Assessing the Temperature Tolerance of Atlantic Sea Scallop Early Life Stages

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2026 Sea Scallop Research Share Day

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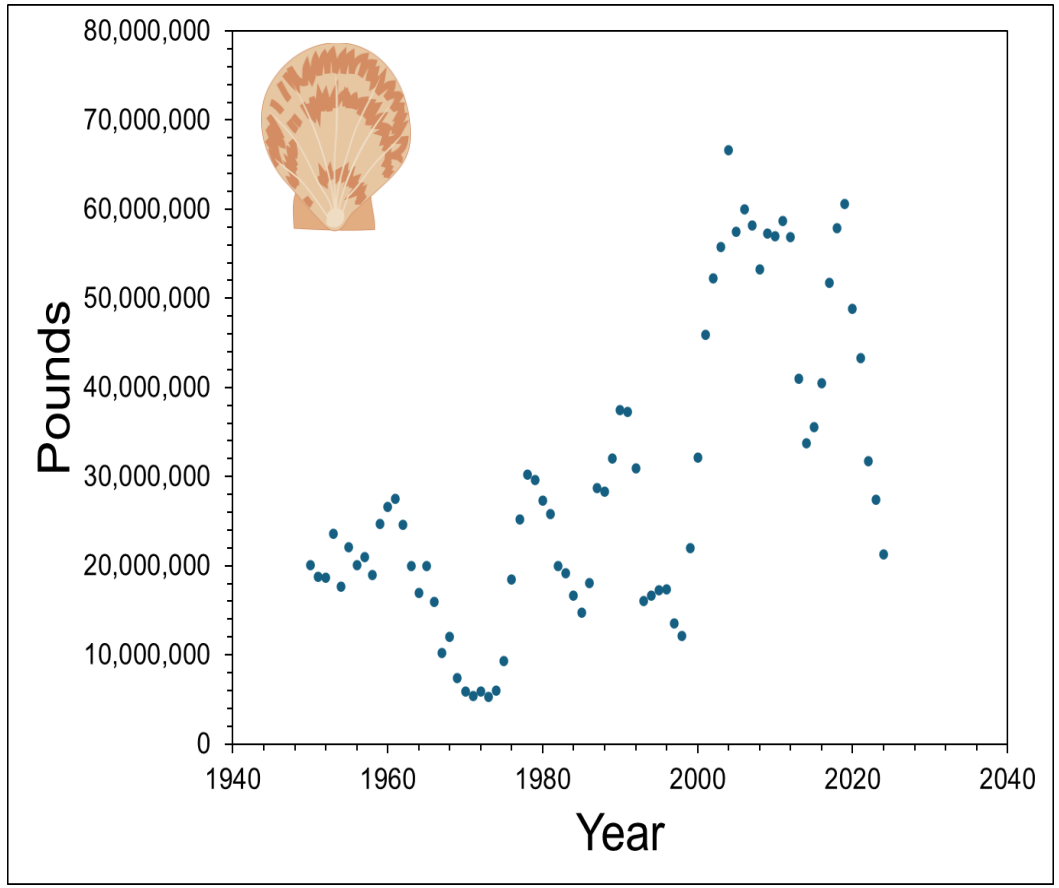
Introduction	Methods	Results: Experiments	Results: Sea Turtle Data	Conclusions

U.S. Sea Scallop Fishery Overview

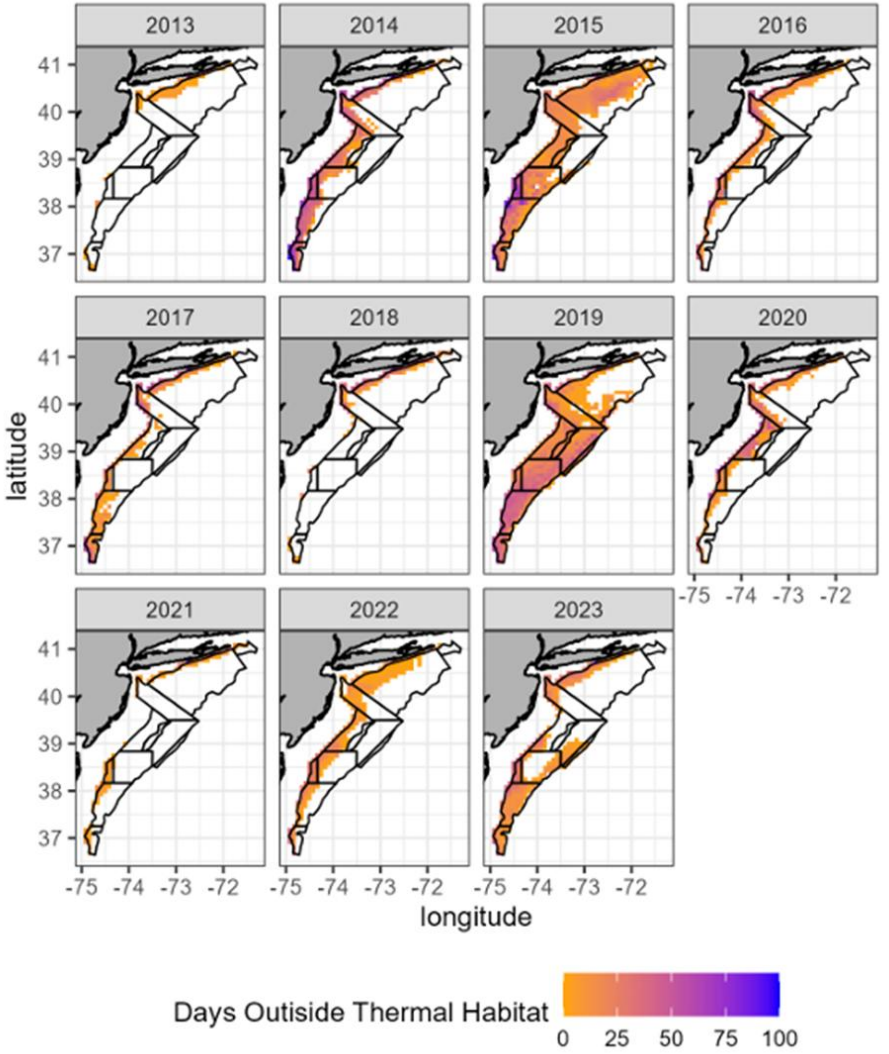
- Found from Virginia to Canada
- Total Abundance:
  - 2004: **51:49% GB:MAB** (Stokesbury et al. 2016)
  - 2016 - 2018: **71:27% GB:MAB** (Stokesbury & Bethoney 2020)
  - 2024: **70:30% GB:MAB** (Delargy & Stokesbury unpublished data)
- Harvests have decreased since ~2020



