Benthic Macroinvertebrate Responses to the Muddy Creek RSC Restoration

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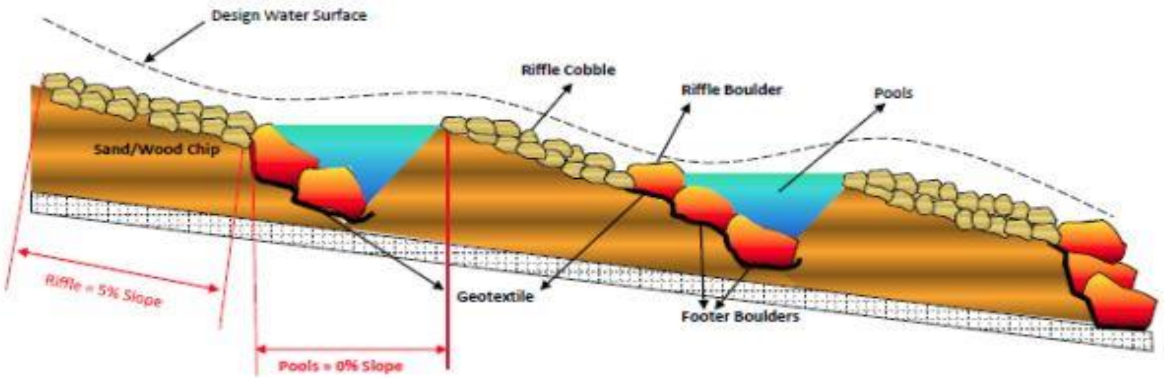
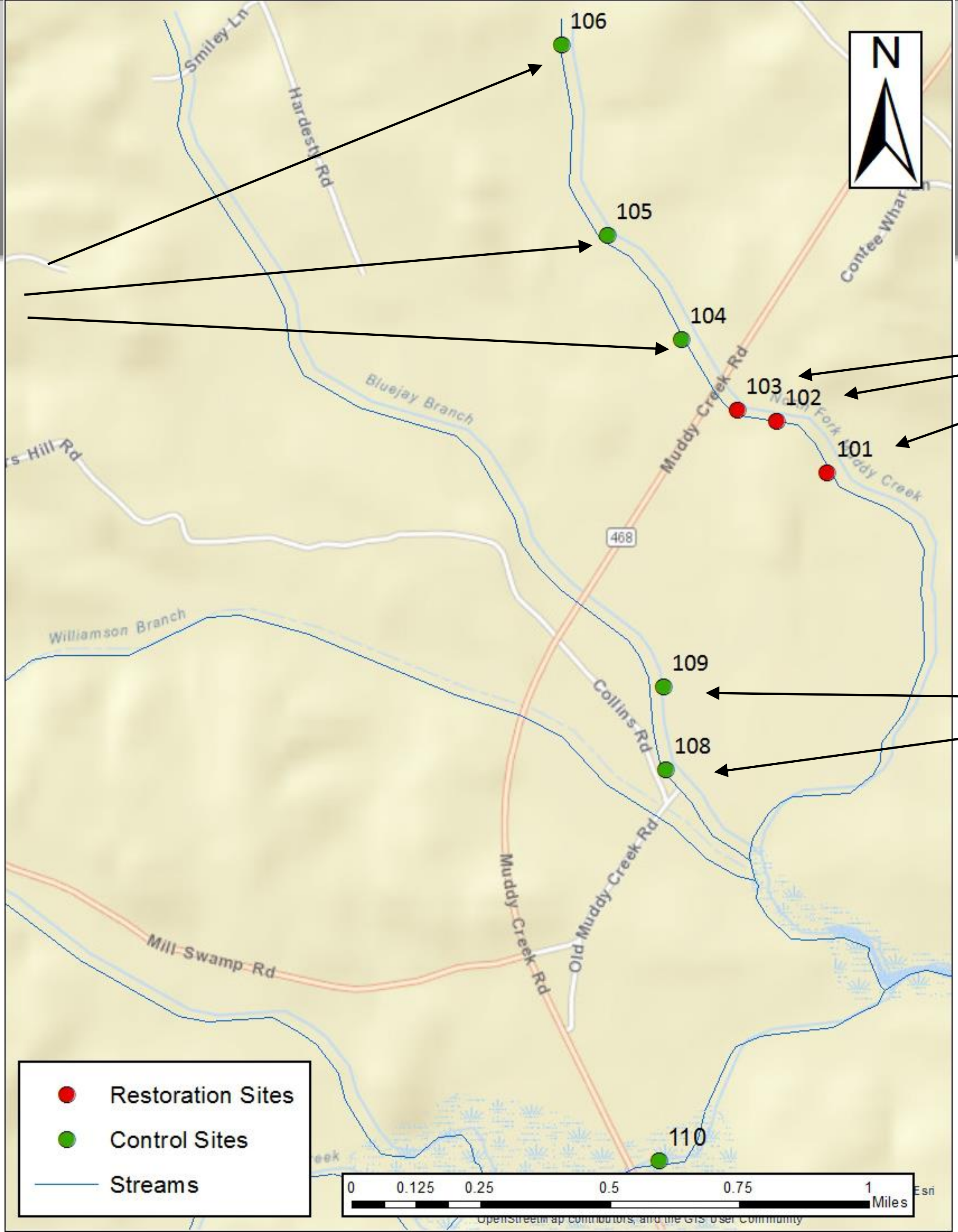
Muddy Creek Background

- A 450-meter section of North Branch Muddy Creek (Muddy Creek) was restored in January 2016 with a Regenerative Stormwater Conveyance (RSC) restoration design, a practice that is gaining in popularity.
- This section was restored because of its deeply incised channel, and to reduce sediments and nutrients from reaching the Bay.
- Limited knowledge about benthic macroinvertebrate responses to RSC restoration.
- In 2014, MDNR established 8 benthic macroinvertebrate monitoring sites to monitor responses to the Muddy Creek RSC restoration (2 years pre, 2 years post).



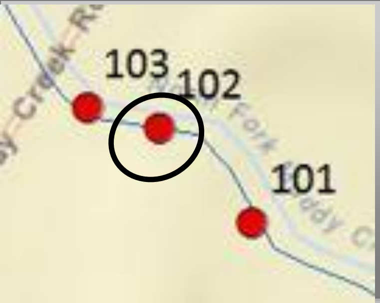
Source: Anne Arundel County, 2011

Upstream Control Sites (Muddy Creek)



Restoration Sites:
Pre- 2014 – 2015
Post- 2016 – 2017

Adjacent Control Sites (Bluejay Branch)



Restoration Site 102 - Spring

2015 – Pre-Restoration

2016 – Post-Restoration

Control Sites - Spring

Site 104 - Upstream

Site 105 - Upstream

Site 106 - Upstream

Site 108 - Adjacent

Site 109 - Adjacent

Benthic Macroinvertebrate Sampling Methods

- Samples were collected at each 75m site using a 540 µm D-net during the Spring Index Period (Mar 1 – Apr 30) between 2014 and 2017.
- 20 1ft^2 jabs were taken within each site to represent diversity of habitat. Most stable, lotic habitats are preferred – more productive.
- Minimum of 100 randomly selected individuals from each sample were identified to the lowest taxonomic level.

