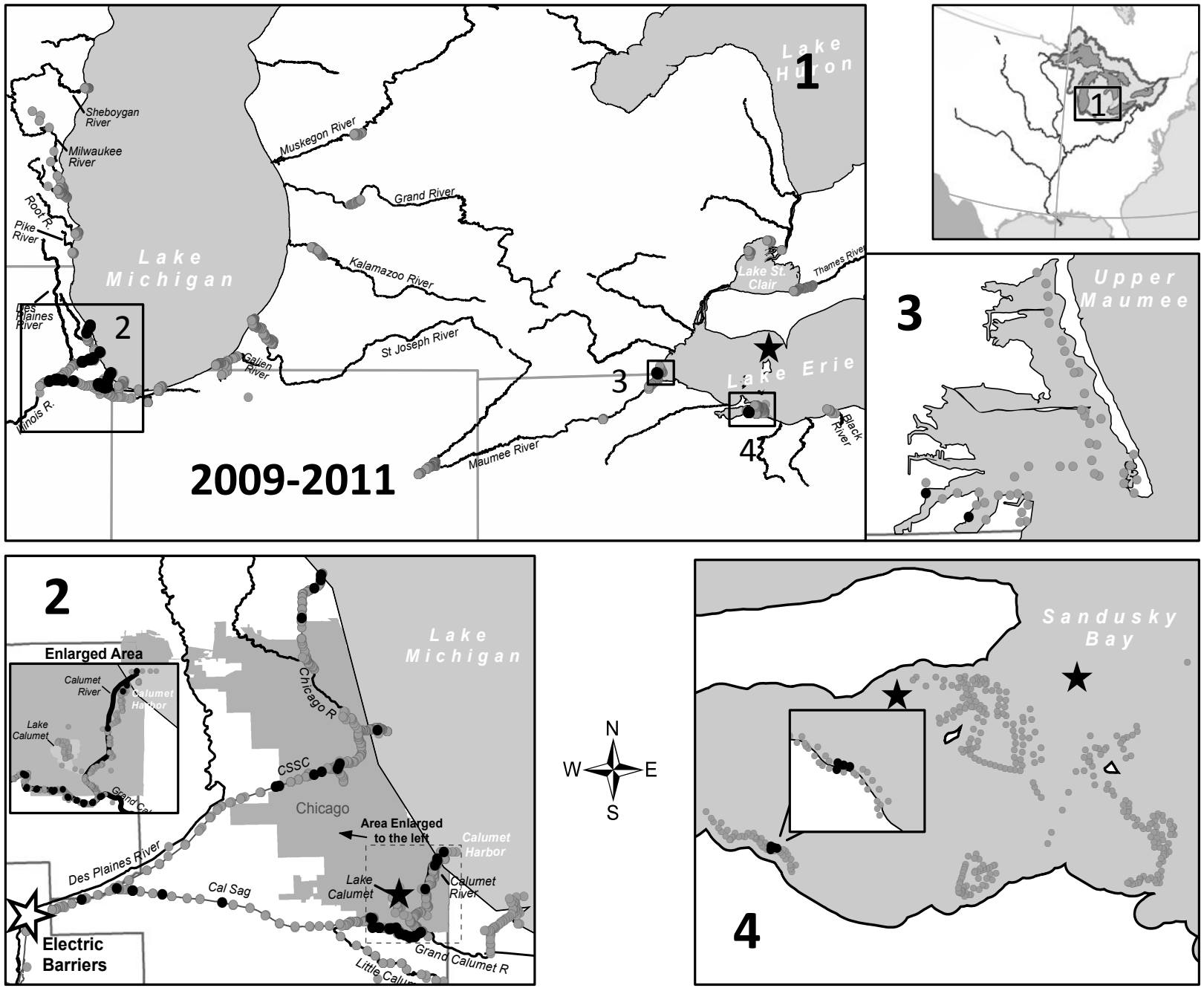
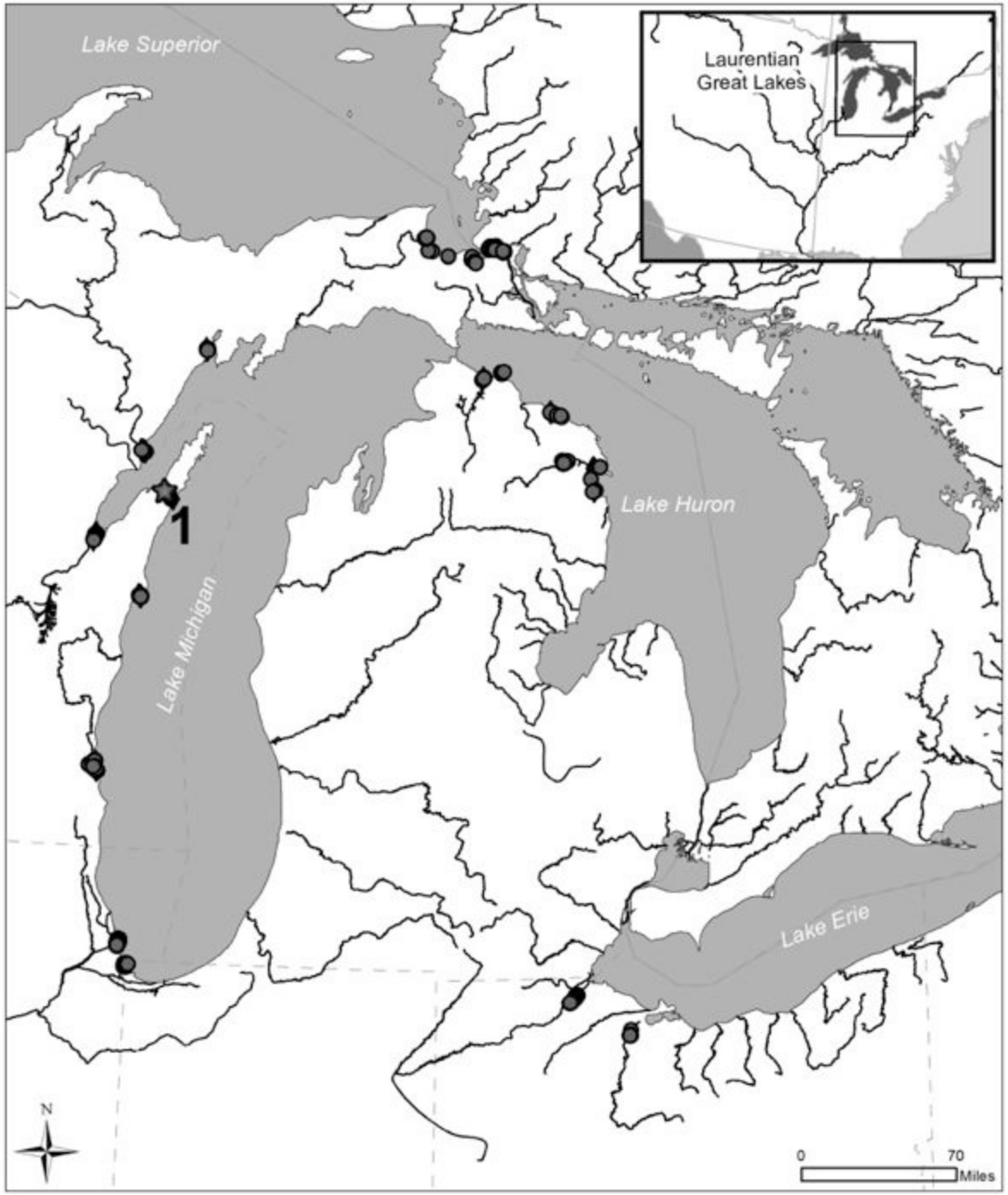
Environmental DNA surveillance in the Great Lakes