NOAA 2026

Global Warming and Scallops

- Adult temperature range: 0 – 18°C (Dickie 1958)
- Warming is hypothesized to reduce suitable habitat
  - Especially in the MAB (Tanaka et al. 2020)
- What is the temperature tolerance of larvae?
  - Sea Surface Temperature within the mixed-layer is increasing (Thomas et al. 2017)



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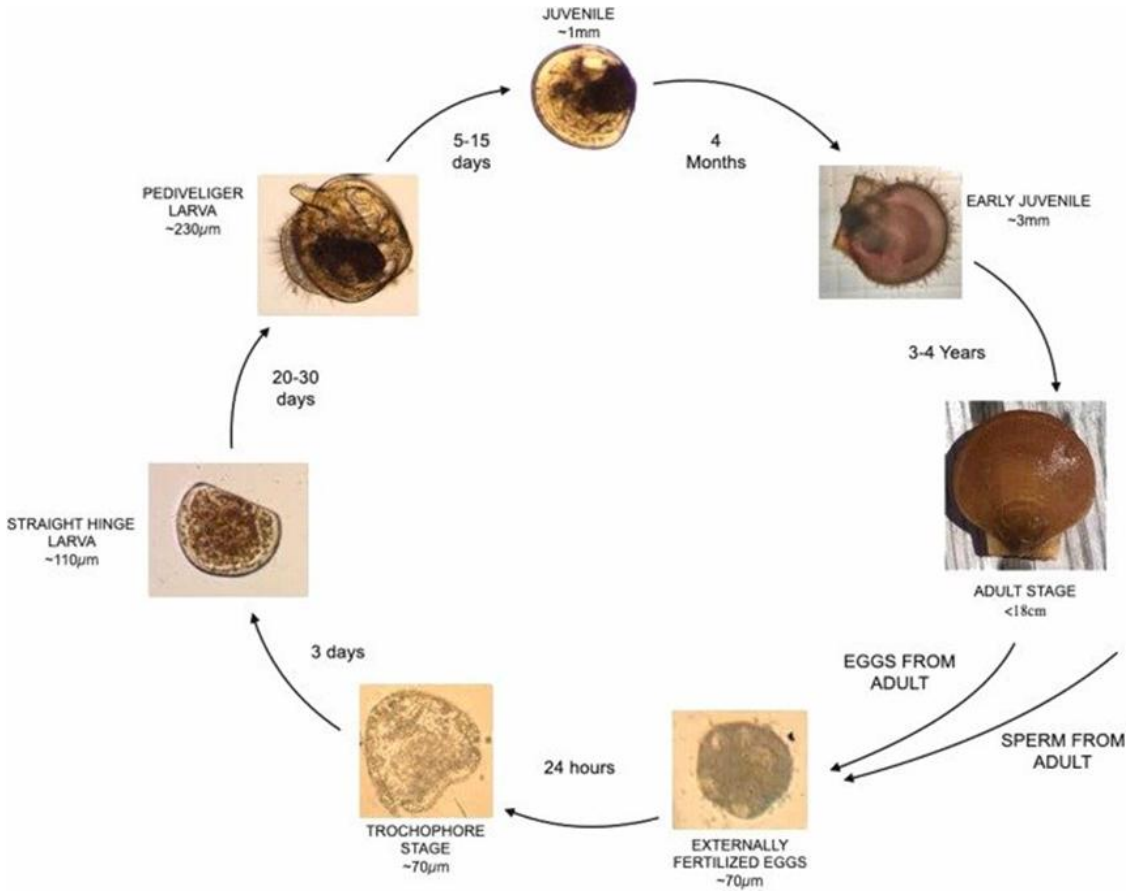
Why Larvae?

- Marine early life stages (across taxa) are susceptible to anthropogenic change
- Year-class strength is strongly correlated with larval survival
- Larval scallop biology and physiology is poorly studied
- Presumed preferable temperature range: 14 - 16°C (B Beal unpublished data)



