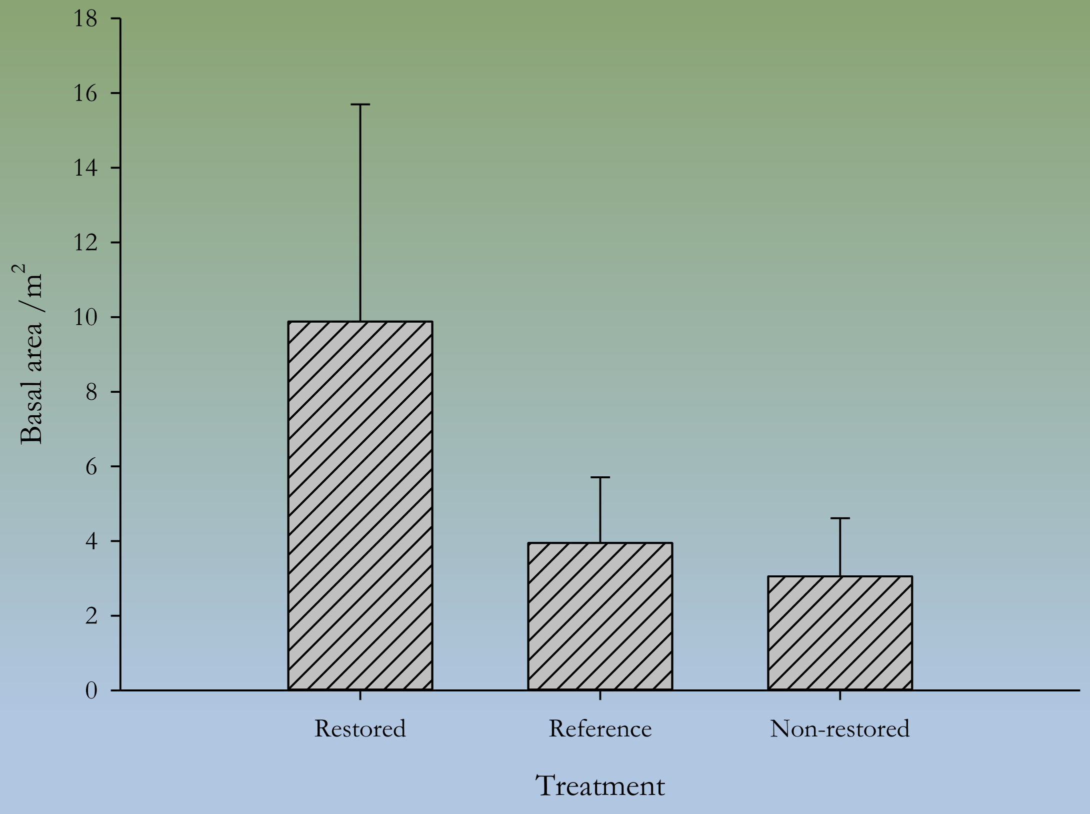
Functional Groups - Analysis

- Statistical analyses performed:
  - ANOVA – examine difference between treatments
  - Pearson Correlation Analysis with soil parameters
  - Linear regression with soil parameters

