



**Lucas Nathan, Andrew Mahon,
Michelle Budny, Margaret McVeigh,
and Christopher Jerde**

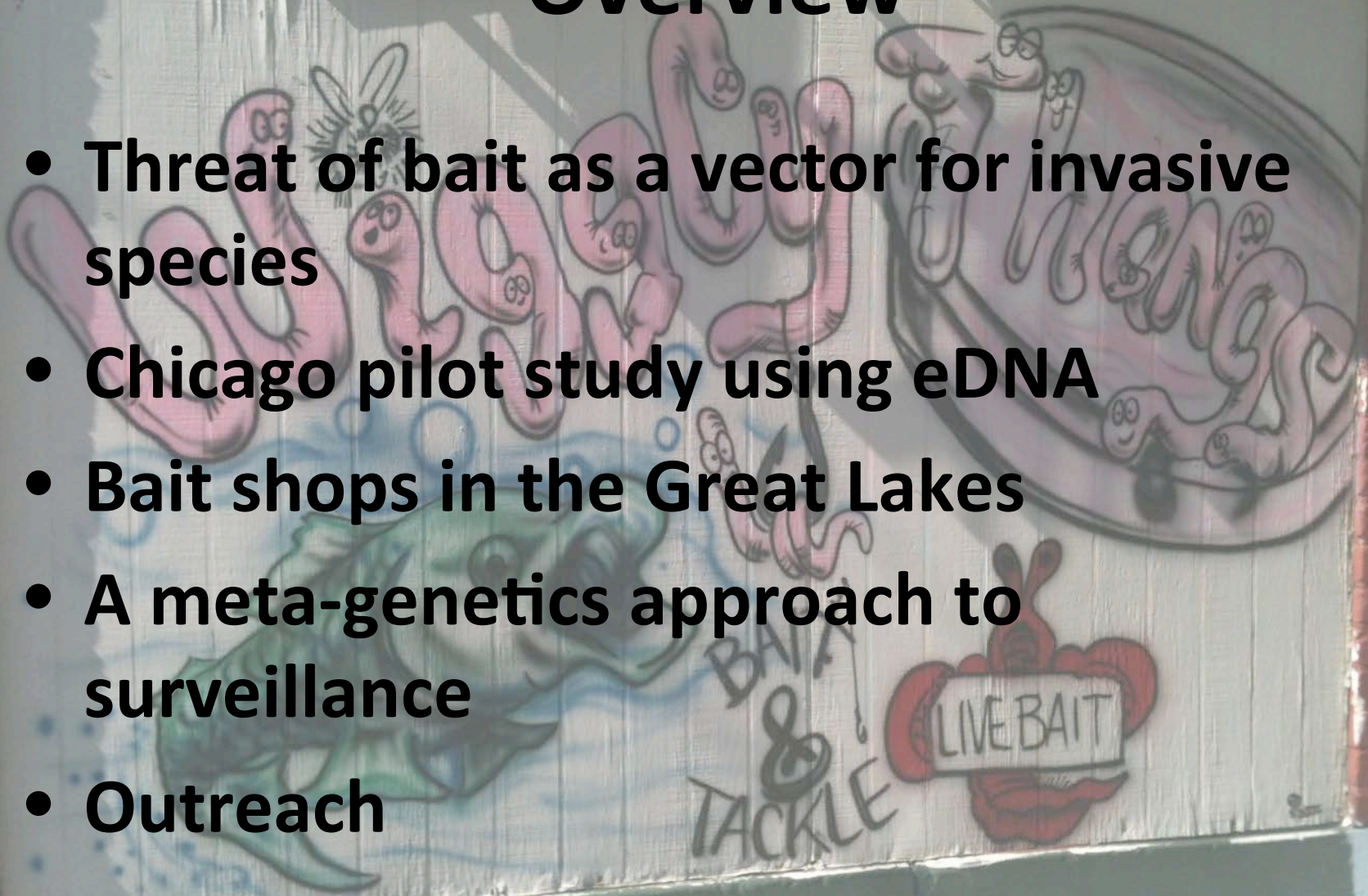


**Great Lakes
RESTORATION**

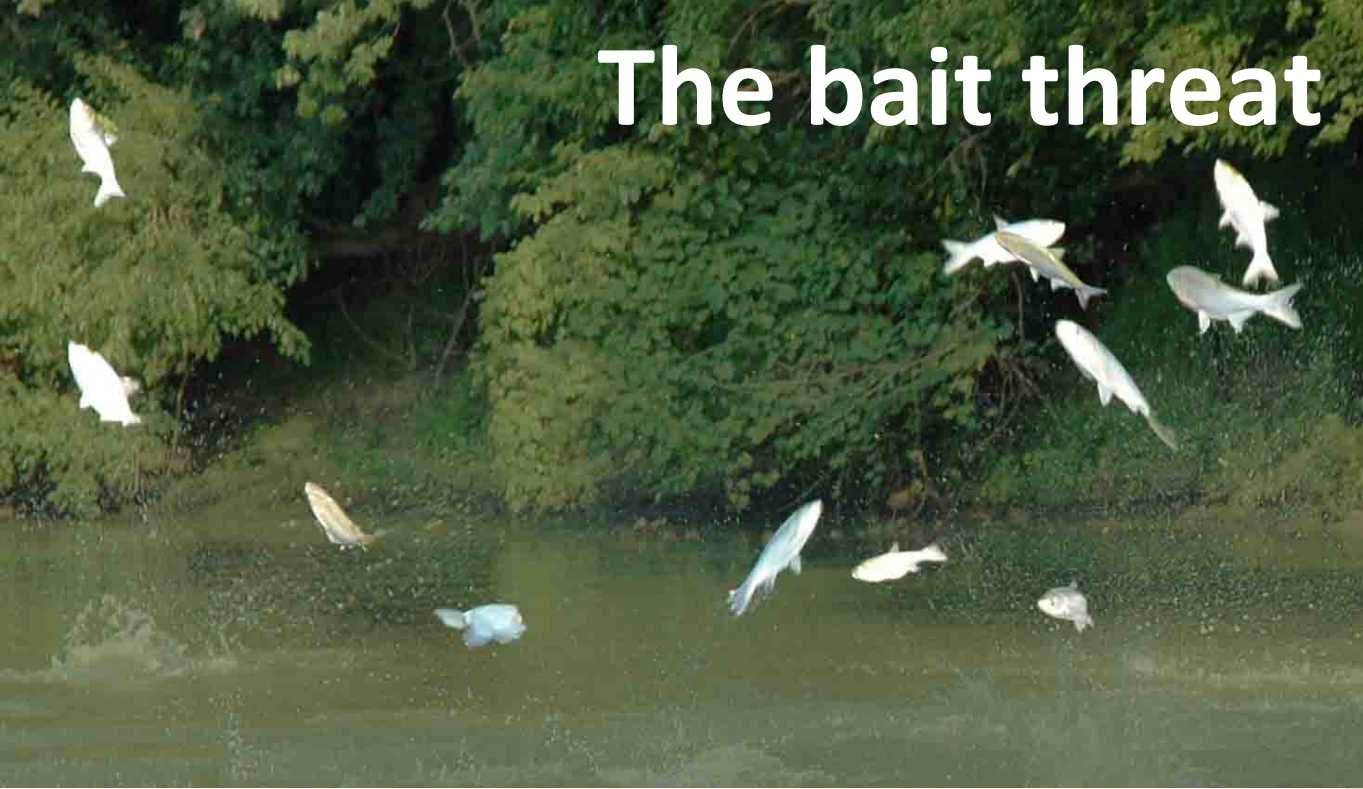


Overview

- Threat of bait as a vector for invasive species
- Chicago pilot study using eDNA
- Bait shops in the Great Lakes
- A meta-genetics approach to surveillance
- Outreach



The bait threat



LETTER

“Sight-unseen” detection of rare aquatic species using environmental DNA

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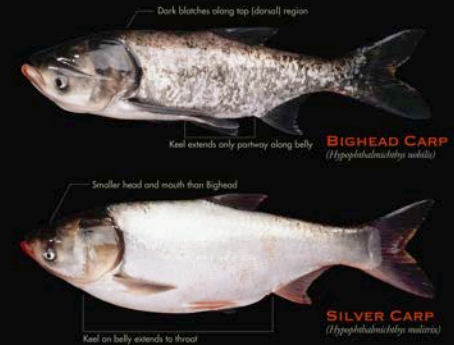
² Great Lakes Project, The Nature Conservancy

If Asian carp are “close “ to the Great Lakes, then could juveniles be in the bait?



BIGHEAD AND SILVER CARP WATCH

Bighead and silver carp are invasive fish spreading within the Mississippi River and Great Lakes regions causing harm to native fish and wildlife.



Bighead & Silver Carp Characteristics

- Low-set eye; large upturned mouth without barbels
- Scaleless head; body scales very small
- Adults may be more than 60 lbs. in weight and 4 ft. in length
- May jump out of water when disturbed by boat motors
- Juveniles difficult to distinguish from local bass/fish species such as gizzard shad (see photos)

What You Can Do

- **Learn** to identify bighead and silver carp.
- **Never release** live fish from one body of water into another.
- **Report** new sightings – note exact location; freeze specimen in a sealed plastic bag; and call the Illinois-Indiana Sea Grant Program (847-872-8677), the Illinois DNR (309-968-7531), or the Indiana DNR (317-234-3883).



Environmental DNA approach

1

Collect
water
sample

2

Filter
water
sample

3

Extract
all DNA

4

Amplify
target
DNA

5

Screen
for DNA
presence

Benefits:

