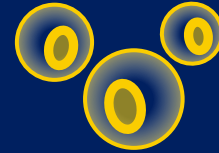
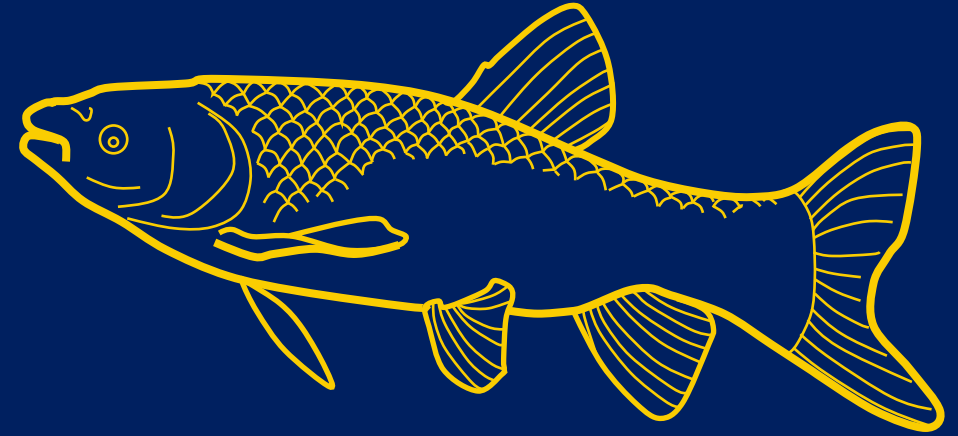


Adaptive Management in Action: Grass Carp control in the Great Lakes

Ryan Brown, R. Mapes, C. Mayer, S. Qian (UT), R. Young, T. Yang, N. Barton (FWS), C. Kemp (MIDNR), E. Weimer, J. Navarro (OHDNR-DOW), M. Acre, J. Roberts, C. Hilling (USGS), T. Krabbenhoft (UB), J. Dettmers (GLFC)

Grass Carp invasion timeline



Imported to U.S. to control aquatic vegetation

Reports of Grass Carp captured by commercial fishers in Lake Erie

Grass Carp eggs found in the Sandusky River

Continued effort



Triploid (sterile) Grass Carp developed

Diploid Grass Carp that originated from the Sandusky River were captured

First strike teams deployed, Grass Carp larvae found in Maumee River



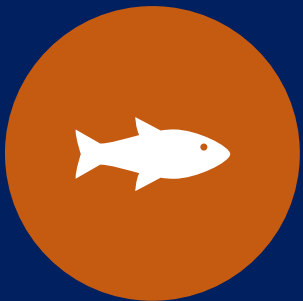
Why are Grass Carp a threat?



Grass Carp captures have increased in recent years



Most Grass Carp captured in the western basin are diploid

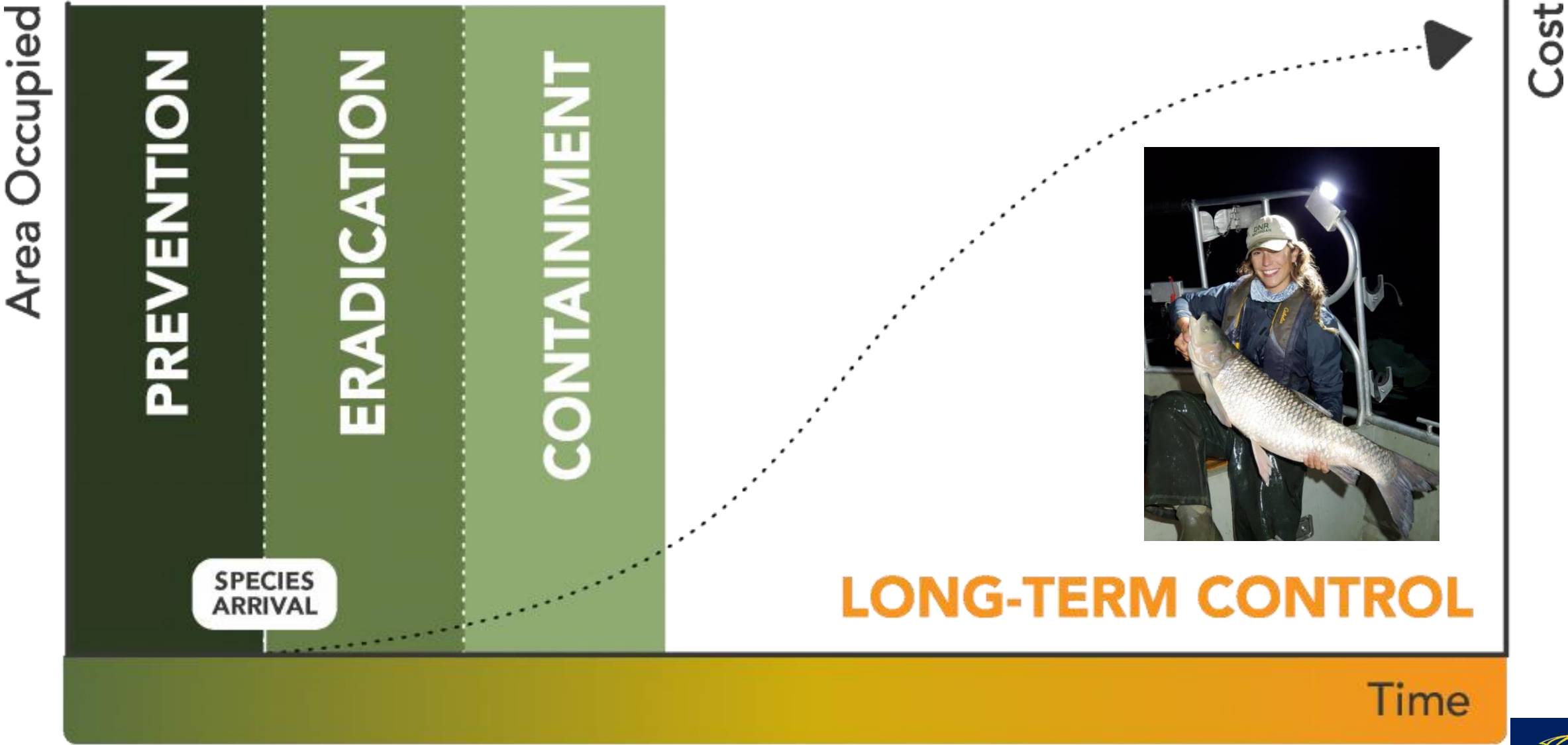


Grass Carp harm aquatic ecosystems when abundant



Eat up to 100% of body weight per day

Grass Carp are relatively rare; now is the time to act



Management Action

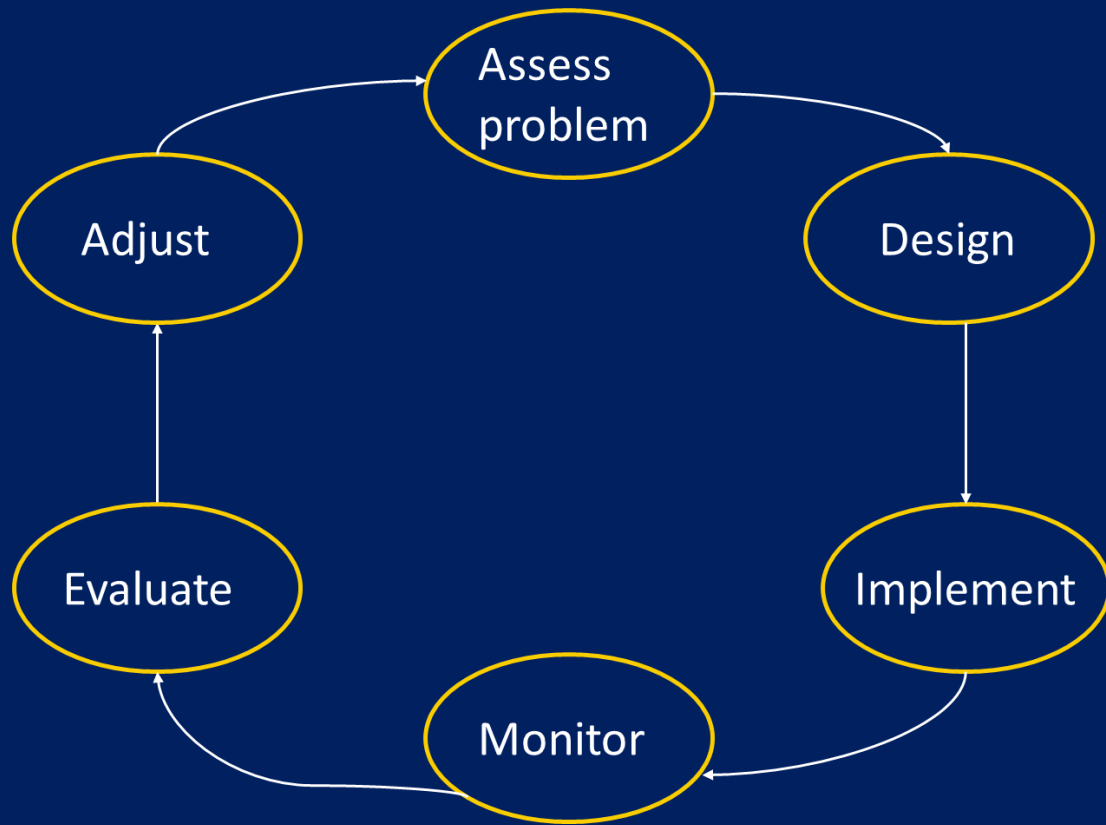
Lake Erie Grass Carp Adaptive Response Strategy 2019-2023



Photo source: J. Francis, Michigan Department of Natural Resources

- Prevent Grass Carp from attaining densities that cause adverse impacts
 - **Science-based, adaptive management approach**
 - Guide effective decision-making by management agencies

Adaptive Management Framework



Adapted from US Department of the Interior Technical Guide


- Informed by completed SDM process
- Uncertainty About Resource Response
- Emphasizes Learning While Doing

