Zebra mussel research at Texas State University (over the past 10 years)

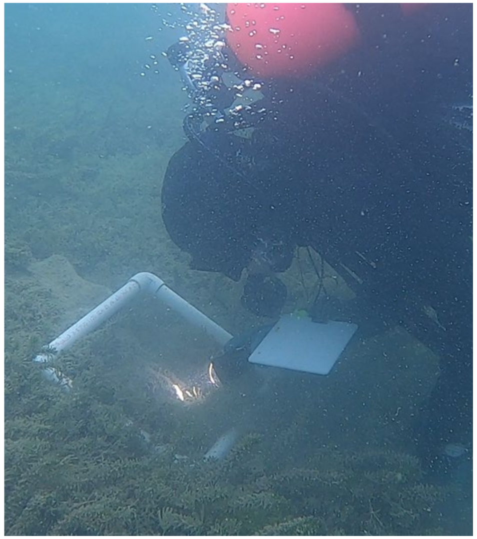
Astrid Schwalb
Department of Biology
Texas State University

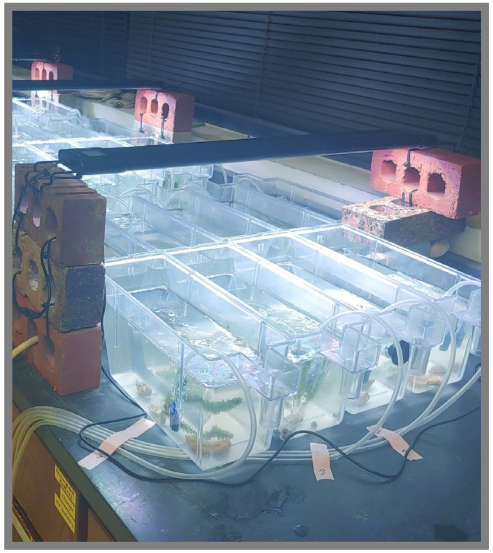
Zebra mussel research at Texas State

Dispersal of zebra mussels

Interaction of zebra mussels with **native species**

Long-term monitoring of population dynamics in Canyon Lake





Dispersal of zebra mussels

Riverine dispersal:

Jenae Olson

Aquatic Invasions (2018) Volume 13, Issue 2: 199–209
DOI: https://doi.org/10.3391/ai.2018.13.2.02

Open Access

Research Article

Dispersal of zebra mussels (*Dreissena polymorpha*) downstream of an invaded reservoir

Jenae Olson[1], Josi J. Robertson[1], Todd M. Swannack[2], Robert F. McMahon[3], Weston H. Nowlin[1], and Astrid N. Schwalb[1,*]

Dispersal via Boaters:

Josi Robertson

Biol Invasions
https://doi.org/10.1007/s10530-020-02333-2

Check for updates

ORIGINAL PAPER

Zebra mussel invasion of Texas lakes: estimating dispersal potential via boats

Josi J. Robertson · Todd M. Swannack · Monica McGarrity · Astrid N. Schwalb

Interactions of invasive zebra mussels with native species

Unionid mussels
Ericah Beason

Aquatic Sciences (2022) 84:21
https://doi.org/10.1007/s00027-022-00853-8
Aquatic Sciences

RESEARCH ARTICLE

Check for updates

Impact of zebra mussels on physiological conditions of unionid mussels in Texas

Ericah Beason[1] · Astrid N. Schwalb[1]

Unionid mussels + thermal stress:
Veronika Hillebrand,
TU Munich

Biol Invasions
https://doi.org/10.1007/s10530-024-03315-4

ORIGINAL PAPER

Check for updates

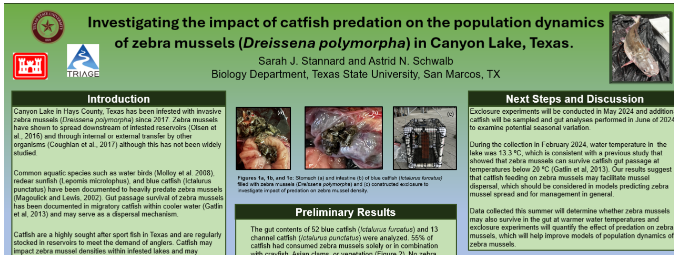
Physiological effects of interacting native and invasive bivalves under thermal stress

Veronika Hillebrand · Andreas H. Dobler · Astrid N. Schwalb · Juergen Geist

Mussels and plants:
Emily Lorkovic

Aquatic Invasions
Two invaders, one reservoir: Hydrilla shapes the distribution of zebra mussels and may facilitate their growth
--Manuscript Draft--

Catfish predation:
Sarah Stannard



Long-term monitoring

Long-term monitoring of Canyon Lake,
since lake was invaded in 2017

Josi Robertson

David Swearingen

Monica McGarrity

TEXAS PARKS & WILDLIFE

+ Comparison with Lake Belton and Stillhouse Hollow

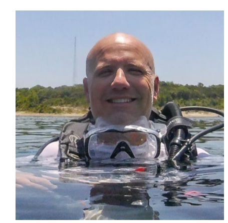
https://doi.org/10.1007/s10530-022-02950-z

ORIGINAL PAPER

Check for updates

Living on the edge: thermal limitations of zebra mussels (*Dreissena polymorpha*) in Central Texas

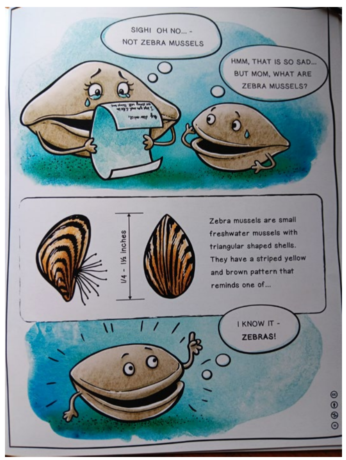
Astrid N. Schwalb · David Swearingen ·
Josi J. Robertson · Jason L. Locklin ·
Josiah S. Moore · Monica McGarrity

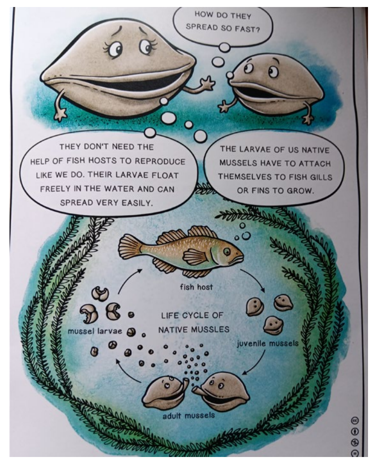


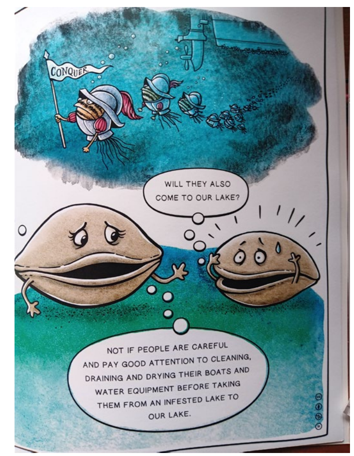
Jason Locklin and Josiah Moore,
Temple College

Outreach

Zebra mussel book for kids
Was sent to ~500 libraries in Texas
(TPWD funds)
Artist: Nicole Harwell







Coloring book accessible at
https://streamecology.wp.txstate.edu/outreach/

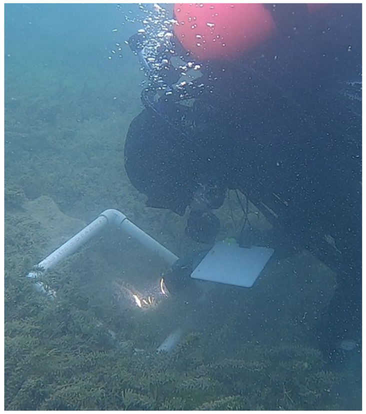
Today's talk

1. **Dispersal** of zebra mussels:

How far are mussels dispersing downstream of an infested reservoir?

2. **Interaction** of zebra mussels with **native species:**

How does zebra mussel presence and attachment affect the physiology of unionid mussels?



3. **Long-term monitoring** of population dynamics in Canyon Lake

How have the drought years affected zebra mussels?

Downstream dispersal

In streams: zebra mussel populations depend on recruitment from an upstream located lake or reservoir.