Pre	**N=6**
Post	**N=6**
Upstream	**N=12**
Adjacent	**N=8**

Benthic Macroinvertebrates as Biological Indicators

- Large # of species with predictable responses.
- They are less mobile than fish and cannot easily escape local perturbations.
- Fast recolonization potential after disturbances (insects), and are not limited by in-stream barriers.
- Samples are given quantitative scores to determine relative stream condition.

Benthic Index of Biotic Integrity (BIBI)

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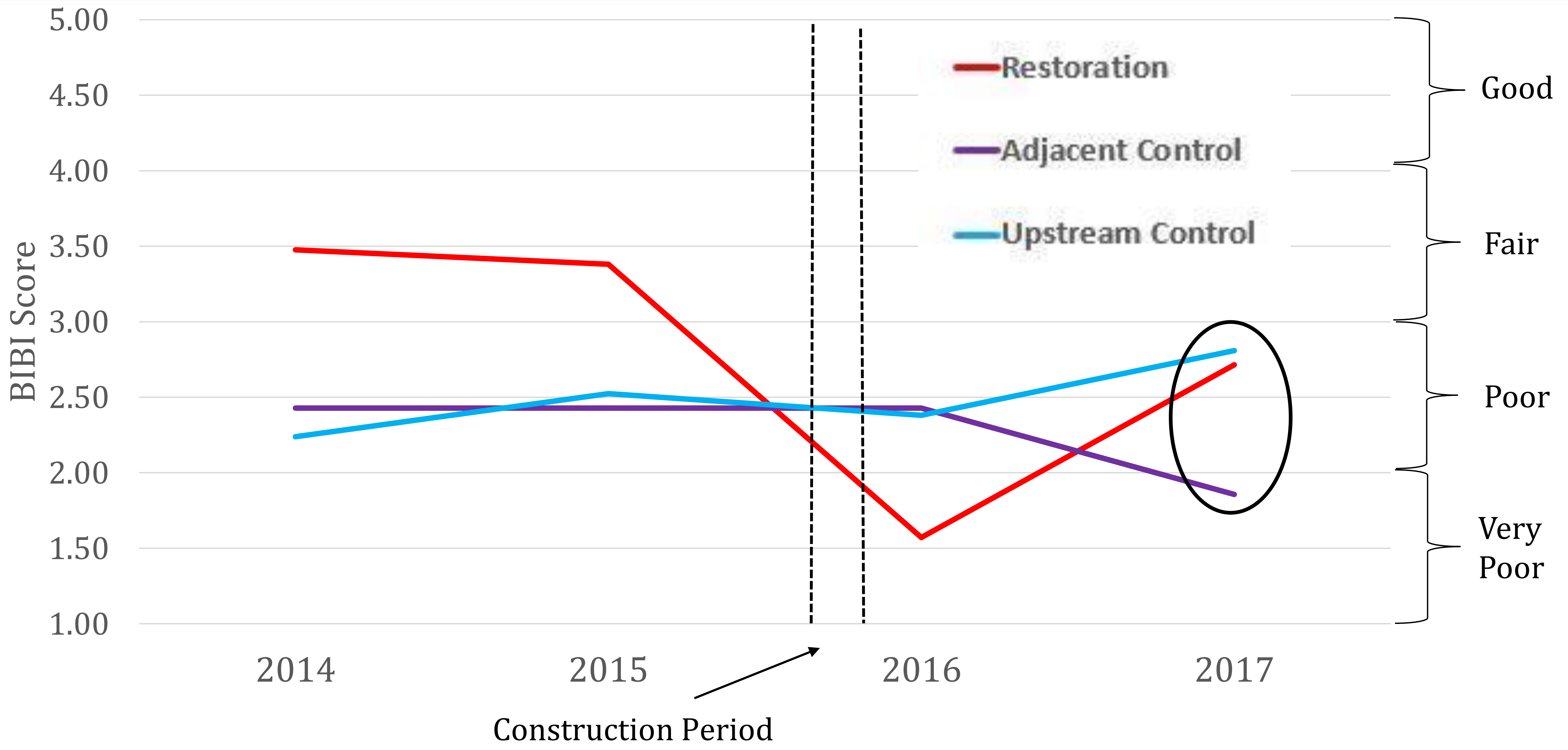
	Thresholds		
Metric Score	**5**	**3**	**1**
Number of Taxa	≥ 22	14 – 21	< 14
Number of EPT Taxa	≥ 5	2 – 4	< 2
Number of Ephemeroptera Taxa	≥ 2	1 – 1	< 1
Percent Intolerant Urban	≥ 28	10 – 27	< 10
Percent Ephemeroptera	≥ 11	0.8 – 10.9	< 0.8
Number of Scraper Taxa	≥ 2	1 – 1	< 1
Percent Climbers	≥ 8	0.9 – 7.9	< 0.9

IBI Score	Narrative Ranking
4.0 – 5.0	Good
3.0 – 3.9	Fair
2.0 – 2.9	Poor
1.0 – 1.9	Very Poor

- Indices of biotic integrity (IBIs) are calculated based on metrics that are indicative of stream health, as evidenced by impacts on the biotic community.
- Raw values found for each metric are given a score of 5, 3, or 1 (5 best, 1 worst). All metric scores are summed and then averaged to obtain the final BIBI score that ranges from 1.0 to 5.0.

Average BIBI Scores



Why Poor BIBI Scores?