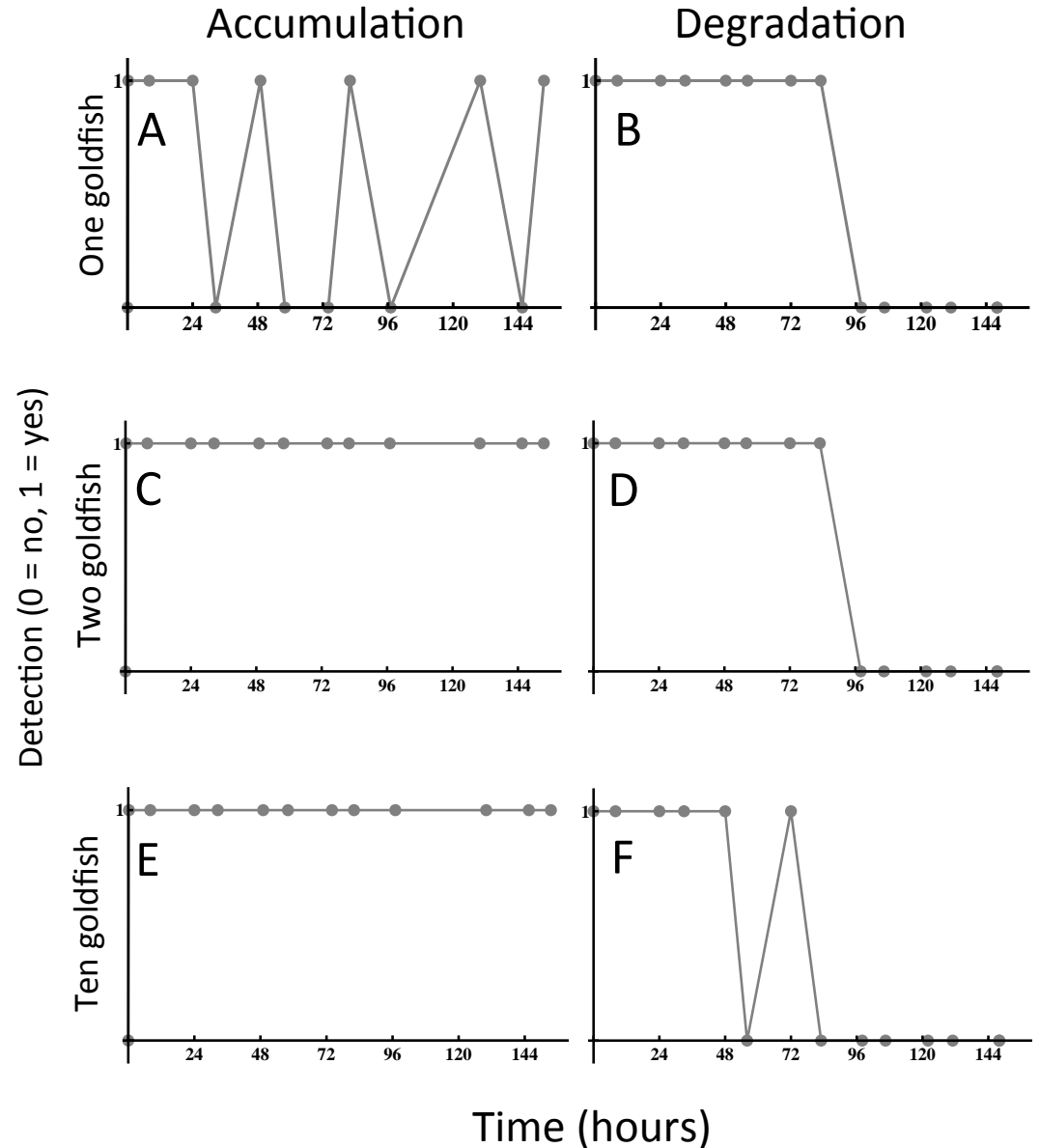
- No taxonomic expertise needed
- No direct handling of minnows
- Quick
- Can be done overtly or covertly
- Can be done cheaply (although not in these studies)

Bait tank calibration



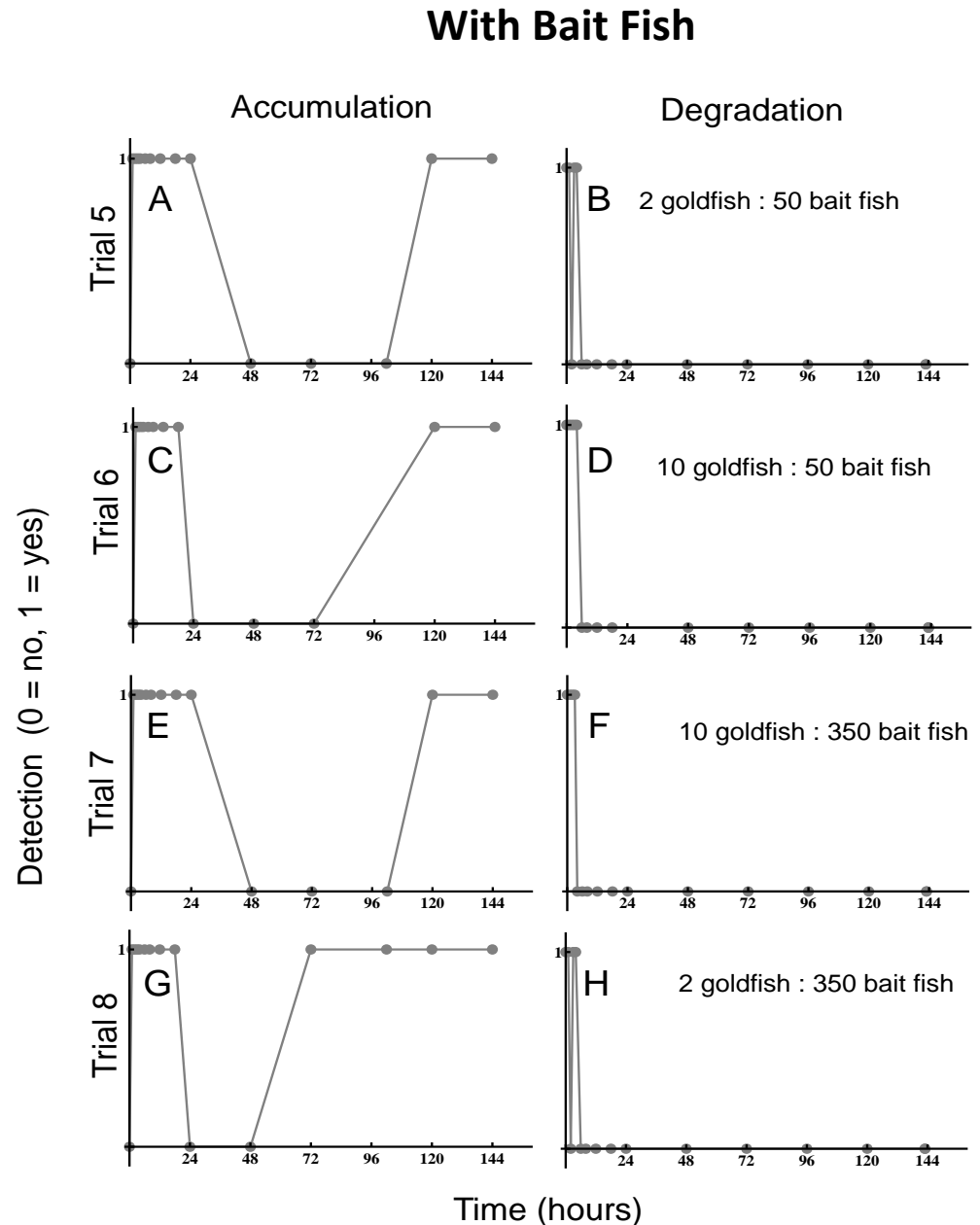
Using eDNA for bait is very effective and DNA does not persist at detectable levels for more than 4 days

