GRASS CARP IN LAKE ERIE: HISTORY, STATUS, AND HABITAT

Nicole R. King
University of Toledo – Lake Erie Center
Nicole.King2@UToledo.edu

Patrick M. Kocovsky
U.S. Geological Survey – Lake Erie Biological Station
Pkocovsky@usgs.gov

Photo: mdc.mo.gov

MULTI AGENCY EFFORTS

Ohio DNR

Michigan DNR

Fish & Wildlife Service

USGS

Fisheries & Oceans Canada

Ontario MNR

University of Windsor

University of Toronto

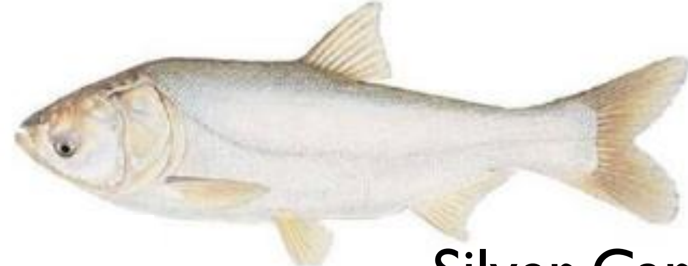
Bowling Green State University

University of Toledo

Holly Embke, Christine Mayer, Song Qian

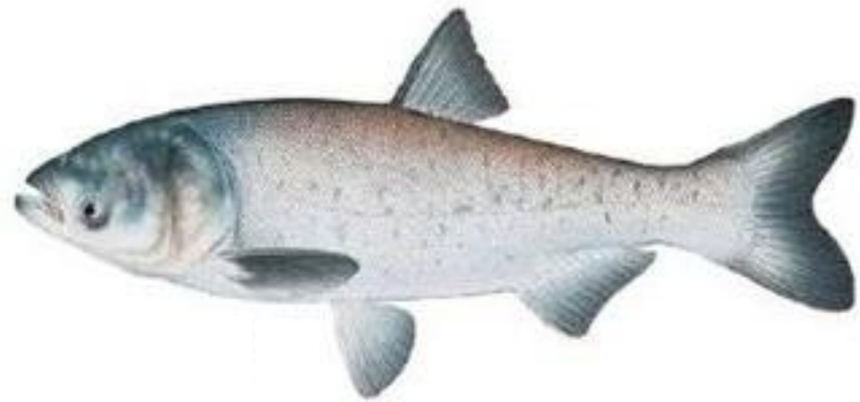
All of the techs!

"Asian carp" is **not a species.**



Silver Carp

Planktivores



Bighead Carp

Grass Carp

Herbivore

Black Carp

Molluskivore

This term gives me nightmares….


This is a Black Carp
…Common Carp
SCENE & HEARD
The Great Lakes' Asian Carp Probl
Posted By Eric Sandy on Fri, Jun 23, 2017 at 1:03 pm
Asian carp spell trouble for the Great Lakes.
SILVER CARP
Study shows Asian carp could establish in Lake Erie with little effect to fishe
SILVER & BIGHEAD CARP
Bighead and silver carp will continue to have
Invasive Asian carp confirmed in St. Croix River
SILVER CARP
…Bighead Carp
…and this is a Silver Carp
eDNA – NO SPECIES?
Asian Carp photo
Asian Carp Confirmed In Lake Huron
Report: Asian carp reproducing i
Lake Erie tributary
October 30, 2013
GRASS CARP
Traverse City, Mich. –
Scientists said
Monday they
have
carp species
has successfully reproduced within the Great Lakes watershed, an ominous development in the
…Silver Carp

"ASIAN CARPS" HISTORY

- Brought to U.S. in 60's & 70's for use in aquaculture ponds
  - Escaped into Mississippi River basin

- **Black Carp:** No observations in GL
- **Silver Carp**: eDNA in Lake MI & Erie, no captures
- **Bighead Carp**: 3 captures in Lake Erie (1997/2000), no eDNA
- **Grass Carp**: captures throughout Great Lakes, except Lake Superior

GRASS CARP IN LAKE ERIE

IMPACTS OF GRASS CARP

Timeline of Grass Carp in Lake Erie

GC imported to US

1963

Timeline of Grass Carp in Lake Erie

GC imported to US

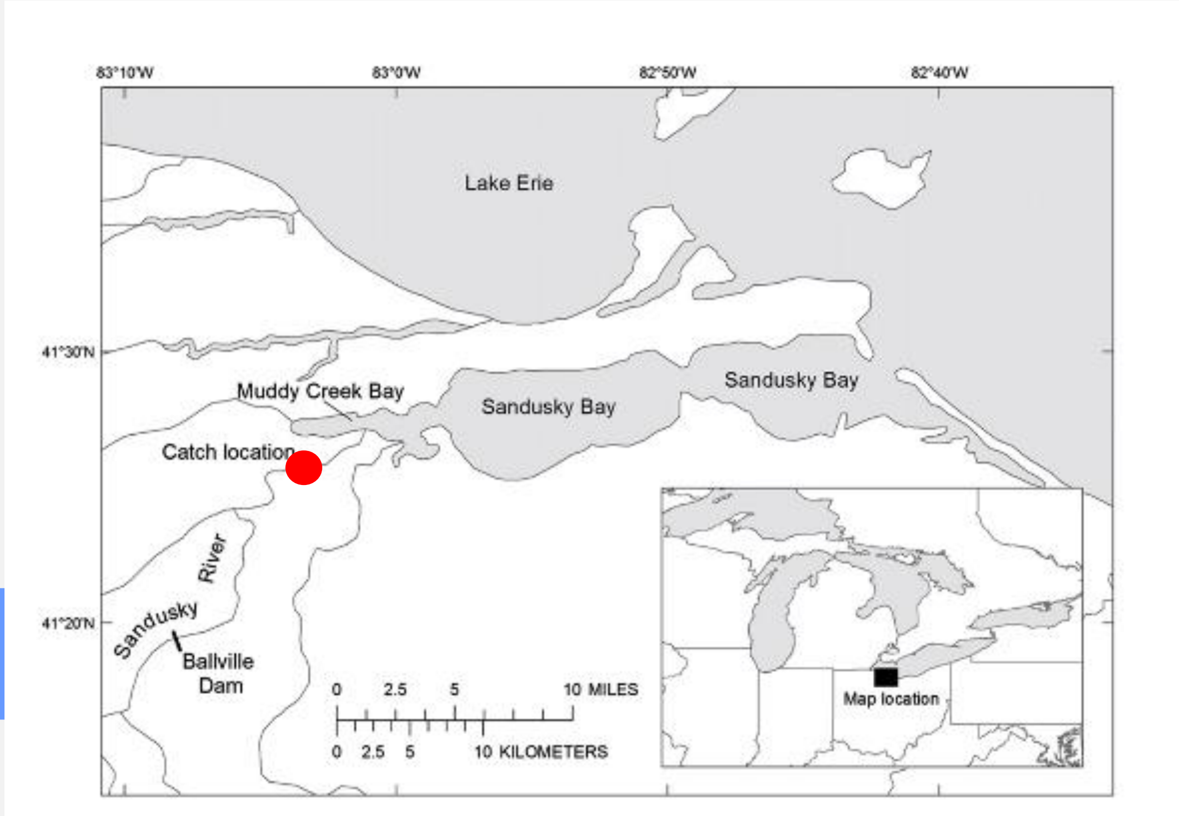
1963

Triploid process

1983

Timeline of Grass Carp in Lake Erie

Timeline of Grass Carp in Lake Erie

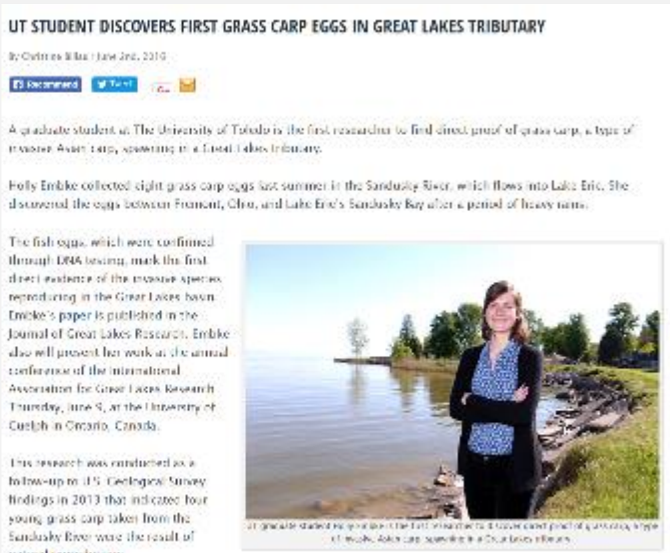


196
198
198

6 juv GC likely from Sandusky River

2012

Timeline of Grass Carp in Lake Erie



UT STUDENT DISCOVERS FIRST GRASS CARP EGGS IN GREAT LAKES TRIBUTARY

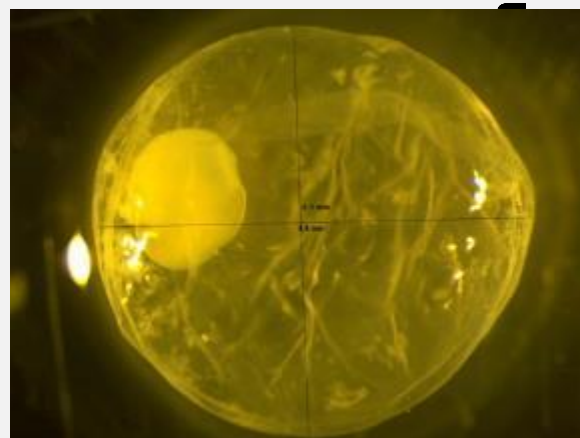
By Christine Billau | June 2nd, 2016

A graduate student at The University of Toledo is the first researcher to find direct proof of grass carp, a type of invasive Asian carp, spawning in a Great Lakes tributary.

Holly Embke collected eight grass carp eggs last summer in the Sandusky River, which flows into Lake Erie. She discovered the eggs between Fremont, Ohio, and Lake Erie's Sandusky Bay after a period of heavy rains.

The fish eggs, which were confirmed through DNA testing, mark the first direct evidence of the invasive species reproducing in the Great Lakes basin. Embke's paper is published in the Journal of Great Lakes Research. Embke also will present her work at the annual conference of the International Association for Great Lakes Research Thursday, June 9, at the University of Guelph in Ontario, Canada.

This research was conducted as a follow-up to U.S. Geological Survey findings in 2013 that indicated four young grass carp taken from the Sandusky River were the result of natural reproduction.



Spawning confirmed
Sandusky River

Eight fertilized eggs found and genetically confirmed

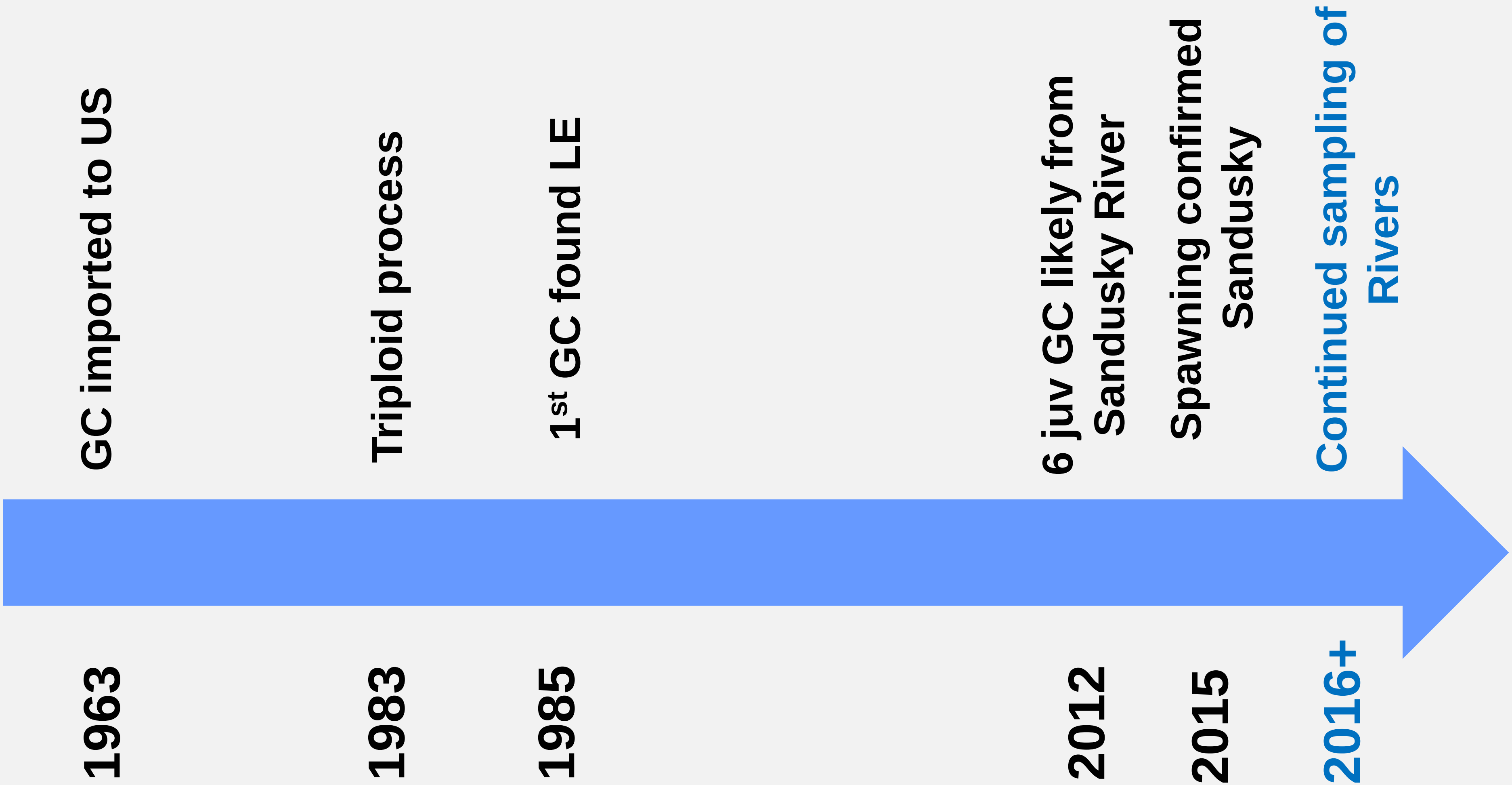
1963

1983

1985

2015

Timeline of Grass Carp in Lake Erie



GRASS CARP CAPTURES IN LAKE ERIE

nas.er.usgs.gov

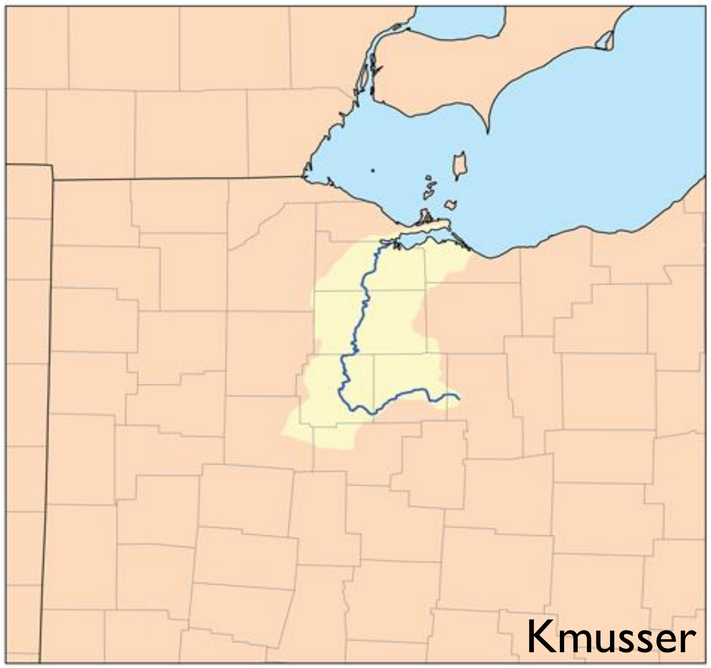
Report your sightings!

