Comparing the Biology of Restored Urban Streams to Non-Urban Streams

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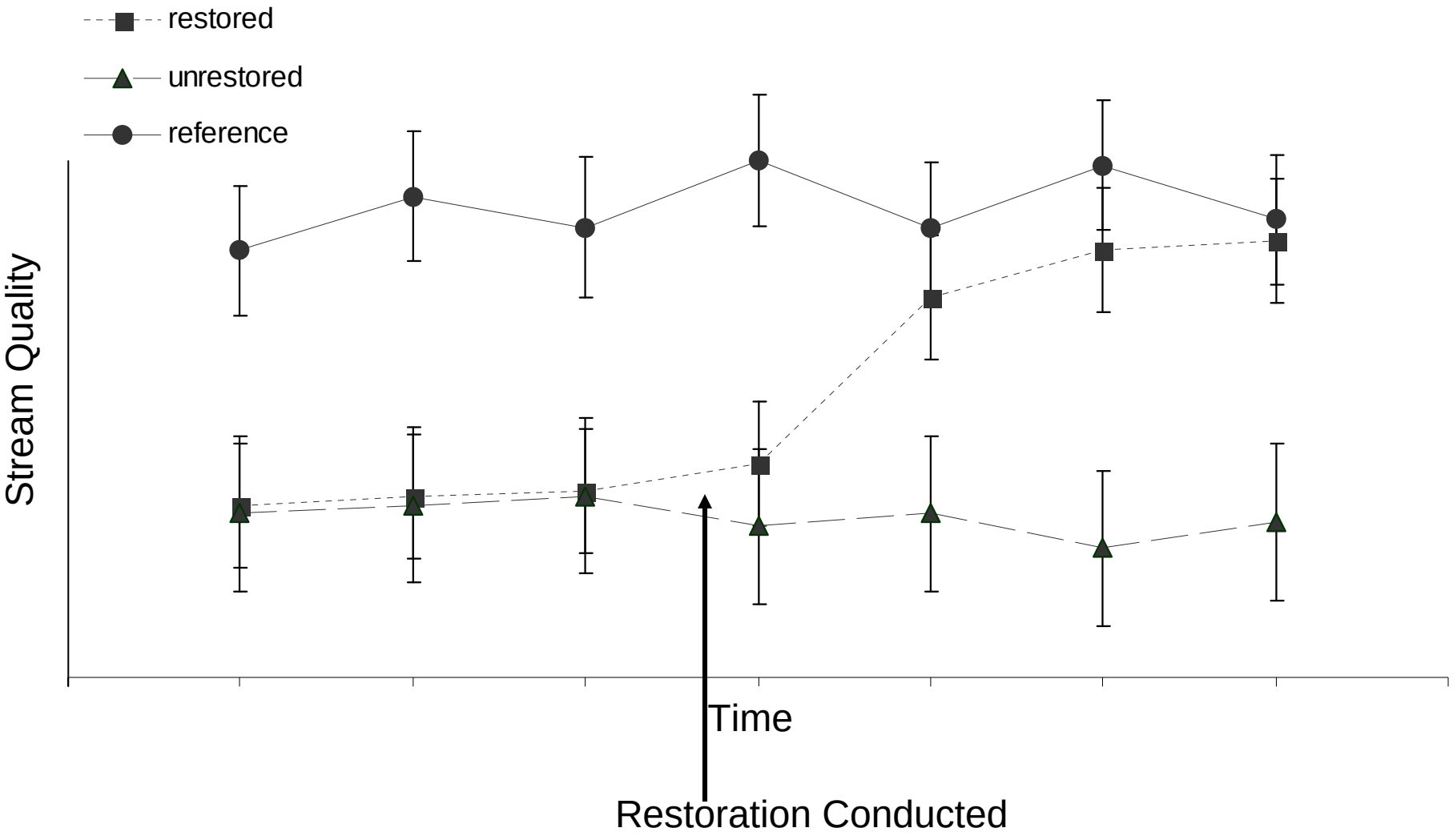
Hypothetical Graph of Restoration Expectation



Urban Restored Streams

All > 60% Urban (NLCD 2001)

Substantial Restoration Conducted

Sligo Creek
Stormwater Retrofits (8)
Created Wetland (1)
Channel Recon (2,670 ft)
Tree Planting
Fish Stocked (23 spp, 6 events)
Completed ~2001
About $2.6 Million

Minebank Run
Remove Concrete (500 ft)
Channel Recon (3.5mi)
Tree Planting

Completed 2005
About $4.0 Million

Longwell Branch
Stormwater Ponds Added (2)
Fortify Banks (~400 ft)
Tree Planting

Completed 1998
About $600,000

Reference Streams

3 of 27 MBSS Sentinel Sites (Best Streams in MD)

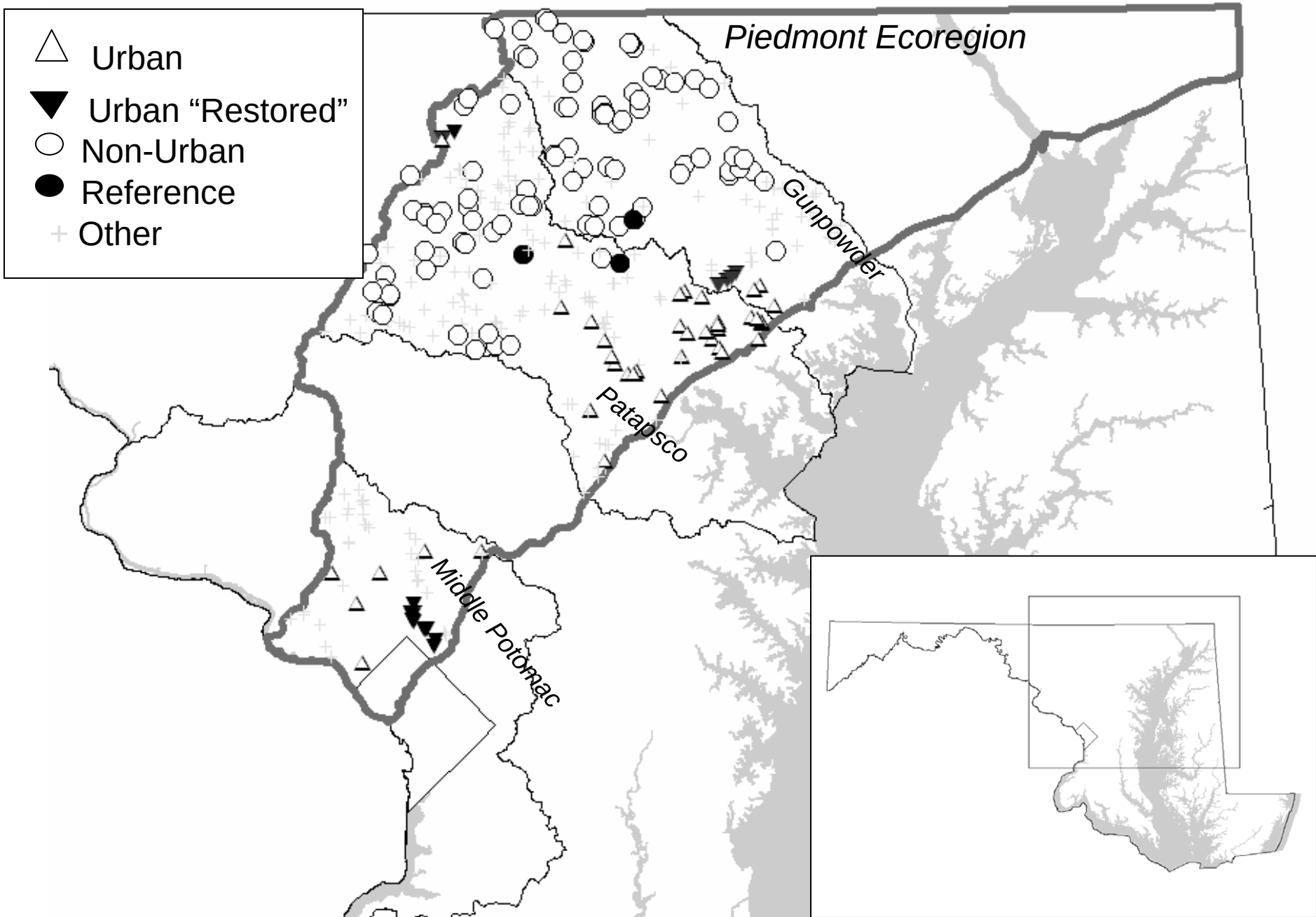
All less than 1% Urban and > 60% Forest (NLCD 2001)

Baisman Run

NB Jones Falls

Timber Run

Sites


Urban
Urban "Restored"
Non-Urban
Reference
Other
Piedmont Ecoregion
Gunpowder
Patapsco
Middle Potomac

Disclaimer

Examined stream biology only, and did not take into account the potential benefits of nutrient and sediment reduction following restoration

Biological Data

Benthic Macroinvertebrate

- IBI
- [illegible]

Spatial Differences?