Without Bait Fish



Bait tank calibration

- Target DNA degrades much quicker in mixed environments
- DNA of rare species is detectable
- False negatives are possible (failure to detect)
- No indication of contamination in any of the controls



Chicago bait shops (2010)

Bait Shops in Northeast Illinois



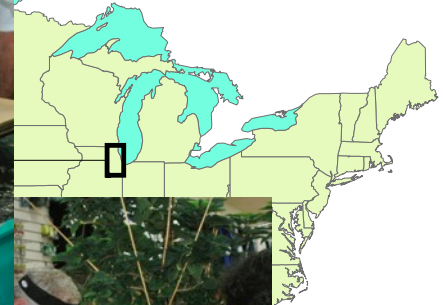
Legend

- Bait shop locations
- States
- Great Lakes

ILLINOIS



DEPARTMENT OF
NATURAL
RESOURCES



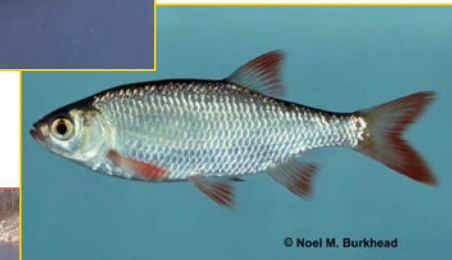
Chicago bait shops (2010)

- 136 water samples collected
- 52 bait shops
- 79% of bait sourced from two wholesalers
- No bighead or silver carp observed with visual inspection or detected with eDNA
- However, 14 shops had gold fish DNA and that corresponded to 8 visual detections
- However, Chicago bait is regionally sourced. Not so elsewhere in GL

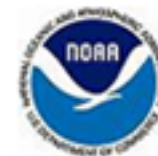


Species of concern

- Goldfish (*Carassius auratus auratus*)
- Round and tubenose gobies (*Neogobius melanostomus* and *Proterorhinus semilunaris*)
- Eurasian rudd (*Scardinius erythrophthalmus*)
- Bighead and silver carp (*Hypophthalmichthys nobilis* and *Hypophthalmichthys molitrix*)

