Monitoring Crayfish Populations in Muskoka Lakes

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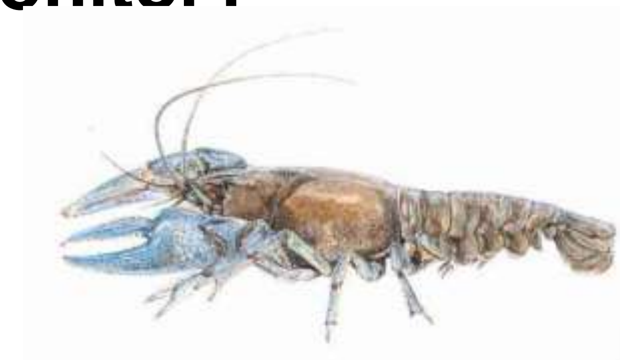
Outline of Presentation

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

Ontario

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

Crayfish as Indicators

Why use crayfish as a "bio" monitor?

- 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

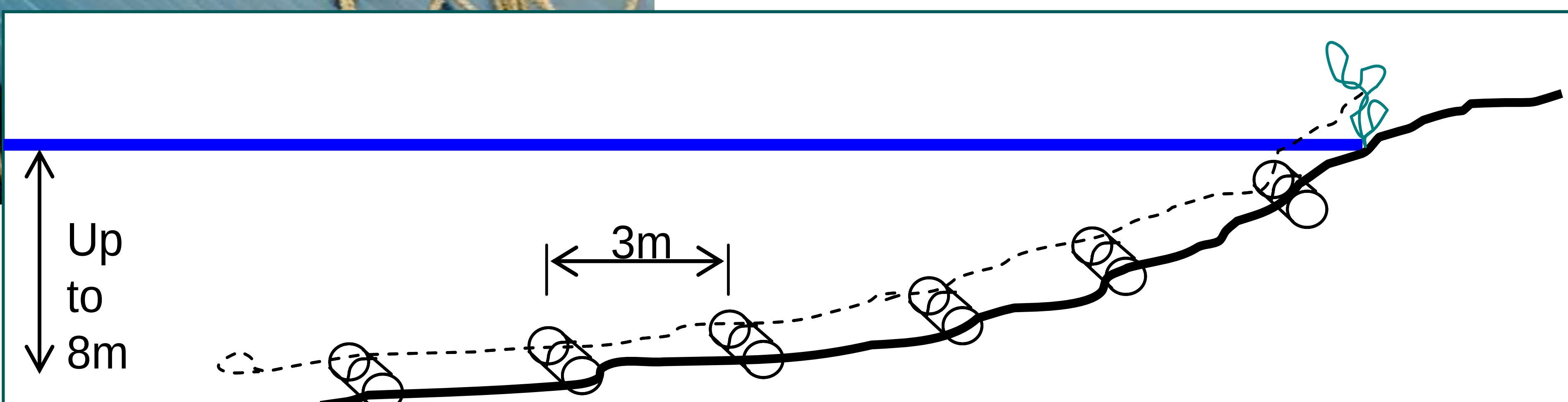
- 54 baited traps
- when - mid-summer
- traps are set for one night (or about 24 hours)
- catch identified to species
- catch is expressed as catch per unit effort – CUE (number caught per trap per night)

