Distributions, population dynamics, and ecological impacts of aquatic invasive species in Grand Lake O' the Cherokees, Oklahoma.

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25th Annual Conference of the
Oklahoma Clean Lakes and Watershed Association
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Invasive Species

- Influence ecosystems in novel ways (ecosystem engineers)
- Alter native communities by outcompeting native species or altering food web structure
- Can be economically costly

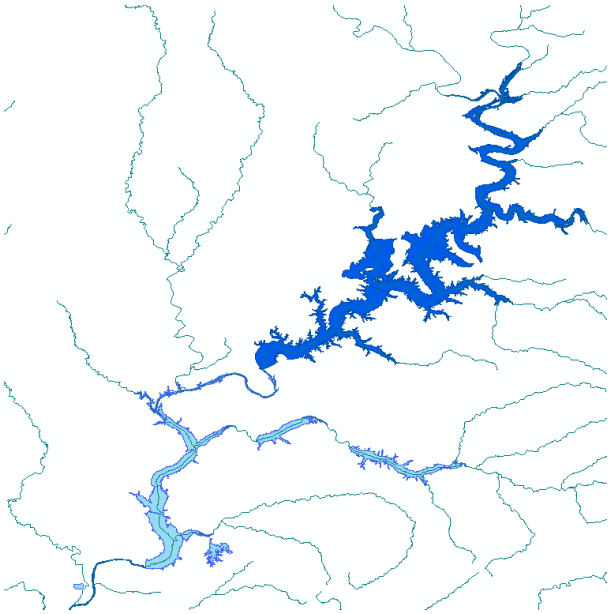
Asian carp

Mustard plant

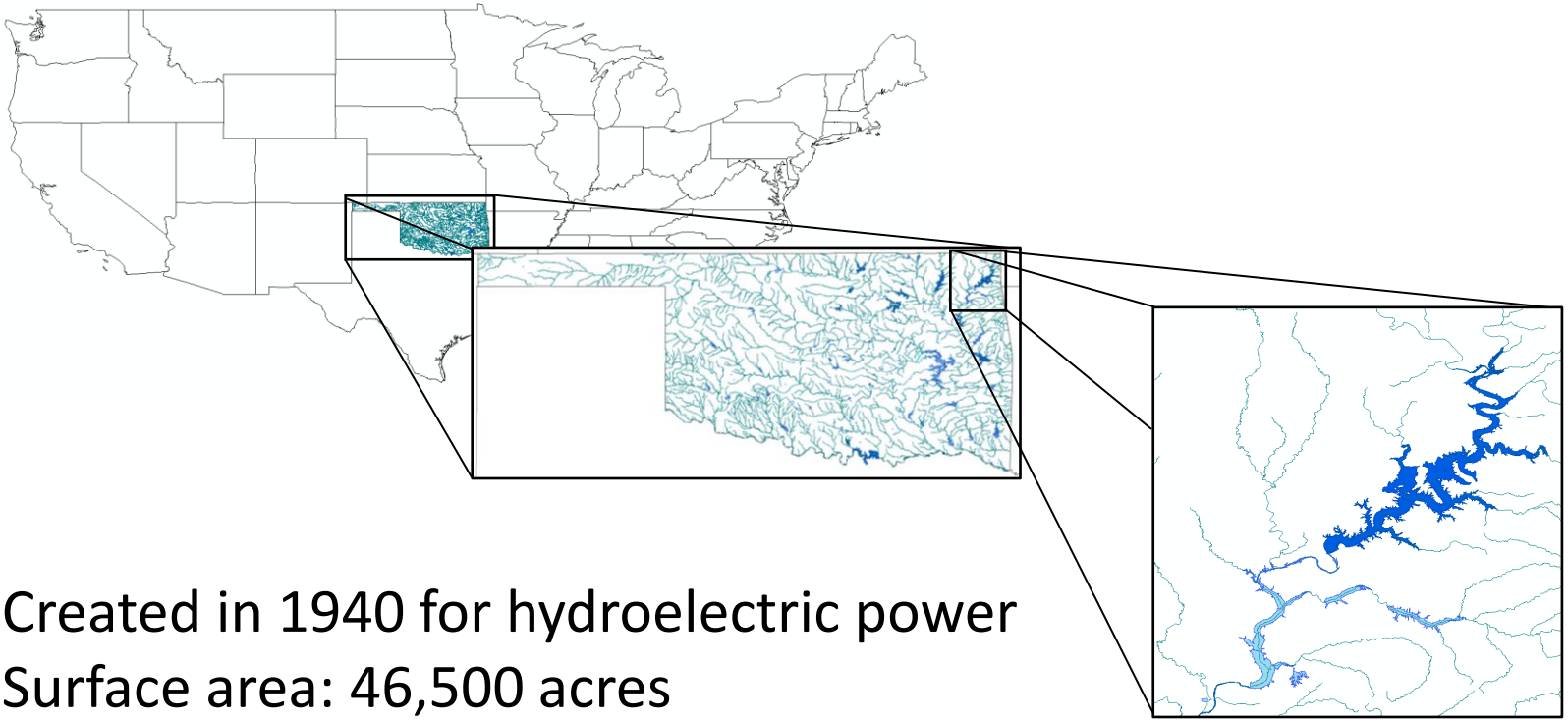
Zebra mussel

Reservoirs

- Man-made systems
- Highly susceptible to invasion
    - Large watersheds
    - Often connected to other reservoirs
    - Human mediated dispersal (fishing gear, boats, etc.)
- Serve as stepping stones to non-invaded systems



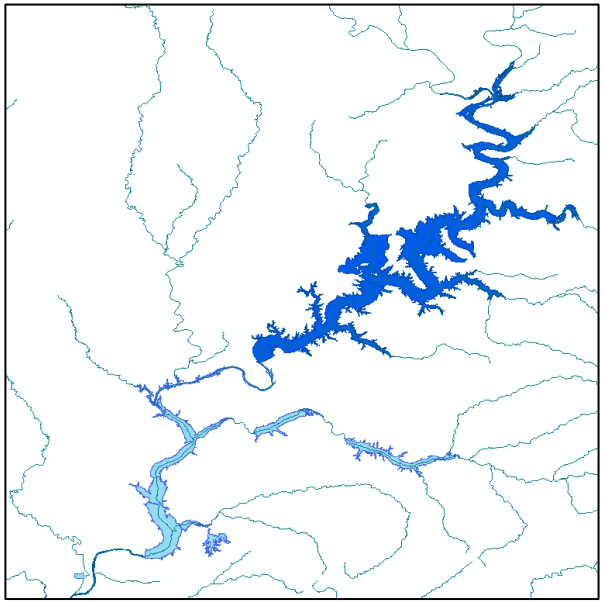
Grand Lake, Oklahoma



- Created in 1940 for hydroelectric power
- Surface area: 46,500 acres

Grand Lake, Oklahoma

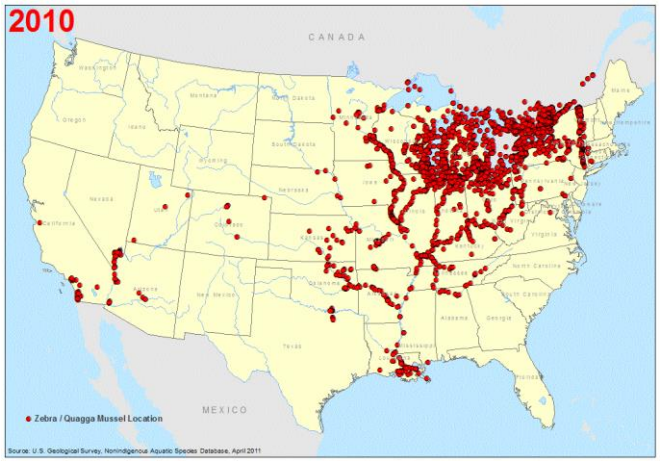
Zebra mussels (ZM)
(*Dreissena polymorpha*)
Confirmed in 2013
Crashed in 2015



