Testing summary

• Ordinal: Results have been shown to 6 different individuals or groups over the past year; feedback incorporated if possible
• Methodological: Input on-going with specific attention from Cornell Profs and outside groups
• Quantitative: Initial results good but test datasets lack robustness; more quantitative testing needed especially at the module level
Hydroecological tool: enhancements and results

Study areas

- Black Creek
- Lakeshore Marshes
- Twelve Mile Creek
- Duffins Creek
- Napanee River
- Sandy Creek
- Credit River
- Sandy Creek
- Black Creek
- Salmon River
- Napanee River
Hydroecological tool: enhancements and results

Disturbance gradient

- Credit
- Twelve Mile
- Duffins
- Black
- Napane
- Lakeshore marshes
- Sandy
- Salmon

Percent combined land use

- Urban + Agriculture
- Forest + Water + Wetland
Disturbance gradient spatially

Hydroecological tool: enhancements and results

- Black Creek
- Lakeshore Marshes
- Twelve Mile Creek
- Duffins Creek
- Salmon River
- Sandy Creek
- Napanee River
- Credit River
Hydroecological tool: enhancements and results

Soils in watersheds

The graph shows the percentage of each soil group in different areas. The x-axis represents the areas: Twelve, Black, Credit, Napanee, Lakeshore Marshes, Duffins, Sandy, and Salmon. The y-axis represents the percent of each soil group.

Legend:
- HSG A
- HSG B
- HSG C
- HSG D
Riparian degradation: results

The diagram shows the percent poor riparian habitat for different areas:

- Credit: 0.10
- Twelve Mile: 0.25
- Duffins: 0.05
- Black: 0.05
- Napanee: 0.05
- Lakeshore marshes: 0.05
- Sandy: 0.05
- Salmon: 0.01
Twelve Mile Creek

Hydroecological tool: enhancements and results

Riparian degradation: results

Salmon River
Riparian degradation: conclusions

- Pattern of degradation across watersheds generally follows disturbance gradient with outliers Twelve Mile Creek and Sandy Creek.
- Even the most degraded watershed (Twelve Mile) had less than 20% habitat in need of riparian restoration.
- Stream segments seem well buffered by forest and wetlands but still patchy.
- Particular attention should be paid to Twelve Mile Creek in terms of restoration.
Hydroecological tool: enhancements and results

Strategies for improving riparian conditions

- Restore native vegetation in riparian areas
- Manage and protect natural flood plains

1995
2000
Hydroecological tool: enhancements and results

Stream degradation: results

Stream degradation

Percent highly degraded

Credit  Twelve Mile  Duffins  Black  Napanee  Lakeshore marshes  Sandy  Salmon
Stream degradation: results

Duffins Creek

Black Creek

Hydroecological tool: enhancements and results

Legend:
- Slightly altered
- Moderately altered
- Highly altered
- na
• Pattern of degradation across watersheds roughly follows disturbance gradient with outlier Duffins Creek

• Degree of degradation ranges from ~30-70% across all watersheds with Black Creek the most degraded watershed

• Stream segments marked as highly altered were largely driven by predictions of open canopy and/or fine sediments

• Particular attention should be paid to Black Creek in terms of possible restoration opportunities
Strategies for Improving stream quality

- Restore instream features such as large woody debris
- Maintain natural stream channels
- Restore sinuosity
Barriers to migration: results

The chart illustrates the percent blocked for various locations. The locations include Credit, Twelve Mile, Duffins, Black, Napanee, Lakeshore marshes, Sandy, and Salmon. Sandy has the highest percent blocked, followed by Salmon. The least blocked is Twelve Mile.
Hydroecological tool: enhancements and results