Packer et al. 1999, Ishaq et al. 2023

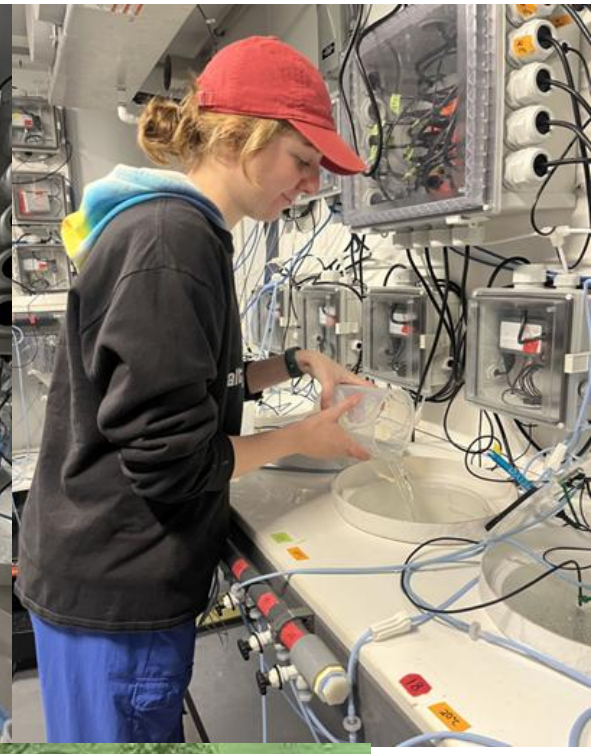
Research Goals

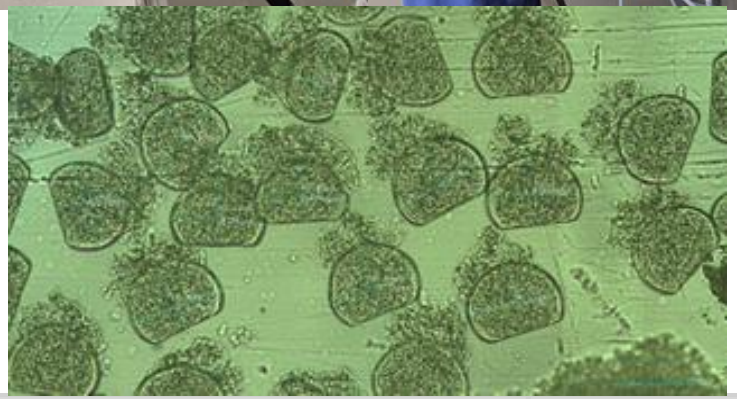
- Quantify larval physiology and survival under current and future temperatures (experiments)
- Develop individual based models to quantify larval population dynamics

Experimental Methods:

- Fully factorial experiments (8 - 22°C)
  - Summer 2025
  - **Spring 2026**
    - Control = 14°C
- Trial #1 (Embryos & Trochophores)
- Trial #2 (Veligers)

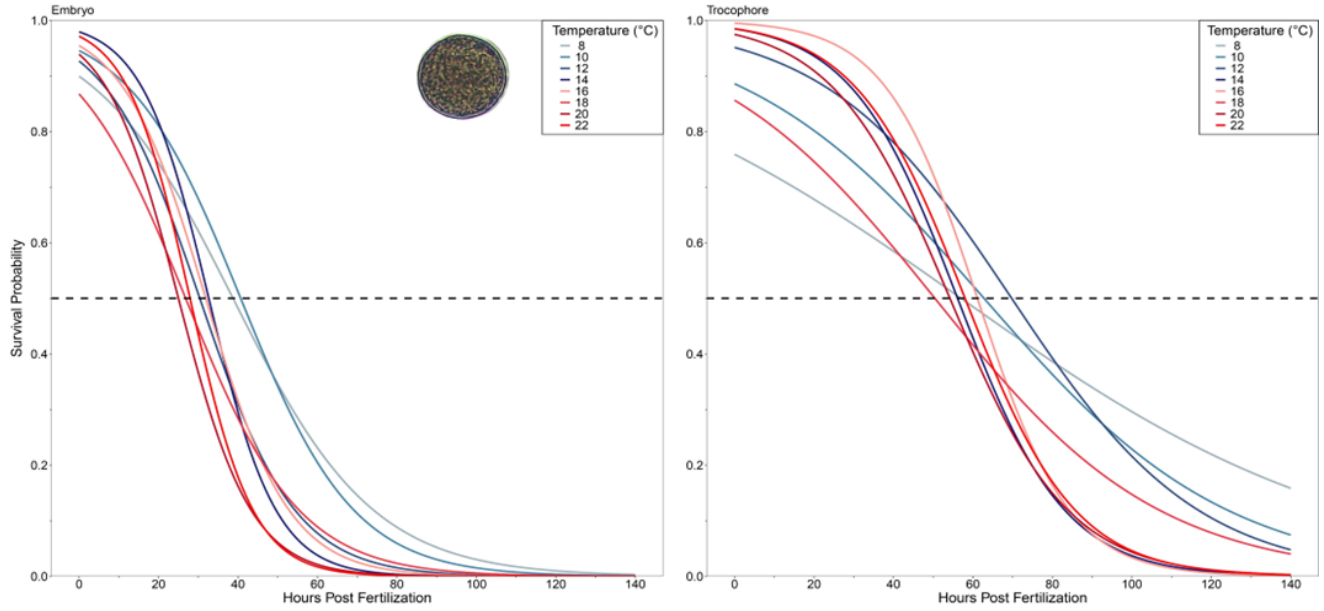
- Quantified:
  - **Survival**
  - **Growth**
  - Respiration and Clearance Rates
  - Scope for Growth





Experimental Methods:

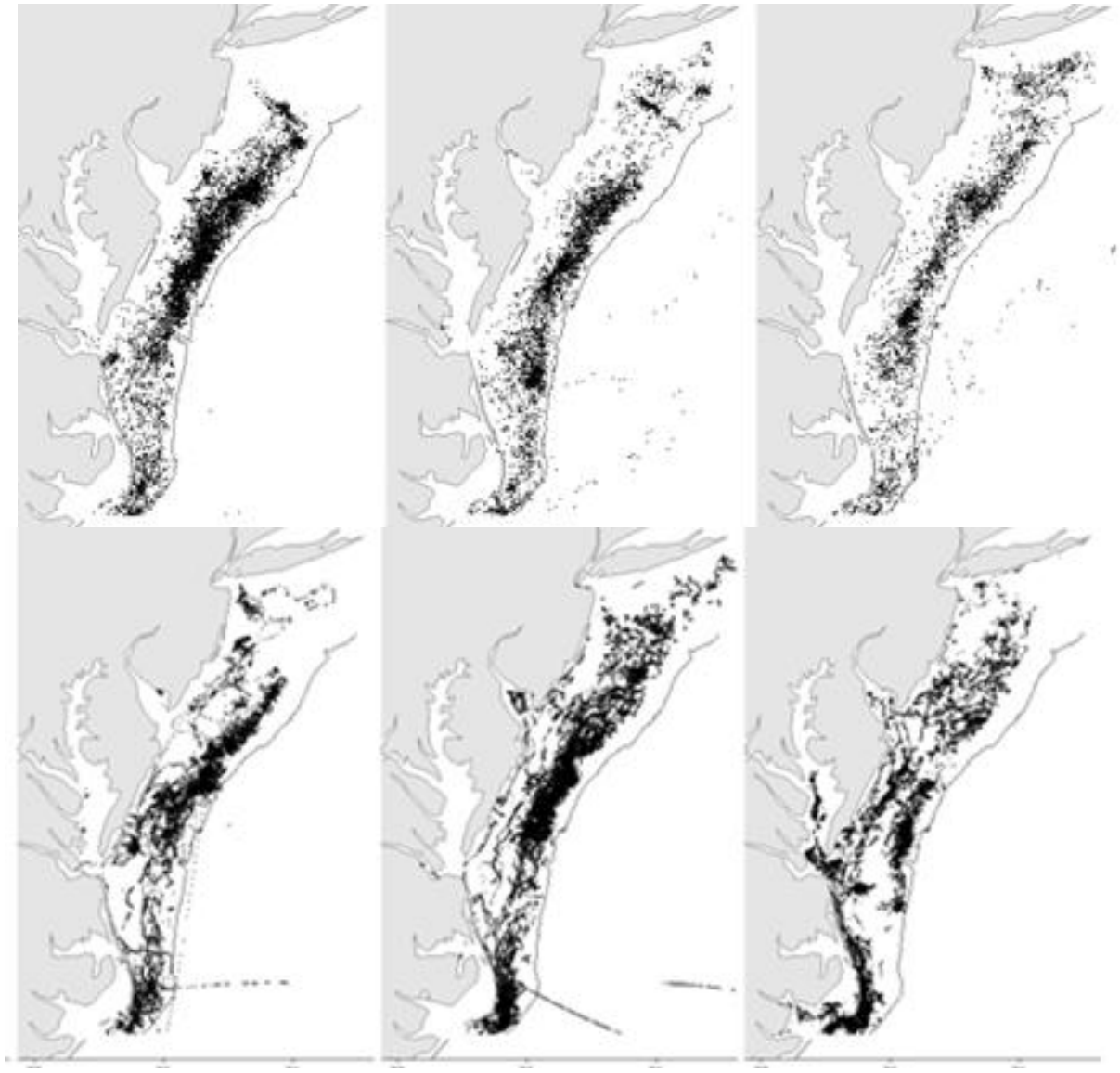
- LT_{50} (Survival)
  - Quasibinomial logistic regressions
- Linear mixed effects models (**analysis ongoing**)



Sea Turtle Methods:

- CFF Loggerhead sea turtle tagging:
  - Collects environmental data allowing for continuous water column profiling

- General Additive Models of water column temperature profiles
  - NOAA data used to run prediction comparisons between GAMs