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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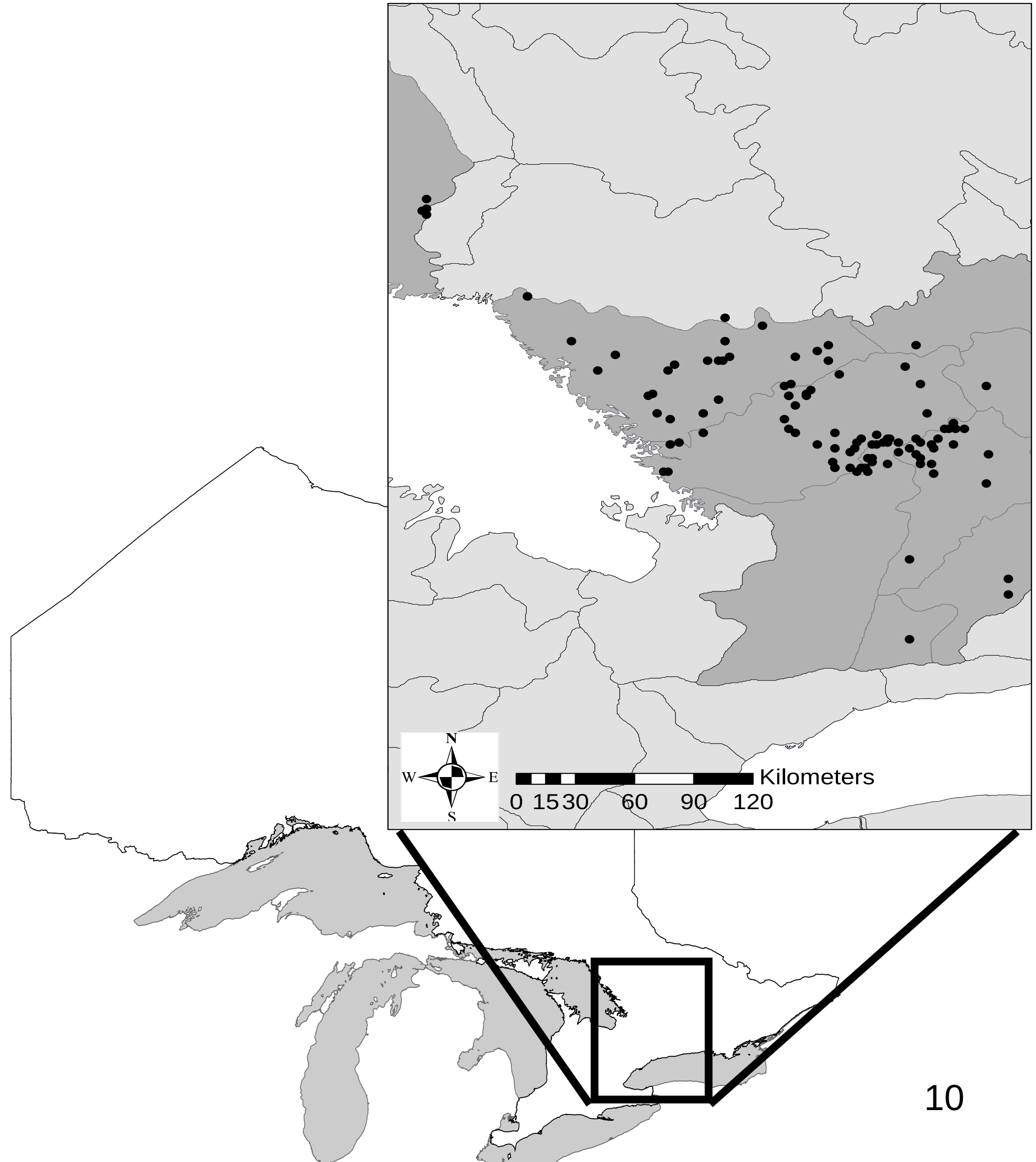
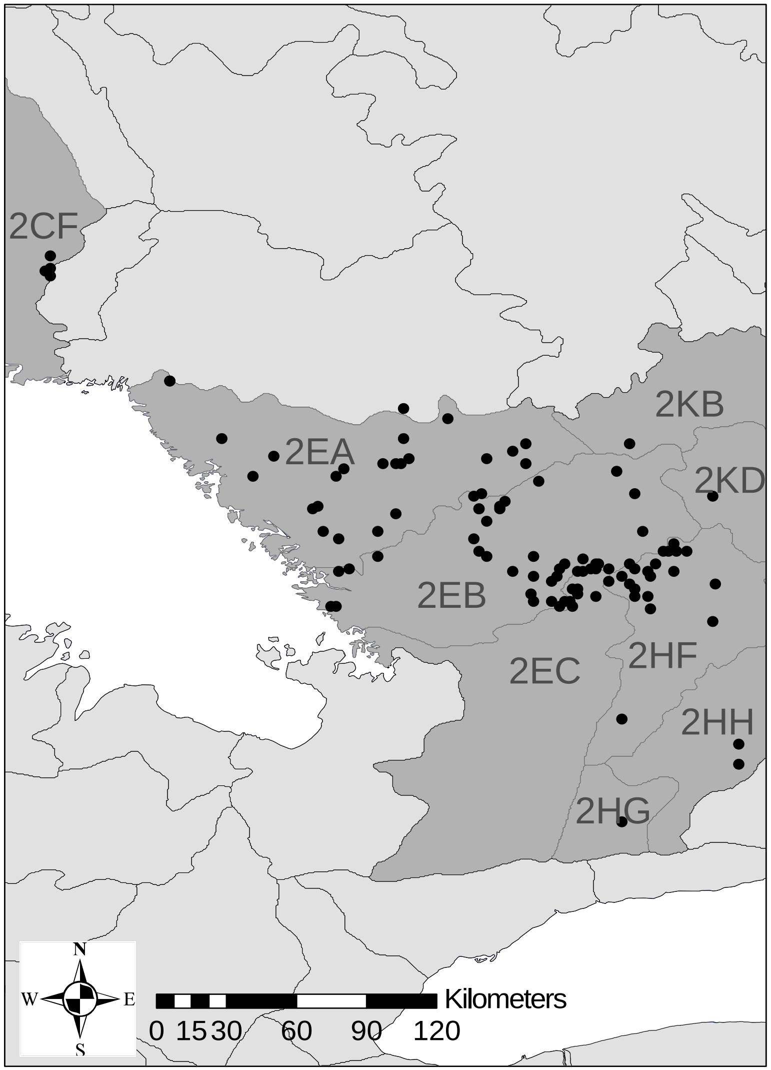
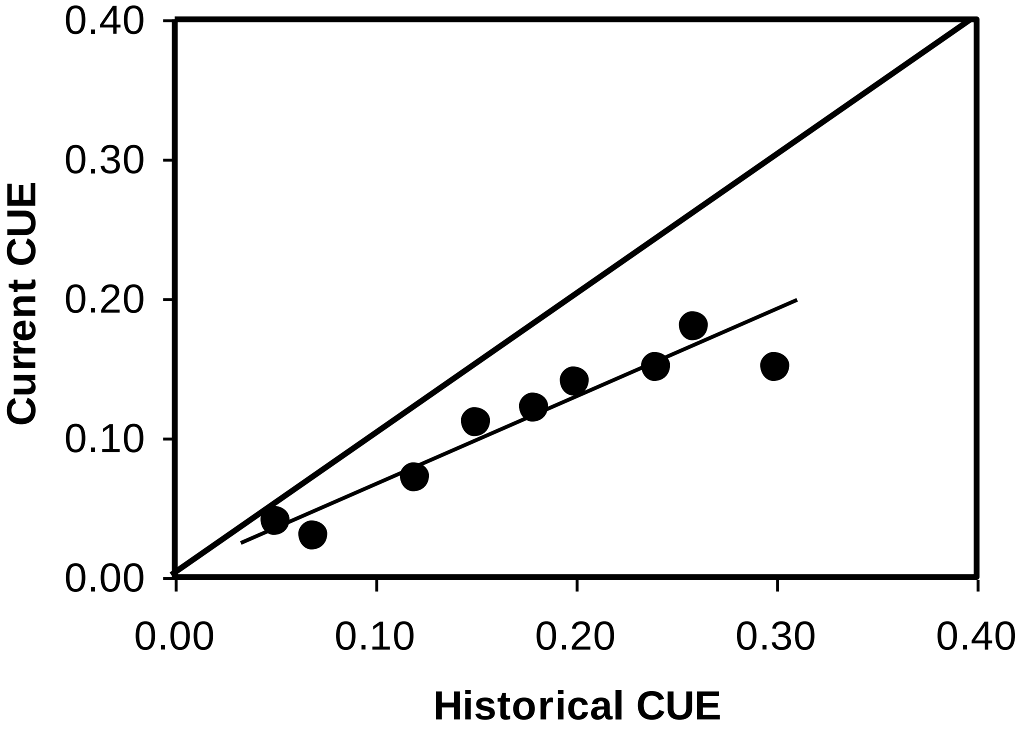


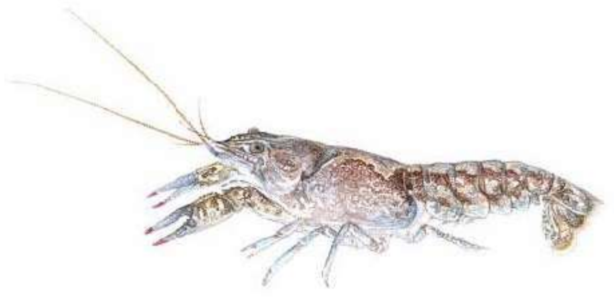
Spatial (100 Lake) Crayfish Survey



- 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.