GC control and research collaborative structure

Lake Erie Committee & GLFC 

Grass Carp Advisory Committee & Structured Decision Making

Removal



Early Detection



Research

Early Life History




Telemetry



Population Modeling



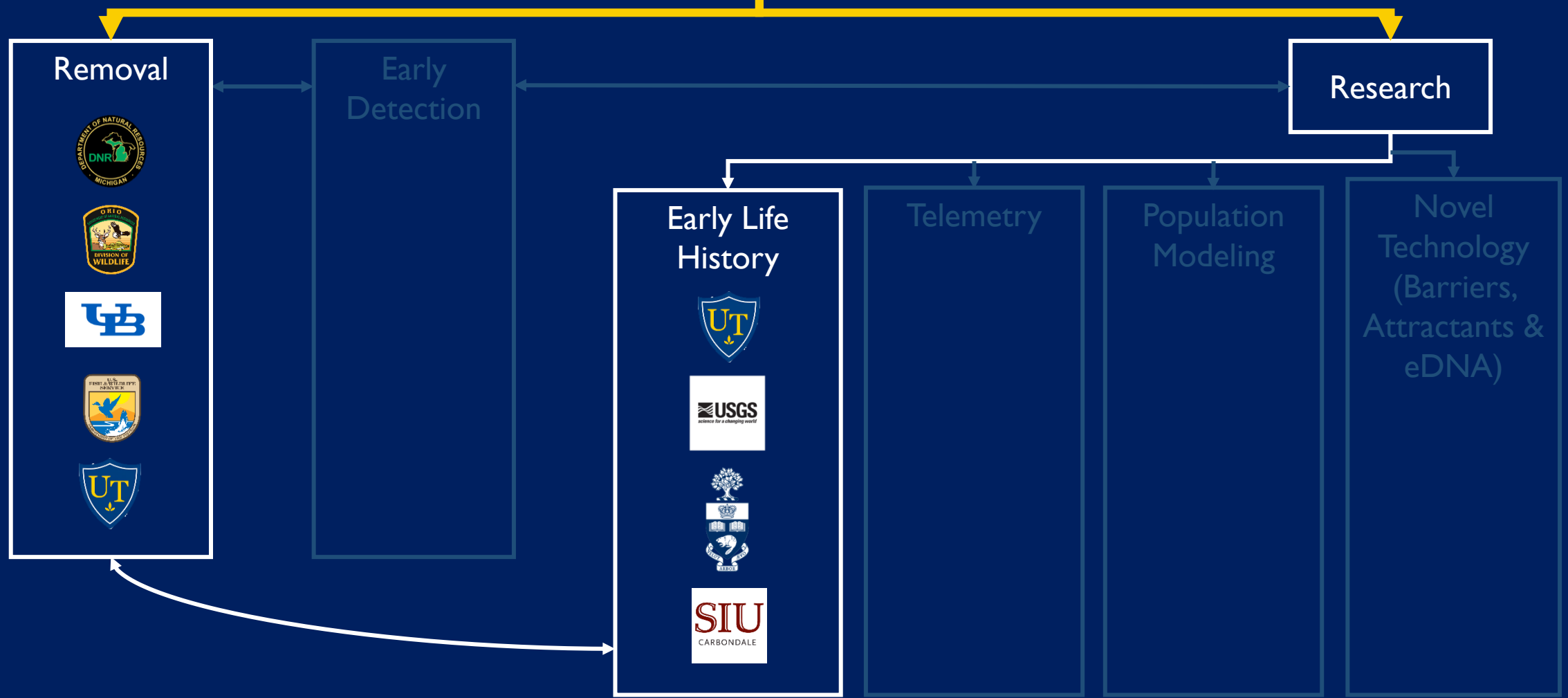
Novel Technology (Barriers, Attractants & eDNA)



GC control and research collaborative structure

Lake Erie Committee & GLFC 

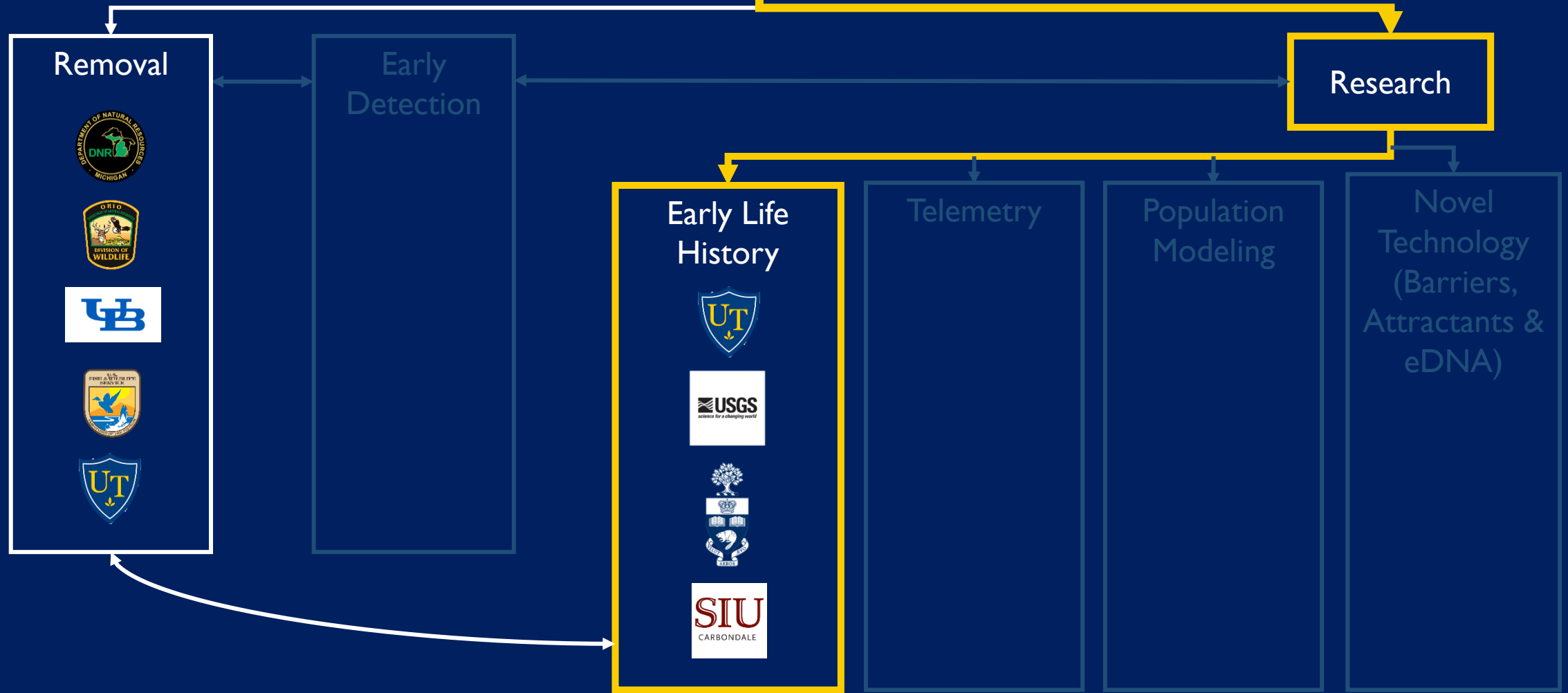
Grass Carp Advisory Committee & Structured Decision Making

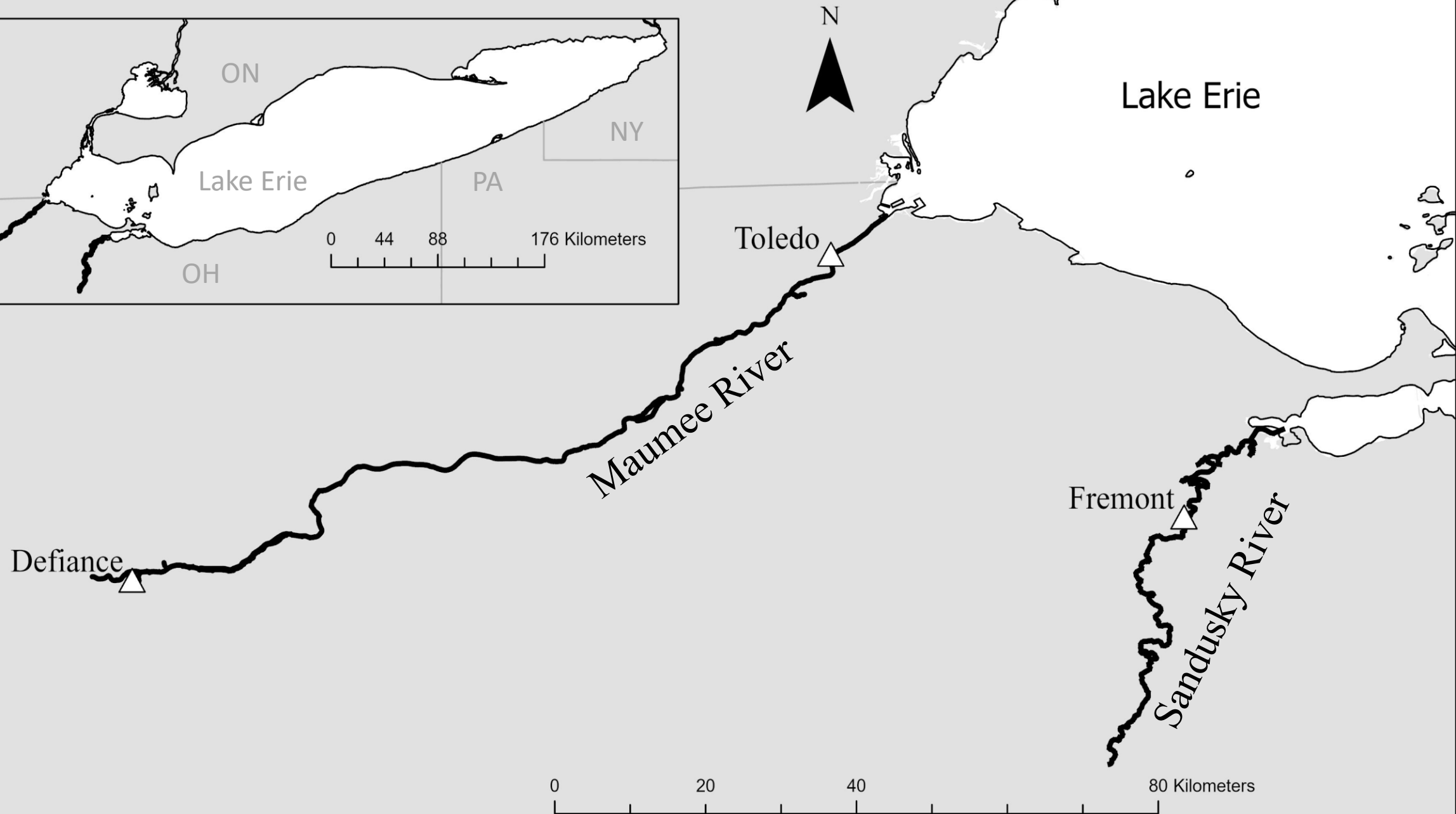
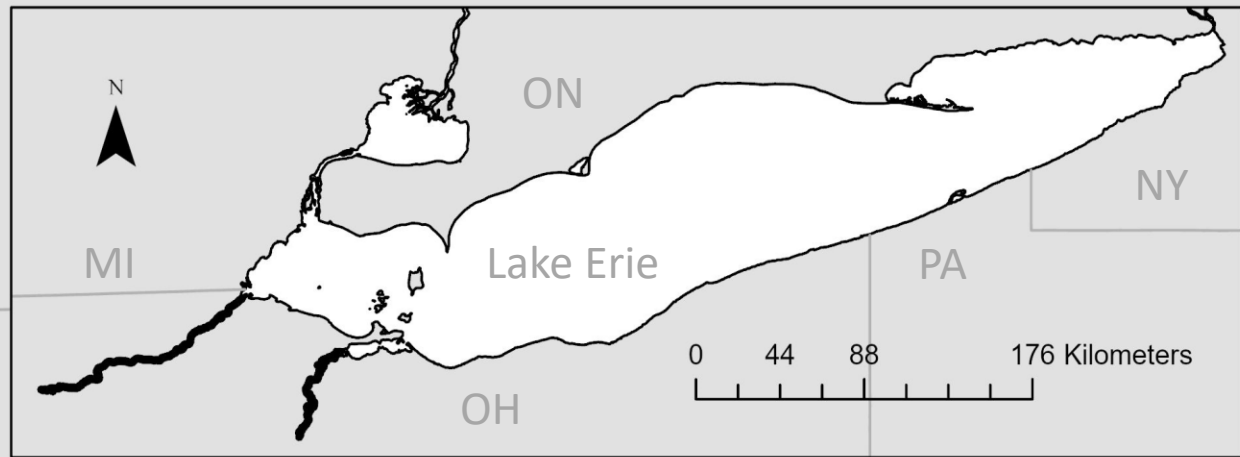