Restoration Site 101 - Fall

Restoration Site 102 - Summer

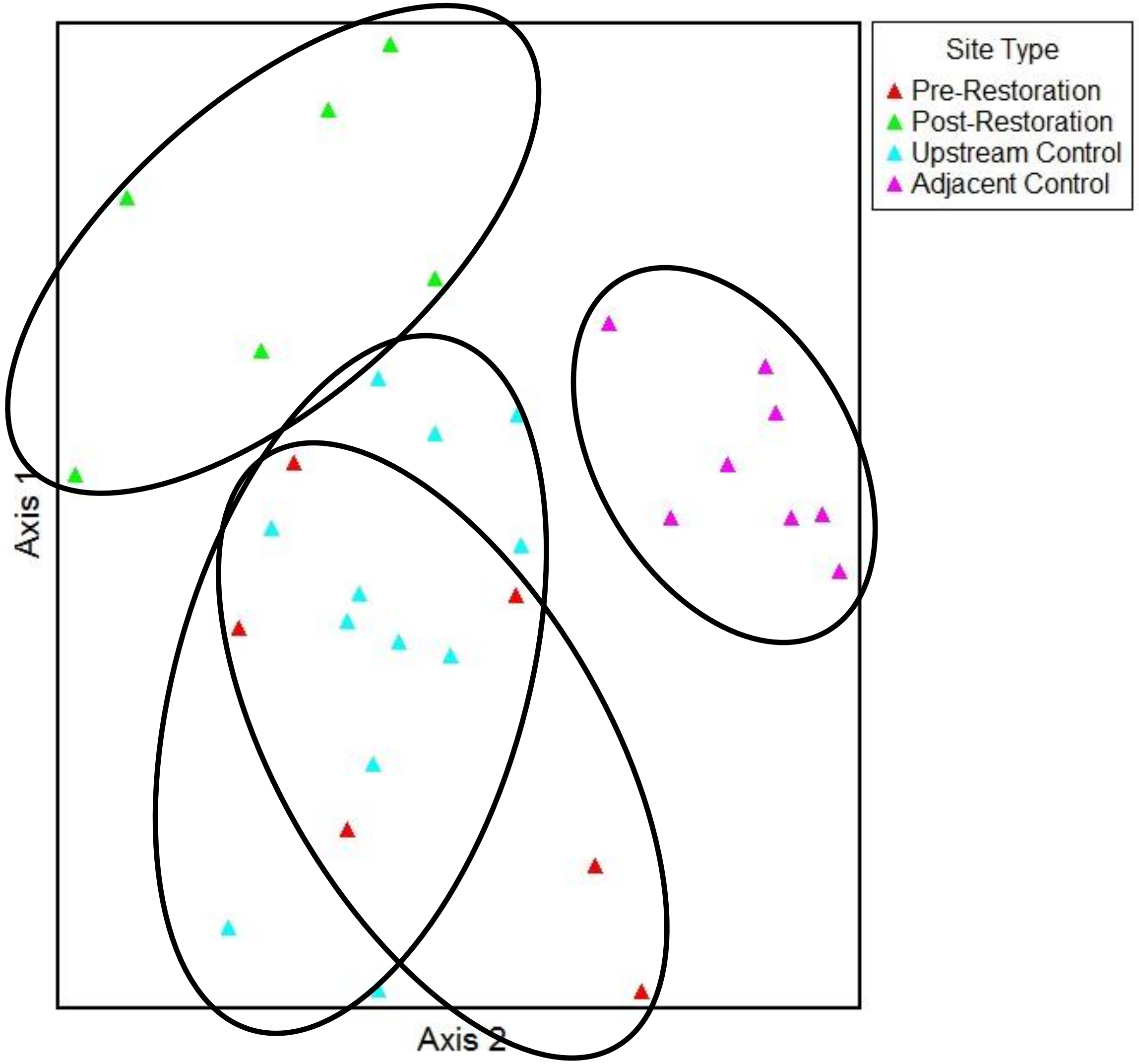
Restoration Site 103 - Summer

Adjacent Control Site 109 - Fall

Upstream Control Site 106 - Summer

Not a perennial stream system….so what kind of bugs can live in these conditions?

Non-Metric Multidimensional Scaling Graphics

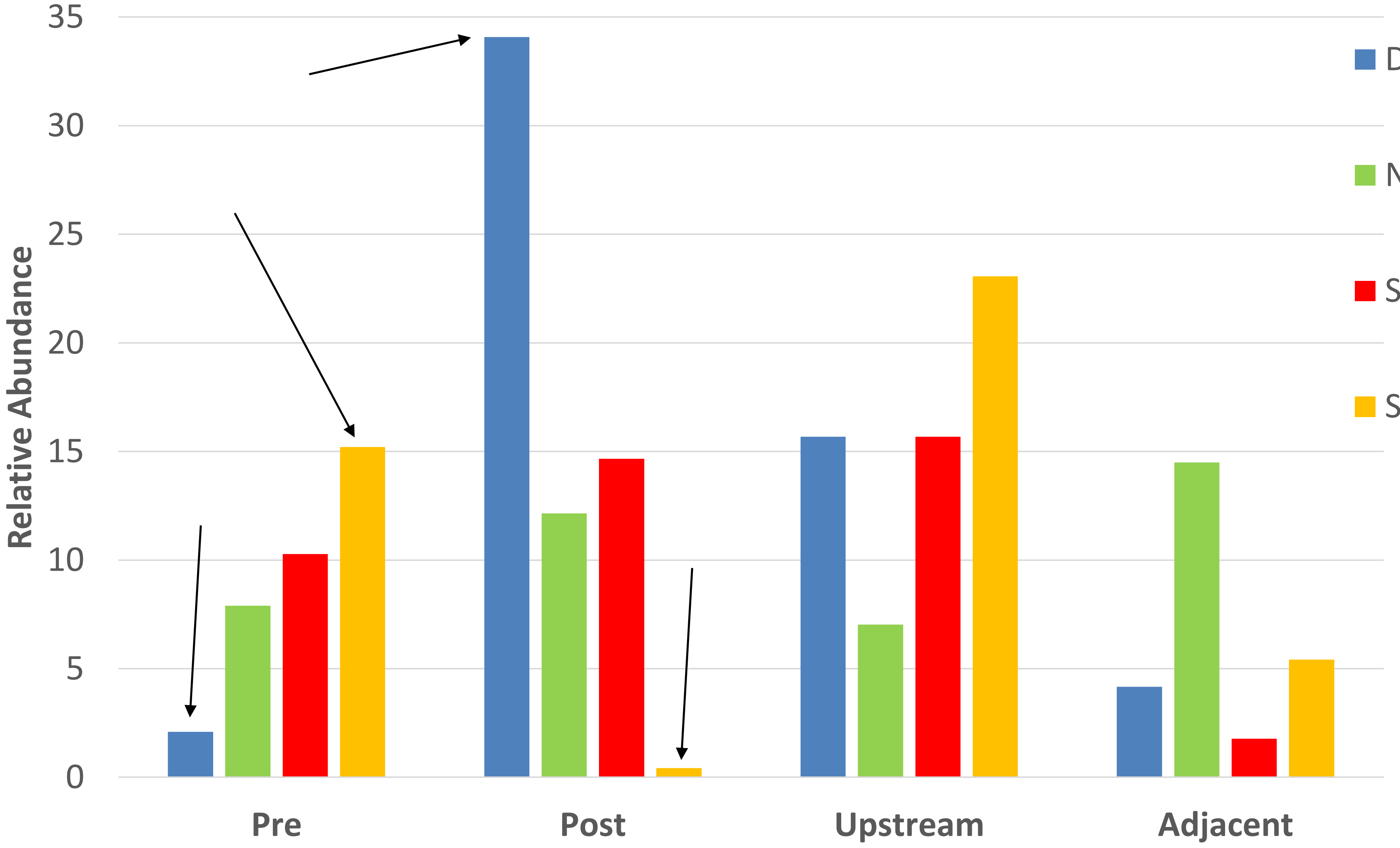


- NMDS is a quick way to visualize differences in community compositions.

- Each triangle represents one sample, consisting of at least 100 benthic macroinvertebrates.

- What taxa are driving this separation in ordination space?