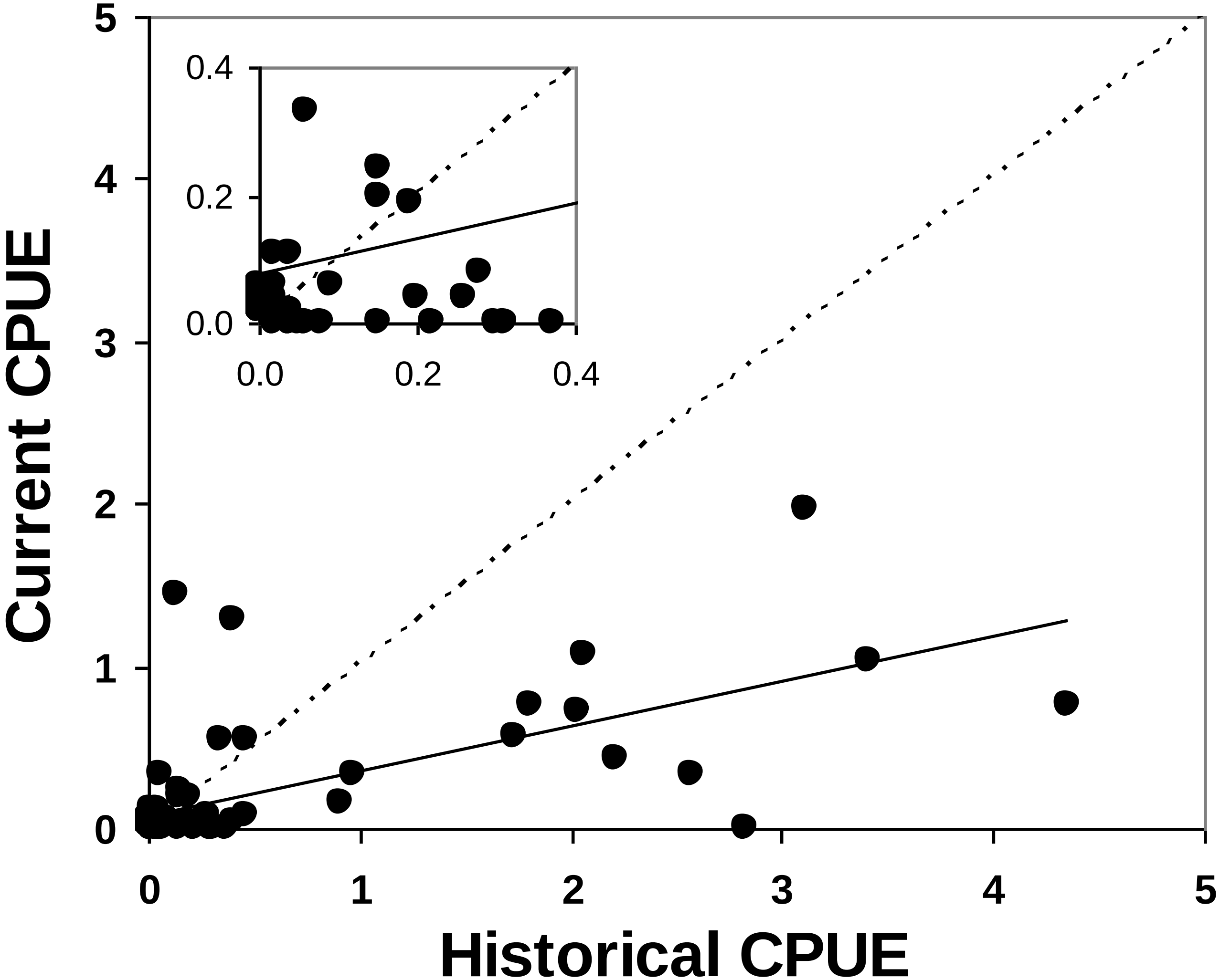
Comparing Catches from 2 Time Periods





- 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*

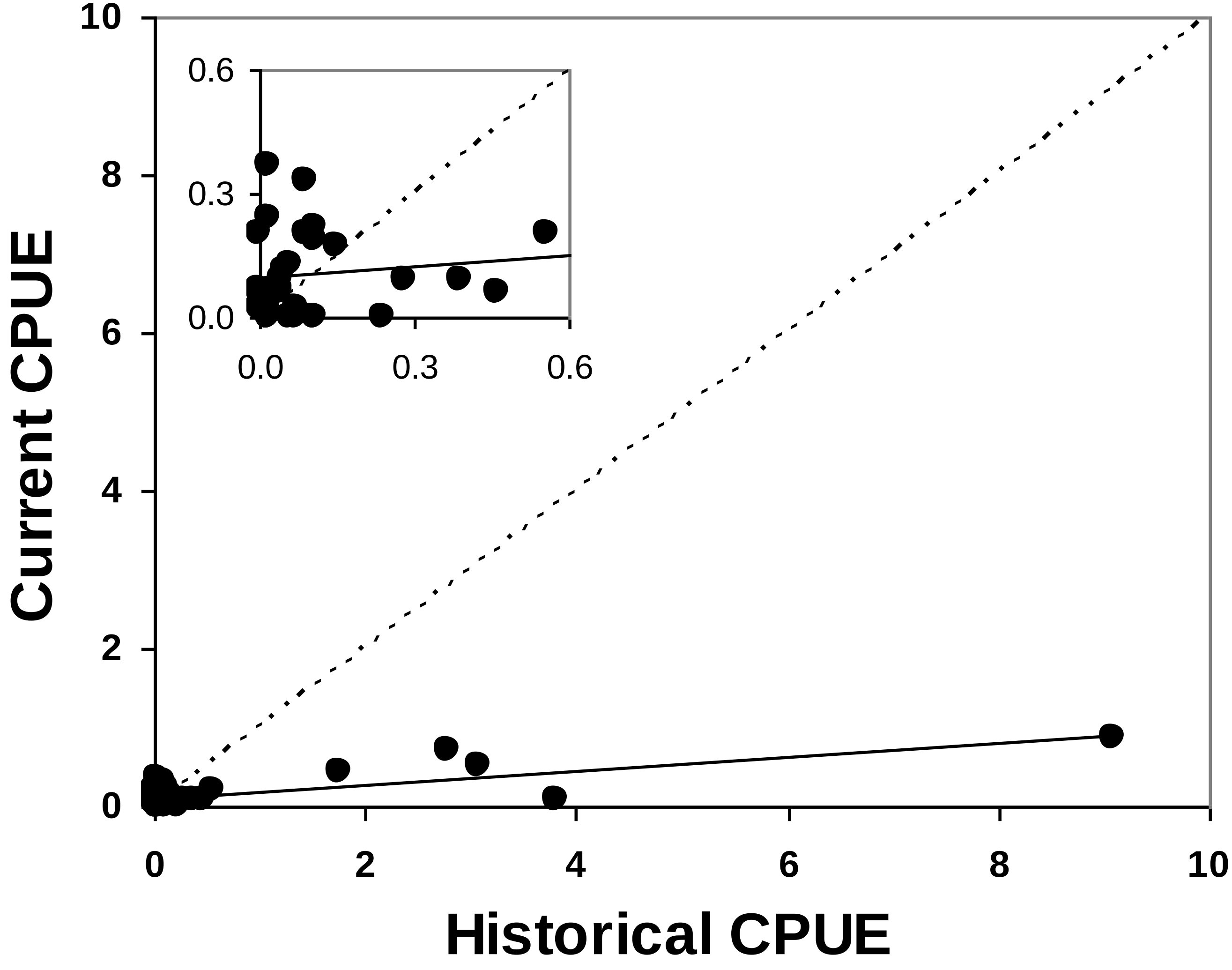


N = 57

Slope = 0.28

Current CUE is 28% of historical CUE

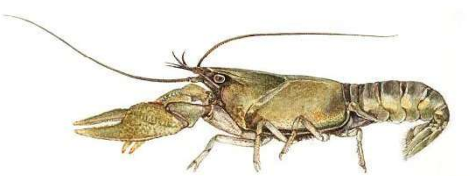
Catches of *Orconectes propinquus*



N = 39

Slope = 0.09

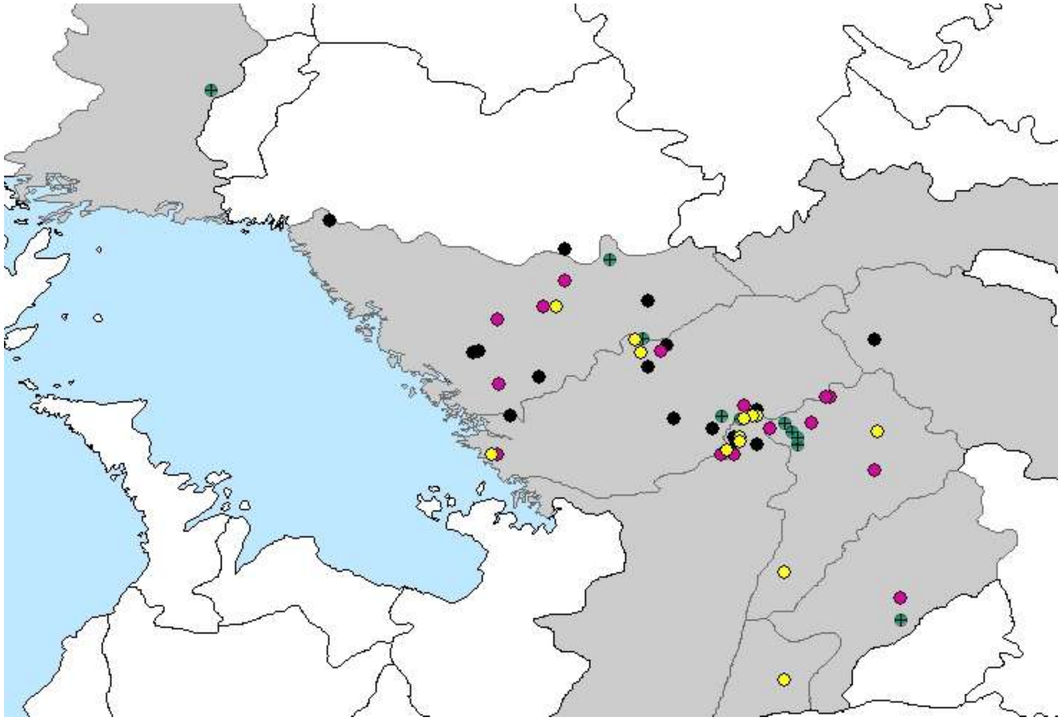
Current CUE is 9% of historical CUE



General Trends in Crayfish Catches

Species	Number of lakes	Slope	% of Historical CUE
O. virilis	57	0.28	28
O. propinquus	39	0.09	9
O. obscurus	9	0.32	32
O. immunis	7	0.38	38
O. rusticus	3	0.09	9
C. bartonii	33	0.10	10
C. robustus	12	0.04	4