UT student discovers first grass carp eggs in Great Lakes tributary

By Christine Billau : June 2nd, 2016

Recommend Tweet

A graduate student at The University of Toledo is the first researcher to find direct proof of grass carp, a type of



s tributary.

ast summer in the Sandusky River, which flows into Lake Erie. She
and Lake Erie's Sandusky Bay after a period of heavy rains.

Lakes Research Thursday, June 9, at the University of Guelph in Ontario, Canada.

QUESTIONS

When do GC spawn?	
Are eggs viable?	
Do eggs hatch in river?	
Where are the spawning grounds?	
What do we do about this?	

HOW WE SAMPLE

(50 lbs. dog for scale)

SANDUSKY RIVER SPAWNING

2015: 4 events

- June 18, 29
- July 1, 13-14

2016: 0 detected

2017: 2 events

- May 30- June 1
- July 12

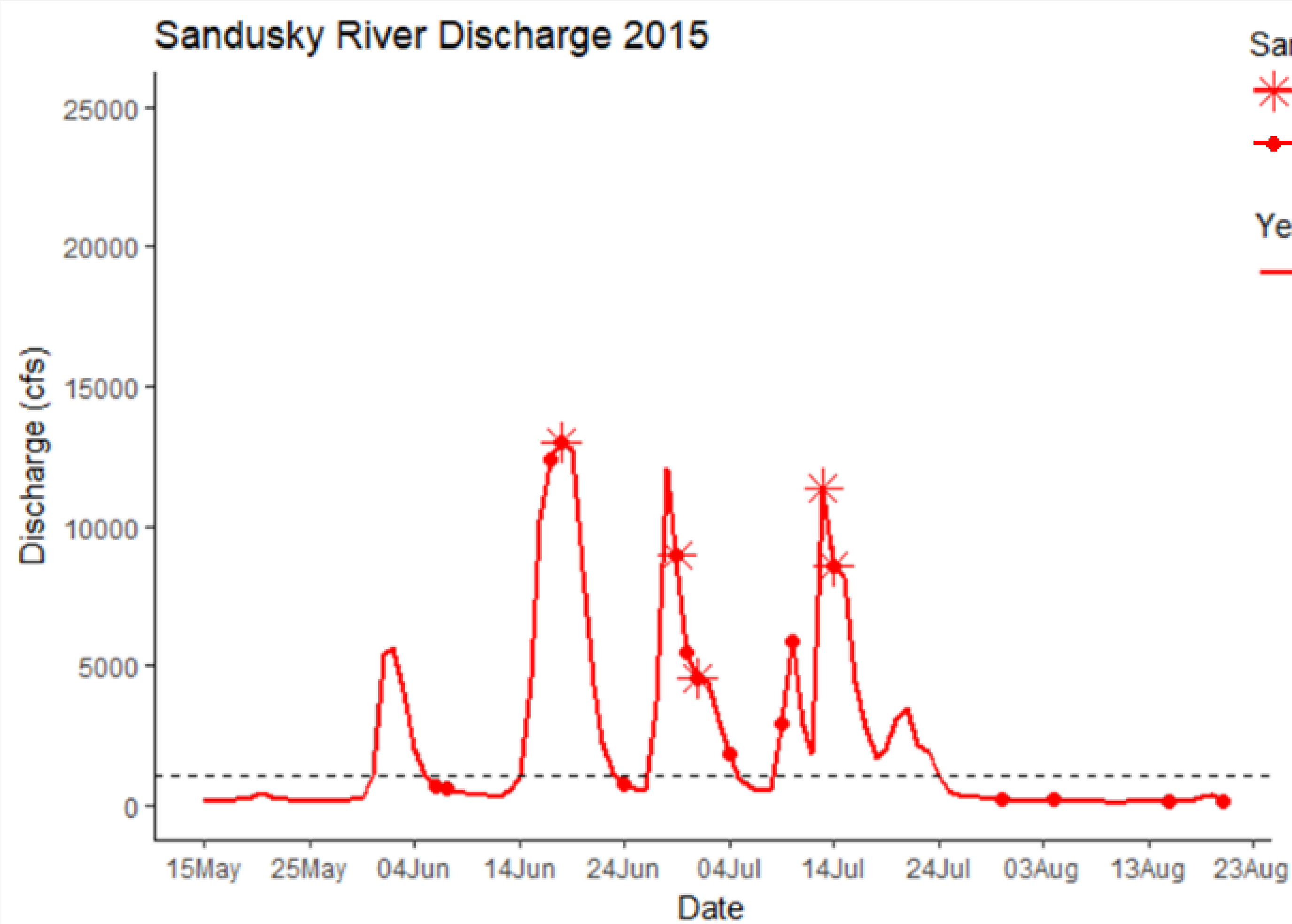
2018: 2 events

- May 23-25
- June 11-13

2019: 4 events

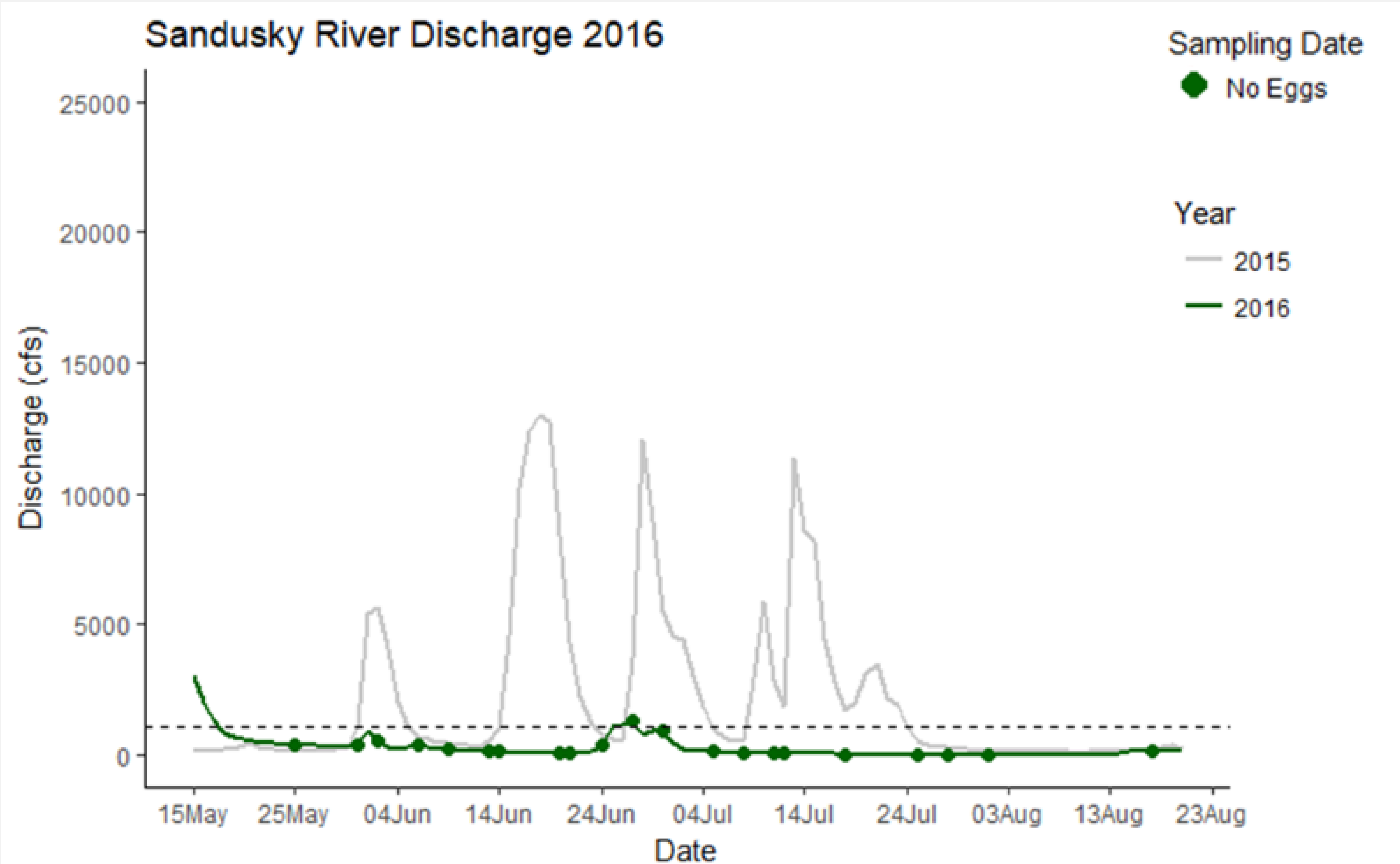
- May 29-30
- June 3-5, 17-20
- July 23

SPAWNING DURING HIGH FLOWS