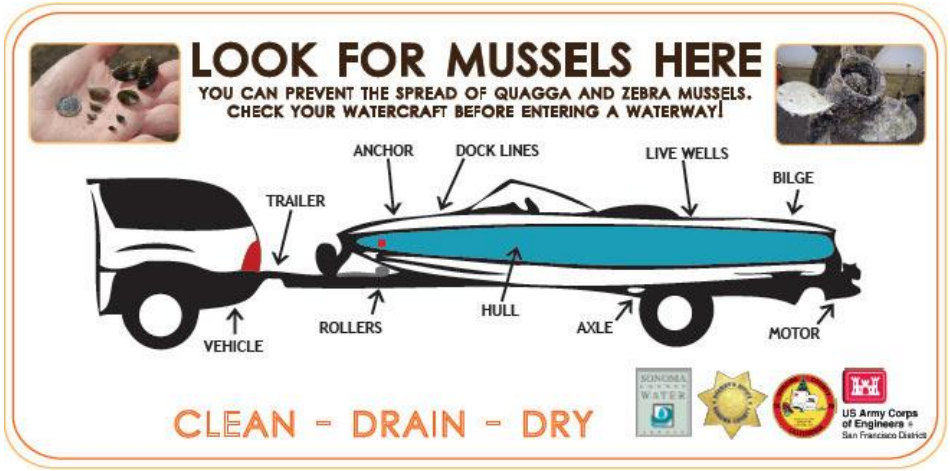
Daphnia lumholtzi (DL)
Confirmed in 1995

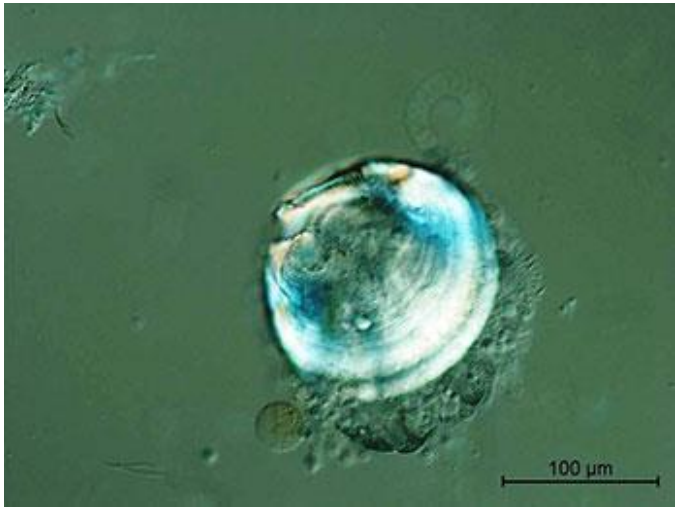
Background

Zebra Mussels (ZM)
(*Dreissena polymorpha*)



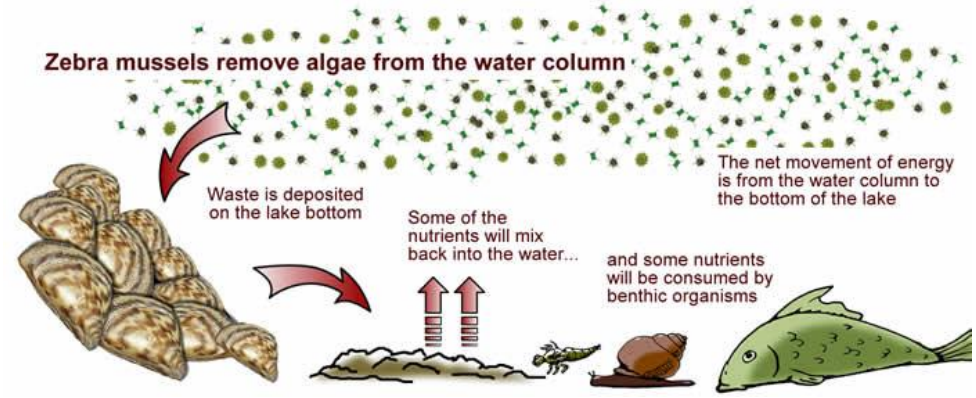
- Invasive in North America (1988)
- Rapidly spreading throughout the U.S.
- Produce free-living larvae (veligers)

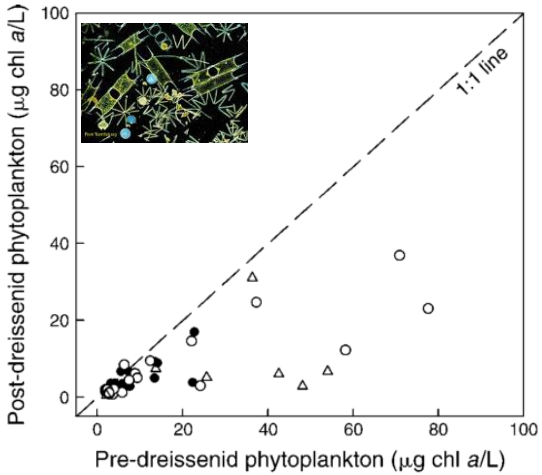


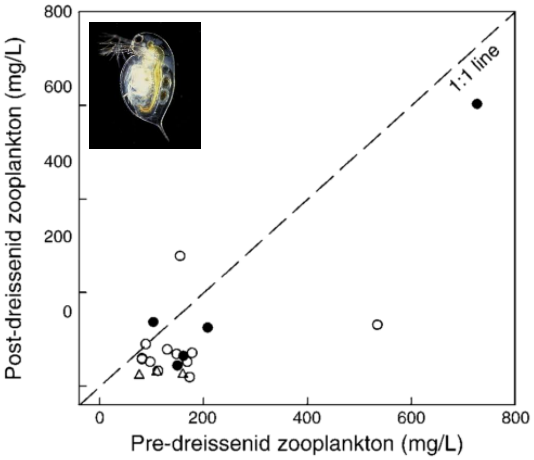


Zebra Mussels (ZM) (*Dreissena polymorpha*)