→ Impoundments facilitate persistence of zebra mussels in larger rivers (Allen & Rancharan 2001)

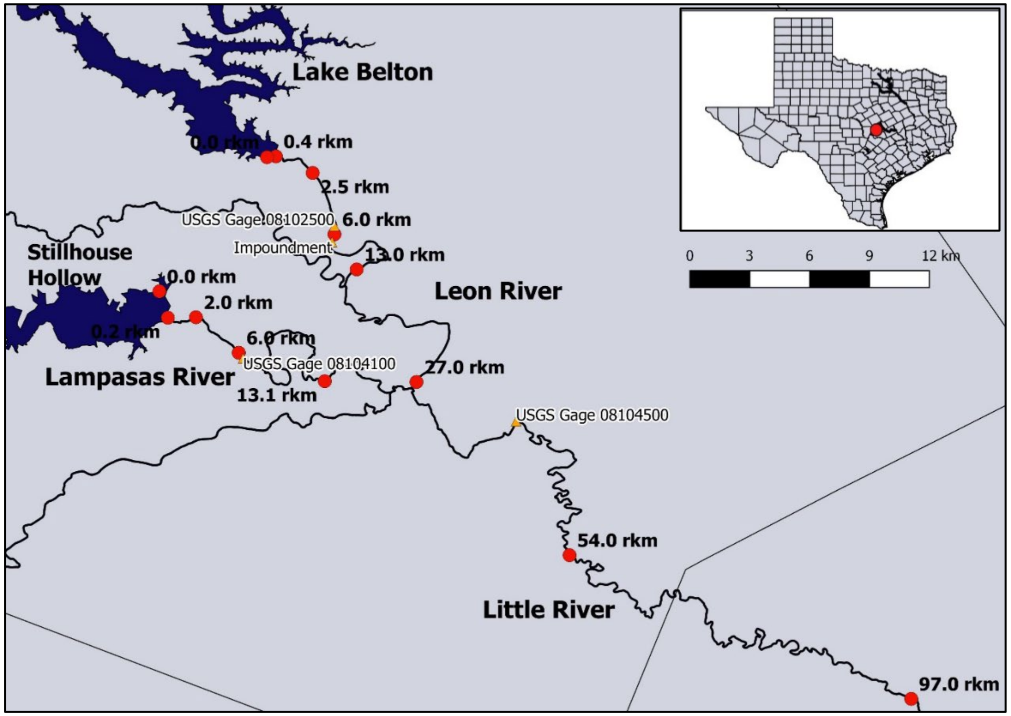
→ Low-head dams could act as stepping stones (Smith et al. 2015)

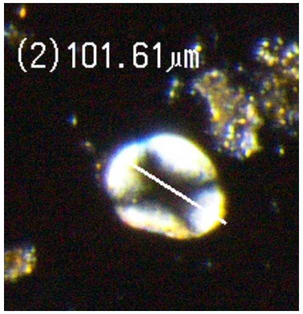
Texas has 7,305 registered dams
+ large number of unreported small and medium sized dams (Chin et al. 2008),
→ could facilitate the spread of zebra mussels

Downstream dispersal

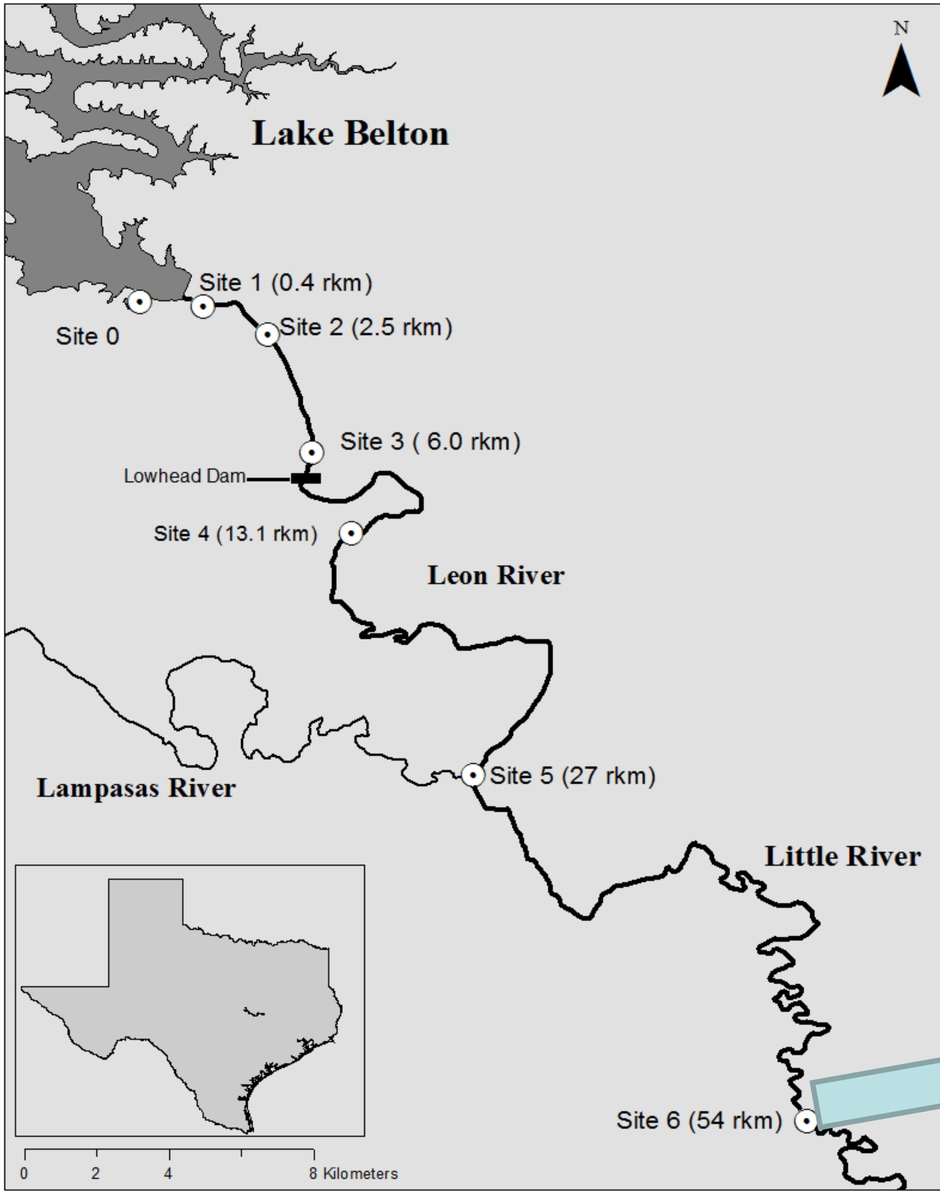
<u>Monitoring of juvenile settlement downstream of:</u>

Lake Belton (invaded 2013): Aug 2015 – Aug 2019
Stillhouse Hollow (invaded 2016): Oct 2016 – Aug 2019
Canyon Lake (invaded 2017): Sep 2017 – August 2021





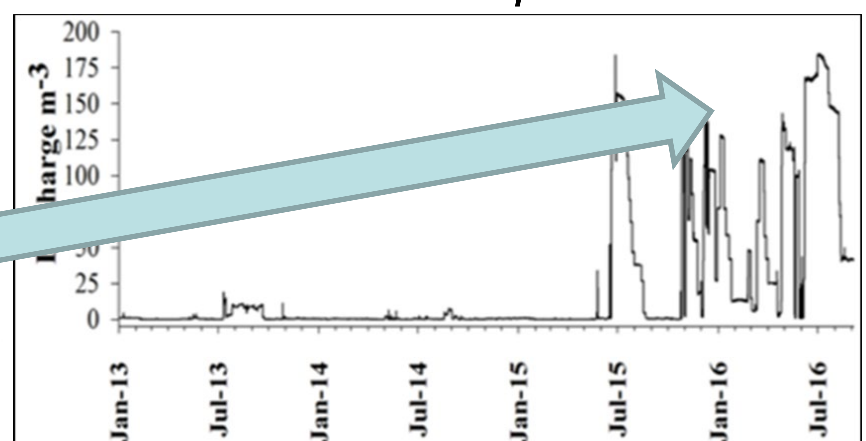
Initial findings
2015-2016



Juvenile settlement
restricted to ≤ 6rkm in 2015.
Up to 54 rkm in April 2016.

→ Prolonged periods of increased river discharge may have facilitated their dispersal further downstream in 2016.

