Response of euphausiids in the southeastern Bering Sea to environmental variability between a recent cold (2008-2012) and warm (2014-2018) period

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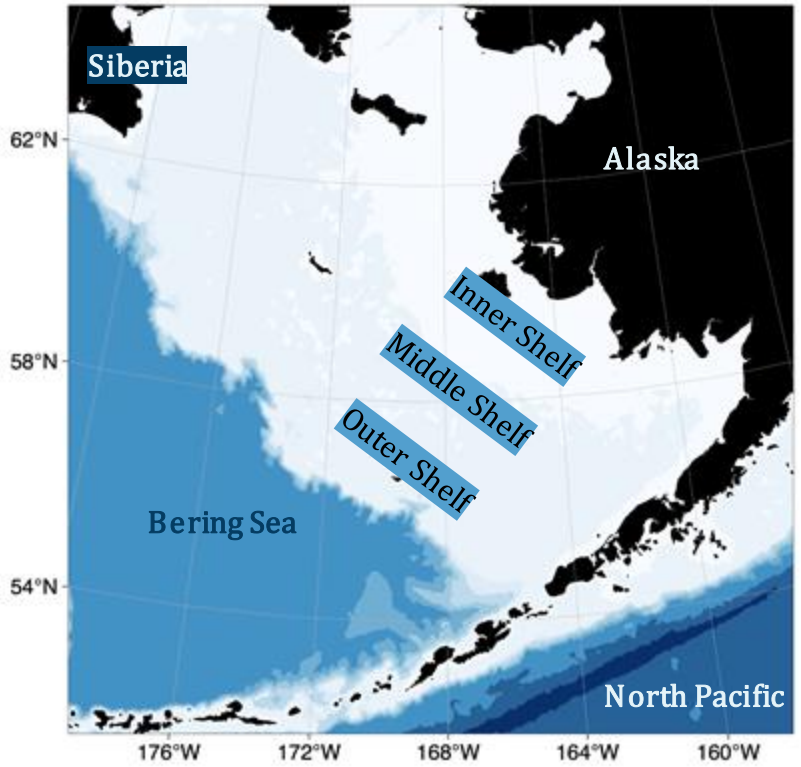
CIMERS
Cooperative Institute for Marine Ecosystem and Resources Studies

EcoFOCI

Oregon State University

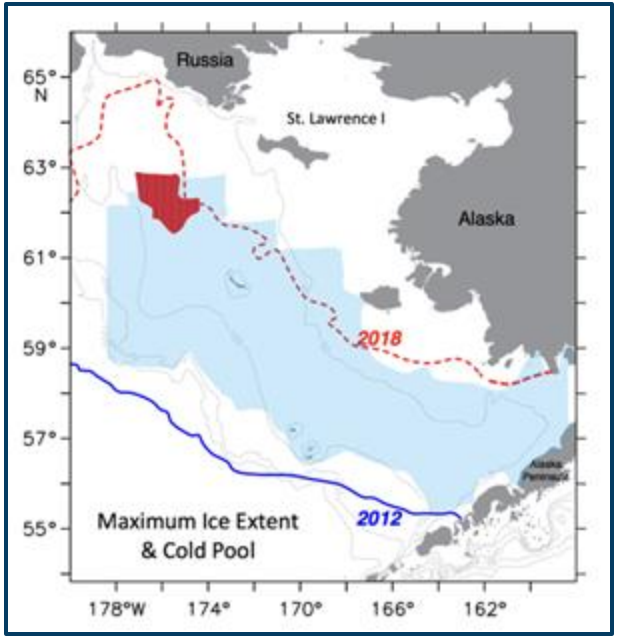
Introduction to the Eastern Bering Sea

- Highly productive and economically important Subarctic region
- Continental shelf
  < 200 m deep
- North-south divide at 60°N
- Southeastern Bering Sea shelf divided into inner, middle, and outer shelf domains



Eastern Bering Sea Climate Variability

- Annual and multi-annual scale
- Cycle of cold and warm periods
  - 2008 - 2012 -> Cold
  - 2014-2018 -> Warm
- Cold periods characterized by
  - Colder temperatures
  - More winter sea ice cover
  - Later sea ice retreat
  - Larger summer cold pool
- Climate variability impacts biota
  - Timing of ice retreat affect timing of spring bloom
  - Changes in cold pool affect species distribution



NOAA Fisheries

Krill in the Southeastern Bering Sea

- Five krill species:
  - *Thysanoessa inermis*
  - *Thysanoessa raschii*
  - *Thysanoessa longipes*
  - *Euphausia pacifica*
  - *Thysanoessa spinifera*