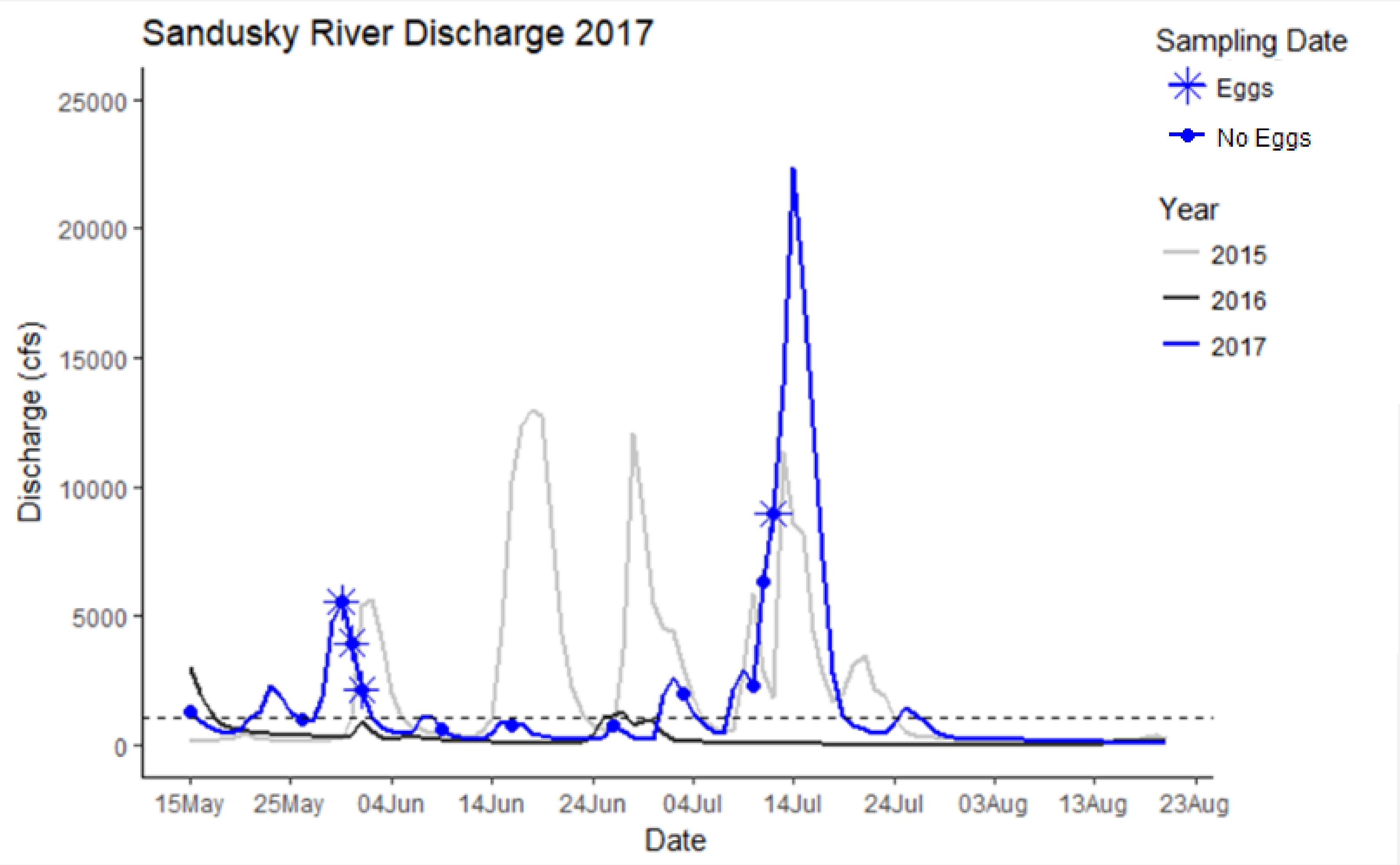


Flow needed to suspend eggs

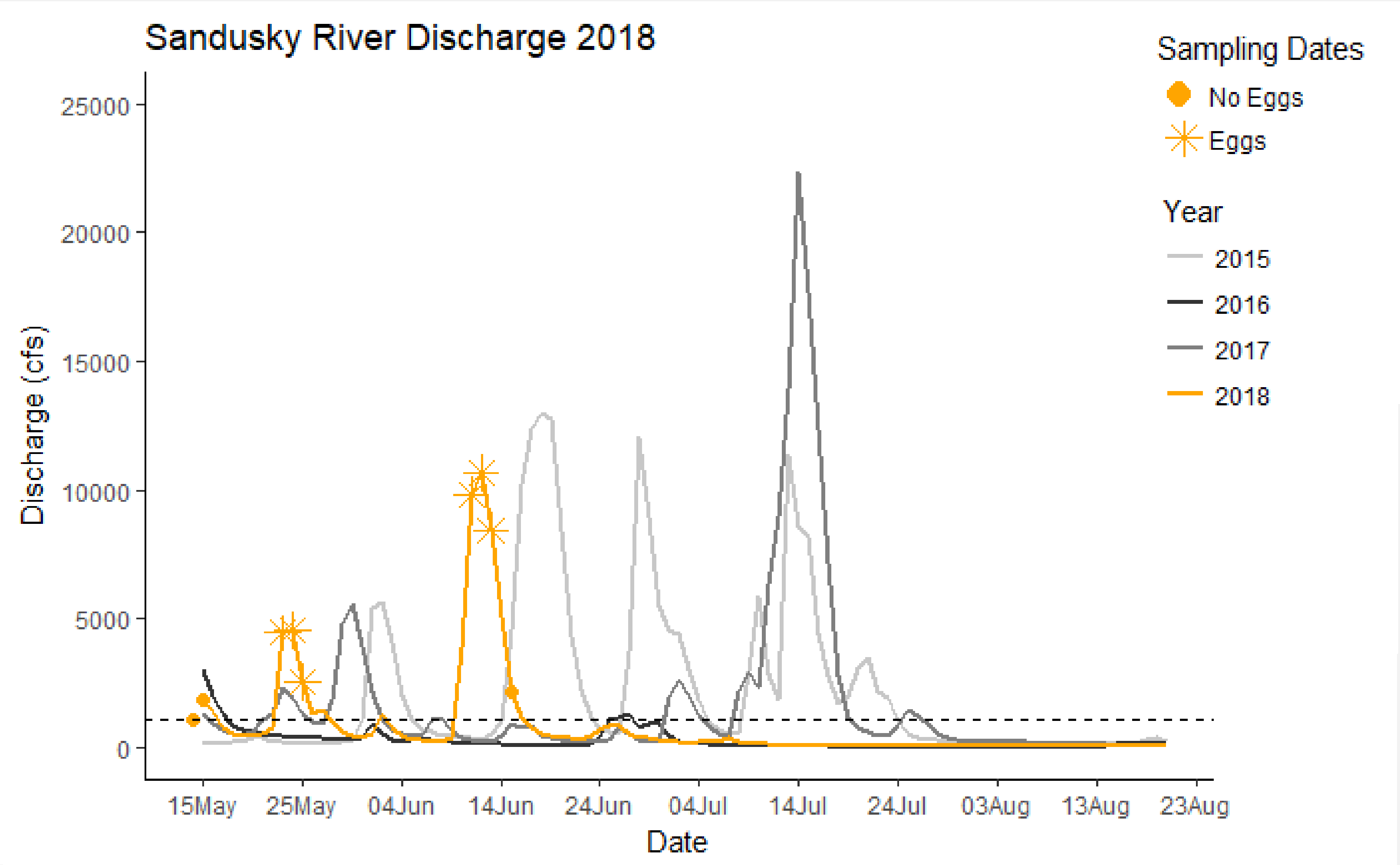
SPAWNING DURING HIGH FLOWS



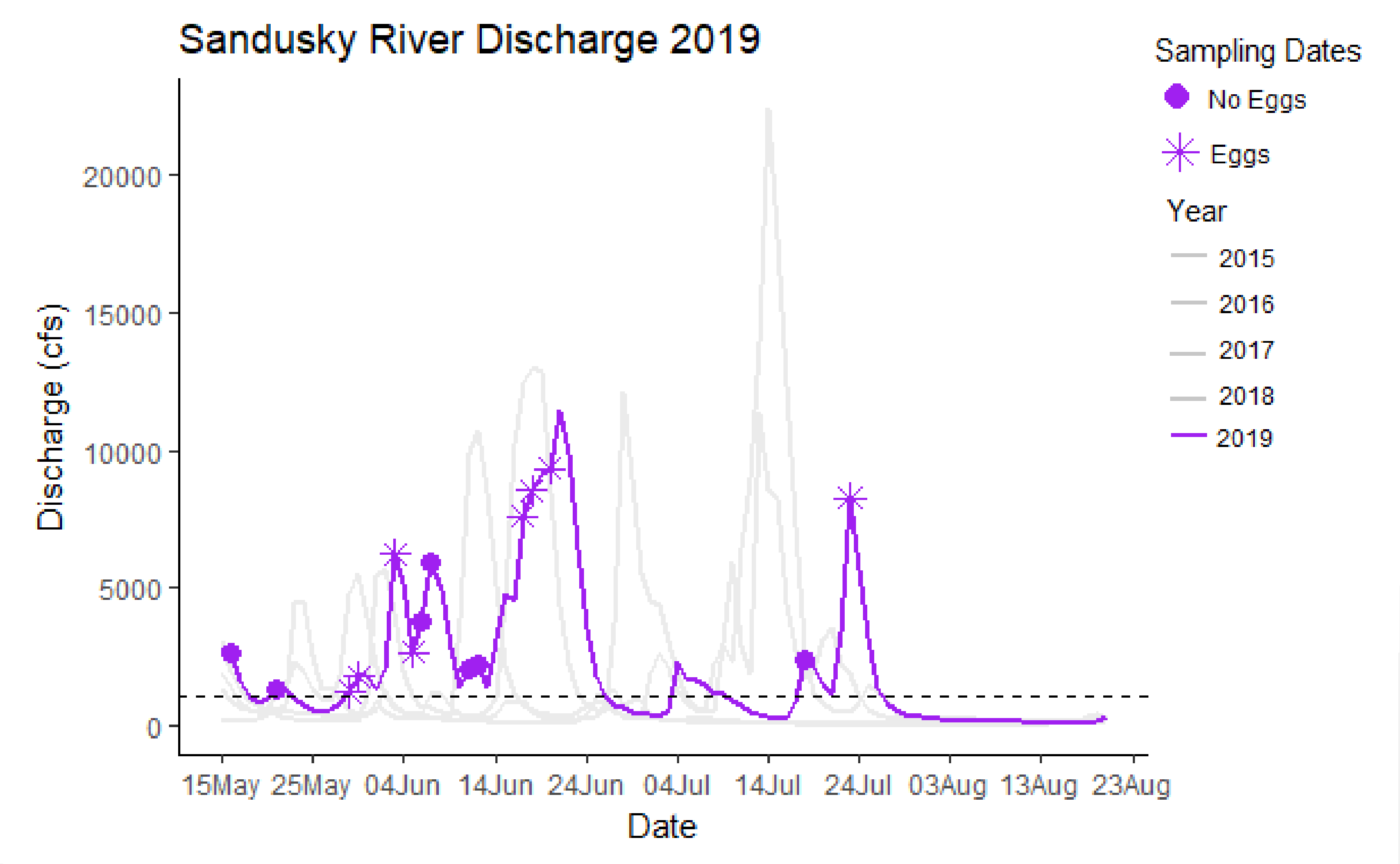
SPAWNING DURING HIGH FLOWS



SPAWNING DURING HIGH FLOWS



SPAWNING DURING HIGH FLOWS



RI

e 20

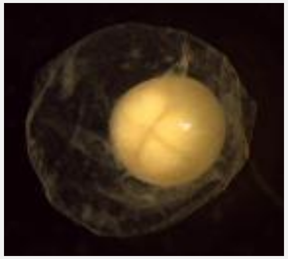
04Ju

Date

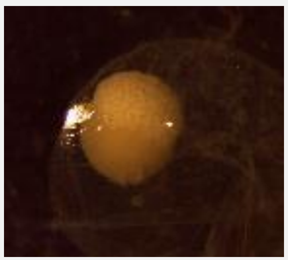
QUESTIONS

When do GC spawn?	**High flows**
Are eggs viable?	
Do eggs hatch in river?	
Where are the spawning grounds?	
What do we do about this?	

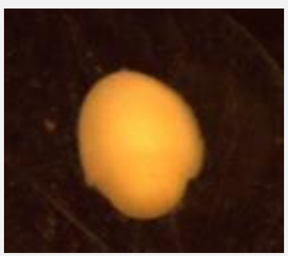
EGGS ARE DEVELOPING



Stage 3



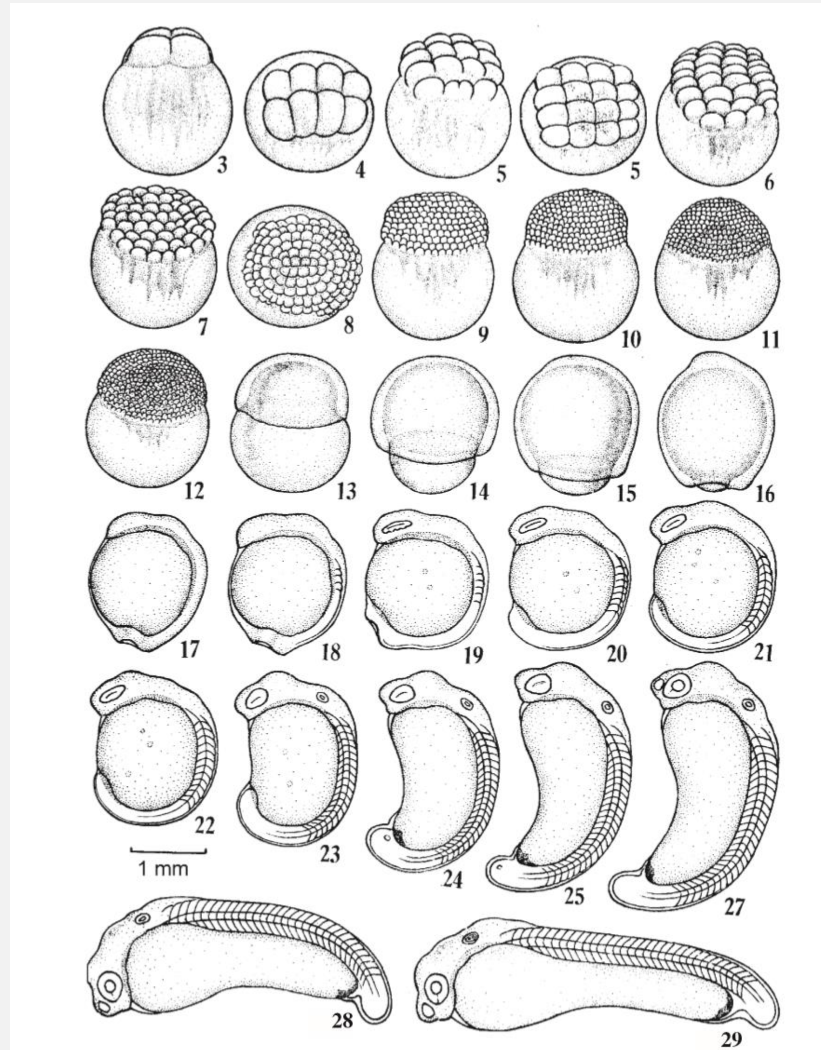
Stage 8



Stage 14

Stage 25

Photos: M. Tomczak



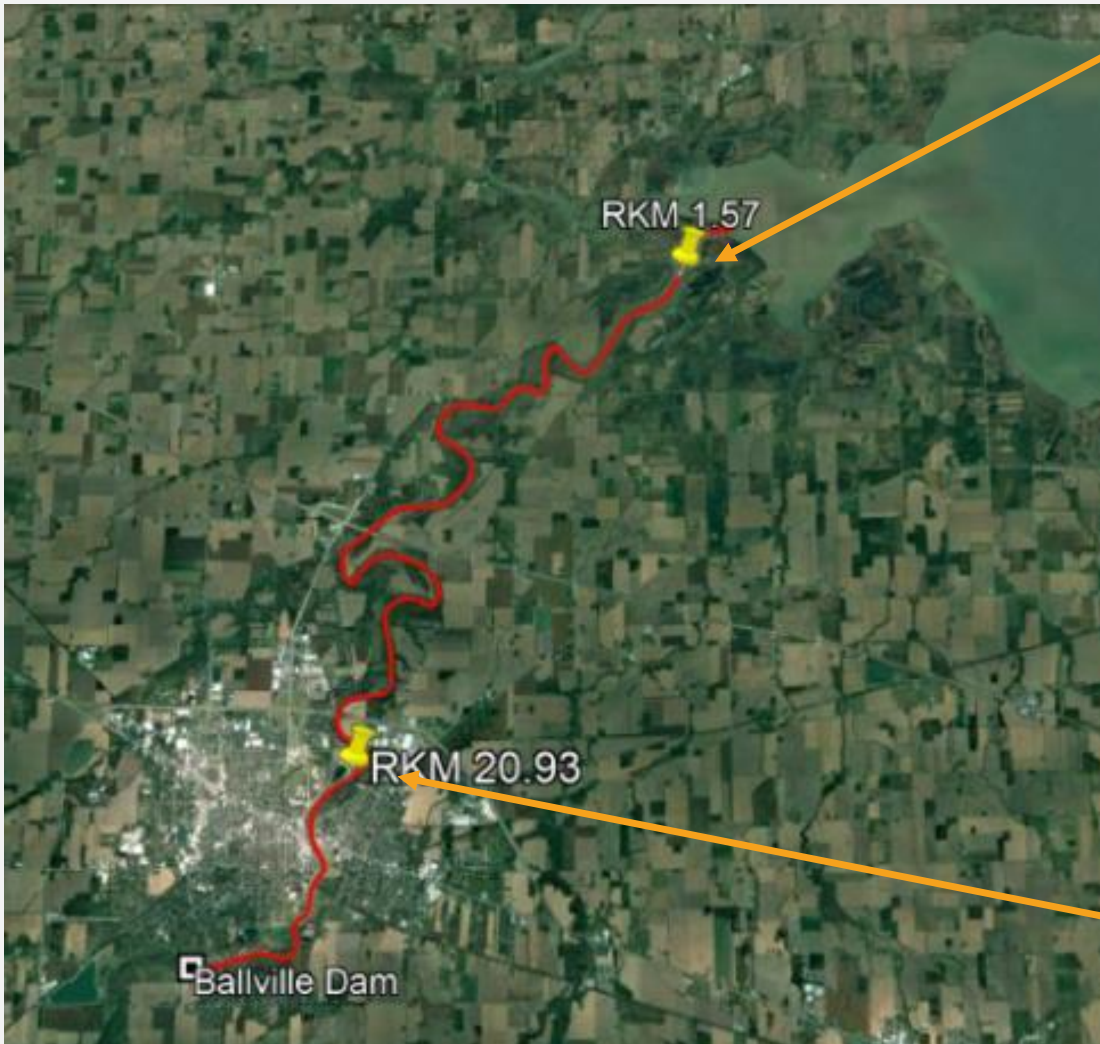
From Yi et al. 2006

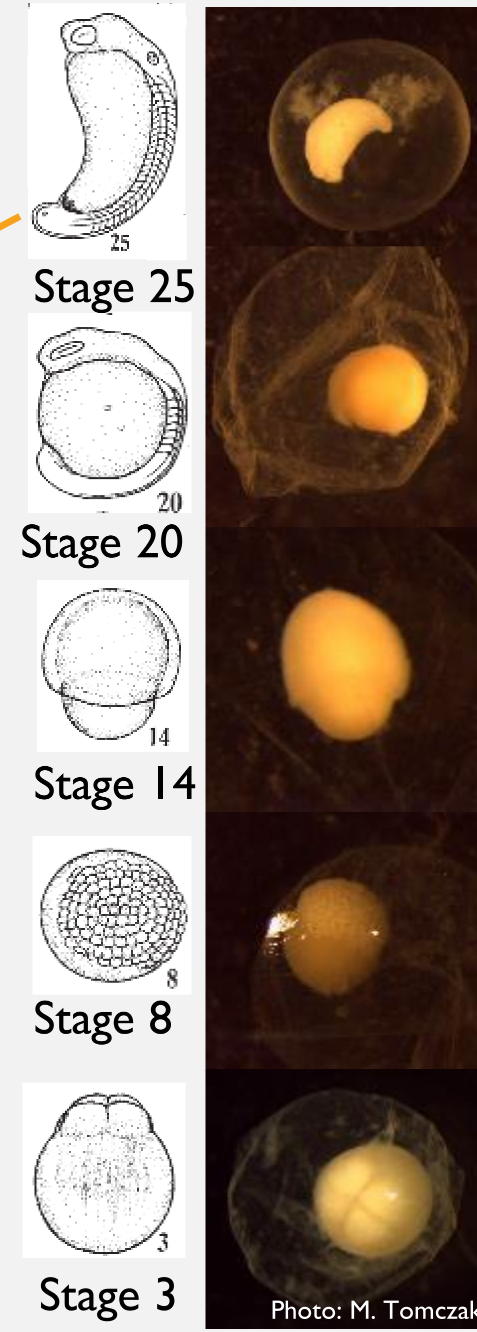
QUESTIONS

When do GC spawn?	Spawning during high flows
Are eggs viable?	**Yes**
Do eggs hatch in river?	
Where are the spawning grounds?	
What do we do about this?	

