10-19-2021

# Negative impacts of flood-associated water quality stressors on early oyster life stages

Jessica Pruett
*University of Mississippi*, jlpruett@olemiss.edu

Ann Fairly Pandelides
*University of Mississippi*

Kristine Willett
*University of Mississippi*

Stephanie Showalter Otts
*University of Mississippi*

Deborah Gochfeld
*University of Mississippi*

# Negative impacts of flood-associated water quality stressors on early oyster life stages

Jessica Pruett[1*], Ann Fairly Pandelides[2], Jaycie Keylon[2], Kristine Willett[2], Stephanie Showalter Otts[3], and Deborah Gochfeld[1,2]
[1]National Center for Natural Products Research; [2]Department of Biomolecular Sciences; [3]National Sea Grant Law Center, University of Mississippi
*jlpruett@olemiss.edu

## Research Objectives

- To determine the effects of single and multiple flood-associated stressors on larval development and survival
- To assess the response and recovery of juvenile oysters to single and multiple flood-associated stressors
- To provide recommendation for oyster reef restoration efforts in the Mississippi Sound

## Background: 2019 Bonnet Carré Spillway Opening

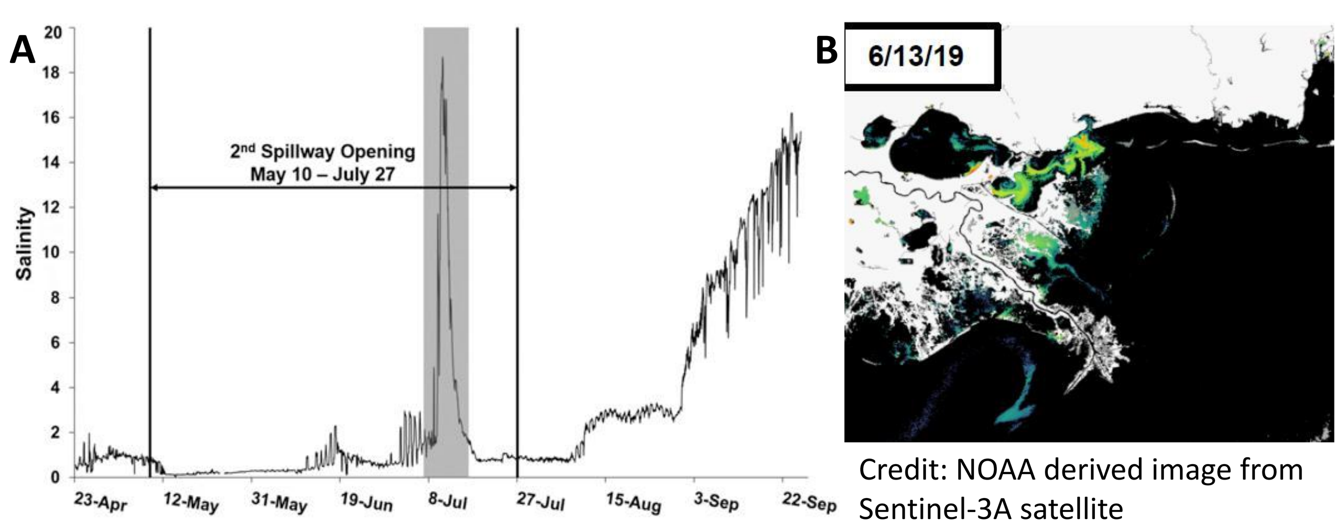
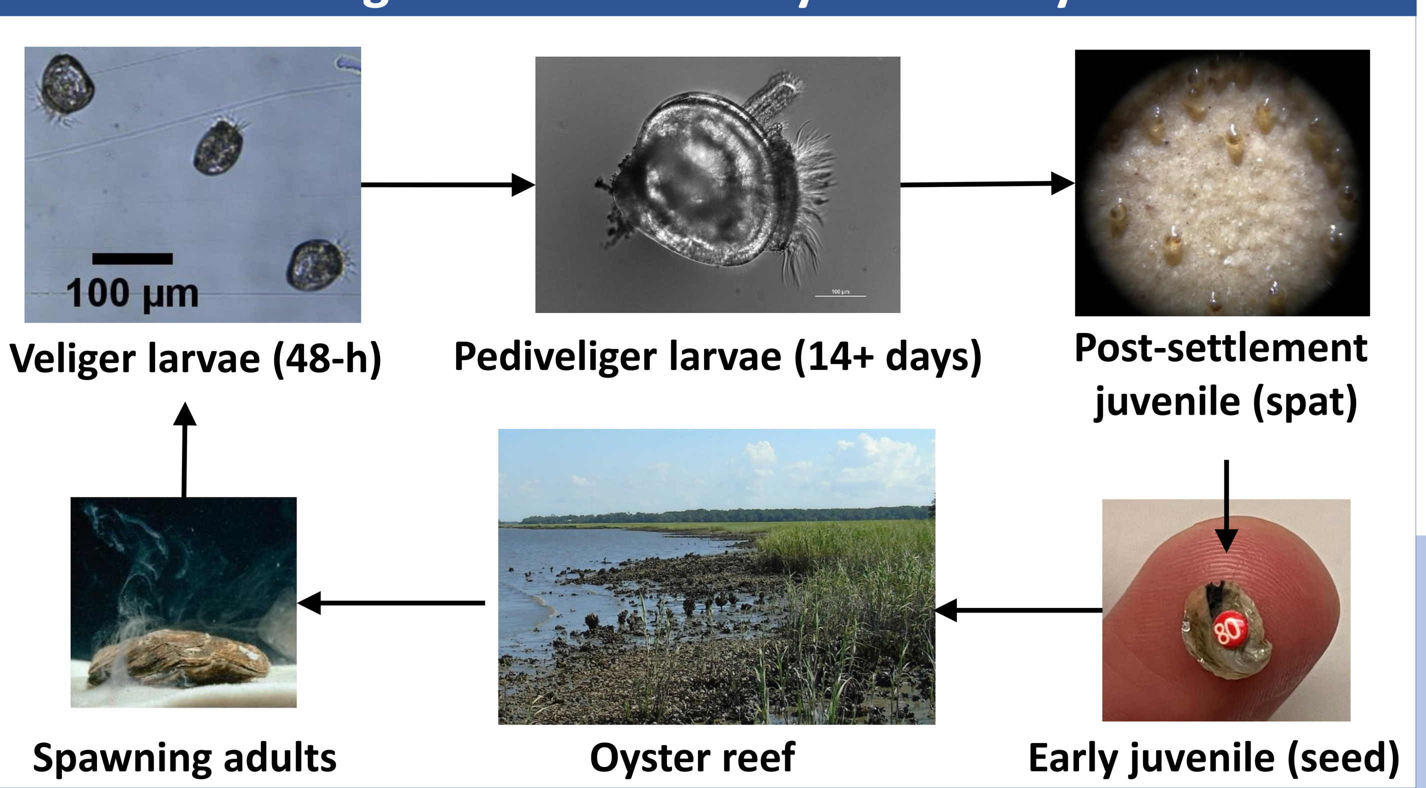