Most Dominant Taxa



Synurella

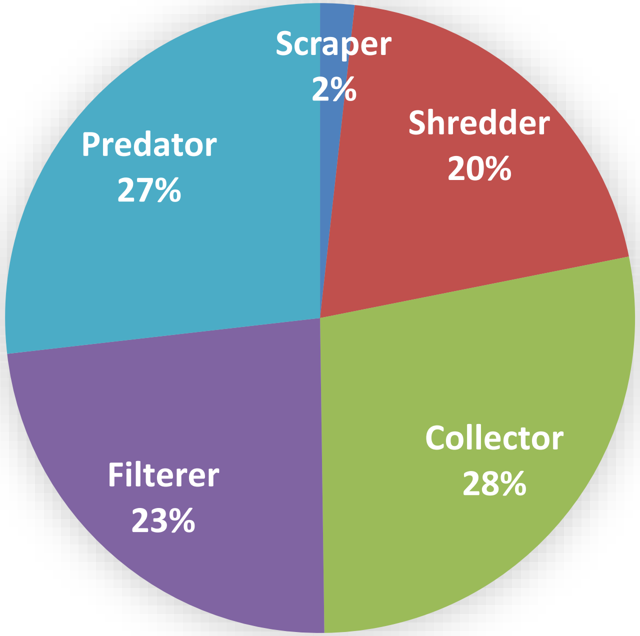
Indicator Species Analysis

	Taxon	Family	IV	p	TV	FFG	Habit
Pre-Restoration	**Pisidiidae**	**Pisidiidae**	**57.6**	**0.0160**	**6.5**	**Filterer**	**Unk**
	Siphlonurus	**Siphlonuridae**	**54.0**	**0.0200**	**7**	**Collector**	**sw, cb**
Post-Restoration	**Diplocladius**	**Chironomidae**	**44.4**	**0.0090**	**5.9**	**Collector**	**sp**
Upstream Control	**Synurella**	**Crangonyctidae**	**36.2**	**0.0330**	**0.4**	**Unk**	**Unk**
Adjacent Control	**Mesocricotopus**	**Chironomidae**	**100.0**	**0.0000**	**6.6**	**Unk**	**Unk**
	Orthocladius	**Chironomidae**	**48.4**	**0.0070**	**9.2**	**Collector**	**sp, bu**
	Hydrobaenus	**Chironomidae**	**45.5**	**0.0380**	**7.2**	**Scraper**	**sp**
	Caecidotea	**Asellidae**	**38.2**	**0.0176**	**2.6**	**Collector**	**sp**