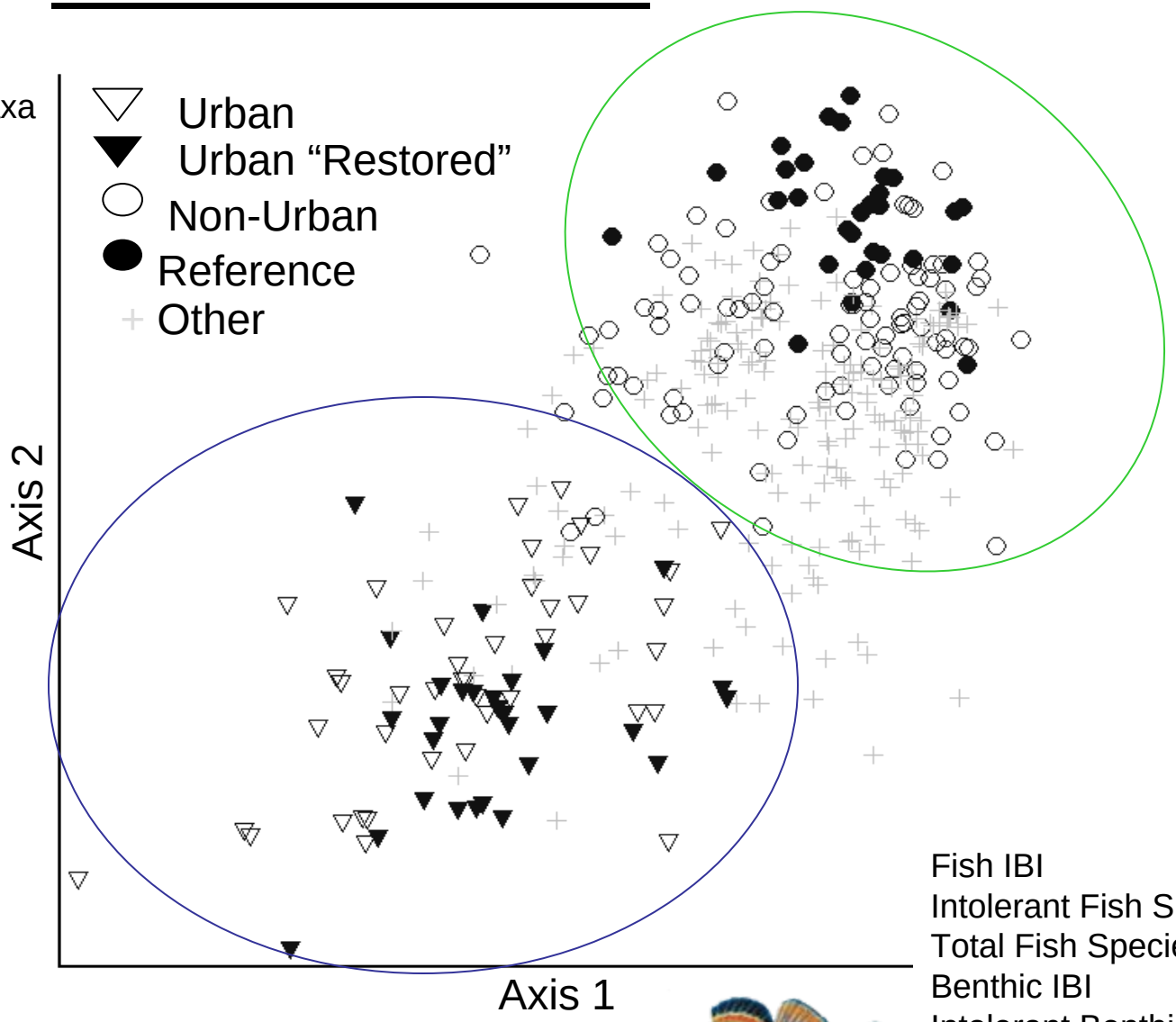
Change Over Time?

Fish

- IBI
- Number of Species (adj. stream size)
- Number of Intolerant Species
- Trout Density
- Sculpin/Darter Density

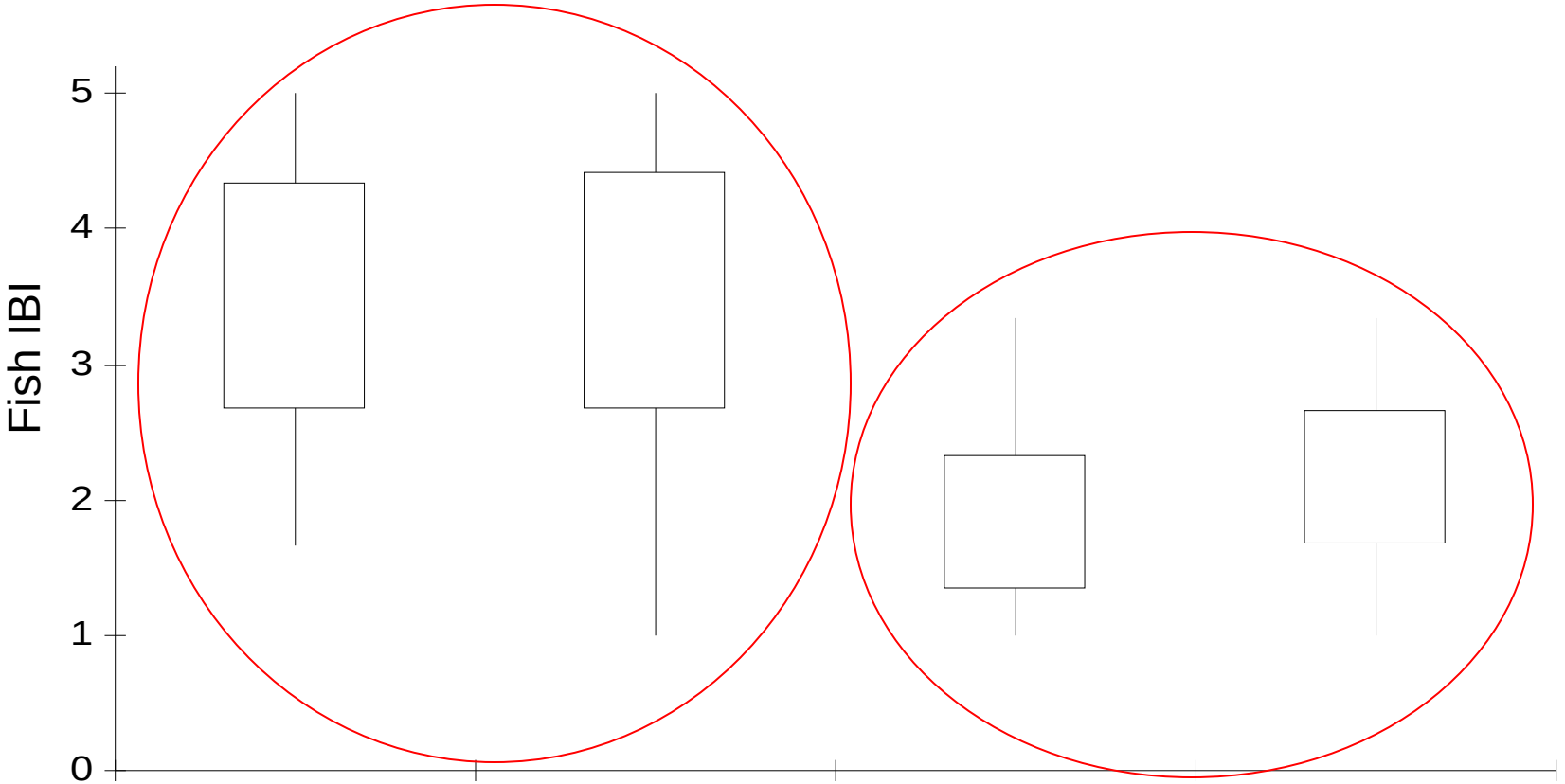
Ordination Results

Benthic IBI
Intolerant Benthic Taxa
Total Benthic Taxa
Mayfly Taxa
Stonefly Taxa
Trout Density



Fish IBI
Intolerant Fish Species
Total Fish Species
Benthic IBI
Intolerant Benthic Taxa
Total Benthic Taxa
Mayfly Taxa