- Alter nutrient pathways (complex)
- Outcompete native zooplankton
- Ecosystem engineers





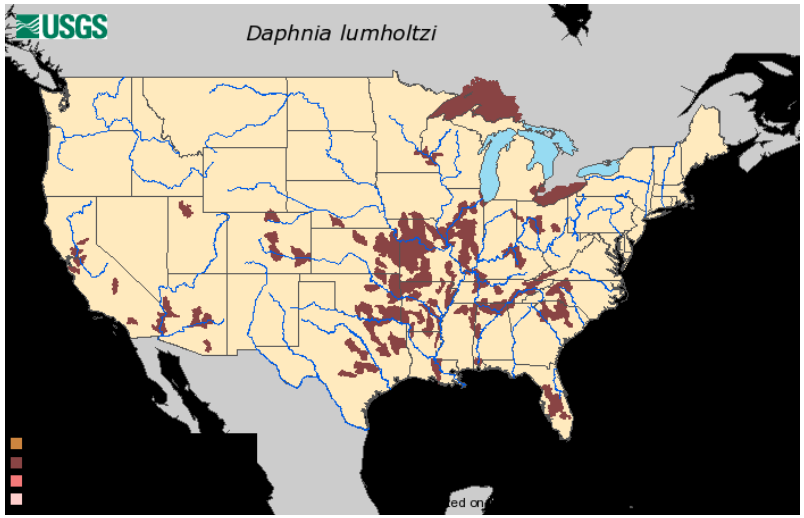


Higgins and Zanden (2010)

Background

Daphnia lumholtzi

- Exotic cladoceran found in a Texas reservoir in 1990
- Has since invaded lakes and reservoirs throughout the eastern half of the U.S.
- Large size and spines protect it from predators
- Thought to displace native zooplankton species

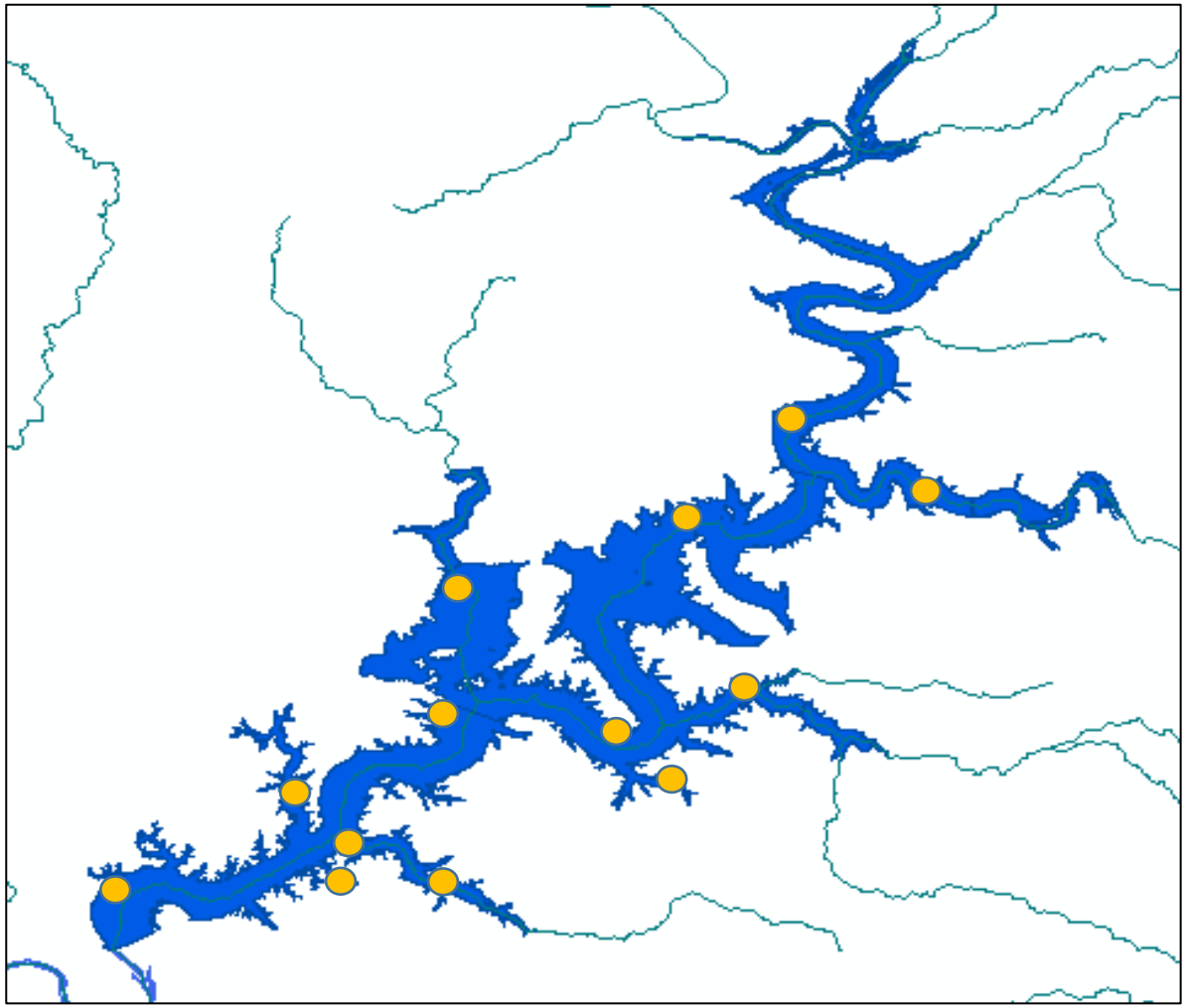


Objectives

- Identify the current distributions and densities of ZM and DL throughout Grand Lake
- Determine whether ZM and DL are influencing native zooplankton communities
- Identify potential causes of 2015 ZM crash

Methods

- In 2014, zooplankton/ZM veliger samples were collected in July and October.
- In 2015, zooplankton/ZM veliger samples were collected monthly.
- Water quality data are collected monthly.



