New blue crab research projects at GCRL

Zachary Darnell

The University of Southern Mississippi

zachary.darnell@usm.edu

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

THE CRABORATORY
The University of Southern Mississippi

- Quantifying and reducing discard mortality of undersized and ovigerous crabs in the Gulf of Mexico blue crab fishery
  - Funded by NOAA/NMFS Saltonstall Kennedy
  - 9/1/2023–8/31/2025

- Predicting impacts of climate change on blue crab growth, size at maturity, and reproductive output
  - Funded by MS-AL Sea Grant Consortium
  - 2/1/2024–1/31/2026

- **Quantifying and reducing discard mortality of undersized and ovigerous crabs in the Gulf of Mexico blue crab fishery**
  - Funded by NOAA/NMFS Saltonstall Kennedy
  - 9/1/2023–8/31/2025

- Predicting impacts of climate change on blue crab growth, size at maturity, and reproductive output
  - Funded by MS-AL Sea Grant Consortium
  - 2/1/2024–1/31/2026

Objectives

1. To quantify bycatch rates of undersized and ovigerous crabs in MS and LA throughout the year
2. To develop a better understanding of the soak time and culling methodologies employed by MS and LA commercial crabbers across time and space.
3. To experimentally assess the fate of crabs discarded in the MS and LA fishery under multiple fishing practices.
4. To develop estimates of discard mortality and best practices for the MS and LA blue crab fisheries.

O1: Quantifying discard mortality

- 3 areas, spanning salinity gradient
- Bimonthly sampling on commercial crab boats
- 50 traps per sampling period per area
- Temp./DO loggers deployed on a subset of traps
- Crabs sexed, measured, undersized/ovigerous crabs assessed with RAMP assay (Walters et al., 2022)

O2: Soak time and culling methodologies

- Mixed-mode (mail and internet) survey distributed to commercial crab license holders in LA and MS
- Survey themes will include:
  - Soak times and seasonality
  - Culling practices (handling, sorting, ice bath, etc.)
  - Spatial strategies for fishing locations
  - Others TBD

O3: Fate of discarded crabs

- Field experiment testing impacts of soak time and culling practices on survival of discards
- Soak times: 48 or 96 hrs
- Culling methods (possibly others):
  - <1 min on deck, immediate culling and release
  - 5 min on deck, in ice bath before release
  - 5 min on deck, no ice bath (crabs held in work box) before release
- Bimonthly, 8 traps per treatment (48 total per month)

O3: Fate of discarded crabs

- Temp./DO loggers on a subset of traps, sal/temp/DO measured at retrieval
- Subset of undersized and ovigerous crabs ‘released’, returned to GCRL.
- Survival monitored for 7 d

O4: Estimates of discard mortality and best practices

- Integrate results from O1-3 to develop spatially and temporally explicit estimates of discard mortality
- Develop best practices for reducing discard mortality, disseminate to fishing industry through workshops, videos, industry groups

Questions/suggestions/ comments?

1. To quantify bycatch rates of undersized and ovigerous crabs in MS and LA throughout the year
2. To develop a better understanding of the soak time and culling methodologies employed by MS and LA commercial crabbers across time and space.
3. To experimentally assess the fate of crabs discarded in the MS and LA fishery under multiple fishing practices.
4. To develop estimates of discard mortality and best practices for the MS and LA blue crab fisheries.

- Quantifying and reducing discard mortality of undersized and ovigerous crabs in the Gulf of Mexico blue crab fishery
  - Funded by NOAA/NMFS Saltonstall Kennedy
  - 9/1/2023–8/31/2025

- **Predicting impacts of climate change on blue crab growth, size at maturity, and reproductive output**
  - Funded by MS-AL Sea Grant Consortium
  - 2/1/2024–1/31/2026

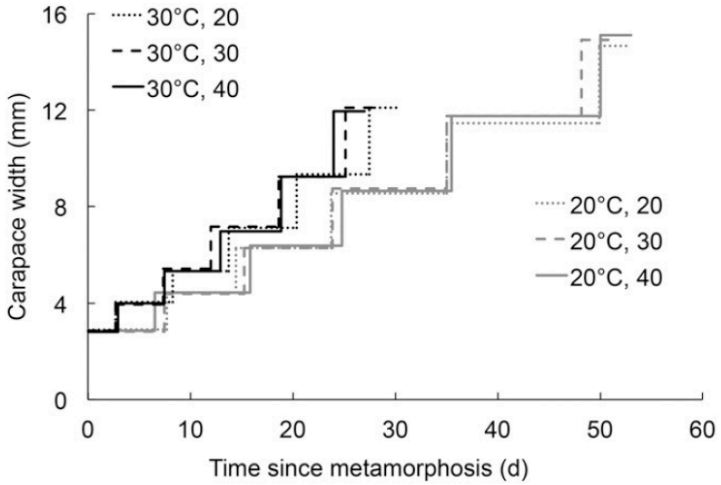


Figure 1. Mean growth trajectories as a function of time since metamorphosis for each temperature and salinity treatment. $n = 2$ well plates per treatment. Line color indicates temperature, whereas line type (solid, broken, dotted) indicates salinity. Error bars are not shown for clarity.

