Recent changes in invasive zebra mussel abundance in Gull Lake

Jeffrey D. White

GLQO Annual Meeting

12 August 2014

MICHIGAN STATE UNIVERSITY

Department of Fisheries and Wildlife • Michigan State University

MICHIGAN STATE UNIVERSITY An Integrated Learning Environment W. K. KELLOGG BIOLOGICAL STATION

Gull Lake Quality Organization www.glqo.net

Zebra mussels: background

- Introduced: 1980s from Europe/Asia
- Transported: ballast water (microscopic larvae)
- Adults attach to surfaces
- Achieve high abundance
- Efficient filter-feeders of phytoplankton (algae)

Veliger larvae (microscopic)


Adult

Zebra mussel
Dreissena polymorpha

Zebra mussels: background

- Biofouling of boats, pipes, and structures
- Re-configuration of foodwebs (shunt energy from open water to the bottom)
- Elimination of native unionid mussels
- Increase toxic *Microcystis* cyanobacteria (blue-green algae)

Pipe clogged with zebra mussels

Native unionid colonized by zebra mussels

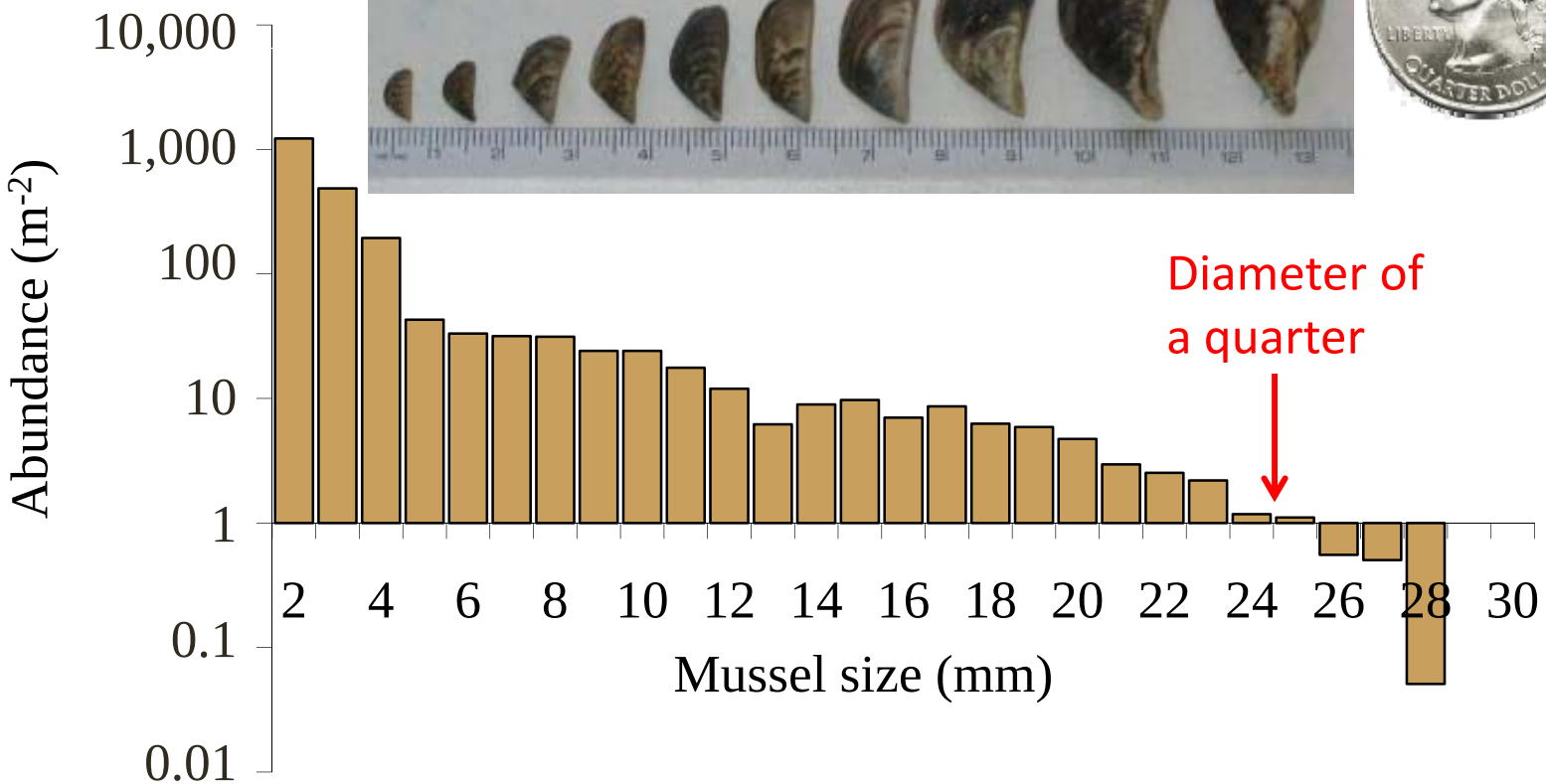
Gull Lake

- One of 255 Michigan inland lakes confirmed to have zebra mussels

- Zebra mussels first discovered in 1994

Gull Lake zebra mussels

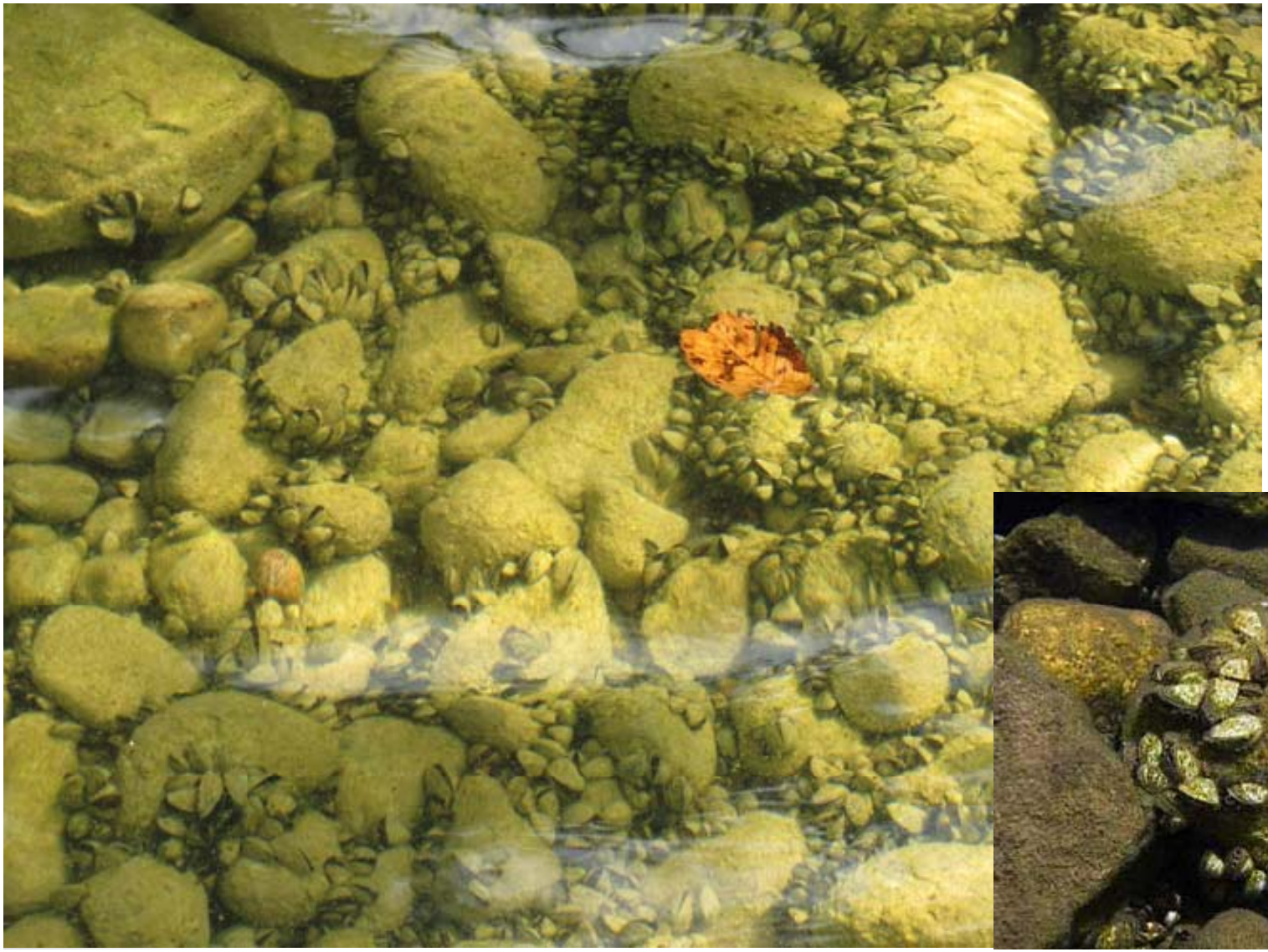
- Population data from 1999 (0-25 feet depth)
- ~2,000 mussels per square meter (~11 square feet)
- Population remained rather stable for 16 years