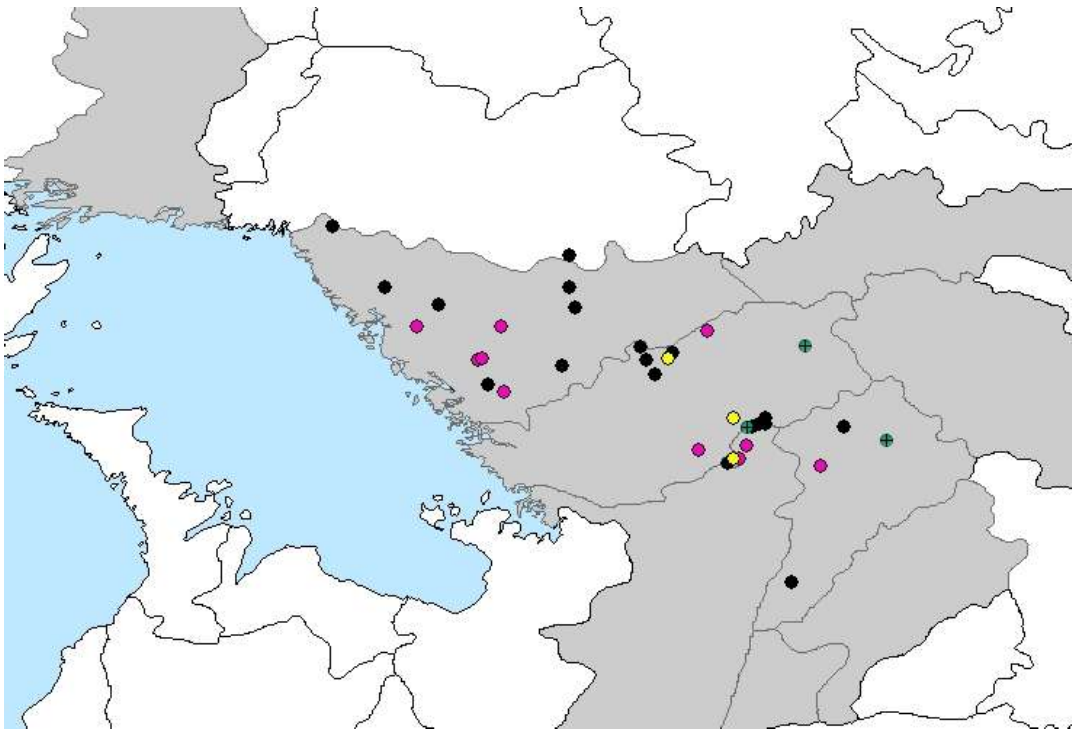
Distribution of *Orconectes virilis (57 lakes)*

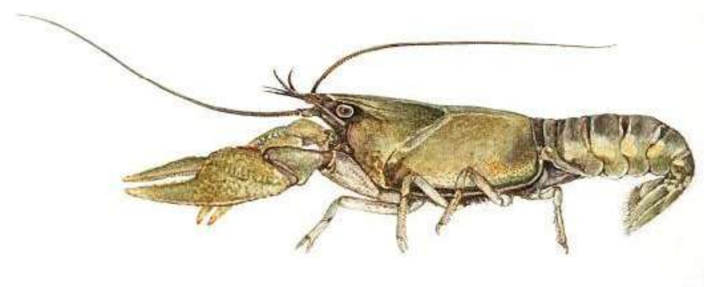


27 lakes – no change
15 lakes – >50% decrease
15 lakes – now absent
10 lakes – new observation

Maintained	Apparently Lost
≥ 50% Less than Historical	Newly Detected

Distribution of *O. propinquus (39 lakes)*

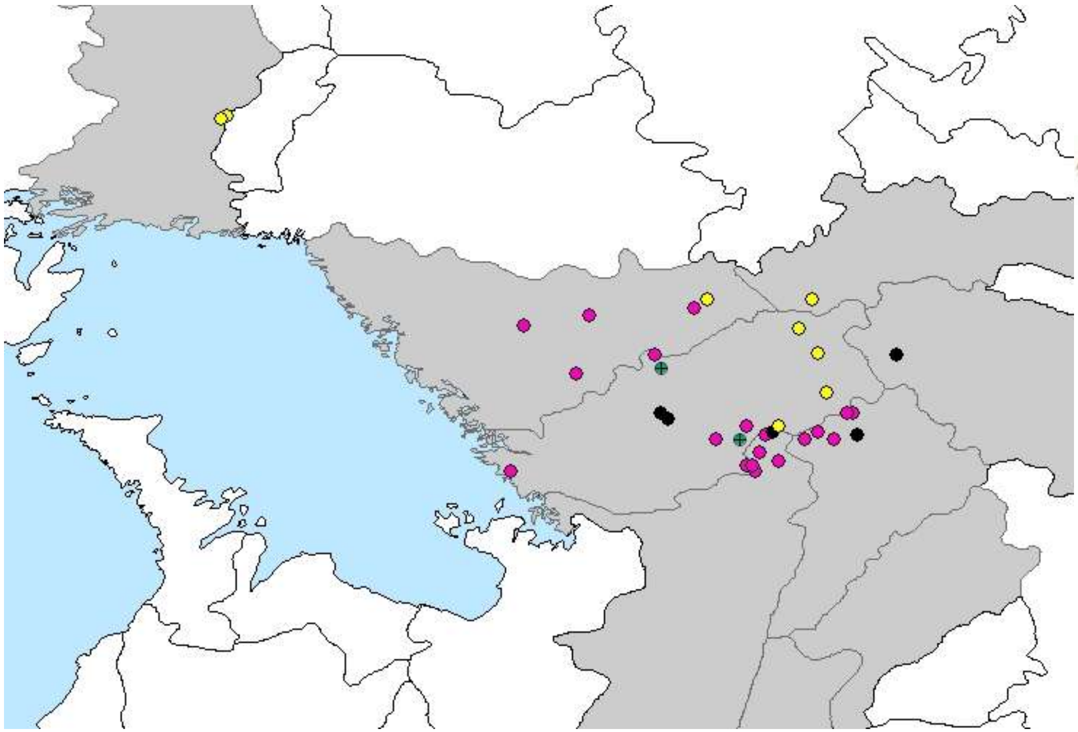




19 lakes – no change
10 lakes – >50% decrease
10 lakes – now absent
4 lakes – new observation