Results-Functional Composition

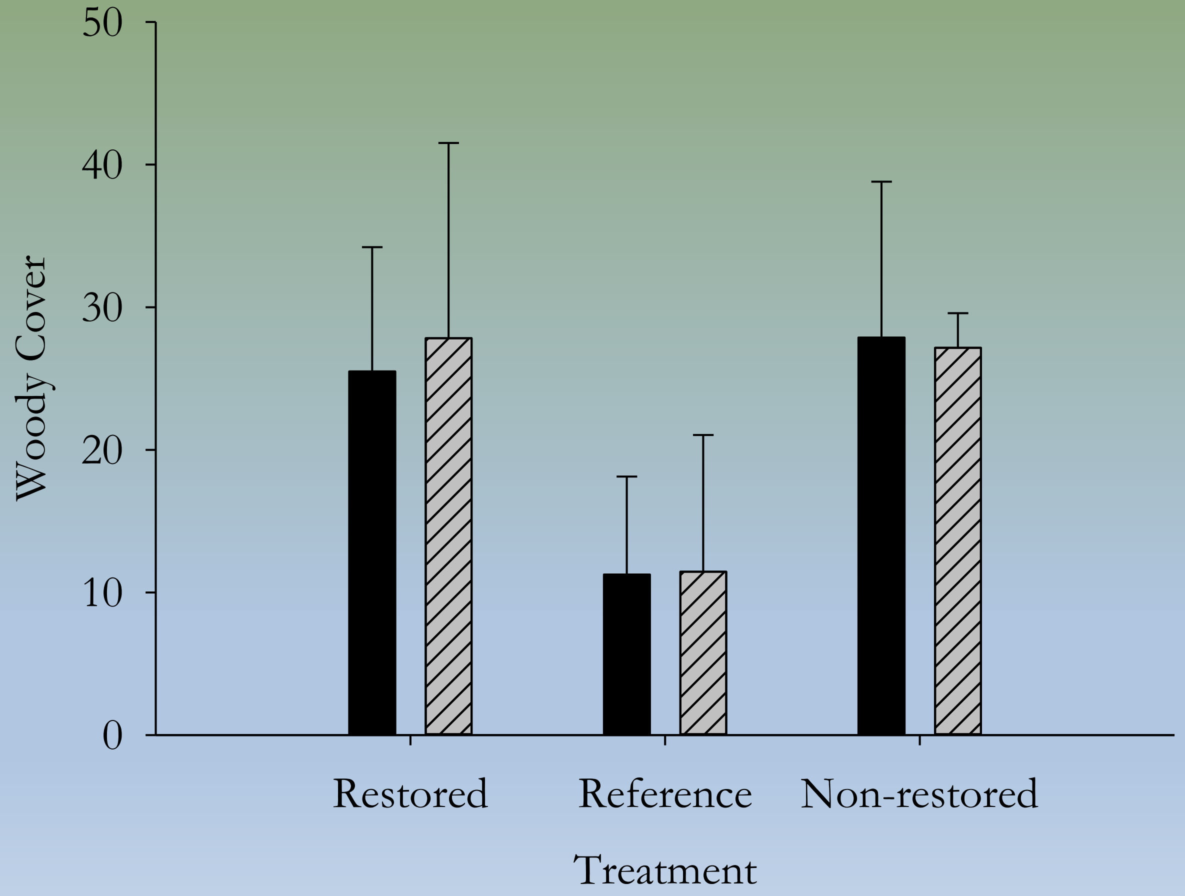


Basal Area

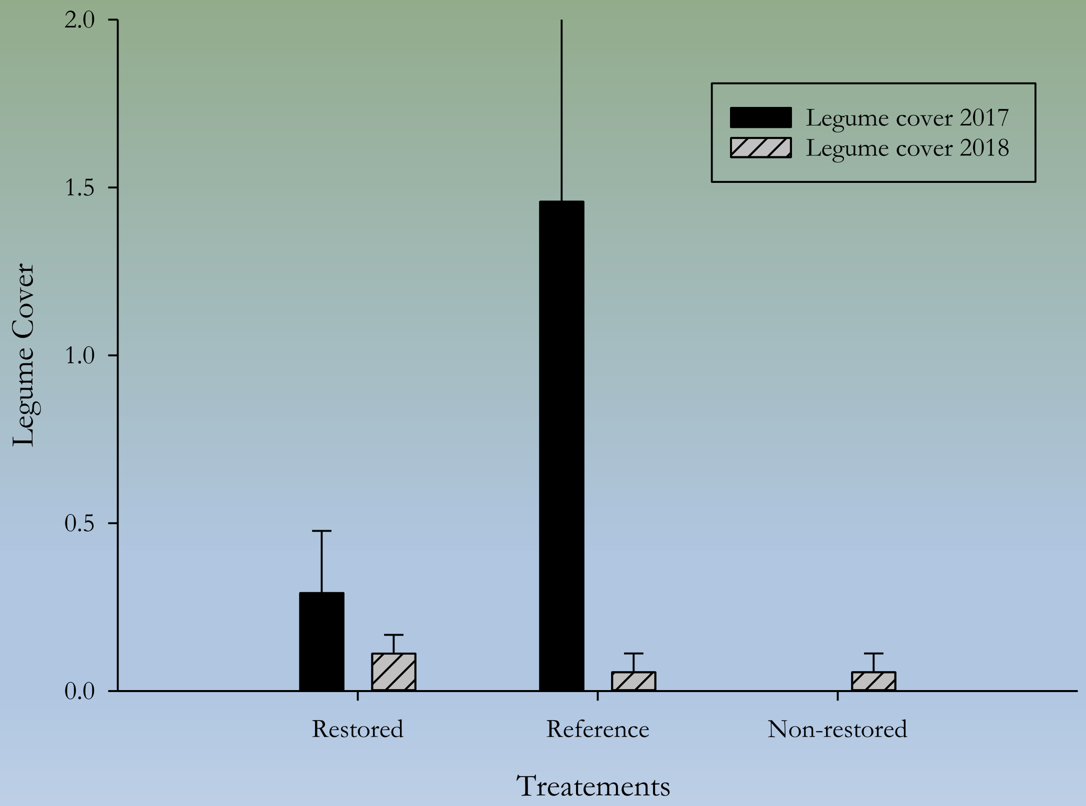