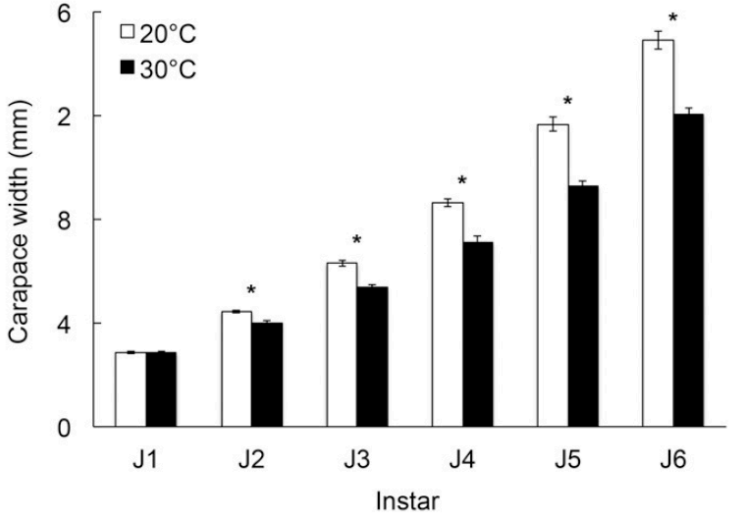
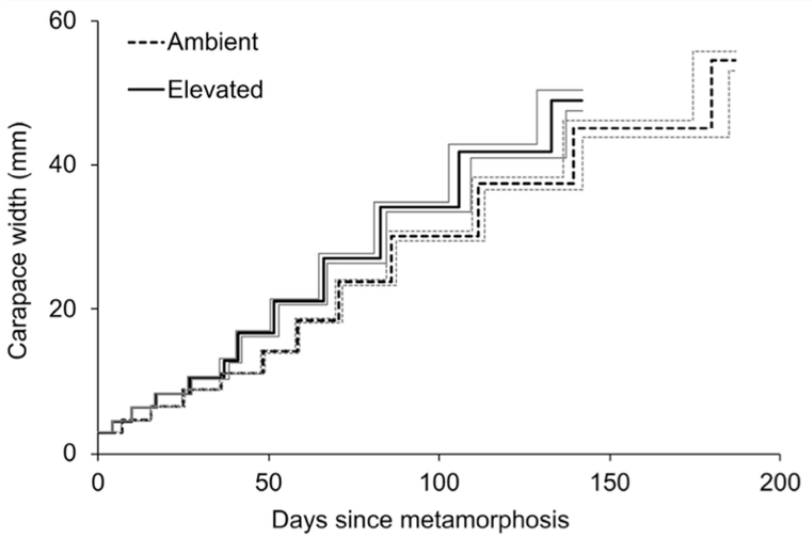
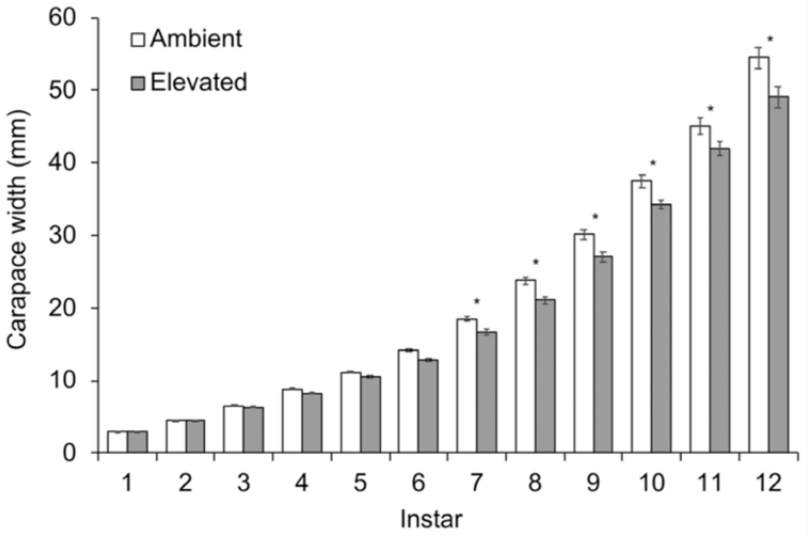


Figure 2. Mean (± SD) CW at each juvenile instar for crabs reared at 20°C (white bars) and 30°C (black bars). $n = 6$ well plates per treatment. * Indicates a significant difference between temperature treatments at $P < 0.05$.





