



The relationship between the spatial distribution of common carp and their environmental DNA in a small lake

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The potential of eDNA for monitoring



However, there are many unknowns

Why common carp?

Abundant

- No detection limit issues

Relatively well-understood

- Relationships to behavior
- Population estimates

Subject of management efforts

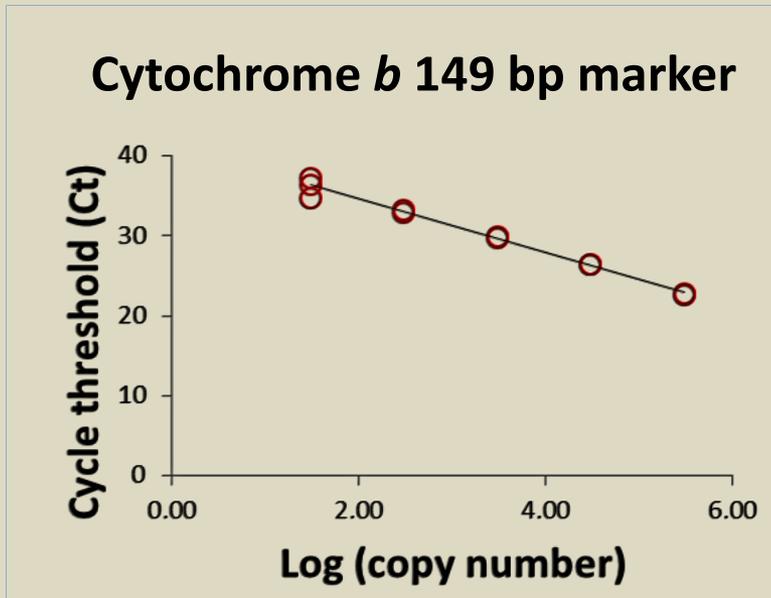
- Possible to conduct field-scale manipulations



Research plan



Assay Development & Validation



Lower limit of detection: 50 copies/rxn

Common name	Scientific name	Amplification
Bowfin	<i>A. calva</i>	N
Freshwater drum	<i>A. grunniens</i>	N
Black bullhead	<i>A. melas</i>	N
Yellow bullhead	<i>A. natalis</i>	N
Rock bass	<i>A. rupestris</i>	N
Goldfish	<i>C. auratus</i>	N
Common carp	<i>C. carpio</i>	Y
White sucker	<i>C. commersonii</i>	N
Quillback	<i>C. cyprinus</i>	N
Grass carp	<i>C. idella</i>	N
Brook stickleback	<i>C. inconstans</i>	N
Spotfin shiner	<i>C. spiloptera</i>	N
Northern pike	<i>E. lucius</i>	N
Muskellunge	<i>E. masquinongy</i>	N
Johnny darter	<i>E. nigrum</i>	N
Silver carp	<i>H. molitrix</i>	N
Bidhead carp	<i>H. nobilis</i>	N
Smallmouth buffalo	<i>I. bubalus</i>	N
Bigmouth buffalo	<i>I. cyprinellus</i>	N
Channel catfish	<i>I. punctatus</i>	N
Green sunfish	<i>L. cyanellus</i>	N
Pumpkinseed	<i>L. gibbosus</i>	N
Bluegill	<i>L. macrochirus</i>	N
Shortnose gar	<i>L. platostomus</i>	N
River redhorse	<i>M. carinatum</i>	N
Smallmouth bass	<i>M. dolomieu</i>	N
Largemouth bass	<i>M. salmoides</i>	N
Golden shiner	<i>N. crysoleucas</i>	N
Mimic shiner	<i>N. volucellus</i>	N
Yellow perch	<i>P. flavescens</i>	N
Black crappie	<i>P. nigromaculatus</i>	N
Fathead minnow	<i>P. promelas</i>	N
Gizzard shad	<i>S. cepedianum</i>	N
Walleye	<i>S. vitreus</i>	N
Central mudminnow	<i>U. limi</i>	N

Field Validation & Testing: Carp removal efforts in ~10 acre lakes

Case 1: confirmed success

Detection: 100% to 0%

Case 2: 50% decrease in fish population

Detection: 96% to 94%

Concentration: 63% decrease

Field Validation & Testing: Small lakes (30 – 100 ha)

Biomass (kg/ha)	% Detection
55	0
90	0
490	~50

What is the optimal sampling design?