Note: Data from 2017 only.

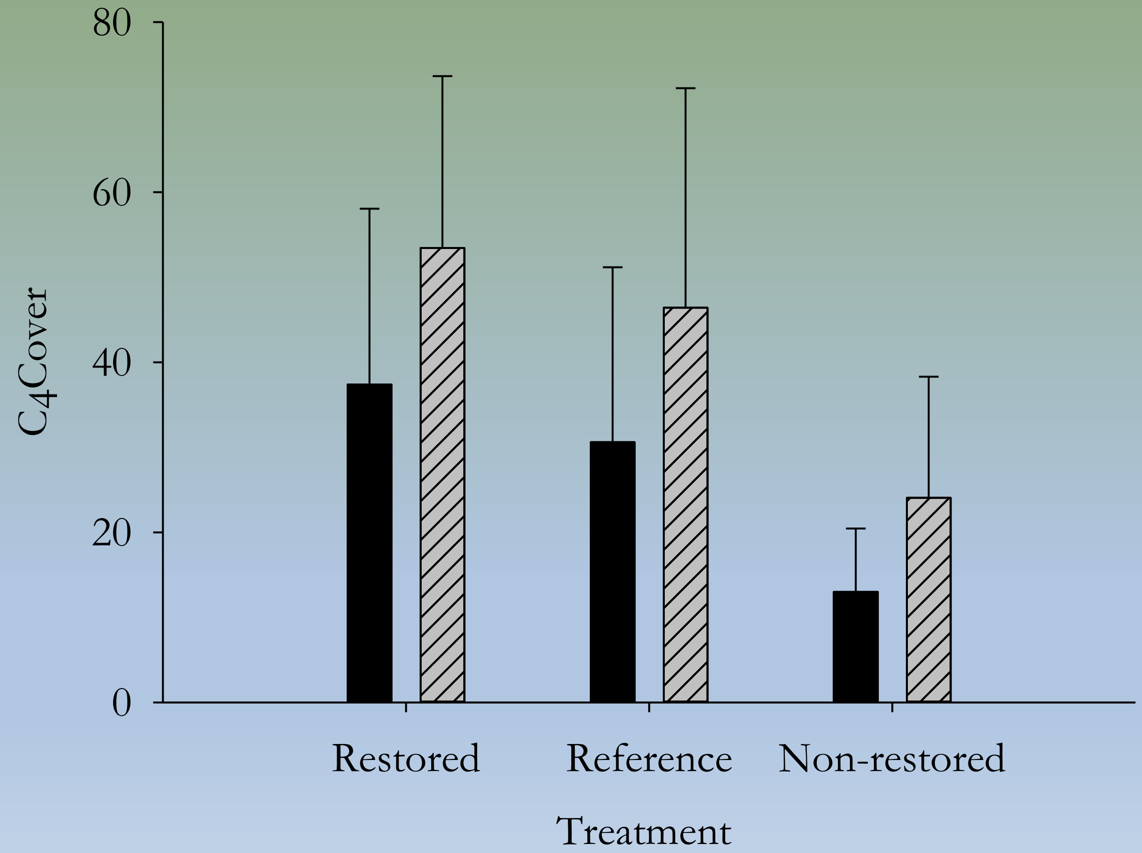
Plant Functional Composition- Woody Cover