Fish Variables



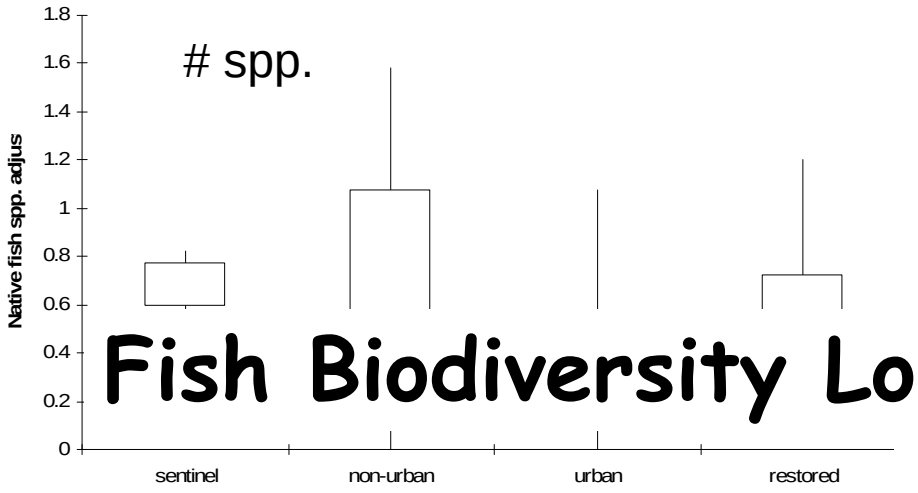
Reference
N=30
3 sites x 10 year

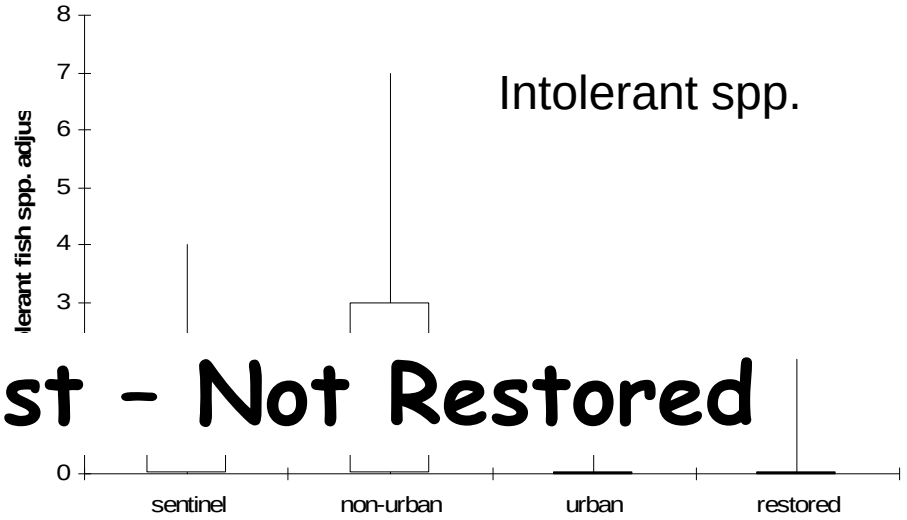
Non-Urban
N=96

Urban
N=44

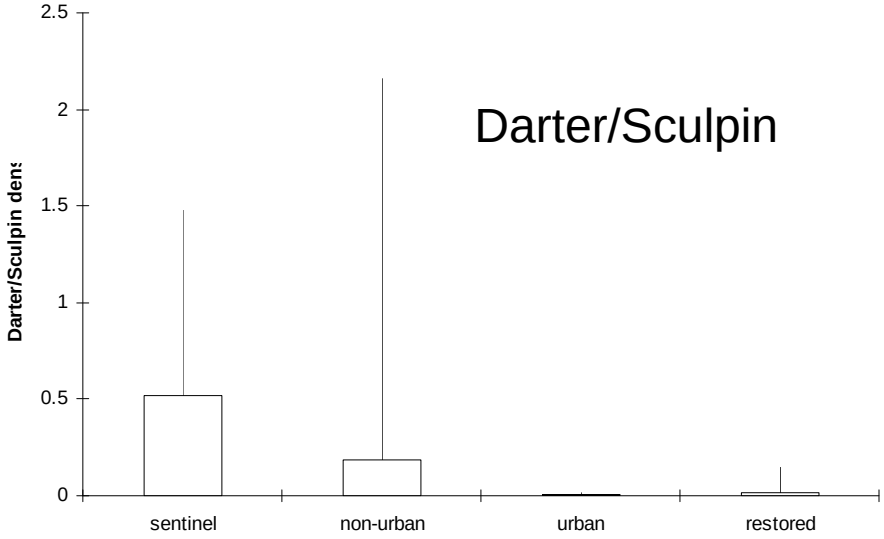
Restored
N=31
11 repeated samples

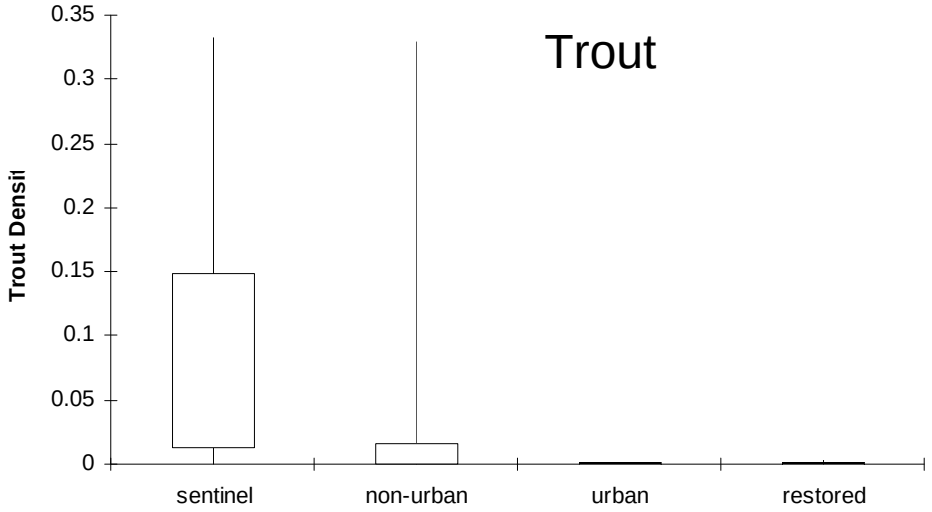
Fish Variables Continued…



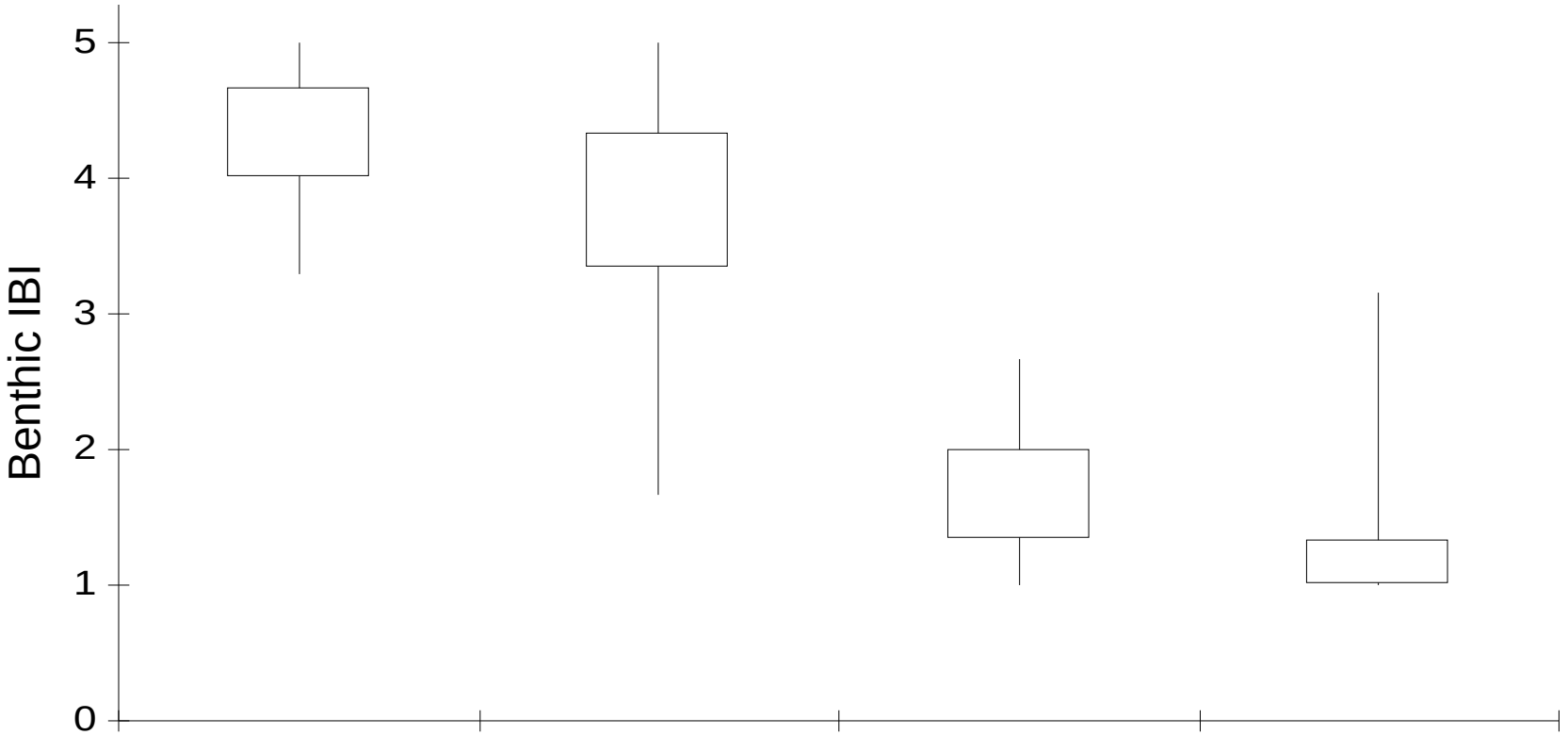


Fish Biodiversity Lost – Not Restored





Bug Variables



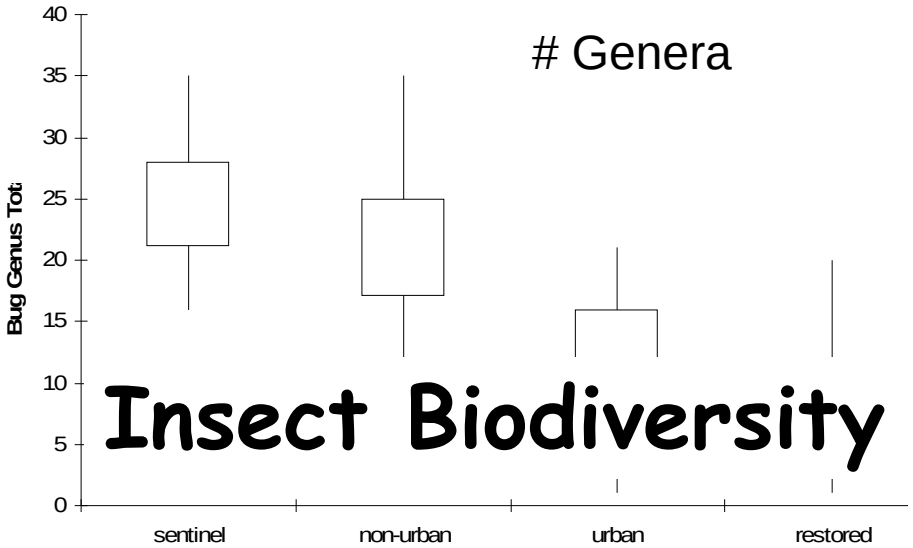