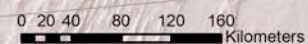
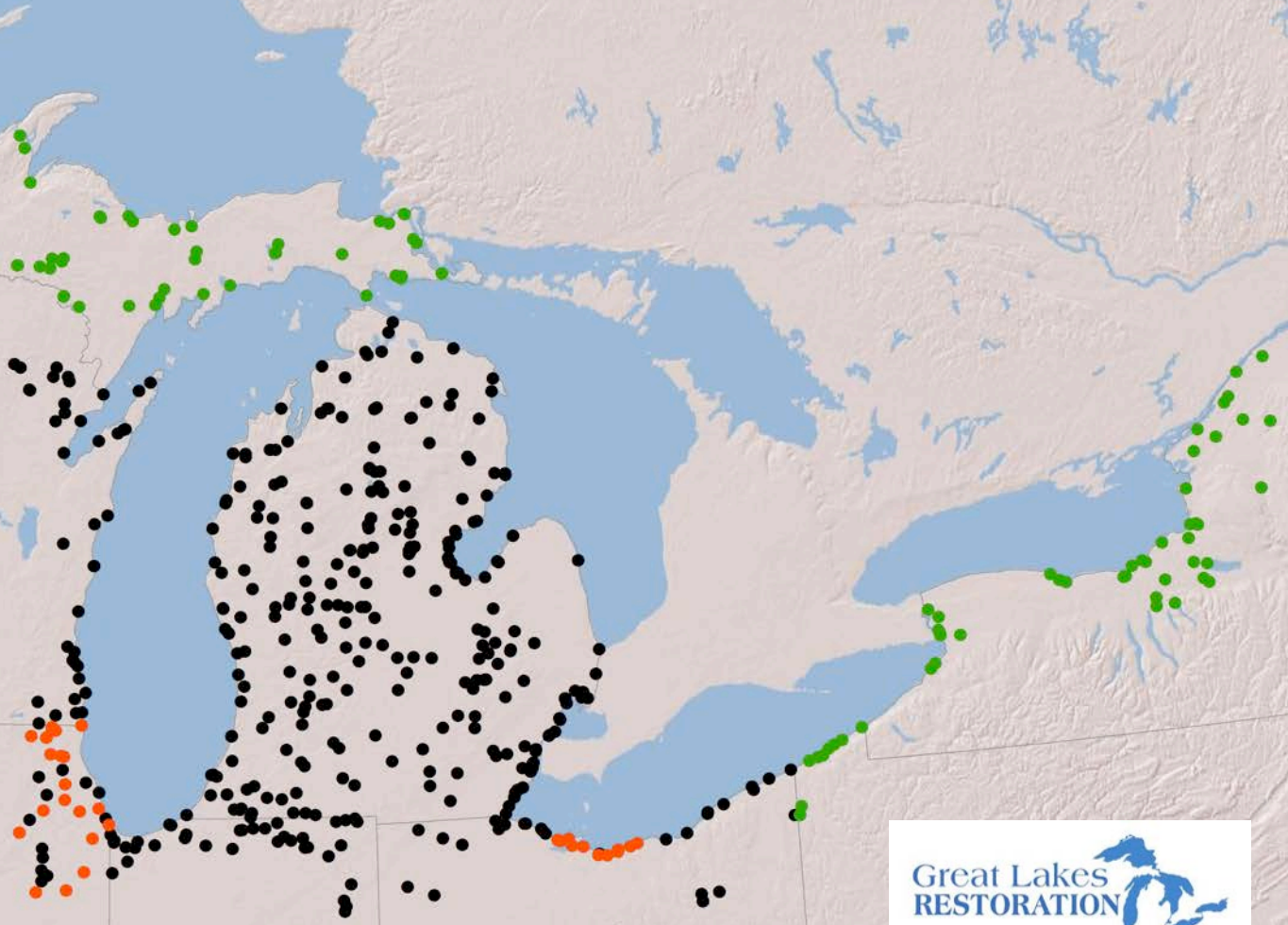
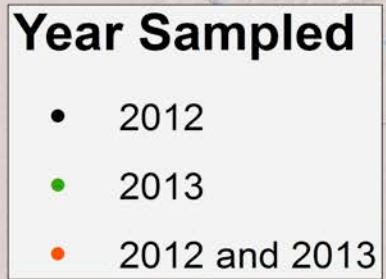


Targets selected with input from the Management Transition Board



Center for Sponsored Coastal Ocean Research