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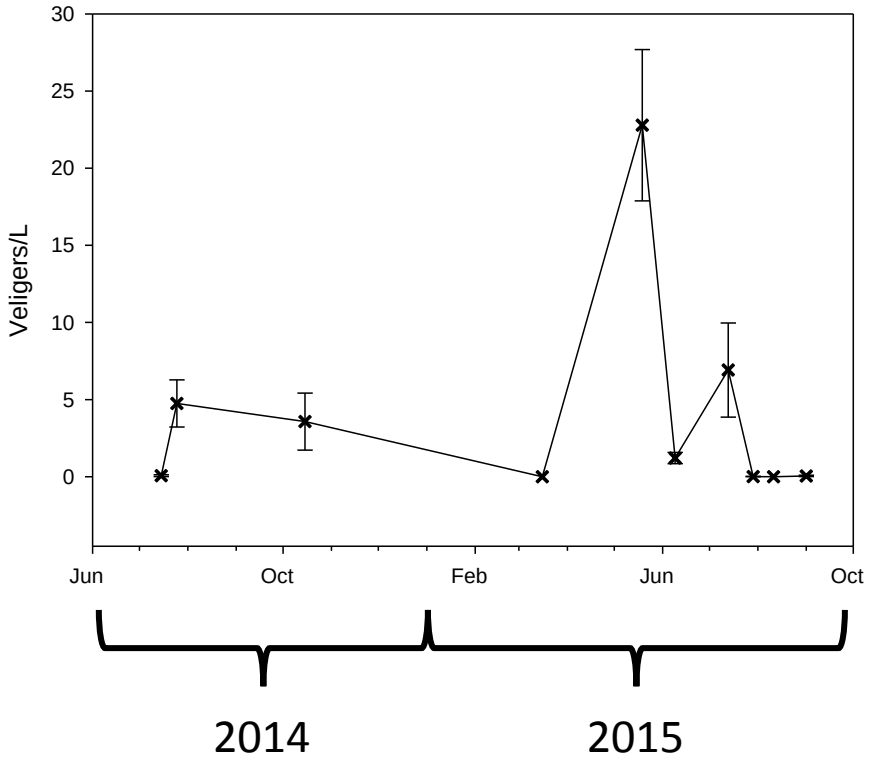
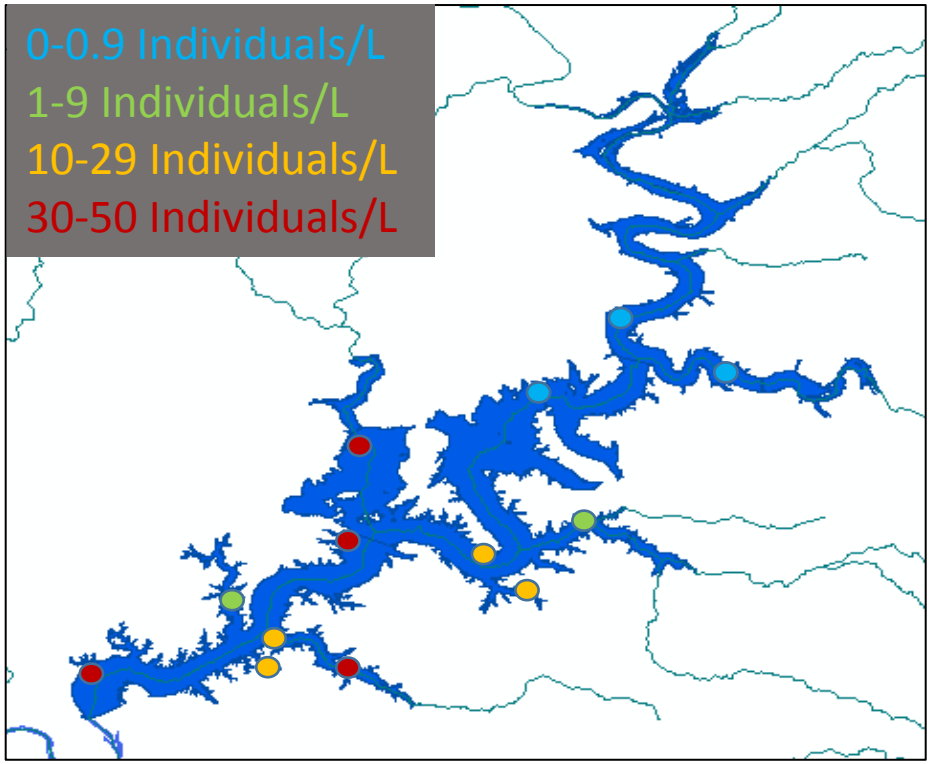
Results