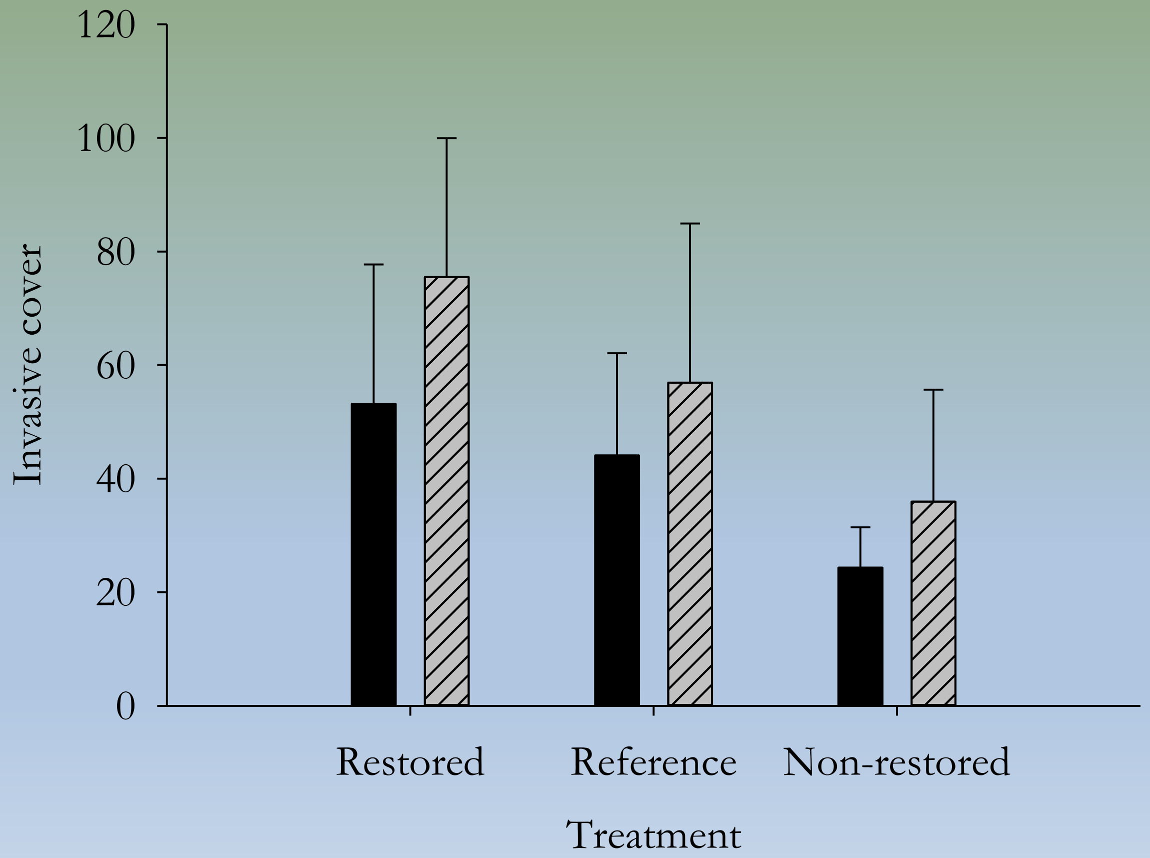
Plant Functional Composition- Legume Cover