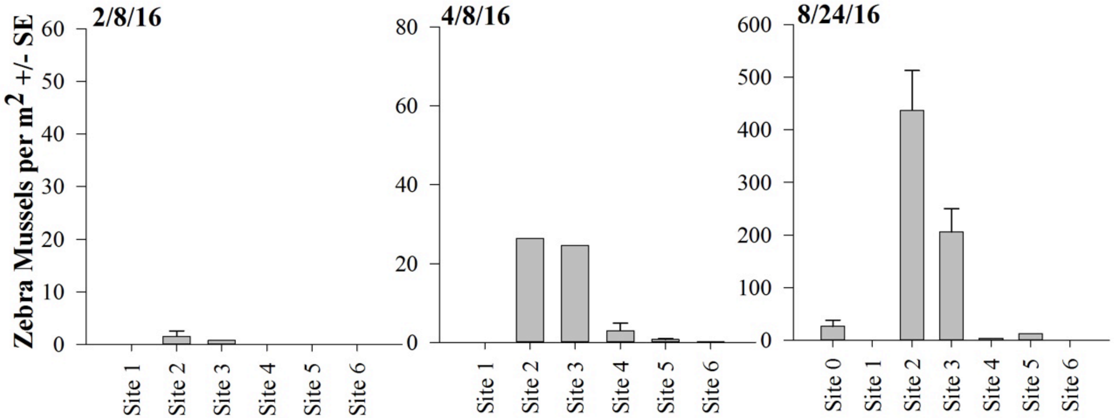
Olsen et al. 2018. *Aquatic Invasions*

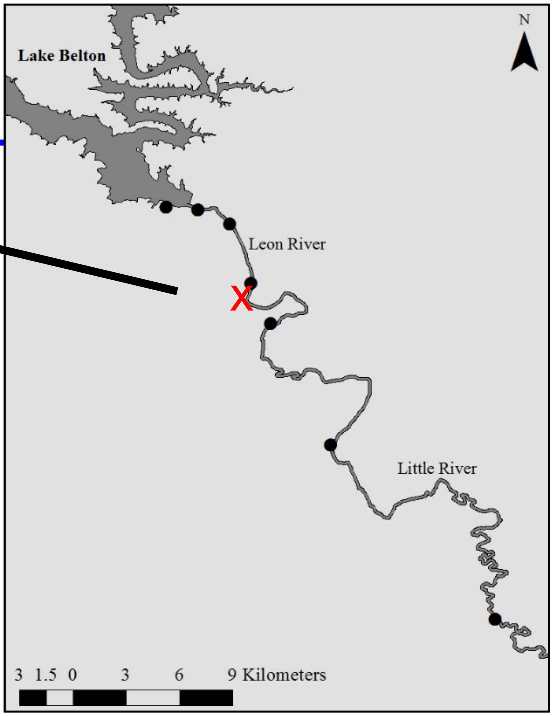


Role of Low-head dams?

Low-head dam at 7rkm

Most settlement detected at sites ≤ 6rkm

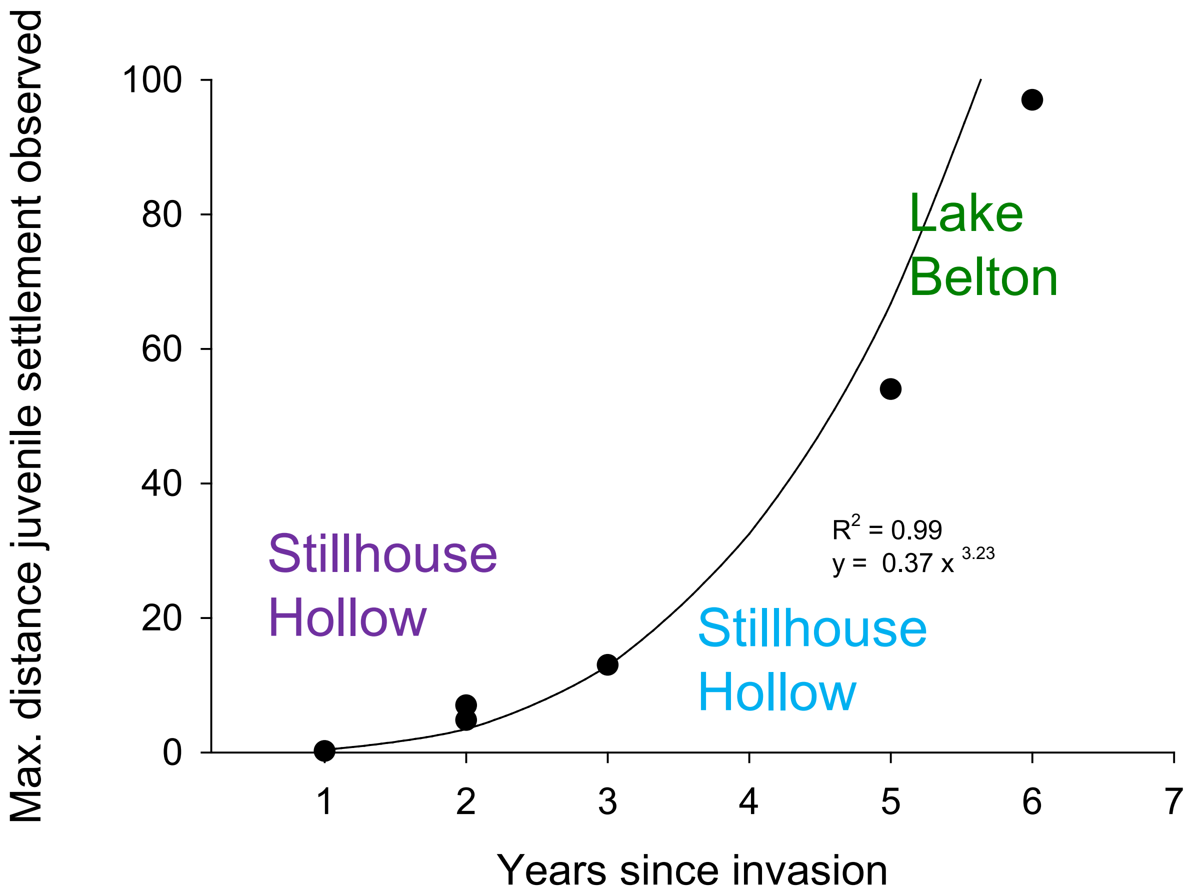




Low-head dams may play an important role for dispersal and settlement, facilitating settlement by reducing flow velocities.

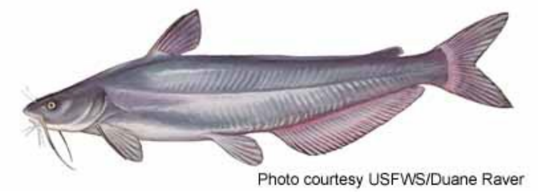
Olsen et al. 2018. *Aquatic Invasions*

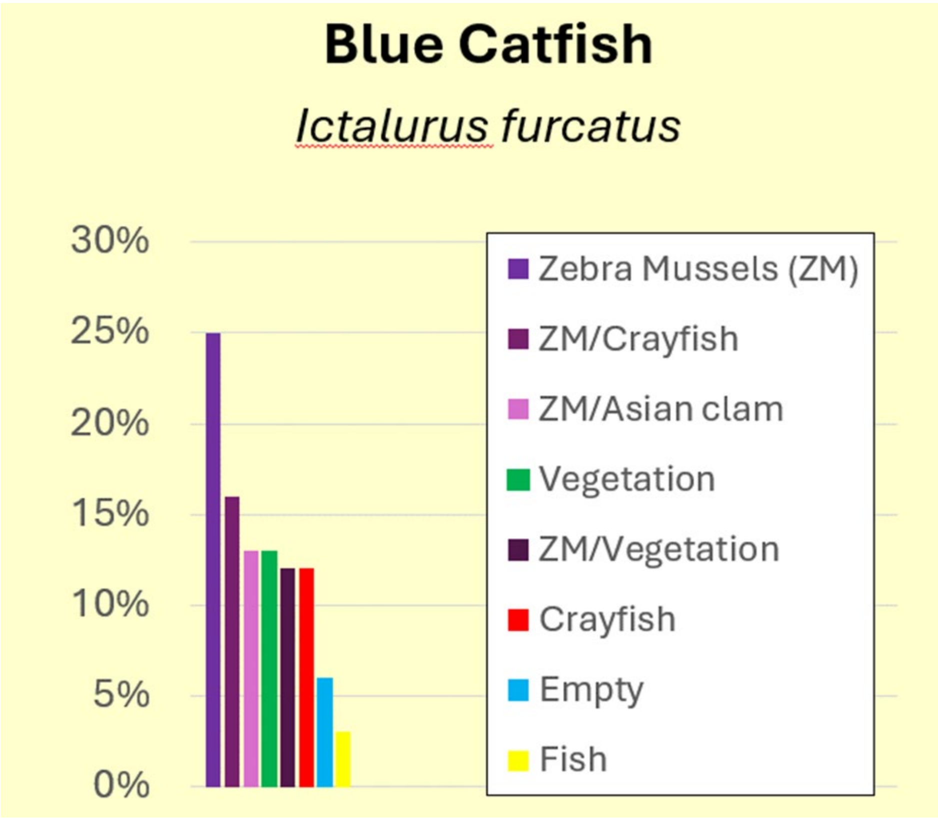
Downstream dispersal depends on time since invasion



Settlement was monitored 2018 and 2019

Potential of dispersal via catfish





Gut content analysis of 52 blue catfish (Ictalurus furcatus) caught in Canyon Lake in February 2024

>60% of blue catfish had consumed zebra mussels

On average 221 ± 5 (mean ± SD) zebra mussels per fish.
15% of blue catfish had > 500 zebra mussels consumed

23% of catfish guts contained at least one living zebra mussel.