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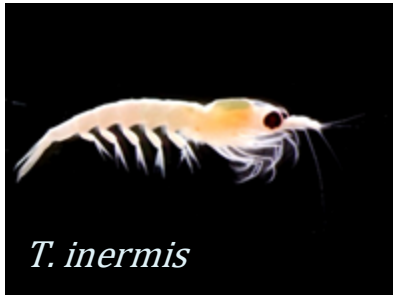
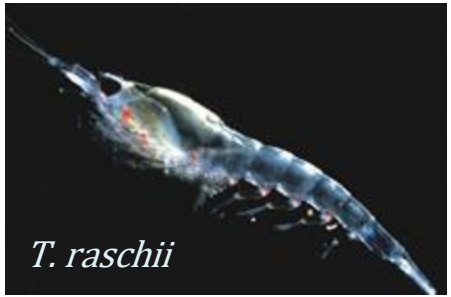
Most dominant



Kwasniewski Slawomir



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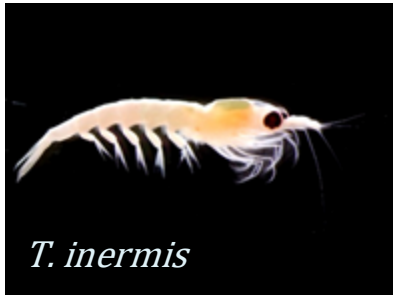
Subarctic



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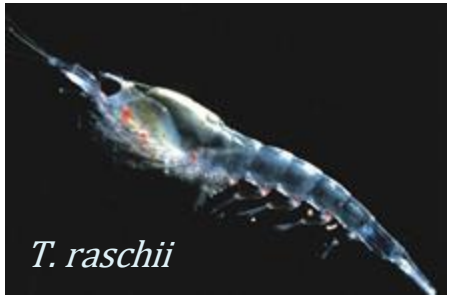

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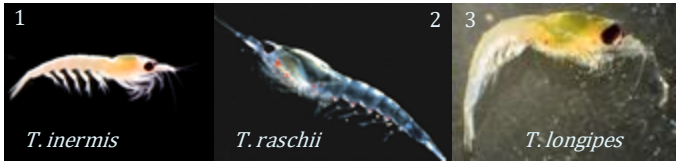
Subarctic-transitional



Hakai Institute

Steven Haddock

(1) Kwasniewski Slawomir (2) Fisheries and Oceans Canada, Jean-François St-Pierre (3) Fisheries and Oceans Canada, Moira Galbraith

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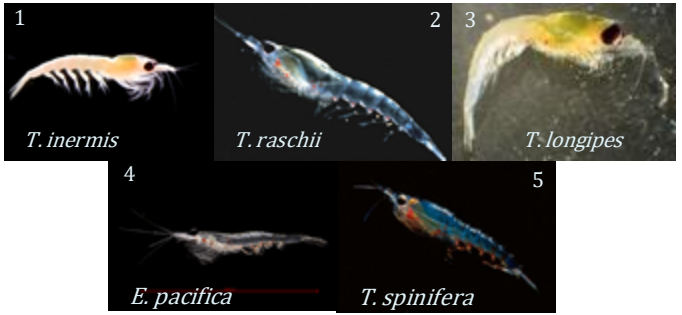

- Krill play an important role in the pelagic food web
  - A lipid rich food source
  - Link between primary producers and upper trophic level consumers
  - Key food source for walleye pollock

- Gaps in current knowledge

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Research Rationale and Questions