GC control and research collaborative structure

Lake Erie Committee & GLFC 

Grass Carp Advisory Committee & Structured Decision Making



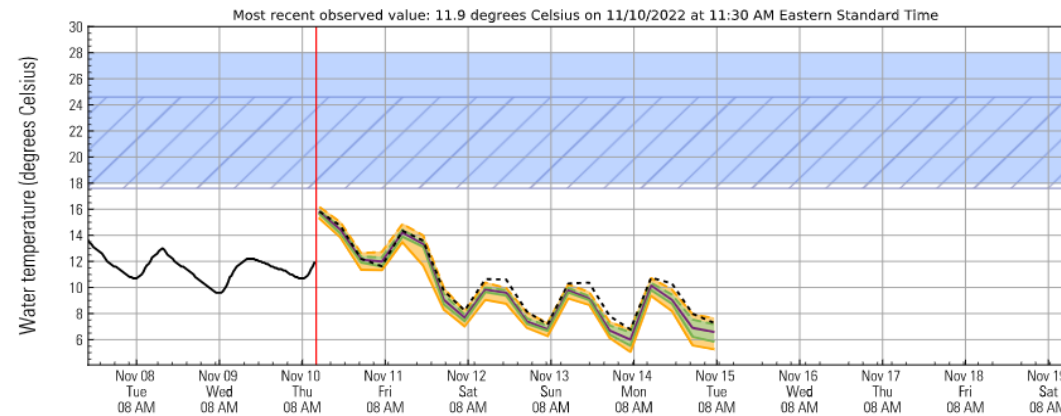


Egg Sampling Methods

- Paired bongo net tows
 - Four boats
 - SpawnCast
- Sample processing
 - Eggs
 - Staging
 - Larval fish
- Seven rivers
 - Ohio = 5
 - Michigan = 2

Sandusky River near Fremont, Ohio (USGS 04198000; NWS FFM01)

Plot last updated on 11/10/2022 at 12:00 PM Eastern Standard Time
NWIS data last updated on 11/10/2022 at 11:30 AM Eastern Standard Time
AHPS forecast issued on 11/10/2022 at 09:39 AM Eastern Standard Time
NAEFS forecast issued on 11/09/2022 at 07:00 AM Eastern Standard Time
NWS weather forecast issued on 11/10/2022 at 09:18 AM Eastern Standard Time



Explanation

— Current time

Spawning Range (grass carp)

▨ Observed

▨ Theoretical *

Measured

— USGS 04198000

Predicted - Deterministic (AHPS)

--- NWS FFM01

Predicted - Probabilistic (NAEFS)

(exceedance probabilities; NWS FFM01)

▨ 5 percent

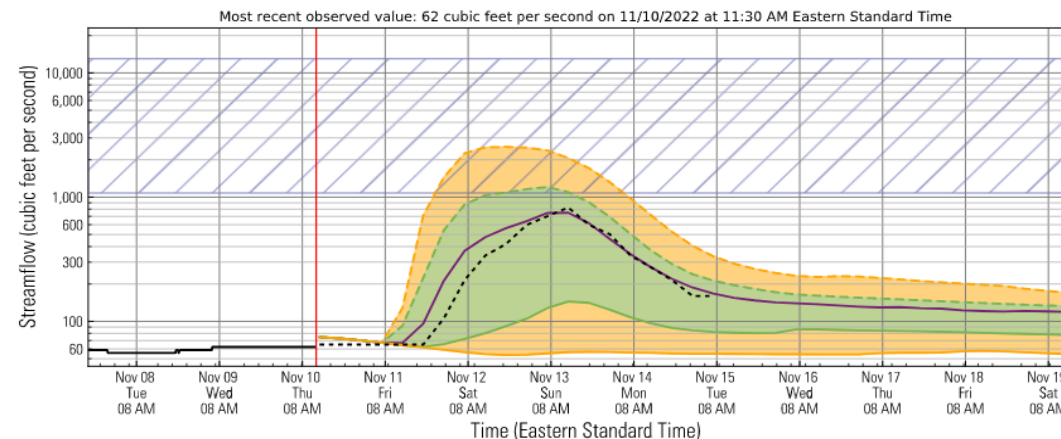
▨ 95 percent

▨ 25 percent

▨ 75 percent

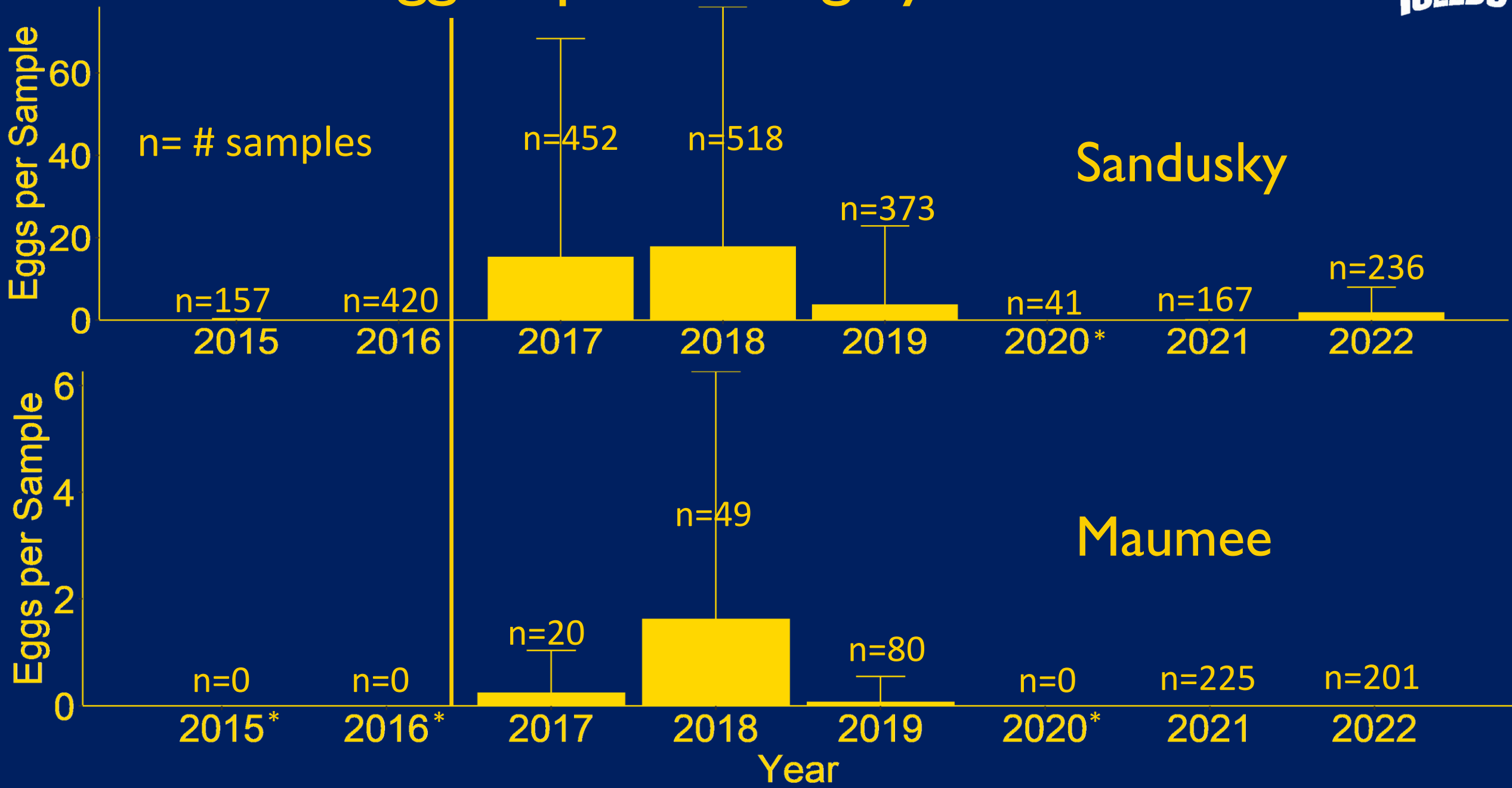
— 50 percent (median)

* Theoretical spawning range not available for streamflow



*Disclaimer: USGS
SpawnCast is in beta
testing and all data
presented are provisional
and subject to revision.*

Egg Captures Highly Variable



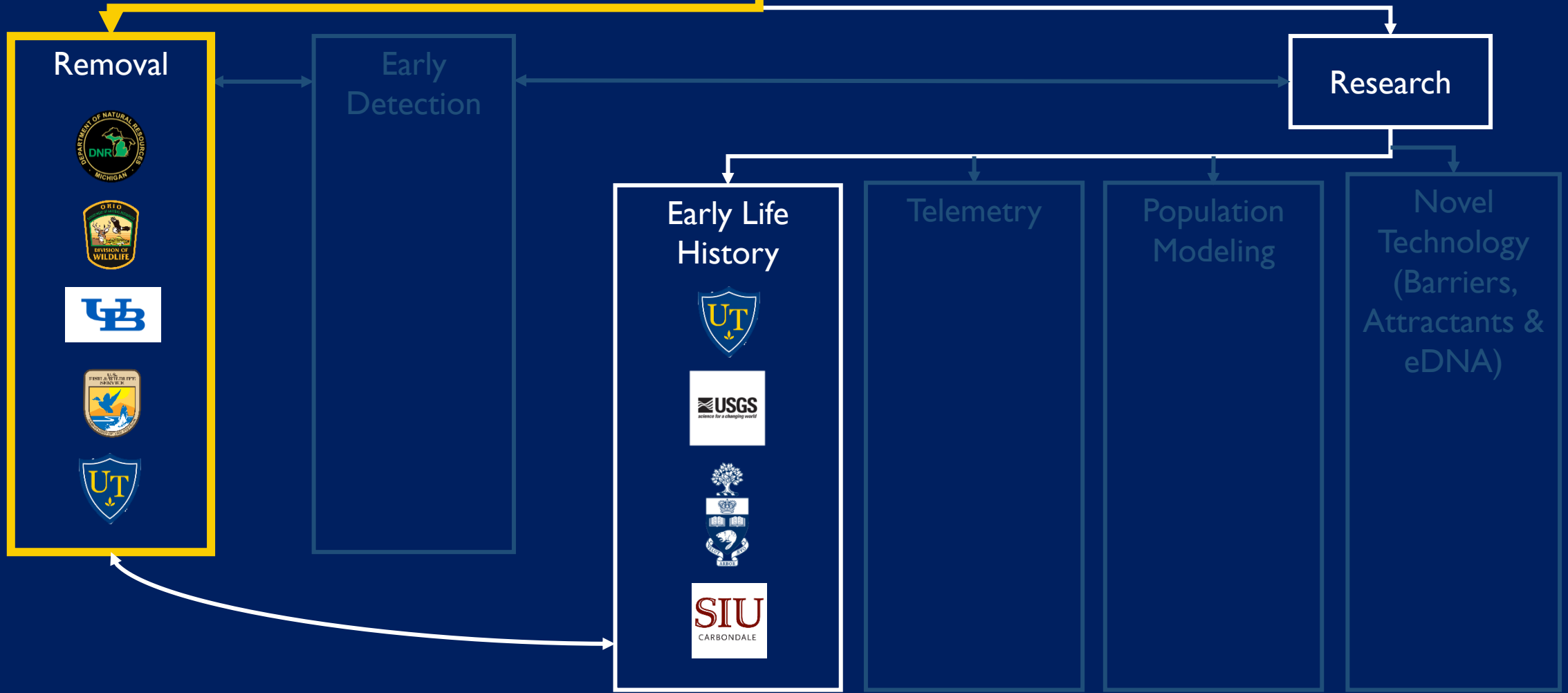
No New Egg Detections

River	Years Sampled	Number Samples	Number Samples with GC Eggs
Cuyahoga River	2019-2022	213	0
Huron River (OH)	2018, 2020-2022	107	0
Grand River (OH)	2022	26	0
St. Joseph River	2021-2022	35	0
Tittabawassee River	2021-2022	73	0