**Figure 1.** In 2019, Bonnet Carré Spillway (BCS) openings caused a major freshwater flooding event that reduced water quality in the Mississippi Sound which decimated the local oyster fishery[2]. A) Continuous data for salinity during and after the second BCS opening in Bay St. Louis Reef, MS. Spike in salinity preceded Hurricane Barry landfall in LA on 13 July 2019 due to wind-induced mixing[2]. B) NOAA derived image from Sentinel-3A satellite showing peak of freshwater microcystin-producing cyanobacterial bloom (red areas) during second BCS opening.

## Background: Eastern Oyster Life Cycle




***Funding Disclaimer:*** *This project was paid for with federal funding from the U.S. Department of the Treasury, the Mississippi Department of Environmental Quality, and the Mississippi Based RESTORE Act Center of Excellence under the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012 (RESTORE Act). The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the Department of the Treasury, the Mississippi Department of Environmental Quality, or the Mississippi Based RESTORE Act Center of Excellence.*

## Larval Lab Experiments

### 2020 Single Stressor Exposures

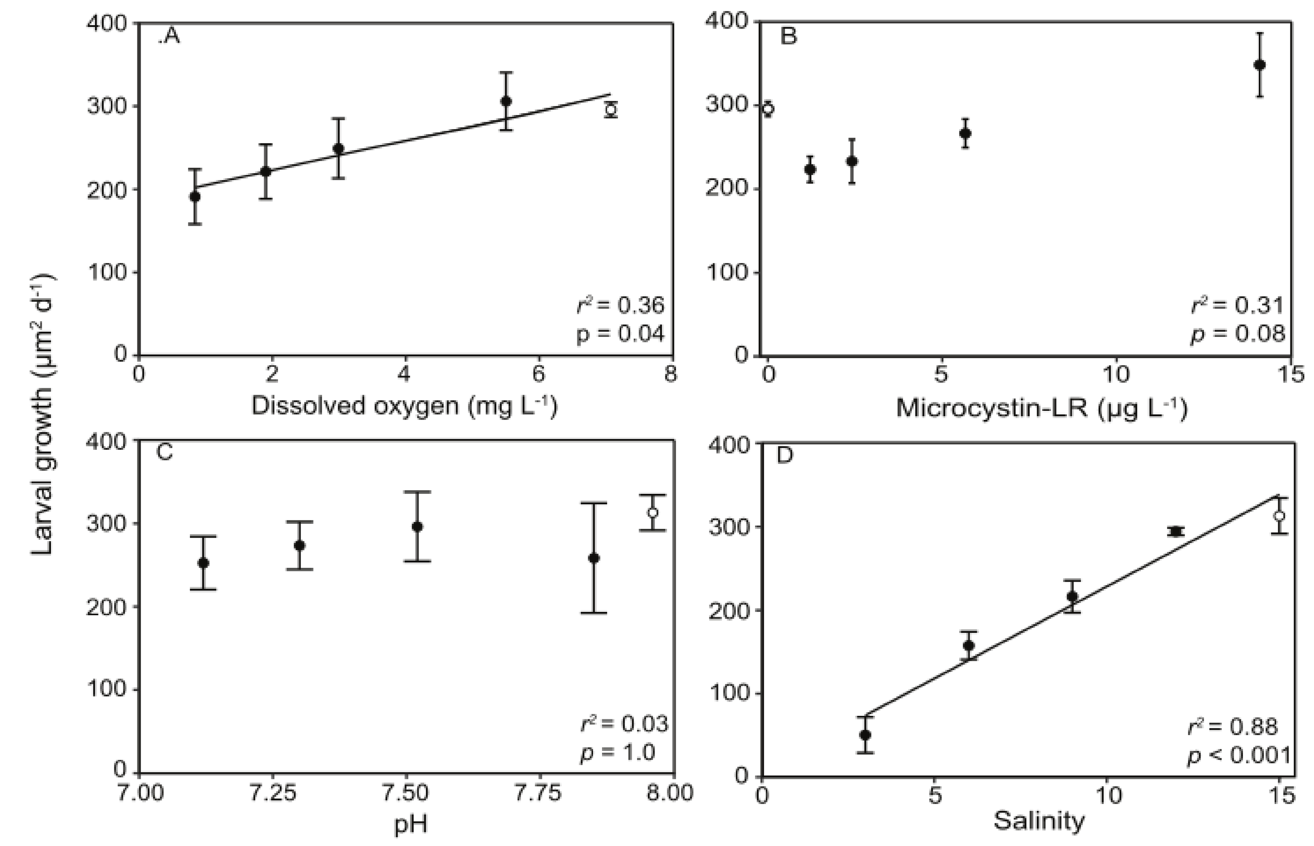



**Figure 2.** Mean (+ SE) shell growth rate of veliger larvae as a function of A) dissolved oxygen, B) microcystin-LR, C) pH, and D) salinity after 96-h single stressor exposure. Open symbol indicates control treatment.