Barriers to migration: results

Credit River

Twelve Mile

Duffins Creek

Napanee Creek

Credit River
Hydroecological tool: enhancements and results

Barriers to migration: results

Sandy Creek

Salmon River

Lakeshore marshes

Black Creek
• Pattern of fragmentation differs across watersheds based on density and height of dams
• Degree of blockage ranges from ~11-90% with Sandy Creek most blocked and Twelve Mile Creek blocked very little
• Many of the watersheds (Sandy, Salmon) have sizeable dams at the downstream end of the watershed blocking most upstream movement by migrating fish
• Efforts should be made to keep relatively unblocked watersheds free of downstream dams and restoration strategies should be considered for the others
Hydroecological tool: enhancements and results

Strategies for reducing barriers to migration

- Design infrastructure for aquatic organism passage
- Remove dams and barriers to fish migration
Hydroecological tool: enhancements and results

Stream flow alteration: results

Stream flow alteration

Percent highly altered

Credit Twelve Mile Duffins Black Napanee Lakeshore marshes Sandy Salmon
Hydroecological tool: enhancements and results

Streamflow alteration: results

- Napanee Creek
- Credit River
- Lakeshore marshes

Legend:
- Low alteration
- High alteration
- n.a.
Stream flow alteration: conclusions

- Pattern of alteration follows the disturbance gradient except for Black Creek which is much higher than the others.
- Degree of alteration ranges from 13% (Sandy) to over 90% (Black).
- Forested land use seems to be a driving factor separating high alteration streams from low alteration.
Strategies for reducing stream flow alteration

- Decrease impervious surface
- Conserve lands important to hydrologic function
- Remove dams or operate them to mimic natural cycles
- Protect, restore, or enhance existing wetlands
Hydroecological tool: enhancements and results

Nutrients & sediment: Results

Average SS/TN/TP

<table>
<thead>
<tr>
<th>Location</th>
<th>% Stream segments exceeding EPA criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit</td>
<td>1</td>
</tr>
<tr>
<td>Twelve Mile</td>
<td>1</td>
</tr>
<tr>
<td>Duffins</td>
<td>1</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
</tr>
<tr>
<td>Napanee</td>
<td>0.8</td>
</tr>
<tr>
<td>Lakeshore marshes</td>
<td>0.8</td>
</tr>
<tr>
<td>Sandy</td>
<td>0.7</td>
</tr>
<tr>
<td>Salmon</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Credit Twelve
Duffins
Black
Napanee
Lakeshore marshes
Sandy
Salmon
Hydroecological tool: enhancements and results

Nutrients and sediment: Results

Credit River

Napanee Creek

SS

TN
• Pattern of alteration follows the disturbance gradient very well
• Many of the more disturbed watersheds potentially have a high degree of EPA criteria exceedence
• More testing would be useful to see if predictions are accurate
Hydroecological tool: enhancements and results

Strategies for reducing nutrient enrichment

- Construct a wetland
- Implement agricultural and urban nutrient management practices
- Buffer stream banks
Strategies for reducing sedimentation

- Stabilize stream banks
- Reduce construction
- Implement sediment barriers
- Use soil bioengineering techniques (geotextiles)
Summary

• Disturbances generally follow a west to east pattern of decreasing impairment. Overall, the most degraded watersheds were Credit, Twelve Mile and Black; least degraded were Sandy and Salmon.

• In terms of percentage of stream reaches affected, riparian degradation seems to be less of an impairment in the study watersheds while water quality issues seem to be quite prevalent.

• There is a wide range of blocked habitat with some watersheds almost entirely blocked and others not blocked much at all. Canadian watersheds possibly considerably less blocked than US watersheds.

• Tool provides a spatially-oriented, coarse, watershed level assessment on a variety of impairments.

• Can be used to guide conservation actions (protection/restoration).
Future tasks

- Incorporate feedback from meeting
- Restoration costs
- Webserver: http://glrestoration.cfe.cornell.edu
Funders and partners:
• Great Lakes Protection Fund
• Natural Heritage Institute
• The Nature Conservancy
• Toronto and Region Conservation Authority

Technical assistants:
Rodrigo de Almeida, Melissa Kalverstrand, Michael Brown, Jordan Gass, Paloma League-Pike

Thank you!