GC control and research collaborative structure

Lake Erie Committee & GLFC 

Grass Carp Advisory Committee & Structured Decision Making



Capture Methods



Spawning

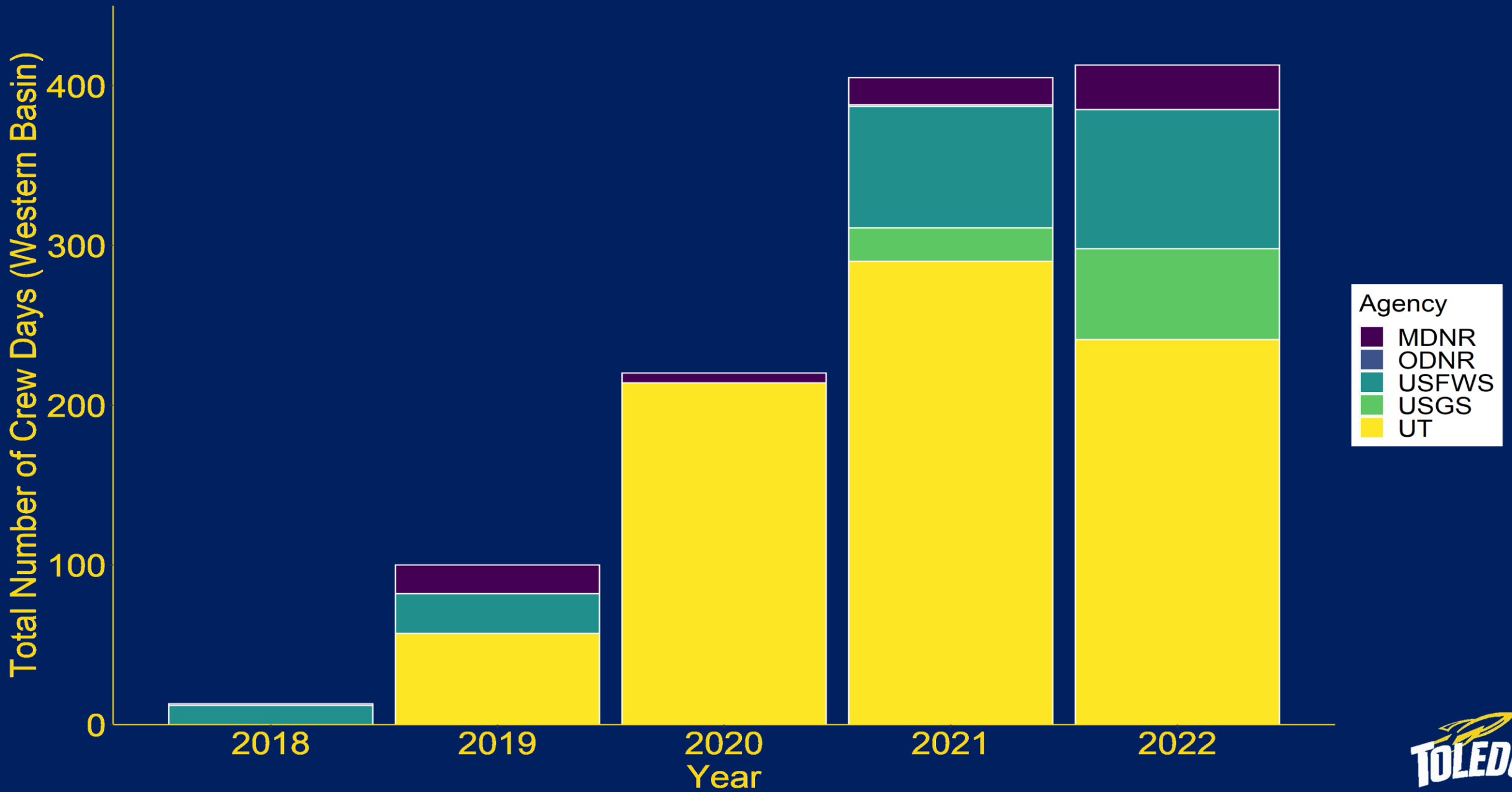
- High Flows
- Multiple Boats
- Electrofishing Only
- High Catch



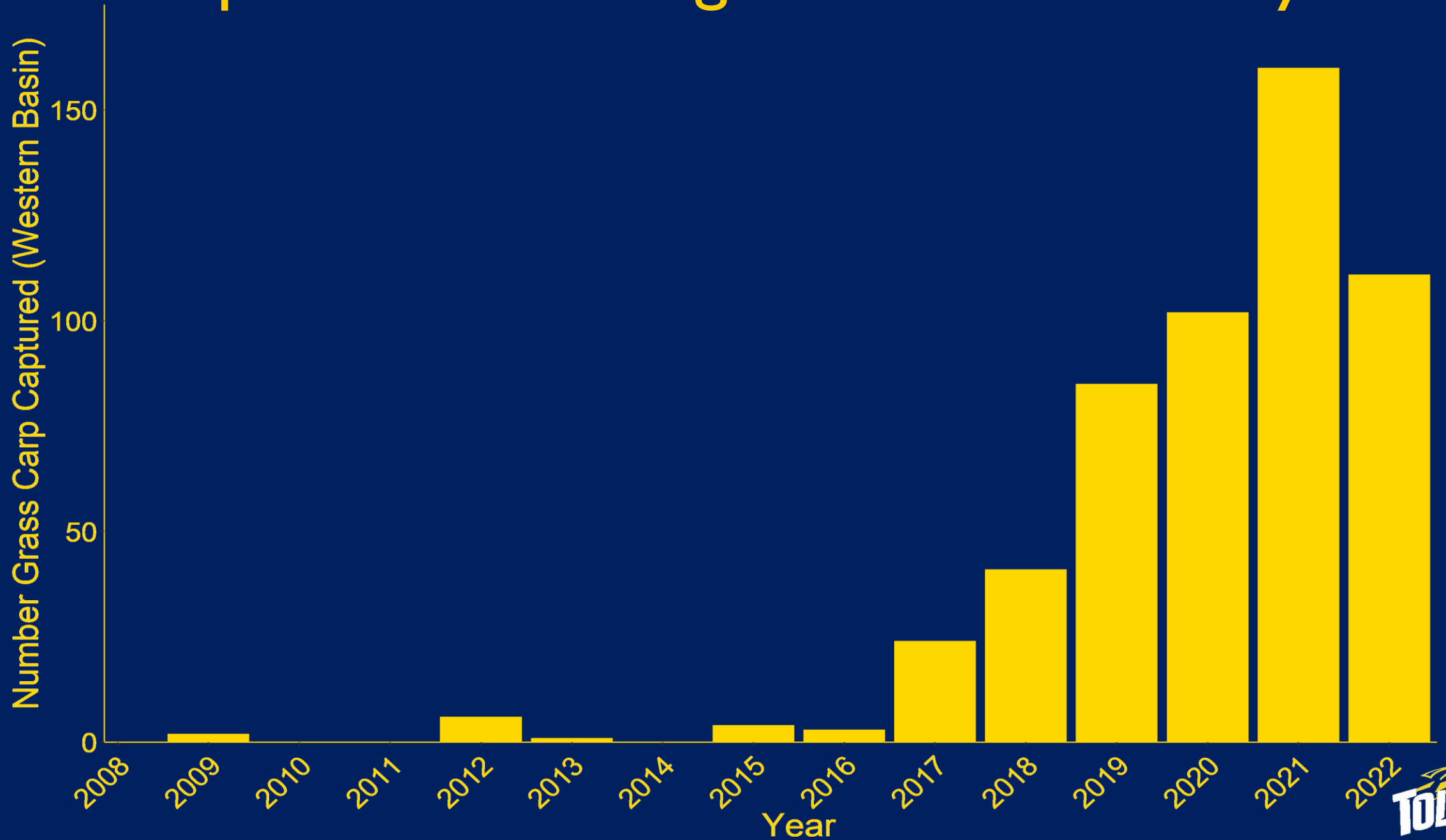
Non-Spawning

- Fish not Aggregated
- Usually One Boat
- Electrofishing and Trammel Nets
- Variable Catch

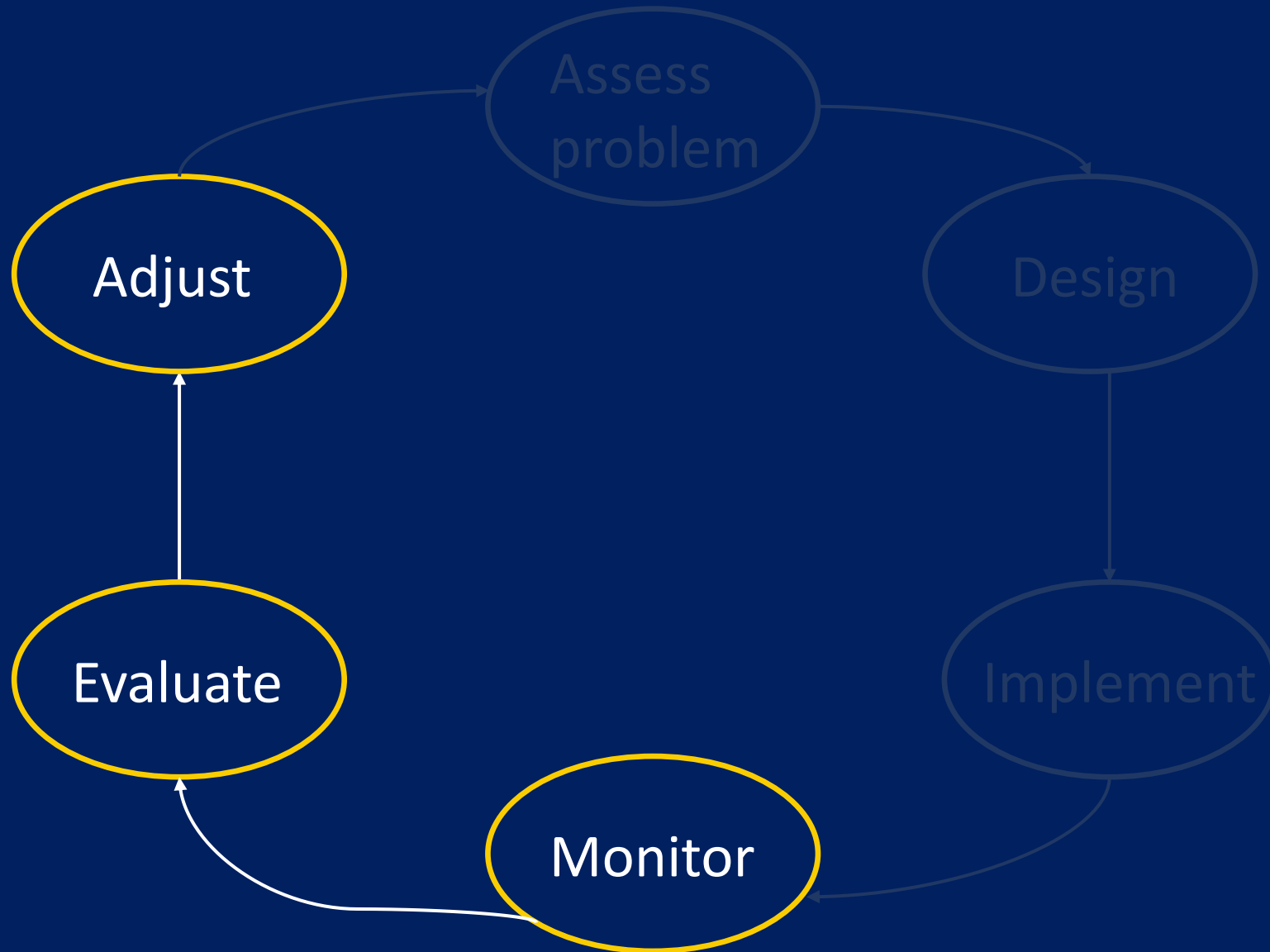
Effort to remove Grass Carp is increasing