### 2021 Multiple Stressor Exposures

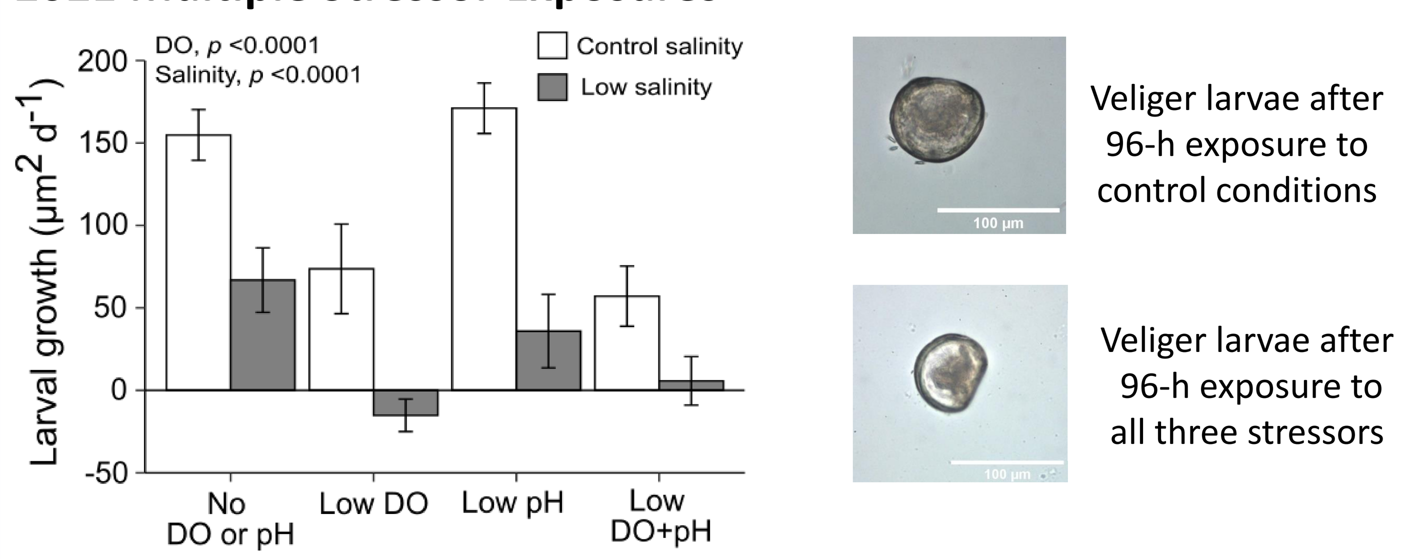



**Figure 3.** Mean (+ SE) shell growth rate of veliger larvae after 96-h exposure to low dissolved oxygen (DO), pH, and/or salinity stressors. Significant main effects appear in upper left corner. There were no significant interactions between stressors.