Plant Functional Composition- C4 Cover



Plant Functional Composition-
Invasive Species Cover

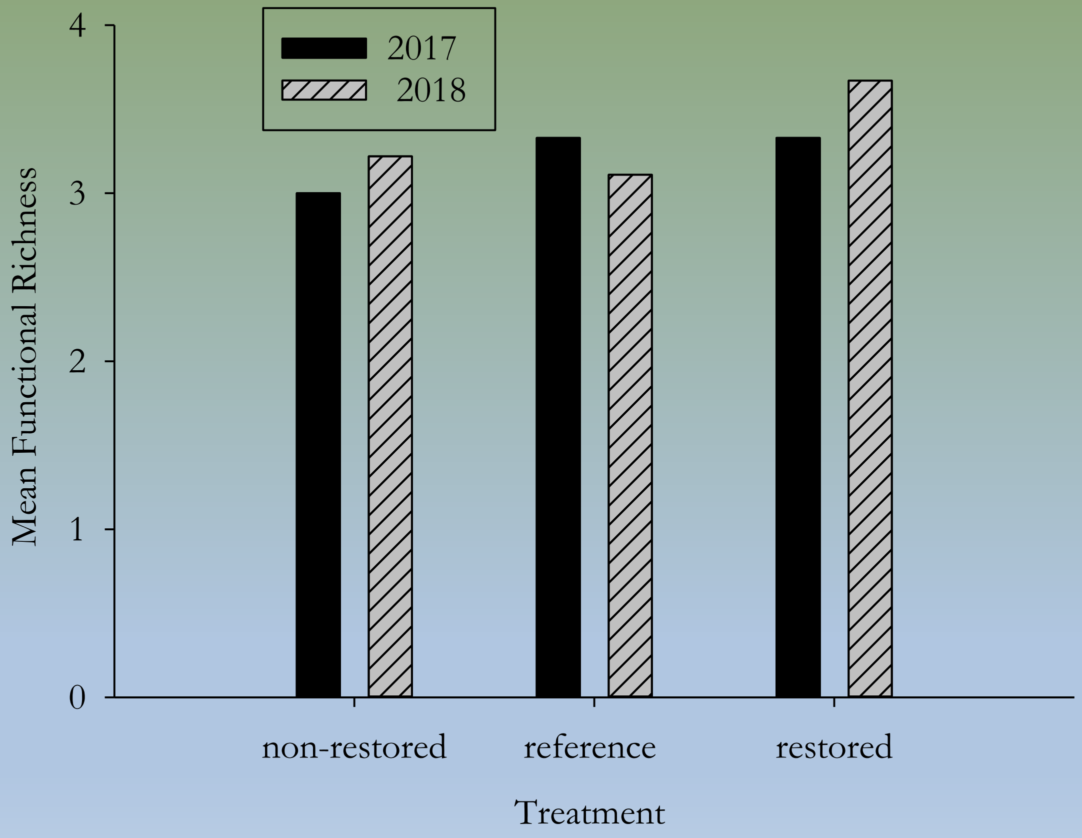


Invasive Species - Results

Red Hill Branch

2018 Dominant Ground Cover	
Control	Reed Canary Grass, Japanese Stiltgrass (~ 70% of ground cover); 13 spp.
Reference	Japanese Stiltgrass (>50% of ground cover); 21 spp.
Restoration	Japanese Stiltgrass and Mile-A-Minute (~80% of ground cover); 14 spp.