White and Sarnelle (2014, *Freshwater Biology*)

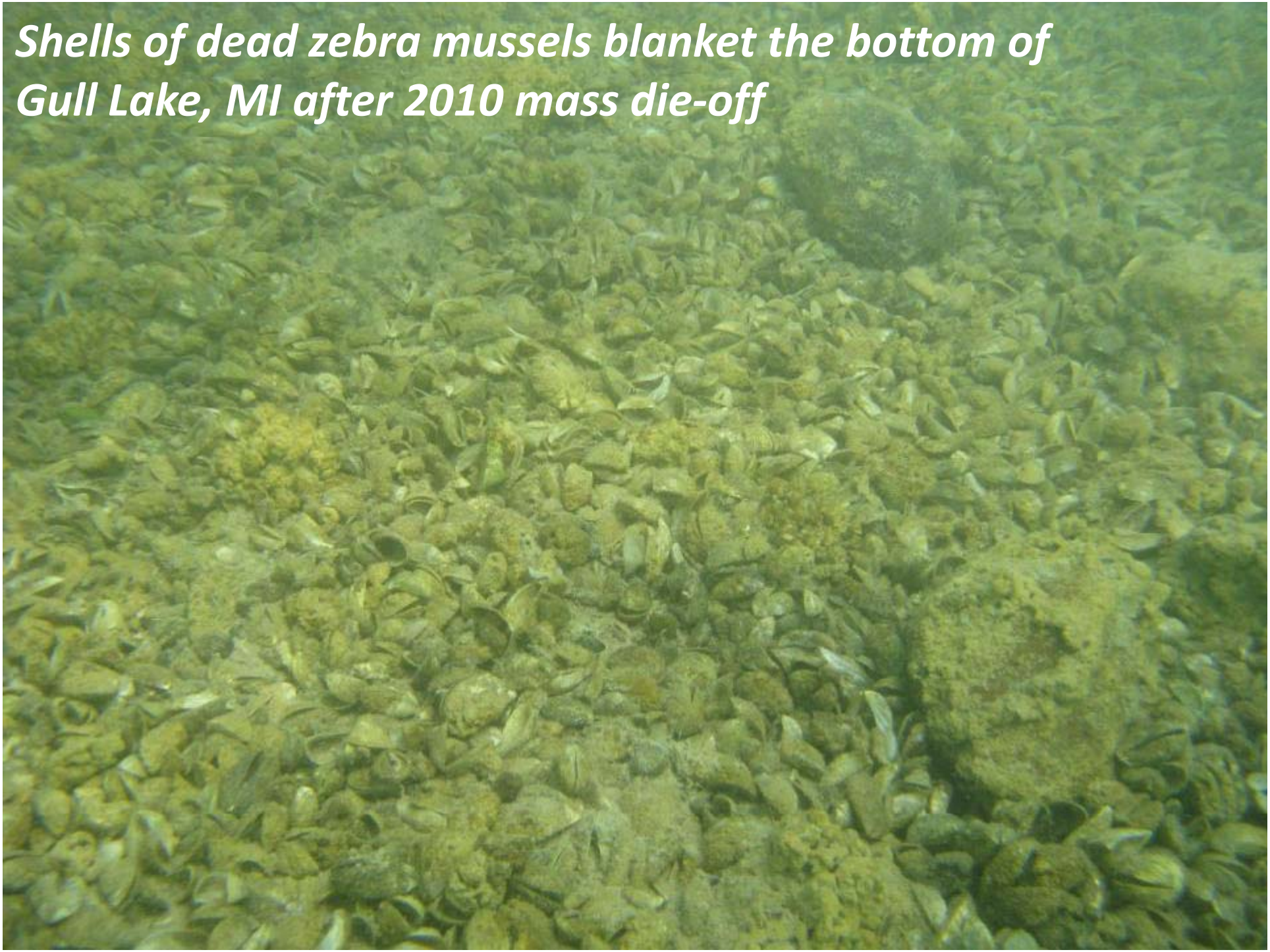
Gull Lake zebra mussels

- Historical density of zebra mussels nearshore in Gull Lake



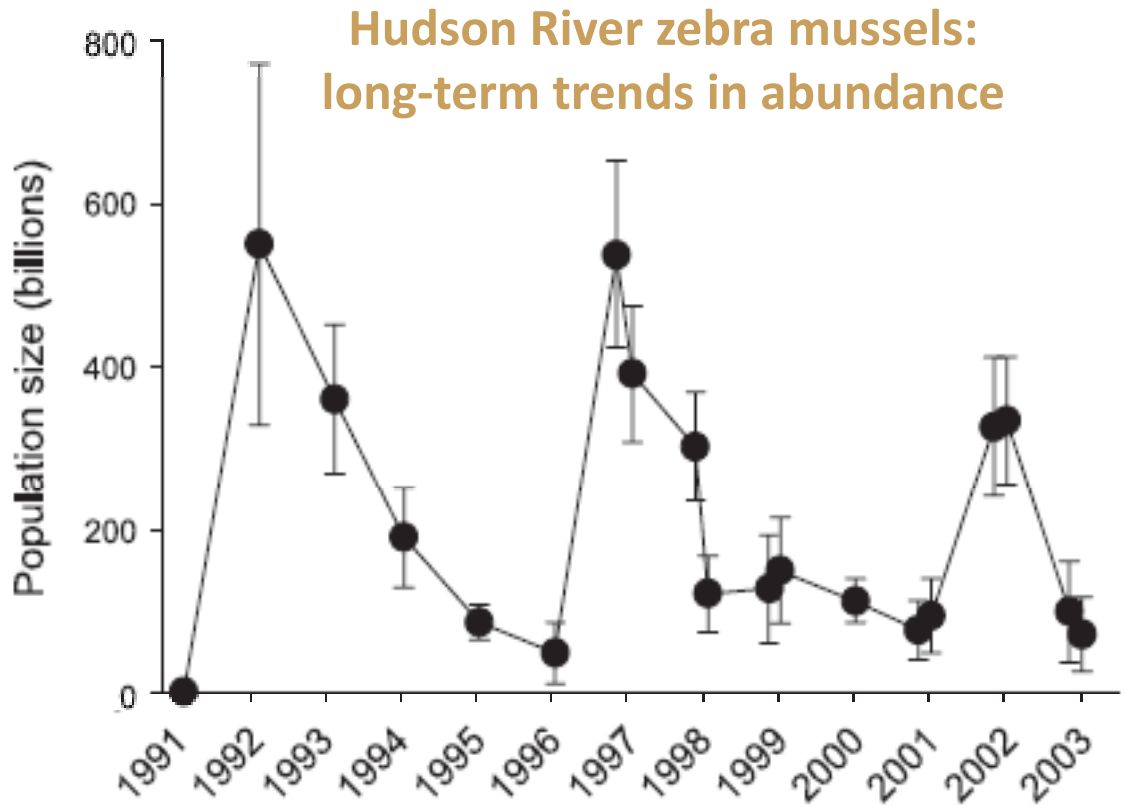
Gull Lake zebra mussels

- Unprecedented, sudden die-off in early August, 2010
- Nearly 100% died down to ~16 feet depth (mixed layer)
- Deeper, mussels survived & appeared healthy


Shells of dead zebra mussels blanket the bottom of
Gull Lake, MI after 2010 mass die-off

What happened in Gull Lake?

- Invasive species often fluctuate, or have initially explosive population growth followed by a decline to stable abundance



Carlsson *et al.* (2011, *Freshwater Biology*)

- *But…the rapidity and sheer extent of the Gull Lake die-off was surprising: is there more to that story than this?*

