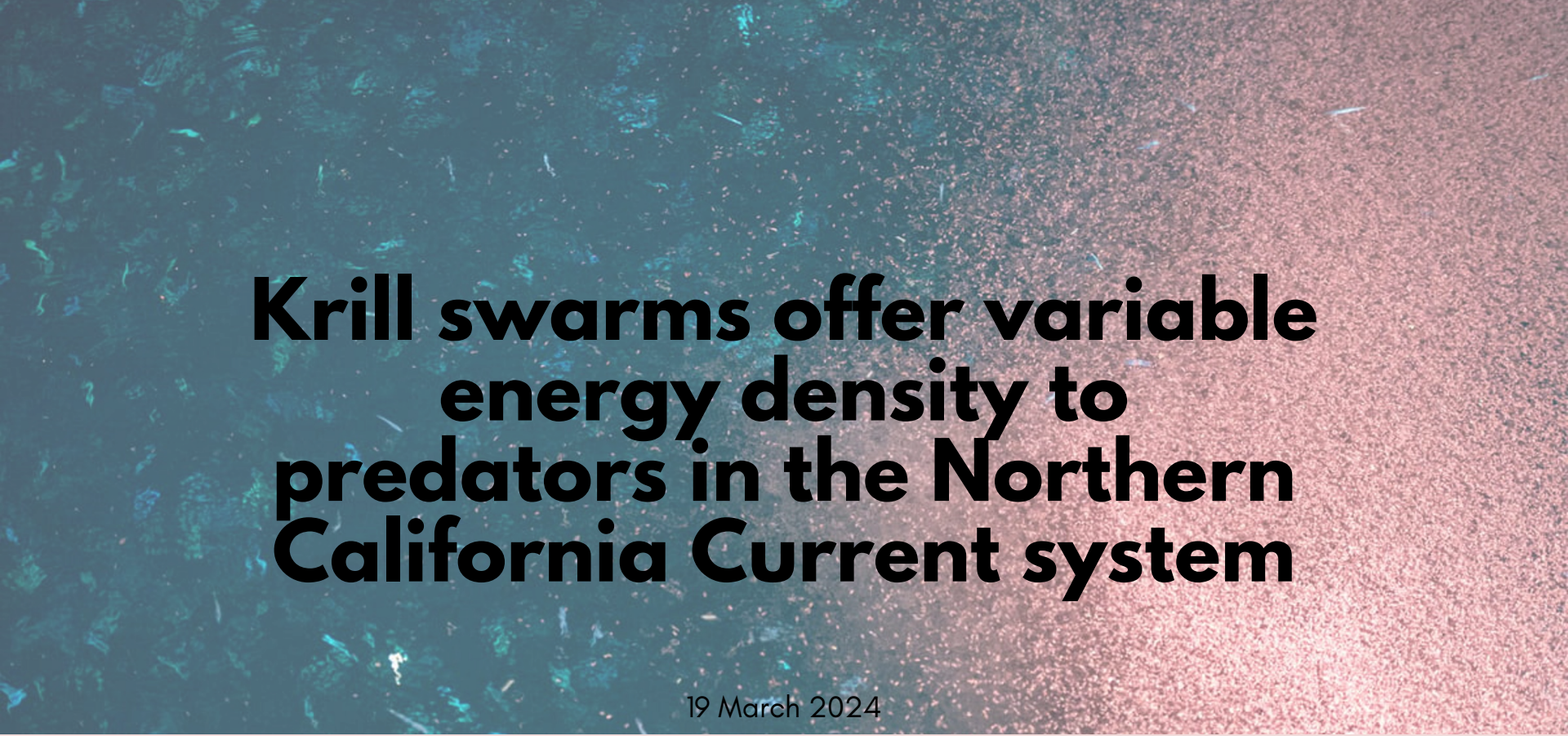

Krill swarms offer variable energy density to predators in the Northern California Current system