DO EGGS HATCH IN RIVER?

7.12.17





From Yi et al. 2006

DO EGGS HATCH IN RIVER?

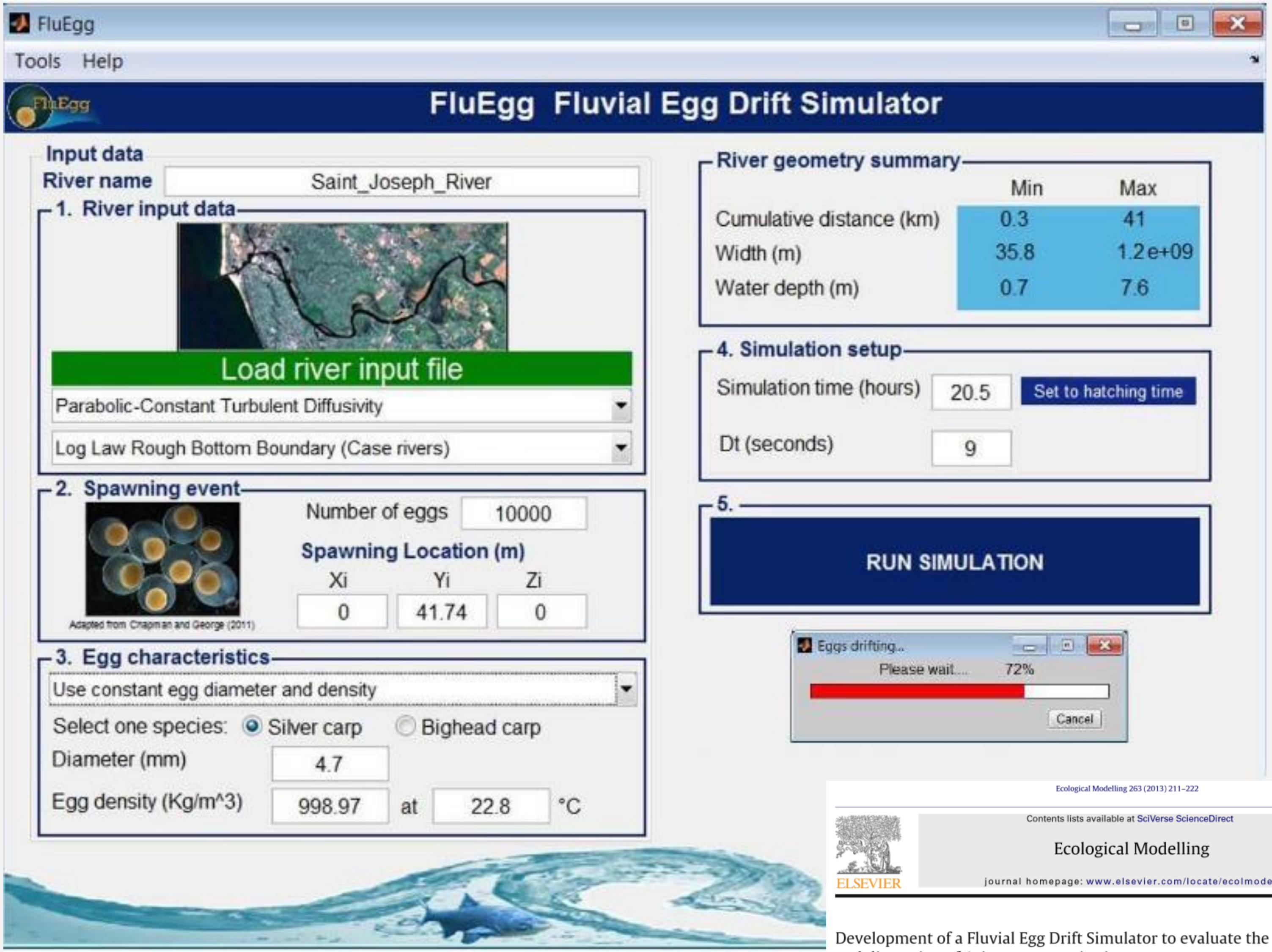
-Development based on temperature

-Location in river based on flow

~9000 cfs

~2500 cfs

DO EGGS HATCH IN RIVER?



Ecological Modelling 263 (2013) 211–222

Contents lists available at SciVerse ScienceDirect

Ecological Modelling

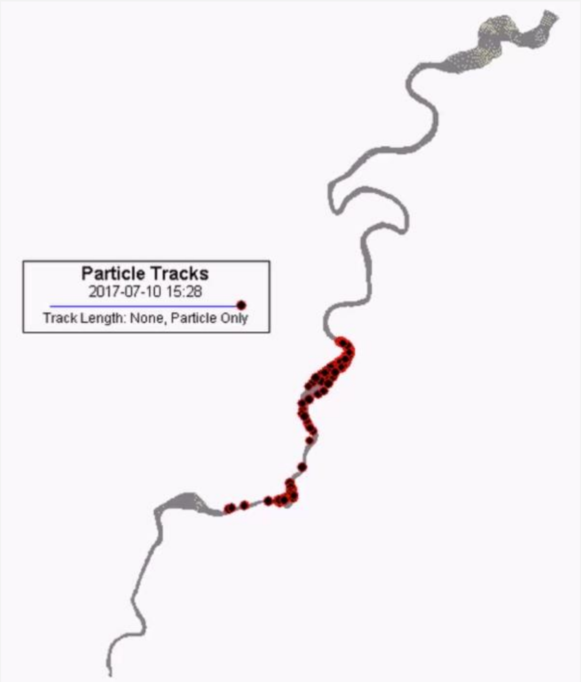
journal homepage: www.elsevier.com/locate/ecolmodel

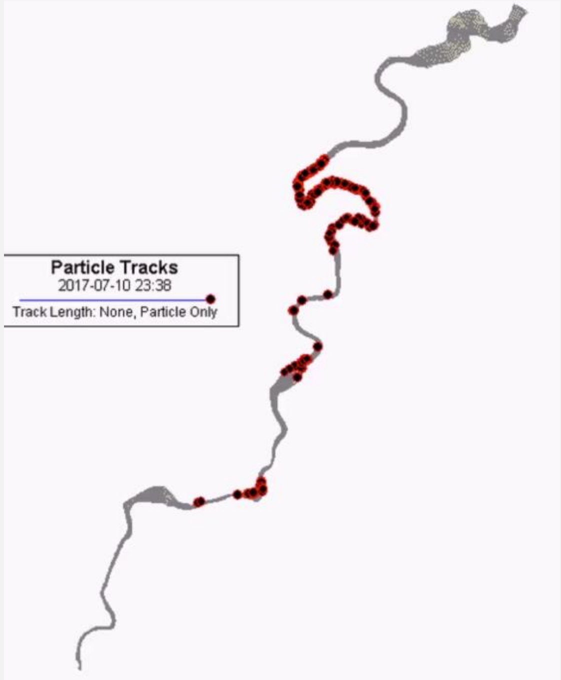
ELSEVIER

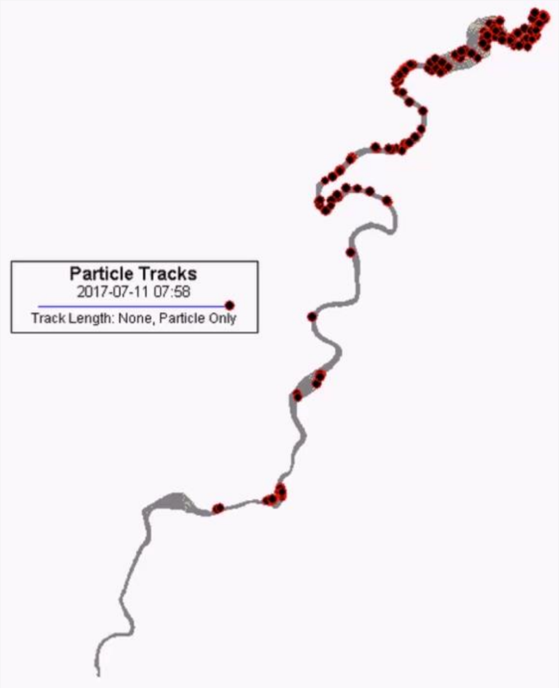
Development of a Fluvial Egg Drift Simulator to evaluate the transport and dispersion of Asian carp eggs in rivers

Tatiana Garcia[a,*], P. Ryan Jackson[b], Elizabeth A. Murphy[b], Albert J. Valocchi[a], Marcelo H. Garcia[a,c]

DO EGGS HATCH IN RIVER?





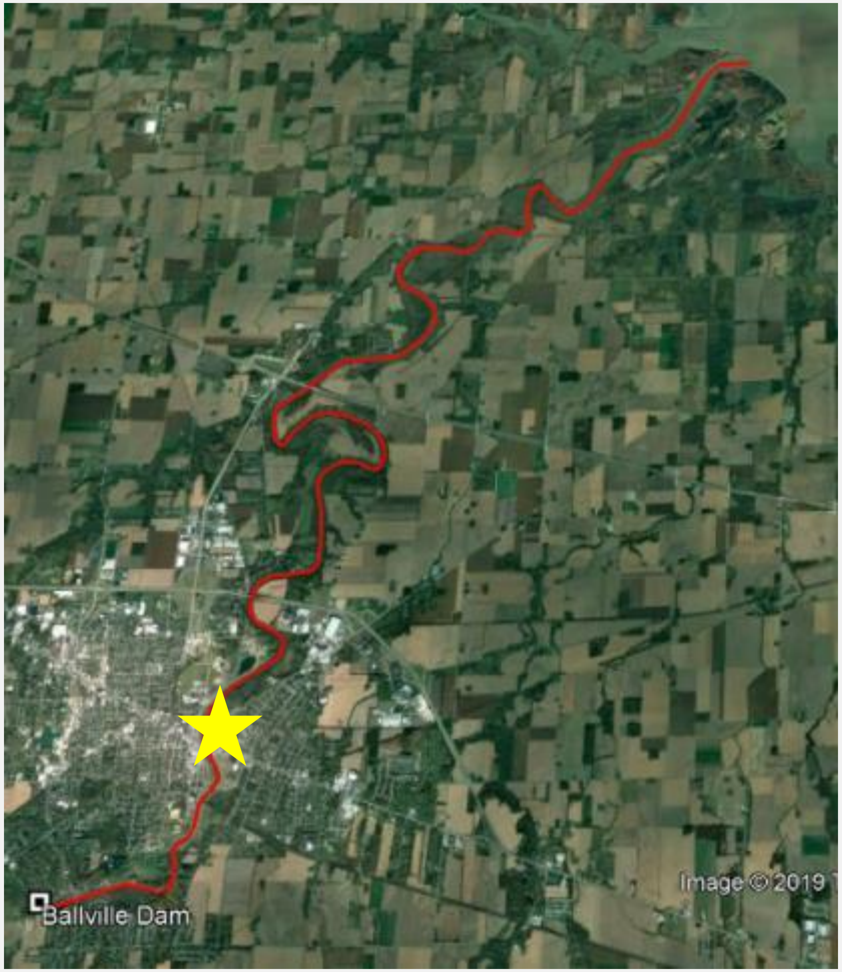


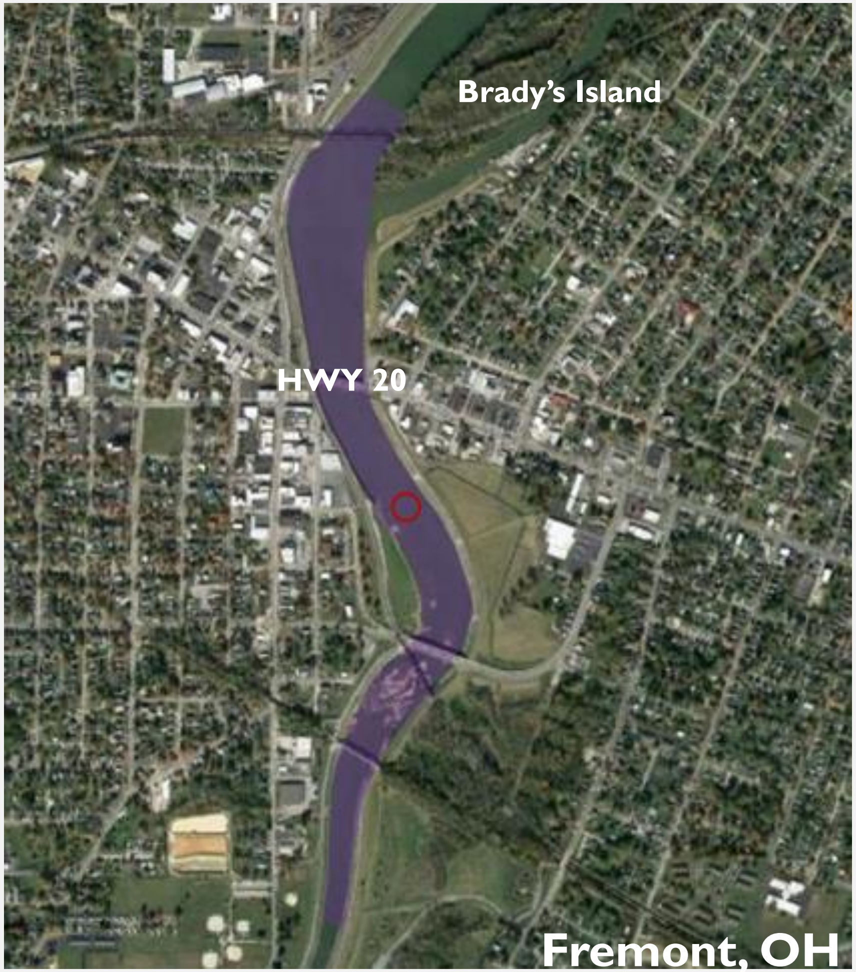
Heer, T., Wells, M.G., Jackson, P.R., Mandrak, N.E. Modelling Grass Carp egg transport using a 3-D hydrodynamic river model: The role of egg retention in dead zones on spawning success. In Review.

QUESTIONS

When do GC spawn?	Spawning during high flows
Are eggs viable?	Yes
Do eggs hatch in river?	**Sometimes**
Where are the spawning grounds?	
What do we do about this?	

FLUEGG ESTIMATED SPAWNING GROUNDS





2018 ODNR PLANNED ACTION & SPAWNING GROUND VERIFICATION

FURTHER VERIFICATION OF SPAWNING GROUNDS

Newly spawned eggs upstream of HWY 20

POST BALLVILLE DAM REMOVAL?

Impassable barrier at RKM 26 removed fall 2018

- Changes in river hydrology?
- Spawning location change?