N=30
3 sites x 10 year

N=96

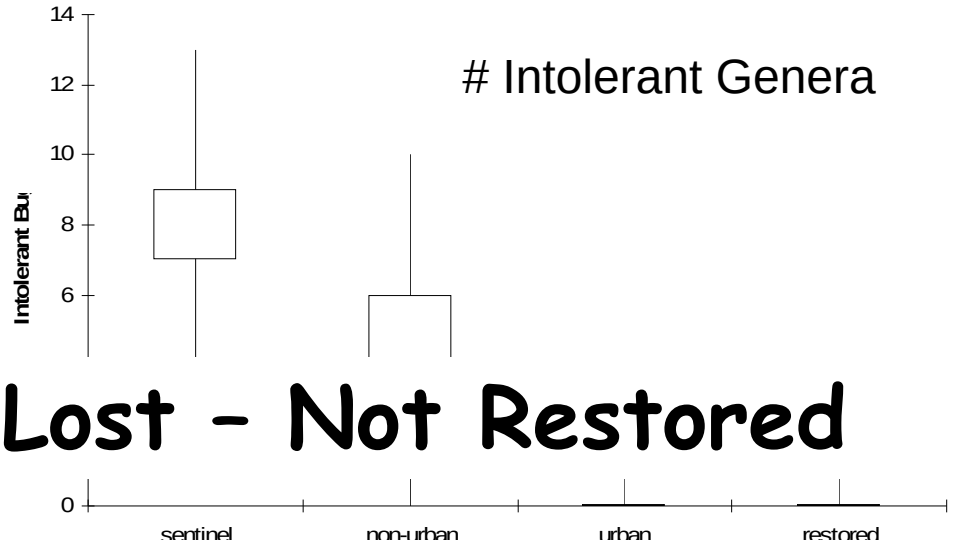
N=44

N=52
26 repeated samples

Bug Variables Continued…

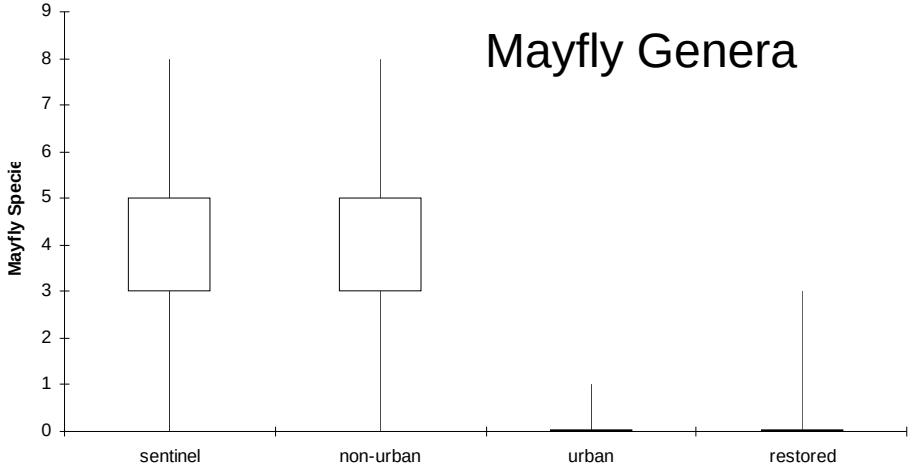


Genera

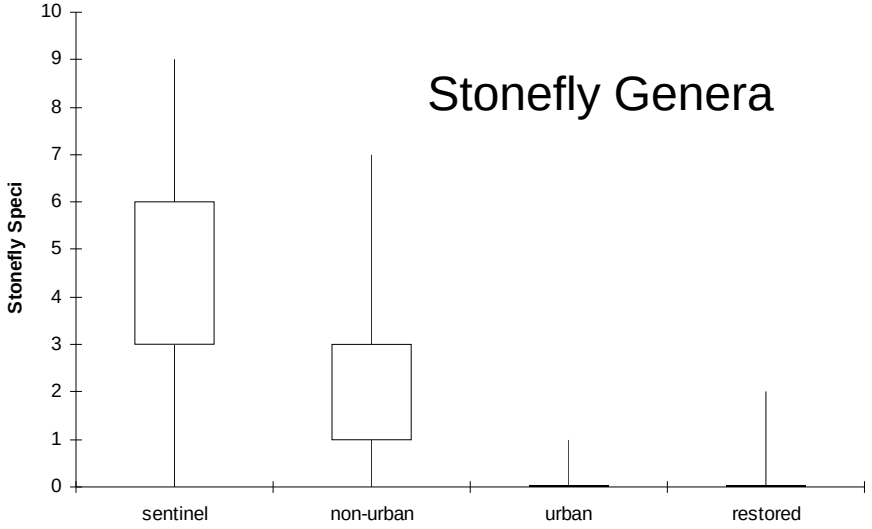


Intolerant Genera

Insect Biodiversity Lost – Not Restored

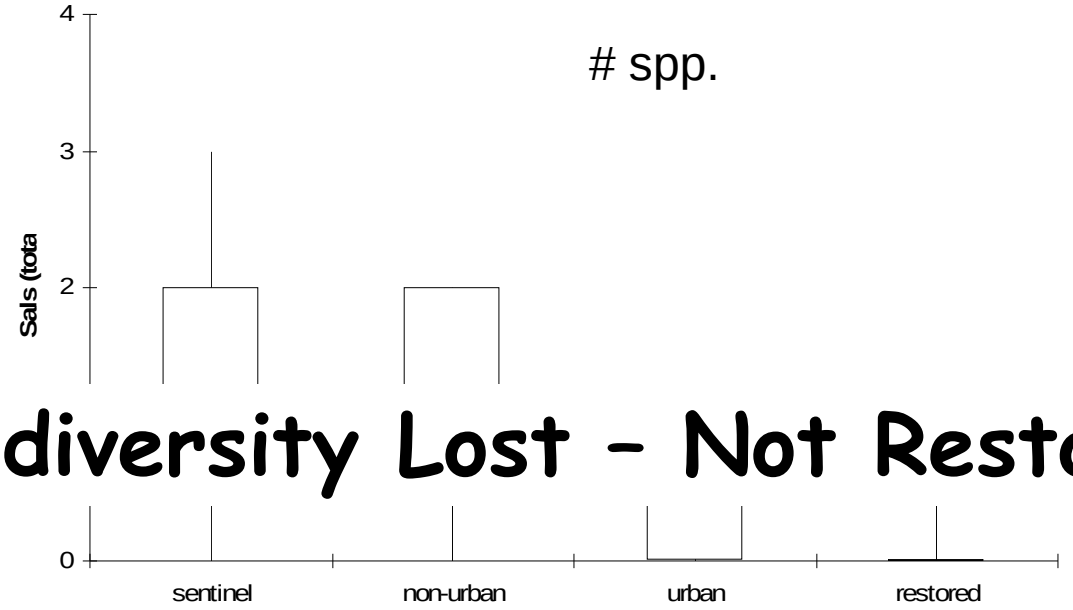


Mayfly Genera



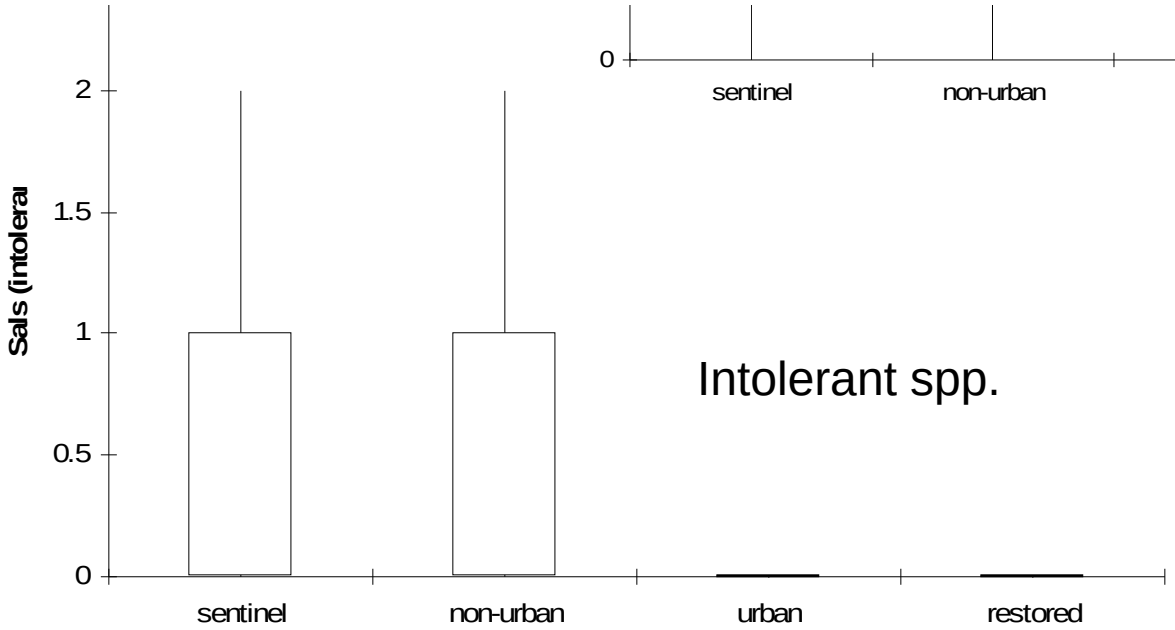
Stonefly Genera

Salamanders



spp.