**i.e. Is it possible to target areas where eDNA
accumulates to improve detection?**

eDNA distribution study

Lake Staring

- Eden Prairie, MN
- 66 ha, shallow
- ~400 carp/ha

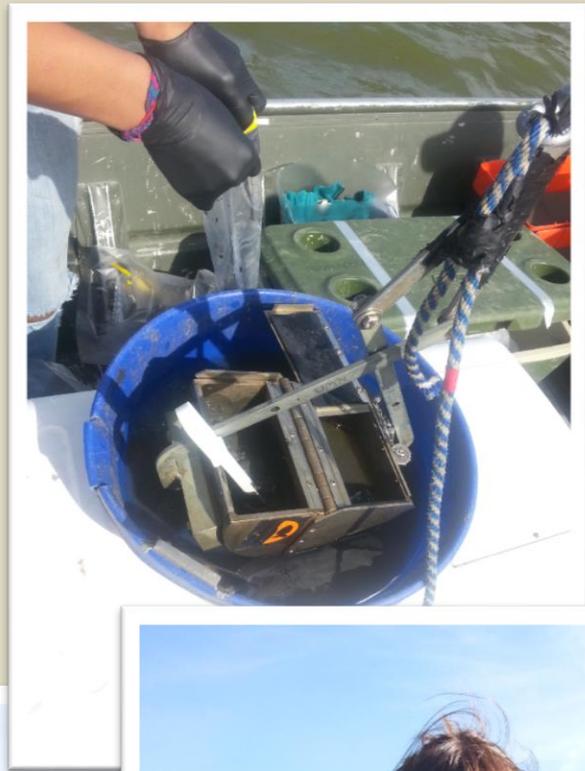
Carp locations have been tracked with radiotelemetry since 2011



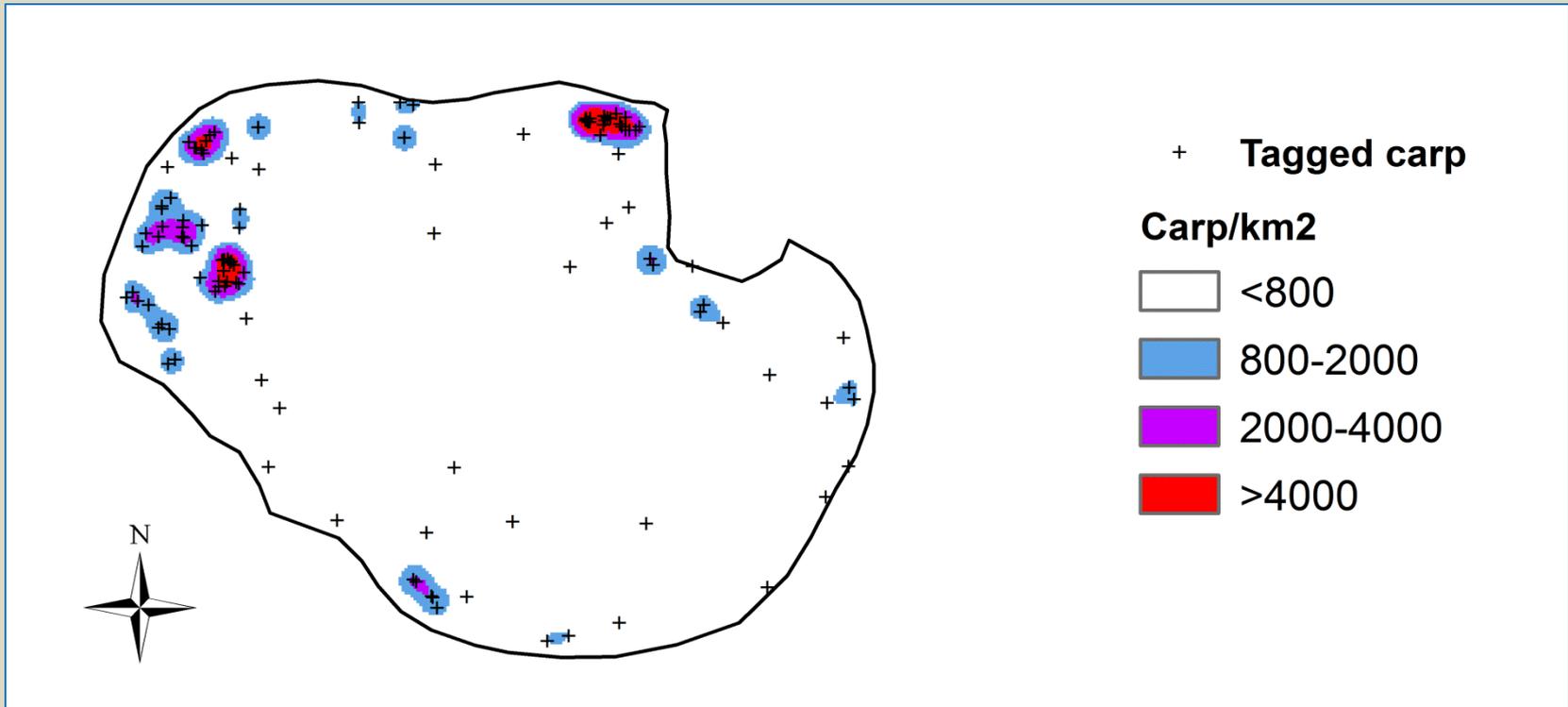
(Bajer & Sorensen, 2012)

Sampling

- Surface water
- Subsurface water (0.5m)
- Sediment (grab)
- 22 locations, including 6 where carp are known to frequent