Captures increasing but with variability



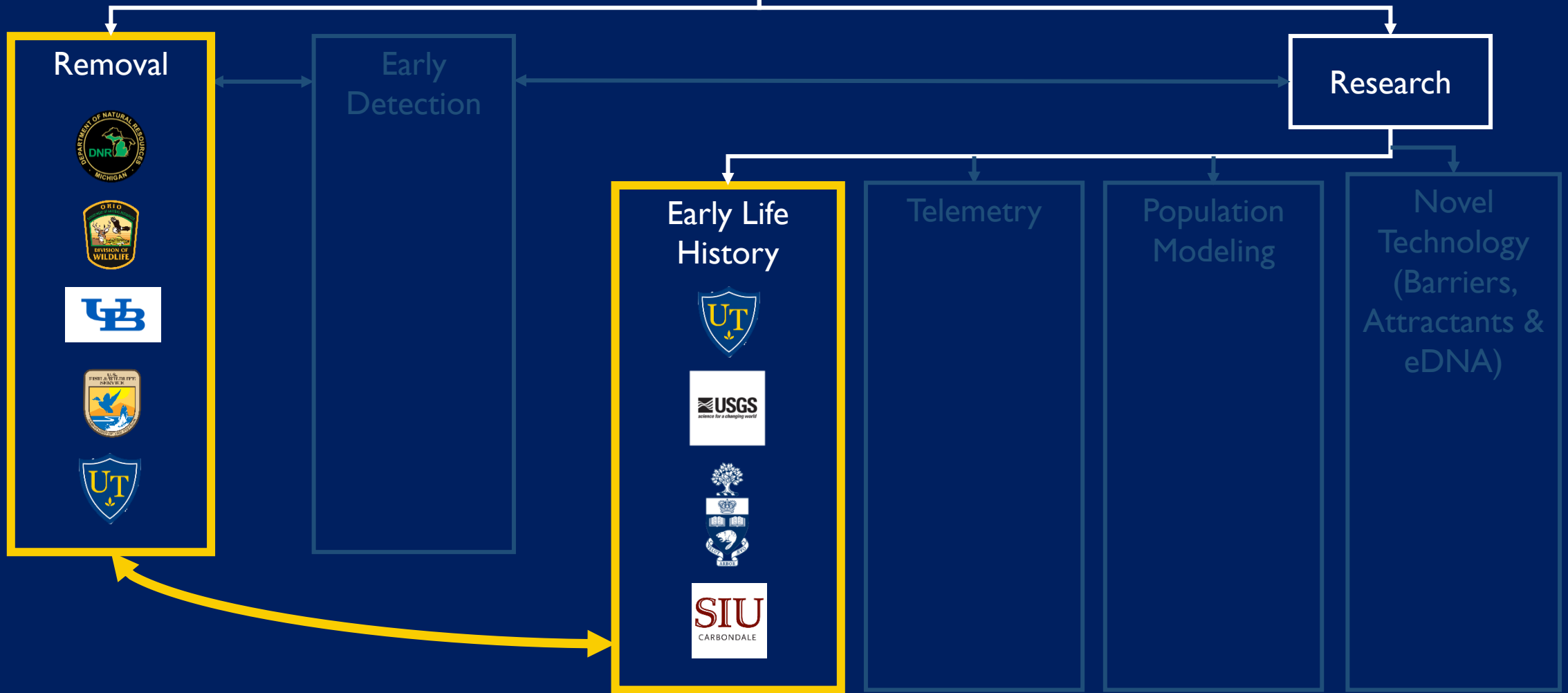
ELH and Removal's Fit into Framework



Adaptive Management in Action – Maumee River

Lake Erie Committee & GLFC 

Grass Carp Advisory Committee
& Structured Decision Making



ELH Research can Inform Removal Crews

- 1. Increased adult captures
- 2. Knowledge of potential spawning locations

Removal



The 'Removal' box contains logos for the Michigan Department of Natural Resources (DNR), the Ohio Division of Wildlife, the University of Buffalo (UB), and the University of Toledo (UT).

Predicted spawning locations, notify removal crews in real time

Early Life History



The 'Early Life History' box contains logos for the University of Toledo (UT), the United States Geological Survey (USGS), and Southern Illinois University Carbondale (SIU).

- 1. Egg sampling
 - a. SpawnCast
- 2. Egg staging
- 3. FluEgg

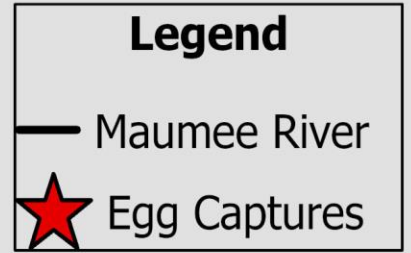
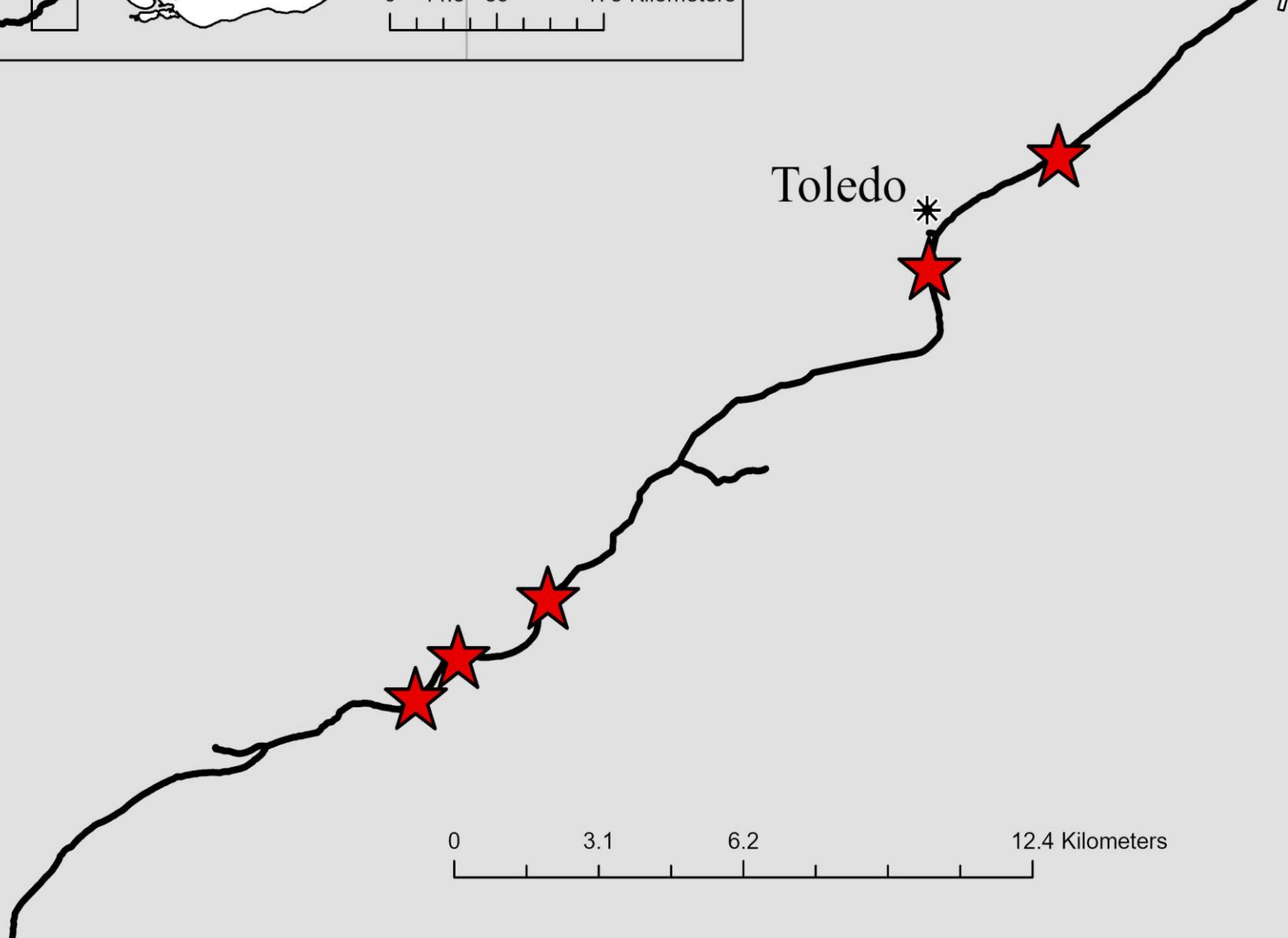
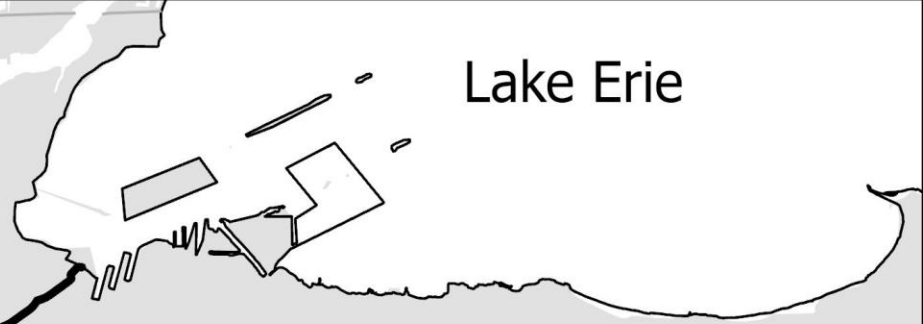
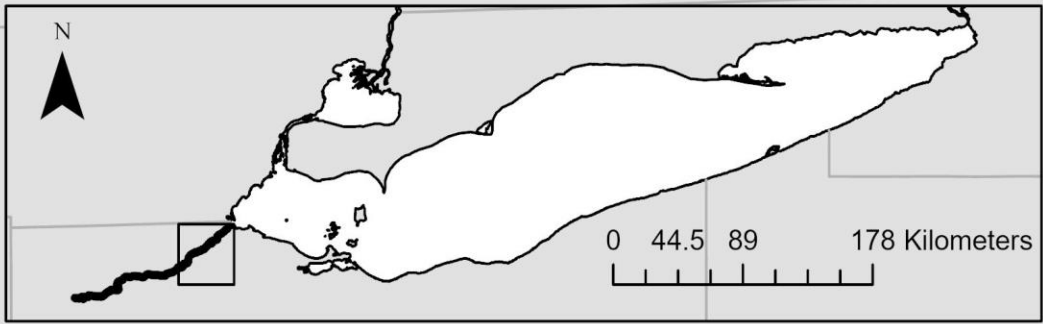
Let's see this in action



Adaptive Management in Action

UT Egg Sampling in Lower Maumee

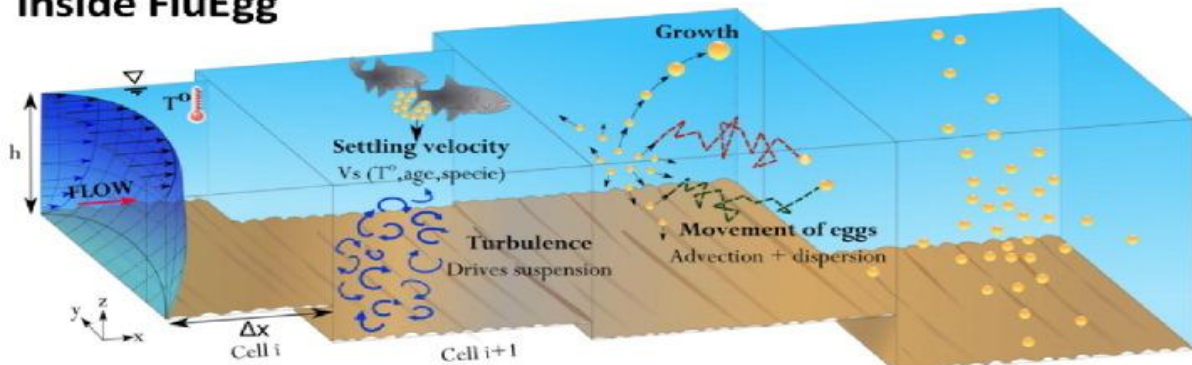




Where do they Spawn? Let's ask FluEgg



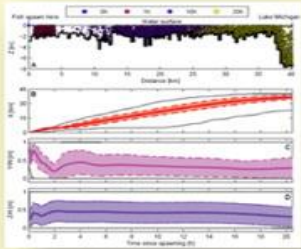
Inside FluEgg



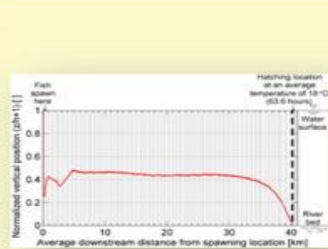
Adapted from Garcia et al. (2013)