Salamander Biodiversity Lost – Not Restored



Intolerant spp.

Change Over Time?

Benthic Macroinvertebrate

- IBI
- Number of Genera
- Number of Intolerant Genera
- Number of Mayfly Genera
- Number of Stonefly Genera

Fish

- IBI
- Number of Species (adj. stream size)
- Number of Intolerant Species
- Trout Density
- Sculpin/Darter Density

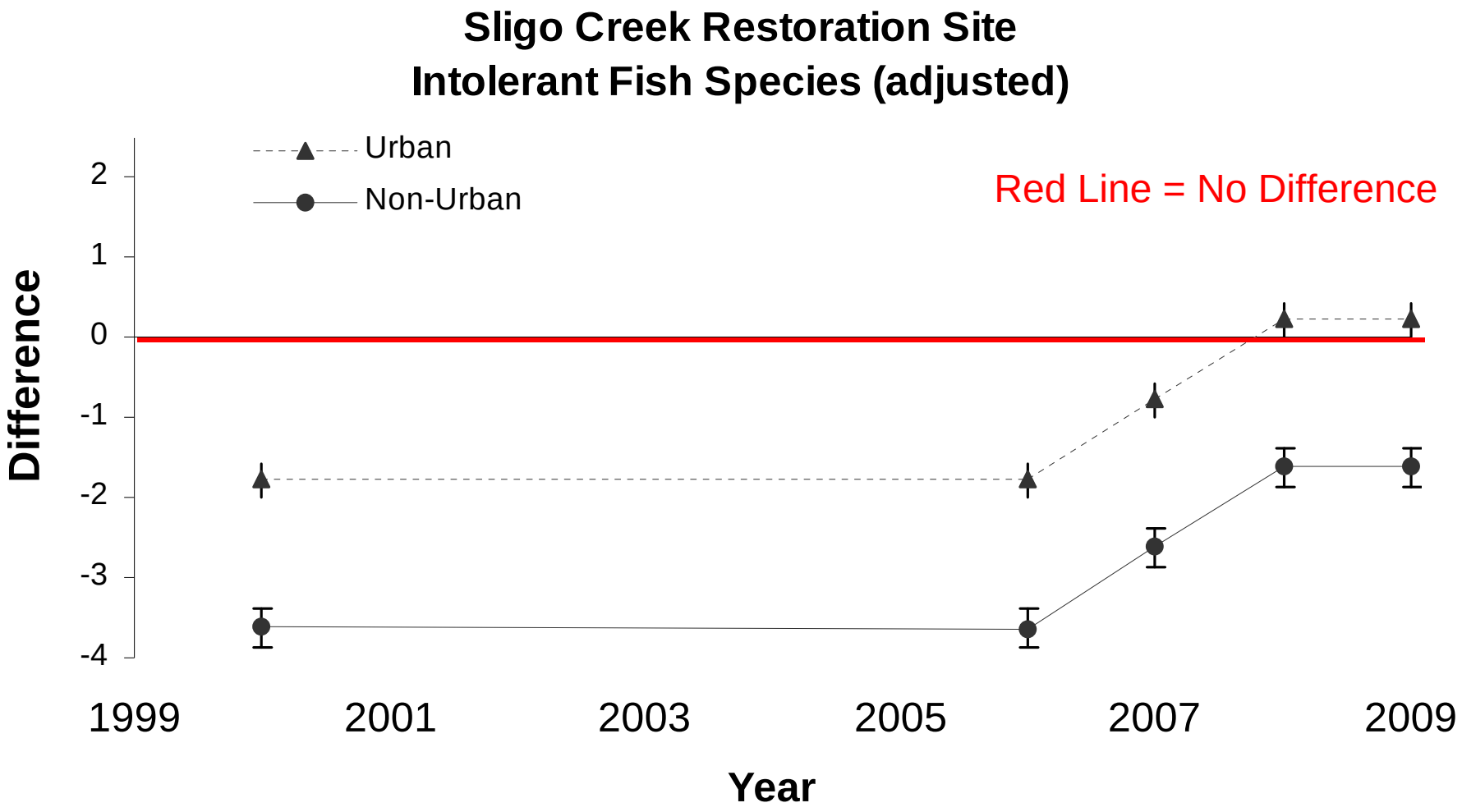
Are Restoration Streams Getting Better with Time?