19 March 2024

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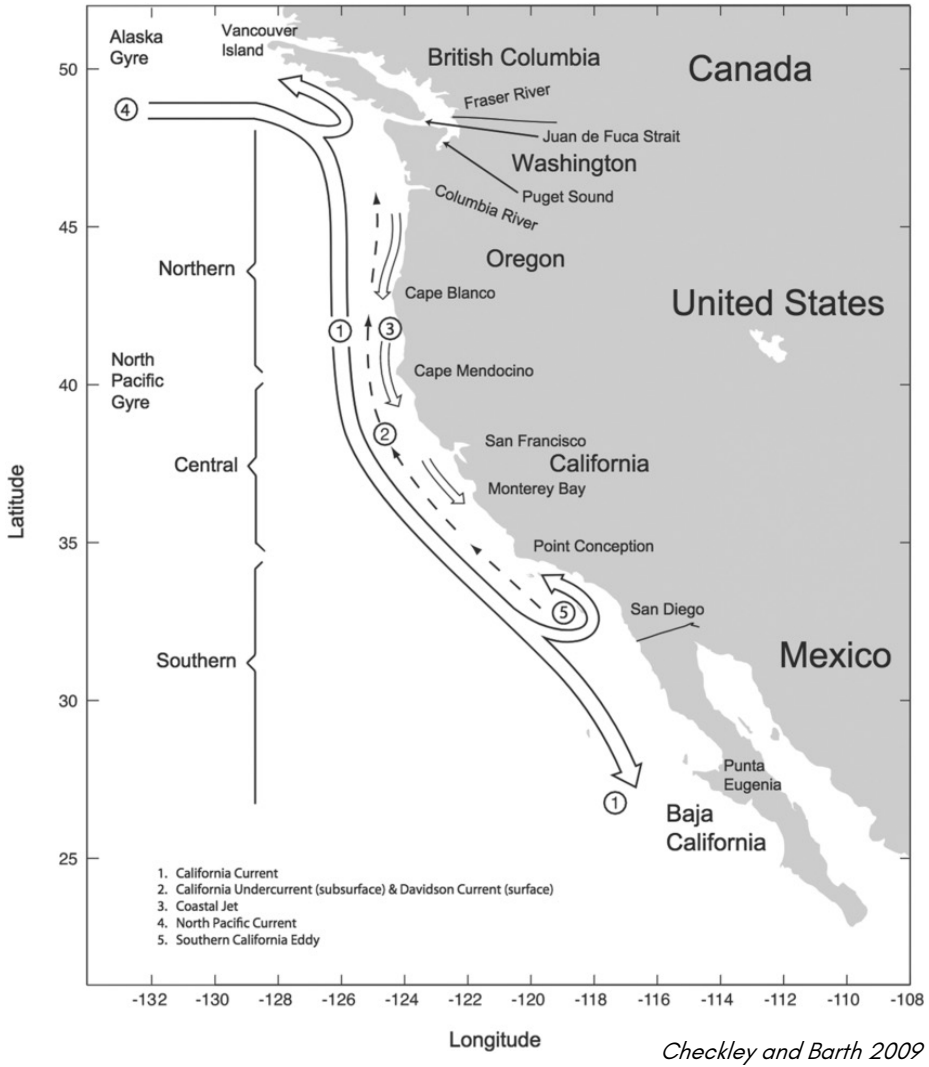
Introduction

Northern California Current region

- Eastern Boundary Current Upwelling System
  - seasonal wind-driven upwelling/downwelling
  - March - November upwelling season
- Productive food web
  - Diatoms → grazers → mesozooplankton → upper trophic levels
- Key species