Maintained	Apparently Lost
≥ 50% Less than Historical	Newly Detected

Distribution of *C. bartonii (33 lakes)*



8 lakes – no change

7 lakes – >50% decrease

18 lakes – now absent

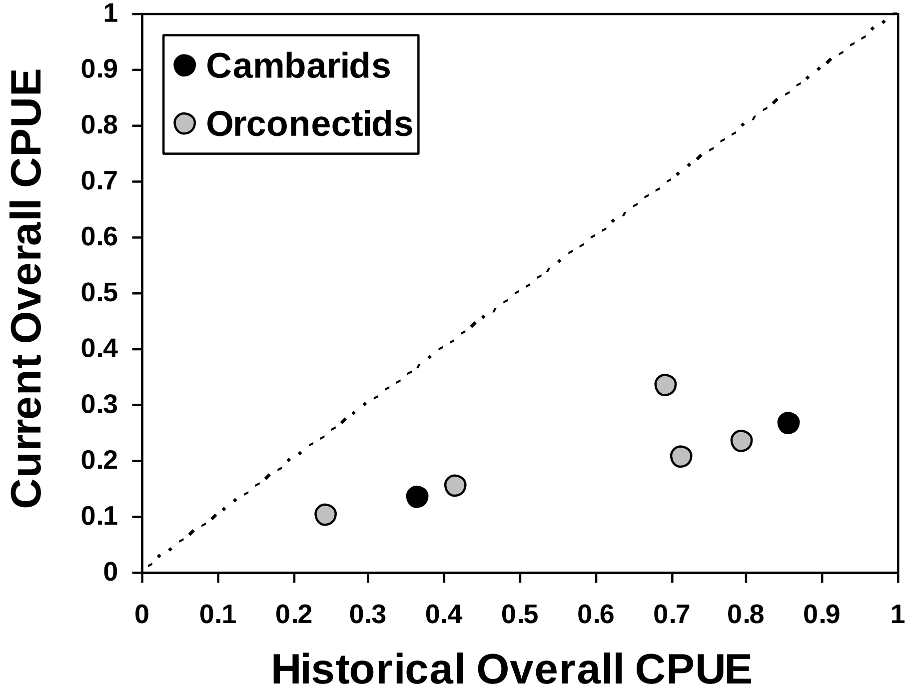
2 lakes – new observation

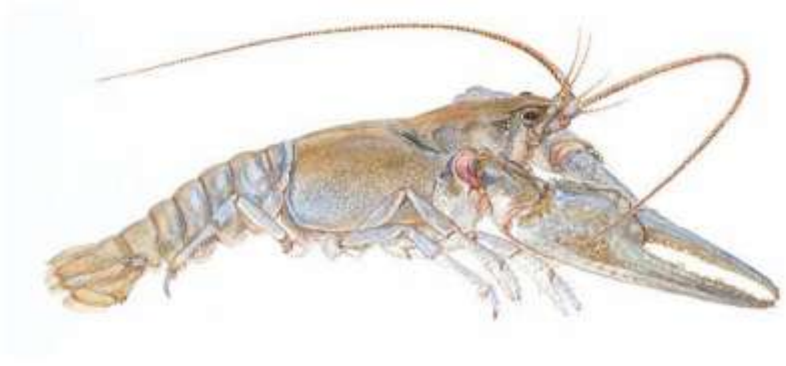
● Maintained ● Apparently Lost

○ ≥ 50% Less than Historical ⊕ Newly Detected

Spatial Survey Summary

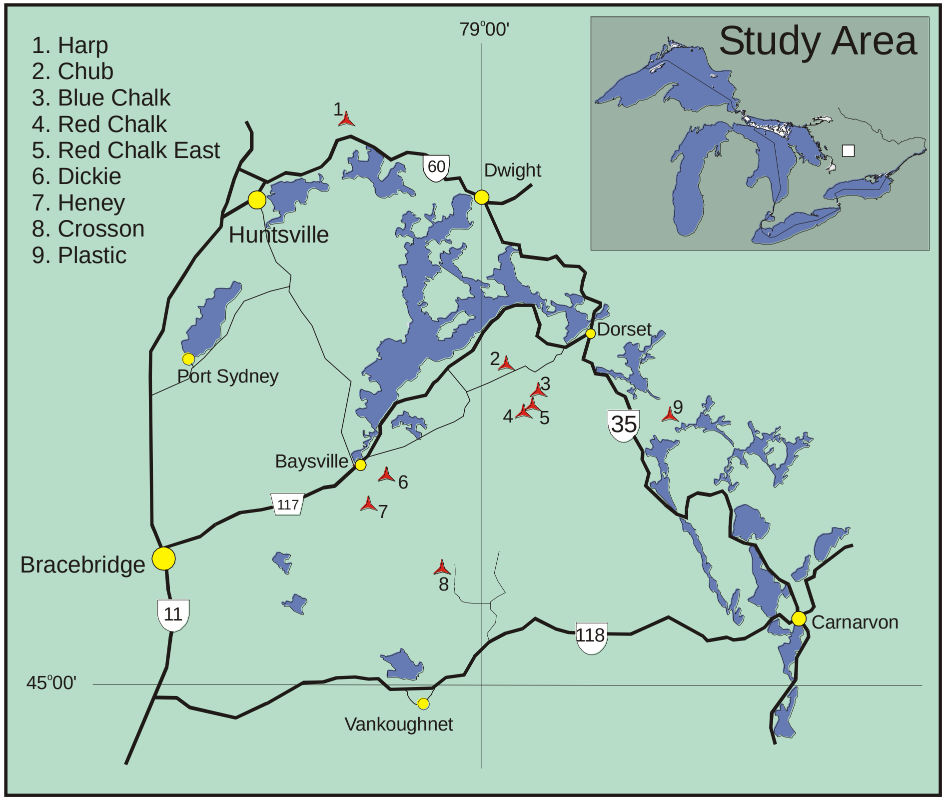
- Decreases in crayfish trap catches have been significant and widespread
- *Cambarus spp.* (*C. bartonii* and *C. robustus*) appear to be faring the worst
- The cause(s) of the decreases are unknown