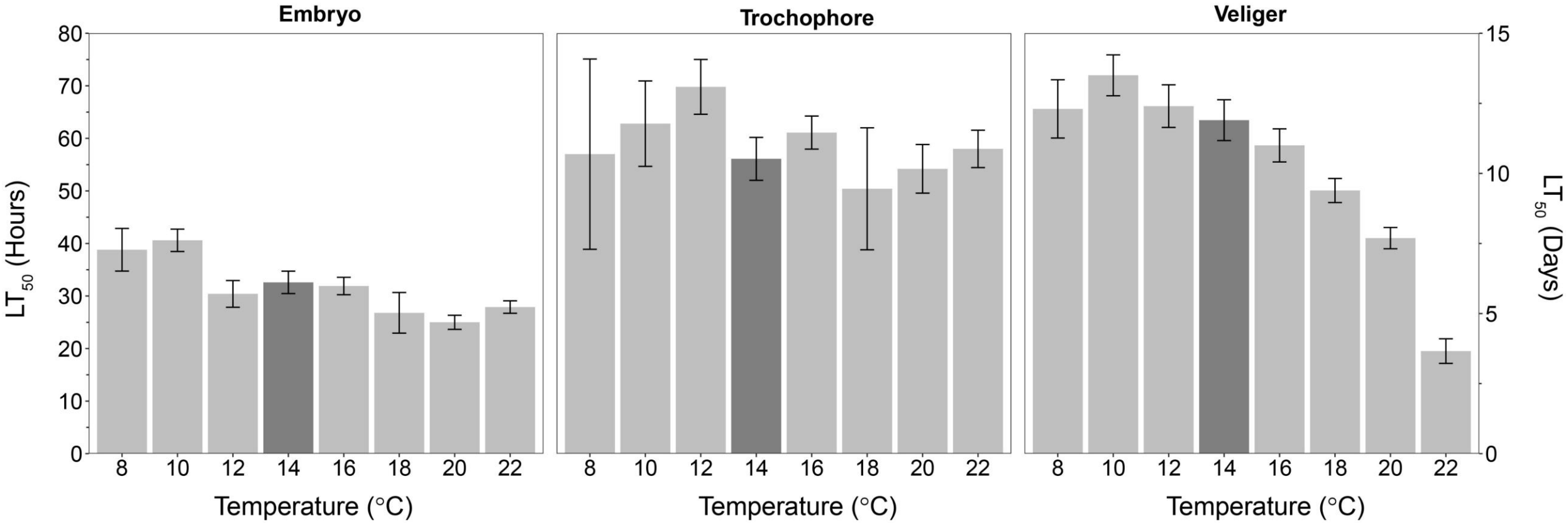


CFF Sea Turtle Tracing 2009-25

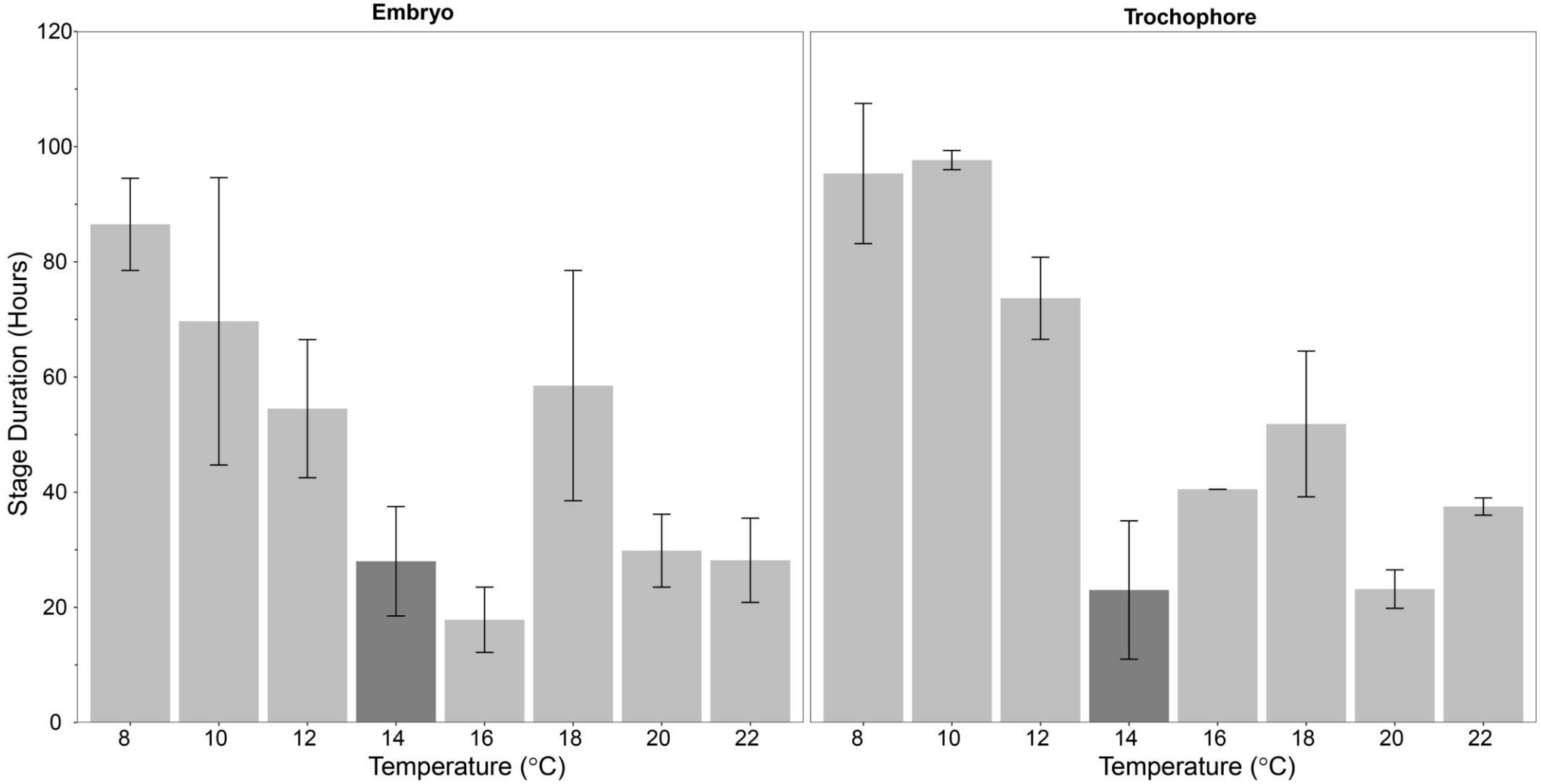
Sea Turtle Methods:

- Thermocline = proxy for mixed layer depth
- Spawning durations (Barber and Blake 2016):
  - Spring: April 1 – May 30
  - Fall: September 1 – October 10
- Developed maps of days within multiple temperature ranges

