Counting calories: Energy density and lipid content of zooplankton near Northeast Pacific seamounts

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Introduction

Zooplankton are a major food source for many marine organisms, representing a key link between primary producers and larger consumers in the open ocean. Quantifying the energy content in zooplankton aids in the understanding of marine food web processes. Energy density is a common metric used in bioenergetic, growth, and other ecosystem modelling. Lipids are the most energy dense biochemical, making them a vital energy source for many consumers. These metrics can help us understand the nutritional properties of different size fractions of zooplankton.

There are 62 known seamounts in Canada's Offshore Pacific Bioregion[1] (**Fig. 1**). The trophic pathways supporting the maintenance of foodwebs in these isolated environments remains unclear, but likely involves energy derived from the advection of zooplankton over seamount summits. Understanding the energetic contribution of prey being supplied to these seamounts will improve our understanding of energy flow within these ecosystems and how we might best protect these regions. Emerging optical techniques also enable better in-situ measurement of particle distribution in the water column, improving our ability to identify the vertical distribution of zooplankton taxa and size classes[3].

Research Objective

To quantify variations in lipid content and energy density of mesozooplankton around seamounts in Canada's Offshore Pacific Bioregion.

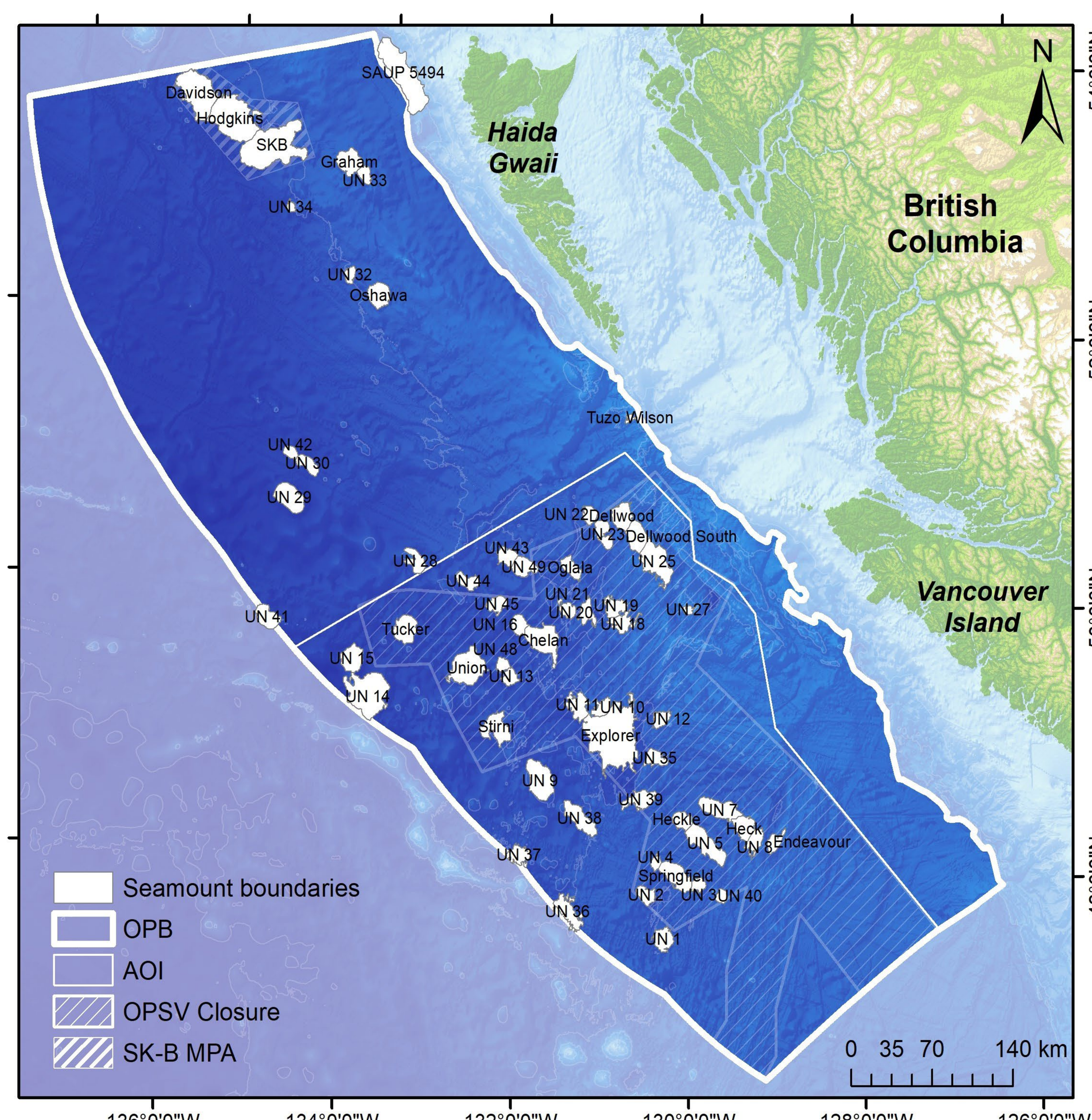
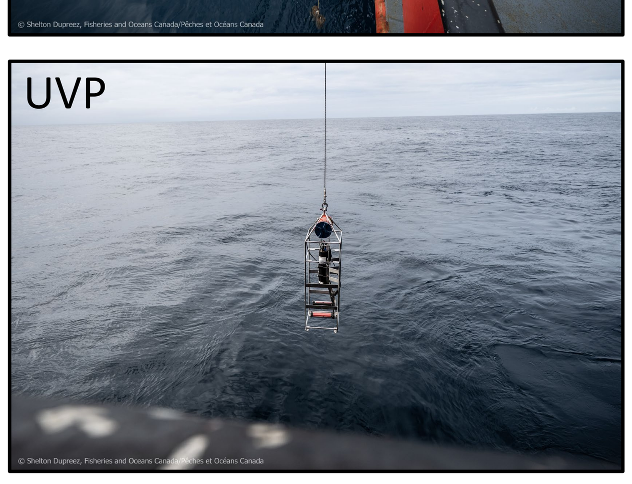


