Perennial Stream, Intermittent Habitat: Impact of Urban BMPs on Fish

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College of William and Mary REU Watershed Program
Summer 2003
National Science Foundation
Paschal’s Creek

1 of 3 first-order perennial streams surrounded by the College Forest flowing into Lake Matoaka

Berkeley - Leastbrook lamprey
Pogonia - Leastbrook lamprey
Mosquito fish
Paschal’s - Leastbrook lamprey

(Spiller, Adam and Morgan Sproul. “Chemical Analysis and Fish Survey of Lake Matoaka Streams,” 23 April, 2003.)
Paschal's Cross-Section Upstream of Bridge

- Average depth = 2.2 cm
- Channel width < 2 m

Temperature in Paschal’s From 7/9/03 to 7/11/03

Temperature Range

17° - 22° Celsius
Surface current velocity = 0.06 m/s
Conductivity = 271 mS
Dissolved oxygen = 8.8 ppm

Sandy and unstable substrate
Historically few fish
Primarily fed by groundwater

BMP located at the headwaters of Paschal’s connects runoff from Williamsburg Crossing (geologically outside Matoaka’s watershed)

What correlations exist between physical characteristics of habitats and the presence or absence of fish?
**HYPOTHESIS**

Low depth is a limiting factor for fish populations in Paschal’s Habitats with sufficient cover - litter, debris, undercut banks, logs - are preferred

**THEREFORE,** creating pools with adequate depth and cover will result in fish in these habitats.

**METHODS**

Survey for fish and habitats to collect baseline data.

- Dipnet to collect fish at each pool
- Identified the fish, and measured total length and weight of each fish
- Recorded maximum depth of each habitat, distance from the previous habitat, and observations about the habitat formation type
Create new habitats that are at least 10 cm deep and sample for fish again.

1st attempt
2nd attempt

Six 24-in. cement edgers
4.7 L buckets with maximum depth of 17.5cm

Heavy storm with 3 inches of rain on Friday night, July 18, 2003, resulted in dramatic changes in the streambed.

Edger #1 on June 30, 2003

Edger #1 on July 22, 2003
Site 1

Previous Max Depth = 12.5 cm
New Max Depth = 72 cm
Width = 2.84 m
Length = 5.4 m
None of my artificial habitats survived
... but plenty of pools to sample, so onward!

Methodology

• set up large, mesh seine with floats and weights just below the habitat to collect fish darting out of the habitat and down the stream

• used a fine seine with two wooden pole handles to collect fish in larger pools and a large dipnet to sample smaller pools and areas

• sampled until zero fish were collected in two consecutive sweeps
• Identified species
• Recorded total length

• Habitat length and width
• Channel width
• Maximum and average depth
• Distance from previous habitat
• Habitat shape - presence/absence of an undercut cover provided by bank, tree, or log
• Percent litter/debris
• Presence/absence of amphipods and/or salamander larvae and noted any other fauna in the habitats
<table>
<thead>
<tr>
<th>Species Name</th>
<th>Common Name</th>
<th>Number of Fish</th>
<th>Median Length (mm)</th>
<th>Average Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Clinostomus funduloides</em></td>
<td>Rosyside dace</td>
<td>503</td>
<td>42</td>
<td>41.6</td>
</tr>
<tr>
<td><em>Semolitus atromaculatus</em></td>
<td>Creek chub</td>
<td>19</td>
<td>63</td>
<td>54.5</td>
</tr>
<tr>
<td><em>Lepomis macrochirus</em></td>
<td>Bluegill</td>
<td>10</td>
<td>51</td>
<td>48.6</td>
</tr>
<tr>
<td><em>Gambusia holbrooki</em></td>
<td>Mosquito fish</td>
<td>1</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td><strong>Total Number of Fish</strong></td>
<td></td>
<td>533</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 36 habitat sites sampled
- 0-127 fish found per site
- 4 fish species surveyed

**Dace** 94%
**Creek Chub** 4%
**Bluegill** 2%
Habitats with Zero Fish

- Undercut: 57%
- Not Undercut: 43%

Habitats with Fish

- Undercut: 93%
- Not Undercut: 7%

All Undercut Habitats

- Tree or LWD: 81%
- Bank: 19%

Undercut bank Log/tree form undercut area
R-Square and P-values for simple linear regressions of each independent variable against the number of fish.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>R-Square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length$^1$</td>
<td>0.468</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Width$^1$</td>
<td>0.553</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Maximum Depth</td>
<td>0.358</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Average Depth</td>
<td>0.114</td>
<td>0.051</td>
</tr>
<tr>
<td>% Litter/Debris</td>
<td>0.001</td>
<td>0.865</td>
</tr>
<tr>
<td>Volume$^2$</td>
<td>0.440</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

$^1$Site 3 (outlier) eliminated for regression analysis

$^2$Volume
= $[\text{length} \times \text{width}/4 \times \pi] \times \text{average depth}$
Predicted Number of fish = 21.428(width) * 7.012(length) - 18.306

R Square = 0.685
P-value = 0.001

C = chub
B = bluegill
M = mosquito fish
Site 8

Width = 2.4 m
Length = 5.8 m

Stream Cross-Section at Site 8
To summarize ...

Length and width together account for 68.5% of the variation.

Maximum or average depth and % litter are not as useful in predicting number of fish.

Volume may still be a significant and useful predictor for number of fish but the calculation needs to be improved.

The presence of undercut banks, primarily provided by large, woody debris, is also significant for fish habitats.
More questions than answers ...

- An extraordinary increase in the number of dace in Paschal’s was observed the week following the storm.
  - Where did they come from?

- Large habitats now disappearing as pools are filling in with sand.
  - Where will they go?
And yet more questions
... to be tackled next summer!

Is the dace population in Paschal’s sustained by periodic overflow from the BMP? What would happen if dace were introduced into Pogonia or Berkely North?

How do fish utilize the habitats in Paschal’s?
• Fish migration along the stream
• Successional study of stream habitats after disturbance events

What is the role of creek chubs in Paschal’s?

They’re not fish but they’re still cute ...
• Study with salamander larvae
Rosyside dace (*Clinostomus funduloides*)

Intolerant of siltation, avoid impoundments, and prefer pools in small, cool, clear creeks

Adults are 50-80 mm standard length

Found in well-buffered streams (6.3-7.0 pH)

Nest associates of nest builders (*Semotilus*)


Mr. Bob Greenlee of the Virginia Department of Game and Inland Fisheries
Rosyside dace or Golden shiner?
Conclusion

Undeveloped, pristine stream with urban BMP upstream

BMP acting as larger pool/source for fish populations in creek

Greater number of fish with increasing habitat width and length

Forested banks provide reliable supplies of LWD and trees/roots
Frog about to jump into the dipnet

Itty bitty crayfish looking jealously at creek chub ingesting a worm

Banded water snake

Salamander species Randy has never seen before
Big Thank You’s to...

Everyone at the Keck Lab ...

Tim for your GIS expertise and helping me find random stuff around the lab ...

And last but definitely not least, Randy for all your help and always coming to my emotional rescue!