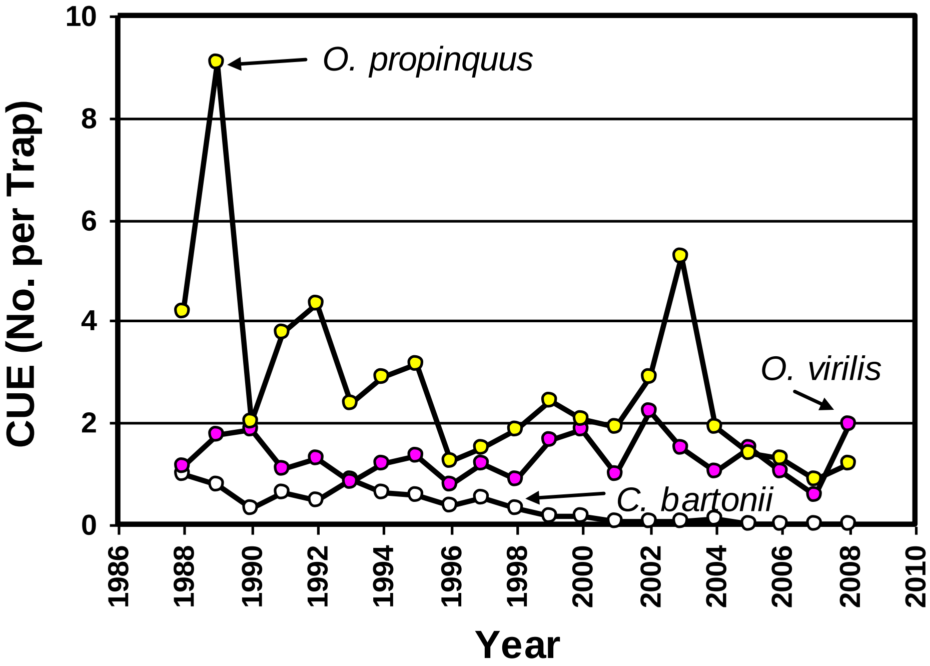
Long-term Monitoring

- 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

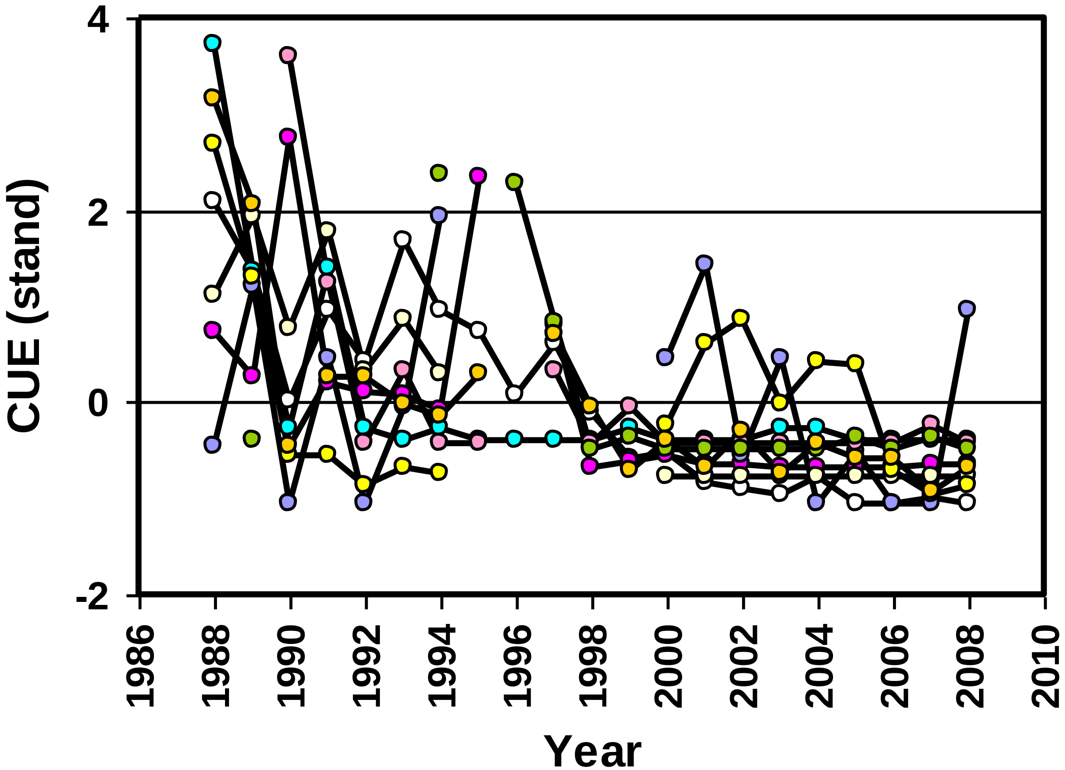


Long-term Monitoring Results

- 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)