OUTPUT

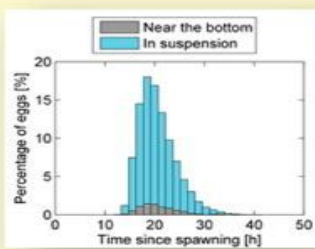
Evolution of a mass of Asian carp eggs



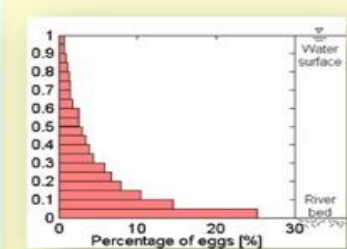
Mean vertical position of eggs as a function of distance



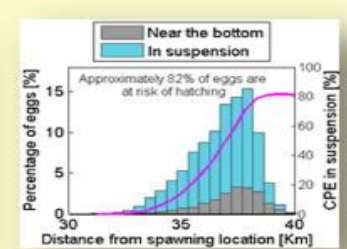
Egg travel-time distribution

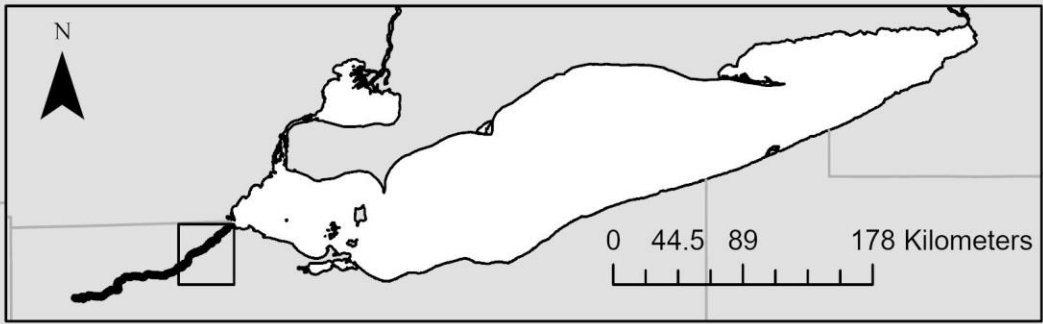


Distribution of eggs over water column at hatching time (or X distance)



Hatching risk

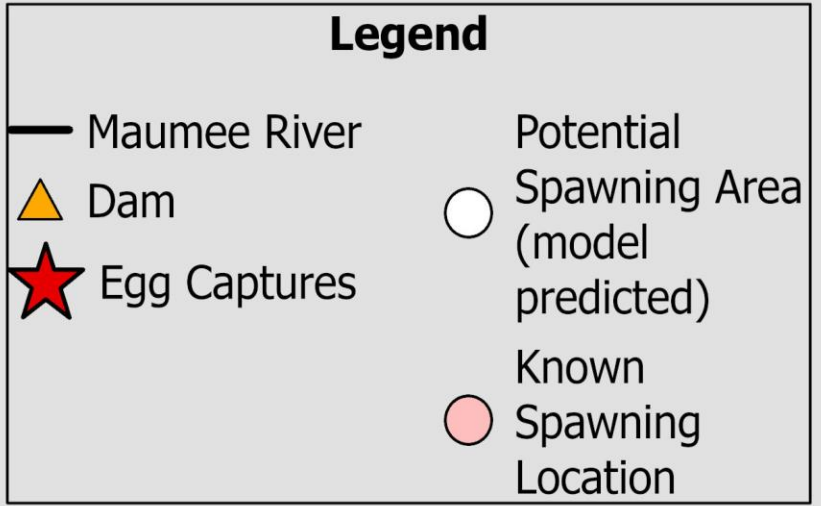




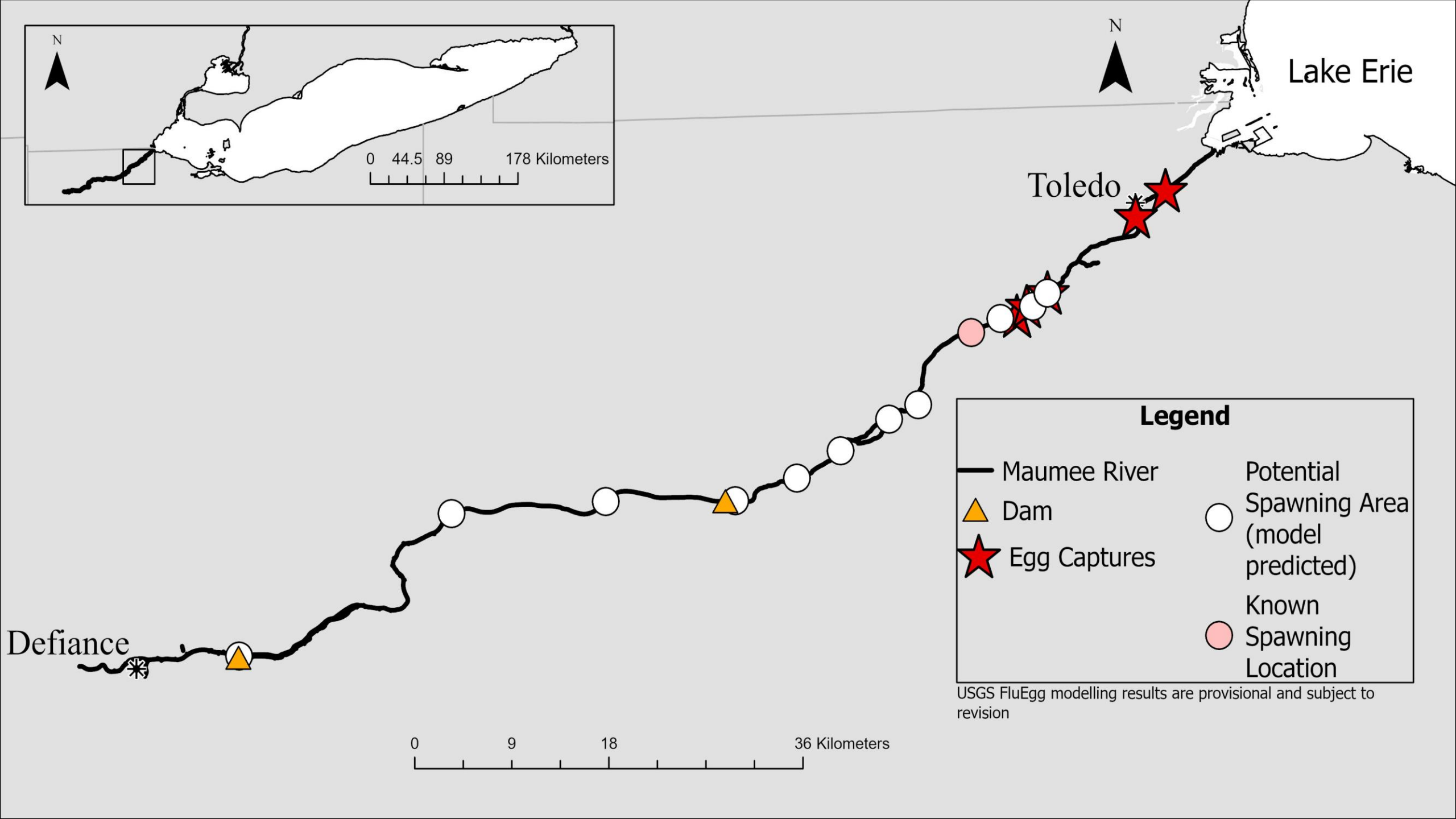
Lake Erie

Toledo

Defiance



USGS FluEgg modelling results are provisional and subject to revision

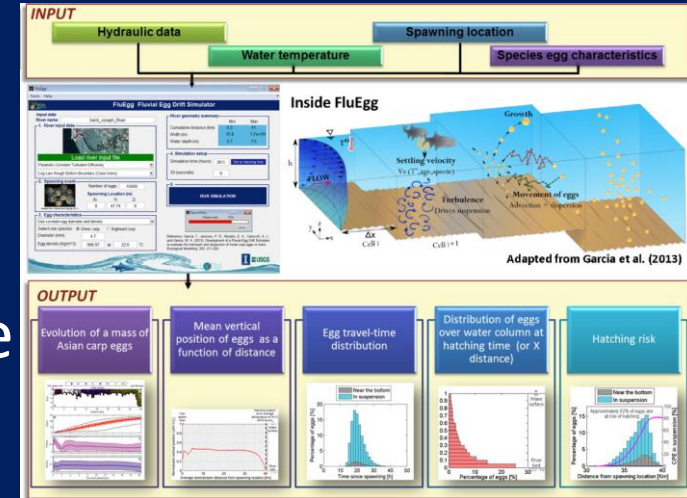


Adaptive Management in Action



UT Egg Sampling in Lower Maumee

USGS FluEgg Model
Predicts Spawning Above Mary Jane
Thurston Dam



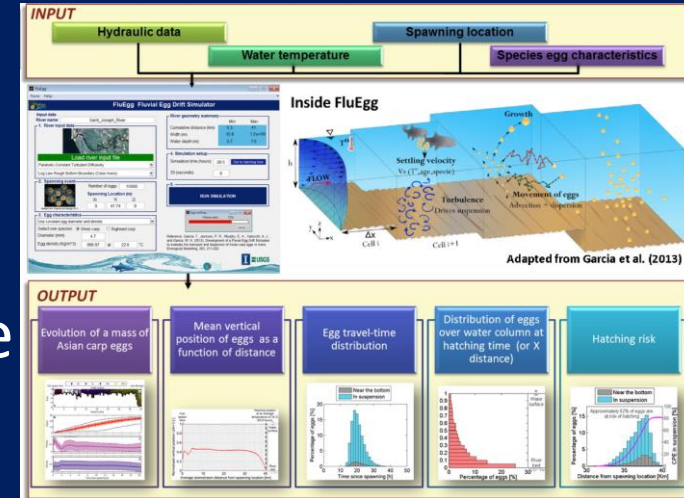
USFWS Scouted Area
First Trip Resulted in Grass Carp
Capture

Adaptive Management in Action



UT Egg Sampling in Lower Maumee

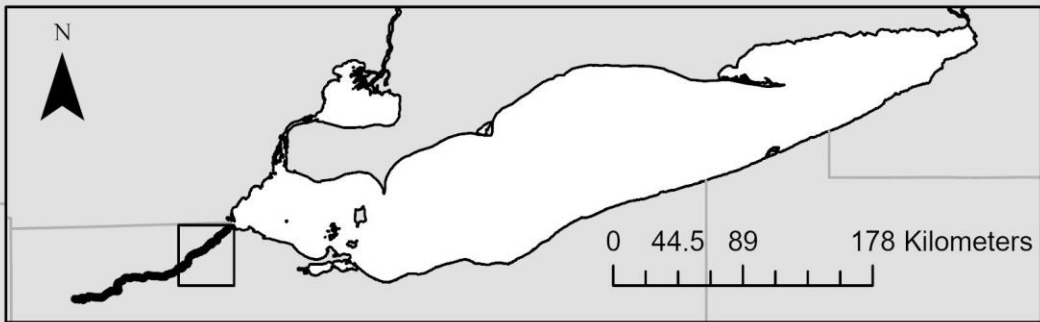
USGS FluEgg Model
Predicts Spawning Above Mary Jane
Thurston Dam