Cunningham and Darnell 2015
Kuhn and Darnell 2019

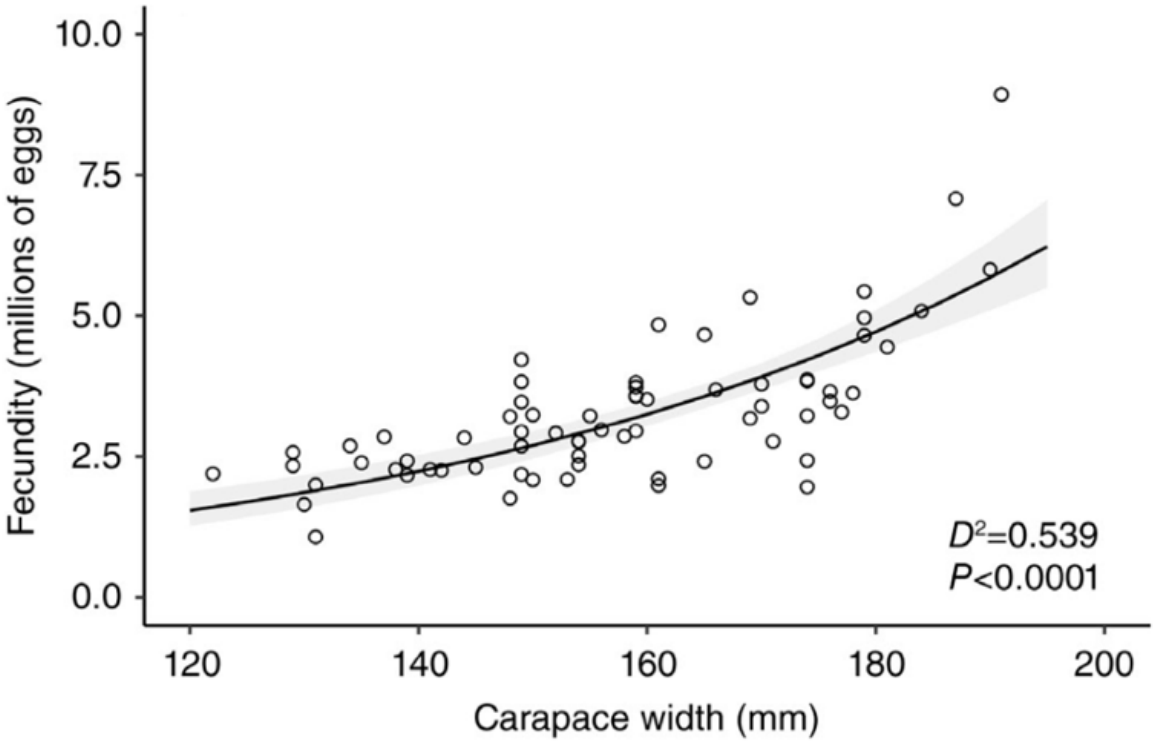
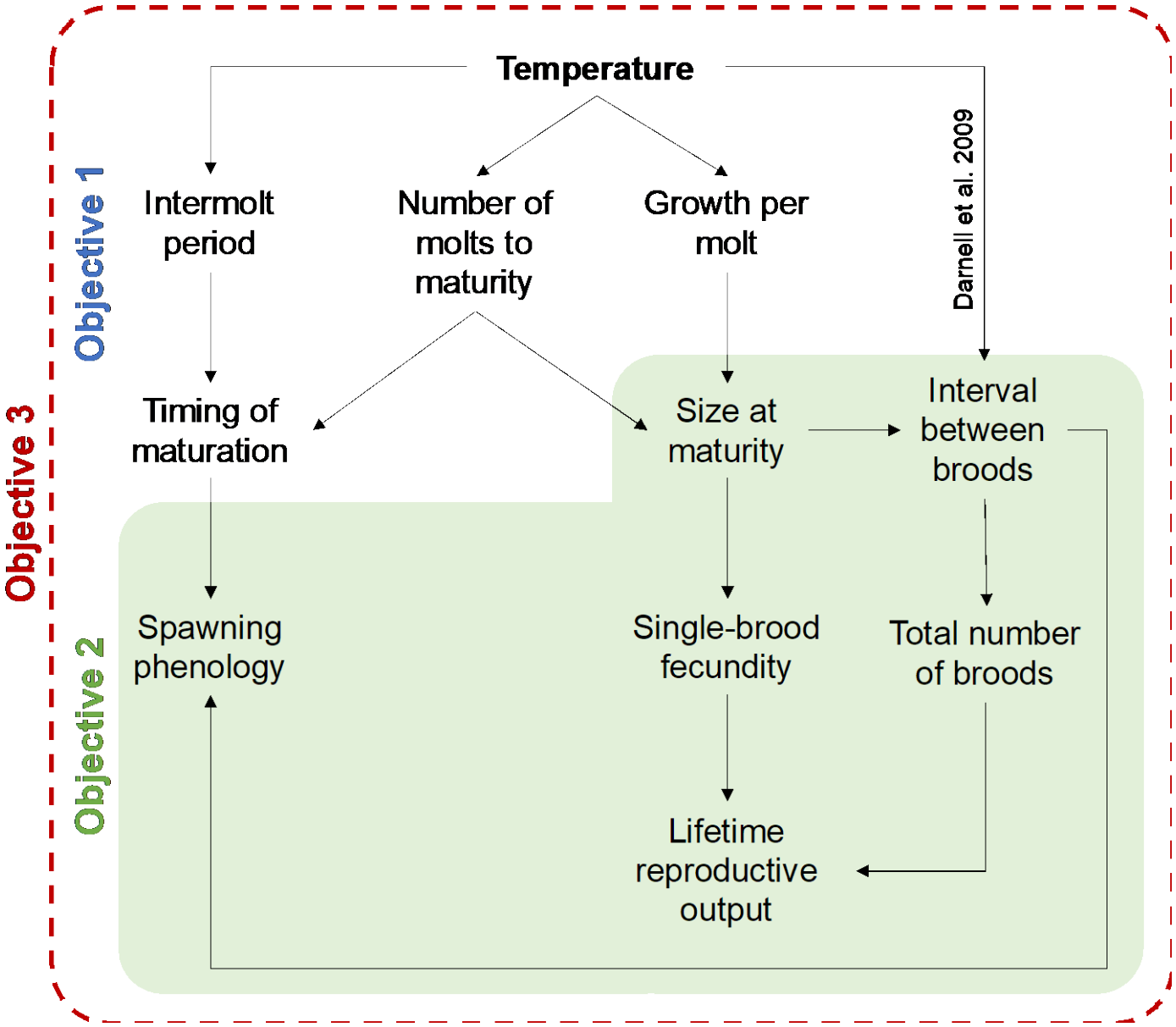