QUESTIONS

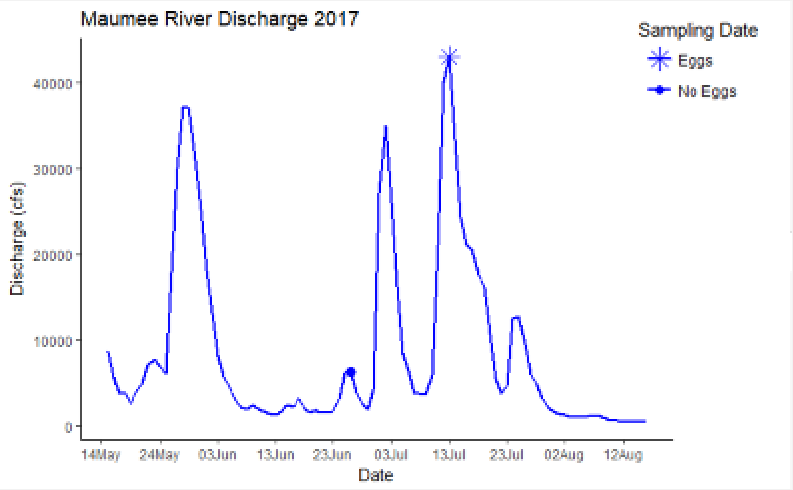
When do GC spawn?	Spawning during high flows
Are eggs viable?	Yes
Do eggs hatch in river?	Sometimes
Where are the spawning grounds?	**Fremont… for now**
What do we do about this?	

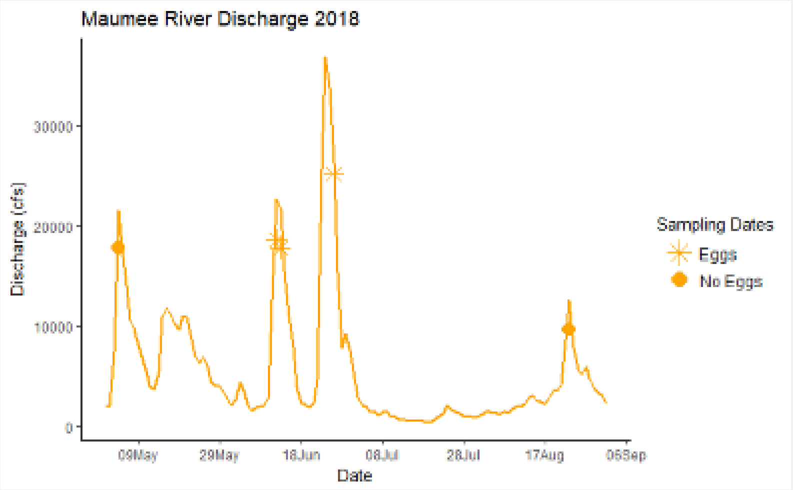
But first……... more bad news

MAUMEE RIVER SPAWNING

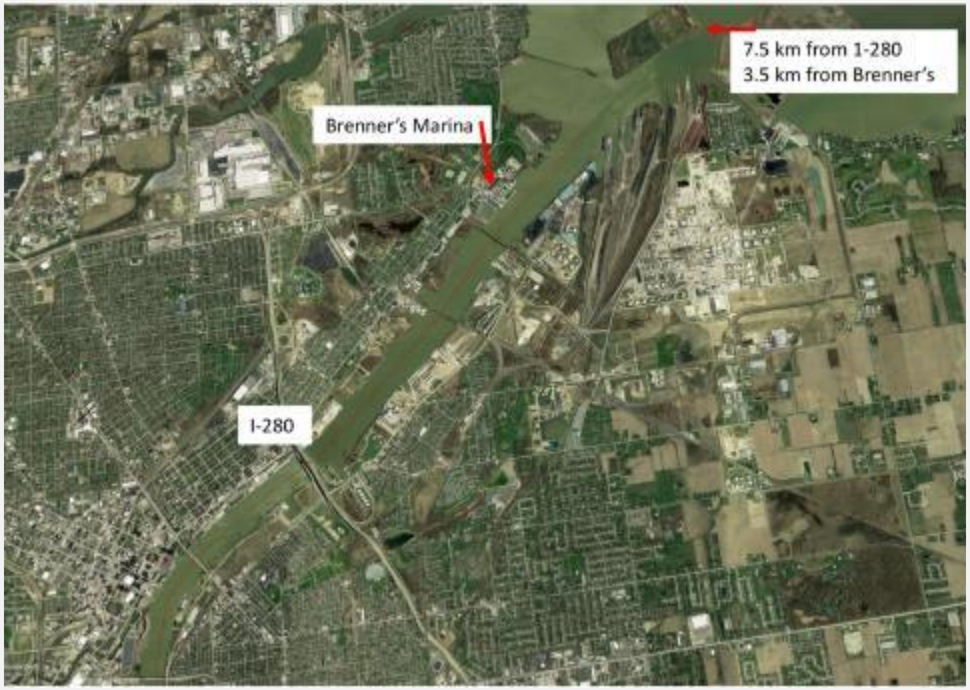
2017
July 13
2018
June 11-14
June 23-27

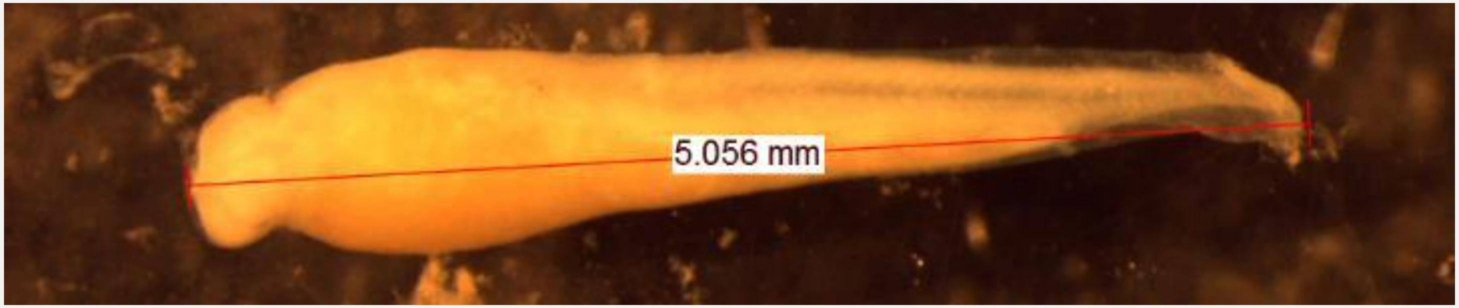
2019
May 29-?
In progress





2018: EGGS CAN HATCH IN RIVER





QUESTIONS

When do GC spawn?	Spawning during high flows
Are eggs viable?	Yes
Do eggs hatch in river?	Sometimes
Where are the spawning grounds?	Fremont (Sandusky) Maumee (unknown)
What do we do about this?	

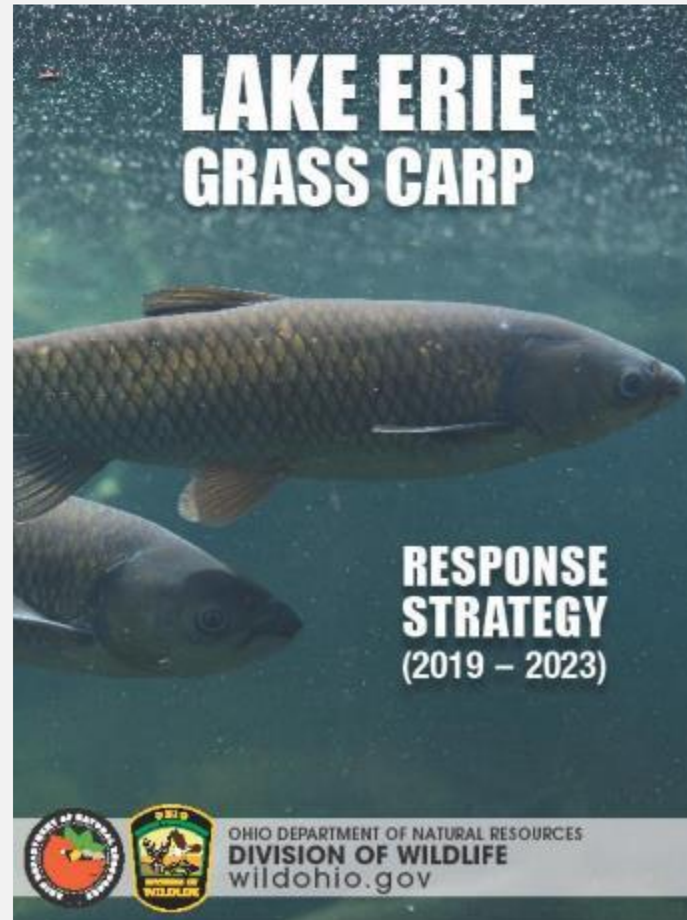
REMOVAL AND RESEARCH EFFORTS

- ODNR Lake Erie Grass Carp Response Strategy

<u>Objectives</u>

- Secure aquaculture supply chain & bait
- Further research: life history, monitoring, minimize expansion, reduce populations
- Removal efforts (partners & commercial fishermen)
- Evaluate potential barriers

OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE



REMOVAL AND RESEARCH EFFORTS (U.S.)

UT/ODNR/MDNR/FWS - Strike Teams
(shock boat, nets, tracking on receivers, processing fish)

155+ Grass Carp removed in 2019!

BACK CALCULATING BIRTH YEARS

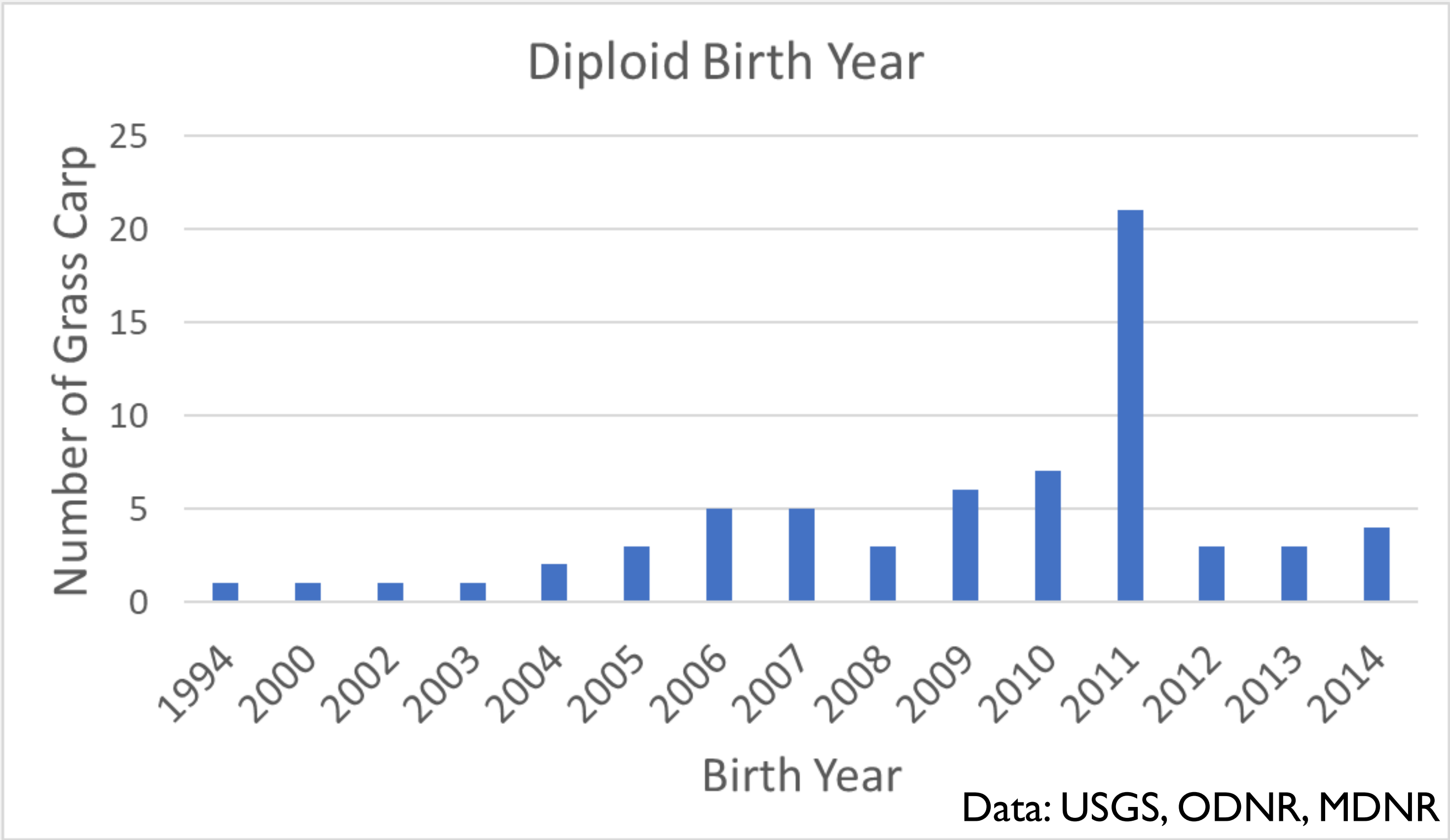
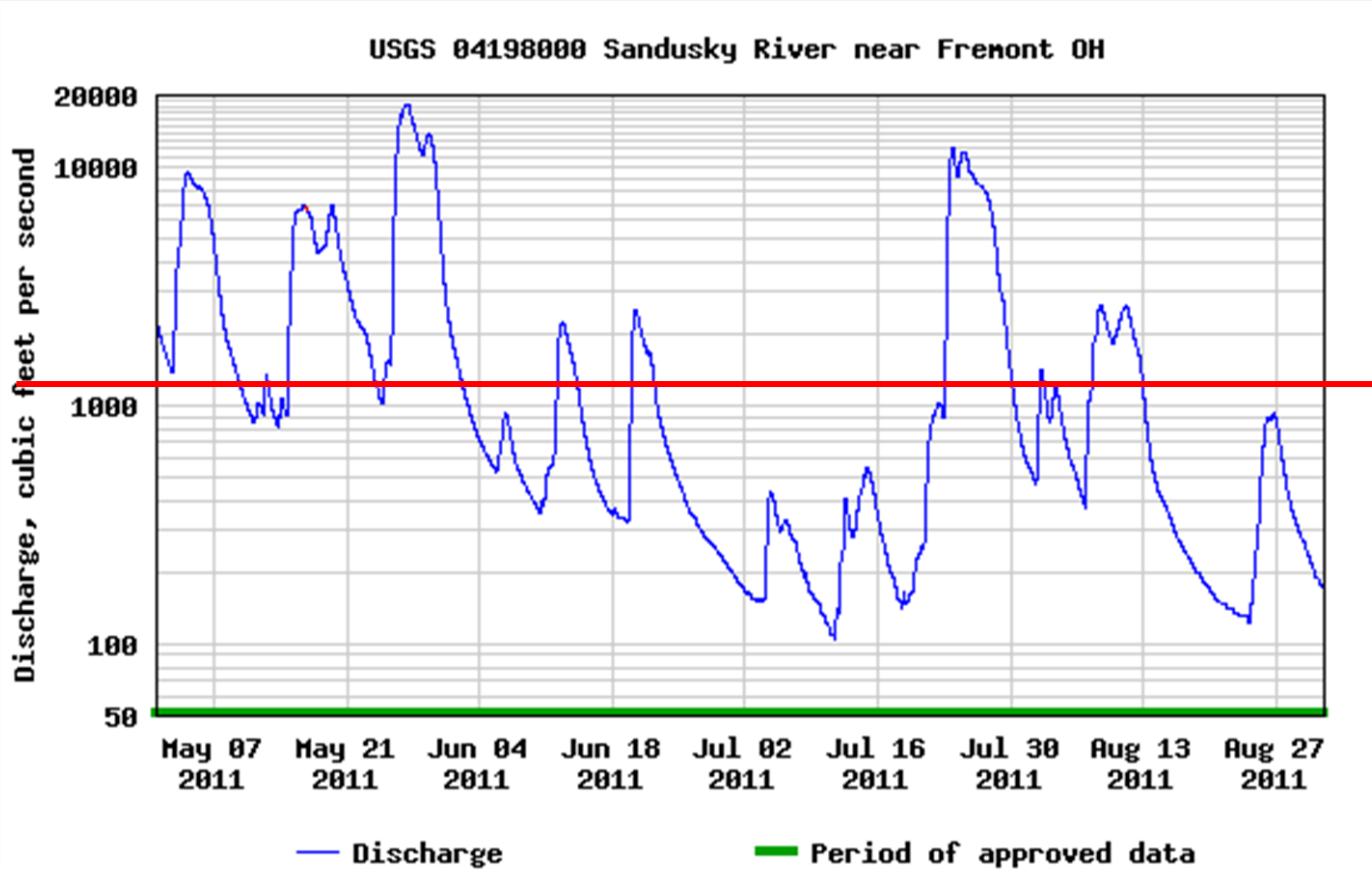