Functional Richness

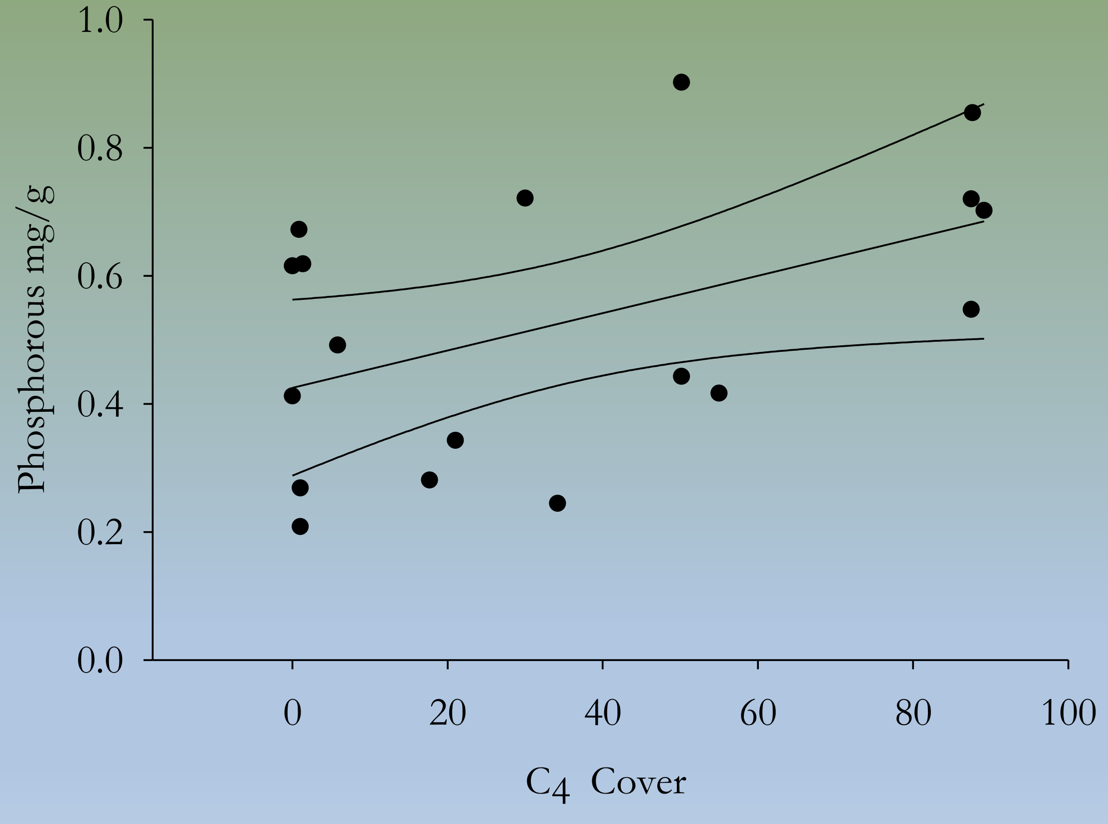


Soils - Results

Basic Correlations

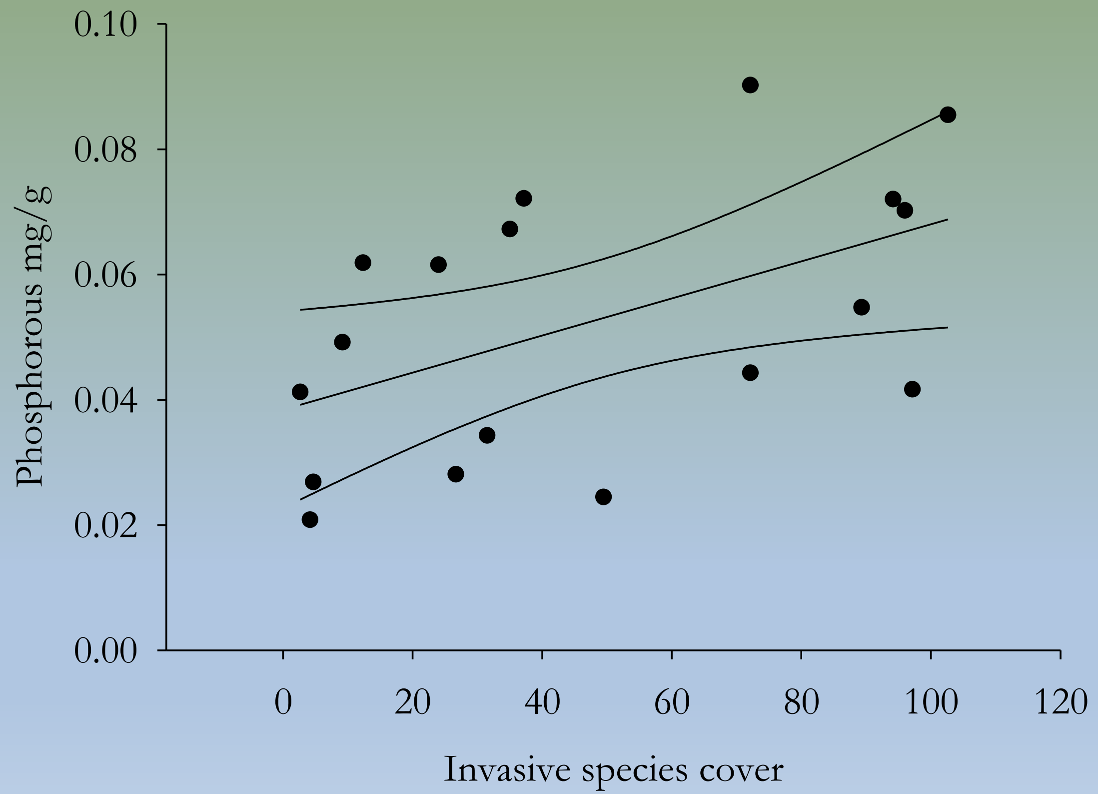
Pearson Correlation Matrix									
	C4_COVER	C3_COVER	FORB_COVER	LEGUME_COVER	WOODY_COVER	N_MGG	C_MGG	P_MGG	CNRATIO
C4_COVER	1.000								
C3_COVER	-0.359	1.000							
FORB_COVER	-0.085	0.457	1.000						
LEGUME_COVER	-0.276	-0.032	0.251	1.000					
WOODY_COVER	-0.604	0.254	-0.031	0.154	1.000				
N_MGG	0.283	-0.372	-0.195	-0.051	-0.171	1.000			
C_MGG	-0.087	-0.218	-0.032	0.210	0.049	0.879	1.000		
P_MGG	**0.476**	-0.132	-0.018	0.186	-0.335	0.430	0.318	1.000	
CNRATIO	**-0.684**	0.265	0.031	0.224	**0.622**	-0.577	-0.207	-0.484	1.000