What happened in Gull Lake?

- Environmental variables monitored in Gull Lake that might be important:

Dissolved oxygen

pH

Calcium (required for shell building)

Chlorophyll (algae—mussel food)

All of these were normal in 2010, as compared to the ~10-year average

Water temperature

2010 was very warm: Gull Lake hit 84 °F nearshore *BUT* temperature is always much cooler at 16+ feet

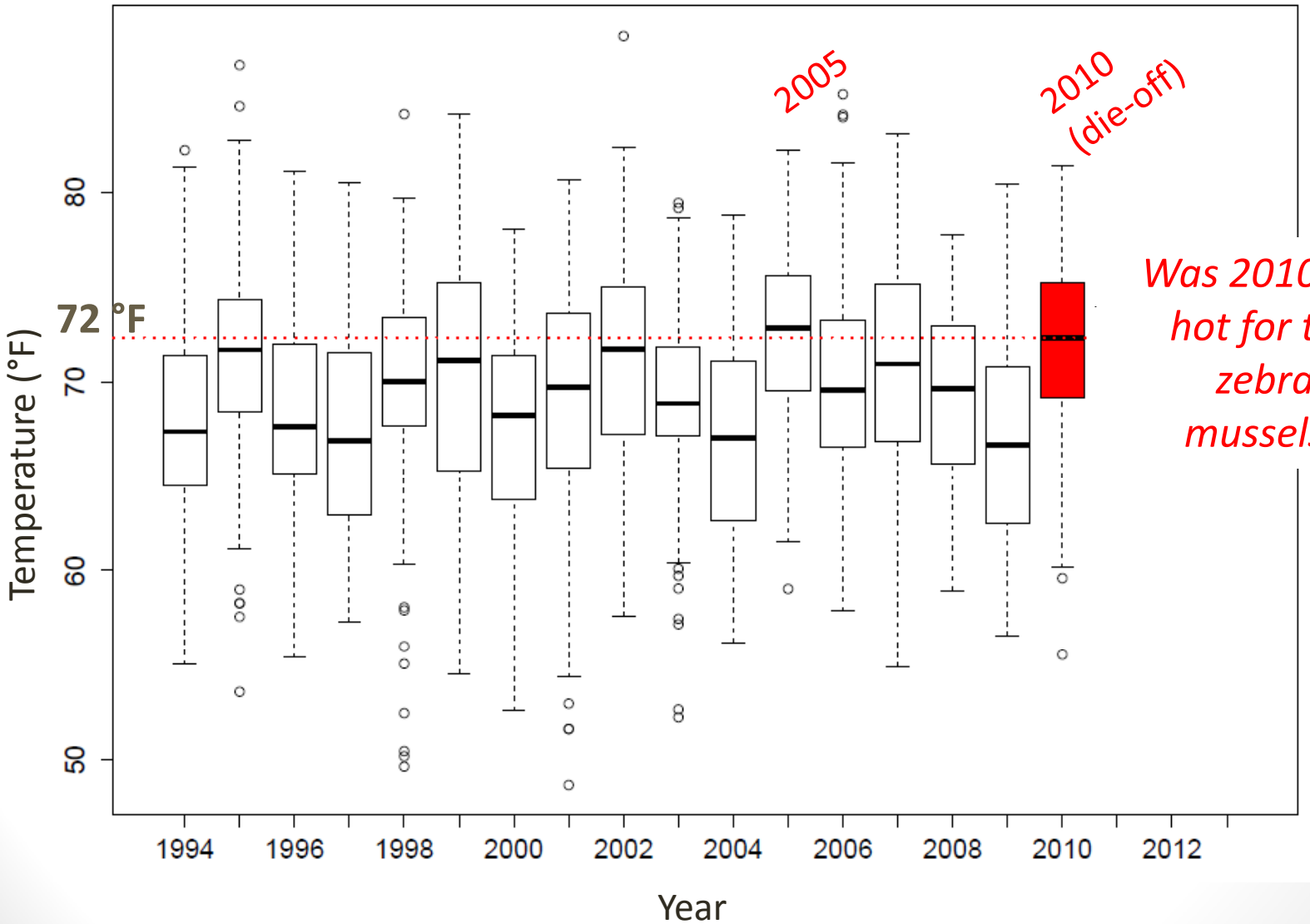
What happened in Gull Lake?

Summer daily average air temperature near Gull Lake (post zebra mussels)

Data from Kellogg Biological Station's Long-Term Ecological Research site

What happened in Gull Lake?

Summer daily average air temperature near Gull Lake (post zebra mussels)