Restoration Streams	Sig. Correlation
Mine Bank Run (n=7)	
Longwell Branch (n=1)	
Sligo Creek (n=1)	Number of Fish Spp. (+.89)
	Number of Intolerant Fish Spp. (+.95)

Sligo Creek More Fish Species and Intolerant Fish spp. with Time

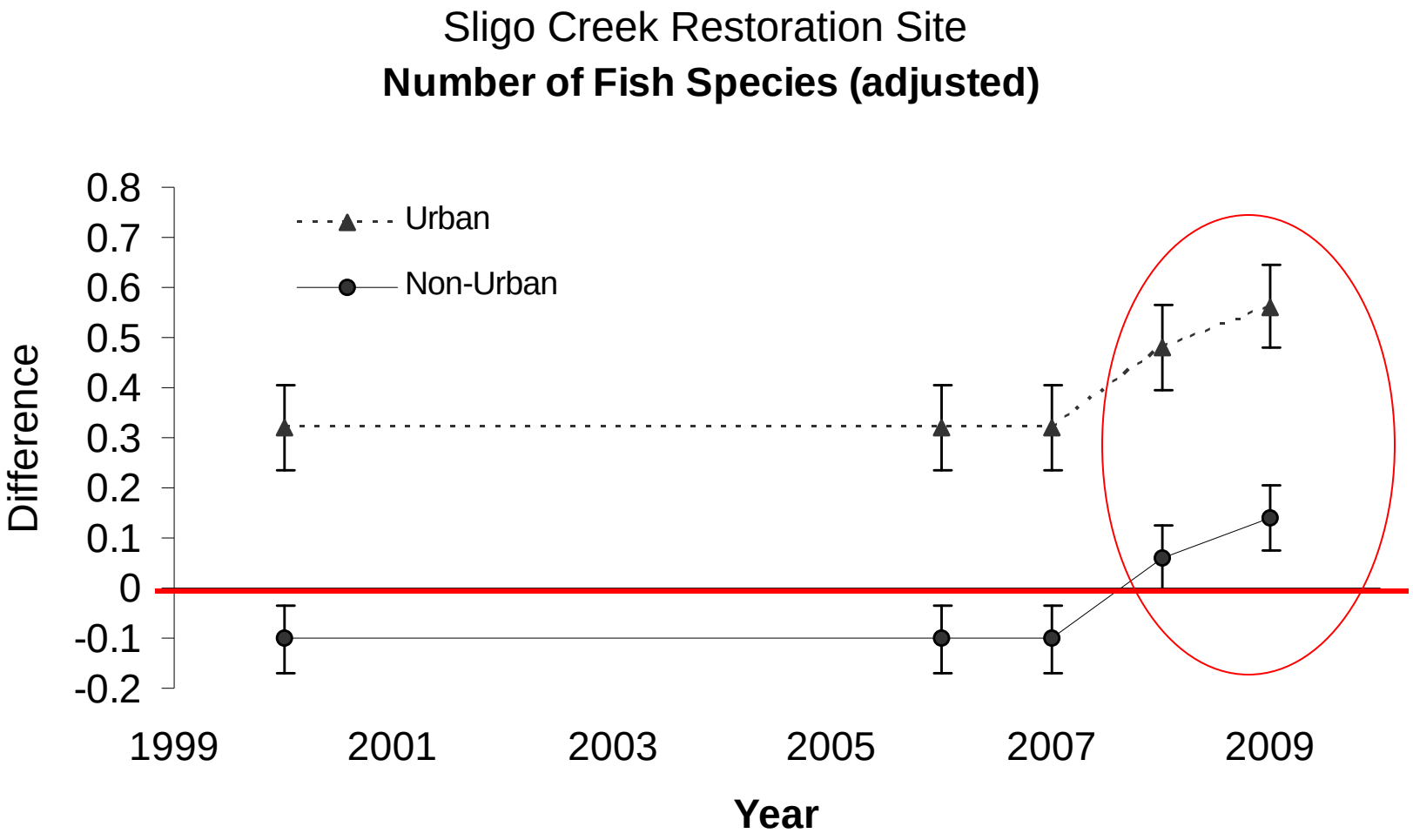
Based on Spearman Correlation

How Does Intolerant Fish Spp Compare to Other Streams?



Number of Intolerant Fish Species Increase

How Does Number of Fish Spp Compare to Other Streams?



Number of Fish Species Higher Than Urban And Higher Than Non-Urban

Why More Fish Species At Sligo?

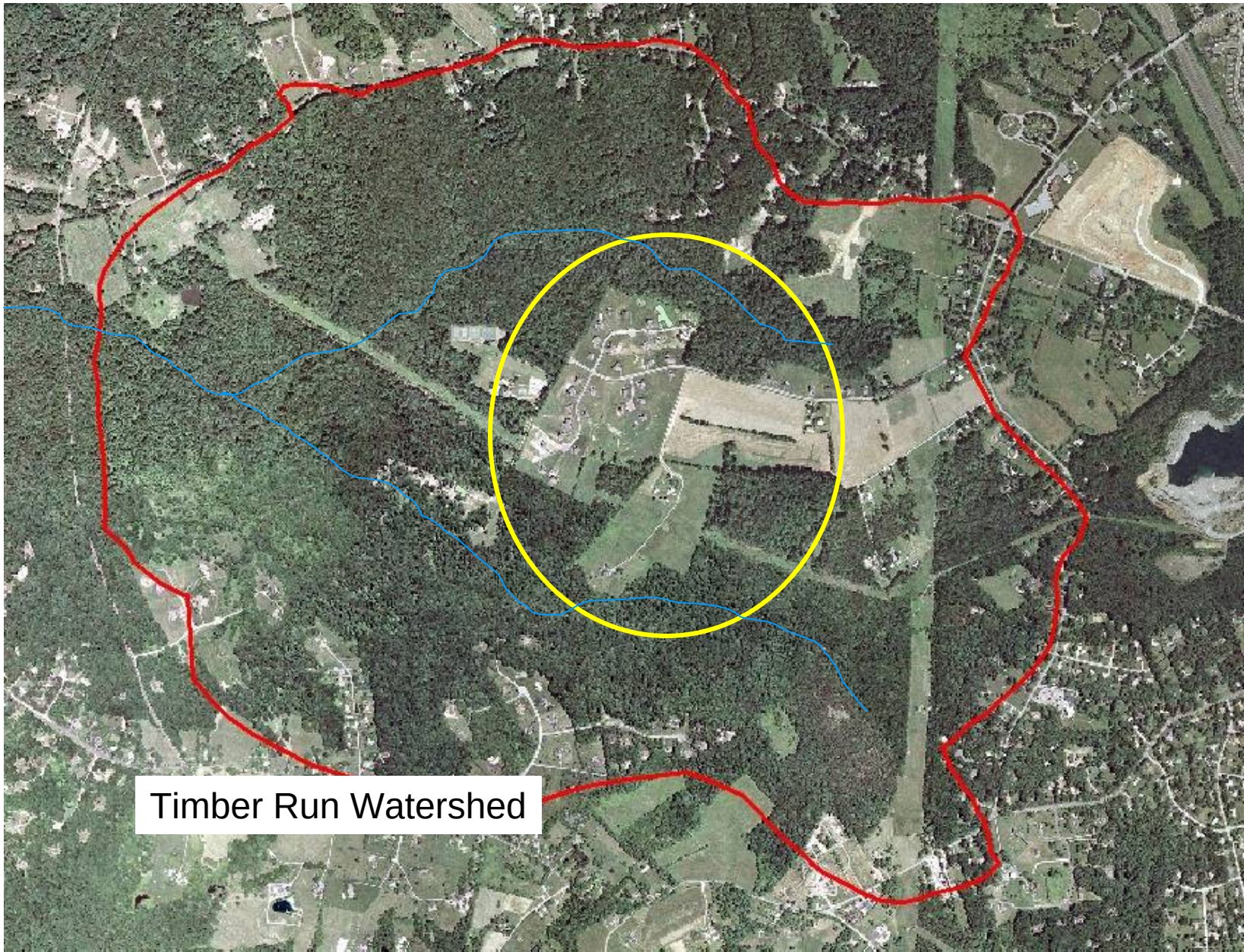
Stormwater Retrofits (8)
Created Wetland (1)
Channel Recon (2,670 ft)
Tree Planting
Fish Stocked (23 spp, 6 events)
Completed ~2001
About $2.6 Million

- Longest Time Since Restoration Began
- The Most Restoration Work Done
- Friends of Sligo Creek
- Many Fish were Stocked