C4 and Phosphorous



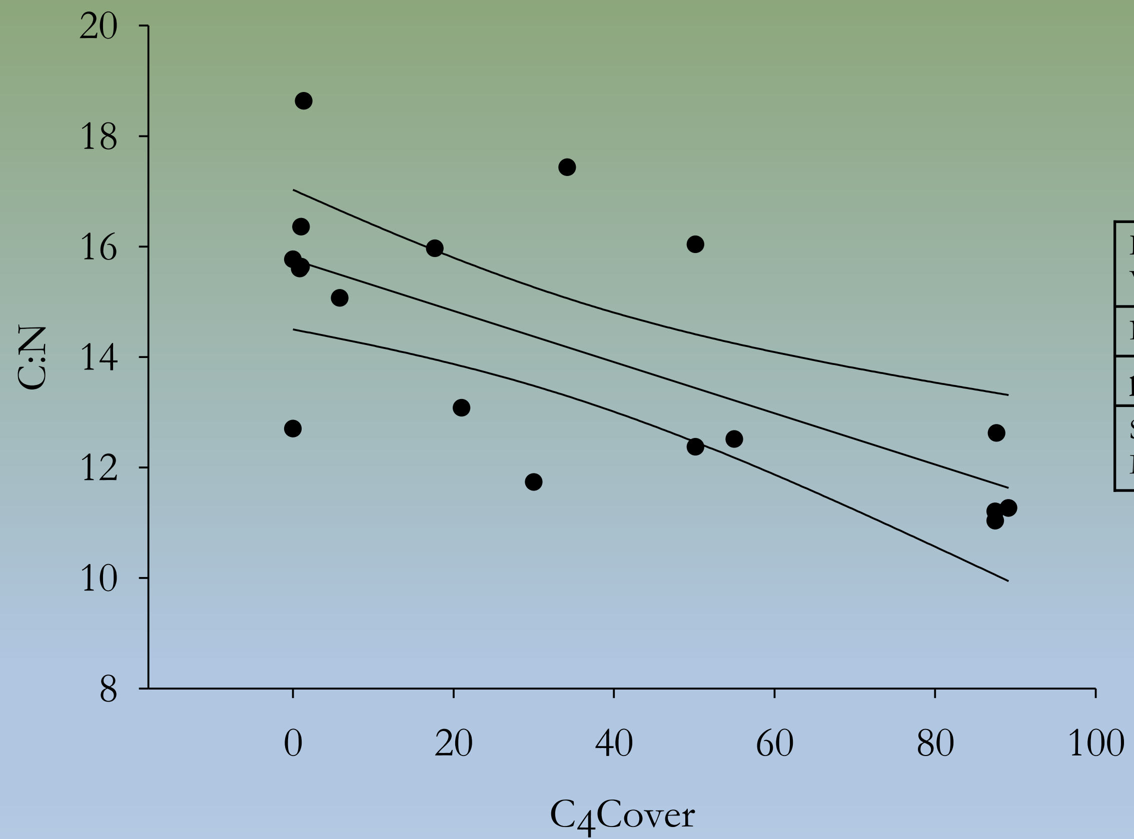
Dependent Variable	P_MGG
N	18
p-value	**0.046**
Squared Multiple R	0.227