- GLRI on Great Lakes surveillance
- GLFI on Great Lakes bait trade
- GLFT on methodology and calibration
- Recommendations & comments


1
Lake Huron
Sheboygan River
Milwaukee River
Muskegon River
Grand River
Root R.
Pike River
Lake Michigan
Kalamazoo River
Lake St. Clair
Thames River
Des Plaines River
2
St Joseph River
Galien River
3
Lake Erie
Illinois R.
4
Black River
Maumee River
2009-2011
1
3
Upper Maumee
2
Enlarged Area
Calumet River
Calumet Harbor
Lake Calumet
Lake Michigan
Chicago R
CSSC
Chicago
Area Enlarged to the left
Calumet Harbor
Des Plaines River
Cal Sag
Lake Calumet
Calumet River
Electric Barriers
Grand Calumet R
N
W
E
S
Sandusky Bay
4

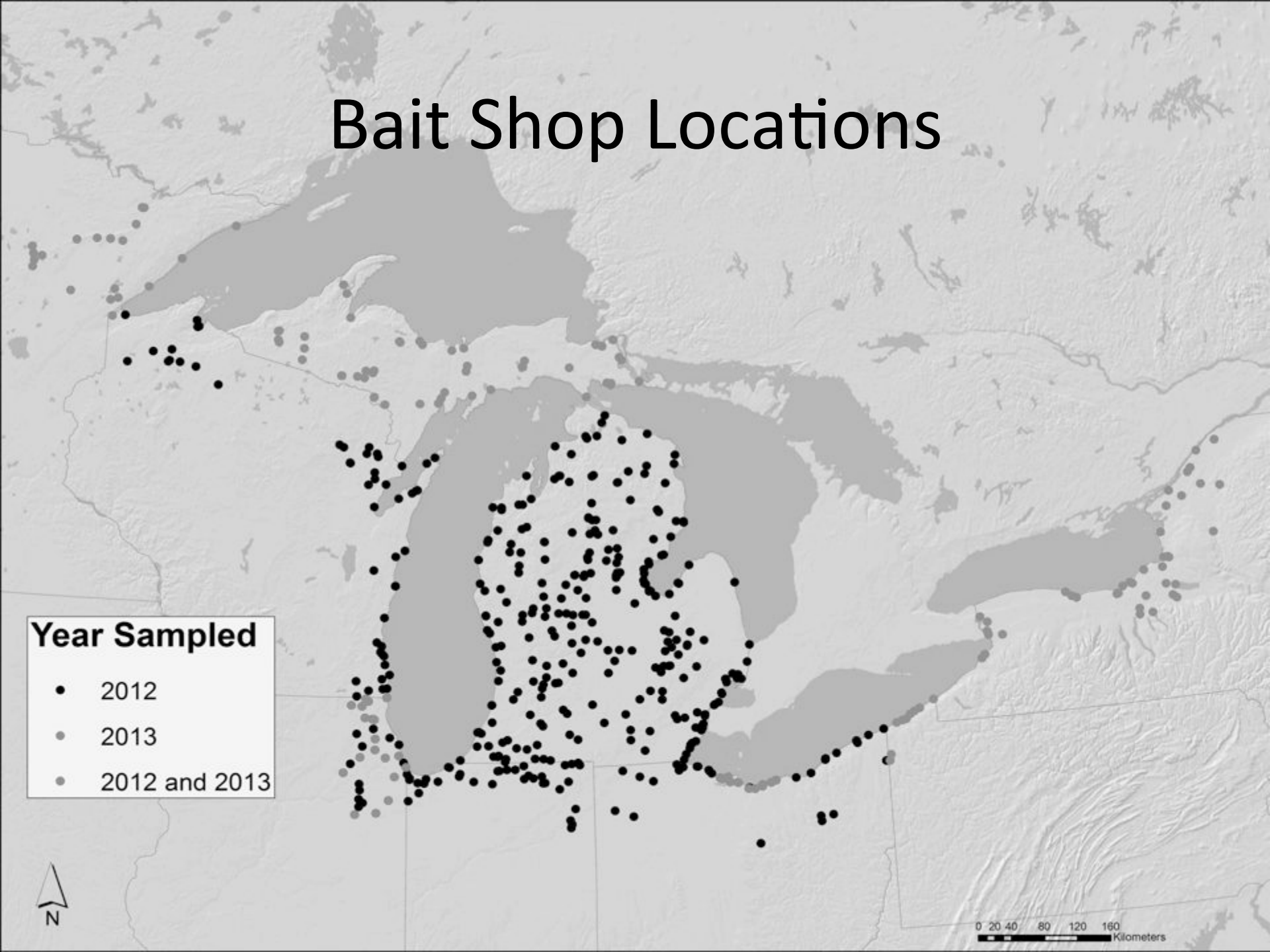

Lake Superior
Laurentian Great Lakes
Lake Huron
1
Lake Michigan
Lake Erie
N
0
70
Miles


1
2012-2013
Sturgeon Bay
Lake Michigan
star = positive detection

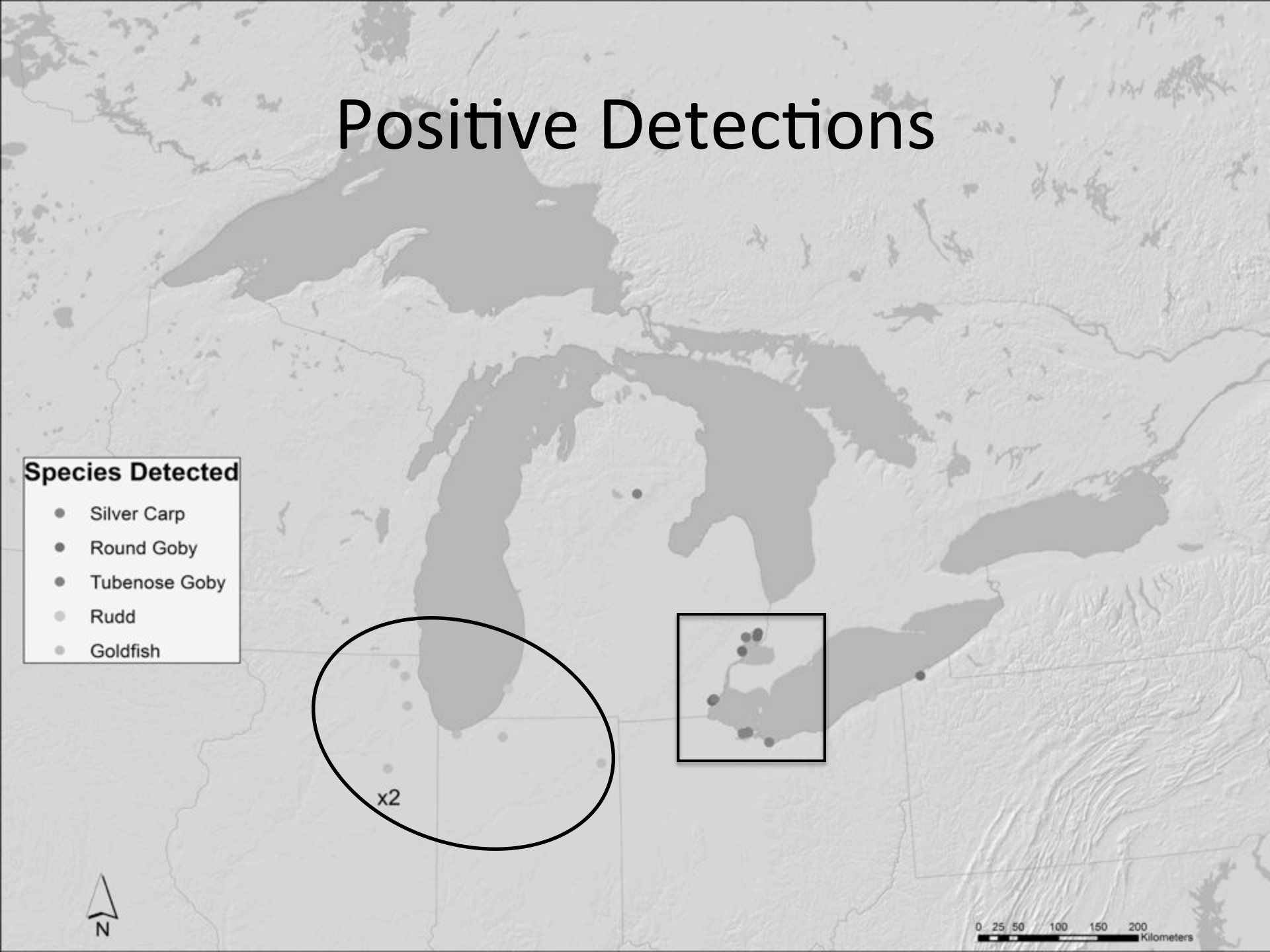
Evaluation of the Great Lakes Bait Trade as a Pathway for Invasive Species Introductions