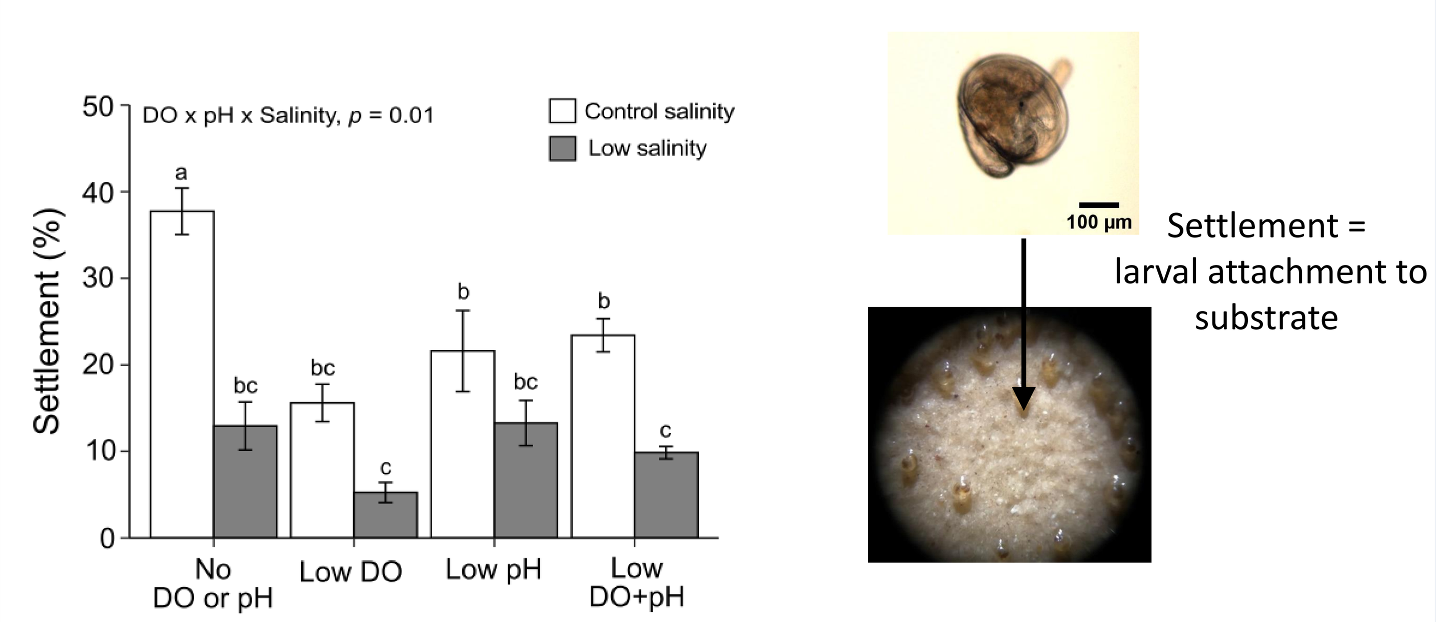



**Figure 4.** Mean (+ SE) percent settlement of pediveliger larvae after 48-h exposure to low dissolved oxygen (DO), pH, and/or salinity stressors. There was a significant interaction between all three stressors. Different letters denote means that are significantly different based on Tukey's post hoc tests ($p < 0.05$).

## Conclusions

- Multiple flood-associated stressors have interactive negative effects on early oyster life stages.
- These negative impacts may reduce recruitment and population resilience so need to be considered in oyster reef restoration planning and flooding risk management.