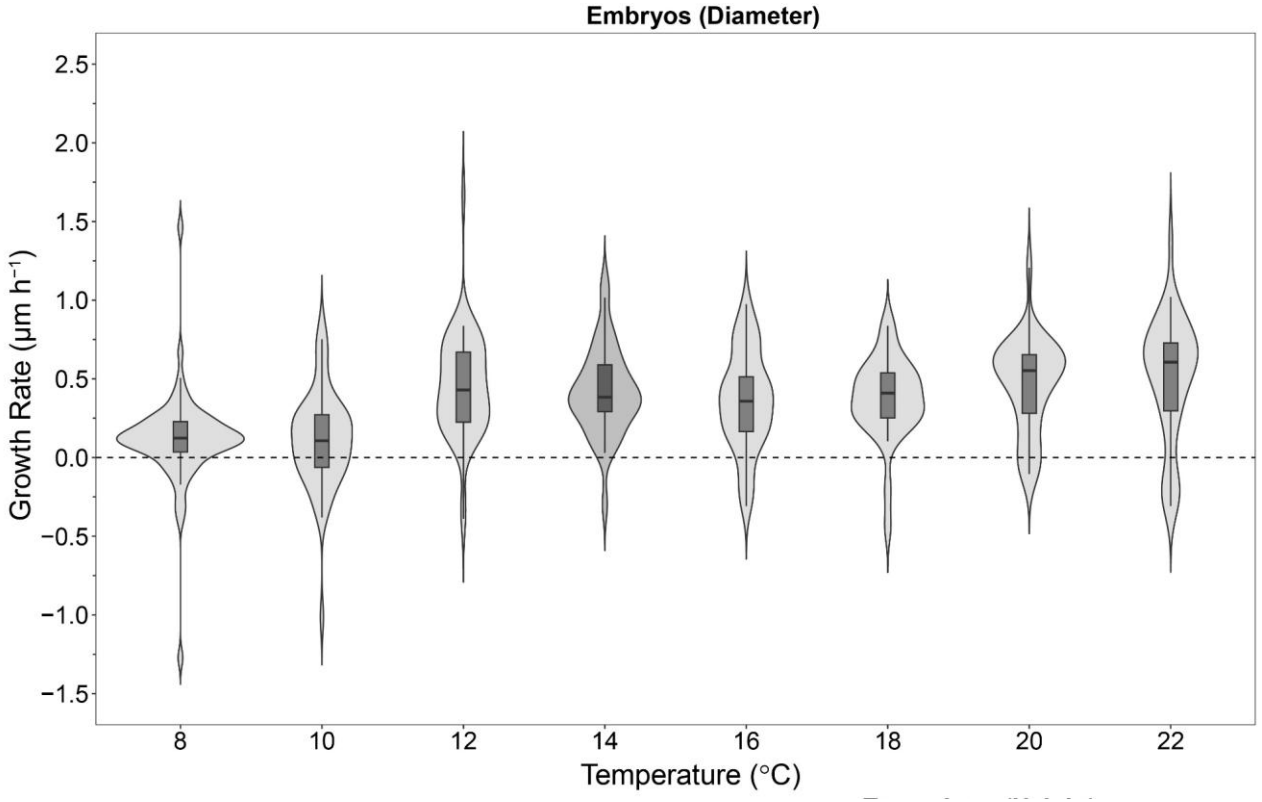
Results: Survival

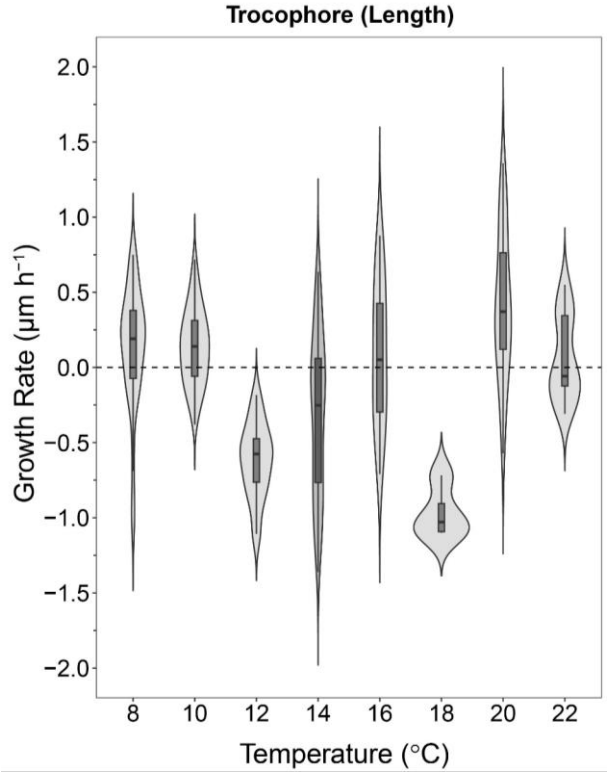


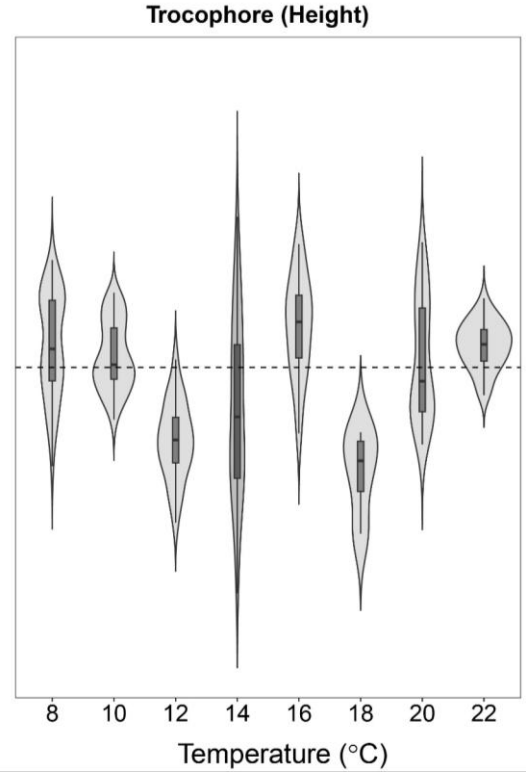
Results: Stage Durations



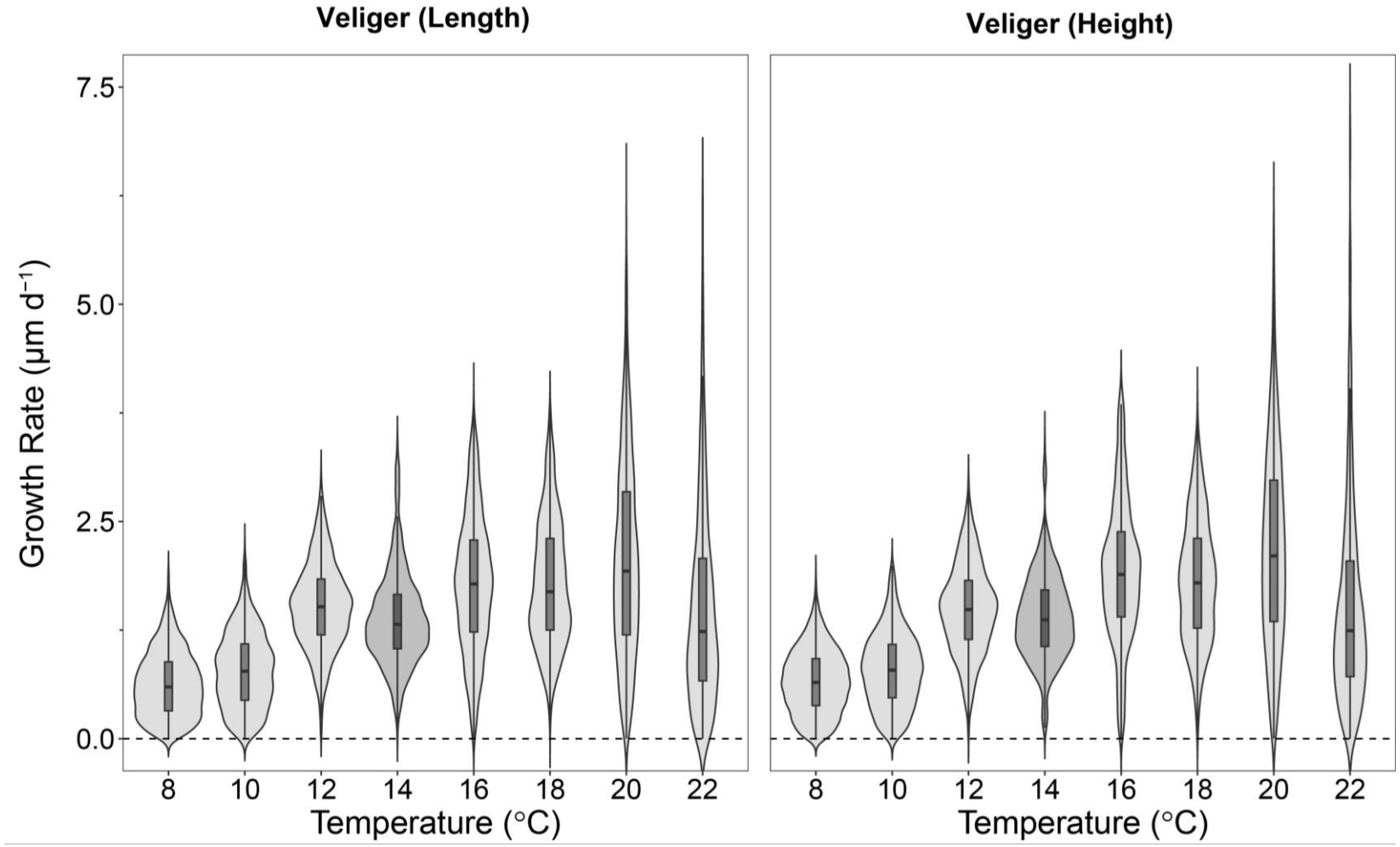