Lucas Nathan at Central Michigan University (Soon to be at University of Connecticut)

Bait Shop Locations



Positive Detections

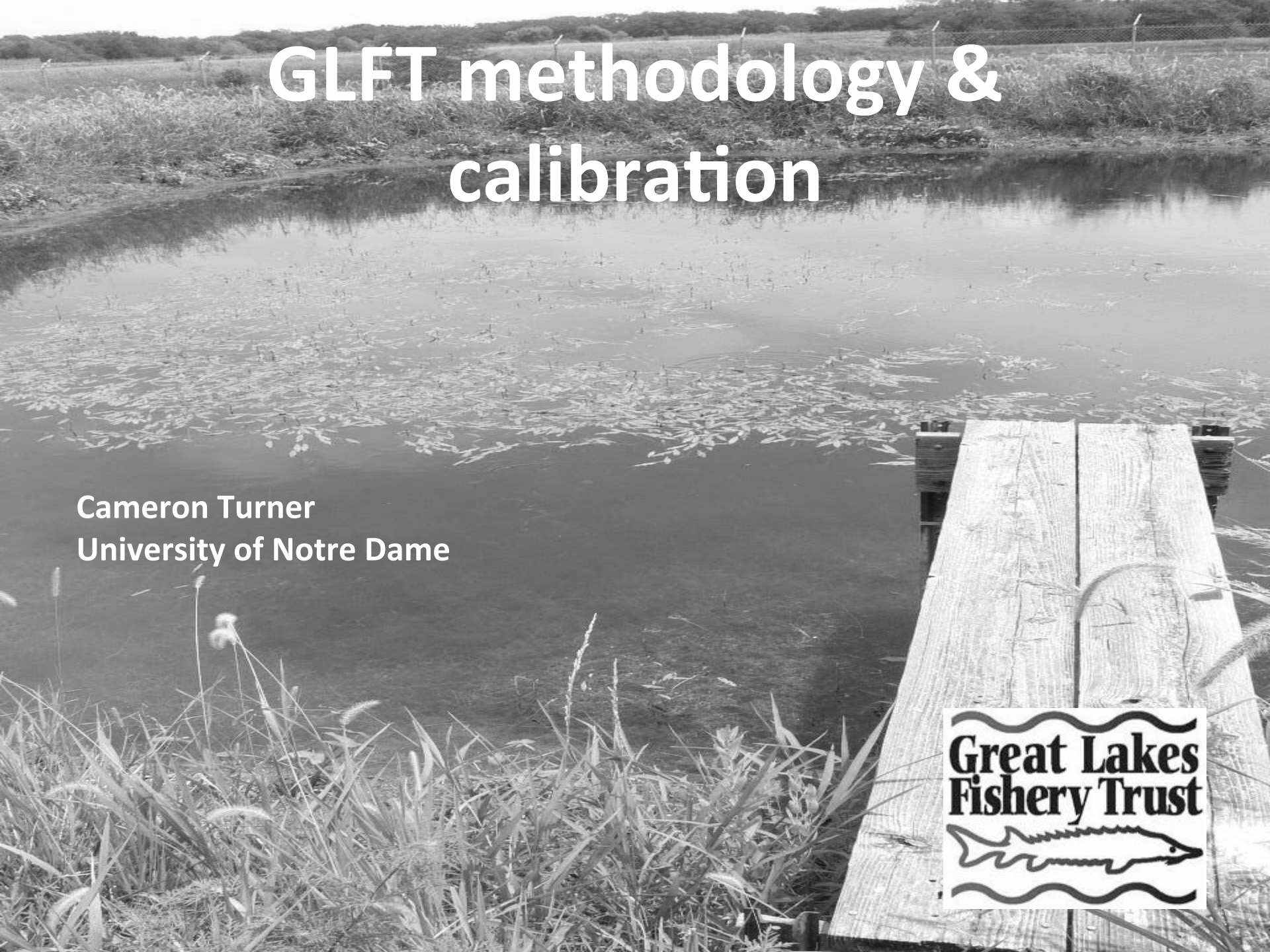


Bait trade conclusion's and comments

- Total # detections: 27/576 (≈4.7%)
- Regional patterns
- Total bait trade contamination?
- Final report to EPA submitted