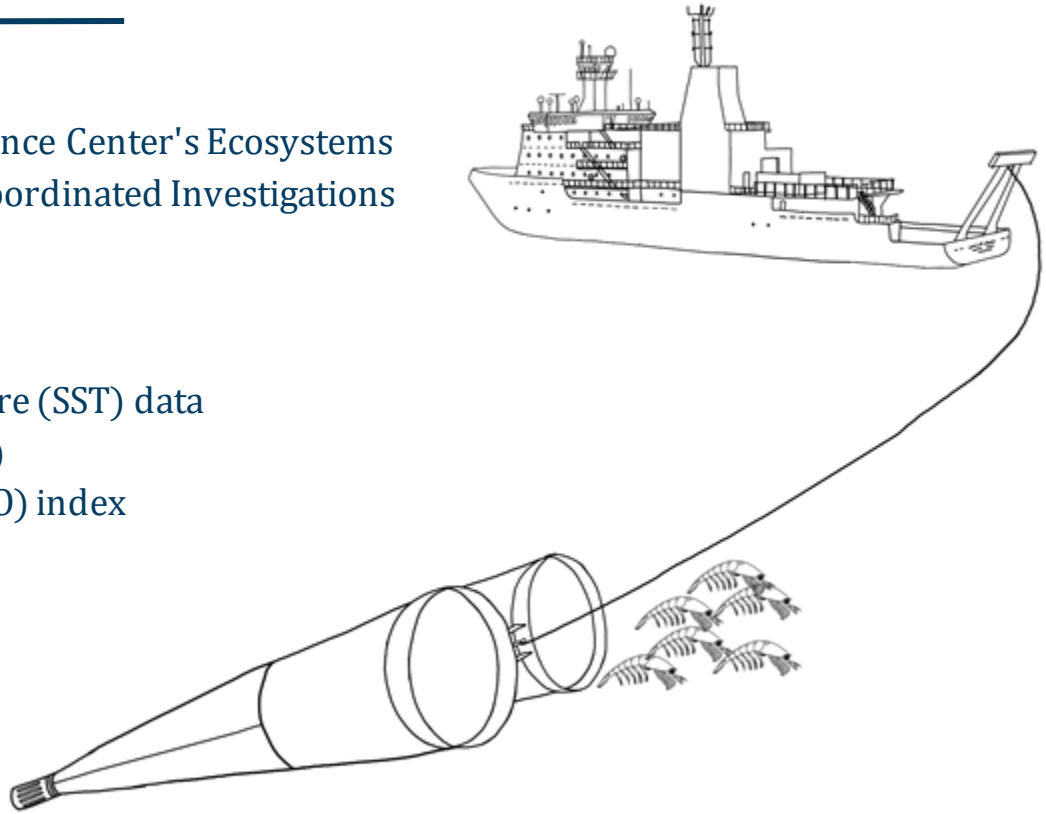
- Rationale
  - Importance in pelagic food web
  - Increasing trend of warming
  - Gaps in current knowledge on krill

- Research Questions
  1. Does the mean abundance of each krill species change between warm and cold periods?
  2. What are environmental and climate predictors of abundance for each species?

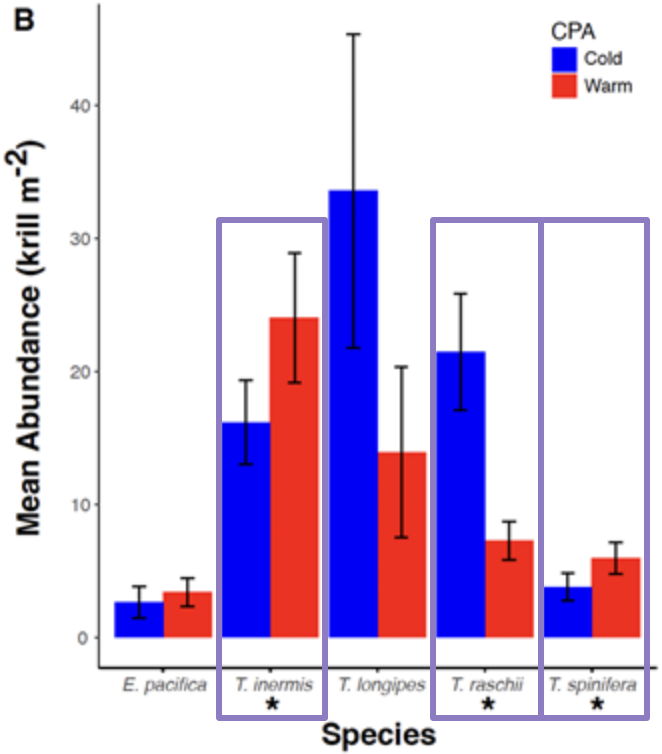
Data

- Sampling Data
  - Data from Alaska Fisheries Science Center's Ecosystems and Fisheries Oceanography Coordinated Investigations (EcoFOCI) Program

- Environmental Data
  - Satellite sea surface temperature (SST) data
  - Summer cold pool extent (CPE)
  - Pacific Decadal Oscillation (PDO) index



Variability in Mean Abundance Between Warm and Cold Periods



Environmental and Climate Predictors of Abundance

- Generalized Additive Models (GAM)

- Predictor variables
  - Latitude and longitude interaction term
  - SST or PDO (covariant)

- Final Models:

  $KA \sim \alpha_1 + s_1(Lon, Lat, k_1) + s_2(SST, k_2) + \varepsilon_1$

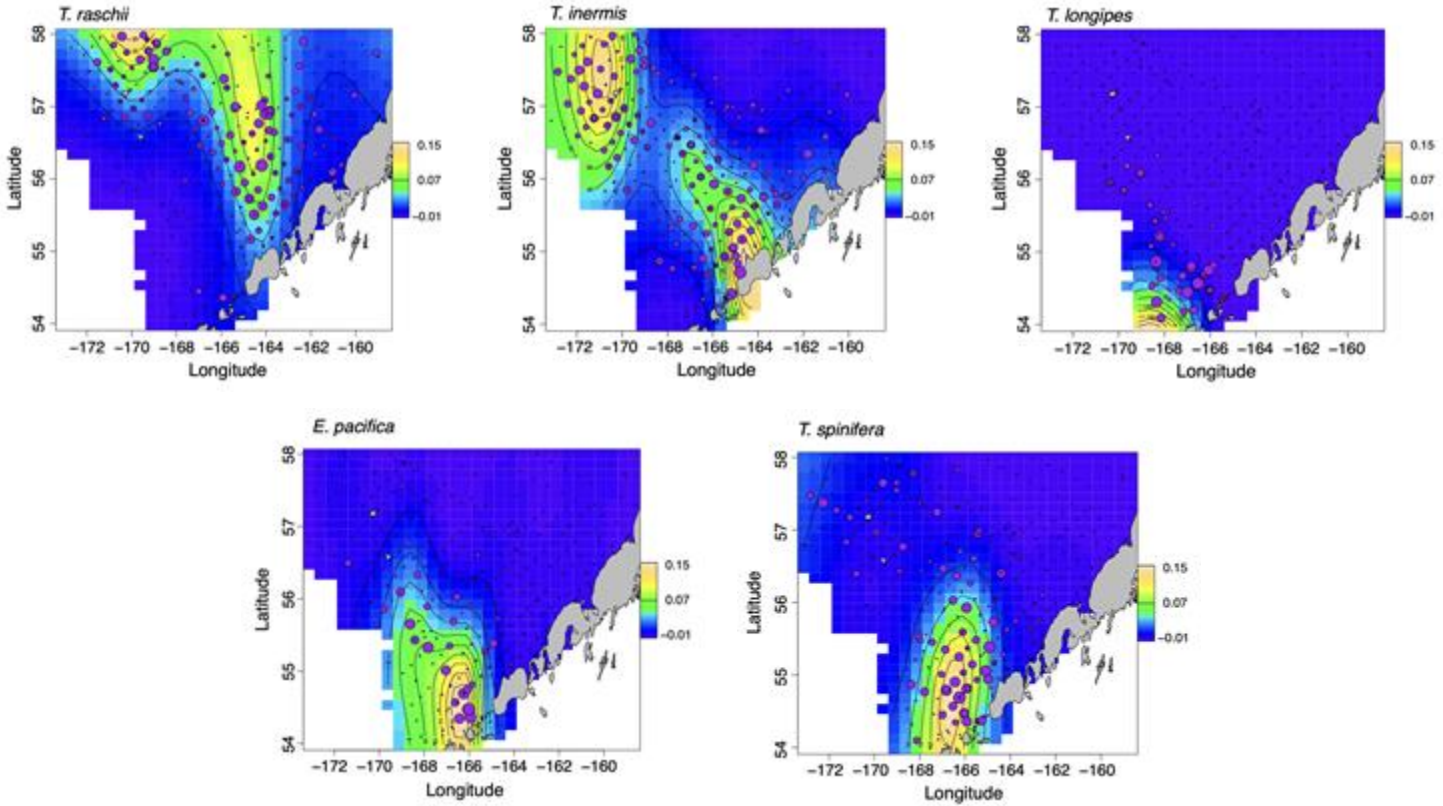
  T. inermis, T. raschii, T. longipes

  $KA \sim \alpha_2 + s_3(Lon, Lat, k_3) + s_4(PDO, k_4) + \varepsilon_2$

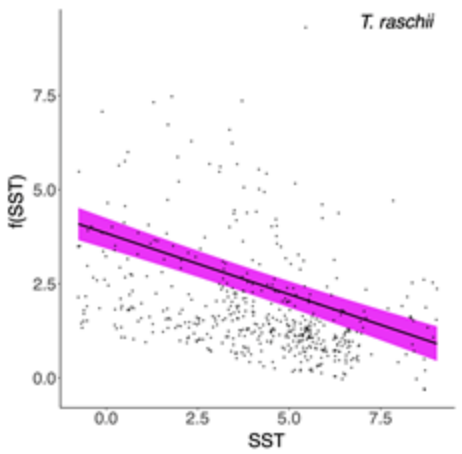
  E. pacifica, T. spinifera

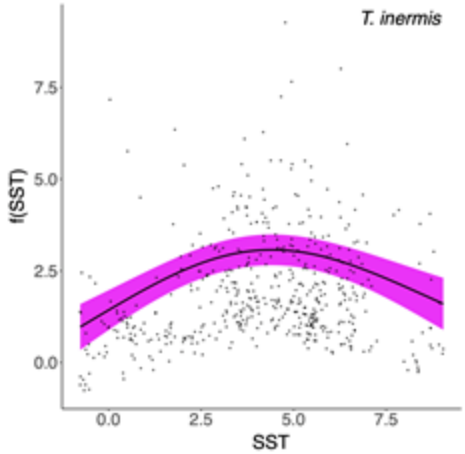
- All predictor variables in final models were significant

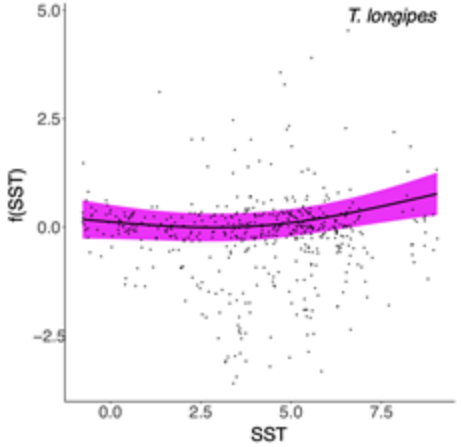
GAM Results: Latitude and Longitude Response