Figure: Sabrina Jaffe, University of Toledo



Waterwatch.usgs.gov

REMOVAL AND RESEARCH EFFORTS

- Early detection
  - eDNA, surveillance
- Identify spawning locations
  - otolith microchemistry
  - egg collection, modeling
- Population estimates
  - genetics, mark-recapture, modeling
- Capture probability
- Baits & attractants
- Seasonal barriers

OHIO DEPARTMENT OF NATURAL RESOURCES DIVISION OF WILDLIFE

DEPARTMENT OF NATURAL RESOURCES DNR MICHIGAN

U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

Bowling Green STATE UNIVERSITY

UT THE UNIVERSITY OF TOLEDO 1872

MICHIGAN STATE UNIVERSITY

University of Windsor

Ontario Ministry of Natural Resources and Forestry

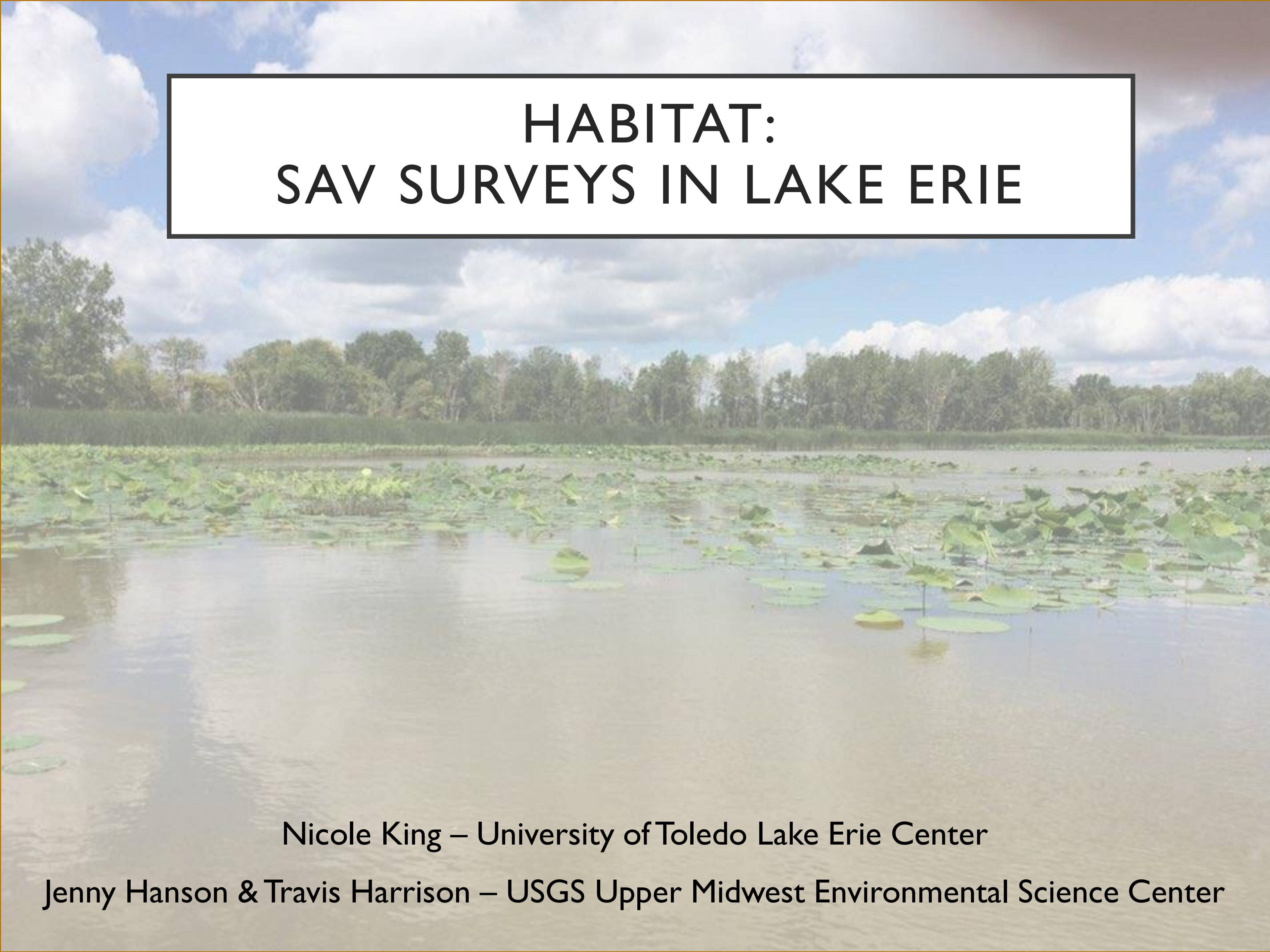
Fisheries and Oceans Canada

Pêches et Océans Canada

USGS

GRASS CARP ARE SPAWNING & EGGS ARE HATCHING: WHAT DOES THIS MEAN FOR ERIE?

- Eggs/Larvae ≠ recruitment
- Population unknown
- Possible damage to aquatic vegetation and wetlands
- Similar spawning requirements to other carp species (bighead, silver, black)



HABITAT: SAV SURVEYS IN LAKE ERIE

Nicole King – University of Toledo Lake Erie Center

Jenny Hanson & Travis Harrison – USGS Upper Midwest Environmental Science Center

3-TIER ASSESSMENT

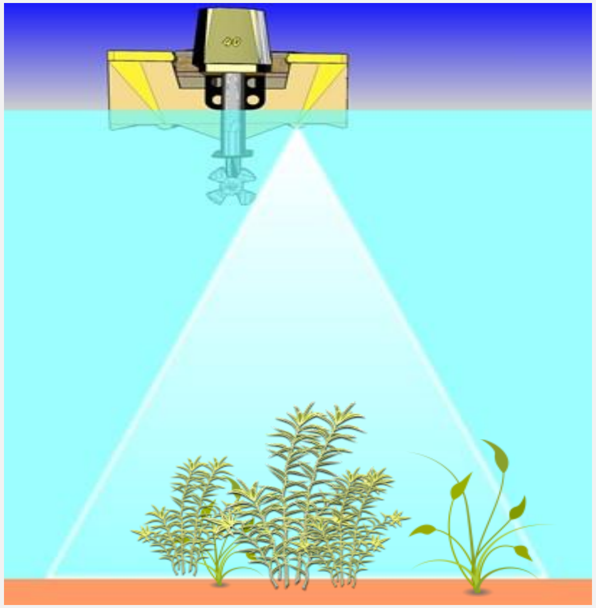
1. Object Based Image Analysis (OBIA)

2. Hydroacoustics

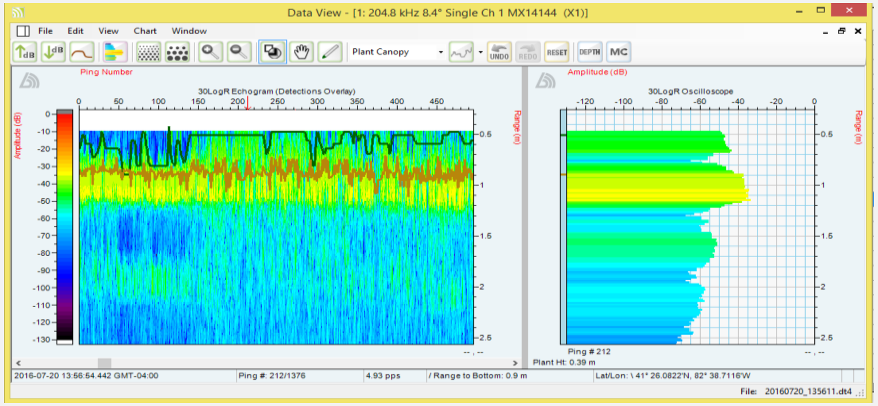
3. Rake Surveys

3-TIER ASSESSMENT

1. Object Based Image Analysis (OBIA)



2. Hydroacoustics



3. Rake Surveys

3-TIER ASSESSMENT

1. Object Based Image Analysis (OBIA)
2. Hydroacoustics
3. Rake Surveys

METHOD COMPARISON

Distribution

Density

Taxa

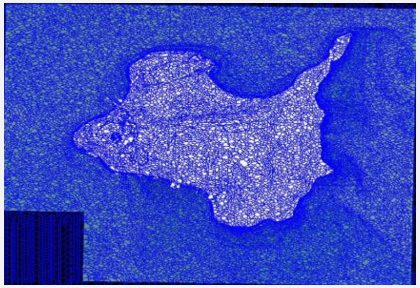
Method	Pros	Cons
OBIA	• Large-scale mapping • Provides starting point for likely submerged aquatic vegetation (SAV) locations • Fast results	• Uses outdated imagery • No community data
Sonar	• Accurate detection of SAV	• Several transects needed/time consuming • No community data
Rake	• Community level data	• Time consuming • Point data

OBIA

1.

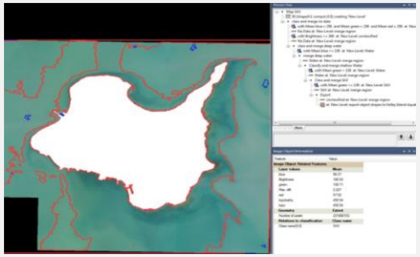
1. Aerial imagery and bathymetric contours were downloaded

2.



2. Multispectral analysis using Trimble's eCognition
- visible light
- near-infra red

3.

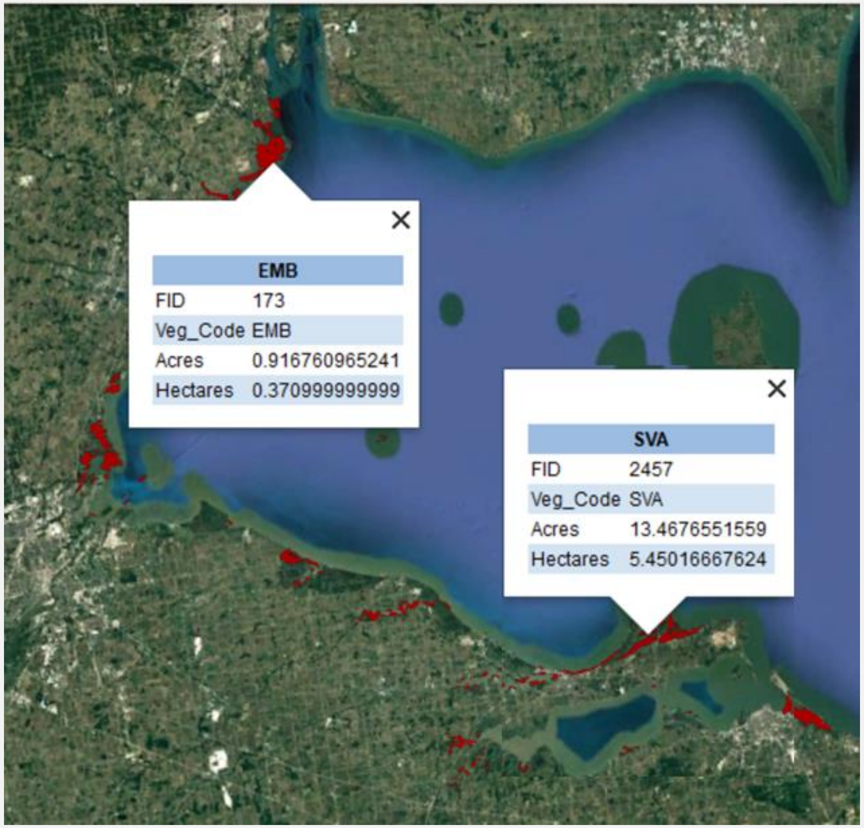


3. Ruleset created and used to classify aquatic vegetation

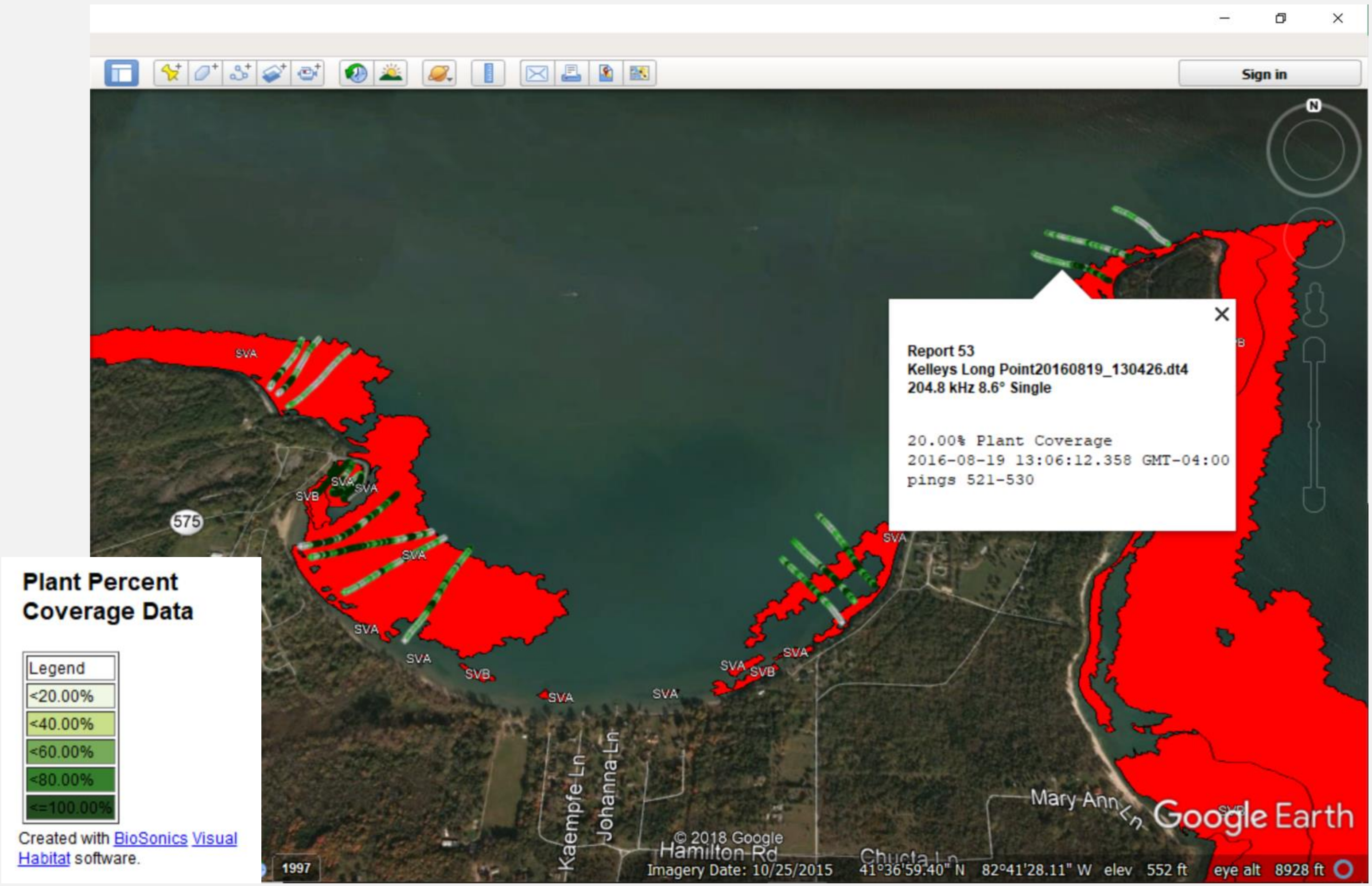
4.