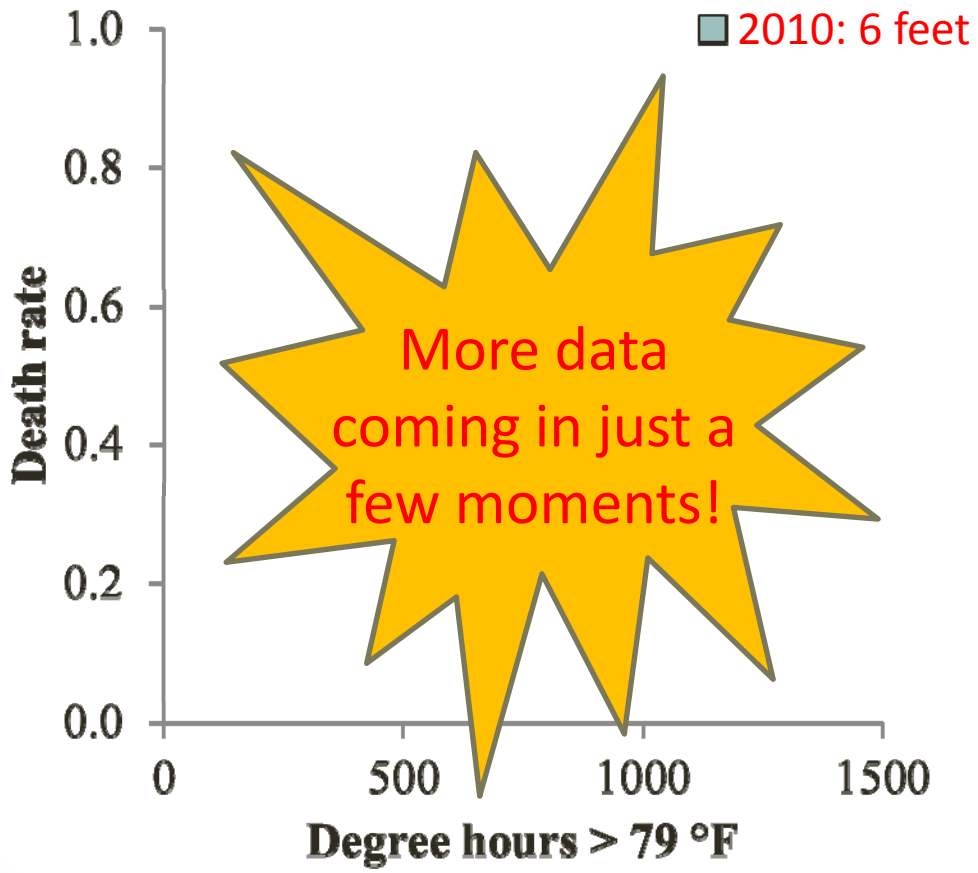


Was 2010 too hot for the zebra mussels?

Data from Kellogg Biological Station's Long-Term Ecological Research site

Was it temperature?

- Death was ~100% at **6 feet** in 2010 (warm summer "die-off")
- Notable observation: over 1,000 hours of "cumulative heat" at or above 79 °F during summer 2010 in the shallows



Gull Lake: caged mussels

At the surface

Going doooooown…

In place on the bottom

- Study of zebra mussels stocked in cages in Gull Lake
- 2011-2014 (May-Oct)
- Temperature loggers