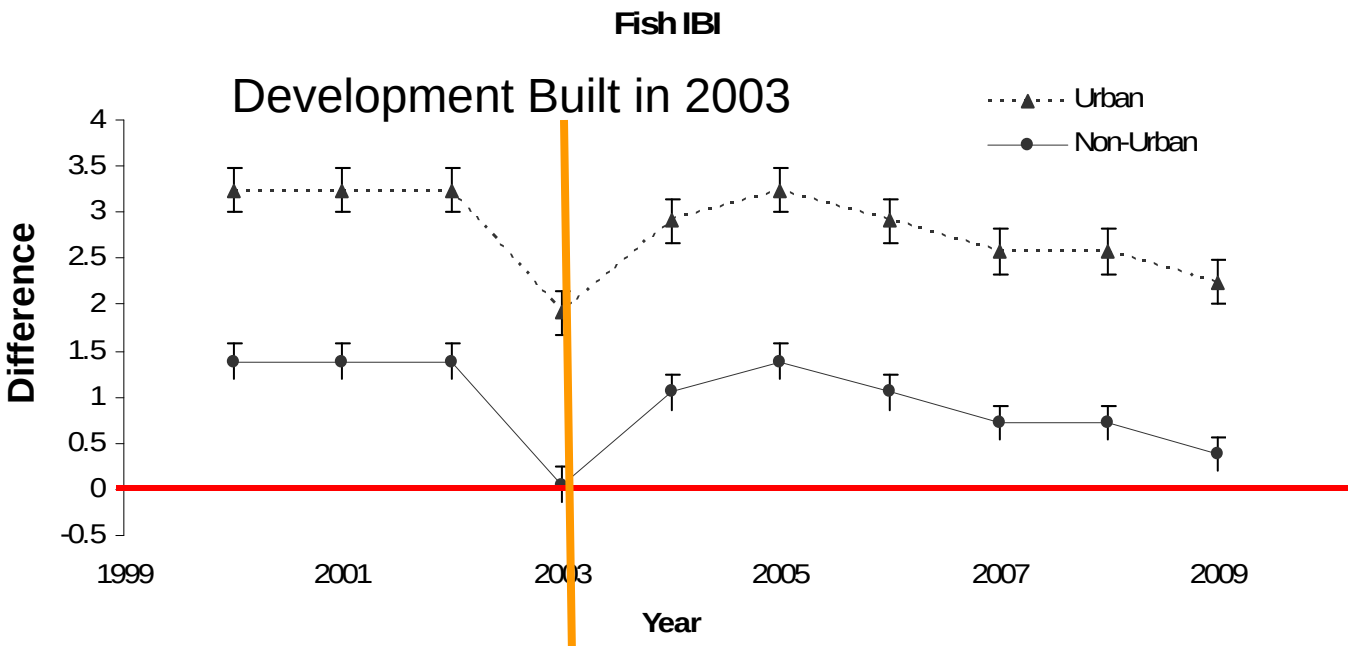
Reference Streams Getting Worse with Time?

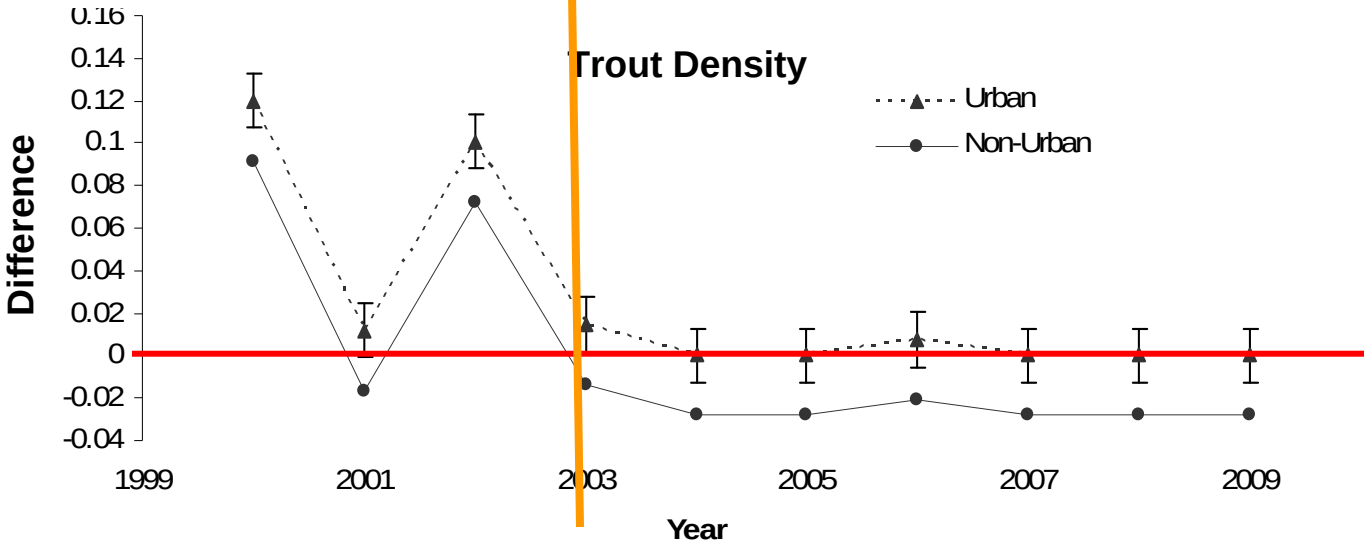
Reference Streams	Sig. Correlation
Baisman Run	
Timber Run	FIBI (-.64) + Trout Density (-.82)
NB Jones Falls	BIBI (-.76) + Mayfly Genera (-.72)

Reference Site LU Change



Timber Run Reference Site





Conclusions:

- We are Losing Biological Diversity From Our Best Streams with Little to No Improvement to the Worst Streams

- Restored Streams are Similar to Urban Streams

- Restored Streams are Not as Good as Non-Urban or Reference Streams

- But, Maybe Slight Improvement to Fish in one of 9 Restoration Sites

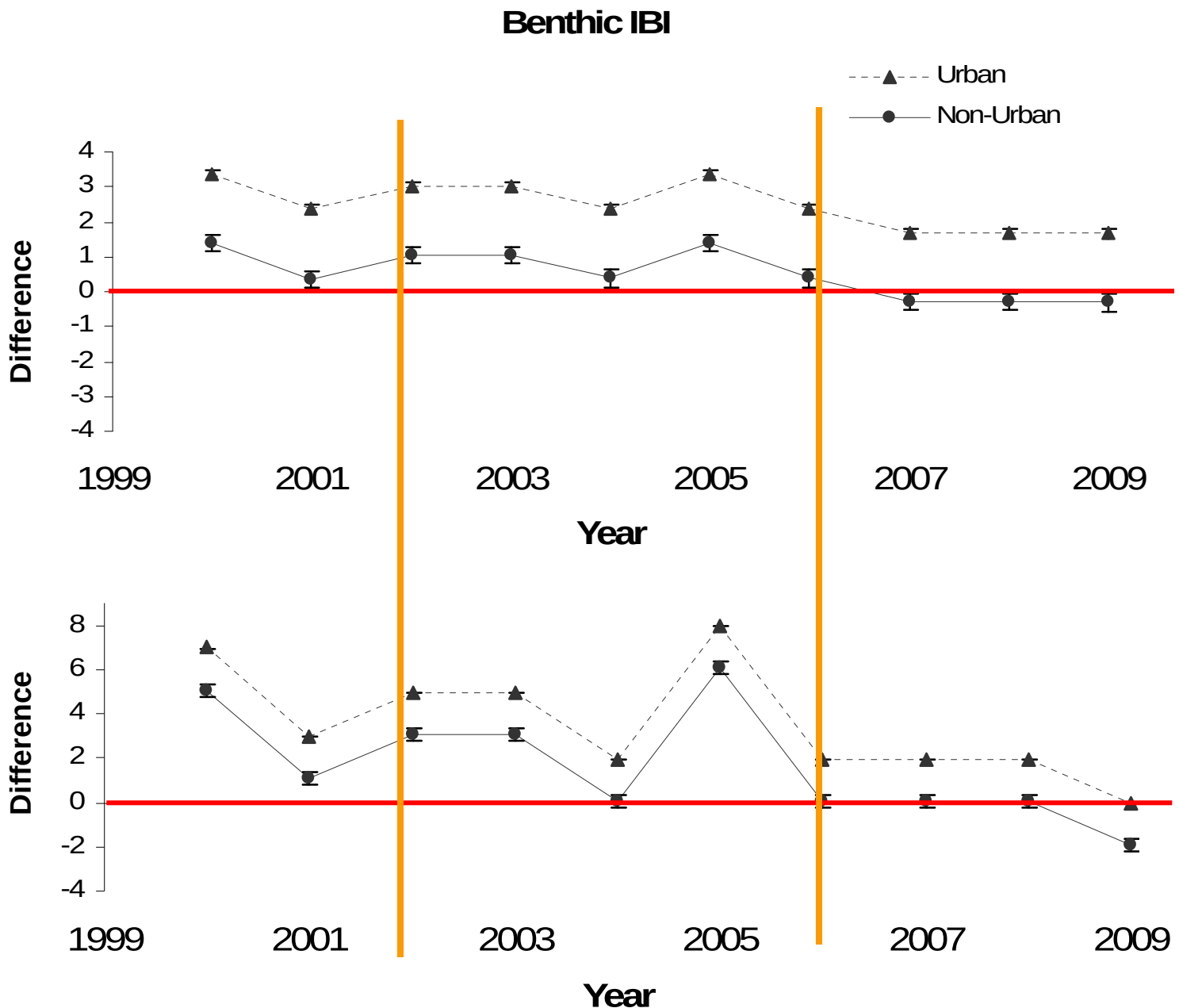
- Decline of Condition in Two of Three Reference Streams Sites

Do We Have Sufficient Time and $$ To Provide Protection AND Conduct Urban Restoration at The Current Scale?