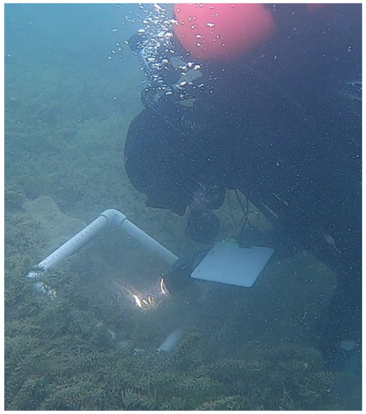
Today's talk

1. **Dispersal** of zebra mussels:

How far are mussels dispersing downstream of an infested reservoir?

2. Interaction of zebra mussels with **native species:**

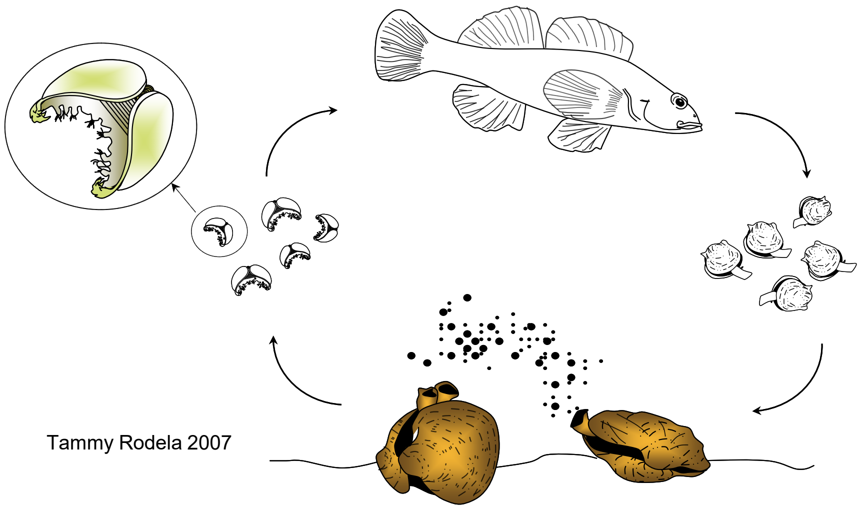
How does zebra mussel presence and attachment affect the physiology of unionid mussels?

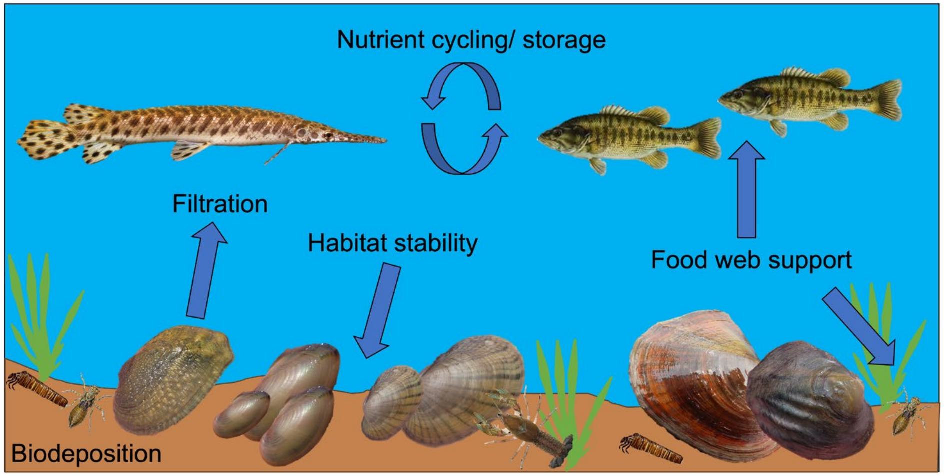


3. Long-term monitoring of population dynamics in Canyon Lake

How have the drought years affected zebra mussels?

Unionid freshwater mussels





Adapted from Kreeger et al. 2018

<u>Unionid mussels 101:</u>
Unique life history, rely on host fish for reproduction and dispersal

Provide important ecosystem services

Highly imperiled, many species have experienced declines

Previous studies

Decline in unionid mussels due to zebra mussel invasion and infestation (Gillis and Mackie 1994, Schloesser and Nalepa 1994, Schloesser et al. 1996, Schloesser 1996)

Impact on physiological health

Symptoms of starvation and stress (Baker and Hornbach 1997, 2000, 2001)

Reduction in glycogen (Haag et al. 1993, Hallac and Marsden 2001, Sousa et al. 2011, McGoldrick et. al 2009)

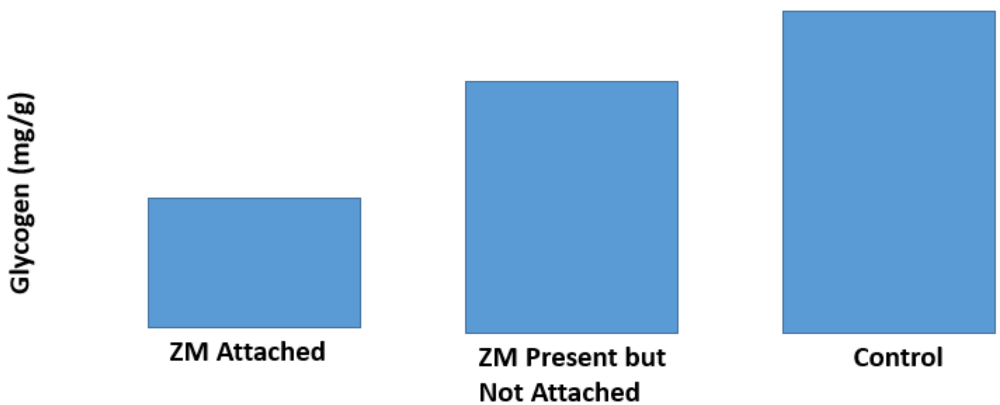
<u>Knowledge gap:</u>

No study has compared impact of infestation and presence of zebra mussels on glycogen storage under controlled conditions.

Objective

Test effects of zebra mussel presence and attachment experimentally

Prediction:



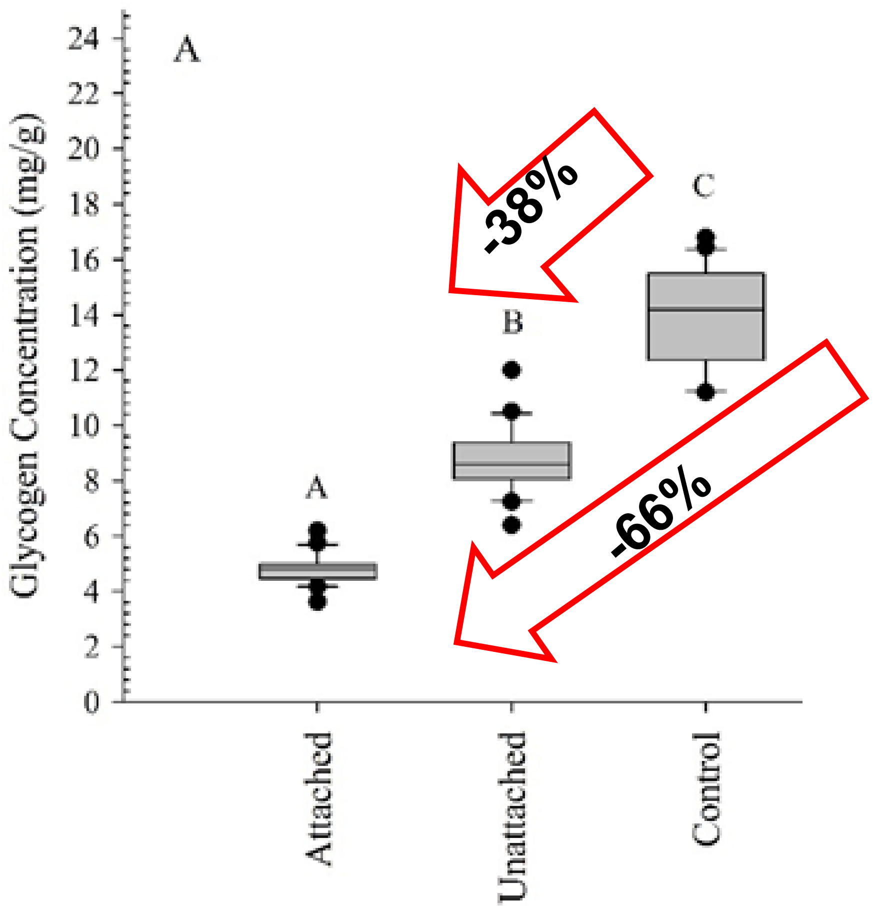
5 *Amblema plicata* per tank, 4 replicates for each treatment and control

Zebra mussel biomass comparable to average field observations

30 days trial, feeding with dosing pump

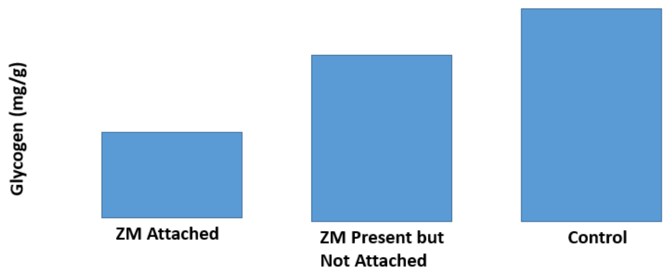
Amblema plicata

Findings



Beason & Schwalb 2022, Aquatic Sciences

Prediction:



Both direct and indirect interactions can significantly reduce glycogen,

but significantly stronger effects by zebra mussel infestation

Tissue samples of field collections generally consistent with lab findings

Today’s talk

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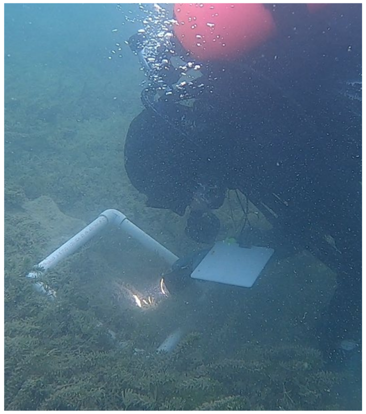


3. Long-term monitoring of population dynamics in Canyon Lake

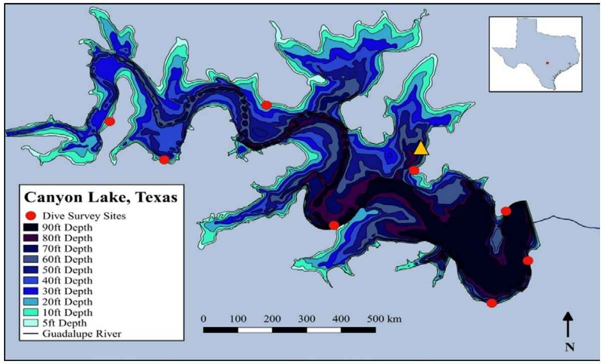
How have the drought years affected zebra mussels?

Monitoring

<u>Juvenile settlement</u>

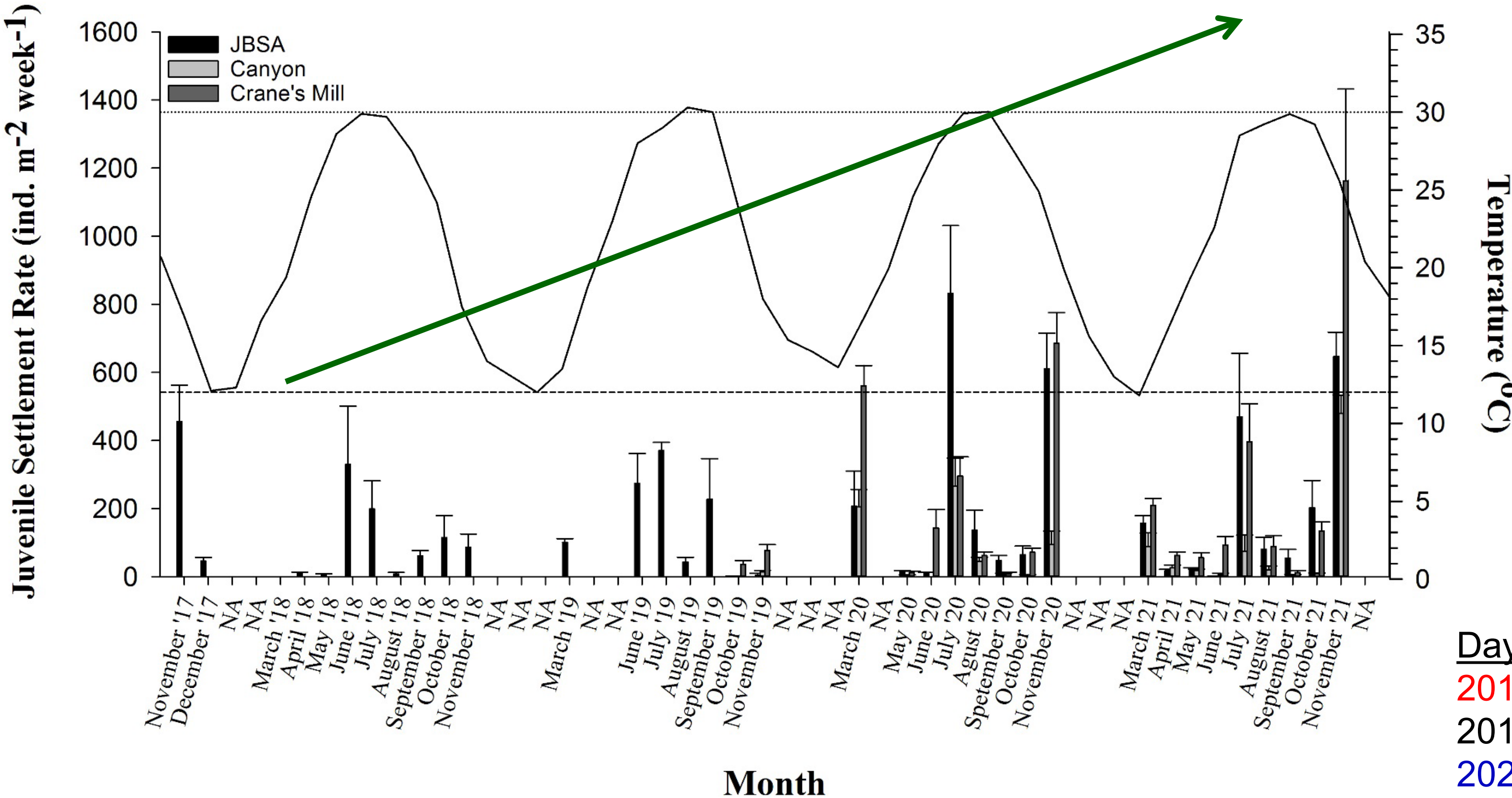
Monthly Sep-Dec 2017, Mar-Nov 2018-2021,
Monthly since Feb 2022

4 bricks at 1-3 marinas for monthly settlement rate
+4 bricks for cumulative settlement



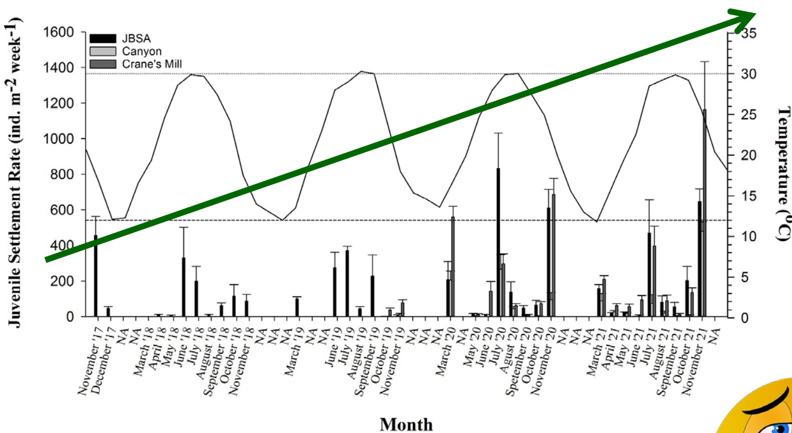
Juvenile settlement

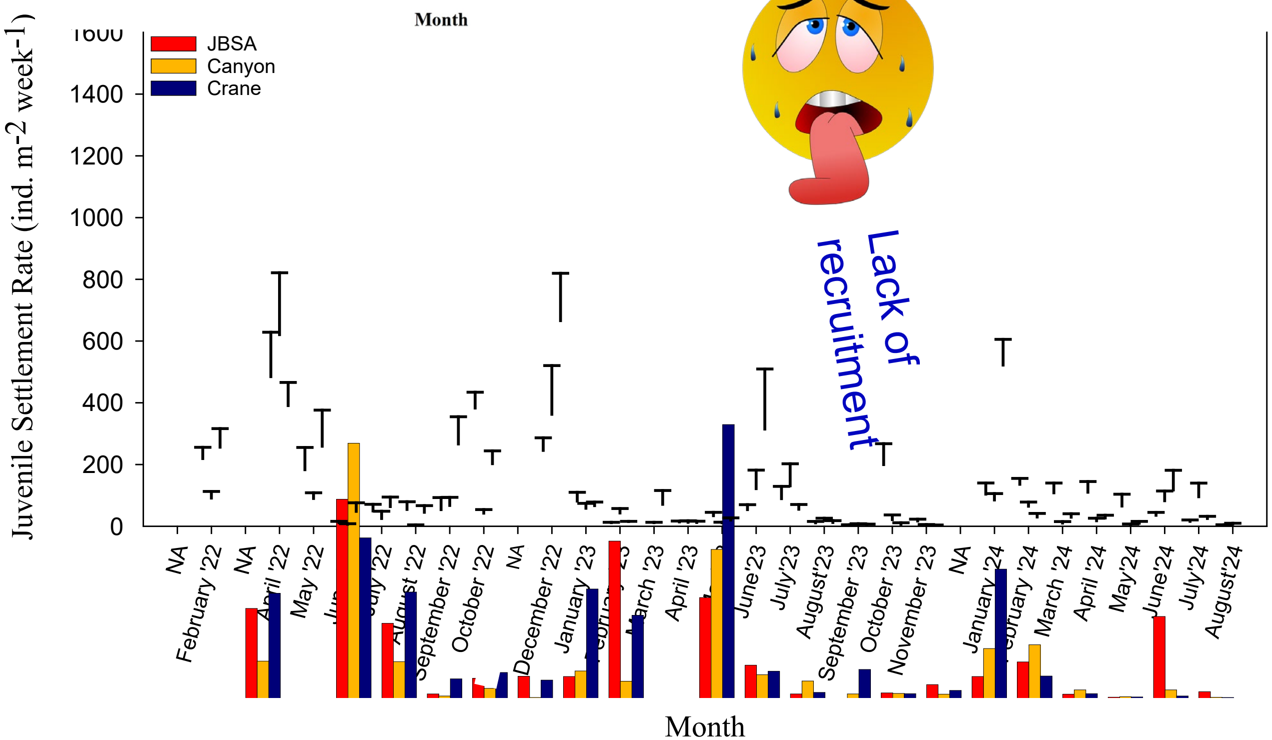
General increase since 2017, highest in November 2021
Peaks often in early summer (Jun/July); highest in 2020 (cooler summer)
Decline when temperature reach 30C;
Other peaks in fall and spring.