Checkley and Barth 2009

Introduction

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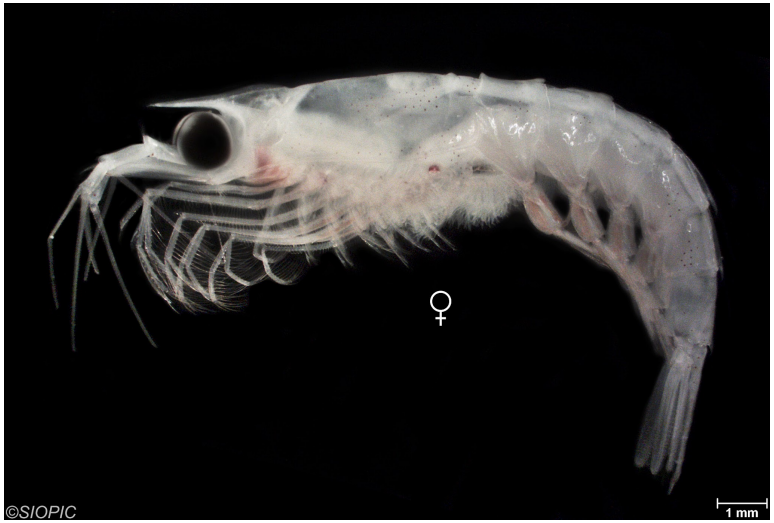
  - seasonal wind-driven upwelling/downwelling
  - March - November upwelling season
- Productive food web
  - Diatoms → grazers → mesozooplankton → upper trophic levels
- Key species
  - Krill
    - *Euphausia pacifica*
    - *Thysanoessa spinifera*



Introduction

NCC as foraging grounds

- Krill predators
  - Fish
  - Seabirds
  - Pinnipeds
  - Cetaceans

- Baleen whales
  - Humpback
  - Blue
  - Fin
    - all are threatened, and protected under federal United States legislation

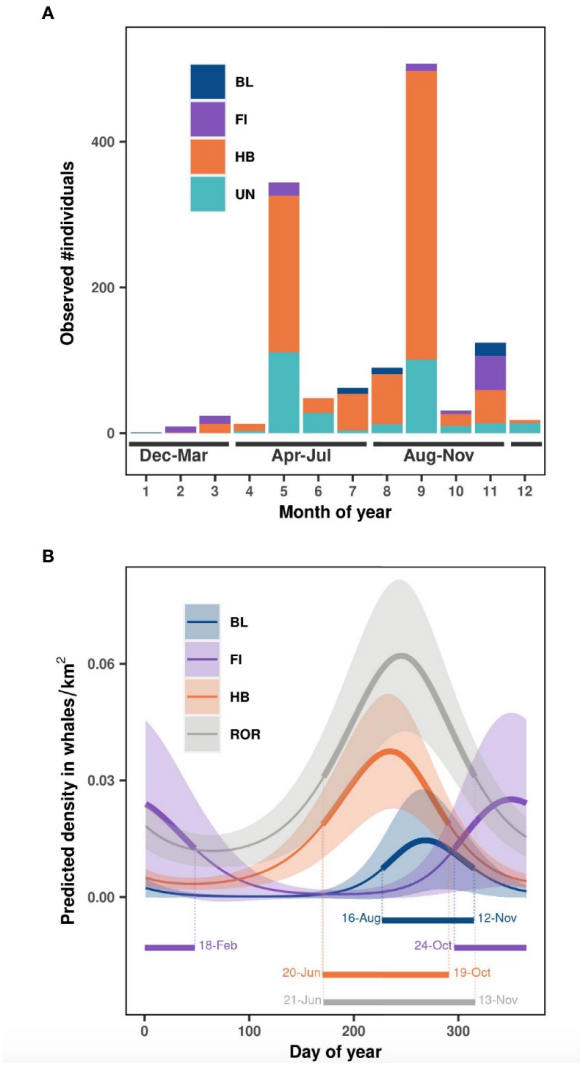
Photos: D. Barlow

Introduction

NCC as foraging grounds

- Baleen whales
  - Migratory lifestyle
  - Capital breeders
  - Prey quality is important!

- Peak occupancy
  - Humpback - August
  - Blue - September
  - Fin - December



Derville et al 2022

Research questions

1) How are krill distributed at scales relevant to baleen whale predators?