ZM densities and distributions

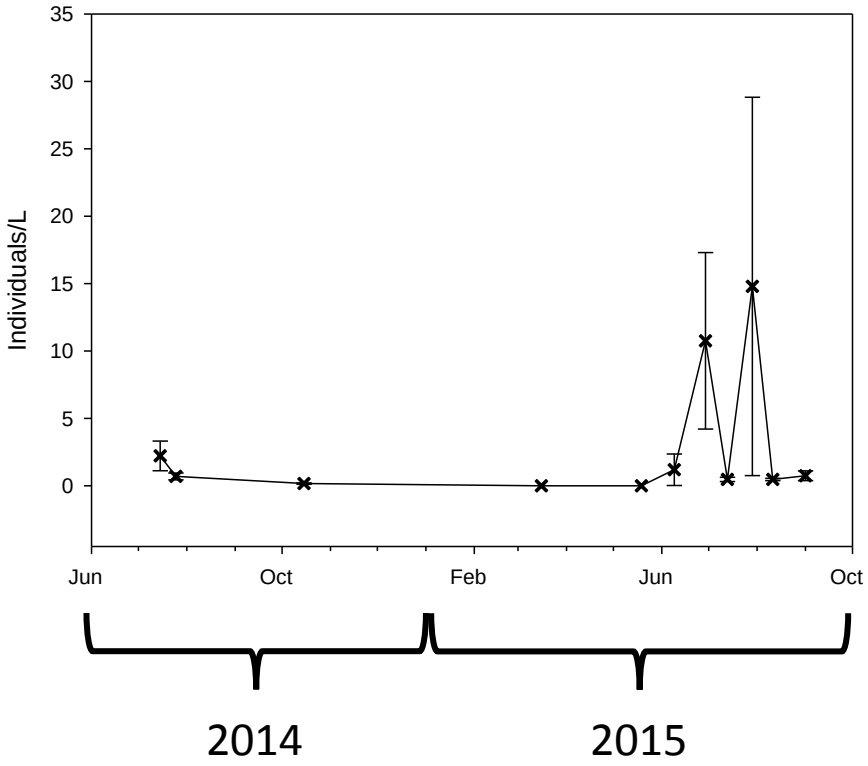


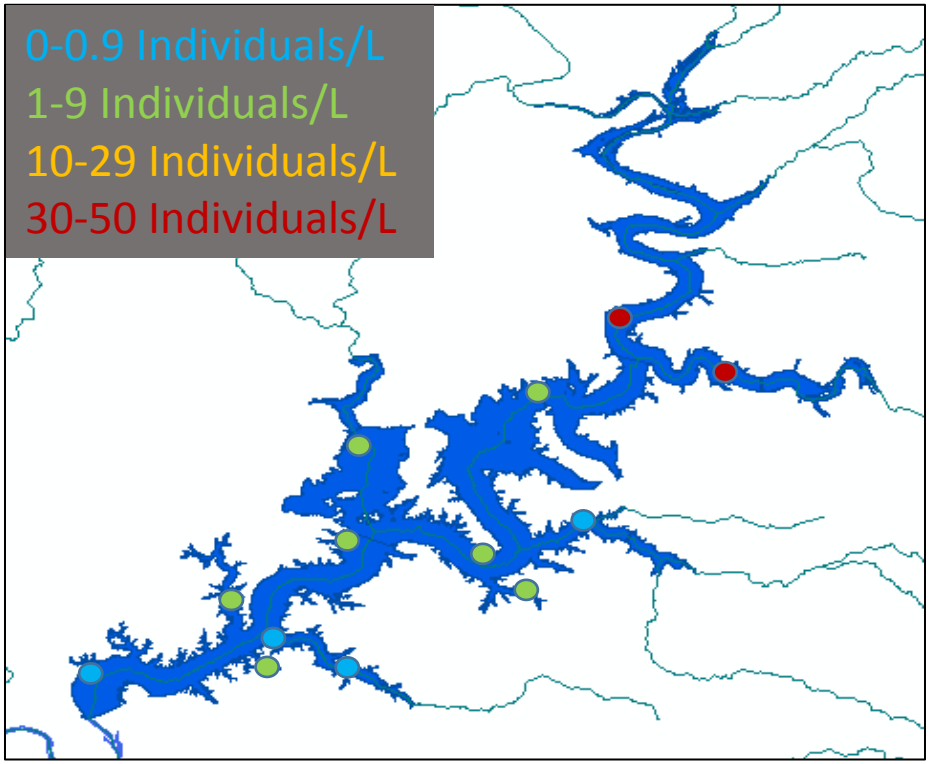


Results

ZM densities and distributions

DL densities and distributions

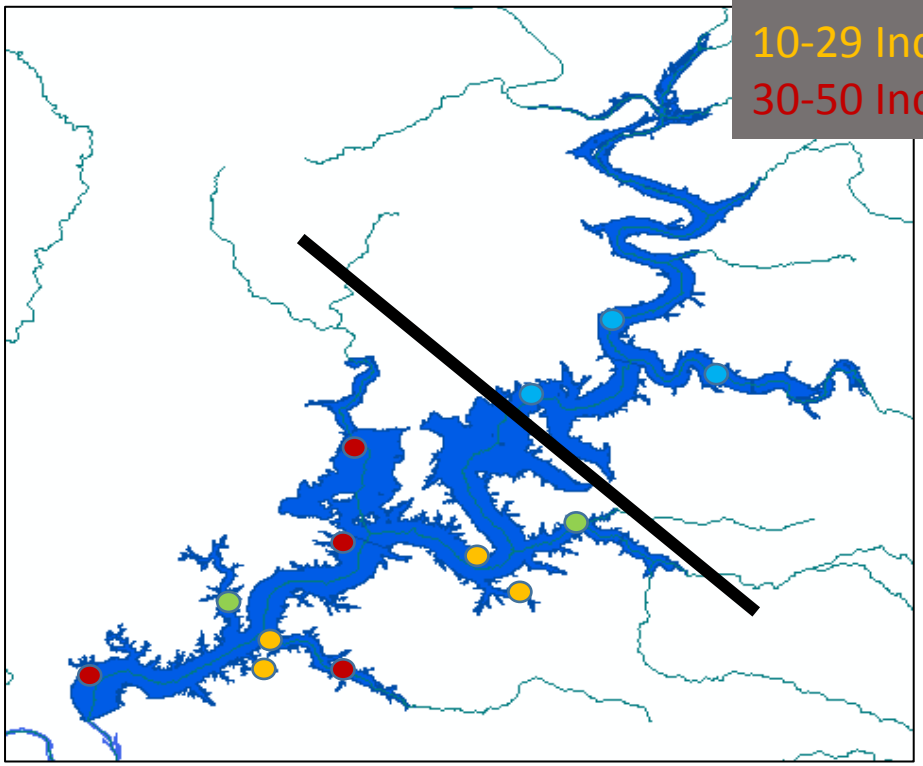


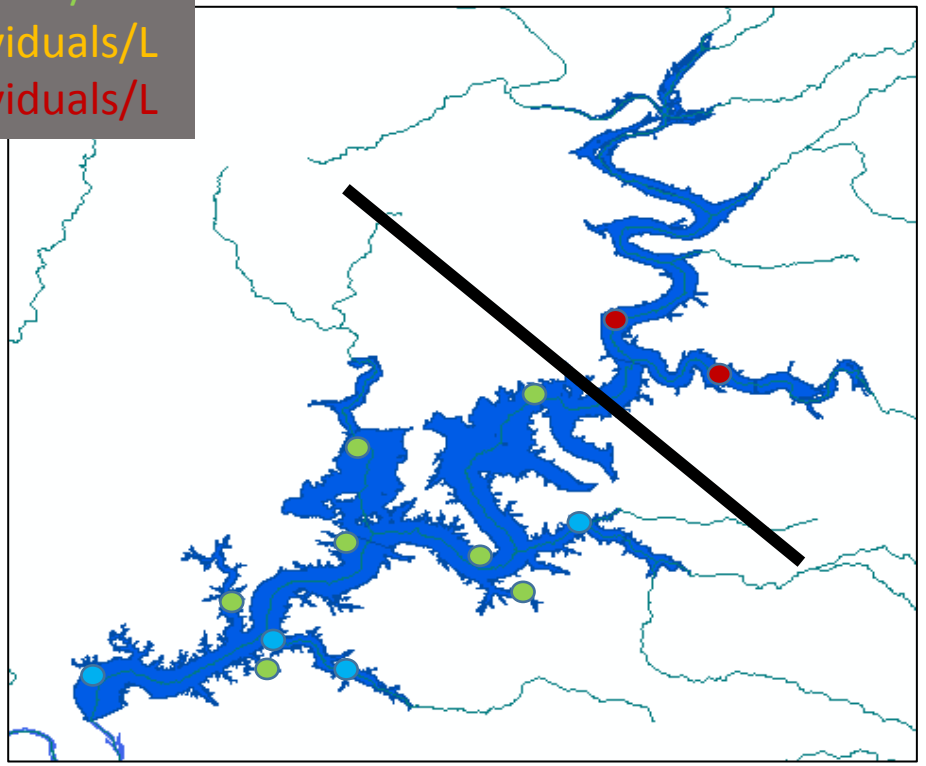


Results

ZM vs DL distributions

0-0.9 Individuals/L
1-9 Individuals/L
10-29 Individuals/L
30-50 Individuals/L





Objectives

- Identify the current distributions and densities of ZM and DL throughout Grand Lake
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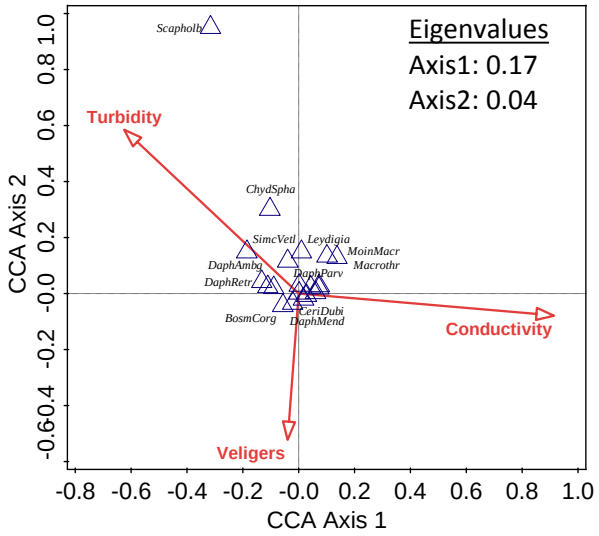
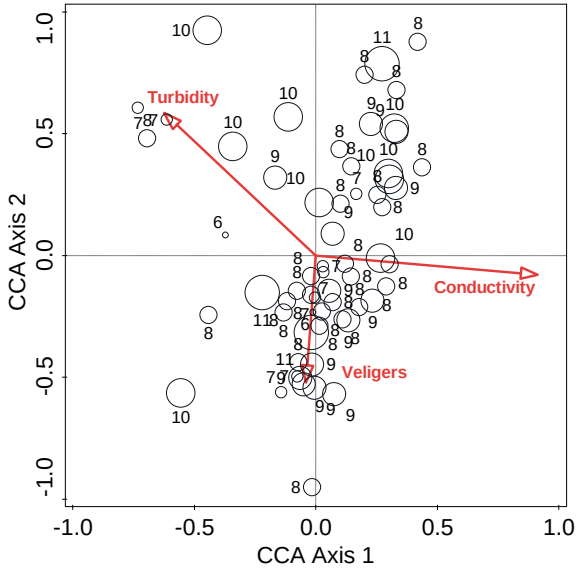
- Identify potential causes of 2015 ZM crash

Results

Influence of ZM and DL on Zooplankton Communities





Variable	Explained Variation (%)	P-value
Conductivity	22.0	.008
Veliger density	4.8	.008
Turbidity	4.1	.08

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Background

- Mechanisms historically responsible for ZM crashes in Oklahoma reservoirs (Churchill 2013; Boekman 2011):
    - Changes in lake elevation
    - High water temperatures
    - Low DO

Background

Filled to the brim: Grand Lake expected to crest at 754.5 feet Saturday

Published on NewsOK • Published: May 28, 2015 • *Updated: May 28, 2015*

Floodwater Release Bulletin

MAY 28, 2015

At 10:00am on Thursday, May 28:

• Grand Lake elevation was 753.25 feet. Daily target elevation for May 28 is 743.80 feet.

• At the direction of the United States Army Corps of Engineers, one (1) floodgate (east spillway) were

discharging 6,376 cubic feet per second (cfs) of water.

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As water conditions continue to improve … GRDA lakes ready to welcome visitors over July 4 holiday

JULY 2, 2015

Langley – Despite historic rainfalls and elevated lake levels in recent weeks, the Grand River

Grand Lake continue to improve, just ahead of the July 4th holiday.

"The lake is in good shape and we expect to see a lot of visitors enjoying the water over the h

Communications Director Justin Alberty. "The water level is steadily returning to normal and th

Alberty added that the latest projections from the United States Army Corps of Engineers sho

3.5 feet above normal on July 4, with GRDA's Lake Hudson at roughly 6.5 feet above normal

The Corps was also directing GRDA to close the last floodgate on Pensacola Dam's east spill

that gate closed, Alberty said the boat ramps located between the spillways (east of Disney) v

For those visiting the lake area near the dam, the GRDA Ecosystems and Education Center (

throughout the holiday weekend, as a resource for those visiting the lake.

"It's a great place to pick up information like lake maps, the GRDA lake guide or other materia

enjoyable," said Alberty, adding that free tours of GRDA's historic Pensacola Dam – which orig

be available all weekend.

Around the lake area, several fireworks displays are also scheduled during the weekend. Disr