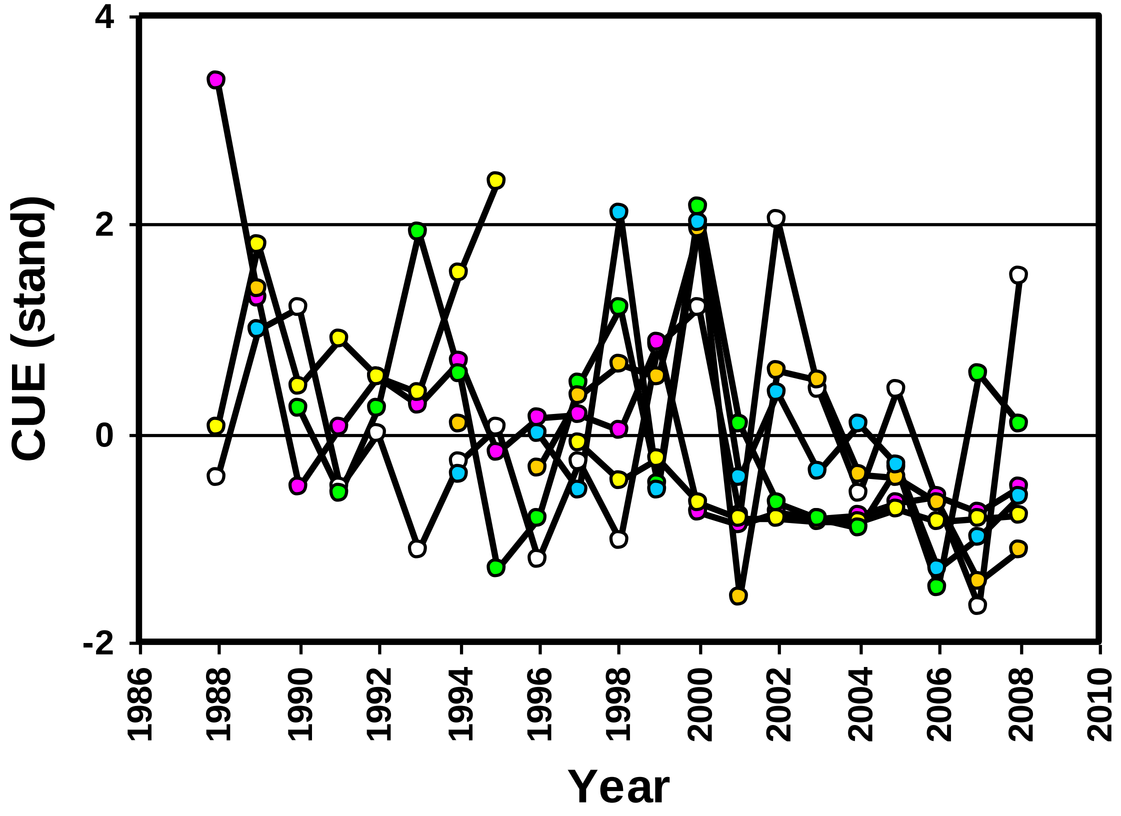
Long-term Monitoring *C. bartonii*



- 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

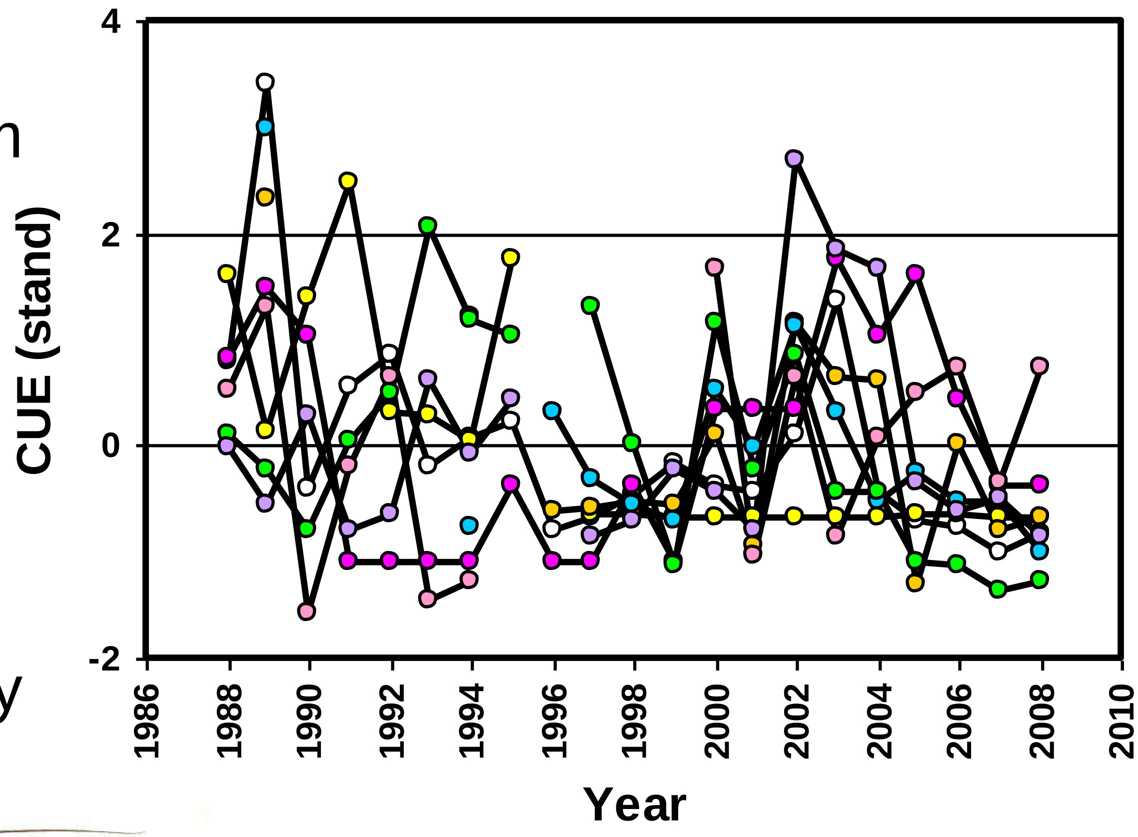
Long-term Monitoring *O. virilis*

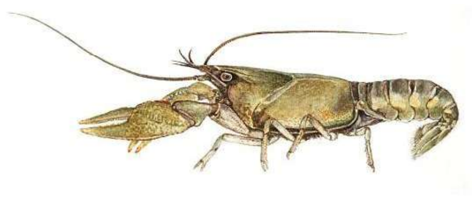
- Standardized CUE for *O. virilis* from 6 lakes also decreased (4 of these trends were significant)



Long-term Monitoring *O. propinquus*

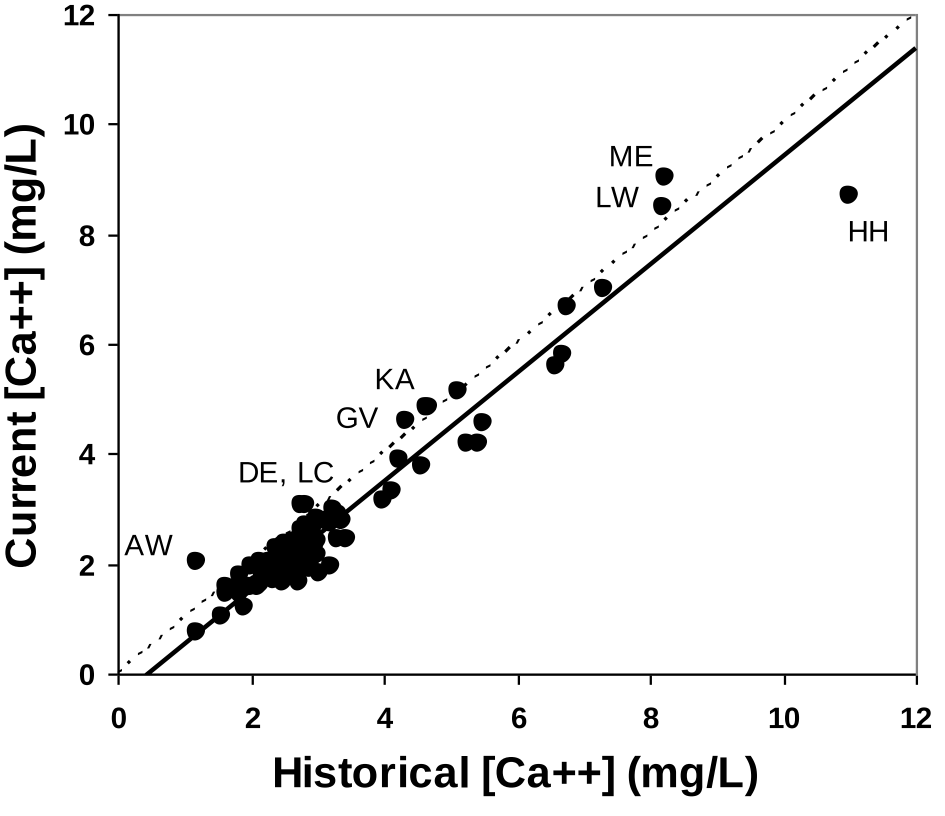
- Standardized catches for *O. propinquus* from 8 lakes were more variable
- 5 populations displayed decreases over time and 3 of these were statistically significant





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

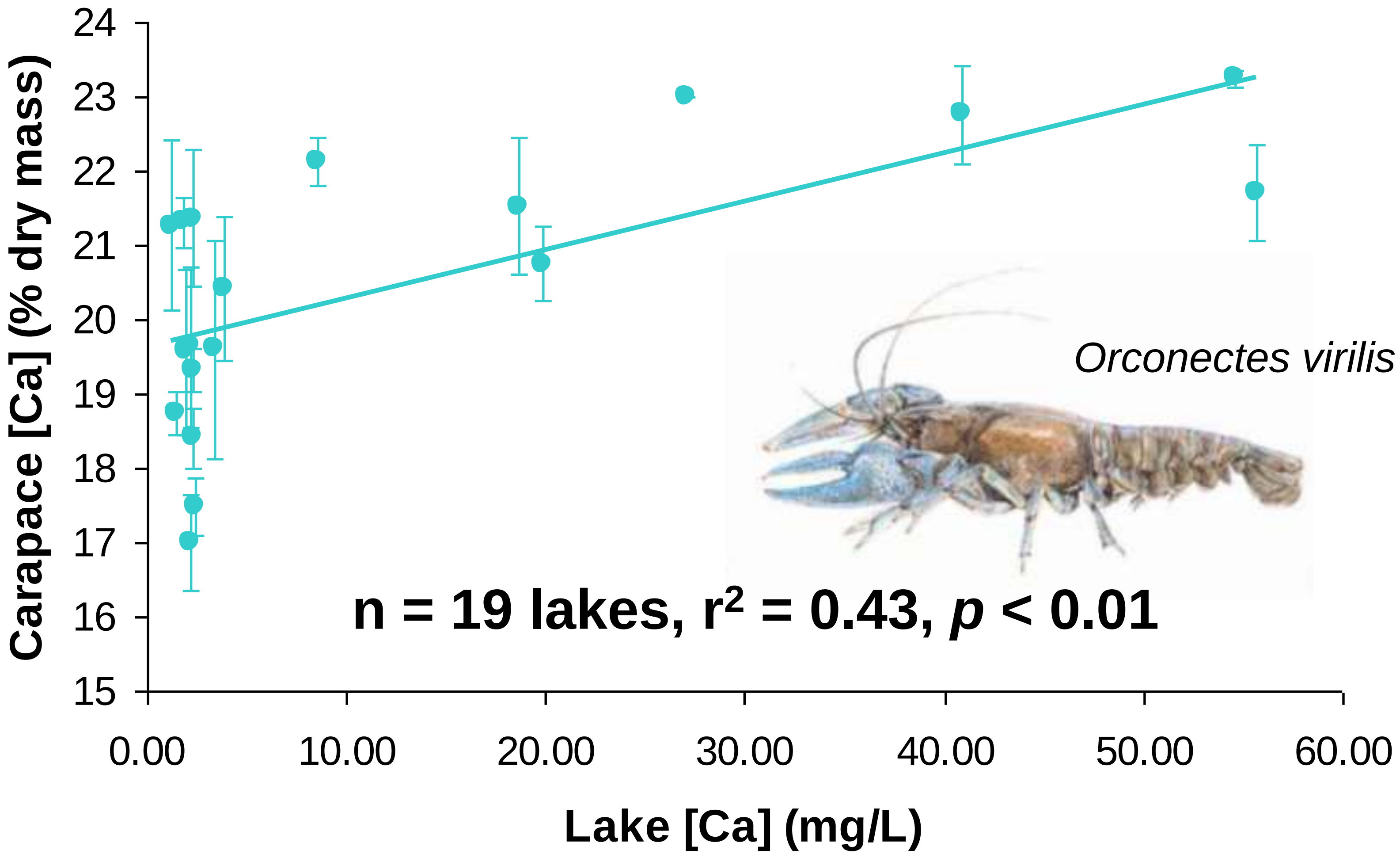


Are Crayfish "limited" by calcium?