GLFT methodology & calibration

Cameron Turner
University of Notre Dame



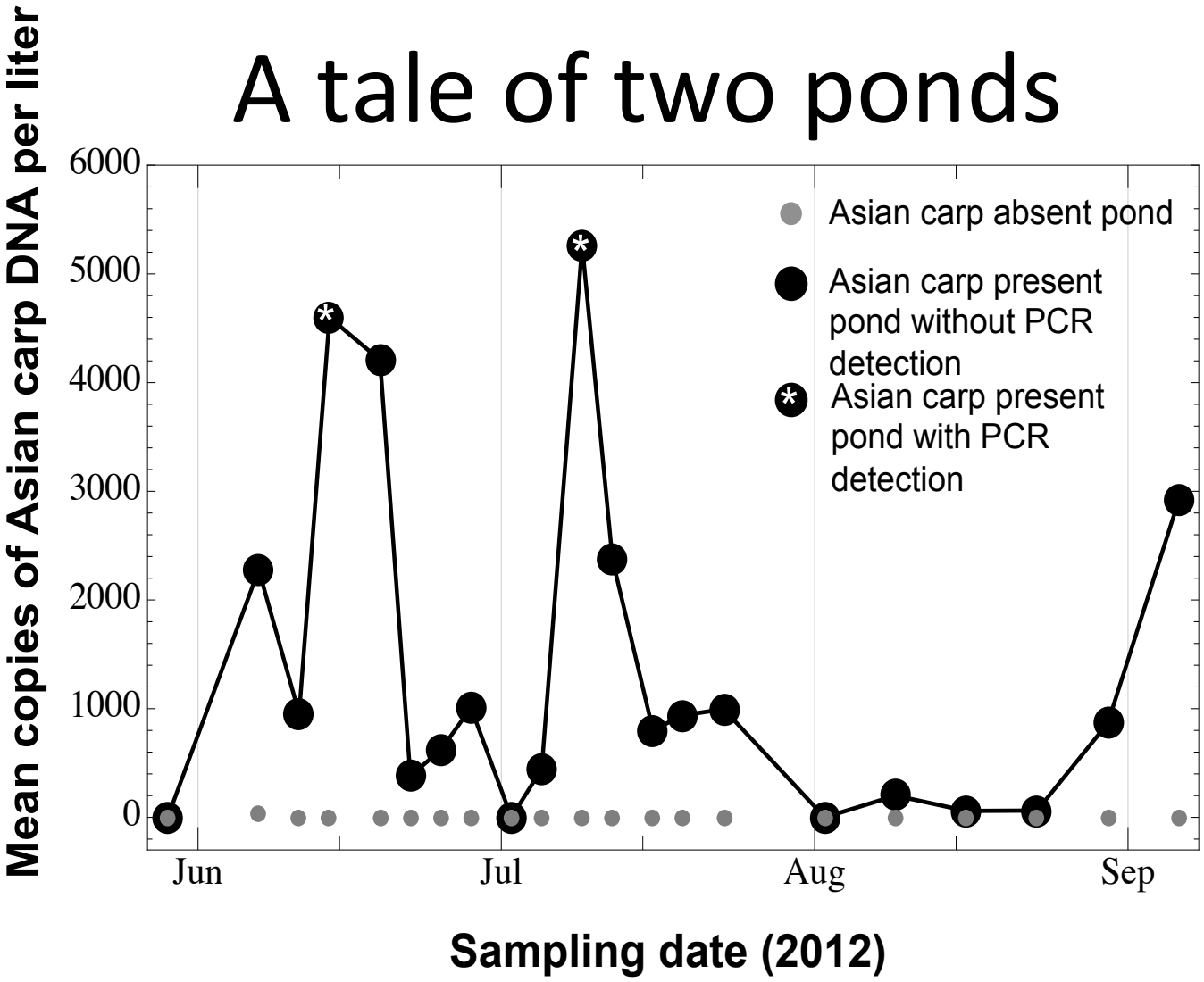


Figure 1: Time series of Asian carp qPCR estimated DNA concentrations for a pond with Asian carp (black dots) and our control pond (gray circles). qPCR always detected Asian carp DNA in the Asian carp present pond and on all but one occasion, the control pond was absent Asian carp DNA. The PCR assay only detected Asian carp DNA twice throughout the study (Black dots with white asterisk).