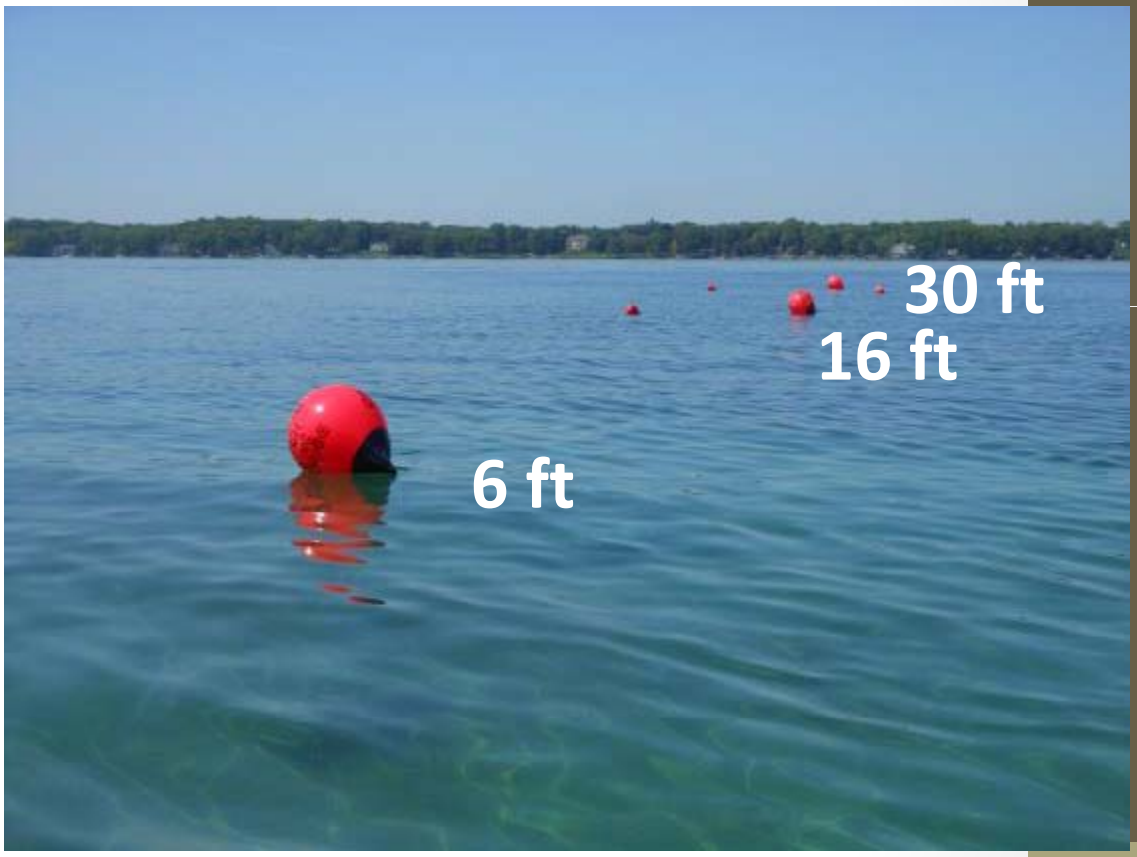
Gull Lake: caged mussels

- 3 depths

6 ft: warmest; largest daily variation

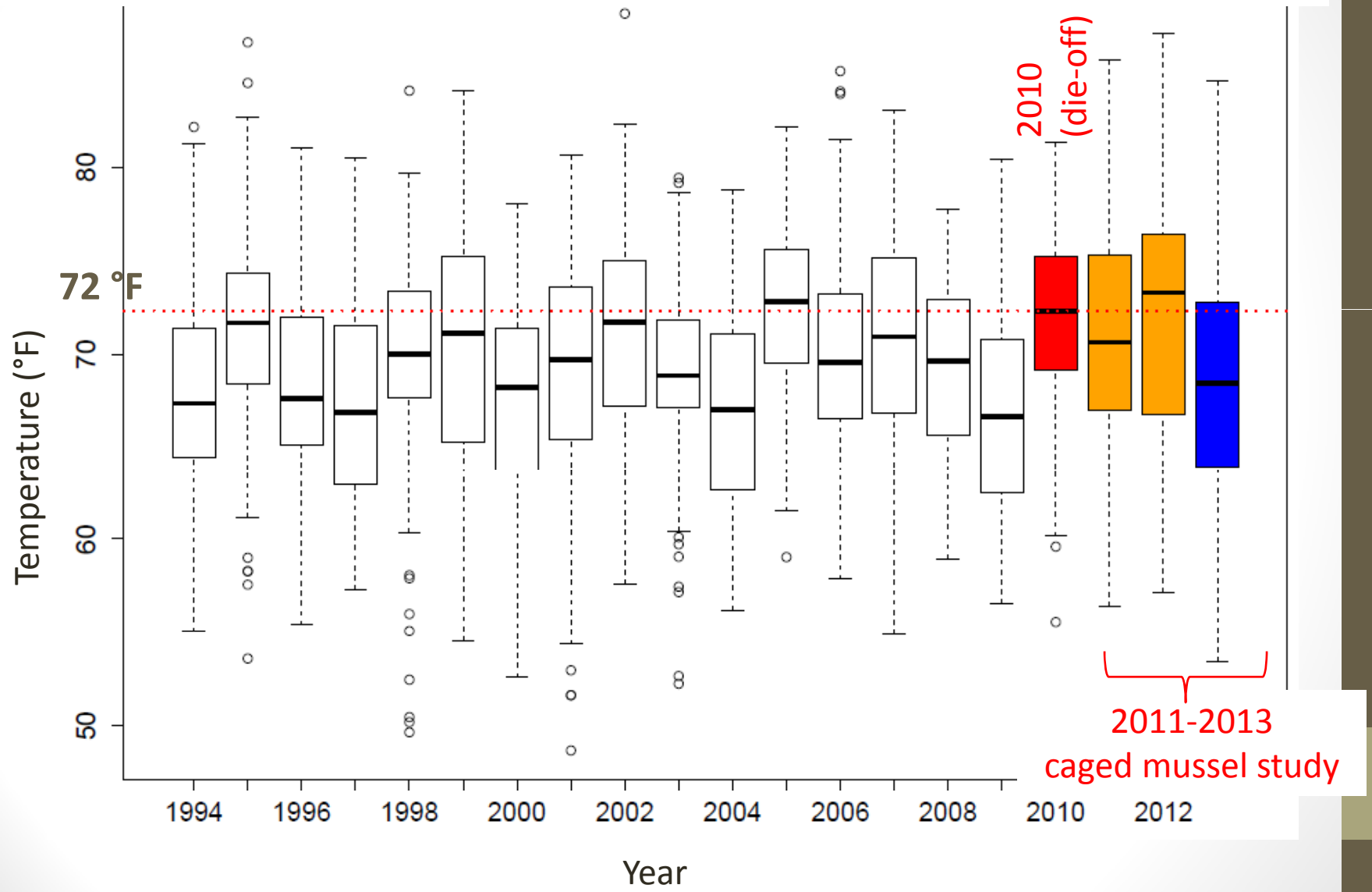
16 ft: warm; slightly less variation

30 ft: below the thermocline—cool; very little variation



What happened post die-off?

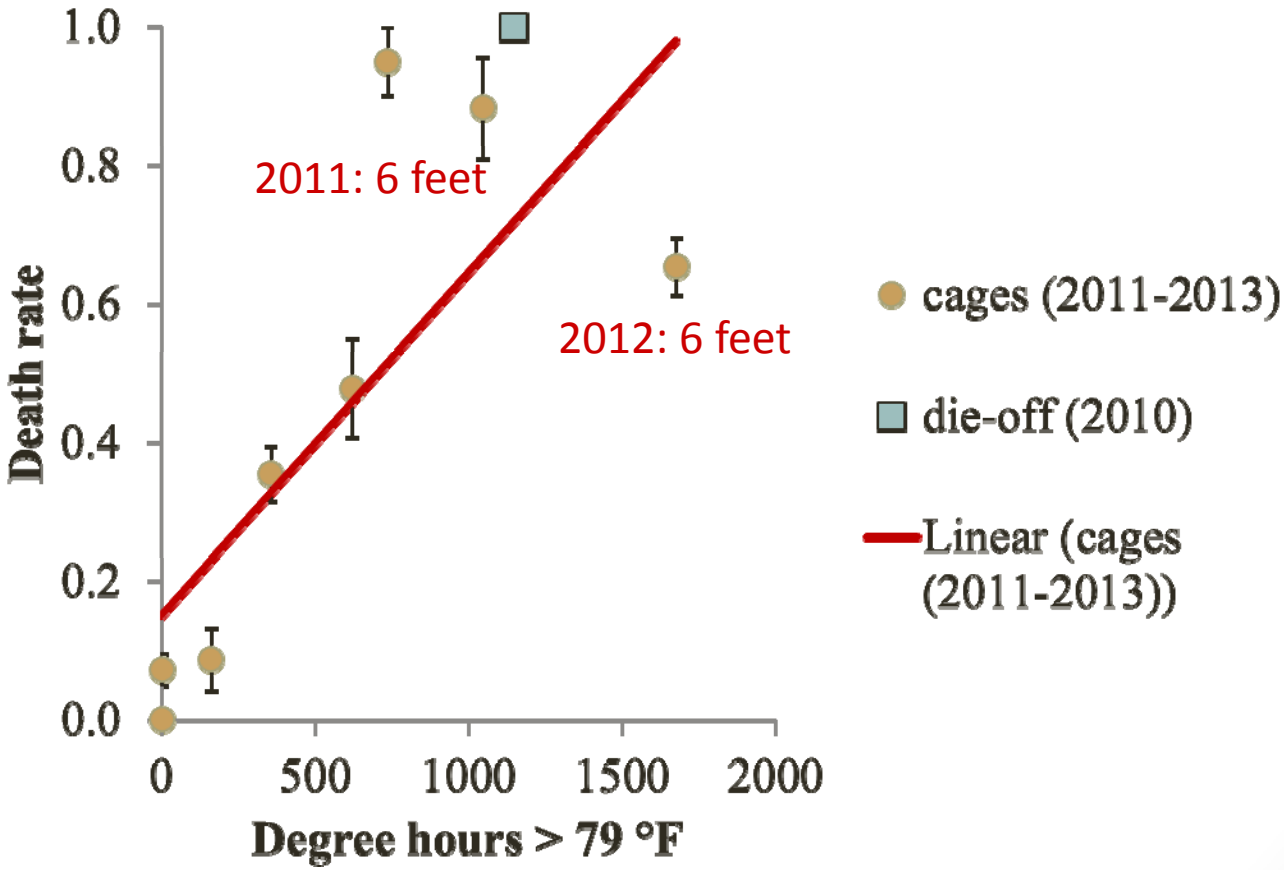
Summer daily average air temperature near Gull Lake (post zebra mussels)