Results: Growth



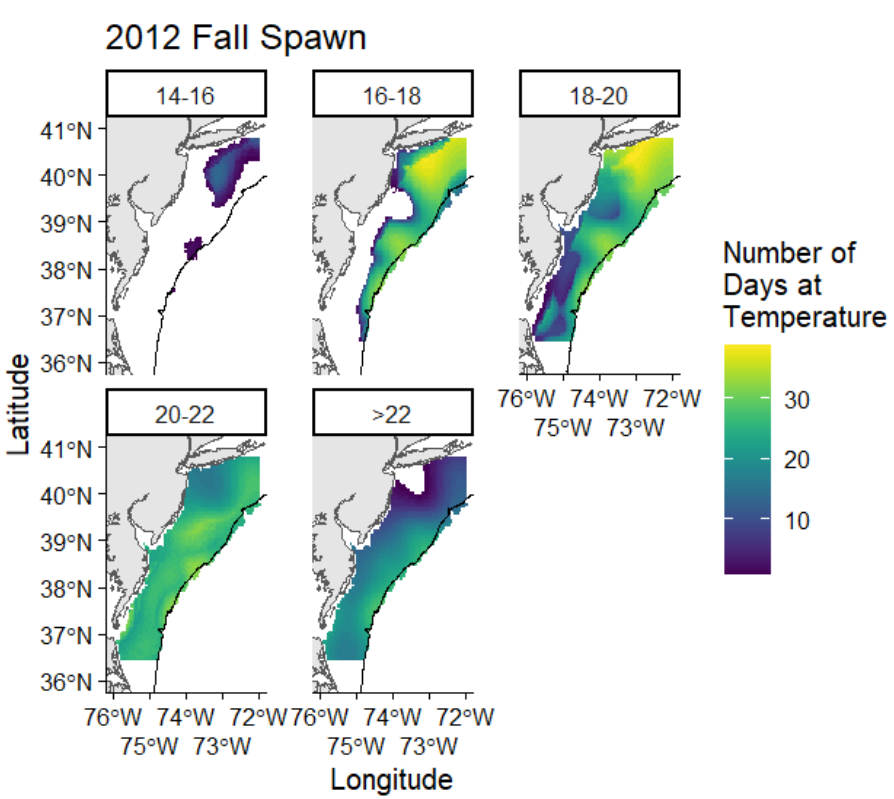


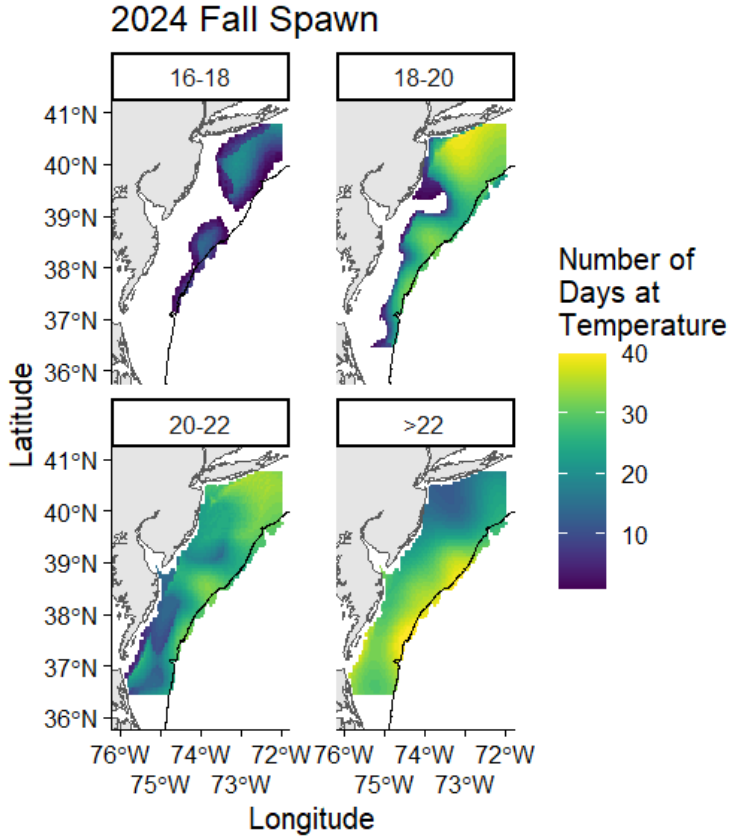


Results: Veliger Growth



Results: Prevalence of non-suitable temperatures is increasing....