Figure 1. A map of Canada's Offshore Pacific Bioregion (OPB) with known seamounts highlighted. Sampling occurred within the outlined Area of Interest (AOI) for a future marine protected area and over Tuzo Wilson seamount.

Methods



- Sampling occurred aboard the *CCGS John P. Tully* in July 2017, July 2019, and June 2021
- Zooplankton collected using bongo nets (236 um mesh) towed from 250m depth to the surface
- Underwater Vision Profiler (UVP) used to create particle depth profiles to 250m
- Zooplankton were size-fractioned into four groups: 0.25-1 mm, 1-2 mm, 2-4 mm, & 4+ mm
- Size fractions were weighed and then freeze dried to determine dry weight
- Ash-free dry weight (AFDW) determined by burning samples at 550ºC for 4 hours
- Energy density (ED) determined as[4]:

$$\log_{10}(ED) = 1.08*\log_{10}(AFDW) - 0.77$$

- Lipids were extracted from bulk zooplankton using a modified Parrish method[5] and measured gravimetrically

Preliminary Results

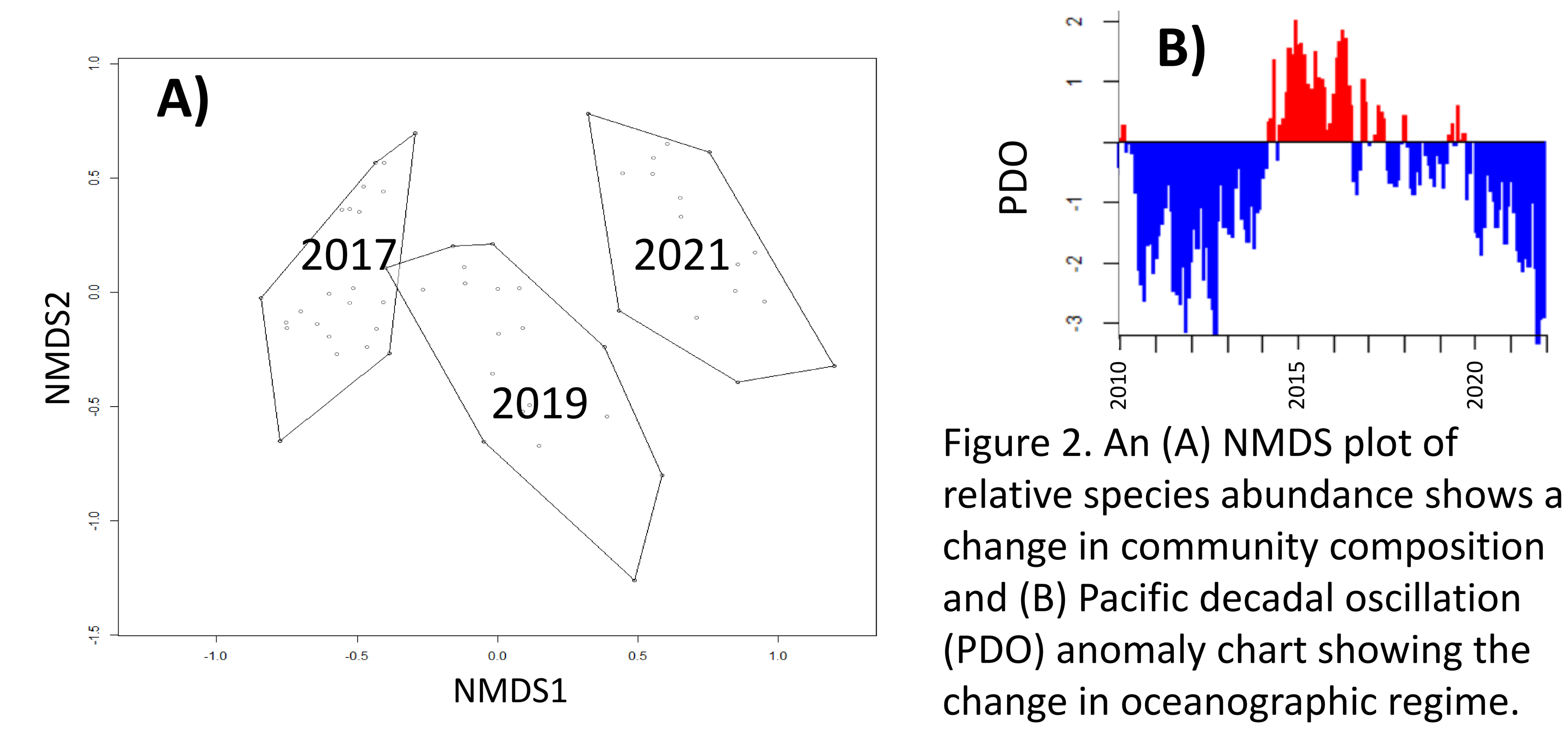


Figure 2. An (A) NMDS plot of relative species abundance shows a change in community composition and (B) Pacific decadal oscillation (PDO) anomaly chart showing the change in oceanographic regime.