USFWS Scouted Area
First Trip Resulted in Grass Carp
Capture

Most Captures in Maumee Ever
More Upstream '22 than Entire River '20-'21

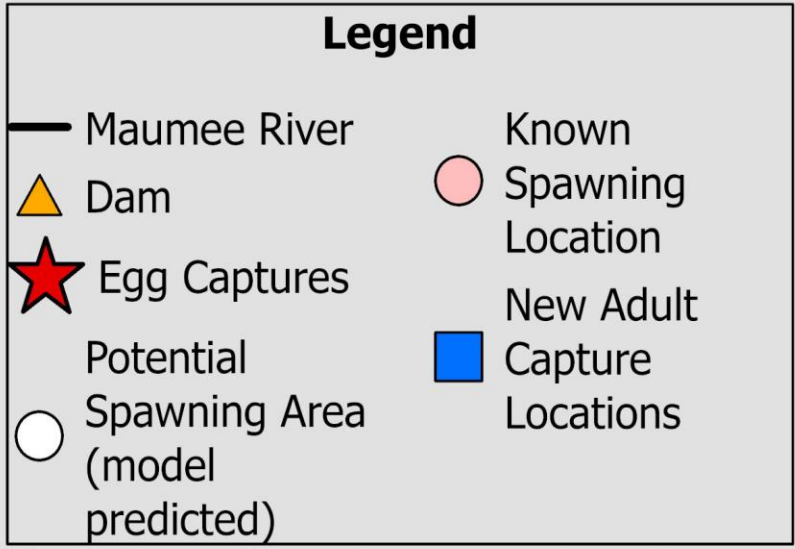




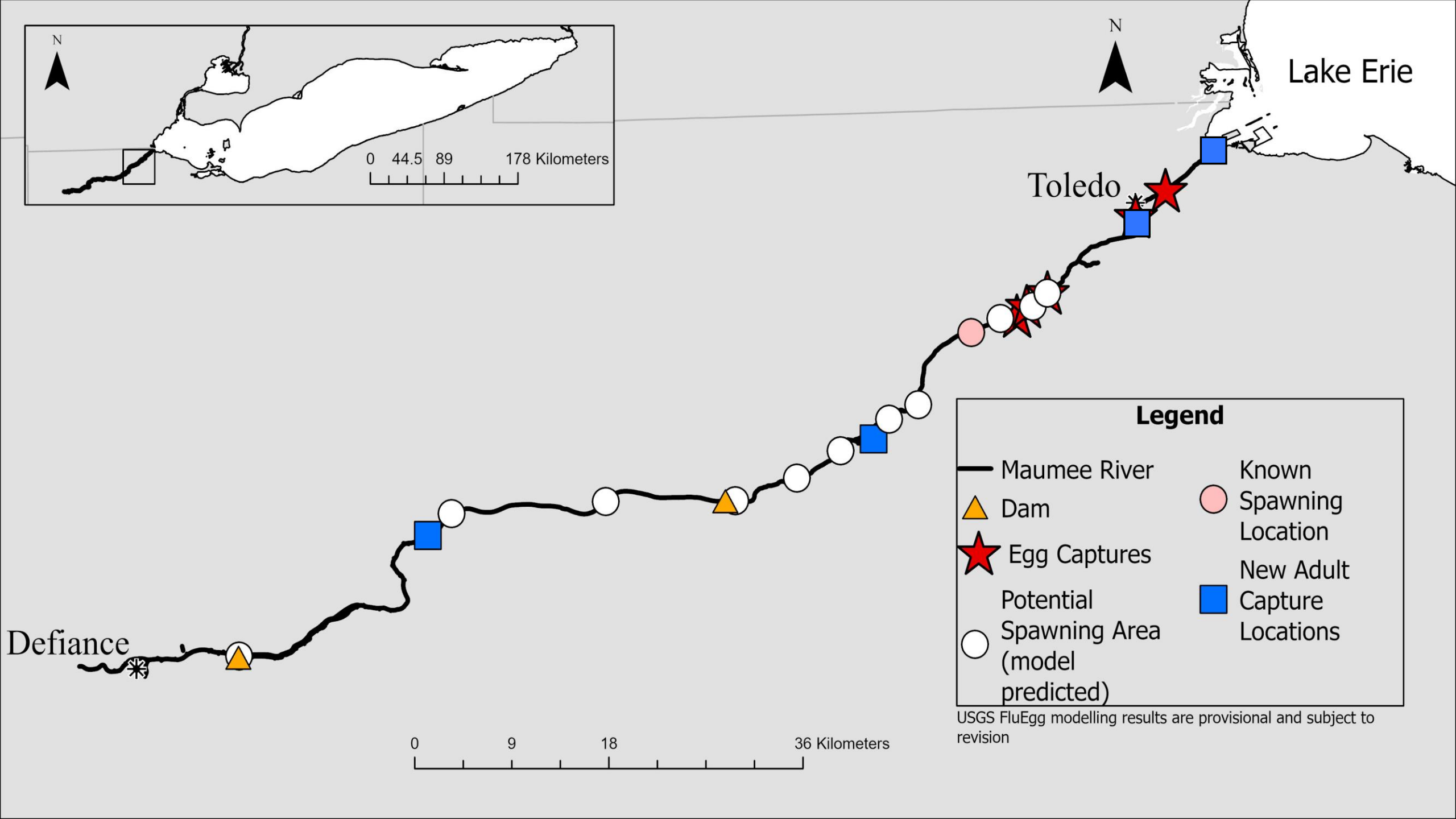
Lake Erie

Toledo

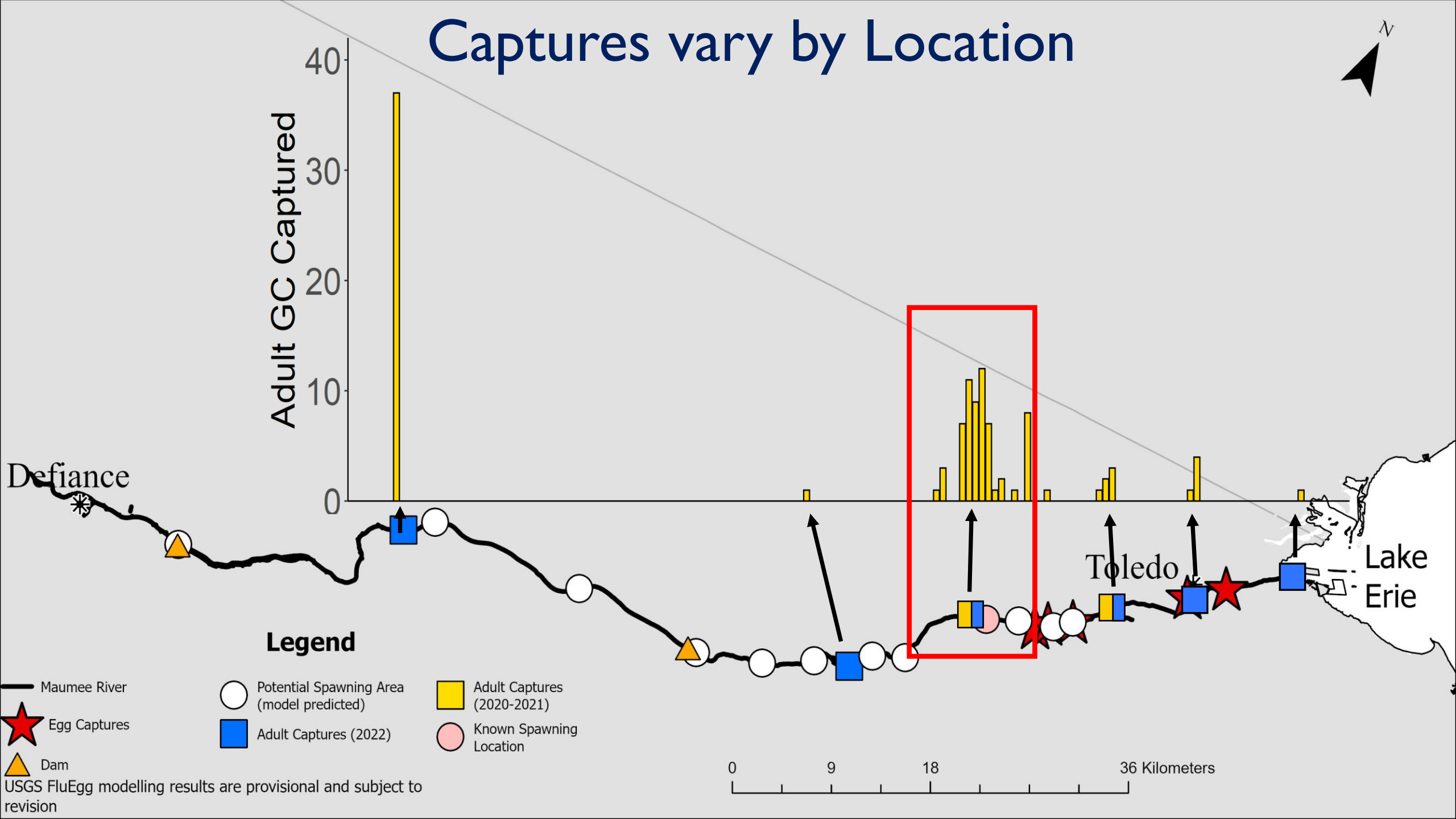
Defiance



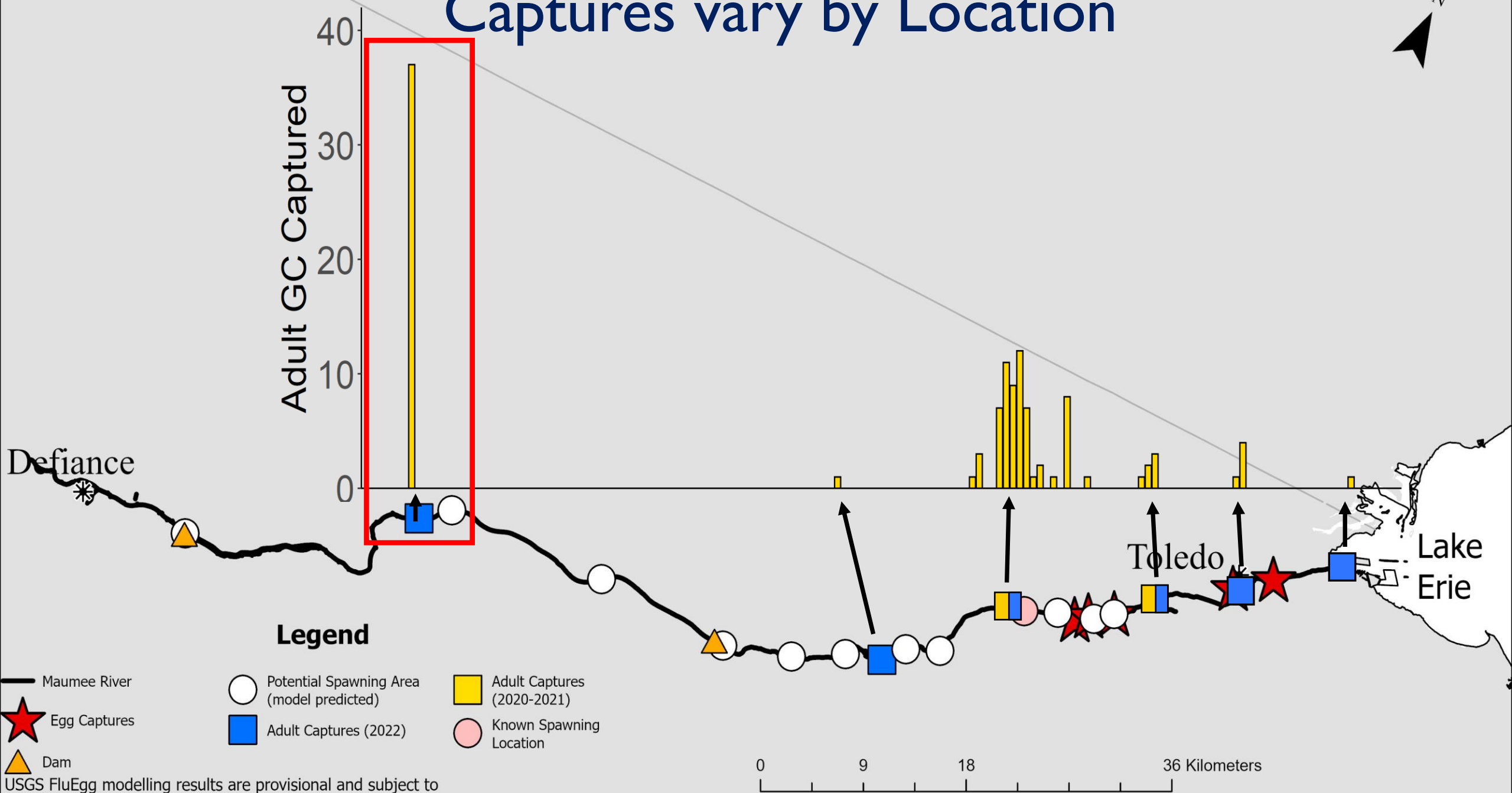
USGS FluEgg modelling results are provisional and subject to revision