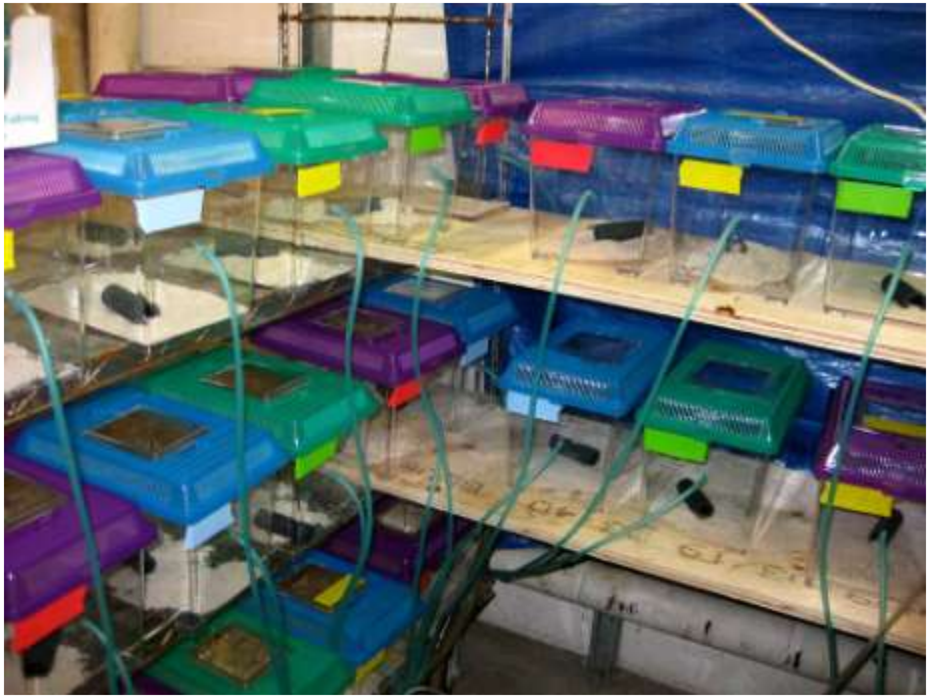
- Crayfish were collected from 19 Muskoka lakes
- Carapaces were dried, sampled and analyzed for calcium content
- Crayfish calcium levels were compared to lake calcium concentrations

[This is part of Brie Edwards PhD thesis work at the University of Toronto]

Correlating Carapace and Lake Calcium



Survival and Calcium Availability



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

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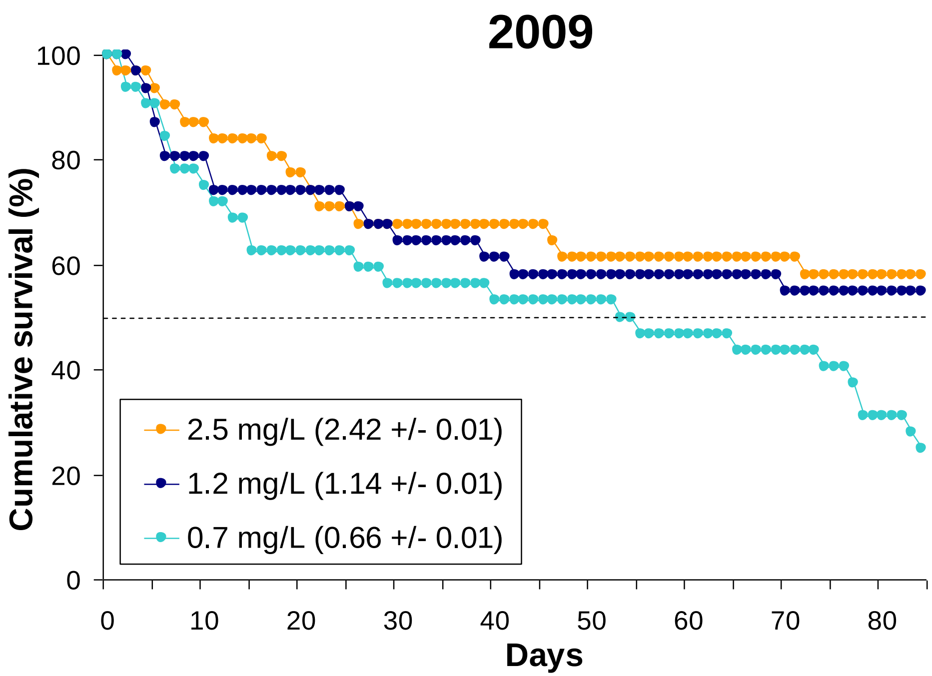
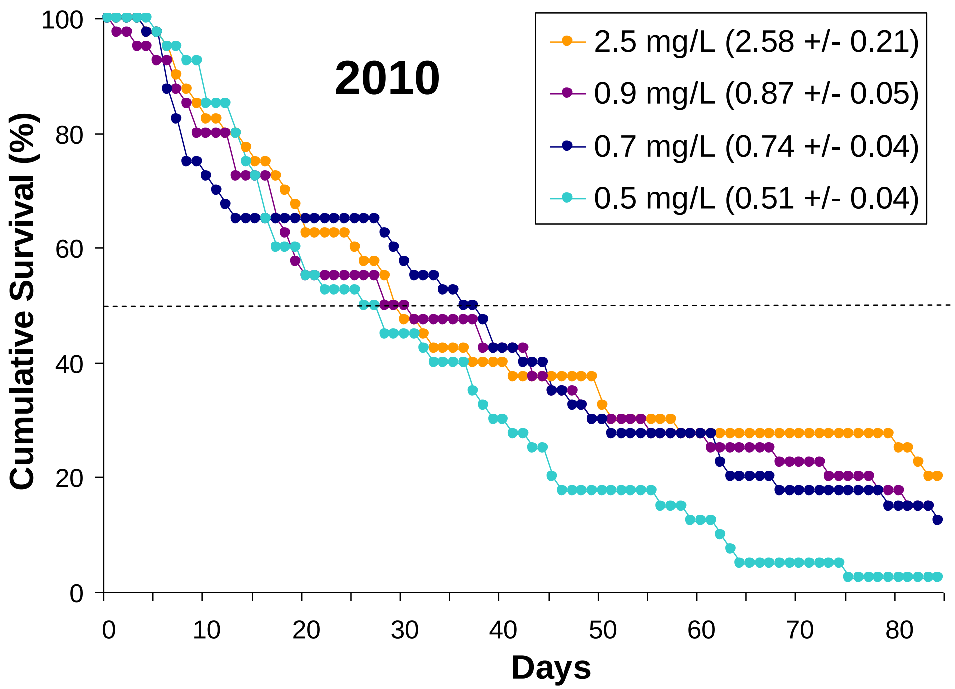
Survival and Calcium Availability





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

Acknowledgements

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