4. Results exported and edited in ESRI's ArcGIS.
- Add density modifiers

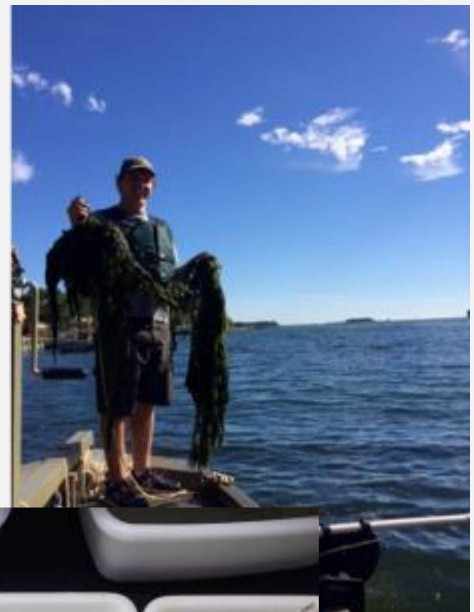
VEGETATION MAPS: OBIA



VEGETATION SURVEYS: HYDROACOUSTICS

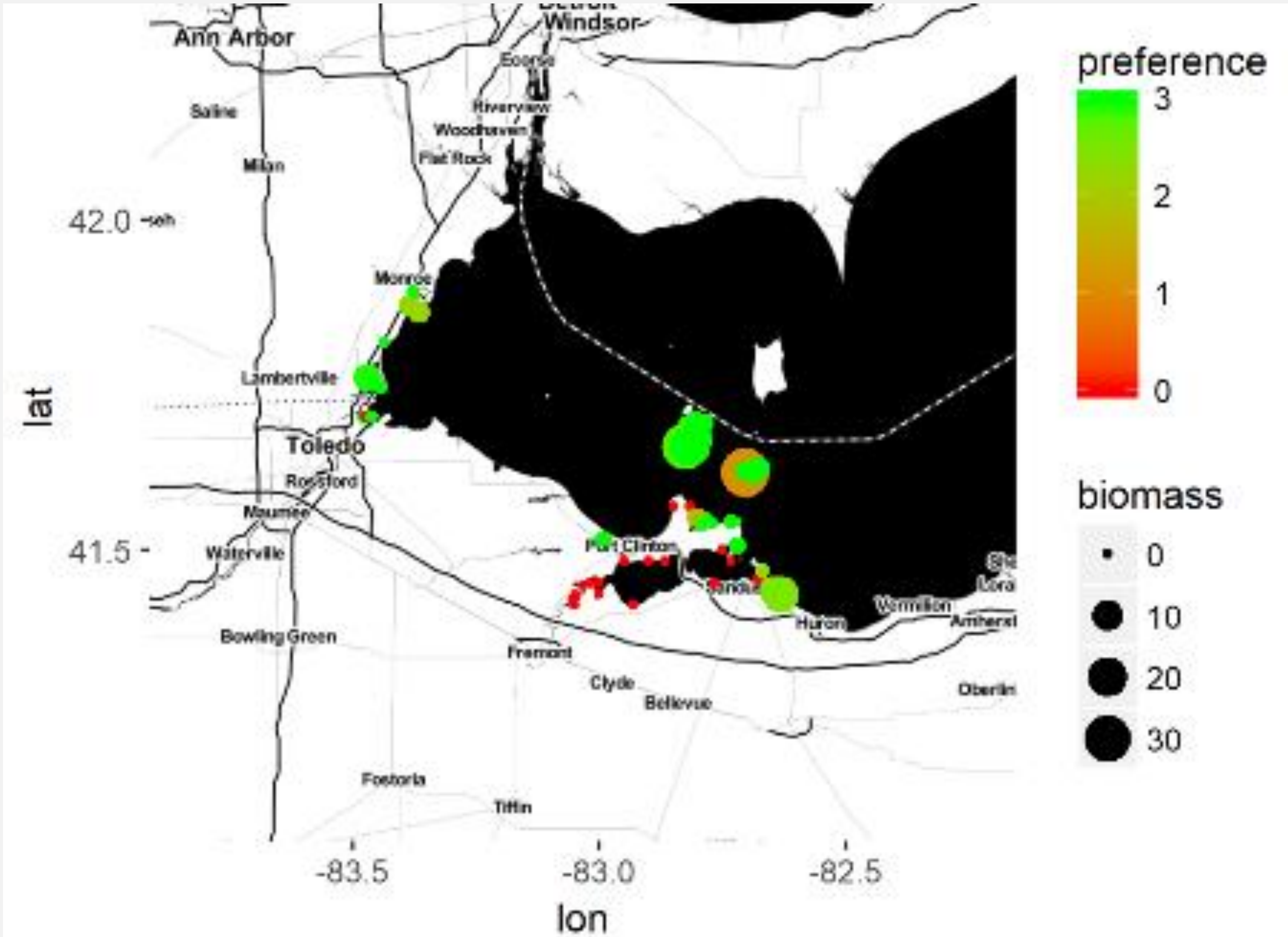


VEGETATION SURVEYS: RAKE SAMPLING



SAV Species	Preference
Cladophora spp.	High
Ceratophyllum demersum (Coontail)	Low
Elodea canadensis (Waterweed)	High
Heterantha dubia (Water Stargrass)	High
Myriophyllum spicatum (Eurasian Water Milfoil)	Med
Myriophyllum spp. (Milfoil)	Med
Najas gracillima (Slender Waternymph)	High
Najas guadalupensis (Southern Waternymph)	High
Nitellopsis obtusa (Starry stonewort)	High
Potamogeton nodosus (Long-leaved Pondweed)	High
Potamogeton pectinatus (Sago Pondweed)	High
Potamogeton pusillus (Small Pondweed)	High
Potamogeton richardsonii (Clasping Leaved Pondweed)	High
Vallisneria americana (Eelgrass)	High
Zannichellia palustris (Horned Pondweed)	High

IDENTIFYING GC PREFERRED HABITAT



3 TIER PRELIM RESULTS

Method Agreement – Presence/Absence of SAV

- Rake Sampling & Hydroacoustics – **93%** agreement
- Rake Sampling & OBIA – **69%** agreement
- Hydroacoustics & OBIA – **54%** agreement *increased to 72% agreement when SAV density >50% (hydroacoustics)

Hydroacoustics best at detecting presence/absence
OBIA difficulty detecting sparse SAV
Rake sometimes misses SAV when sparse or sporadic

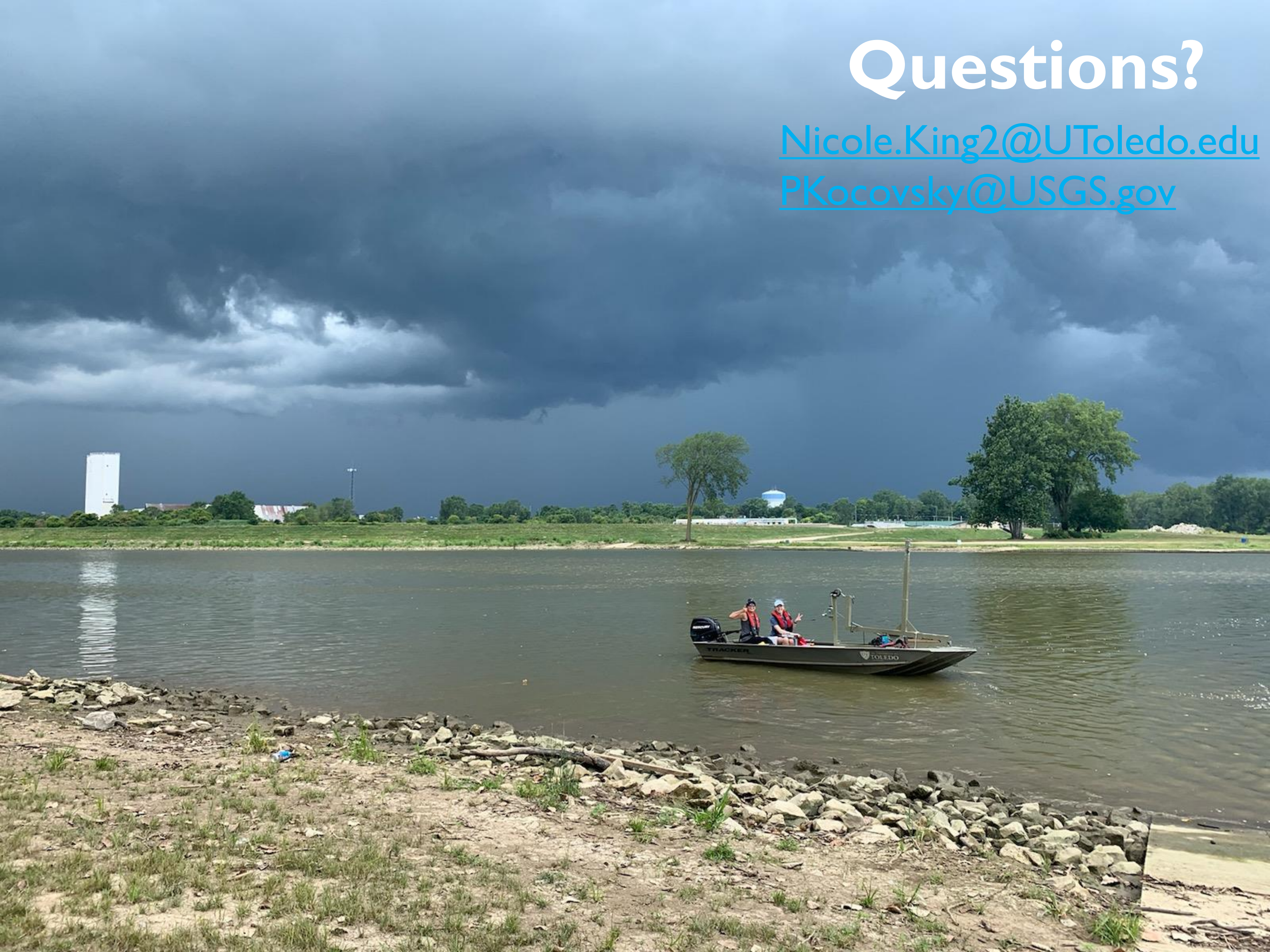
SAV SURVEYS

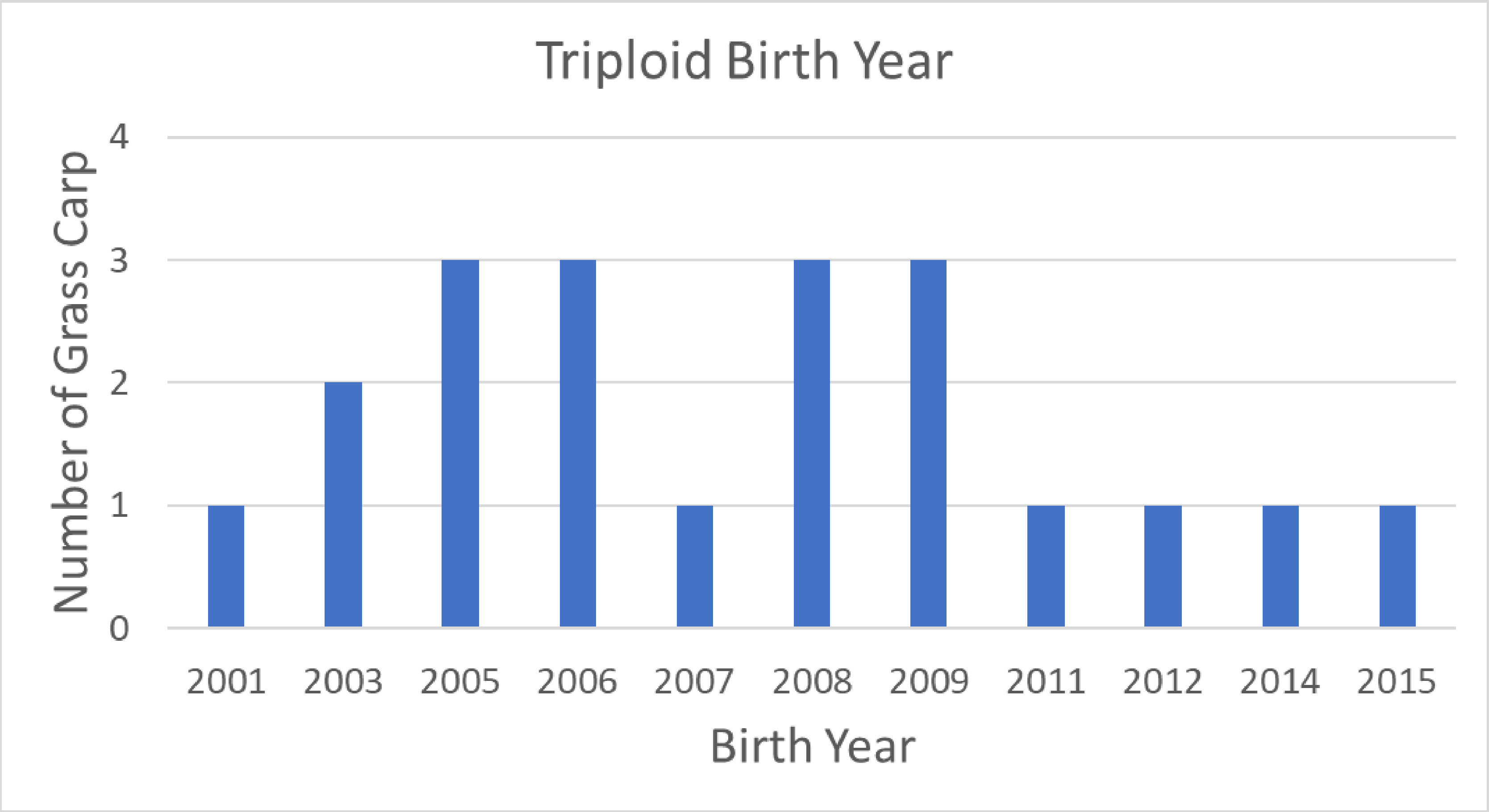
Baseline data

- Track changes in distribution, density, community composition
  - changes *possibly* due to Grass Carp herbivory
- Comparing data and methods with others including TNC & Cleveland Metroparks

Questions?