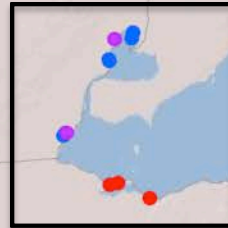
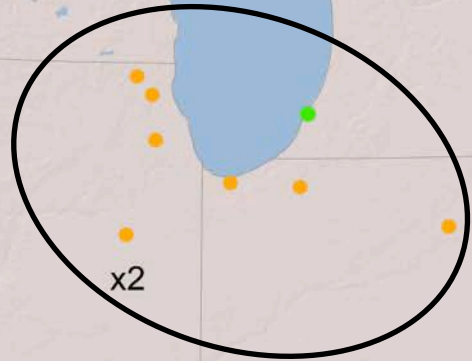
Great Lakes bait shop visits



Positive Detections

Species Detected

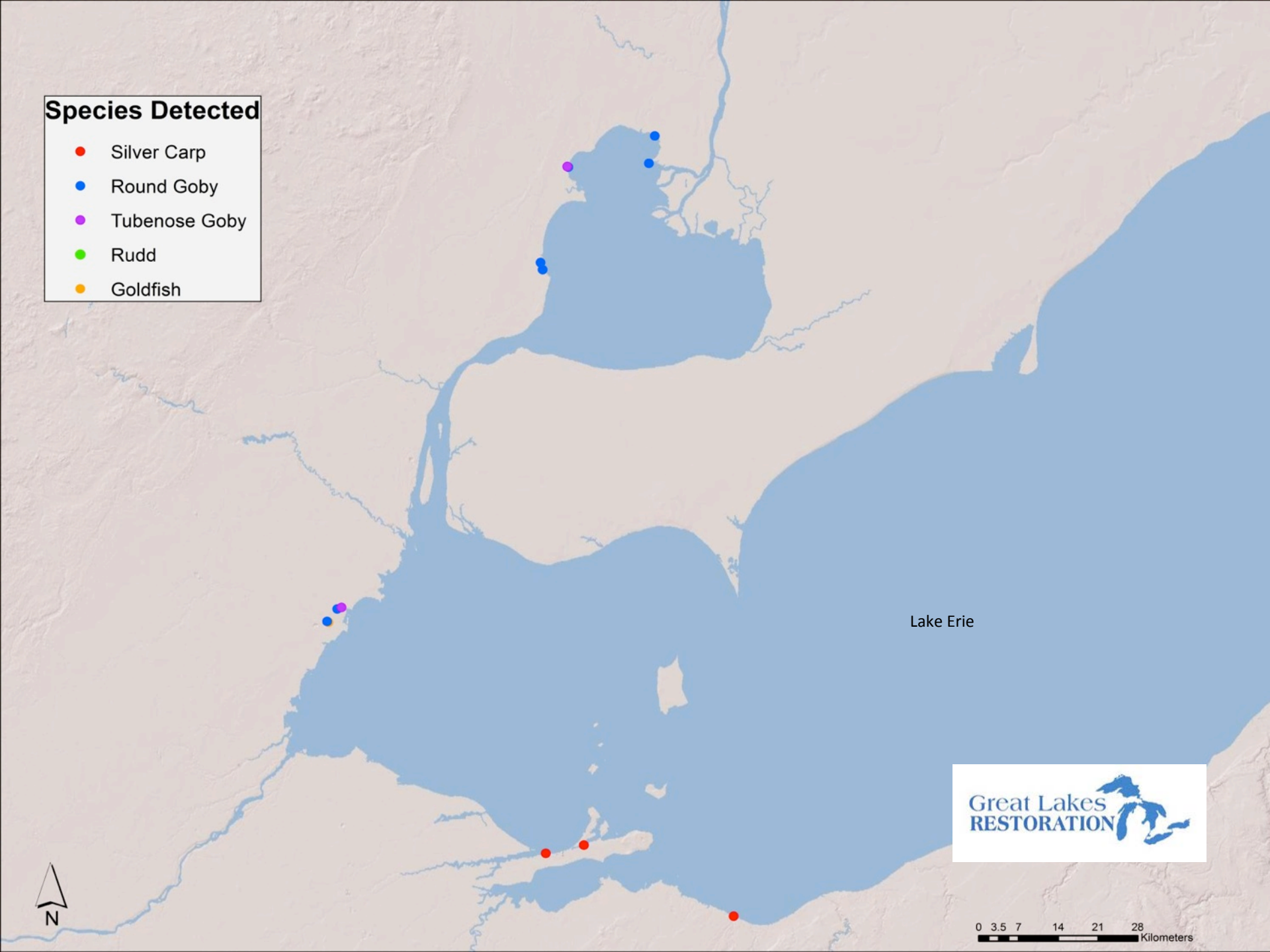
- Silver Carp
- Round Goby
- Tubenose Goby
- Rudd
- Goldfish