Show is scheduled for Friday, July 3 at 9:30PM. The Monkey Island Fireworks Show is also Fr

Birthday America" Celebration, from 6-10PM, with fireworks scheduled for 9PM.

Meanwhile, the Duck Creek Fireworks show, considered to be the largest in the state, takes p

Creek arm of Grand Lake. While the actual fireworks go off at 9:30PM, other activities in the a

along the shores of GRDA's Lake Hudson, the community of Salina will also have its fireworks

"Around the GRDA lakes area there will be plenty of places to enjoy fireworks displays both o

encourage everyone to use common sense, boat safe, smart and sober and enjoy the weeke

Finally, the GRDA Police Department reminds boaters that if they need immediate assistance

However, if they are on a boat with no cell phone access, they can also use Marine Band 16

GRDA Police reminds boaters to use extreme caution on water, avoid areas of floodwater discharge

JUNE 1, 2015

Langley — The current elevated levels of Grand and Hudson lakes have prompted the Grand River Dam Authority Police Department to remind boaters to use extreme caution on the water.

pography of the shoreline can change drastically," said GRDA Assistant General Manager/Chief of Law

an Edwards. "So we are reminding boaters to use extreme caution and especially be aware of their boat

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GRDA lakes will have a slow return to normal elevations

JUNE 5, 2015

Floodgates at GRDA's Robert S. Kerr Dam release water from flood-swollen Lake Hudson on Monday, June 1.

Despite the high lake levels, the Grand River Dam Authority is reminding boaters that lake-area businesses around the shores of Grand and Hudson are open and GRDA does expect the lake to be busy over the weekend and the days ahead.

"We simply want to stress common sense and caution as boaters visit the lakes during this time," said GRDA Corporate Communications Director Justin Alberty.

Alberty added that the heavy inflows into the Grand River Watershed have slowed in the last few days, but a return to normal water levels may take weeks for both Grand and Hudson lakes.

"Because this flooding episode was so widespread, across several reservoirs in the region, it's just going to take a while to get all the water downstream safely," he said. "The good news is, lake levels are headed in the right direction, but it will take some time before they return to normal."

Alberty said the United States Army Corps of Engineers, which controls floodgate operations and GRDA's Pensacola and Robert S. Kerr Dams, is managing releases not only from the Grand River Watershed but from several flood-swollen lakes in Oklahoma.

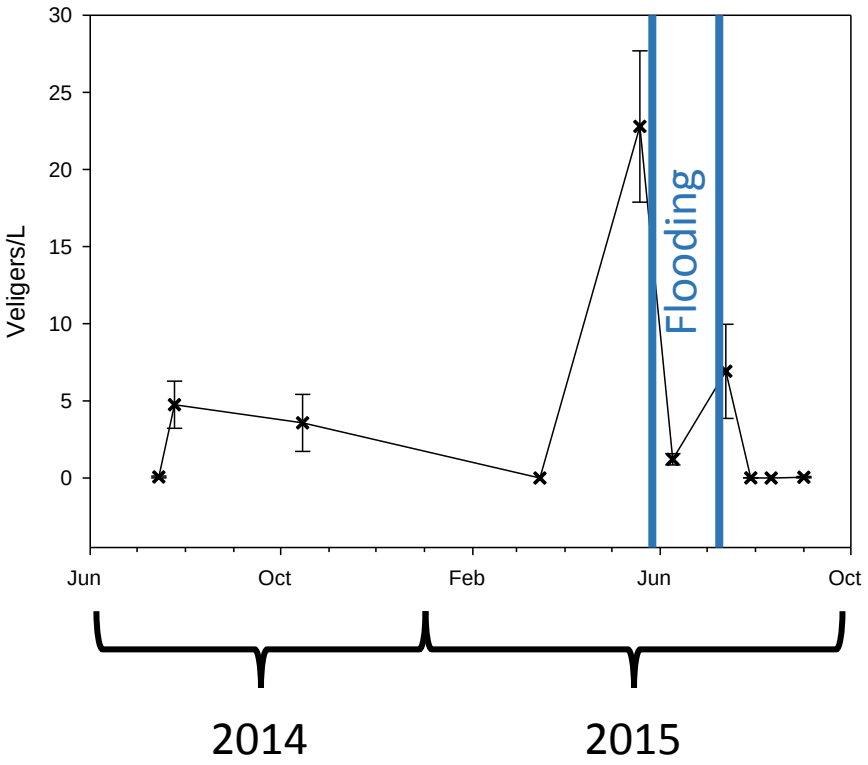
"Most river systems in Oklahoma have experienced flooding and that includes the systems south of GRDA's lakes which are also trying to release water safely," he said. "Right now, we are continuing to work under the direction of the Corps as floodgate operations are made and our lakes are brought down."