- Latitudinal and cross-shelf distribution patterns
- Characteristics of krill aggregation structures

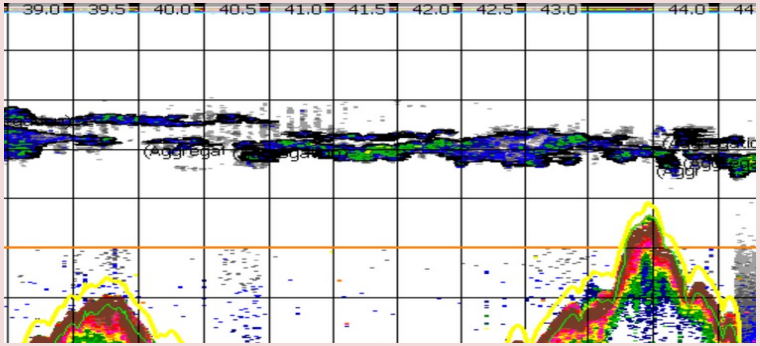
2) How does the energetic value of krill vary in relation to seasonal upwelling?

- Early season (pre-spring transition)
- Late season (after upwelling and productivity accumulation)

Methods – Paired data streams

Active acoustics

- dB differencing (120-38 kHz; 2018-2022)
- swarm characteristics (2022)
- Hierarchical Cluster Analysis

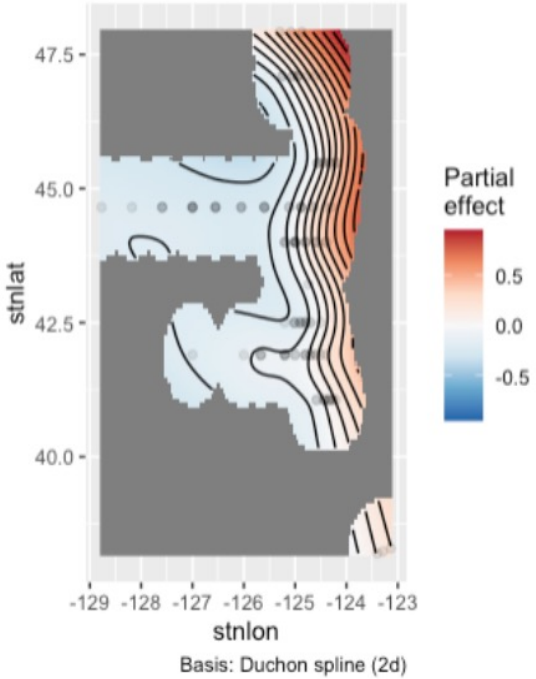


Bongo net tows

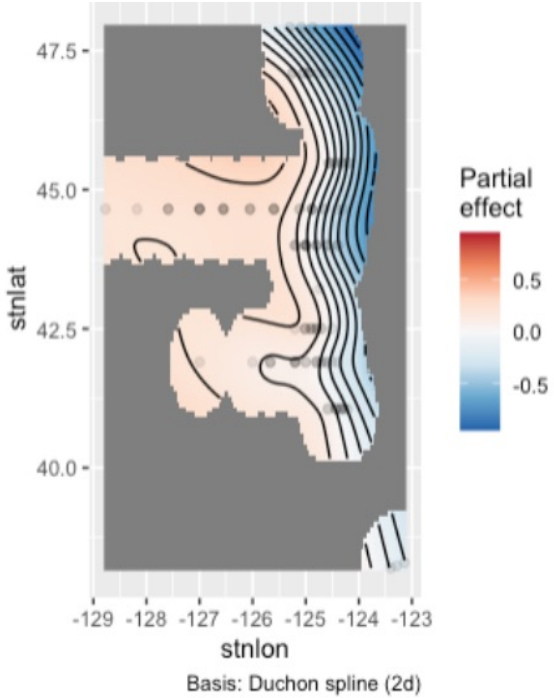
- krill counts and tow proportions (2018-2022)
- bomb calorimetry samples (2022)
- Generalized Additive Models