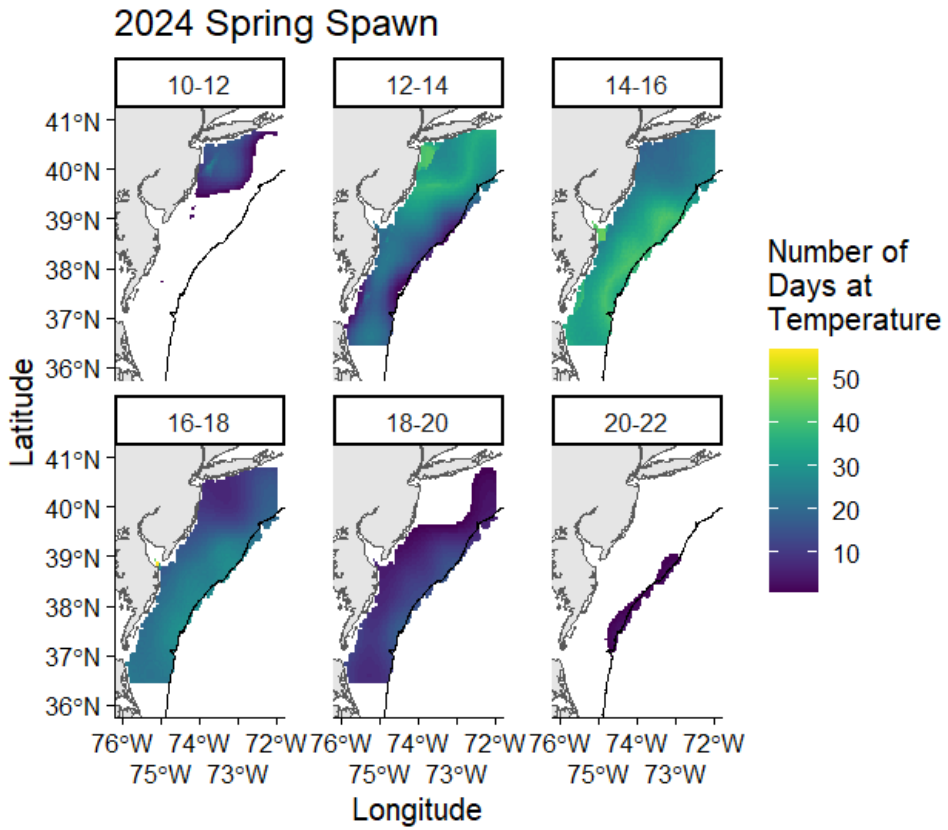


Conclusions:

- Preliminary results suggest:
  - Veliger survival decreases with increasing temperature
  - Embryo and trochophore development is slowest at temperatures below 12°C
  - Veliger growth is slowest at 8 and 10°C and stunted at 22°C

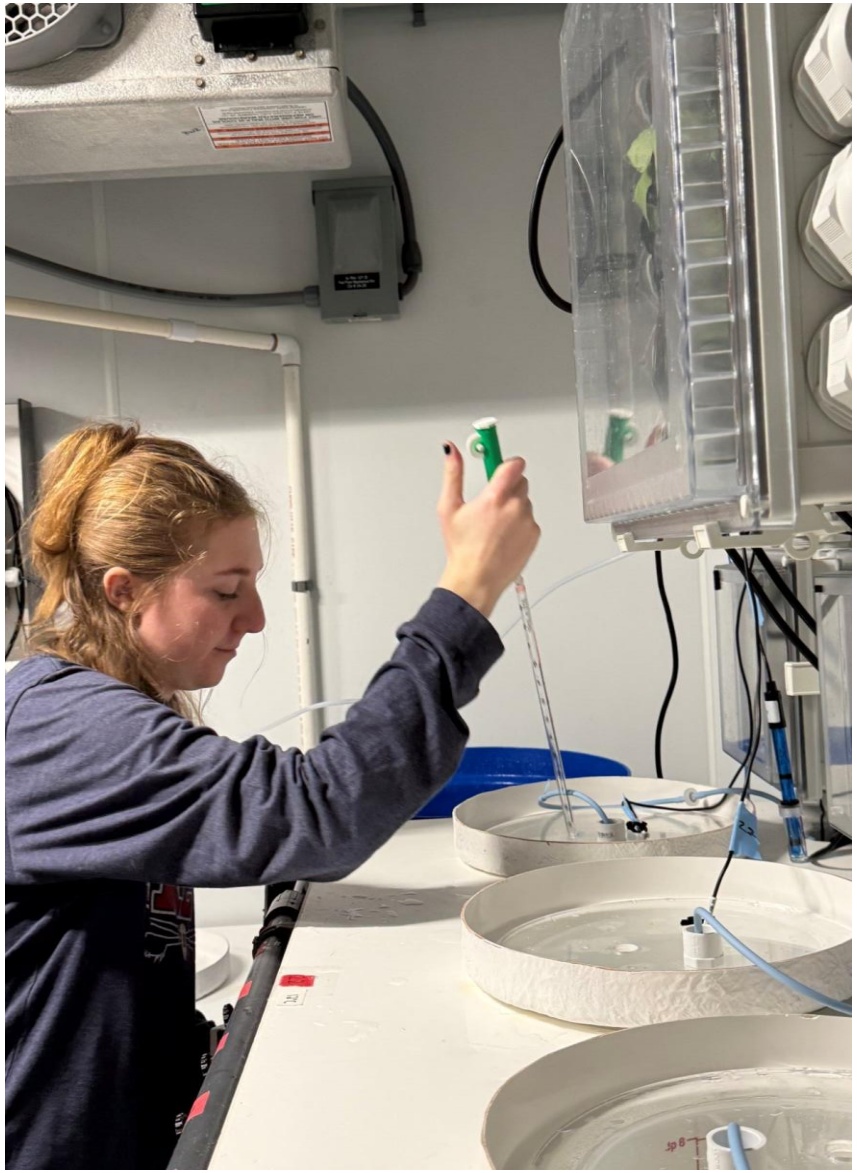
Conclusions:

- Sea turtle satellite tag data provides a cheap method to gather temperature-depth profiles in the Mid-Atlantic Bight
- The number of days within a temperature range has changed over time
  - This may have population-level consequences
- Need to ground truth predicted GAM temperatures with FVCOM



Next Steps:

- Analyze stage-specific respiration and clearance rates and calculate scope for growth
- Parameterize Individual-Based-Models using experimental results
- Develop degree day thresholds from sea turtle data across years to better quantify changes in thermally suitable habitat



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Questions?

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