GRDA Police work to remove floating debris from a buoy line in front of Robert S. Kerr Dam on Monday, June 1. If you are

The GRDA Police Department does offers the following tips boaters should keep in mind if they plan to visit Grand or Hudson lakes during the next few weeks:

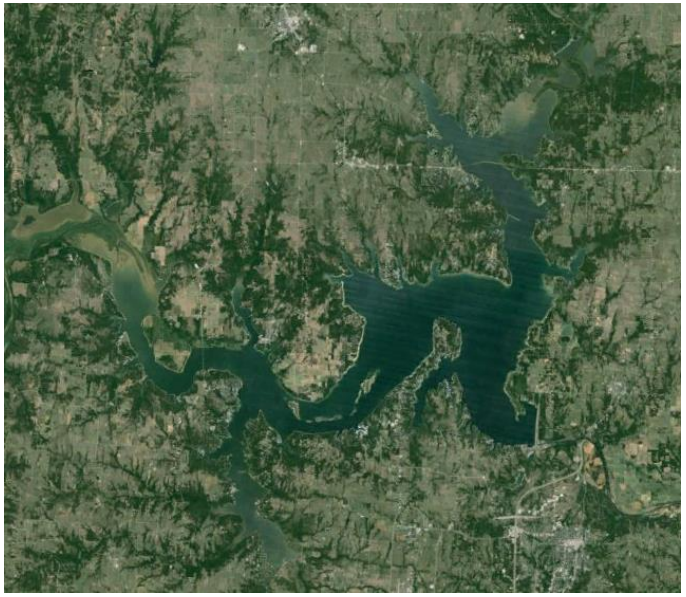
• Be mindful of your boat wake and proceed with caution in areas near structures. When lake levels are elevated boat wakes can cause damage to structures that are normally above the shoreline.

Background


30
25
20
15
10
5
0
Veligers/L
Flooding
Jun
Oct
Feb
Jun
Oct
2014
2015

Background

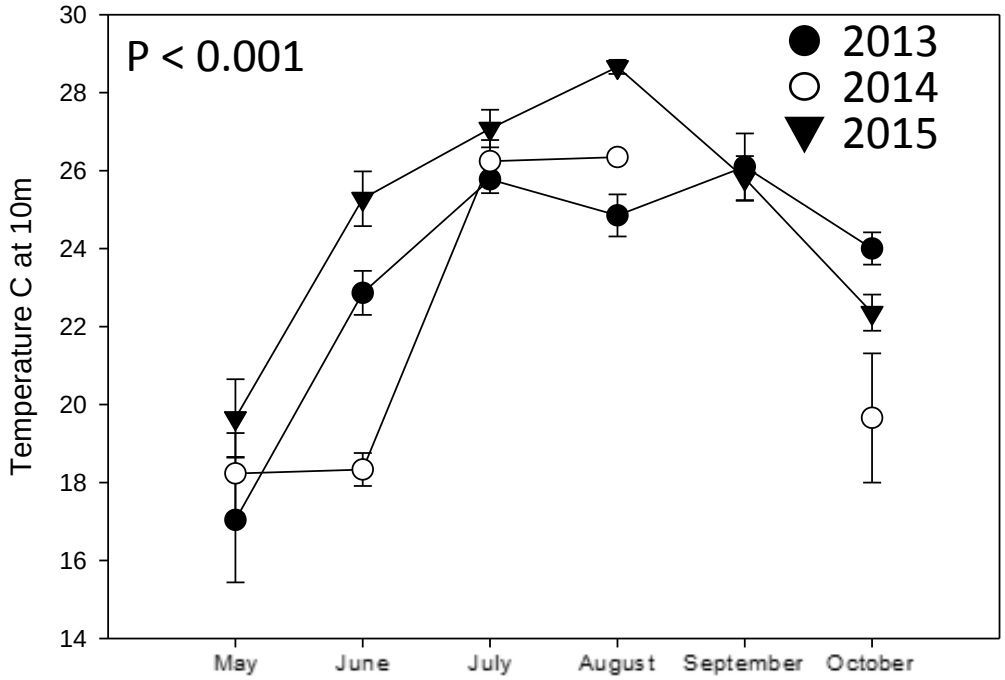
Churchill (2013)



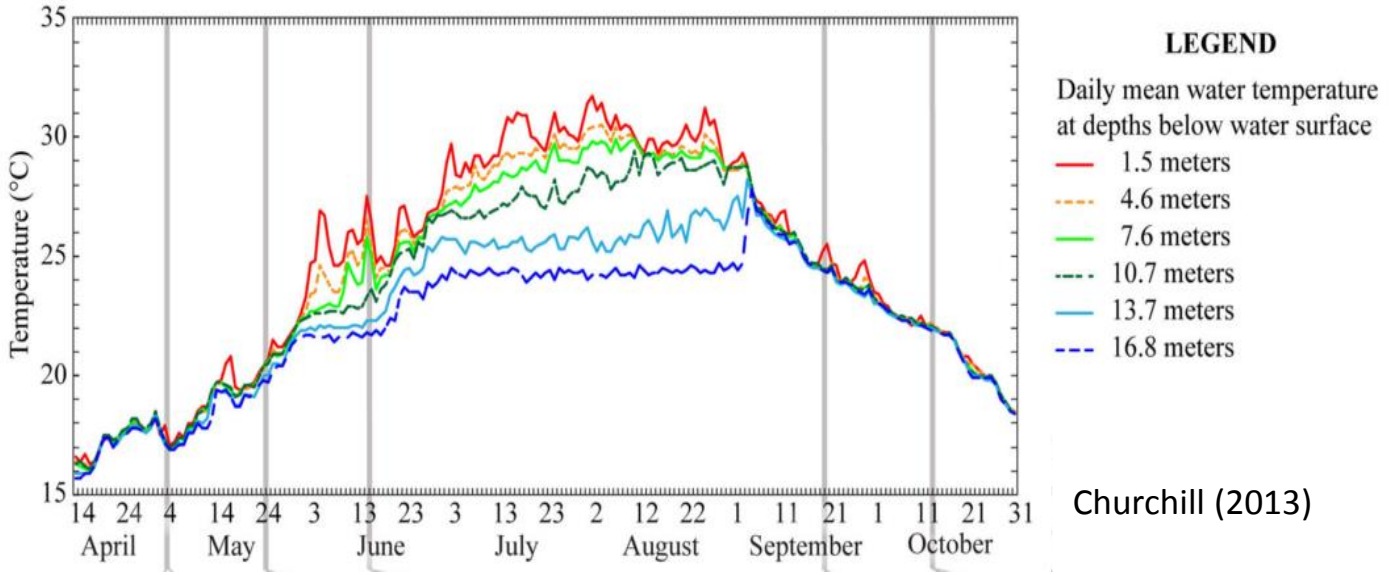
- ZM crashed in Lake Texoma in 2011
- Crash suspected to be the result of low lake levels and high temperatures