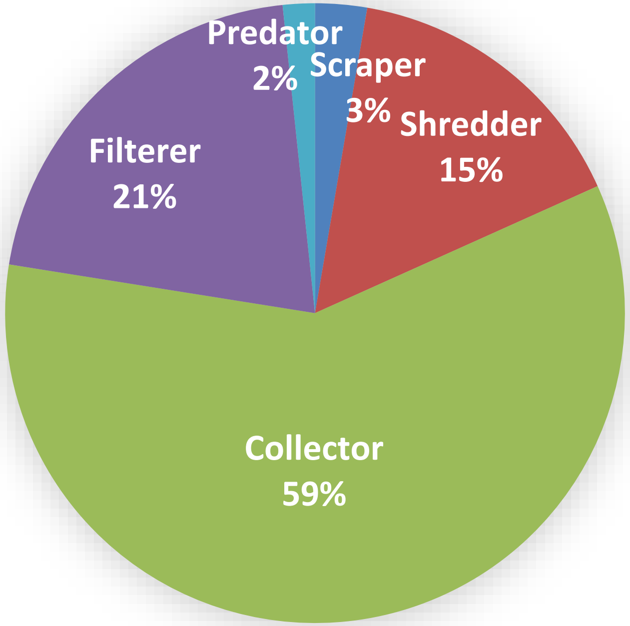


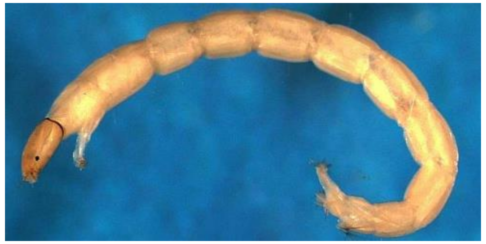

Functional Feeding Group Changes

Pre-Restoration



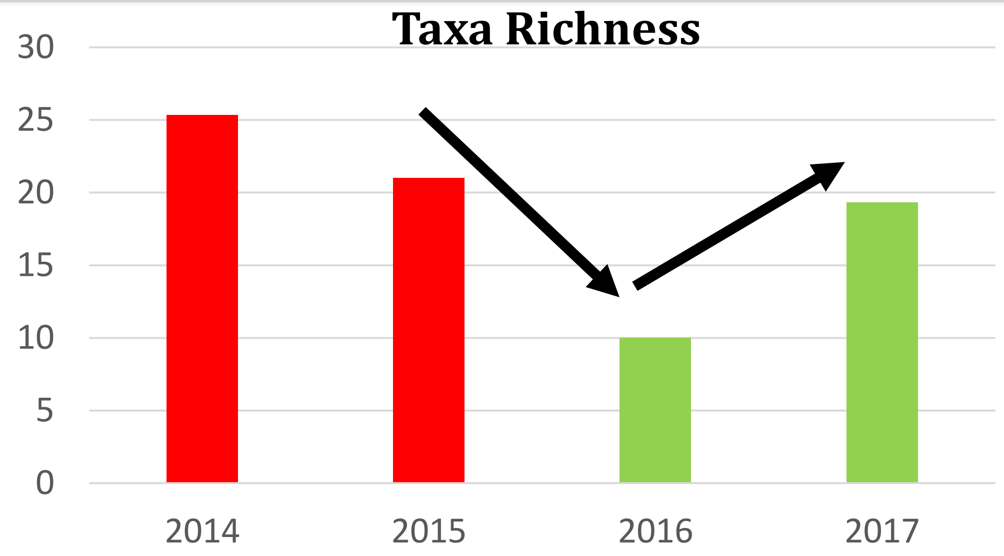
Post-Restoration

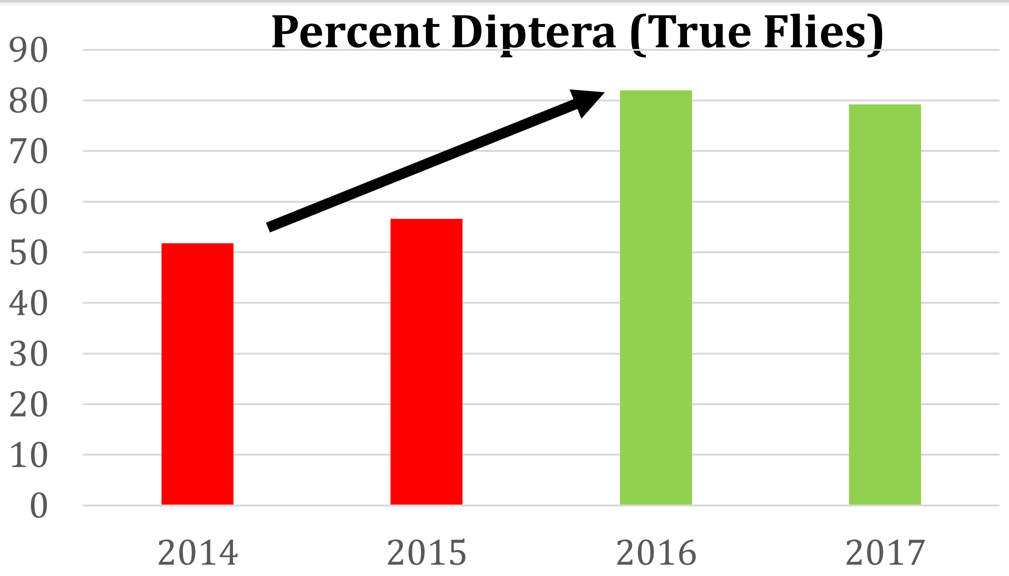


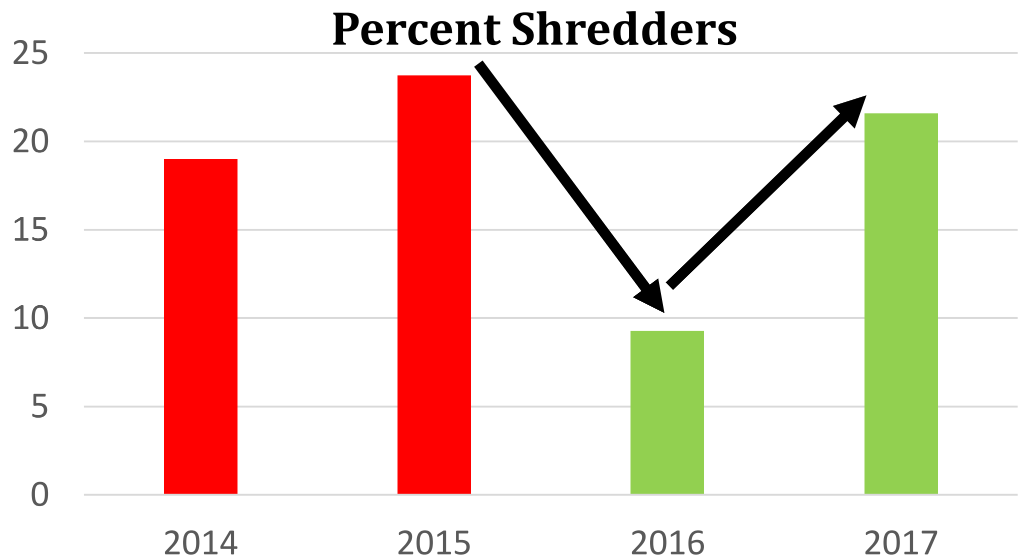


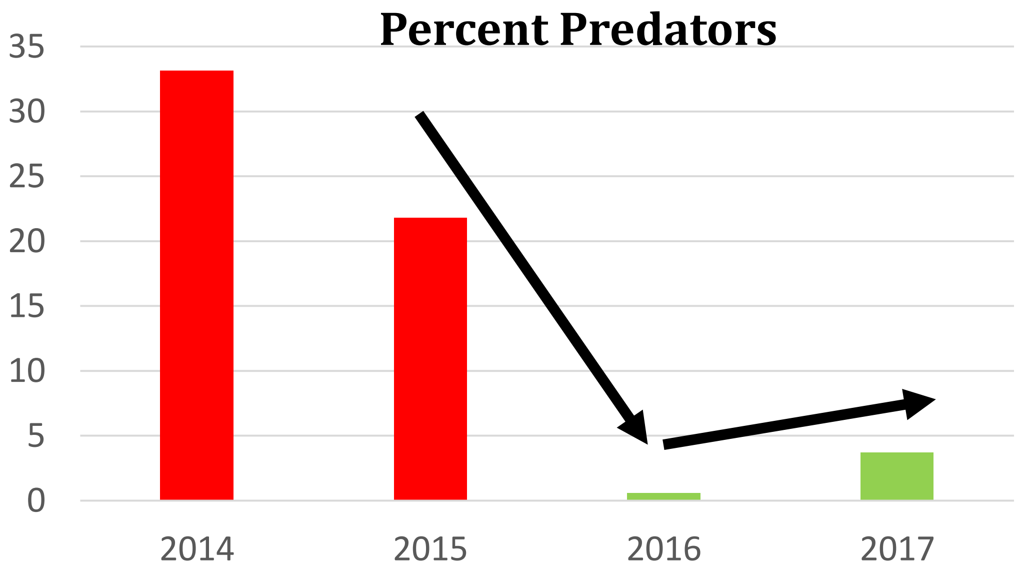
- Pre-restoration has an even balance of FFG's
- Decrease in predators (Ceratopogonidae *and Zavrelimyia*) and increase in collectors (*Diplocladius*) post-restoration