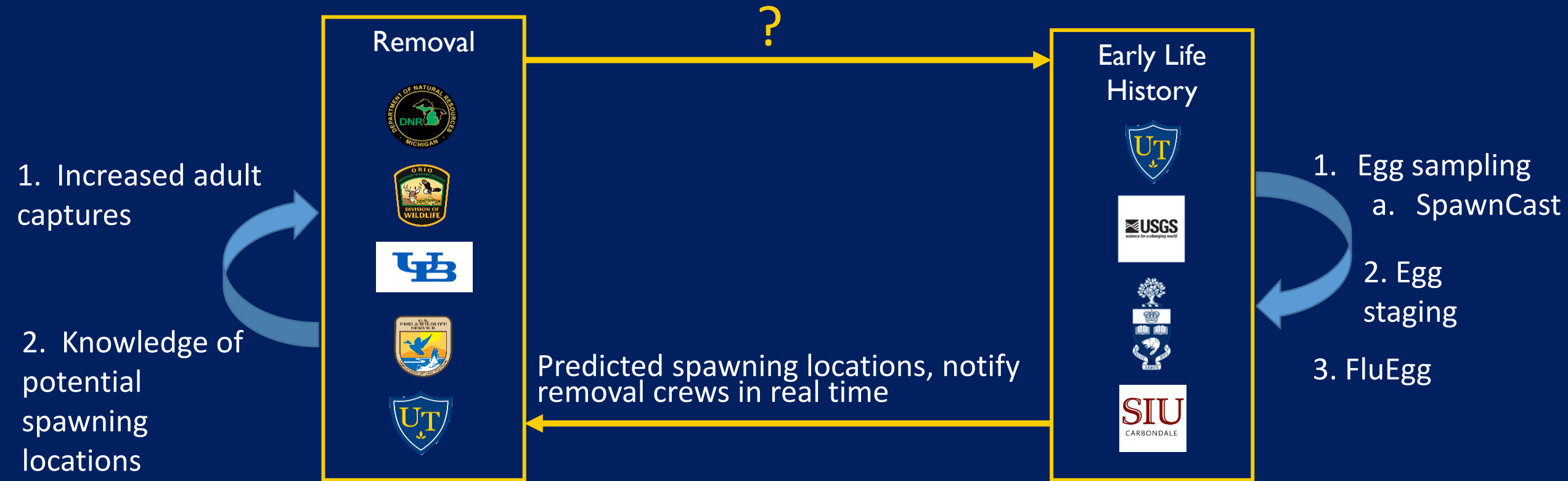
Captures vary by Location



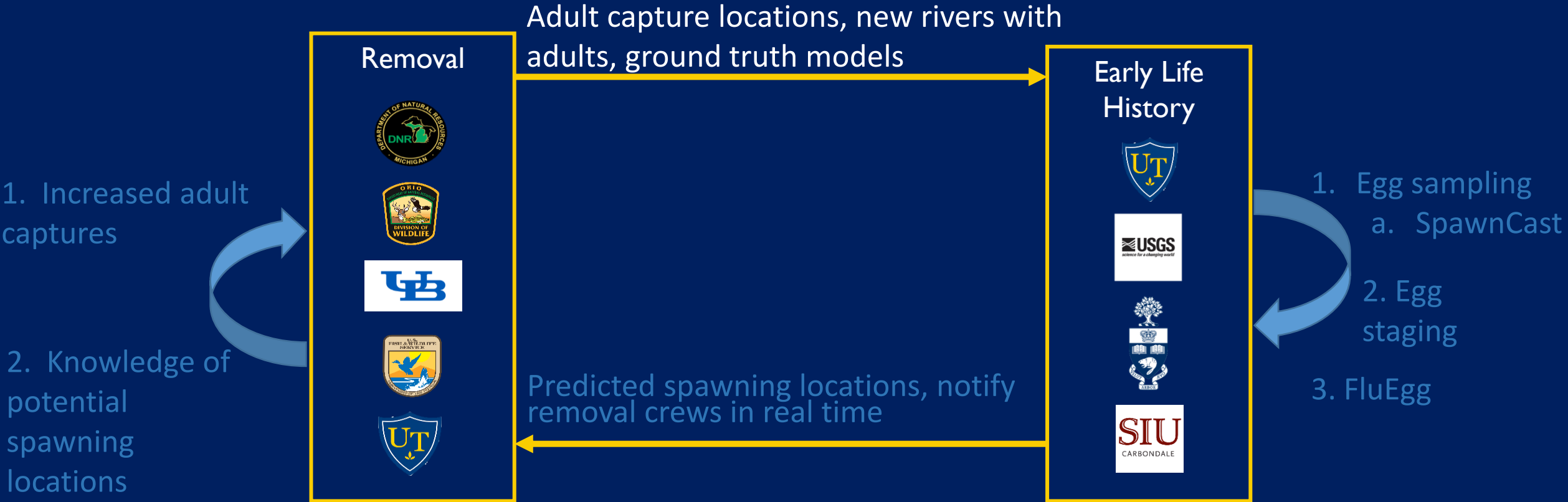
Captures vary by Location

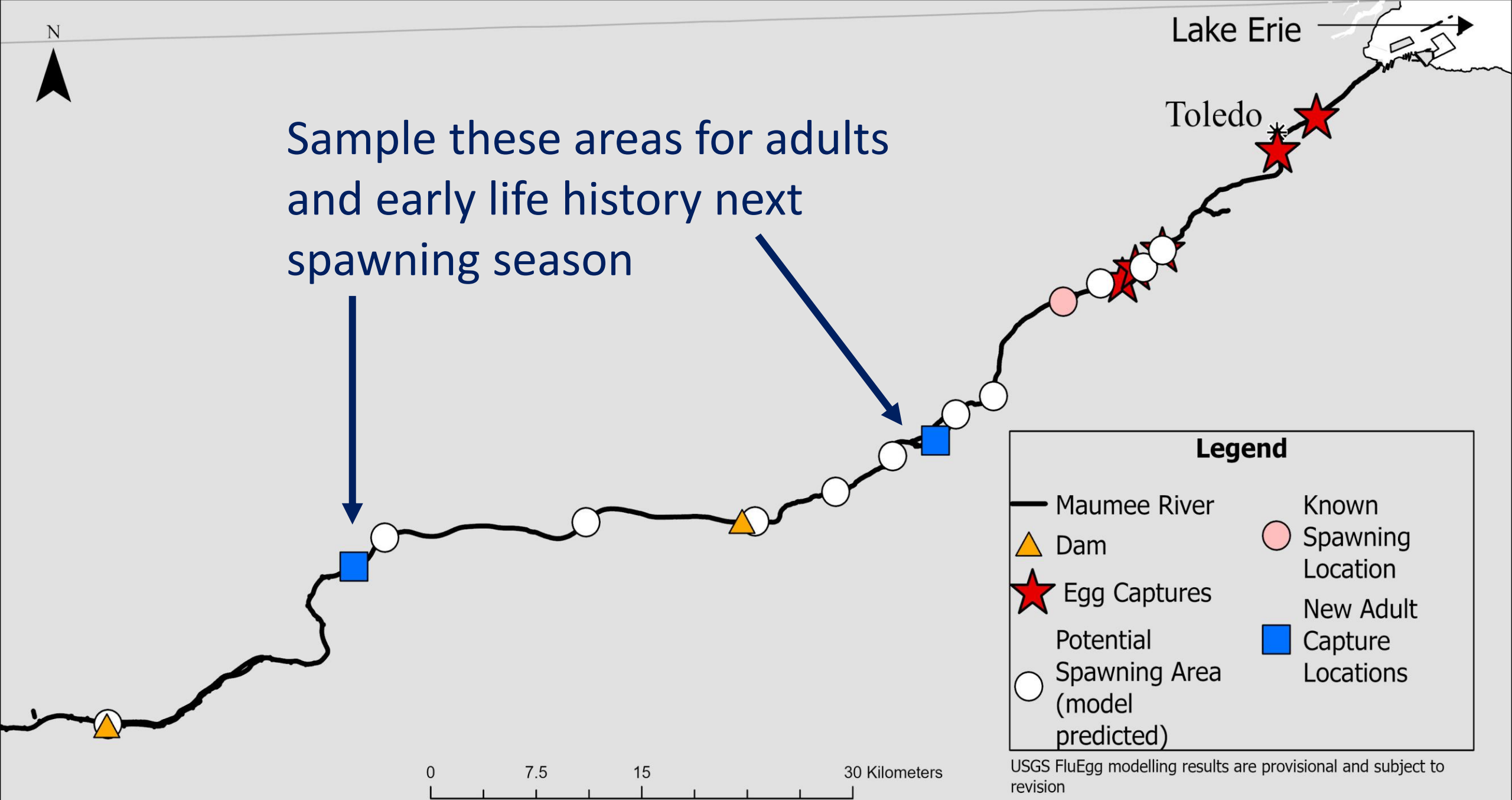


How do Removal Crews inform ELH?



New Locations and Truthing





N

Lake Erie

Toledo

Sample these areas for adults and early life history next spawning season

Legend	
	Maumee River
	Dam
	Egg Captures
	Potential Spawning Area (model predicted)
	Known Spawning Location
	New Adult Capture Locations

0 7.5 15 30 Kilometers

USGS FluEgg modelling results are provisional and subject to revision

Adaptive Management Showing Early Success


- Large coordinated removal and research effort
- Removal increases with effort
- Feedback loop
 - Early life history research helps target increased adult removals
 - Removal crews inform ELH of high-risk tributaries
 - Not isolated to these two groups

GC control and research collaborative structure

Lake Erie Committee & GLFC 

Grass Carp Advisory Committee & Structured Decision Making

Removal



Early Detection



Research

Early Life History




Telemetry



Population Modeling



Novel Technology (Barriers, Attractants & eDNA)



Adaptive Management Showing Early Success

- Large coordinated removal and research effort
- Removal increases with effort
- Feedback loop
 - Early life history research helps target increased adult removals
 - Removal crews inform ELH of high-risk tributaries
 - Not isolated to these two groups

More Than Any One Organization Could Do Alone

Thank You