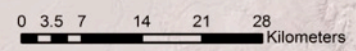
0 25 50 100 150 200 Kilometers

Species Detected

- Silver Carp
- Round Goby
- Tubenose Goby
- Rudd
- Goldfish



Lake Erie



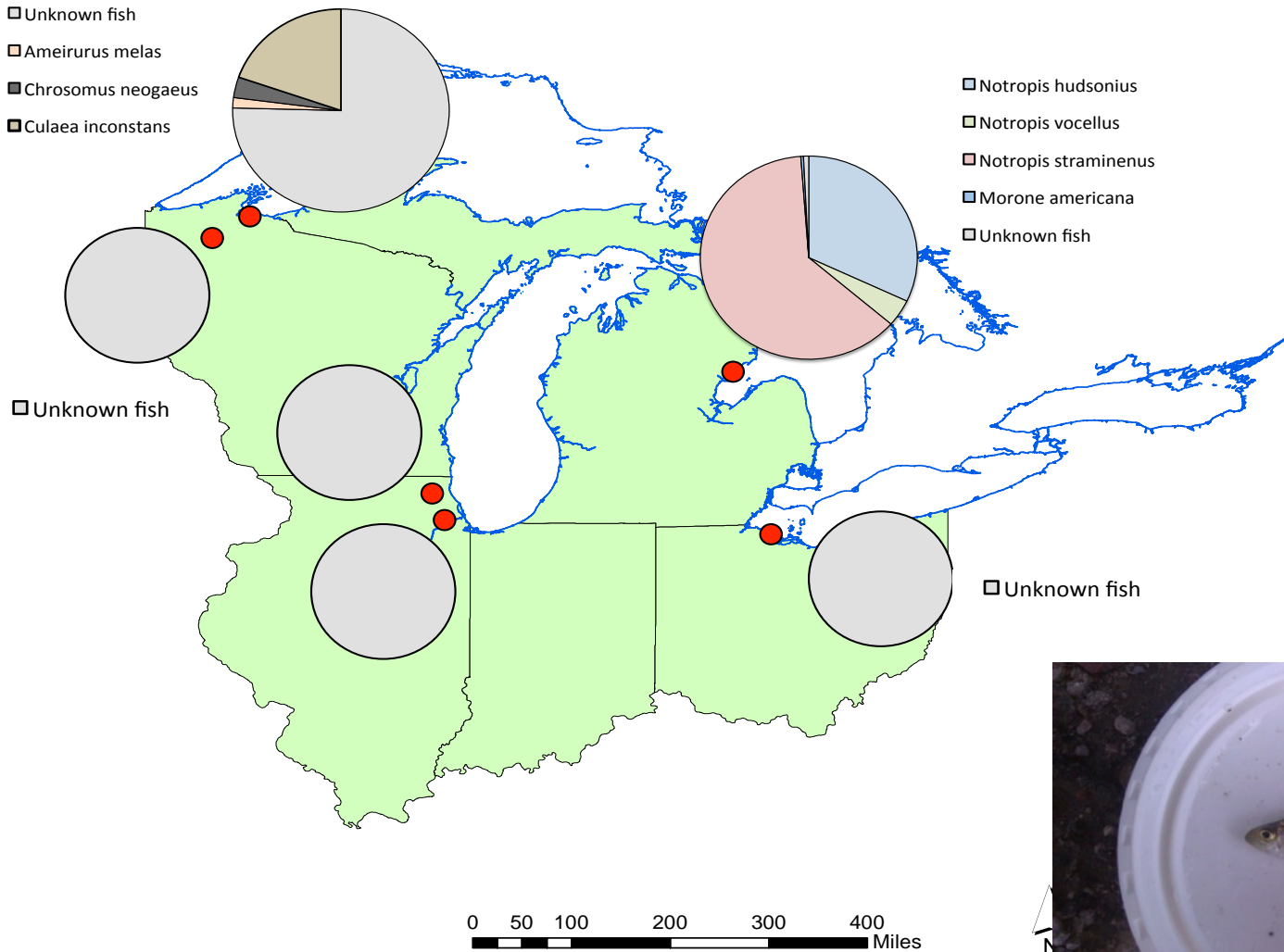
Bait trade eDNA results

- Second set of samples show goldfish presence
- Gobies entering regional bait trade
 - Perils of local bait production
- Silver carp positive detection. Same bait hauler transported on the same day to these three shops. From Southern US.
- In the same vicinity of positive silver carp eDNA detections in Lake Erie
- Overall 4.7% contamination rate of samples

A meta-genetics approach

- Active surveillance: “Is Asian carp DNA present in this sample?”
- Passive surveillance: “What fish species’ DNA are present in this sample and are there any DNA sequences identified to invaders?”
- Uses rapidly developing technology of high-throughput sequencing and computing power to clean, sort, and identify DNA to species

Six bait shops



Surveillance Synthesis

- Anglers do not want AIS, bait shops do not want AIS, natural resource managers do not want AIS, scientists do not want AIS
- Bait is a potential vector for introduction
- Profit margin on bait sales is small
- Potential for screening at the wholesale level
- Current work ignores sometimes illegal transport of bait from anglers and retailers (wild capture)

Outreach signage

- Document AIS signage during bait shop visits (Total = 525)
- Distribute window statics posters to all accepting retailers
- Re-visit \approx 20% of shops after one year



Thank you Pat Charlebois and Sarah Zack!

Signage Observations



STOP AQUATIC HITCHHIKERS!
Prevent transport of aquatic invasive species.
Clean all recreational equipment.

www.ProtectOurWaters.net

- **INSPECT** your boat/equipment for any plants or animals that may have hitchhiked on board.
- **DRY** your boat/equipment thoroughly before and after each trip.
- **REMOVE** all plants and animals from your boat/equipment.
- **DISPOSE** of unwanted live bait, fish, plants, and animals in the trash.
- **DISINFECT** your boat and equipment with high pressure water.
- **DO NOT** emptying for all bait-free traps before going to another water.
- **DO NOT** release organisms from one water body into another.



Keep Our Waters Great!

Don't Dump Your Bait

Fish disease like Viral Hemorrhagic Septicemia (VHS) can be transferred in your bait bucket!

It's the law:

- Dump all unused bait in the trash.
- Empty buckets and traps at the camp.
- Don't handle live fish to avoid them when where they were caught.

Help prevent disease transfer

Control disease and keep fish in a health solution.

100% fish kills in 1 gallon of water.

How do I get it? In my trap/trap before using in a different lake/river?

For more information Go to:
<http://www.michigan.gov/vhs>
Great Lakes, Great Times, Great Outdoors

Dispose of bait on land or in the trash

Bait and non-native plants and animals hitchhiking in bait can harm our lakes and rivers.

PROTECT OUR WATERS.



For more information about non-native species, visit:
www.glnrls.org

Sea Grant
Great Lakes Network
Developed by Michigan Sea Grant, Ohio Sea Grant, and the University of Michigan School of Natural Resources and Environmental Science at University of Michigan.



BIGHEAD AND SILVER CARP WATCH

Bighead and silver carp are invasive fish species that are spreading across the Great Lakes Basin and other regions, causing harm to native fish and wildlife.



Bighead Carp

Silver Carp

Report a Store Buy Observation

Look for the common fish and other species that are native to the Great Lakes Basin. If you see a fish that is not native to the Great Lakes Basin, report it to the Michigan Sea Grant.

What You See

Bighead and silver carp are invasive fish species that are spreading across the Great Lakes Basin and other regions, causing harm to native fish and wildlife.

VHS ALERT

ATTENTION ANGLERS

REMEMBER

You must drain all water from your boat and equipment when leaving any state water except:

- You can take up to 2 gallons of water needed to hold live minnows that can be legally transported in confined boxes.

You may not leave a water with any live fish, or fish eggs except:

- You can take live minnows brought from a Wisconsin bait dealer and left over after a fishing trip away from any state water and use them.
- again in that same water or
- in other waters but only if no lake or river water, or other fish were added to their container.

For more information on the VHS check out: fishingscience.org

Sign Retention

- 135 shops re-visited
- 54% of signs remained posted
- No differences between states or posted vs. handed out
- Retailer responses



STOP AQUATIC HITCHHIKERS!
Prevent the transport of aquatic invasive species.
Clean all recreational equipment.
www.ProtectYourWaters.net

Help Bait Dealers Prevent the Spread of Aquatic Invasive Species

PROTECT YOUR WATERS!

- ✓ **Inspect** bait and remove hitchhikers during dip net transfer.
- ✓ **Dispose** of unwanted bait and worms in the trash, not on land or in water.
- ✓ **Do Not** move bait away from a waterbody if it has been in contact with lake water, unless you're returning to same lake.

Do Not Release Live Bait!

If you see any of these, remove them from your bait.