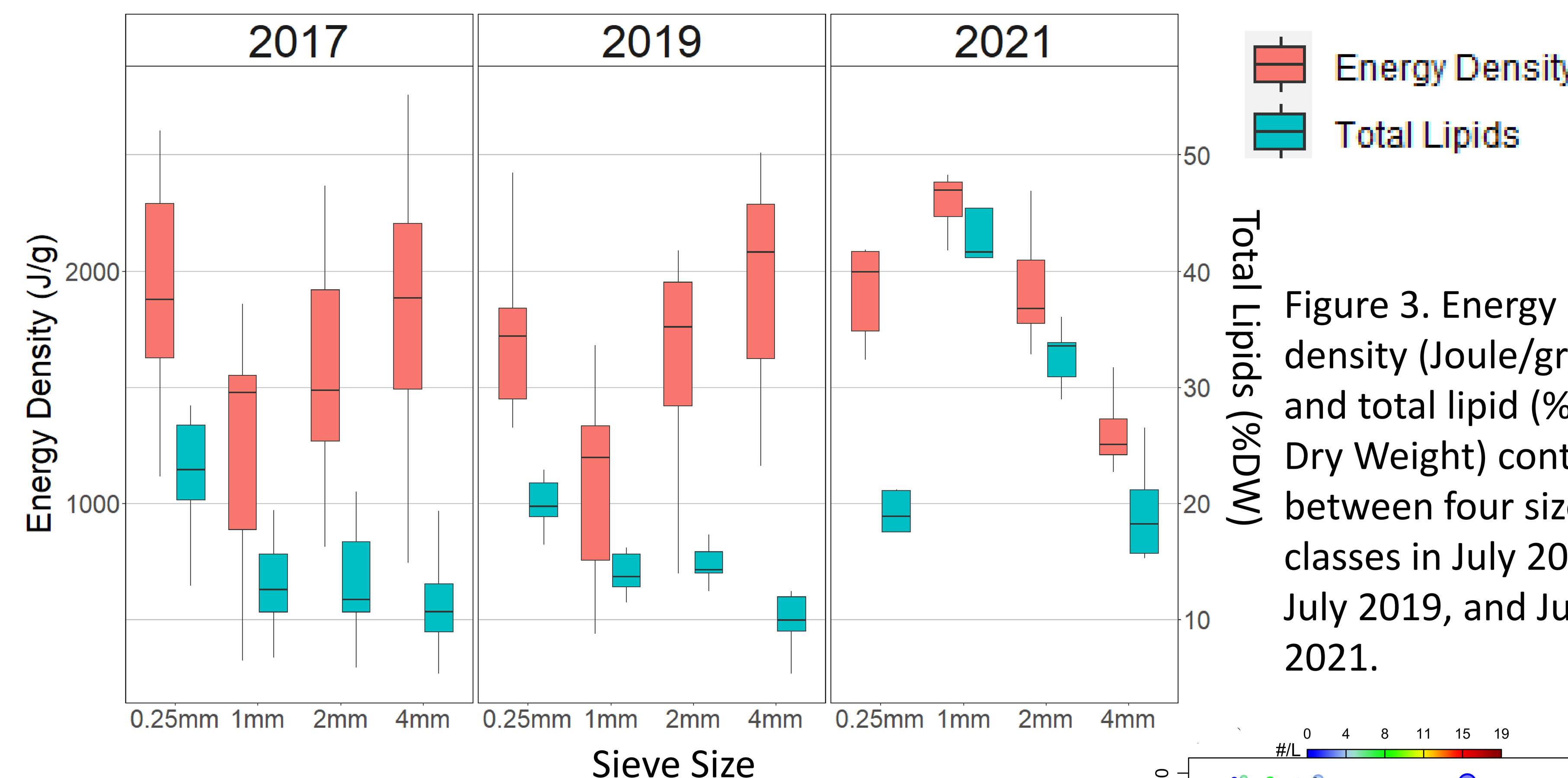


Figure 3. Energy density (Joule/gram) and total lipid (% Dry Weight) content between four size classes in July 2017, July 2019, and June 2021.

- Shift from a zooplankton community of predominantly small copepod species in 2017 and 2019 to a community dominated by large copepods in 2021 (**Fig. 2**)
- The shift in species composition resulted in changes to energy density and lipid content of different zooplankton size fractions between sampling years (**Fig. 3**)
- Particles/zooplankton (>250µm ESD) tend to be evenly distributed throughout the top 250m of the water column at both day and night (**Fig. 4**)

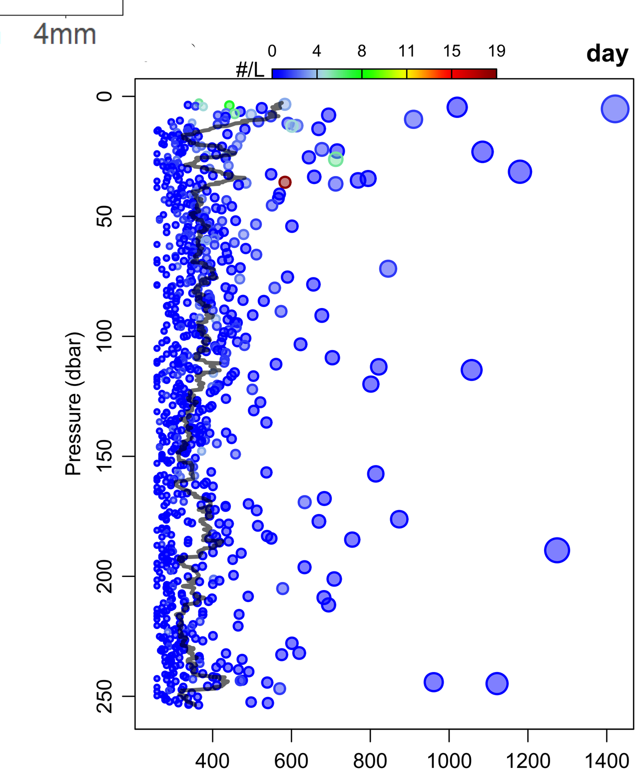


Figure 4. Vertical distribution and abundance of particles >250 ESD. Collected in June 2021.

Discussion

Interannual changes in the zooplankton community affect the nutritional properties of prey available to seamount foodwebs. The zooplankton community was much more lipid-rich in 2021 as a result of abundant large lipid-storing copepods. Due to the similar energy density of bulk zooplankton across these years it could be hypothesized that 2017 and 2019 zooplankton will have higher protein or other energetic material to account for this discrepancy. Future research can use particle distribution and size fractioned data to estimate the vertical distribution of high-quality prey near these seamounts and whether large lipid-rich prey will increase energy flux to seamount summits.

Significance

- Contributes to our understanding of the prey quality available to fish, bird, and marine mammal species in Canada's Offshore Pacific Bioregion
- Provides important baseline data on the zooplankton community for future creation and monitoring of marine protected areas
- This research contributes to the understanding of energy distribution within Canada's Offshore Pacific Bioregion seamount ecosystems

Literature Cited

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Acknowledgements

Chelsea Stanley, Tammy Norgard, Dr. Cat Stevens, Shelton Du Preez, Northeast Pacific Seamount Expedition Partnerships (Fisheries and Oceans Canada, Ocean Networks Canada, the Council of the Haida Nation, the Nuu-Chah-Nulth Tribal Council), and the captain and crew of the CCGS John P. Tully.