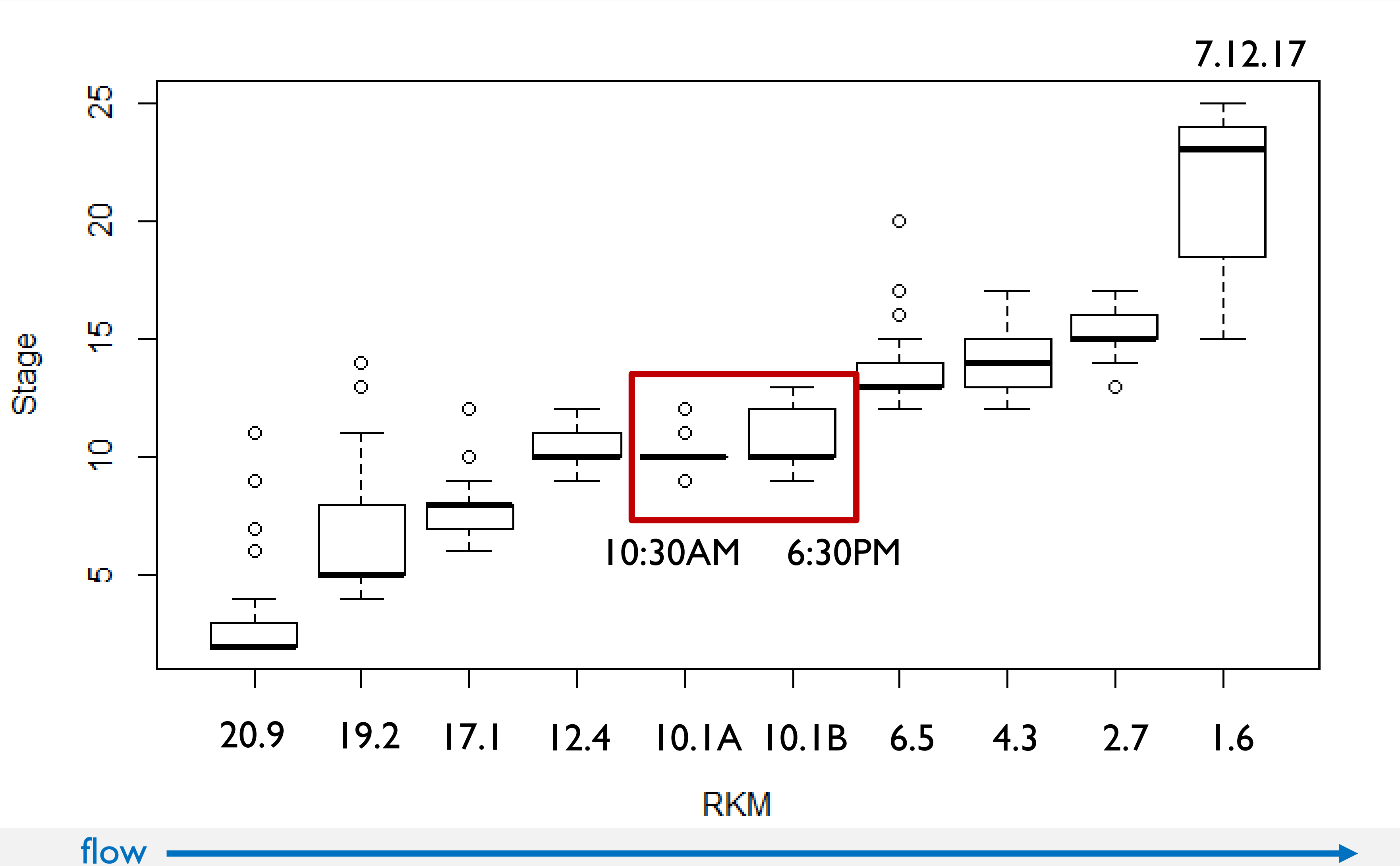
Nicole.King2@UToledo.edu
PKocovsky@USGS.gov





Triploid Birth Year
Number of Grass Carp
0
1
2
3
4
2001
2003
2005
2006
2007
2008
2009
2011
2012
2014
2015
Birth Year

DO EGGS HATCH IN RIVER?



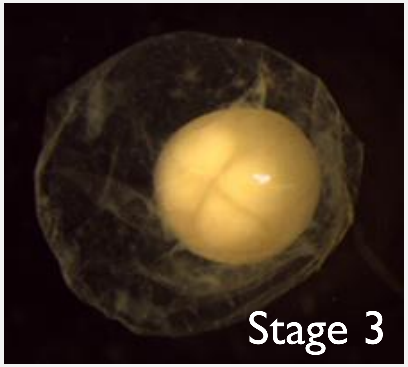
CUMULATIVE THERMAL UNITS

$$CTU = t(T_c - T_{min})$$

t = time in hours

T_c = treatment temperature in degrees Celsius

T_{min} = thermal minimum in degrees Celsius



CTU=9.915

CTU=184.279

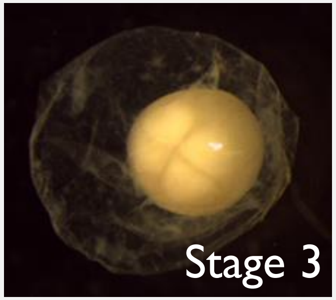
Citation: George AE, Chapman DC (2015) Embryonic and Larval Development and Early Behavior in Grass Carp, Ctenopharyngodon idella: Implications for Recruitment in Rivers. PLoS ONE 10 (3): e0119023. doi:10.1371/journal.pone.0119023

CALCULATING FERTILIZATION TIME

Development based on temperature

- CTU from George & Chapman 2015
- Temp of river (USGS gauge 04198000)

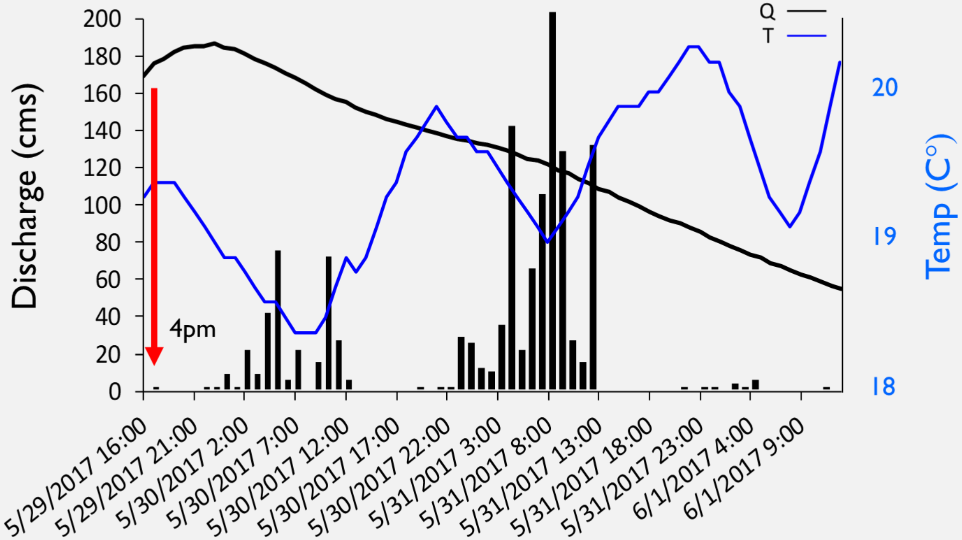
Hours post fertilization = CTU/(T - 13.5) ← Thermal min

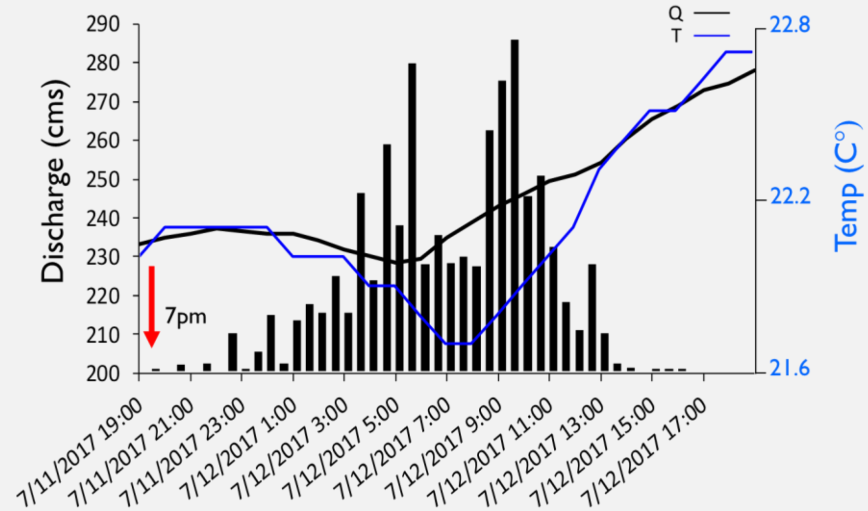


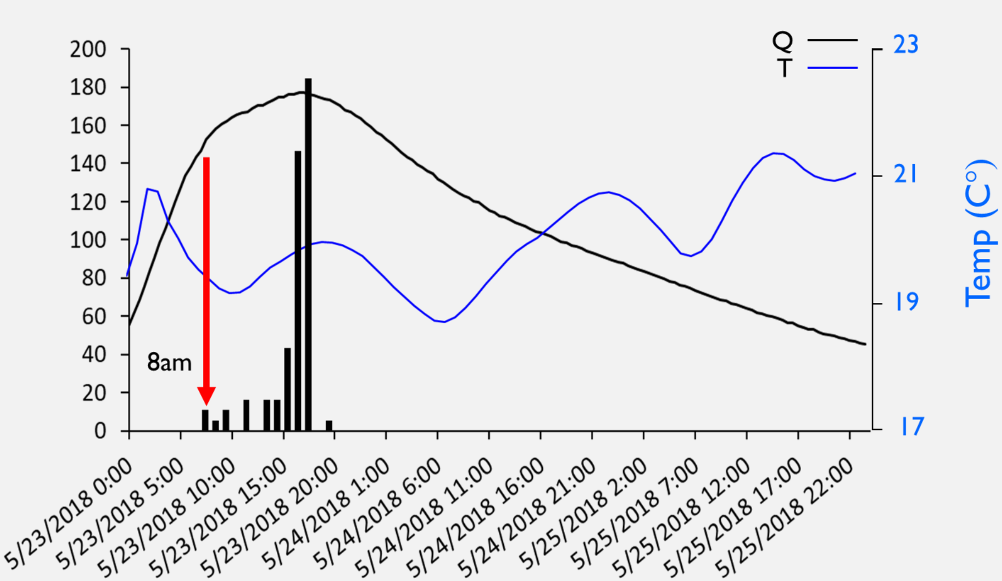
CTU=9.915 Water temp=20.48°C

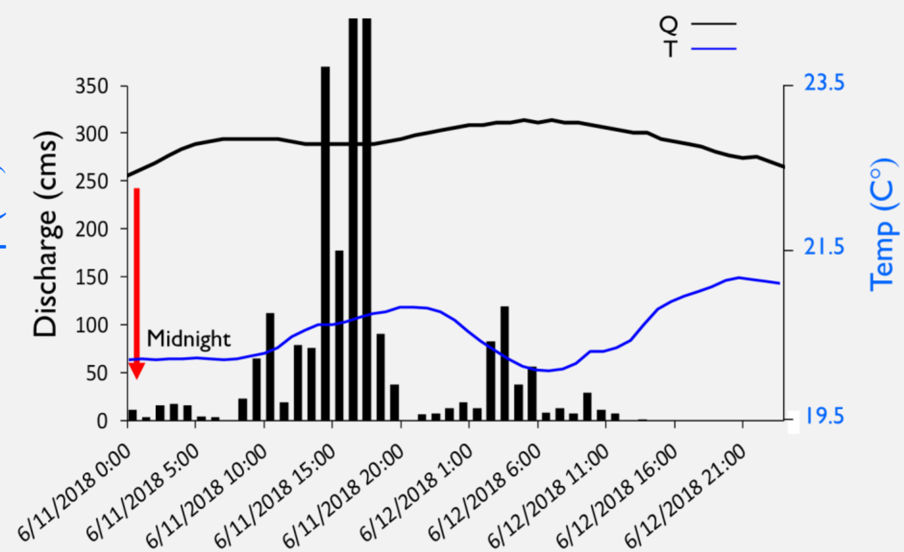
Fertilization time = Capture time - HPF

11:27am 12:53pm 1.42


Discharge (cms)
Temp (C°)
Q
T
4pm
200
180
160
140
120
100
80
60
40
20
0
20
19
18
5/29/2017 16:00
5/29/2017 21:00
5/30/2017 2:00
5/30/2017 7:00
5/30/2017 12:00
5/30/2017 17:00
5/30/2017 22:00
5/31/2017 3:00
5/31/2017 8:00
5/31/2017 13:00
5/31/2017 18:00
5/31/2017 23:00
6/1/2017 4:00
6/1/2017 9:00


Discharge (cms)
Temp (C°)
Q
T
7pm
290
280
270
260
250
240
230
220
210
200
22.8
22.2
21.6
7/11/2017 19:00
7/11/2017 21:00
7/11/2017 23:00
7/12/2017 1:00
7/12/2017 3:00
7/12/2017 5:00
7/12/2017 7:00
7/12/2017 9:00
7/12/2017 11:00
7/12/2017 13:00
7/12/2017 15:00
7/12/2017 17:00


Temp (C°)
Q
T
8am
200
180
160
140
120
100
80
60
40
20
0
23
21
19
17
5/23/2018 0:00
5/23/2018 5:00
5/23/2018 10:00
5/23/2018 15:00
5/23/2018 20:00
5/24/2018 1:00
5/24/2018 6:00
5/24/2018 11:00
5/24/2018 16:00
5/24/2018 21:00
5/25/2018 2:00
5/25/2018 7:00
5/25/2018 12:00
5/25/2018 17:00
5/25/2018 22:00


Discharge (cms)
Temp (C°)
Q
T
Midnight
350
300
250
200
150
100
50
0
23.5
21.5
19.5
6/11/2018 0:00
6/11/2018 5:00
6/11/2018 10:00
6/11/2018 15:00
6/11/2018 20:00
6/12/2018 1:00
6/12/2018 6:00
6/12/2018 11:00
6/12/2018 16:00
6/12/2018 21:00