Days over 30C:
2019: 41
2018, 2021: 27, 28
2020: 17.

Impact of drought on juvenile recruitment?



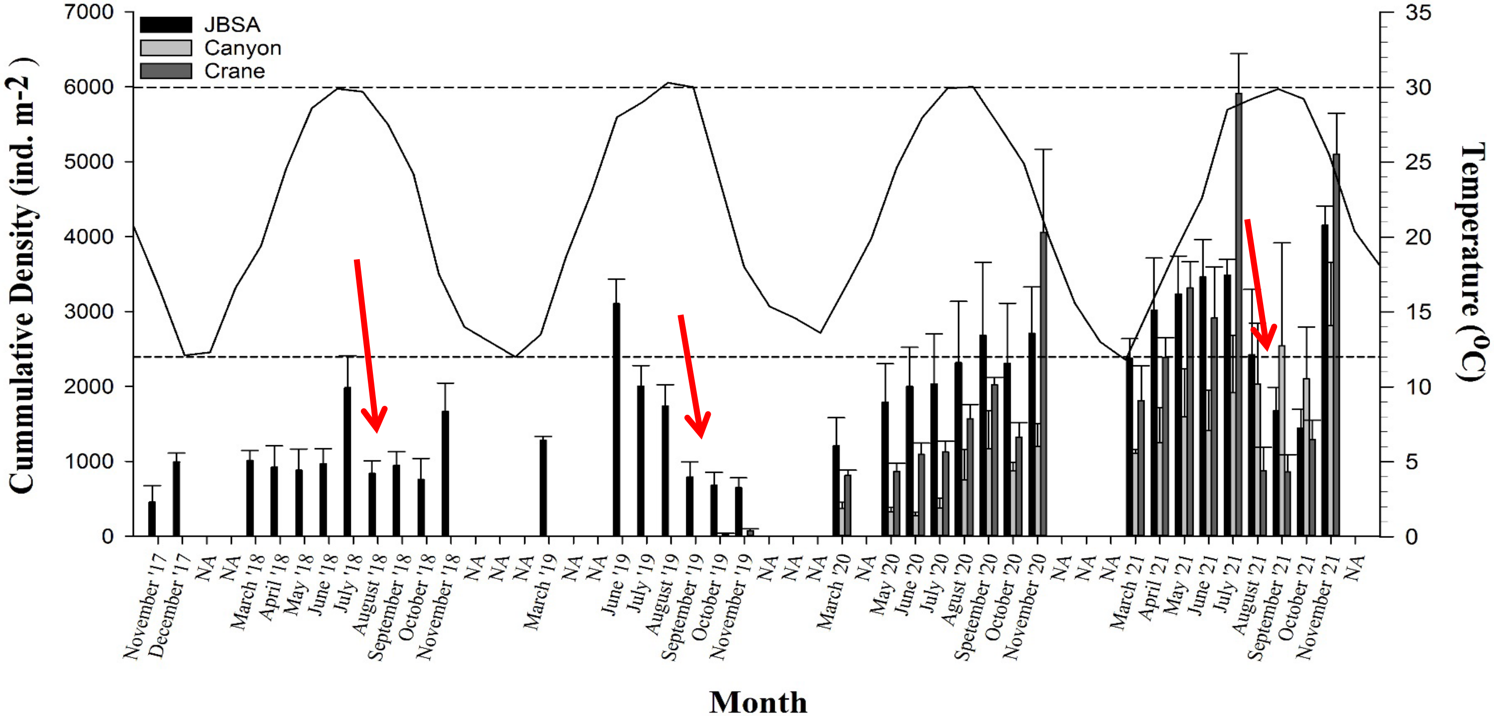


General increase since 2017, max. November 2021

Generally lower recruitment since 2022
→ Drought
Especially low in 2023
→ Lack of recruitment
Aug – Nov 2023
(except JBSA Oct, Nov)

Highest recruitment in April and December 2022 not anymore in early summer.

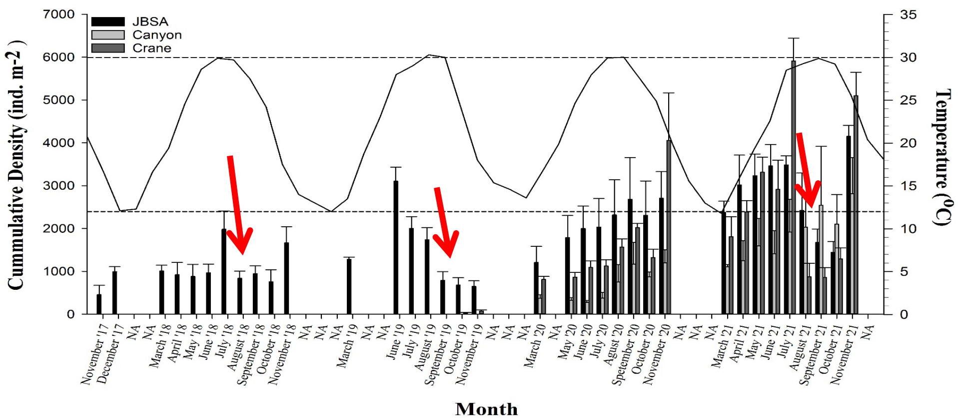
Summer mortality observed on cumulative settlement monitors



In Canyon Lake larger declines (more than -50%) occurred during hot sommer months in 2018, 2019, 2021, but not in 2020
In 2021 only at location with lower DO levels (Crane's Mill)

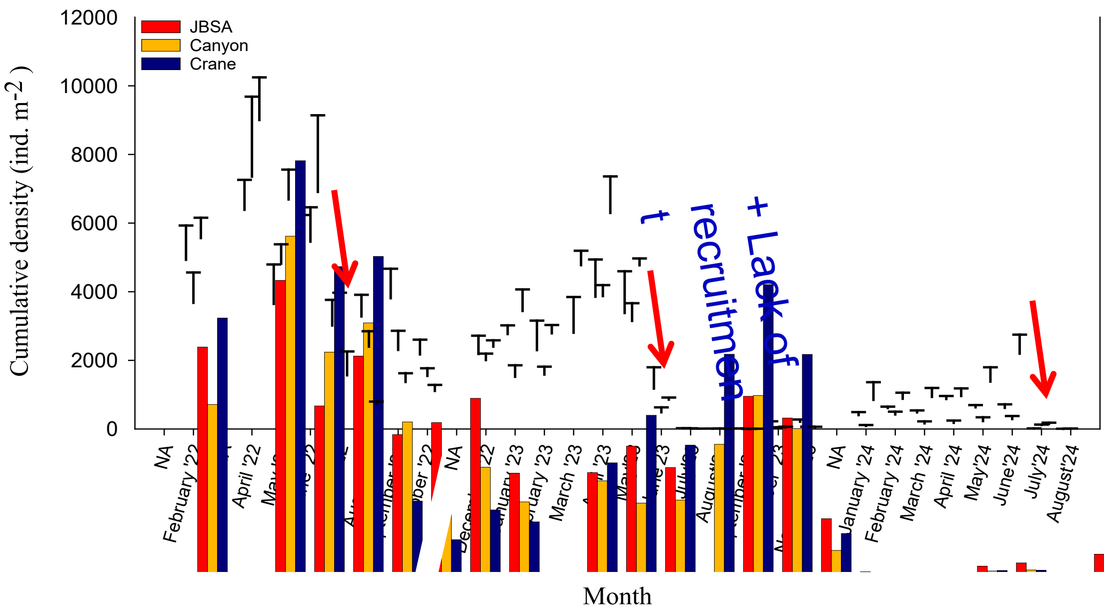
Days over 30C:
2019: 41
2018, 2021: 27, 28
2020: 17.

