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

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County Support and Data Providers:
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Hypothetical Graph of Restoration Expectation

- ■ - restored
- ▲ - unrestored
- • - reference

Stream Quality vs Time with restoration conducted at a specific point.
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
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
- Number of Genera

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>N=30</td>
<td>3 sites x 10 year</td>
</tr>
<tr>
<td>Non-Urban</td>
<td>N=96</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>N=44</td>
<td></td>
</tr>
<tr>
<td>Restored</td>
<td>N=31</td>
<td>11 repeated samples</td>
</tr>
</tbody>
</table>
Fish Variables Continued...

Fish Biodiversity Lost – Not Restored

Darter/Sculpin

Trout

Native fish spp. adjusted

Intolerant fish spp. adjusted

Darter/Sculpin density

Trout density
Bug Variables

<table>
<thead>
<tr>
<th>Category</th>
<th>Sample Size</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>N=30</td>
<td>3 sites x 10 year</td>
</tr>
<tr>
<td>Non-Urban</td>
<td>N=96</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>N=44</td>
<td></td>
</tr>
<tr>
<td>Restored</td>
<td>N=52</td>
<td>26 repeated samples</td>
</tr>
</tbody>
</table>
Bug Variables Continued...

Insect Biodiversity Lost – Not Restored

Mayfly Genera

Stonefly Genera
Salamanders

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?

<table>
<thead>
<tr>
<th>Restoration Streams</th>
<th>Sig. Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Bank Run (n=7)</td>
<td></td>
</tr>
<tr>
<td>Longwell Branch (n=1)</td>
<td></td>
</tr>
<tr>
<td>Sligo Creek (n=1)</td>
<td>Number of Fish Spp. (+.89)</td>
</tr>
<tr>
<td></td>
<td>Number of Intolerant Fish Spp. (+.95)</td>
</tr>
</tbody>
</table>

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

Based on Spearman Correlation
How Does Intolerant Fish Spp Compare to Other Streams?

Sligo Creek Restoration Site
Intolerant Fish Species (adjusted)

Red Line = No Difference

Number of Intolerant Fish Species Increase
How Does Number of Fish Spp Compare to Other Streams?

Sligo Creek Restoration Site
Number of Fish Species (adjusted)

Year
1999 2001 2003 2005 2007 2009

Difference
-0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

Urban
Non-Urban

Number of Fish Species Higher Than Urban And Higher Than Non-Urban
Why More Fish Species At Sligo?

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

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
## Reference Streams Getting Worse with Time?

<table>
<thead>
<tr>
<th>Reference Streams</th>
<th>Sig. Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baisman Run</td>
<td></td>
</tr>
<tr>
<td>Timber Run</td>
<td>FIBI (-.64) + Trout Density (-.82)</td>
</tr>
<tr>
<td>NB Jones Falls</td>
<td>BIBI (-.76) + Mayfly Genera (-.72)</td>
</tr>
</tbody>
</table>
Reference Site LU Change

Timber Run Watershed
Timber Run Reference Site

Fish IBI

Development Built in 2003

Trout Density

Urban
Non-Urban
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
**Multi-Resolution Permutation Procedure (MRPP)**

$A = 0.06, p<0.00000003$

<table>
<thead>
<tr>
<th>MRPP Pairwise Results</th>
<th>A</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban vs. Restored</td>
<td>0.03</td>
<td>0.013</td>
</tr>
<tr>
<td>Urban vs. Non-Urban</td>
<td>0.27</td>
<td>&lt;0.000001</td>
</tr>
<tr>
<td>Urban vs. Sentinel</td>
<td>0.46</td>
<td>&lt;0.000001</td>
</tr>
<tr>
<td>Restored vs. Non-Urban</td>
<td>0.29</td>
<td>&lt;0.000001</td>
</tr>
<tr>
<td>Restored vs. Sentinel</td>
<td>0.46</td>
<td>&lt;0.000001</td>
</tr>
<tr>
<td>Sentinel vs. Non-Urban</td>
<td>0.07</td>
<td>&lt;0.000001</td>
</tr>
</tbody>
</table>
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**

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

**Bold r>0.5**

- Fish IBI
- Intolerant Fish Species
- Total Fish Species
- Benthic IBI
- Intolerant Benthic Taxa
- Total Benthic Taxa
- Mayfly Taxa
**Sentinel (Reference) Sites Over Time?**

**Spearman Correlation**

<table>
<thead>
<tr>
<th># Fish Spp</th>
<th># Intolerant Fish</th>
<th>Fish IBI</th>
<th>Trout Density</th>
<th>Benthic IBI</th>
<th># Mayfly Genera</th>
</tr>
</thead>
</table>

**Restored (years with data)**
- Mine Bank Run 7 (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?

Sligo Creek Restoration Site
Fish IBI

Year
2001 2003 2005 2007 2009

Difference
-2.5 -1.5 -0.5 0.5 1.5 2.5

Urban
Non-Urban

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