A tale of many ponds with variable fish density

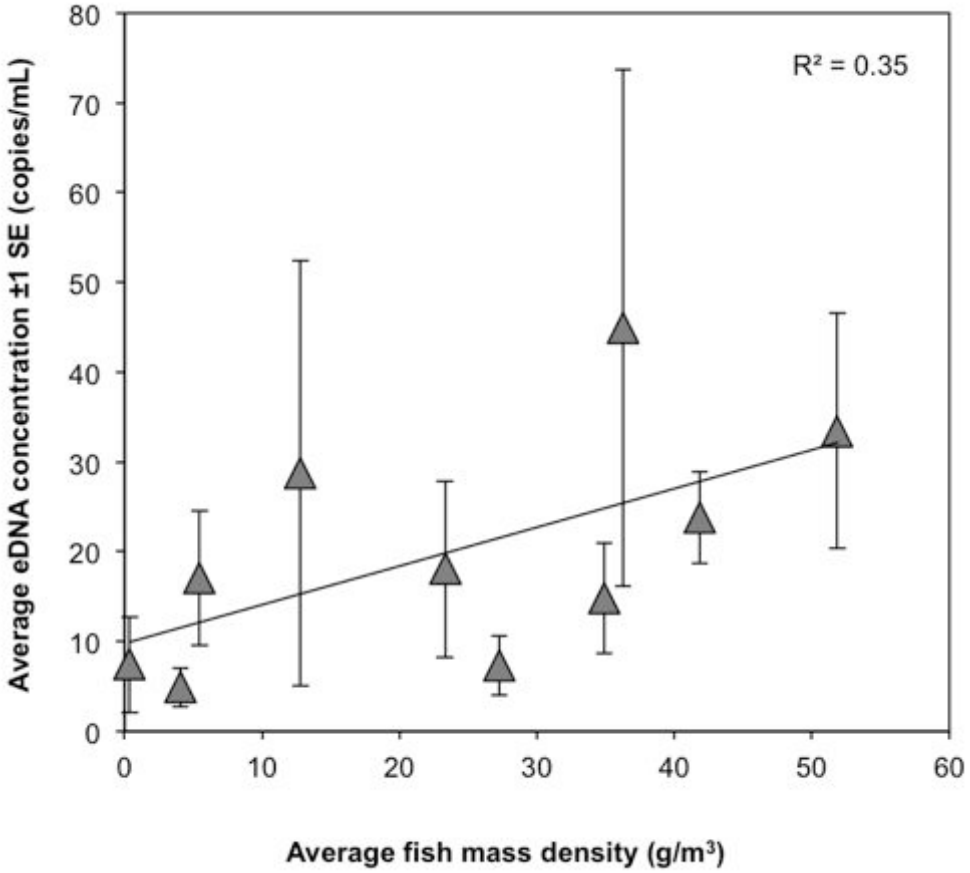


Figure 2: Average Asian carp DNA concentration (copies/mL) as a function of Average fish mass density across 10 experimental ponds for the study period (5/30/2012 to 10/16/2012) using precipitation collection method. There is a positive correlation between fish mass density and Asian carp DNA concentration ($P<0.05$), but much of the variability in the relationship is unexplained and attributed to differences in environmental conditions. The range of fish numbers per pond was 1to 27.

Conclusions – there is a positive correlation between fish mass density and Asian carp DNA concentration…and the PCR assay is less sensitive to detection of Asian carp DNA than the qPCR assay

Synthesis and recommendations for going forward

Recommendation 1

- **Laboratories conducting eDNA research should have separation between eDNA extraction and PCR amplification**

Mifflin TE (2007) Setting up a PCR laboratory. Cold Spring Harbor protocols. Vol. 2007. p. pdb.top14.

Recommendation 2

- **Increase the sensitivity of Asian carp detection using the qPCR assay**

Turner, Cameron R. et. al. Submitted. Improved methods for capture, extraction and assay of Asian carp eDNA.

Wilcox, Taylor M., Kevin S. McKelvey, Michael K. Young, Stephen F. Jane, Winsor H. Lowe, Andrew R. Whiteley, and Michael K. Schwartz. "Robust detection of rare species using environmental DNA: the importance of primer specificity." *PloS one* 8, no. 3 (2013): e59520.

