Monitoring Crayfish Populations in Muskoka Lakes

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Outline of Presentation

• Using crayfish as indicators
• How we sample crayfish
• Results from spatial surveys
• Results from long-term monitoring
• Exploring cause and effect
• Summary
Crayfish as Indicators

Why use crayfish as a “bio” monitor?

• Crayfish live for several years
• Crayfish are non-migratory
• There are several crayfish species with different preferences and tolerances
• Crayfish are common in Muskoka
• Crayfish are easily sampled

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We assume that:

Crayfish are good indicators of ecosystem health because their occurrence and abundance are linked to physical and chemical habitat features.
What do we know about crayfish?

- There are 7 native and 3 introduced species of crayfish in Ontario.
- Crayfish activity and life history events (periods of moulting and reproduction) are temperature dependent.
- Behaviour and habitat preferences differ among species (and sexes).
We also know that:

- There are a number of different ways to sample crayfish
- Each method with its own strengths and weaknesses
- Methods include using SCUBA or snorkelling to collect crayfish by hand along transects or quadrats, using traps, throw nets, seines, dip nets, and electrofishing...
Crayfish Sampling

- 54 baited traps
- when - mid-summer
- traps are set for one night (or about 24 hours)
- catch identified to species
- catch is expressed as catch per unit effort – CUE (number caught per trap per night)
Crayfish Sampling

- traps are standard “Gee” minnow traps with opening widened to ~3.5 cm
- bait is “canned cat food” specifically fish or tuna flavoured
- bait is delivered in 35 mm film canisters with holes (6-8) punched in the sides with one-hole paper punch
- canisters are prepared in advance, frozen, and used one per trap
Crayfish Sampling

- traps are set in groups or traplines attached to shore
- each trapline consists of 6 traps attached to a line at 3-m intervals
- the first trap is placed at a depth of 0.5-1 m and subsequent traps are lowered to the bottom
- 3 traplines are set in each habitat (rock, macrophyte, and detritus)
Spatial (100 Lake) Crayfish Survey

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Lakes in 9 tertiary watersheds

Included:
- Sudbury
- Algonquin Provincial Park
- South of the Shield

Lakes originally surveyed between 1989 and 1994

Lakes were re-sampled between 2005 and 2007 using same methodology.
Comparing Catches from 2 Time Periods

- Y axis is current catch per unit effort (CUE)
- X axis is historical catch per unit effort (CUE)
- one-to-one line indicates no change
- above that line – current CUE is more than historical CUE
- below 1:1 line – current CUE is less than historical CUE
Catches of *Orconectes virilis*

Historical CPUE

Current CPUE

N = 57
Slope = 0.28
Current CUE is 28% of historical CUE
Catches of *Orconectes propinquus*

- **N = 39**
- **Slope = 0.09**
- Current CUE is 9% of historical CUE
## General Trends in Crayfish Catches

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of lakes</th>
<th>Slope</th>
<th>% of Historical CUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O. virilis</em></td>
<td>57</td>
<td>0.28</td>
<td>28</td>
</tr>
<tr>
<td><em>O. propinquus</em></td>
<td>39</td>
<td>0.09</td>
<td>9</td>
</tr>
<tr>
<td><em>O. obscurus</em></td>
<td>9</td>
<td>0.32</td>
<td>32</td>
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<td><em>O. immunis</em></td>
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<td>0.38</td>
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<td><em>O. rusticus</em></td>
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<td>0.09</td>
<td>9</td>
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<tr>
<td><em>C. bartonii</em></td>
<td>33</td>
<td>0.10</td>
<td>10</td>
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<tr>
<td><em>C. robustus</em></td>
<td>12</td>
<td>0.04</td>
<td>4</td>
</tr>
</tbody>
</table>
Distribution of *Orconectes virilis* (57 lakes)

- 27 lakes – no change
- 15 lakes – >50% decrease
- 15 lakes – now absent
- 10 lakes – new observation

![Map showing distribution of *Orconectes virilis*](image)

- **Maintained**
- **≥ 50% Less than Historical**
- **Apparently Lost**
- **Newly Detected**
Distribution of *O. propinquus* (39 lakes)

- 19 lakes – no change
- 10 lakes – >50% decrease
- 10 lakes – now absent
- 4 lakes – new observation

Legend:
- Black: Maintained
- Pink: Apparently Lost
- Yellow: ≥ 50% Less than Historical
- Green: Newly Detected
Distribution of *C. bartonii* (33 lakes)

- 8 lakes – no change
- 7 lakes – >50% decrease
- 18 lakes – now absent
- 2 lakes – new observation

- **Maintained**
- **≥ 50% Less than Historical**
- **Apparently Lost**
- **Newly Detected**
Spatial Survey Summary

- Decreases in crayfish trap catches have been significant and widespread.
- *Cambarus* spp. (*C. bartonii* and *C. robustus*) appear to be faring the worst.
- The cause(s) of the decreases are unknown.
Long-term Monitoring

- Crayfish populations in ~20 Muskoka-area lakes have been monitored for 23 years (1988-2010)
- The same sampling methods (i.e., 54 baited traps) have been used throughout the study
- Original goal was to monitor biological recovery from acid rain
Long-term Monitoring Results

- Some lakes had no crayfish – other lakes had 3 species
- Abundances varied a great deal among species and over time
- CUE tended to go down over time (didn’t suggest recovery)
Long-term Monitoring *C. Bartonii*

- When catches for a given species are standardized over time there is considerable variation, but an overall decrease in catch is evident.
- *C. Bartonii* from 9 lakes revealed 7 significant decreases in CUE over time.
Long-term Monitoring *O. virilis*

- Standardized CUE for *O. virilis* from 6 lakes also decreased (4 of these trends were significant)
Long-term Monitoring *O. propinquus*

- Standardized catches for *O. propinquus* from 8 lakes were more variable.
- 5 populations displayed decreases over time and 3 of these were statistically significant.
Exploring “cause and effect”

- It is not immediately clear why crayfish catches have generally decreased over time.
- One of many hypotheses focuses on observed decreases in calcium concentrations in Muskoka lakes.
Are Crayfish “limited” by calcium?

- Crayfish were collected from 19 Muskoka lakes
- Carapaces were dried, sampled and analyzed for calcium content
- Crayfish calcium levels were compared to lake calcium concentrations

[This is part of Brie Edwards PhD thesis work at the University of Toronto]
Correlating Carapace and Lake Calcium

Orconectes virilis

\[ n = 19 \text{ lakes, } r^2 = 0.43, \ p < 0.01 \]
Survival and Calcium Availability

• conducted a lab experiment with juvenile crayfish grown in tanks with different concentrations of calcium

[This is part of Brie Edwards PhD thesis work at the University of Toronto]
Nonparametric Log-Rank tests showed significant differences between Control and Extreme treatments ($p < 0.05$)
Summary

• Crayfish seem to “work” as biomonitors.
• Trends over time based on a 100-lake survey and year-to-year monitoring of about 20 lakes indicate crayfish catches are generally decreasing despite ongoing chemical recovery from acid rain.
• The cause of these decreases are unknown, but may be related to gradual decreases in calcium – efforts to identify the cause(s) are ongoing.
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