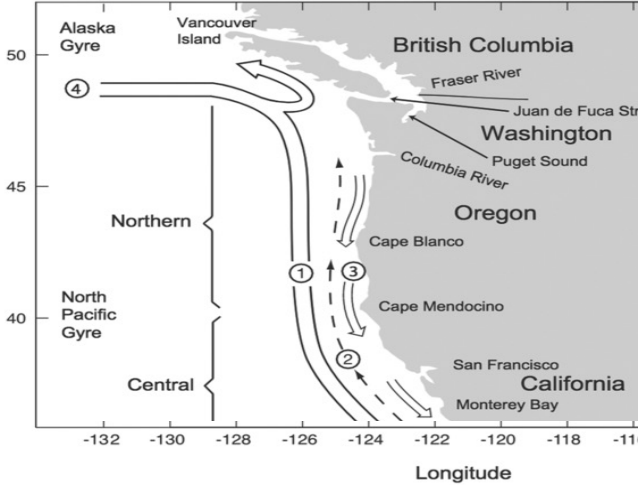
Results – NCC krill distributions

T. spinifera



E. pacifica



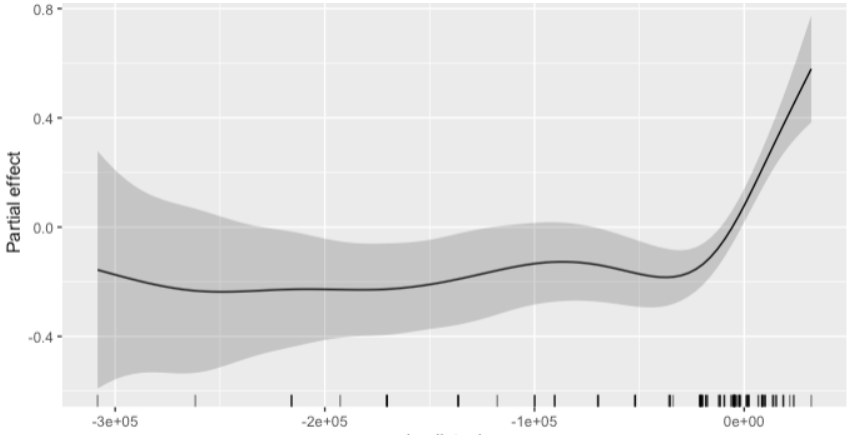


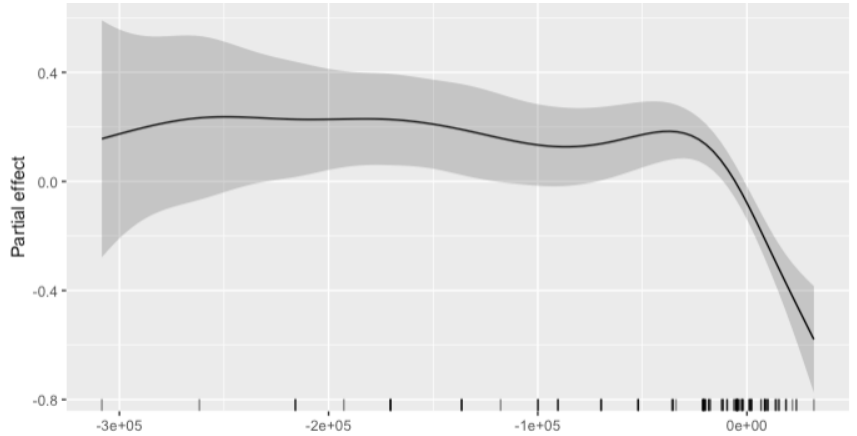
Adapted from Checkley and Barth 2009

Results – contrasting cross-shelf distributions