Data from Kellogg Biological Station's Long-Term Ecological Research site

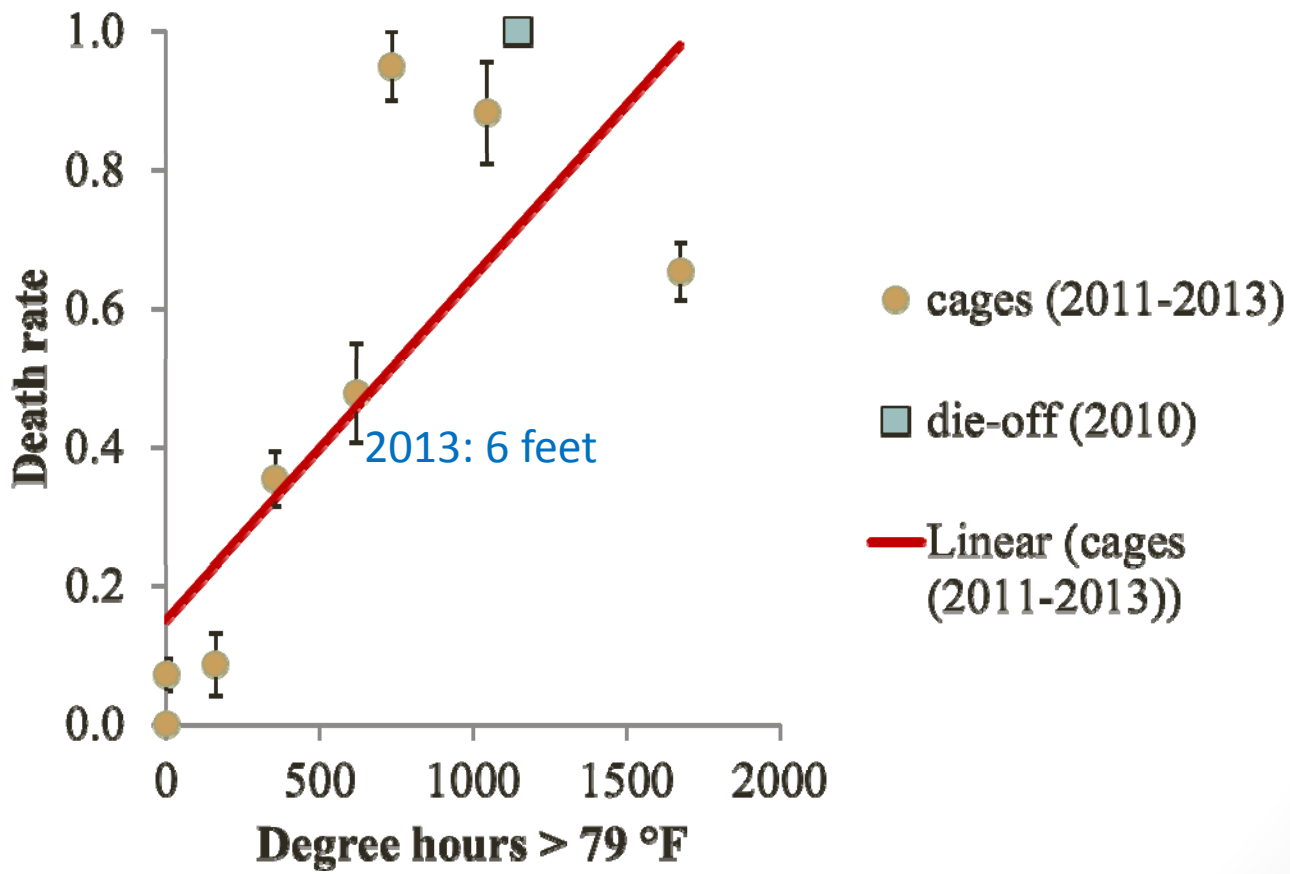
Gull Lake: caged mussels

- Death rate 65-88% at **6 feet** during warm summers (2011, 2012)
- Over 1,000 hours of "cumulative heat" at or above 79 °F



Gull Lake: caged mussels

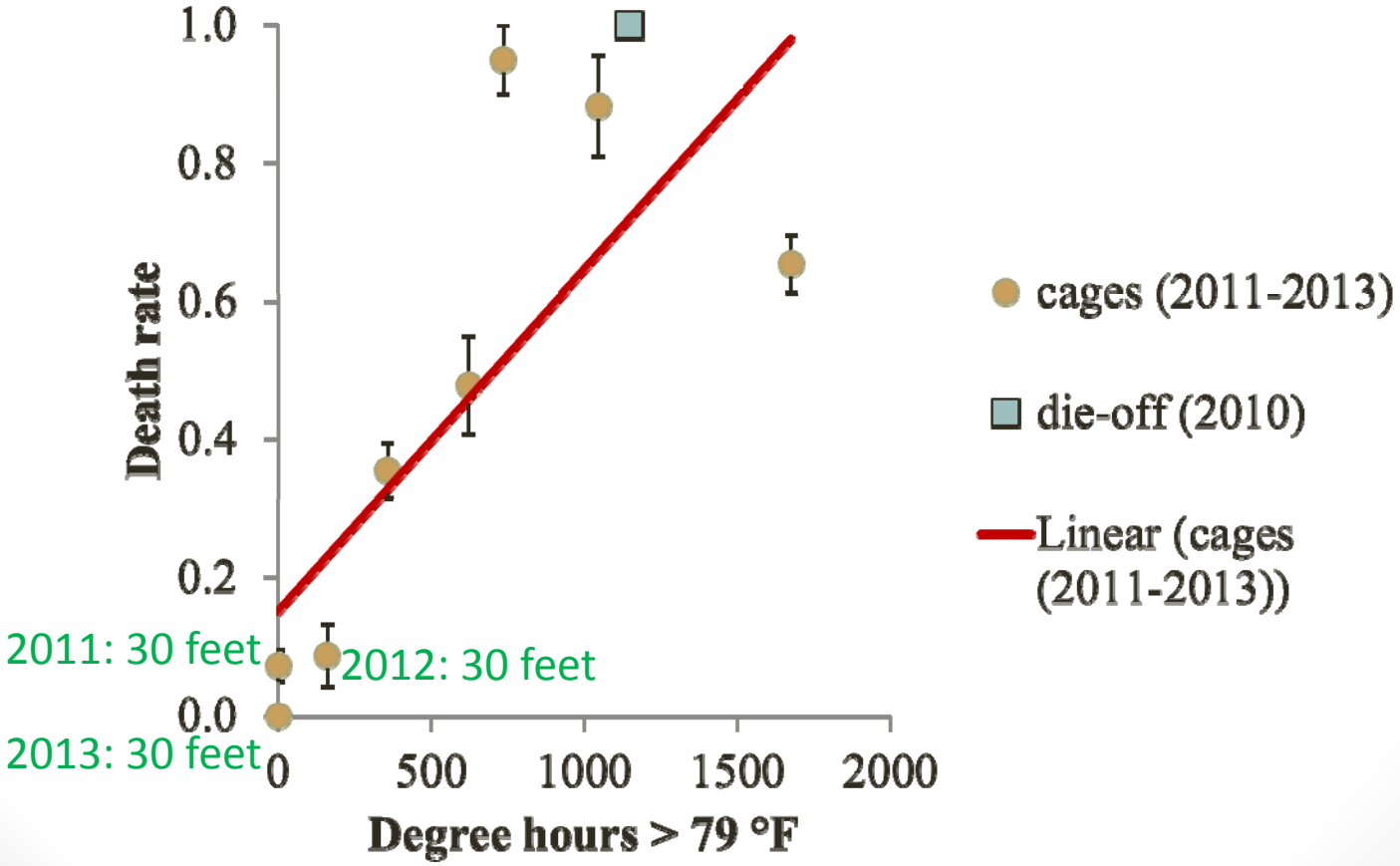
- Death rate only 48% at **6 feet** during cooler summer (2013)
- ~600 hours of "cumulative heat" at or above 79 °F



Gull Lake: caged mussels

- Death rate only 0-9% at **30 feet** (cooler water temperatures) during all years (2011, 2012, 2013)