## Juvenile Lab Experiments

### 2020 Single Stressor Exposures

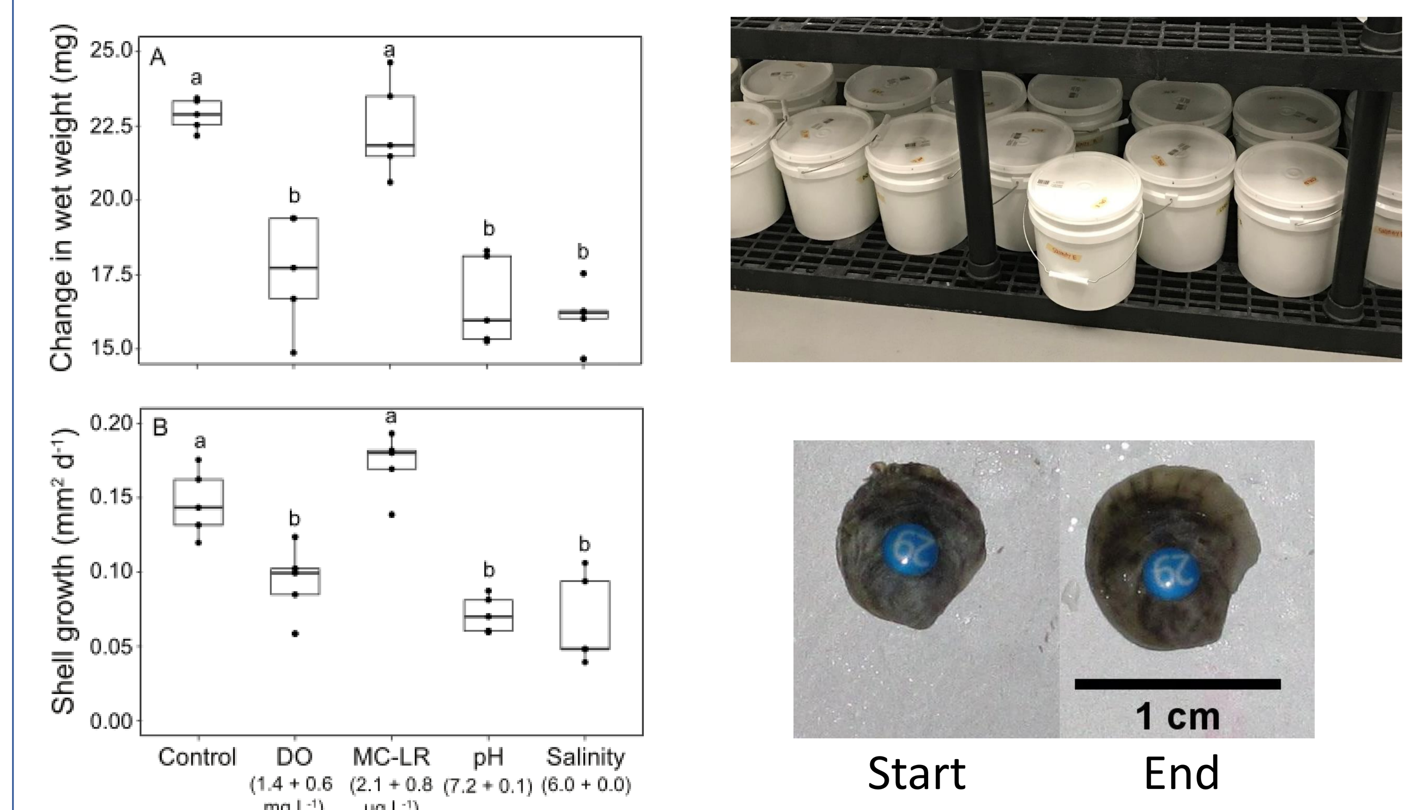



**Figure 5.** Boxplots with raw values showing juvenile oyster growth as (A) change in juvenile wet weight and (B) shell area in each single stressor treatment after 24-d exposure. Mean ± SD values for each stressor treatment are shown. Different letters denote means that are significantly different based on Tukey's post hoc tests ($p < 0.05$).

### 2021 Multiple Stressor Exposures

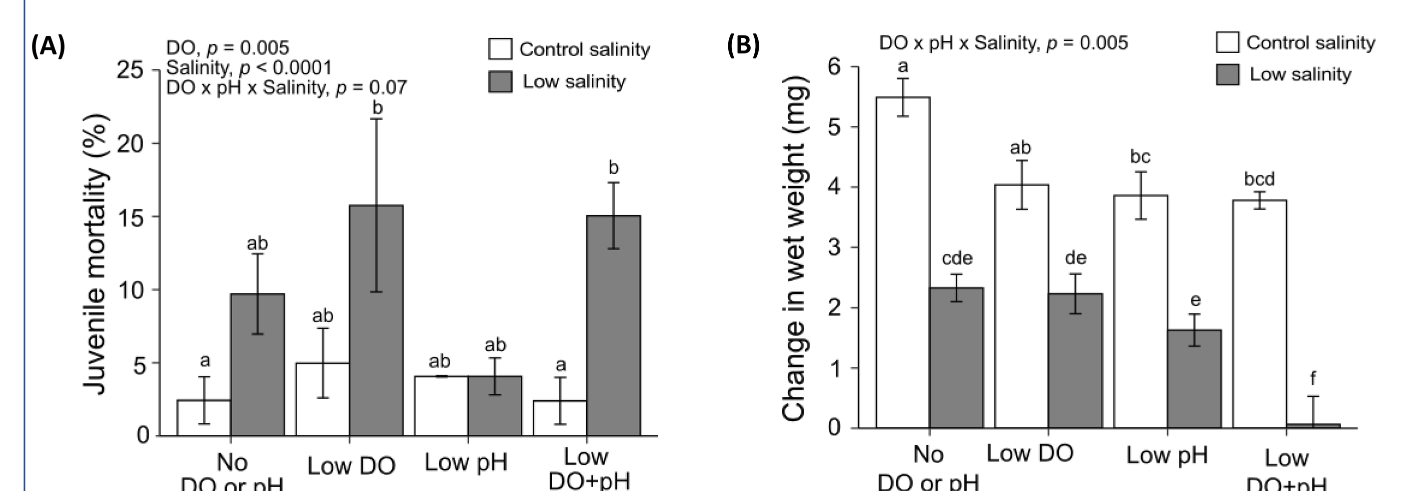



**Figure 6.** Mean (+ SE) (A) percent juvenile mortality and (B) change in wet weight after 24-d exposure to low dissolved oxygen (DO), pH, and/or salinity stressors. Significant main effects and interactions appear in upper left corner. Different letters denote means that are significantly different based on Tukey's post hoc tests ($p < 0.05$).