Restoration Reach Metric Changes

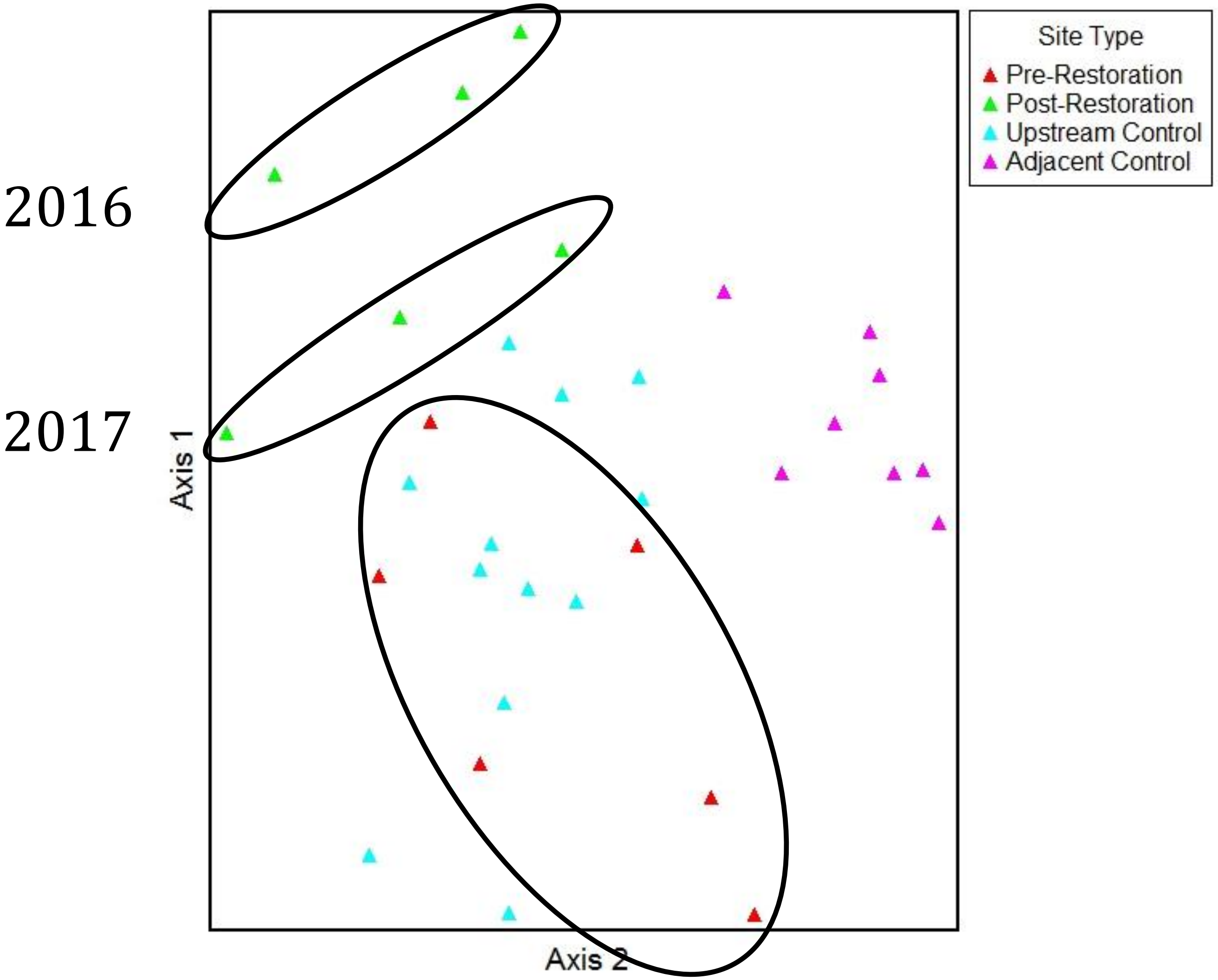






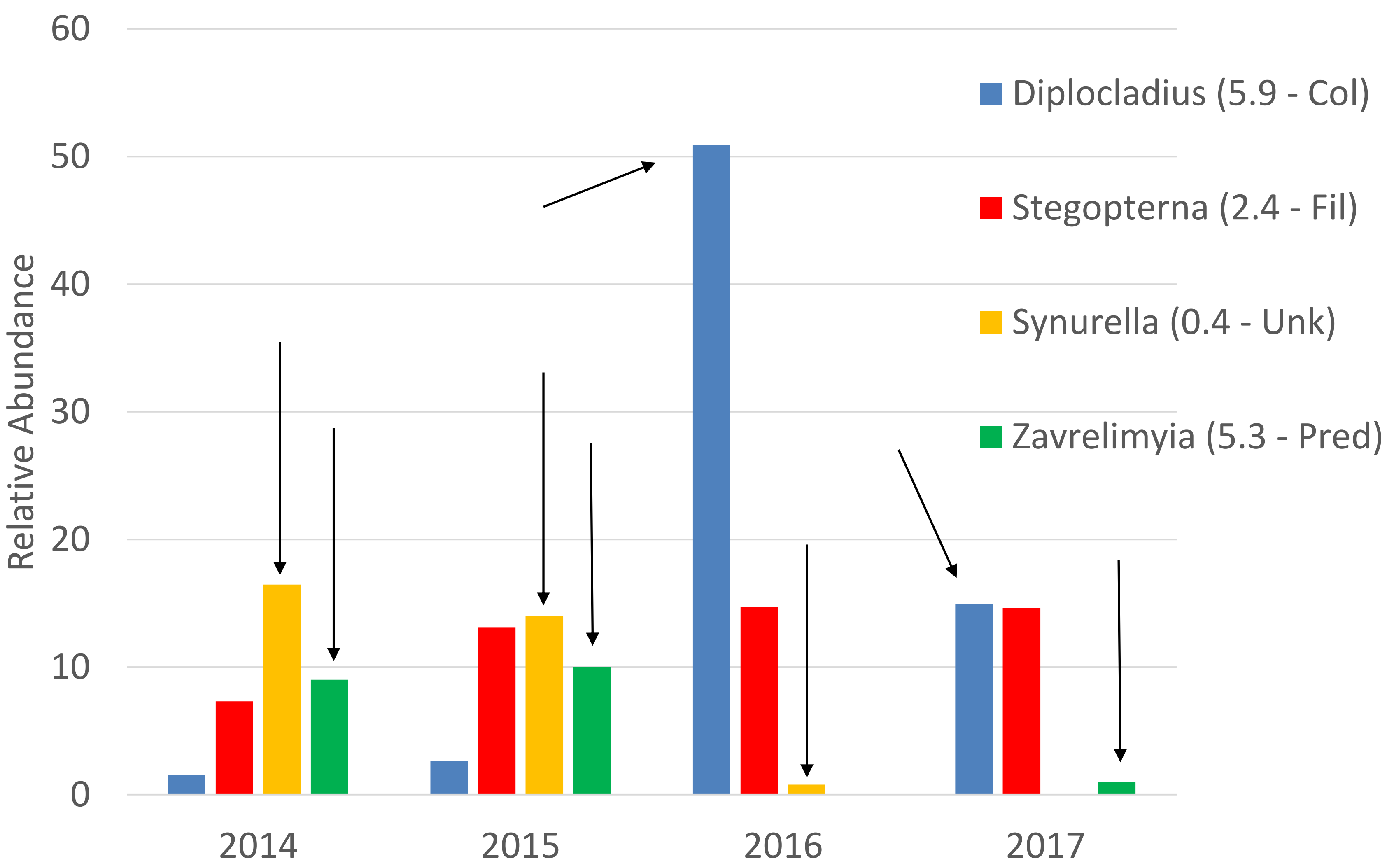


Post-Restoration Comparison



- 2017 post-restoration samples are closer in ordination space to pre-restoration and upstream control samples.
- Early indication of a shift towards pre-restoration conditions?

Post-Restoration Taxonomic Changes



- *Diplocladius* is highly dominant in 2016, less dominant in 2017
- Both *Synurella* and *Zavrelimyia* decrease significantly post-restoration
- *Siphlonurus* (7.0 – Col), *Caecidotea* (2.6 – Col) never returned

Conclusions

- Despite 2017 data suggesting some ecological recovery since restoration in 2016, some taxa have not yet recolonized post-restoration. Post-restoration samples were dominated by lotic Diptera (Chironomidae, Simuliidae) and lotic Nemouridae (intolerant Stonefly).

- Not ideal results in the literature; many restoration structures have negative or no significant impacts on benthic macroinvertebrates communities, some have positive impacts (urban streams).

- Too early to determine if macroinvertebrates have responded positively or negatively. Some studies suggest benthic recolonization is still occurring 20-50 years after restoration.



Questions?