Results

Grand Lake

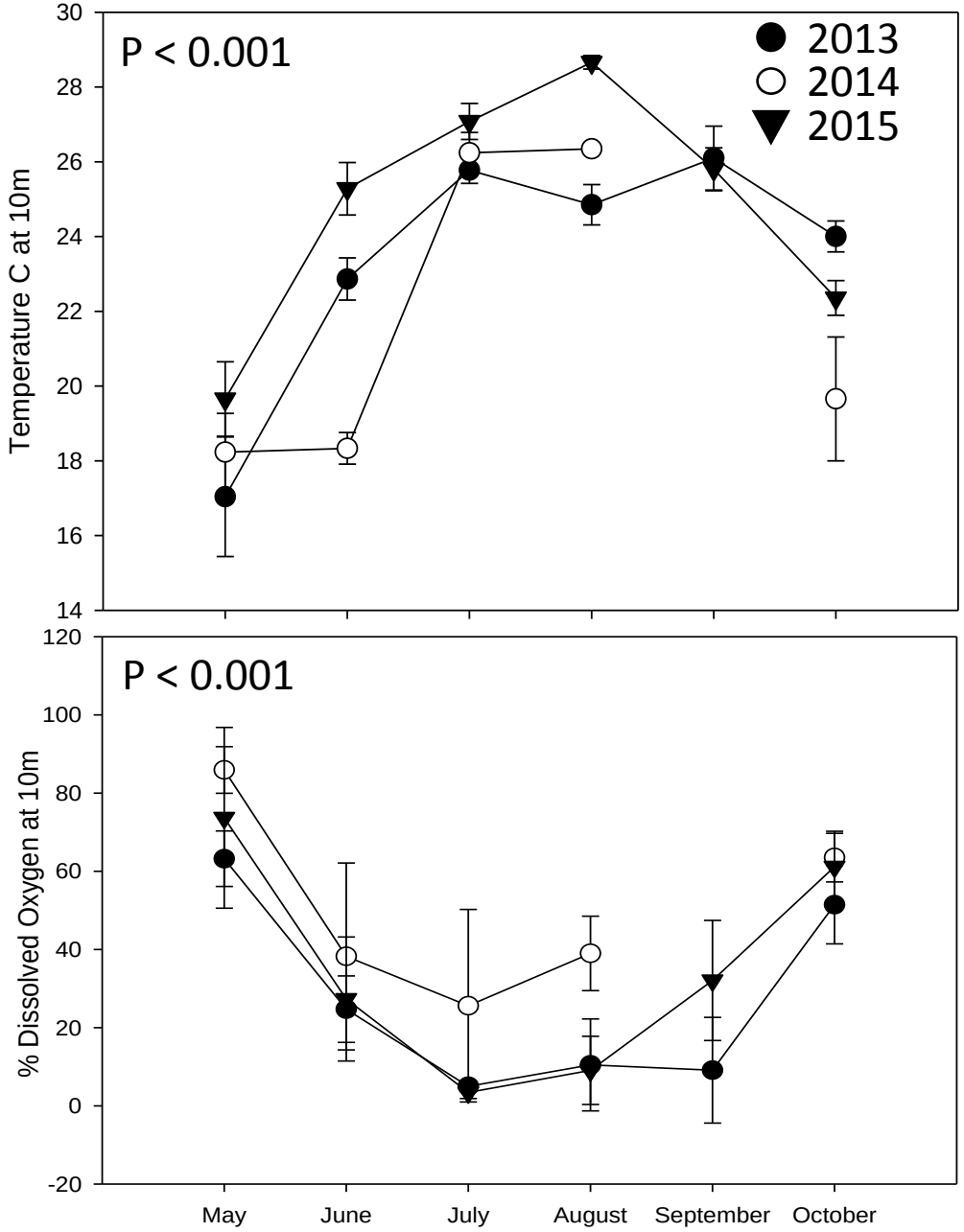


Lake Texoma



Churchill (2013)

Results

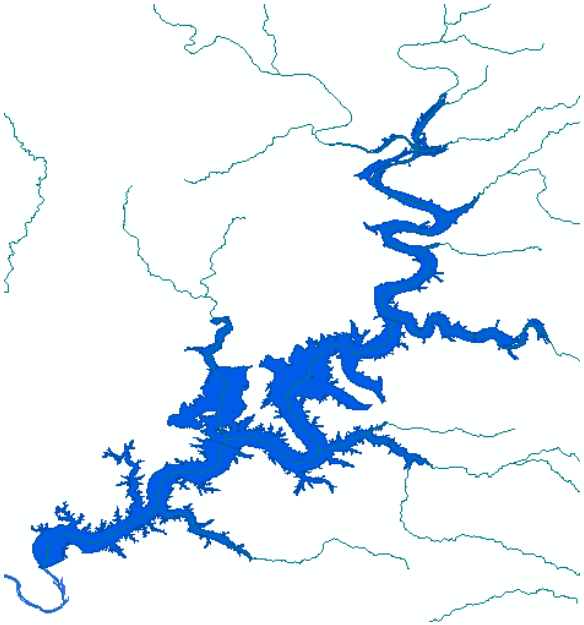

P < 0.001
2013
2014
2015
Temperature C at 10m
30
28
26
24
22
20
18
16
14
P < 0.001
% Dissolved Oxygen at 10m
120
100
80
60
40
20
0
-20
May
June
July
August
September
October

Conclusions

- ZM veligers were detected throughout Grand Lake, but concentrated in the southern portion
- DL were detected throughout Grand Lake, but reached highest densities in the northern portion
- ZM may have a small influence on zooplankton communities
- 2015 ZM crash was probably driven by a combination of flooding and the highest water temperatures and lowest DO levels since ZM were confirmed at Grand Lake in 2013

Future Directions

- Continue to monitor ZM and DL populations
- Survey surrounding watersheds to determine if ZM and DL are dispersing to Grand Lake from multiple sources



Acknowledgements