- Less than 200 hours of "cumulative heat" at or above 79 °F



Lab experiment

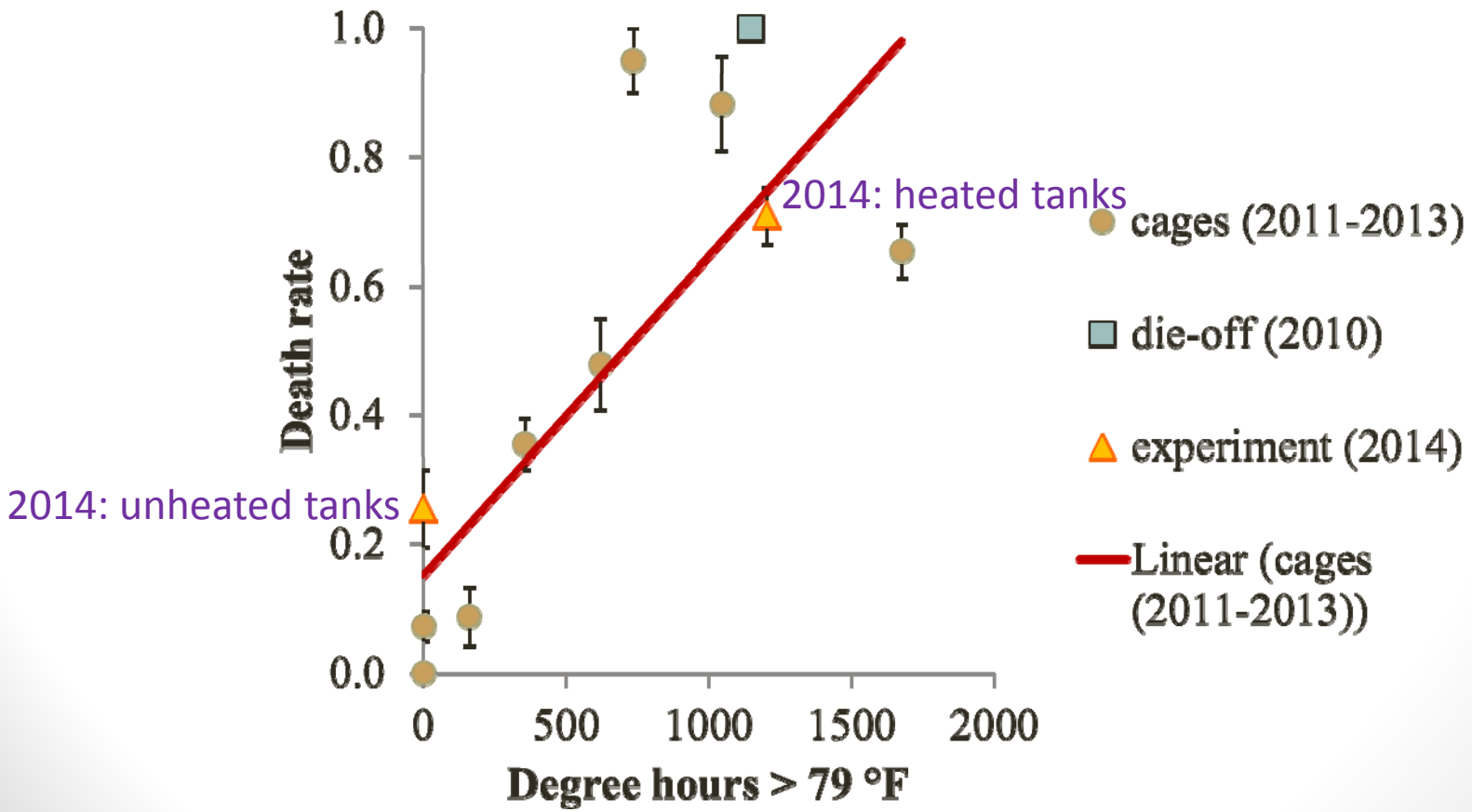
- *Can the lake observations be recreated in the lab?*
- Gull Lake zebra mussels
- Heated tanks targeting over 1,000 hours of "accumulated heat" at or above 79 °F
- Unheated tanks (always below 79 °F)

Results "hot" off the press!

Lab experiment

- Death rate 71% in **heated tanks** (over 1,000 hours of "cumulative heat" at or above 79 °F)

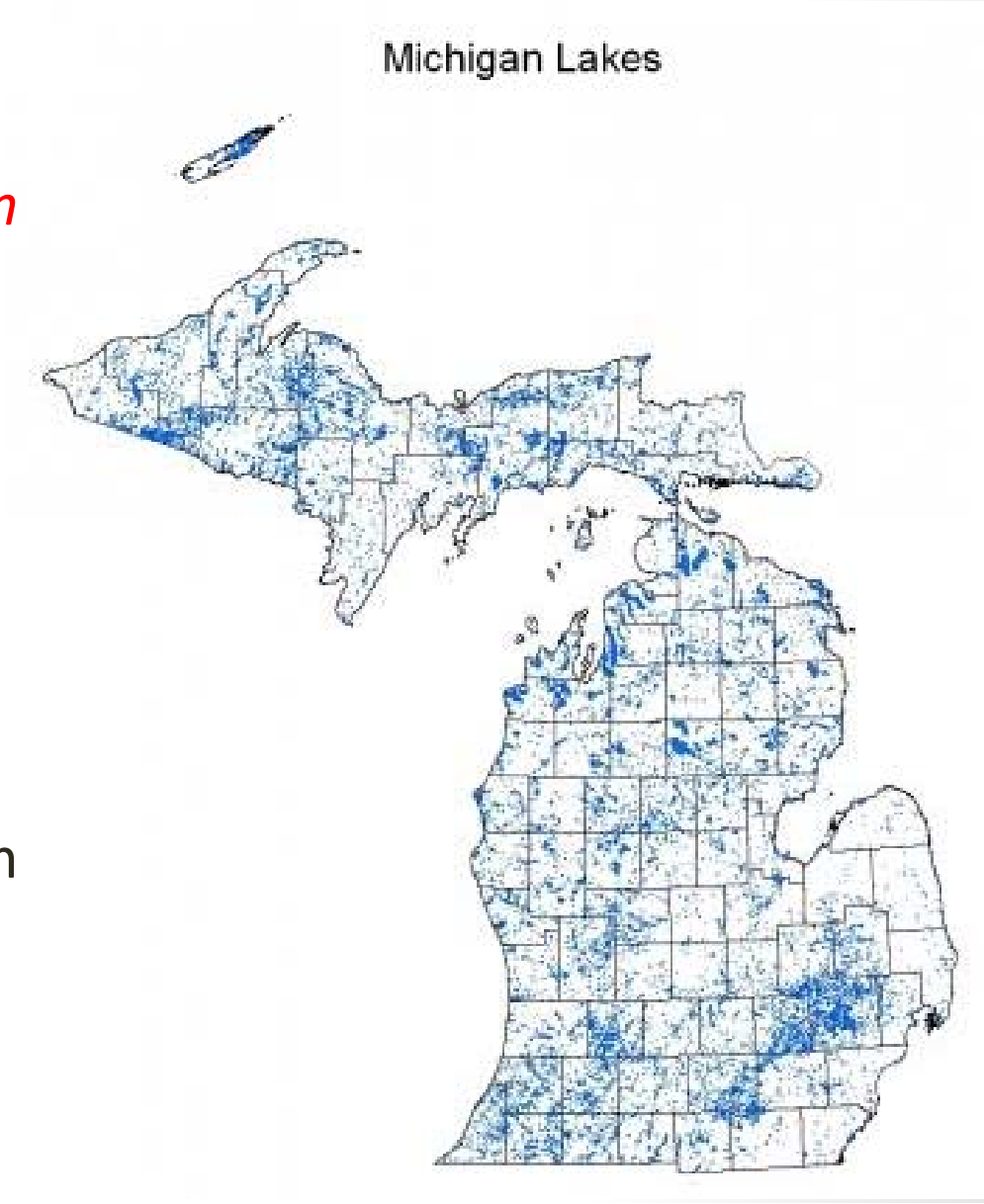
- Death rate only 25% in **unheated tanks** (never above 79 °F)



Was it just Gull Lake?