Restoration Must Continue, But Protection Is Drastically Needed, is More Cost Efficient, AND More Effective

We Must Be Honest and Realistic About Expectations of Urban Restoration

NB Jones Falls Reference Site



Multi-Resolution Permutation Procedure (MRPP)

A = 0.06, $p<0.00000003$

MRPP Pairwise Results

	A	P
Urban vs. Restored	0.03	0.013
Urban vs. Non-Urban	0.27	<0.000001
Urban vs. Sentinel	0.46	<0.000001
Restored vs. Non-Urban	0.29	<0.000001
Restored vs. Sentinel	0.46	<0.000001
Sentinel vs. Non-Urban	0.07	<0.000001

Next Steps?

Ordinate habitat and temperature data?
Problem – county data not comparable with MBSS data
Could just use MBSS, but will have MANY fewer restoration sites

List all species collected from “restored” and “reference” sites (random selection or rarefaction?)

OK, Significant Trend in Fish Numbers……

But, How Does Sligo Fish Community Compare to Other Sites?

CIPS (Control Impact Paired Series):

Calculated Mean and 95% CI of Difference Between
- Sligo and Urban
- Sligo and Non-Urban

Analyses

Ordination (NMS)

Multi-Resolution Permutation Procedure (MRPP)

ANOVA

CIPS (Control Impact Paired Series)

Ordination Results

Benthic IBI
Intolerant Benthic Taxa
Total Benthic Taxa
Mayfly Taxa
Stonefly Taxa
Trout Density

Urban
Urban "Restored"
Non-Urban
Reference
Other

Axis 2

Axis 1

Fish IBI
Intolerant Fish Species
Total Fish Species
Benthic IBI
Intolerant Benthic Taxa
Total Benthic Taxa
Mayfly Taxa

NMS Correlation Coefficients	Axis 1	Axis 2
Benthic Macroinvertebrate IBI	**0.661**	**0.851**
Number of Benthic Genera	**0.603**	0.086
Intolerant Benthic Genera	**0.643**	**0.915**
Stonefly Genera	0.408	**0.669**
Mayfly Genera	**0.645**	**0.766**
Fish IBI	**0.769**	0.449
Number of Fish Species	**0.674**	0.157
Intolerant Fish Species	**0.77**	0.223
Trout Density	0.248	**0.5**
Darter/Sculpin Density	0.394	0.289
Bold r>0.5		

Sentinel (Reference) Sites Over Time?

Spearman Correlation

	# Fish Spp	# Intolerant Fish	Fish IBI	Trout Density	Benthic IBI	# Mayfly Genera
Restored (years with data)						
Longwell Branch (2000, 2002, 2004)						
Mine Bank Run 2 (2006-2008)						
Mine Bank Run 3* (2006-2008)						
Mine Bank Run 4 (2006-2008)						
Mine Bank Run 5* (2006-2008)						
Mine Bank Run 6* (2006-2008)						
Mine Bank Run 7 (2006-2008)						
Mine Bank Run 8* (2006-2008)						
Sligo Creek (2000, 2006-2009)	89.443 (0.04)	94.868 (0.01)				

* Only benthic macroinvertebrate data were available, no fish data.

I agree, and have long argued, that an ounce of prevention is worth a million bucks of cure. I do not have the file here at home, but I use Sligo to make that point in talks which I give on the Potomac and restoration.

But we should keep in mind that they are also separate tasks with independent values.

Where would we be today if in the 60s we made the decision to "forget trashed rivers, like the Potomac and Cayahoga, and lets just protect good rivers because it "cost too much" to restore them." The Potomac would still be crap, and so would MANY other rivers.

To paraphrase Frost, Don't just taking the road most-easily travelled!

Other components to consider are:

Average urban streams usually do not get restoration attention or $. Sligo was one of the worst of the urban sites, which may be the case for your other examples of restored urban streams as well, so improvement to a status that becomes comparable to the average urban stream or even a little better than average is a significant improvement.

The climb out of a trashed stream is not an even incline, you have to expend a good deal of energy getting up that vertical bank first.

As we discussed, the restored stream had much greater aesthetic value, trash removed, stream banks restored and vegetated, more park-like, less dump-like, so it

Restoration Expectation:

Restoration Should Make Streams Better.
Restored Streams Should Become Less Like Similarly Impaired Streams and More Like Reference (Unimpaired) Streams.

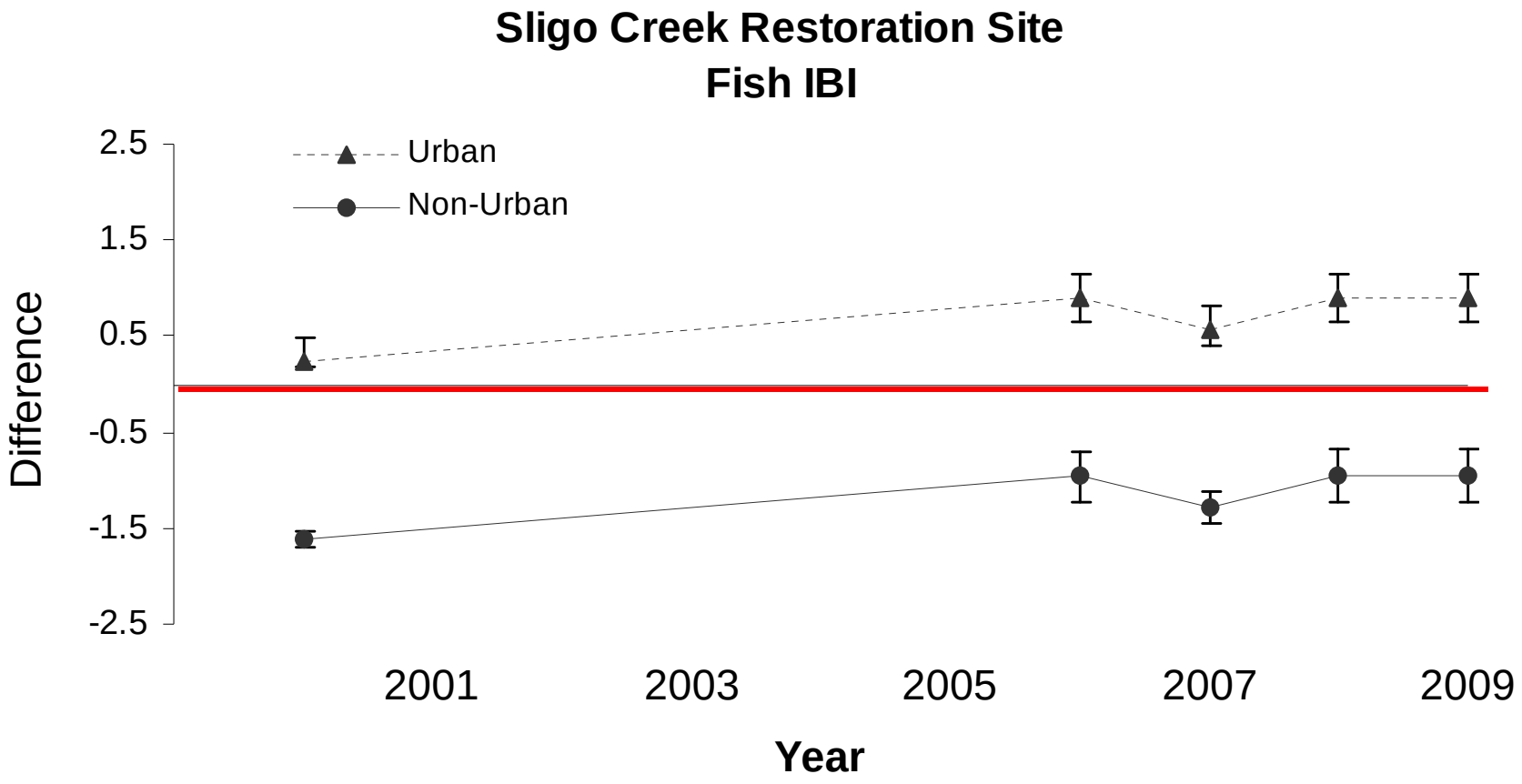
•Myths of restoration (Hilderbrand et al.)
•What makes a good restoration (Palmer et al. 2005)
•Sligo report from Jim Cummins showed improvement right after restoration
•Other papers where restoration has been shown to be successful…..
•Booth and Jackson showed that stormwater ponds don't really work
•Tullos showed that channel reconfiguration degraded biology, not improved, - - especially already highly degraded urban streams.

Protecting streams is more successful and takes less time and $$.....

Insufficient time and $$ are available to conduct comprehensive restoration or to provide sufficient protection to stream biodiversity. That means we must evaluate the successes of both approaches (restoration and protection) and determine the level of each required for success.

Additional Benefit of Citizen Involvement and Stewardship
Sligo Creek Watershed

How Does Sligo Fish Community Compare to Other Sites?



Fish IBI Better Than Urban! Not As Good As Non-Urban