Tagged carp distribution 2011-2013

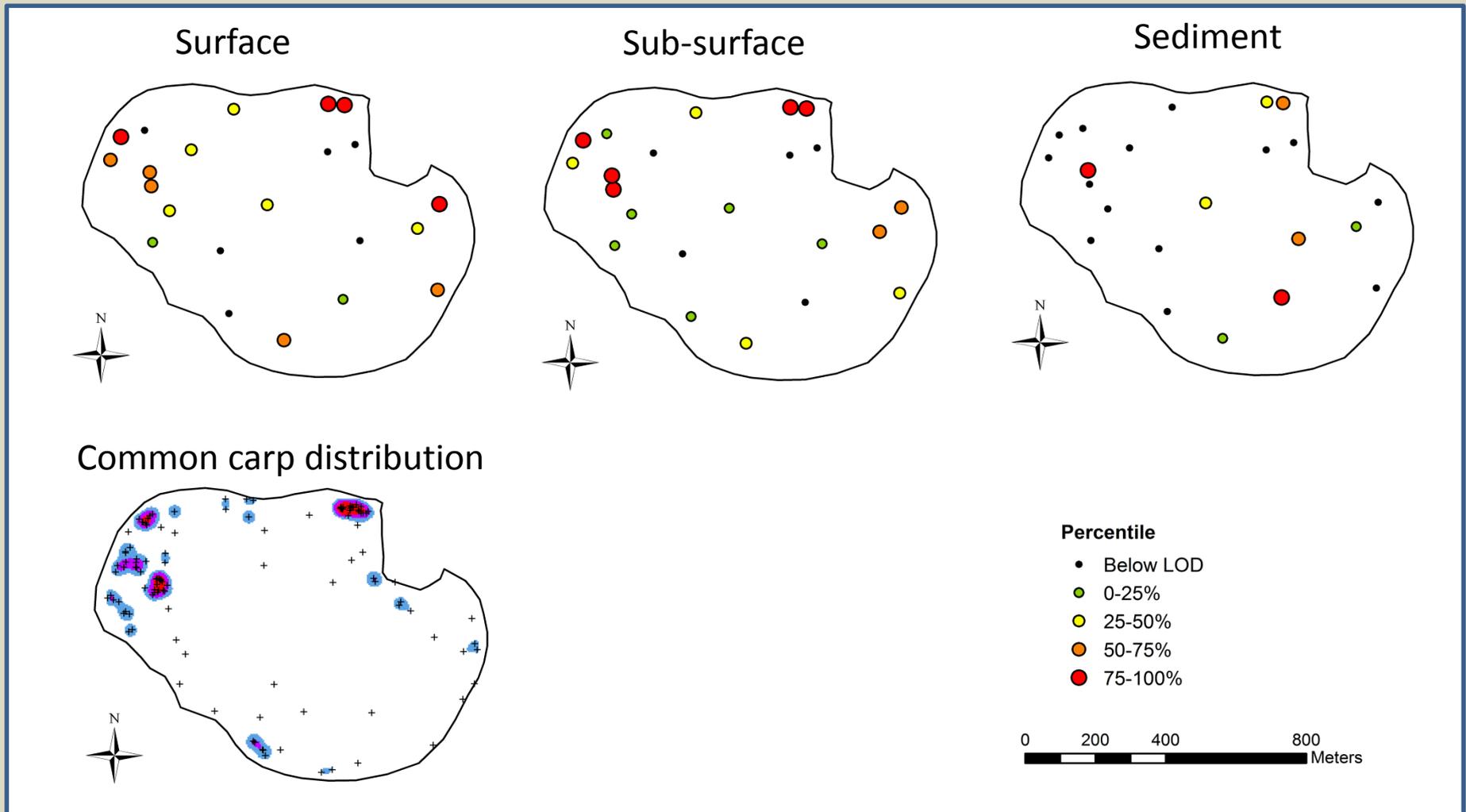


≥800 tagged carp/km² was defined as a **high use** area

<800 tagged carp/km² was defined as a **low use** area

This cut-off is equivalent to ~1,248 carp/ha

eDNA distribution



eDNA distribution was patchy, indicating that degradation and/or settling was high.

Water samples

Carp usage	Mean (copies/L)	Detection (%)	N
Low-use	3.1×10^4	63	30
High-use	2.4×10^5	100	14
Total	5.7×10^4	75	44

No significant difference in detection or conc. between surface and sub-surface samples.

Areas of high carp use have higher conc. and detection.

Sediment samples

Carp usage	Conc. of samples above LOD		Detection	
	Mean (copies/g)	N	(%)	N
Low-use	1.2×10^5	5	33	15
High-use	2.3×10^5	3	43	7
Total	1.5×10^5	8	36	22

Fish use has a significant effect on detection rates in water, but not sediment.

eDNA is abundant in sediment, but difficult to detect.

Conclusions

Monitoring for carp eDNA in shallow lakes should employ water sampling informed by patterns of fish habitat usage.

eDNA sampling schemes should be critically evaluated for the specific organism and the type of aquatic environment they inhabit.

Synergistic IPM approach

Use of eDNA as a robust early detection tool:

Potential issue: right place at the right time

Potential solution: Attraction + eDNA