Rusty Crayfish



Eurasian Watermilfoil



Spiny Water Flea



Threespine Stickleback



Juvenile Asian Carp



Zebra or Quagga Mussels



Round Goby

Great Lakes RESTORATION

WISCONSIN DEPT. OF NATURAL RESOURCES

Sea Grant University of Wisconsin

UW Extension Cooperative Extension



Bait bucket stickers

**Dispose of bait on
land or in the trash**

**Bait and non-native plants and
animals hitchhiking in bait can harm
our lakes and rivers.**

**PROTECT OUR
WATERS...**



For more
information
about non-
natives, visit
www.sgnis.org

Sea Grant
Great Lakes Network

Developed by Illinois-Indiana Sea Grant, Illinois Natural History Survey, and Department of Natural Resources and Environmental Sciences at University of Illinois.

Outputs

Nathan, LR, AR Mahon, ML Budny, and CL Jerde. Invasive species surveillance of the Great Lakes' commercial bait trade using environmental DNA. Conservation Biology. In revision.

Mahon AR, L Nathan, and CL Jerde. Use of meta-genetics to identify rare invasive species contaminants in the bait trade. Conservation Genetics Resources. Accepted

Mahon AR, CL Jerde, and L Waits. Investigating error and quality assurance in environmental DNA surveillance. Submitted

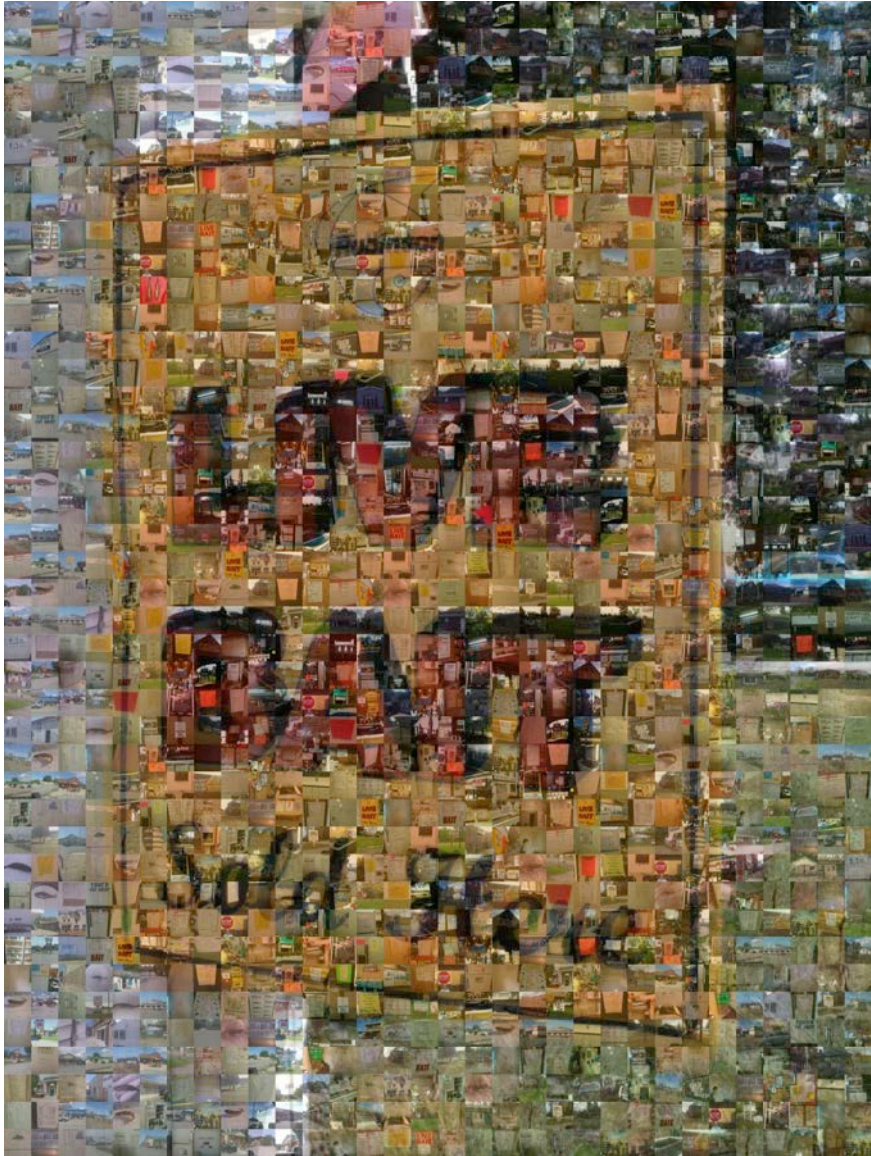
Nathan, LR, CL Jerde, M McVeigh, and AR Mahon. Preventing Great Lakes invasive species introductions through bait trade regulations and angler education. Submitted.

Budny, ML, CL Jerde, AR Mahon, MA Barnes, MP Galaska, JM Deines, WL Chadderton, and DM Lodge. Invasive species surveillance of the bait trade using environmental DNA. Nearing submission.

Mahon, AR, CL Jerde, M Galaska, CR Turner, WL Chadderton, and DM Lodge. Failure to detect: the influences of on-target DNA on environmental DNA surveillance in aquatic systems. Nearing submission

Invasive species surveillance of the bait trade. US Environmental Protection Agency. 2011 Great Lakes Restoration Initiative. COMPLETED

Environmental DNA surveillance for Asian carp in Chicago area bait shops. 2010 Great Lakes Restoration Initiative to Illinois Department of Natural Resources. COMPLETED



Thank you

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ENVIRONMENTAL
CHANGE
INITIATIVE