Opposing trends

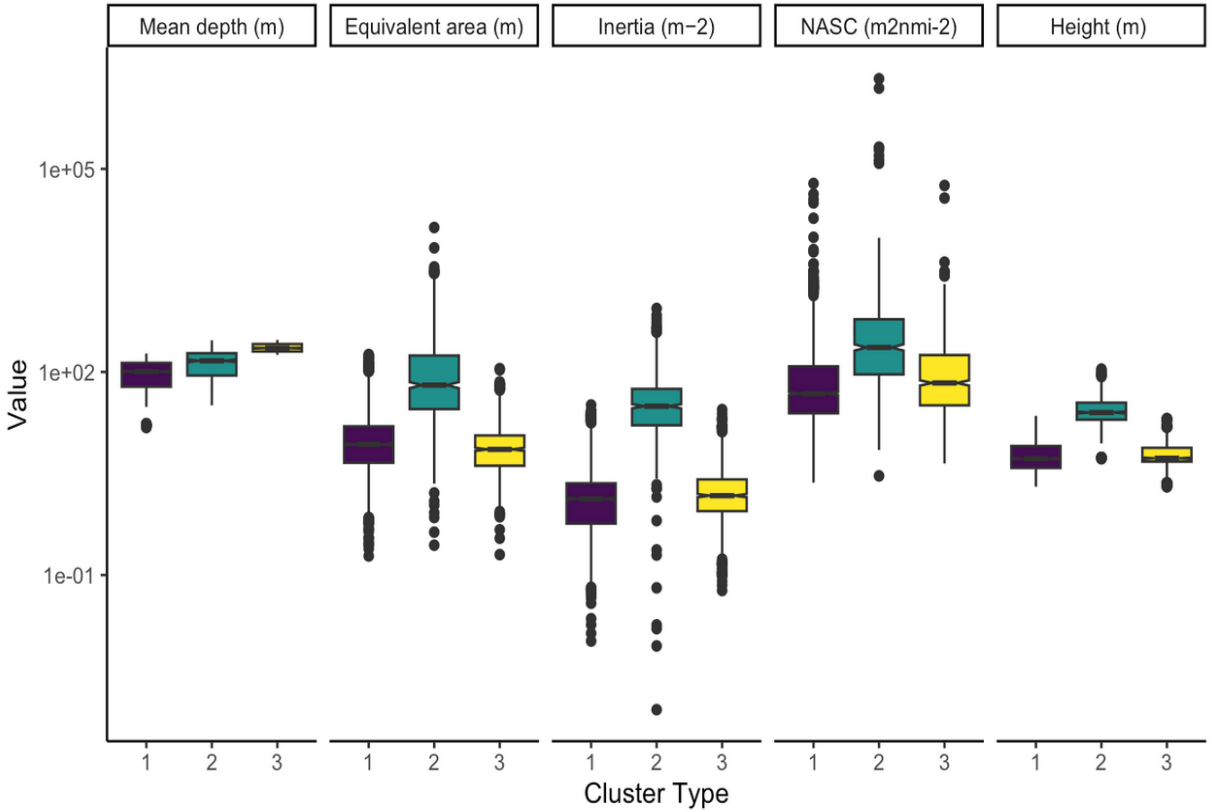
- *Thysanoessa spinifera*
  - Coastal distribution
  - Peak occupancy on the shelf
- *Euphausia pacifica*
  - Shelf, slope, oceanic distribution
  - Peak occupancy offshore of the shelf break