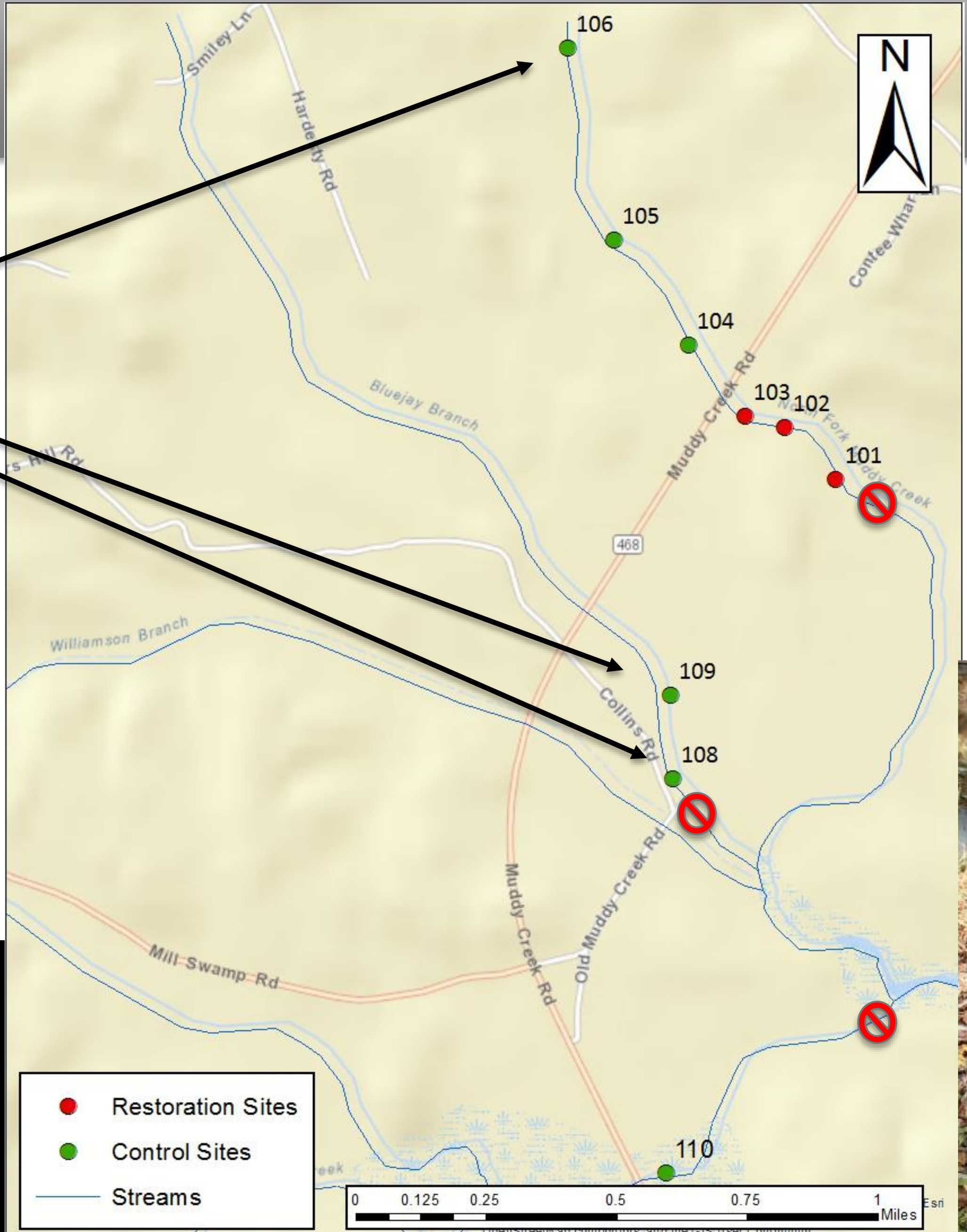
Thanks to Ellen Friedman and Neal Dziepak for identifying thousands of benthic macroinvertebrates for this project!

Fish Results – Summer

Control Sites

No fish observed

104 & 105:
American eel & goldfish
(5 individuals total pre-restoration, none post)

