EFFECTS OF URBANIZATION:
Nine years of monitoring stream fish and macroinvertebrate biodiversity within nine watersheds across the Toronto Region

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Latornell 2011
Background:

- 1851: Ontario population 952,004 14% Urban
- Urbanization around the Toronto area followed the general pattern of stemming from Lake Ontario and expanding north (Wichert, 1991; Wichert and Regier, 1998).
- 2011: Ontario population 13,373,000 85% Urban
- Future population estimated to increase!
Same Paradox: an exponentially growing population and the need to further develop and expand our city.

CONSEQUENCES?
Questions:

1. What affect has urbanization had on our streams in the last 9 years (2001-2009)?
   a) Changes in stream habitat.
   b) Changes in the fish community and its response.
   c) Changes in the macroinvertebrate community.

2. What conclusions can be drawn regarding our stream habitat and the response of biota in our streams?
Methods and Data Analysis:

• Quantified urbanization: ROAD DENSITY (Forman & Alexander 1998).

• As urbanization road density

• Relationship between road density and stream habitat variables (width, depth, temperature), fish species richness, community composition, as well as some BMI metrics!

• $R^2$ + ANCOVA and CCA
Results: Changes in Stream Habitat

- Streams are getting wider and warmer as road density increases.
- Significant differences between stream orders.
- Magnitude of these differences is not the same for each stream order.
Spatial Patterns: Fish Species Richness
Obs / Exp Species Richness Ratio
Results: Fish Species Richness

So what?

(Paul and Meyer 2001, Walsh et al., 2005)
Blacknose Dace
Longnose Dace
White Sucker
Creek Chub
Brook Stickleback
Brown Bullhead
Common Shiner
Fathead Minnow
Johnny Darter
Pumpkinseed
Bluntnose Minnow
Brown Trout
Rainbow Darter
Rainbow Trout
Redside Dace
Rock Bass
Sand Shiner
Spotfin Shiner
Spottail Shiner
Atlantic Salmon
American Brook Lamprey
Brook Trout
Northern Hog Sucker
River Chub
Blackside Darter
Largemouth Bass

Trophic Guild: 4
Family: 5
Species: 8-15
# Results: BMI Metrics and Road Density

<table>
<thead>
<tr>
<th>Metric</th>
<th>Trend</th>
<th>$R^2$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Richness</td>
<td>↓</td>
<td>0.54</td>
<td>82.975</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td># EPT Families</td>
<td>↓</td>
<td>0.299</td>
<td>52.527</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% Oligochaeta</td>
<td>↑</td>
<td>0.224</td>
<td>35.415</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FBI</td>
<td>↑</td>
<td>0.409</td>
<td>85.361</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Similar to fish, what inverts do we lose and at what road density?
The graph shows a negative correlation between BMI family richness and road density. The equation of the line of best fit is given as $p < 0.0001$, $R^2 = 0.54$. This suggests that as road density increases, BMI family richness decreases significantly.
Bringing it all together: CCA

Habitat

Fish

BMI
So what does all this really mean? What do we really know? Road Density

- Water Quality (Angela Wallace)
- Species Richness
- Sensitive Species

- Stream Width: Depth
- Water Temperature
- Tolerant Species
So what does all this really mean?
Something to think about:

- **Same Paradox:** an exponentially growing population and the need to further develop and expand our city.

- **How do we go about insuring sustainable development in the face of what appears to be an exponentially growing population and the need to expand?**

- **Coming soon to a journal near you!** Wallace A., Croft-White M., and J. Moryk (20??). *Are Toronto’s Streams Sick?: A Look at the Fish and Benthic Invertebrate Communities in the Toronto Region in relation to the Urban Stream Syndrome. CJFAS (We hope).*
Thank You
Deborah Martin-Downs
Scott Jarvie
Angela Wallace
Melanie Croft-White
Jeff Vandenberg
Christine Tu-Parker
David Lawrie
Jason Tam

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