- *Have zebra mussels declined in other Michigan inland lakes during the same time period of observations from Gull Lake?*

- October 2013: electronic surveys
  - Michigan Lake & Stream Association (MLSA)
  - Michigan Clean Water Corps (MiCorps)



Not just Gull Lake…

"I observed a die off in 2011-12 to the point where mature mussels were rarely observed during the summer"
-- Dr. John Wilks, Indian Lake (Kalamazoo County)

"the zebra mussels have disappeared to the degree that it's almost safe to go in the water without shoes"
--John Roberts, Burt Lake (Cheboygan County)

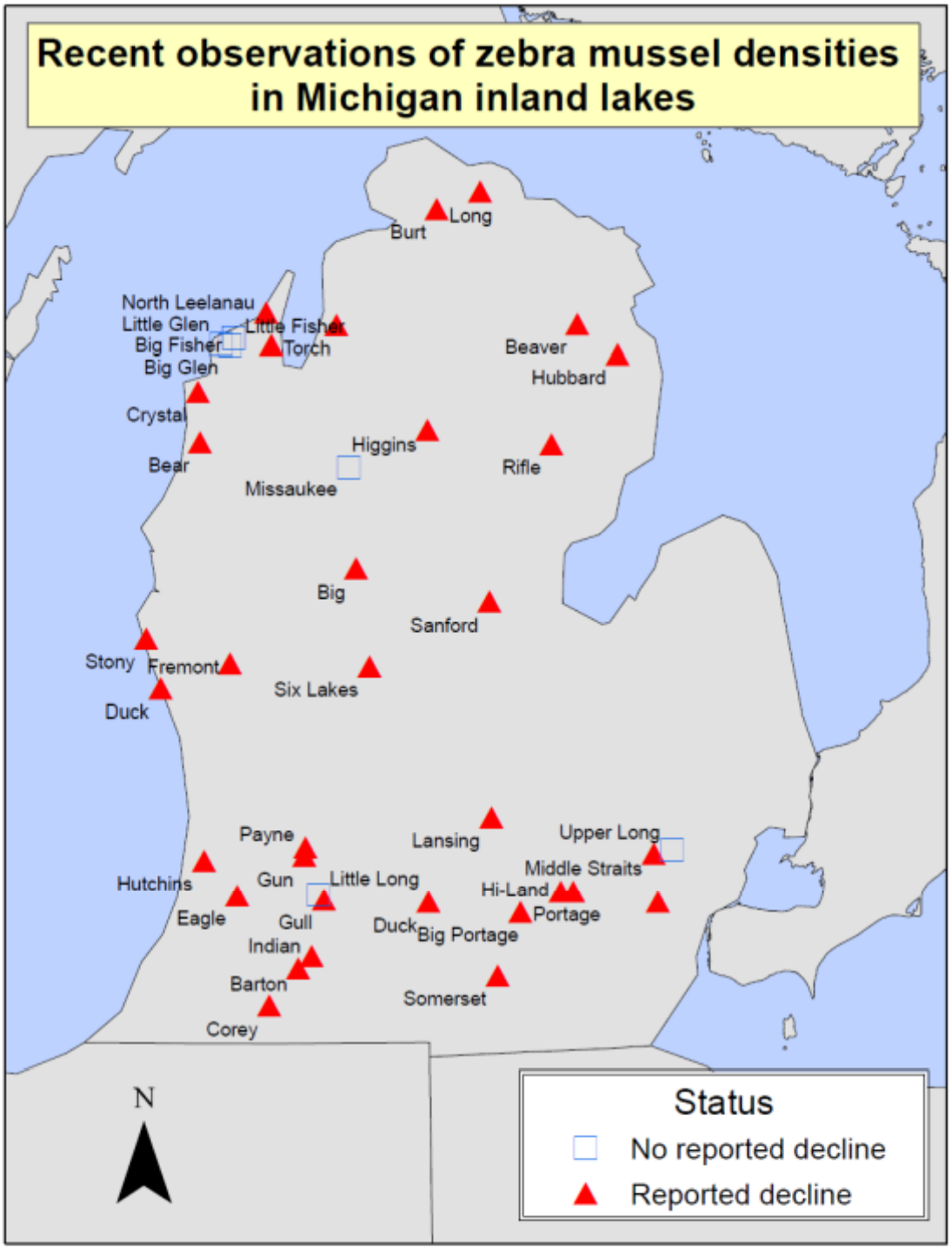
"August 2011 and 2012: Didn't have to look very hard to find them….August 2013: Unable to find any, even when actively looking"
--Betse Stuart, Torch Lake (Antrim County)

"We have noted a die off of the zebra mussels in the lake over the last few years. We are very certain that their population is down"
--Linda Davis, Payne Lake (Barry County)

Not just Gull Lake…

"…people around the lake have been commenting on how few mussels are on their docks…"

Photo & quote from Julie Stivers, Stony Lake, MI, October 2013 (Oceana County)



Not just Gull Lake…

- Reports received from 40 inland lakes all over the Lower Peninsula
- Declines or die-offs observed in 33 (83%) of the cases during the period 2010-2013

On the rebound?

"…this year they seem to be back, not in the numbers that were evident during the first infestations, but much more than the last two or three years"
--Julie Stivers, Stony Lake (Oceana County)

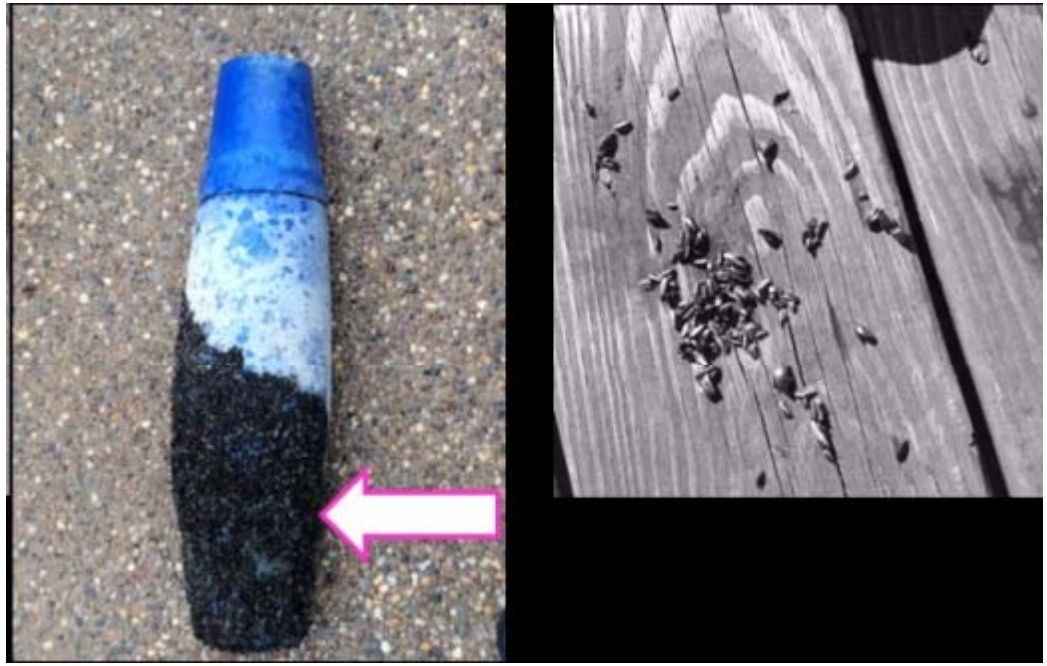


Photo from Dr. John Wilks, Indian Lake, MI, October 2013 (Kalamazoo County)

"[In] 2013, the population seemed to increase [from significantly reduced numbers] but not to the extent of earlier"
--Claudia Kerbawy, Lake Lansing (Ingham County)

Current status in Gull Lake

Summer 2014: Highest abundance observed since the die-off

….but still below historical levels

Summary

- Gull Lake observations consistent with recent high temperature-driven die-offs of zebra mussels
- Lab experiment with Gull Lake zebra mussels closely reproduces the lake observations
- Anecdotal reports from inland lakes around the Lower Peninsula point to obvious recent declines of zebra mussels

Remain vigilant: don’t spread invasive species

DON’T MOVE A MUSSEL

STOP AQUATIC HITCHHIKERS!™

Thank you!

Jeffrey White

Dept. of Fisheries and Wildlife, MSU

whitej82@msu.edu