Science Advances Our Understanding of Headwater Systems

*Trim the Tribs Research*

Les Stanfield
Ecohealth Solutions

Nottawasaga Inn, November 16th, 2015
Background

“The only effects that matter are cumulative effects”

(Merriam pers. Comm.)
Background: 2000 – 2014

- **Input variables:**
  - Fish (species and community); benthos; temperature; baseflow; peak flows; habitat

- **Built predictive models based on:**
  - Land use
  - Catchment variables (geology, climate, area, etc.)
  - Barriers
  - Instream habitat
  - Biological interactions
Results: Lots of Models
Other Stressors: Fragmentation

- Dendritic Connectivity Index:
  - Mahlum et al. 2014 - Lake Ontario Tribs,
  - Stanfield - Lake Simcoe
  - Edge et al. - TRCA

Conclusion:
Fragmentation reduces resiliency & recolonization
For fish

But is less important than land use
Proximity an Riparian Condition Analysis

• Upland area land use similar predictive power as Riparian areas..... I.e. Headwaters are critical
Headwaters are the missing link
Trim the Tribs\textsuperscript{1}

• Workshop 2013

Questions:
  – Which tribs are most important to ecosystem integrity
  – Which and How many tribs can be “pruned”

• Developed Study Design and proposal

• Funding NSERC 2014

1. Cumulative effects from alteration of headwater drainage features and the loss of ecosystem integrity of river networks: http://www.trca.on.ca/dotAsset/190979.pdf
Cumulative Effects in a Riverscape Across Scales

- John Richardson  UBC (lead)
  Lenka Kuglerova,
  Brian Kielstra
  Headwater/forest specialist
  riparian health and processes
  Spatial patterns, nesting, benthics

- Dan Moore - UBC
  Hydrologic changes (processes)

- Jim Buttle – Trent
  Ibrahim Rashid
  Predictive changes in flows
  SWAT predictive modeling

- Antoine Morin (UofO)
  Bernadette Charpentier
  Understanding variance in fish
  and benthos

- Laura Del Giudice (TRCA)
  Les Stanfield
  Integration with Policy
  P.I.A.
## Nested Analysis Approach

<table>
<thead>
<tr>
<th>Study Scale</th>
<th>Measurable indicator/protocol</th>
<th>Predictor Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headwater Segment (fishless)</td>
<td>Headwater condition - protocol sediment/flows/connectivity</td>
<td>Segment Condition - GIS measured &amp;/or supplemented with rare features (GWU, etc.)</td>
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</tbody>
</table>
| Mid-reach Segment            | Biological indicators (Fish/benthos) and possible diagnostic indicators (e.g., water quality, substrate etc..) | Weighted condition to a point on the network e.g.,  
  \[ f(C) = f(A1) + f(A2) + f(A3) + I \]  
  \[ f = \text{HDF}, C = \text{mainstream}, I = \text{local conditions} \] |
| Watershed                    | Summary statistic for mainstem (e.g., flows)                      | Weighted condition to a downstream point on the network (i.e., outlet)              |
Understanding Hierarchical Structure HDF Sites

Brian Kielstra
Valued Ecosystem Components

Fish, benthos and others....
Understanding longitudinal Sources of Variance

• Riparian soil biochemistry, more process data
• Expand in 2016

Brian Kielstra, Lenka Kuglerova
Soil and Water Assessment Tool

- WSC-hydata data to validate mainstem
- OSAP headwater & baseflow spot discharges
- Flashiness
- Beta version 😊

Ibrahim Rashid, Jim Buttle
Variances in biota

- Antoine Morin, Élysabeth Théberge, Marie-Ève André
- SMARTER datasets
- benthics & fish
Road Density = 1.25 km/km²
% Intense Ag = 60%
Predicted %EPT deviation = -12.4%
Define Threshold at, say, $\alpha=0.10$ for Fail status
Estimate risk of “Fail” if catchment is developed

(60% intense Ag and Road Density of 1.25 km/km² = -12.4% EPT deviation)
Estimate risk of “Fail” if catchment is developed

- If developed at this intensity the risk of Fail would be 49.9%
Current Work:

- Expanding analysis to the rest of southern Ontario
- Testing multiple metrics
- Better understand temporal and spatial variability influence on measures of states
Linkages and Partnerships

• Bruce McVicar et al (UofW)
  – understanding sediment transport in urban systems in a changing climate

• Andrea Kirkwood, Brian Kilstra
  – Understanding decomposition processes

• Don Jackson, Chris Edge, Marie Jose-Fortin, Cindy Chu, et al.,
  – Fish assemblage and climate change
Next Steps: Implementation

• Preliminary analysis of spatial patterns
  – Part of gap analysis
• Continue to analyze indicators (VECs)
• Field Work 2016
• Build the integrated models that
  – Incorporate scale effects
  – Processes (e.g., hydrology, sediment transport
  – Support with process based research
Final Vision

- Build/enhance a Decision Support System
- Incorporate LID & wetland restoration
- Incorporate Ecohealth metrics
- Implement within municipally based user pays software
Thank you

Contact me at
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Check out:
Headwater papers

Modeling papers at:
http://www.trca.on.ca/the-living-city/monitoring/southern-ontario-stream-monitoring-research-team.dot