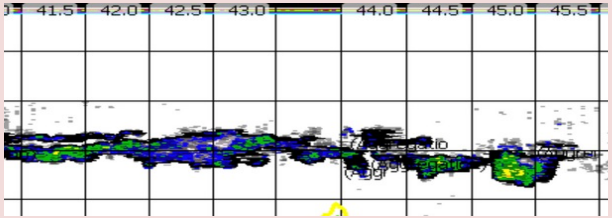
Distance from the shelf break

Results - Fine-scale aggregation structures

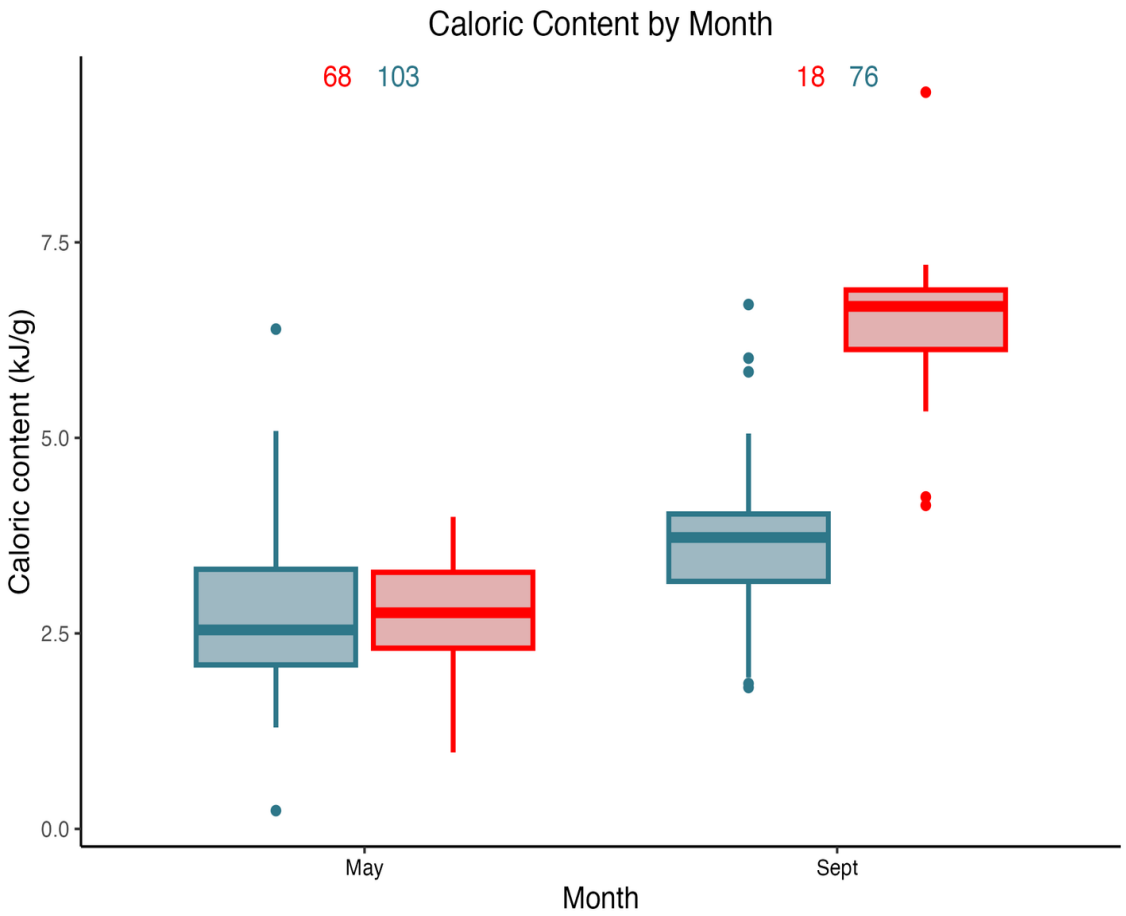


Swarm characteristics

- Length
- Height
- Density
- Spatial variability



Results – Seasonal caloric signal



ANOVA

*** month

*** species

Post-hoc Tukey test

All groups are significantly different ($p < 0.05$), except May *E. pacifica* and *T. spinifera*

Main take-aways

1) How are krill distributed at scales relevant to baleen whale predators?

- *T. spinifera* dominates shelf, *E. pacifica* dominates slope and offshore waters
- NCC-wide distribution (with intra- and interannual variability)

2) How does the caloric value of krill vary seasonally in relation to upwelling?

- Early season - lower caloric content, similar value between species
- Late season - *E. pacifica* slightly elevated, *T. spinifera* skyrocketed

3) What are the characteristics of individual krill aggregation structures?

- Variable swarm height, length, density, etc.
- Are large, accessible swarms (Cluster 2) preferential prey for whales?

Next steps

1) Integrate caloric values with acoustic data

2) Bring in the whales – examine preyfield around humpback whale groups

3) Broaden swarm structure analysis and compare with different whale species (blue, humpback, fin whales)

4) Ultimately, results will inform models for use in management

Acknowledgements

Data

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Thank you!