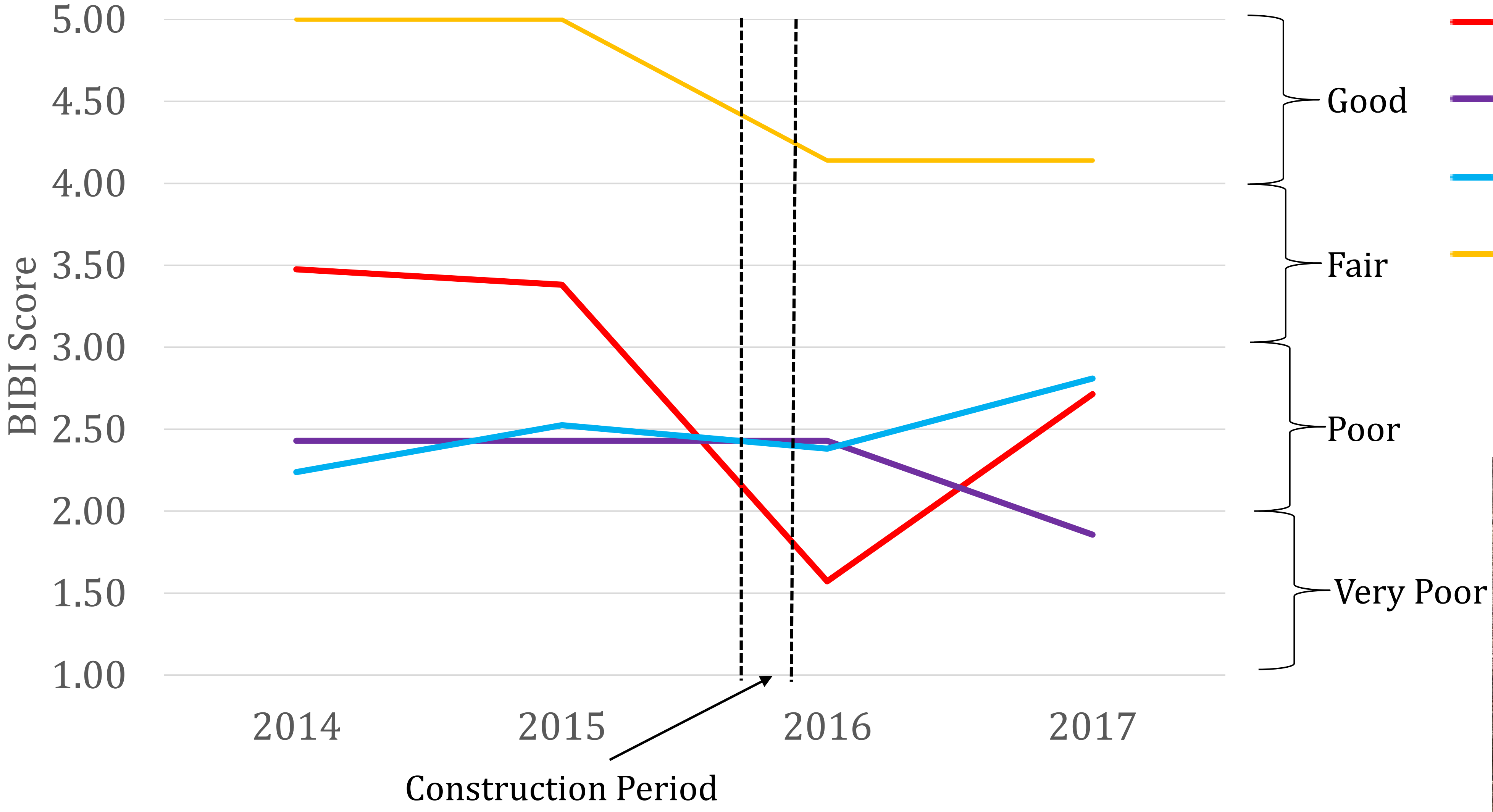


Restoration Sites

Pre- Green sunfish, golden shiner, bluegill, LMB

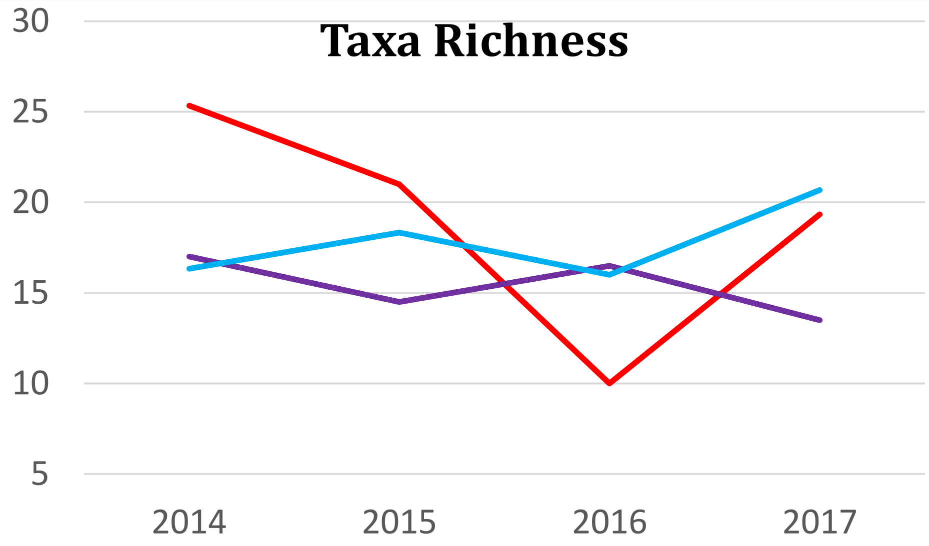
Post- Eastern mosquitofish

Reference Comparison – Reeder Run

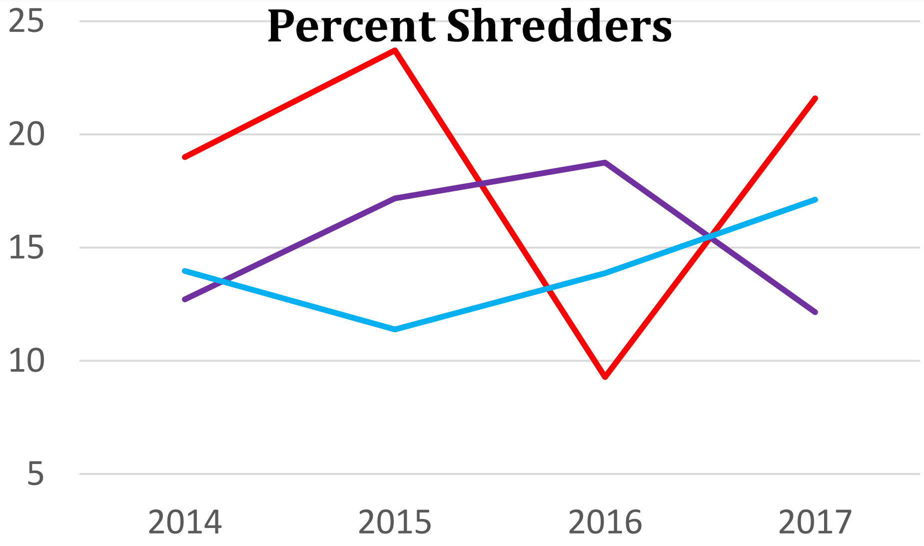


Reeder Run

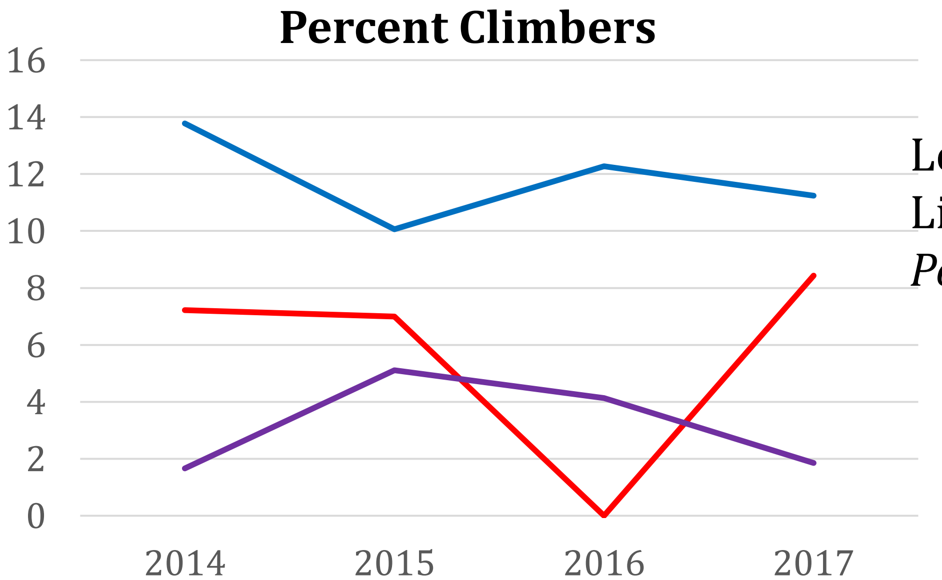
Response to Restoration



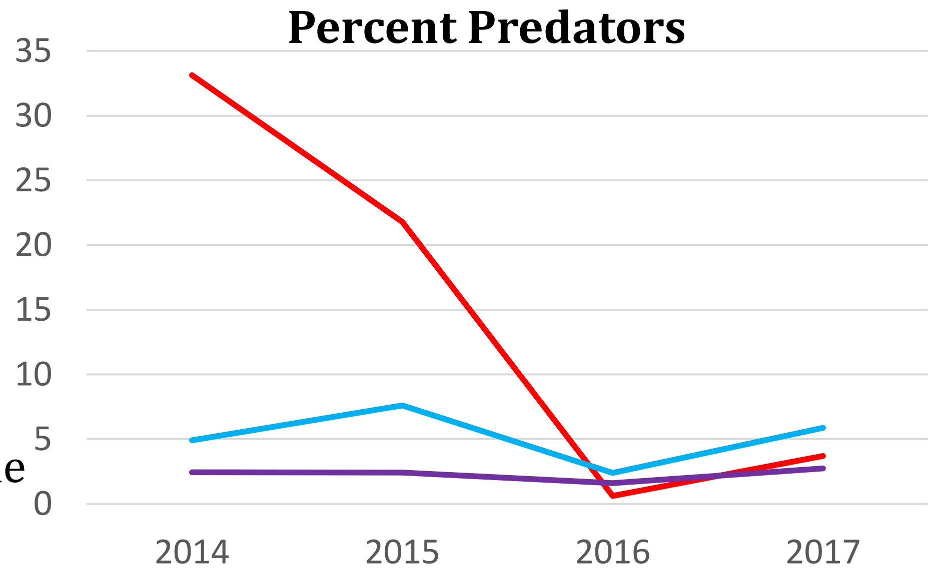
Decrease in
Trichoptera



Restoration
Adjacent Control
Upstream Control



Loss of
Limnephilidae,
Polypedilum



Loss of
Ceratopogonidae
and *Zavrelimyia*