Figure 2. Relationship between single-brood fecundity and carapace width for ovigerous blue crabs collected during the 2017 Southeast Area Monitoring and Assessment Program Groundfish (Trawl) Survey in the northwestern Gulf of Mexico. Line indicates relationship from generalized linear model. Shaded region represents the 95% confidence interval. D^2 = deviance explained. From Kemberling and Darnell (2020).

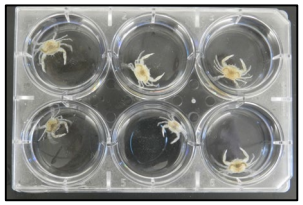

Objective 3
Objective 1
Objective 2
Temperature
Darnell et al. 2009
Intermolt period
Number of molts to maturity
Growth per molt
Timing of maturation
Size at maturity
Interval between broods
Spawning phenology
Single-brood fecundity
Total number of broods
Lifetime reproductive output

Objectives

1. To experimentally quantify the dependence between growth parameters and water temperature and develop a temperature-dependent molt-process model for blue crab growth.
2. To quantify the relationship between size at maturity and reproductive output over the female reproductive lifespan.
3. To integrate results of objectives 1 and 2 to simulate growth rates, size/age at maturity, and lifetime reproductive output under a range of current and predicted future thermal regimes.

O1: Temperature and growth

- Lab experiment
  - Megalopae → J6 at 5 temperatures (16-36°C)
  - Megalopae → Maturity at 3 temperatures (26-36°C)



- Temperature-dependent molt-process model
  - IMP submodel: probability of molting as a function of accumulated degree-days; cumulative molting probability density function
  - GPM submodel: continuous relationship between GPM and water temperature (from GLM and/or GAM)
  - Can be used to simulate growth under both constant and variable thermal regimes.

O2: Size and lifetime reproductive output

- Collect females within 1 week of terminal molt/mating, hold until end of life
- For each brood:
  - Fecundity
  - Fertilization rate
  - Hatching success

O3: simulate growth, maturity, and lifetime reproductive output under a range of thermal regimes

- Molt process model to simulate growth and maturation + data from Obj. 2 used in similar model to simulate spawning.
- Current and future scenarios, all will incorporate seasonal temperature variation
  - Average year
  - Warm year
  - Cold year
  - Several projected climate change scenarios

Questions/suggestions/ comments?

1. To experimentally quantify the dependence between growth parameters and water temperature and develop a temperature-dependent molt-process model for blue crab growth.
2. To quantify the relationship between size at maturity and reproductive output over the female reproductive lifespan.
3. To integrate results of objectives 1 and 2 to simulate growth rates, size/age at maturity, and lifetime reproductive output under a range of current and predicted future thermal regimes.