Recommendation 3:

- Change to using polycarbonate track etched filter (PCTE) filters with CTAB extractions
  - Cheaper
  - More DNA recovered
  - Reduced contamination risk (less handling)
- Notre Dame's eDNA group will be moving to this method but will adjust sample volume

Turner, Cameron R. et. al. Nearing submission. Improved methods for capture, extraction and assay of Asian carp eDNA.

Comment 1: Volume matters

- Single Large or Several Small (SLOSS)
- Unclear results from CAWS using precipitate or centrifuge methods
- 2-L sample clearly performed better than surface collected 15ml and 50 ml samples
- Need to resolve “how many 15 or 50 ml samples” to take to equal one 2-L sample

Comment 2: "When" matters

- Water volume
- Water quality
- Life history of target organism
- Degradation rates
- Behavior of target organism
- Inhibitors
- …
- Repeated and seasonal sampling is needed for inferences in some locations and for some species

Comment 3: Increased sensitivity requires increase vigilance to reduce chance of contamination

Assay sensitivity may result in dramatic changes in collection procedures

A dialog is needed about what contamination means and does not mean

Best practices are being developed for the different assays, collections, extractions, and communication of results

People

Jerde, Chadderton, Mahon, Lodge, Tucker, Turner, Barnes, Nathan, Renshaw, Budny, Uy, Deines, Galaska, Corush, Gantz, Feeks, Xu, Miller, Mysorekar

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