## 2020 Juvenile Field Deployment

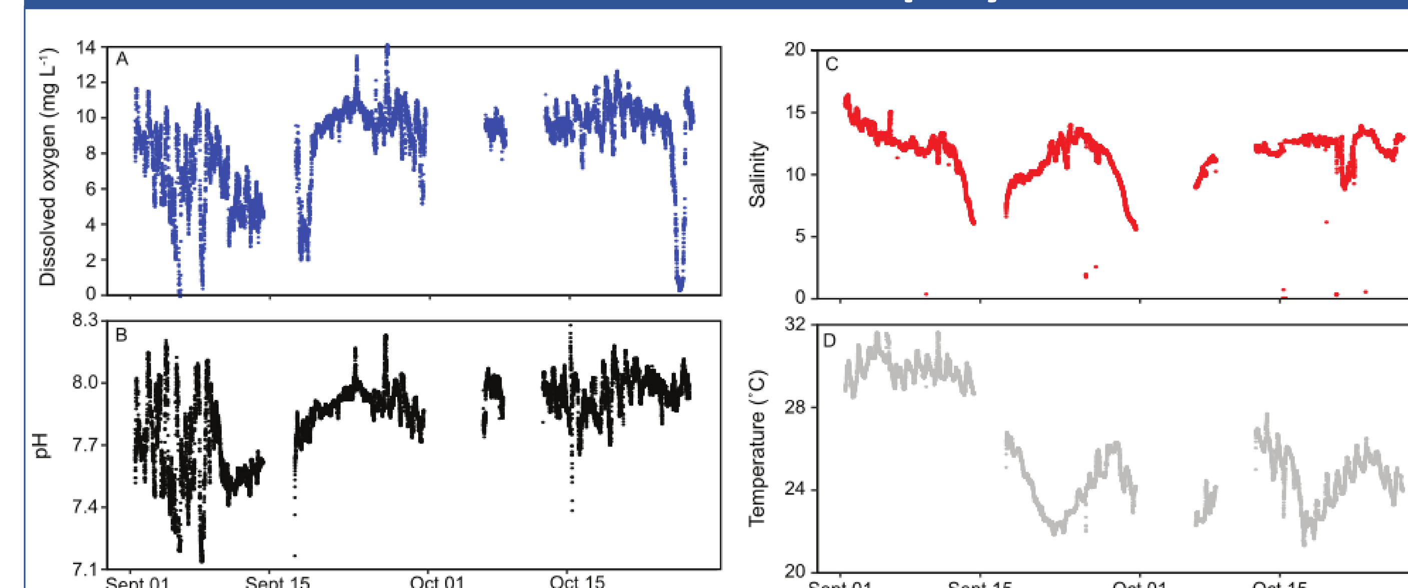



**Figure 7.** Continuous water quality data during the two-month field juvenile deployment at Bay St. Louis, MS. Gaps in data due to equipment removal for hurricanes or sensor maintenance.

## Acknowledgements

We thank Scott Rikard (Auburn University Shellfish Laboratory) for providing oysters and husbandry advice, Greg Easson for use of the water quality sensors and Suresh Sulochana for MC-LR analysis. Field assistance was provided by Letha Boudreaux and the Saint Stanislaus High School Marine Science Program interns. Field research was conducted under Mississippi Department of Marine Resources Scientific Research Permit SRP-026-20.

## References

1. A. Rozier, A flood catastrophe: how a warming climate and the Bonnet Carré Spillway threaten the survival of Coast fishermen. *Mississippi Today* 29 Apr 2020 https://mississippitoday.org/2020/04/29/a-flood-of-catastrophe-how-a-warming-climate-and-the-bonnet-carre-spillway-threaten-the-survival-of-coast-fishermen/
2. J. H. Gledhill, A. F. Barnett, M. Slattery, K. L. Willett, G. L. Easson, S. S. Otts, D. J. Gochfeld, Mass mortality of the eastern oyster *Crassostrea virginica* in the western Mississippi Sound following unprecedented Mississippi River flooding in 2019. *Journal of Shellfish Research.* **39**, 235-244 (2020).
3. J. L. Pruett, A. F. Pandelides, K. L. Willett, D. J. Gochfeld, Effects of flood-associated stressors on growth and survival of early life stage oysters (*Crassostrea virginica*). *Journal of Experimental Marine Biology and Ecology* **544**, 151615 (2021).