C4 and Invasive Species



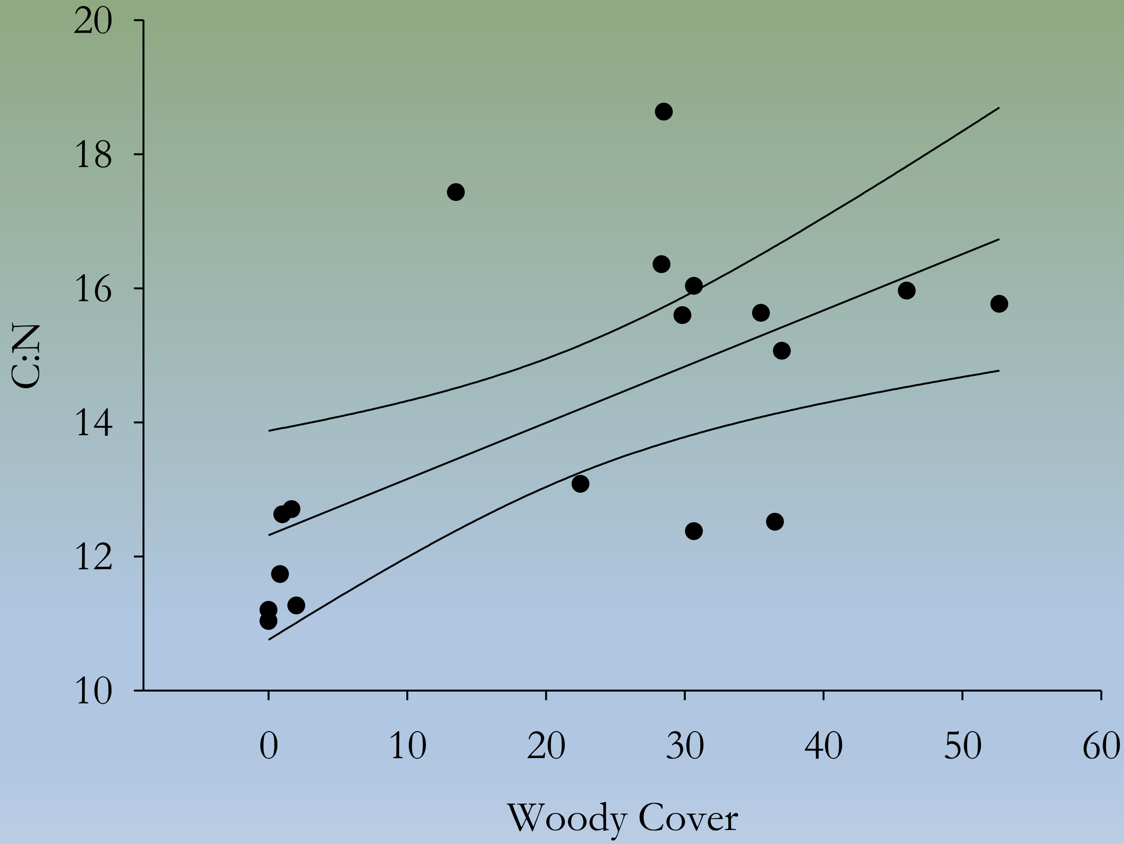
Dependent Variable	P_MGG
N	18
p-value	**0.030**
Squared Multiple R	0.262

C4 and C:N Ratio



Dependent Variable	P_MGG
N	18
p-value	**0.002**
Squared Multiple R	0.468

Woody Cover and C:N Ratio



Dependent Variable	P_MGG
N	18
p-value	**0.006**
Squared Multiple R	0.386

Conclusions and Discussion- Functional Composition

- Restored sites:
  - Higher species richness and functional richness (not significant)
  - Similar to reference sites
    - Higher C4 cover –Similar to non-reference sites though likely driven by Japanese stilt grass
    - Woody cover higher than reference sites

Soils

- P Stocks correlated with higher C4/invasive species cover (Japanese Stilt grass)
- C:N declines as C4 cover increases
- C:N increases as woody cover increases

Next Steps?

- Continue sampling at these stations to capture a longer time period
- Add instream work – benthic macroinvertebrates, mussels.
- Incorporate direct ecosystem process measurements on floodplain and instream (i.e. Soil CO_2 flux, N and P mineralization and uptake rates)
- Calculate total carbon stocks from existing data using allometric equations.
- Increase the size of the sample frame beyond these four stations

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GARDEZ BIEN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

National Fish and Wildlife Foundation

Translation by Kevin Wilsey

What does this mean for me?

<u>What do I take from this if I am a practitioner</u>:

- Does biodiversity impact performance and water quality?
  - If yes, do we get more credit?

<u>What do I take from this if I am a regulator</u>:

- What are realistic site conditions post-restoration? Can a biodiverse site be achieved?
- Does biodiversity impact water quality? Good or bad?
- Are there potential changes to the plant communities that can have more or less impact on water quality?