Summer mortality observed on cumulative settlement monitors



Summer declines also observed in 2022, 2023, and 2024

Will zebra mussels increase again in 2025?



What caused declines?

Extremely low water levels

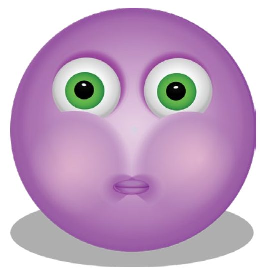
→ smaller lake

→ Less rocky habitat

→ Smaller ZM population

More hydrilla

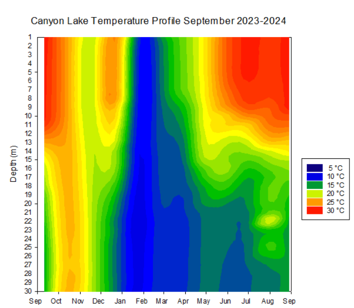
→ Oxygen depletion

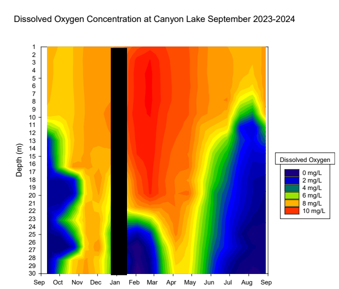


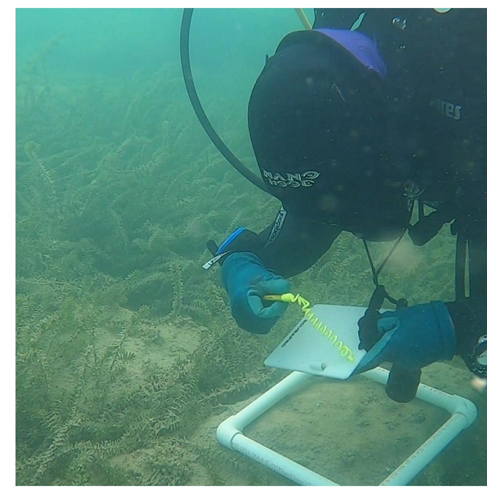
High temperatures (<10m)

Hypoxia (> 10m)

→ Higher mortality







Canyon Lake 3-day DO depletion measured ~3 mg/L
others found ~1.5mg/L

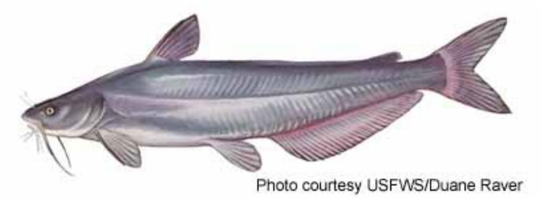
Summary

Riverine dispersal:

Seems to depend on years since invasion

May be facilitated by low-head dams

Another potential vector = catfish predation



Impact on native mussels:

Both zebra mussel presence and infestation can significantly reduce glycogen,

but significantly stronger effects by zebra mussel infestation

Long-term monitoring:

Declines of zebra mussels during drought years.

Recovery once water levels increase?

TEXAS PARKS & WILDLIFE

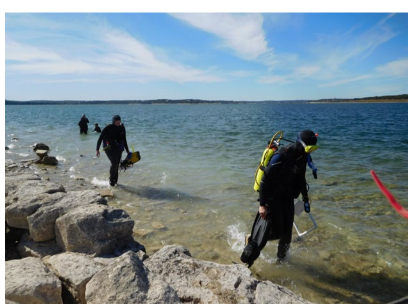
Thanks!

TRIAGE

Thanks to TPWD and USACE for funding our studies!

Thanks to our many helpers in the field and the lab

And to my former and current zebra mussel grad students in my lab and their thesis committee members.