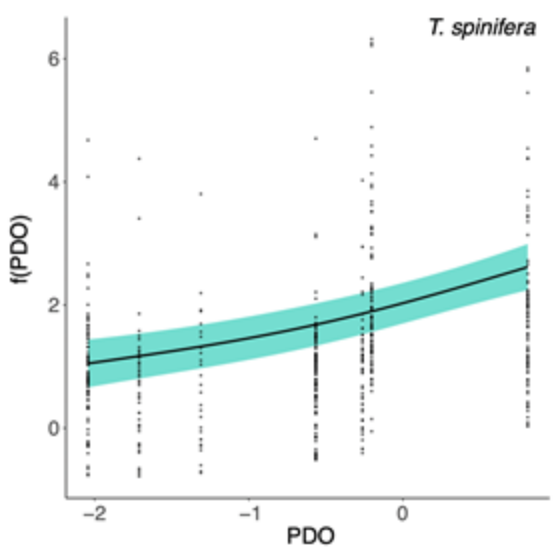
GAM Results: SST Responses

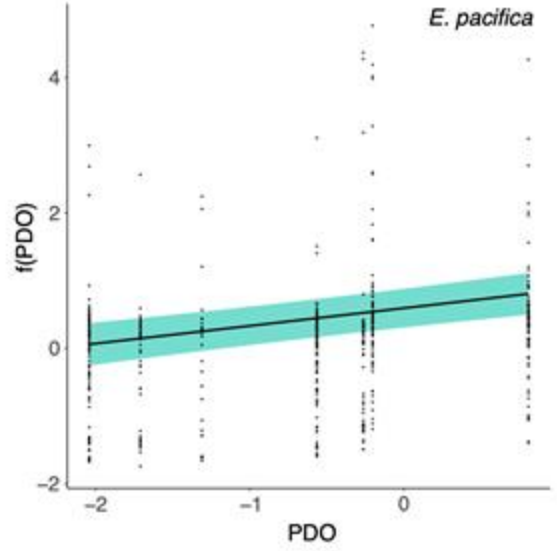






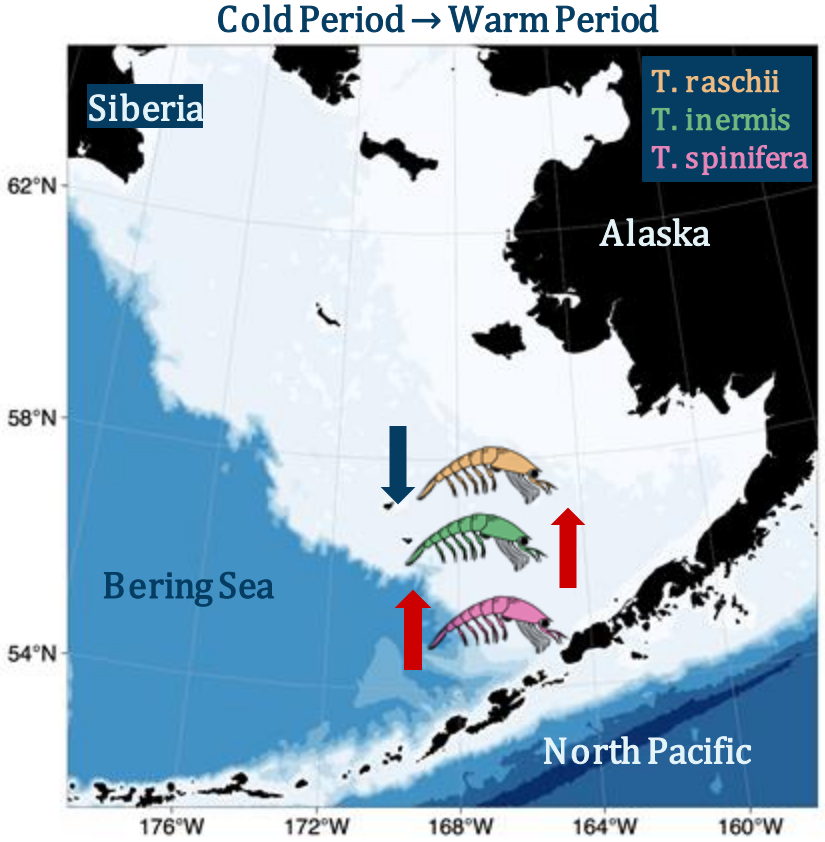
GAM Results: PDO Responses





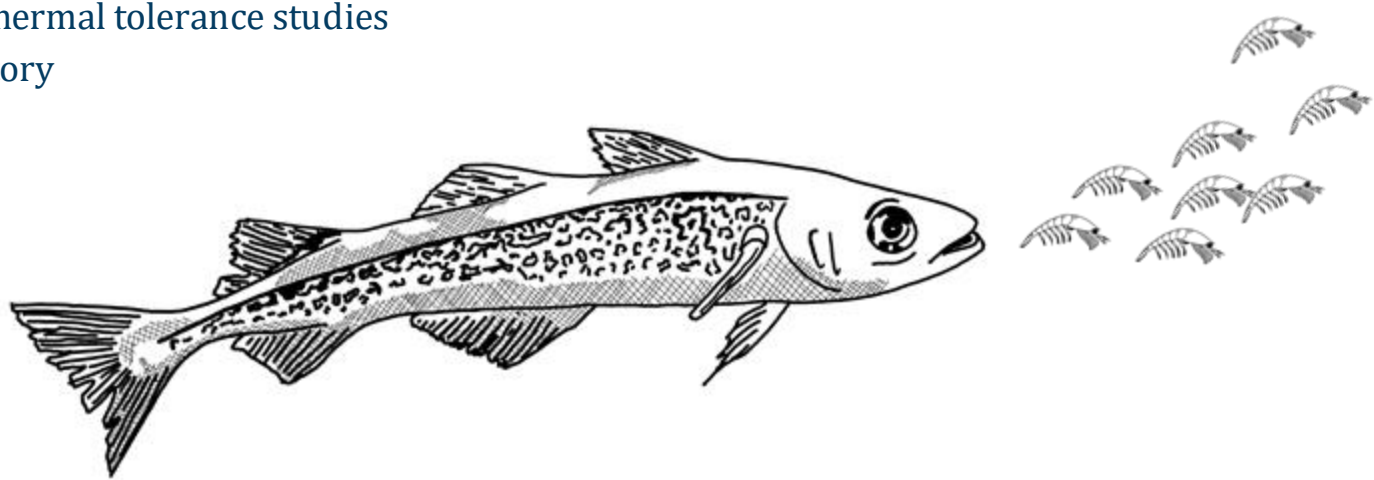
Key Takeaways

- Variability in response to changes in environmental factors
- Difference in spatial distribution impacts ability of krill to supplement each other in food web
- Continued warming has implications for pelagic food web



Implications and Future Directions

- Implications
  - Fisheries management
- Future Directions
  - Better euphausiid monitoring
  - Mechanistic studies
    - Thermal tolerance studies
  - Life history




Thank You