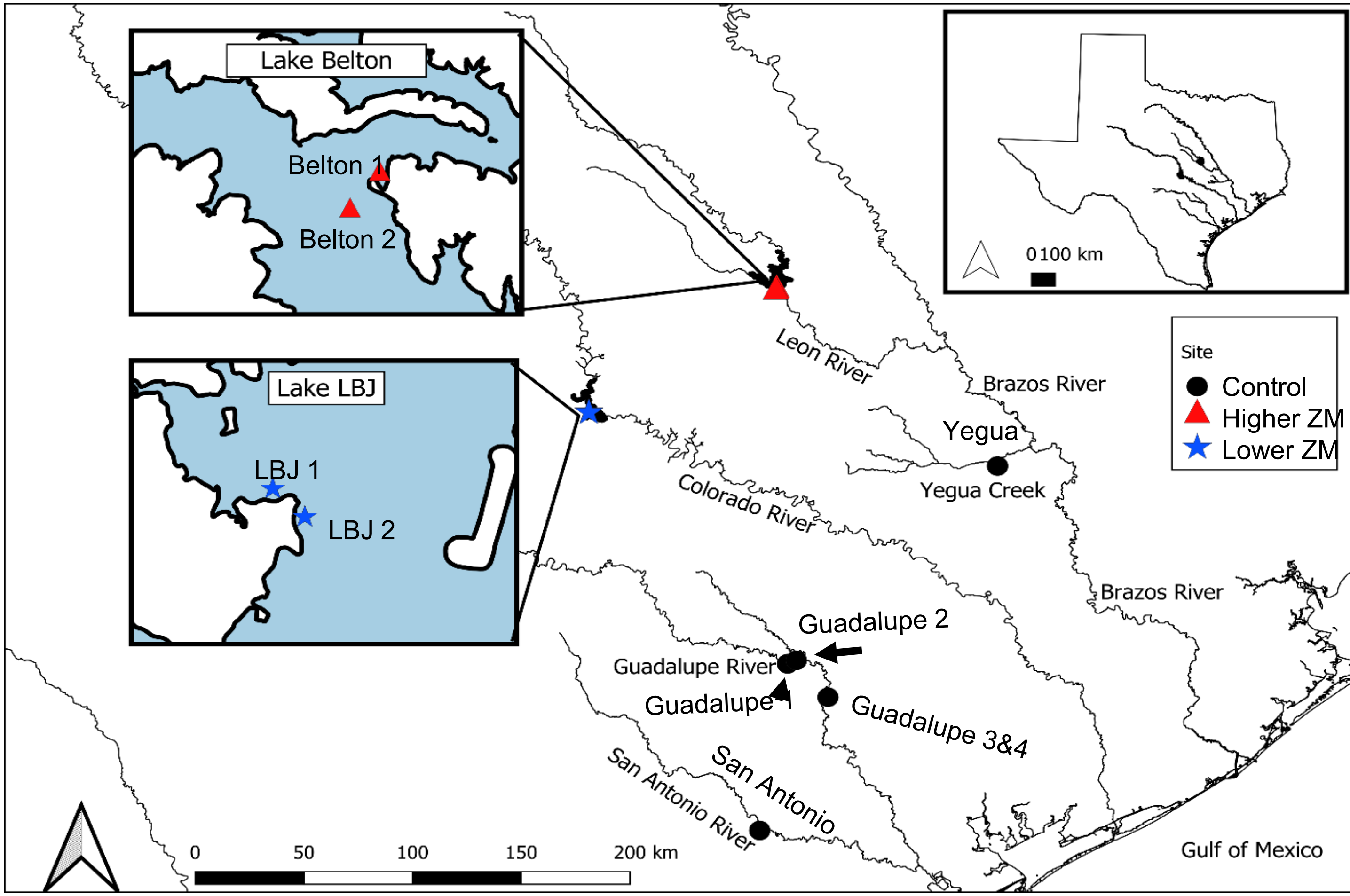


Study Sites

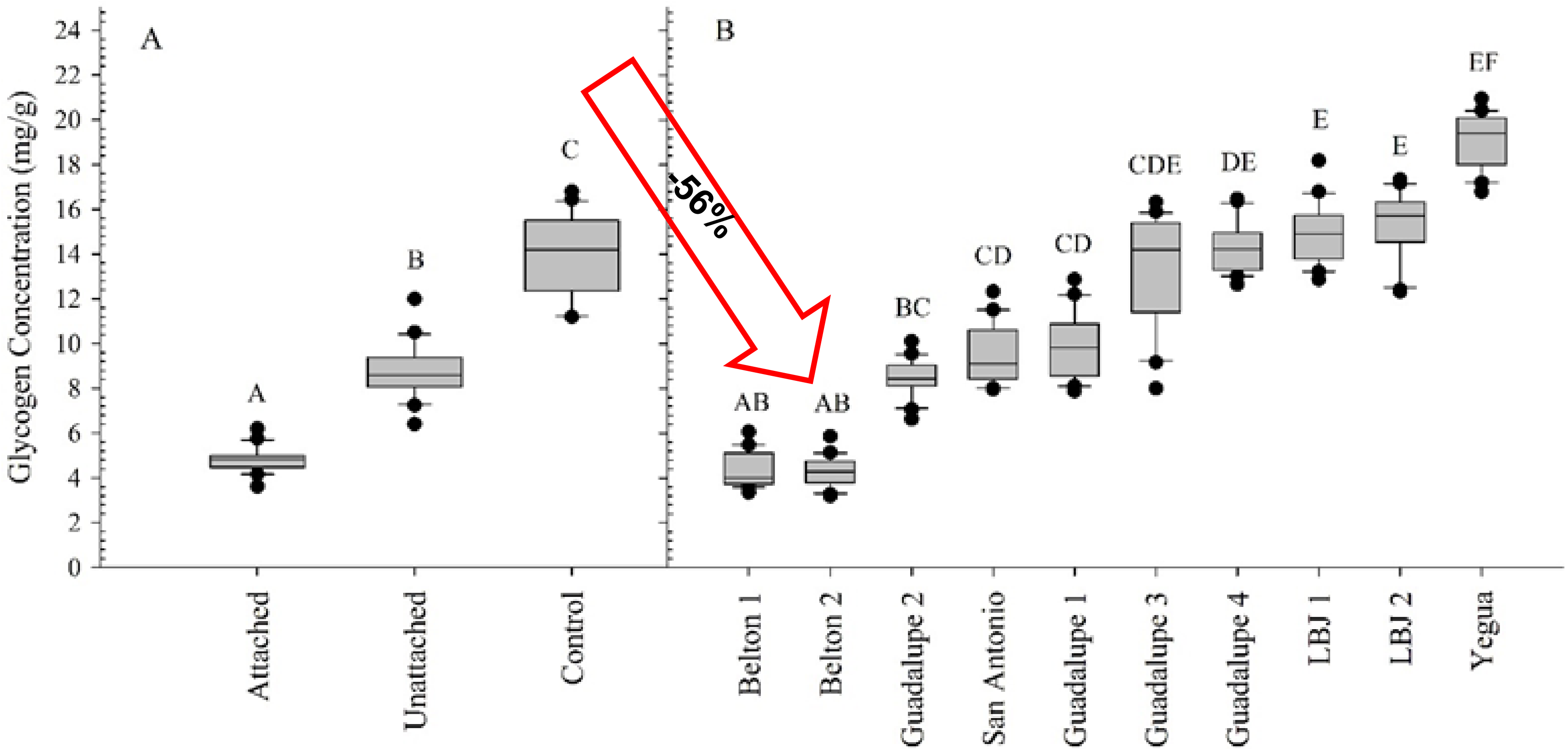
6 control
2 lower ZM
2 higher ZM

Measurement of chlorophyll a

Glycogen samples taken within one month

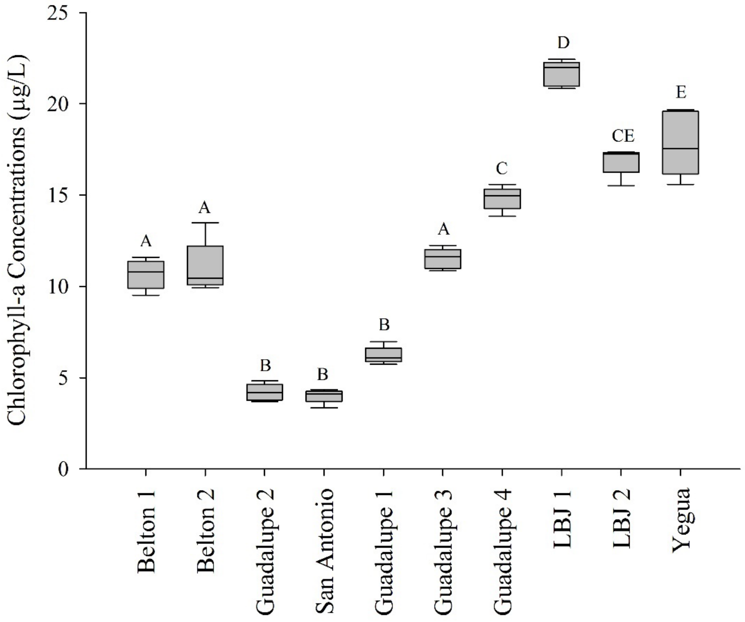


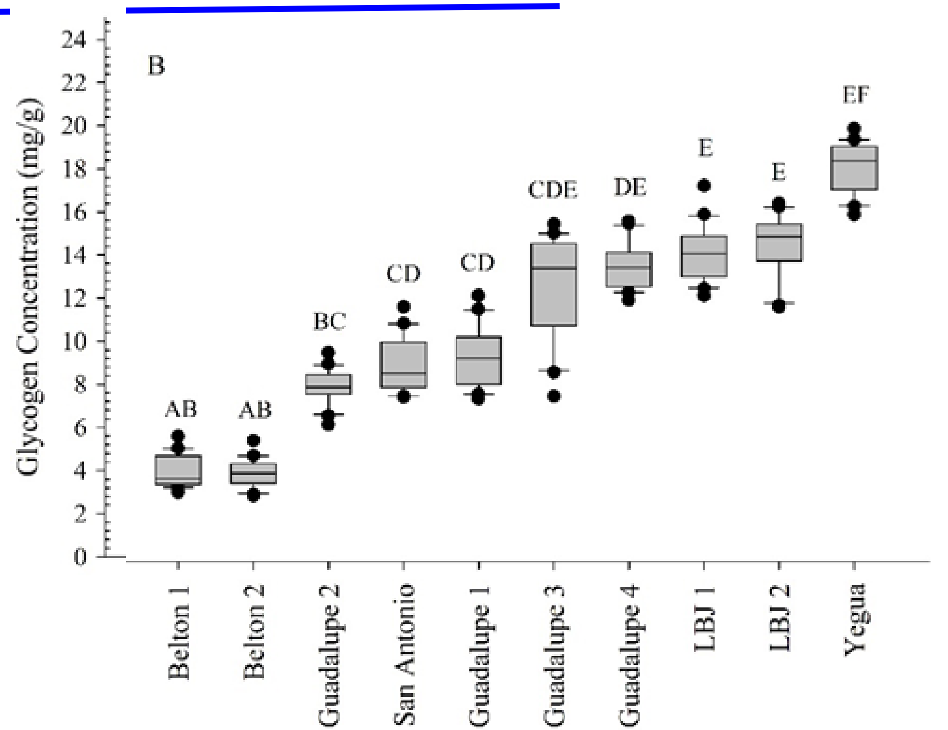
Results



Glycogen Concentration (mg/g)
0
2
4
6
8
10
12
14
16
18
20
22
24
A
B
A
B
C
AB
AB
BC
CD
CD
CDE
DE
E
E
EF
-56%
Attached
Unattached
Control
Belton 1
Belton 2
Guadalupe 2
San Antonio
Guadalupe 1
Guadalupe 3
Guadalupe 4
LBJ 1
LBJ 2
Yegua

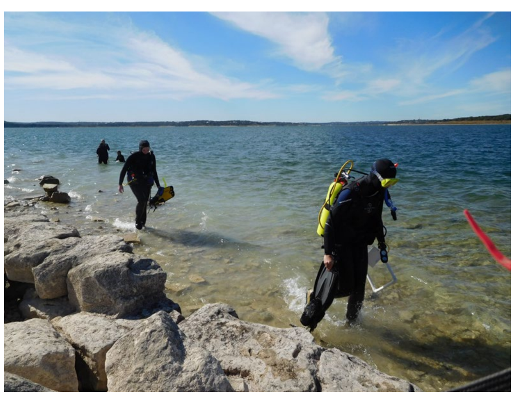
Results





Variation in glycogen best explained by chlorophyll-a + zebra mussel densities or infestation rate

Indication of limitation by high temperature



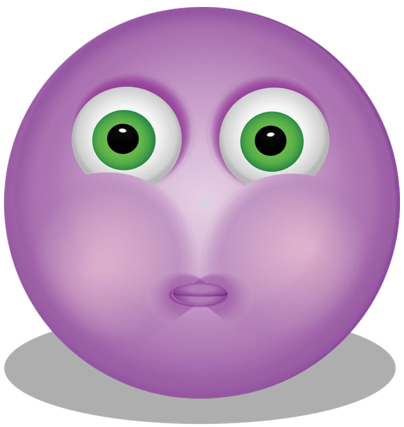
Cumulative settlement: Larger declines during hot summer months in all years, except 2020
+ most frequent declines in 2019 (hottest summer)

Dive surveys: Some declines between July and October at some sites and depths

Cage experiments: Lowest mortality associated with lower temperatures
(at 1m in Lake Belton at 9m in Stillhouse Hollow)

Settlement rates: Highest in July 2020, year with somewhat cooler temperatures.

Indications of limitation by low DO



Lake Belton:
High mortality at 9m.

Canyon Lake:
Higher mortality at at location with lower DO