Microplankton microscopy and biovolume analysis from Lugol's samples collected in Resurrection Bay, AK from January to March of 2023

Website: https://www.bco-dmo.org/dataset/954189
Data Type: Other Field Results
Version: 1
Version Date: 2025-02-21

Project
» Collaborative Research: Zooplankton restarts in a high-latitude marine ecosystem: species-specific recruitment and development in early spring (Zooplankton recruitment)

Contributors	Affiliation	Role
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Abstract
The Gulf of Alaska is a highly seasonal environment characterized by an order-of-magnitude increase in copepod biomass in the photic zone between winter and spring. The study focused on copepod recruitment to characterize species-specific naupliar production. Concurrent environmental monitoring included taxonomic identification of microplankton using microscopy.

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Coverage

Location: Gulf of Alaska, sub-arctic Pacific
Spatial Extent: **Lat**:60.025 **Lon**:-149.3583
Temporal Extent: 2023-01-05 - 2023-03-24

Methods & Sampling

Microzooplankton samples were collected at 3 depths (50, 150, and 280 m) by gently draining 250 mL of seawater from the Niskin bottle with a silicon tube to avoid bubbling. Samples were then preserved with acid Lugol's solution to a final concentration of 5% (Strom et al., 2019). Glass was added to saturate silica and prevent dissolution of diatoms. Samples were gently mixed and 100 mL subsamples were settled onto microscope slides. Diatoms, dinoflagellates, and ciliates were identified to lowest taxonomic classification, enumerated, and imaged under an inverted microscope. Linear length and widths of cells were measured for a subset of 5 cells (or maximum number) per sample per taxon using ImageJ. Biovolume was estimated using the median linear measurements per taxon and biovolume was calculated using the volumetric equations most closely matching the cell shape (Hillebrand et al., 1999). Biovolume was then converted to carbon biomass according to established diatom and protist carbon:volume relationships (Menden-Deuer and Lessard, 2000).

Day-trips aboard the R/V Nanuq conducted approximately biweekly in Resurrection Bay, AK during January to March, 2023.

Data Processing Description

For the microscopy, biovolume was estimated using the median linear measurements per taxon and biovolume was calculated using the volumetric equations most closely matching the cell shape (Hillebrand et al., 1999). Biovolume was then converted to carbon biomass according to established diatom and protist carbon:volume relationships (Menden-Deuer and Lessard, 2000).

BCO-DMO Processing Description

* Sheet 1 of submitted file "Sheet 1-1-NaupProj2023_Lugols_BCODMO.csv" was imported into the BCO-DMO data system for this dataset. Table will appear as Data File: 954189_v1_microplankton-microscopy.csv (along with other download format options).

* A unique list of taxonomic names used in the data table was matched with identifiers using the World Register of Marine Species (WoRMS, marinspecies.org) taxa match tool on 2025-02-24. The resulting species list was attached as a supplemental file.
* "Tintinnid" was matched to "Tintinnidae" the formal taxon representation of the name. urn:lsid:marinespecies.org:taxname:183533
* The incorrect phonetic spelling of "Dytilum" was corrected to "Ditylum" (urn:lsid:marinespecies.org:taxname:149022) in the data table and subsequent supplemental file.
* "Navicula" and "Nitzschia" returned ambiguous name match results however, each only had one matching result that was a diatom as described by the column "group" to the appropriate LSIDs could be assigned in this dataset. The other possible matches were in Mollusca and Platyhelminthes.

Problem Description

No acid Lugol’s sample was processed for the 150 m depth on March 12th.

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Related Publications

Block, L. N. (2024). Evaluating Species-Specific Naupliar Recruitment During the Winter-to-Spring Transition in the Northern Gulf of Alaska Using Molecular Tools (Master's thesis, University of Hawai'i at Manoa). Available from https://hdl.handle.net/10125/108679
Results

Hillebrand, H., Dürselen, C.-D., Kirschtel, D., Pollingher, U., & Zohary, T. (1999). Biovolume calculation for pelagic and benthic microalgae. Journal of Phycology, 35(2), 403–424. doi:10.1046/j.1529-8817.1999.3520403.x
Methods

Menden-Deuer, S., & Lessard, E. J. (2000). Carbon to volume relationships for dinoflagellates, diatoms, and other protist plankton. Limnology and Oceanography, 45(3), 569–579. doi:10.4319/lo.2000.45.3.0569
Methods

Schneider, C. A., Rasband, W. S., ... (n.d.). ImageJ. US National Institutes of Health, Bethesda, MD, USA. Available from https://imagej.nih.gov/ij/
Software

Strom, S. L., Fredrickson, K. A., & Bright, K. J. (2019). Microzooplankton in the coastal Gulf of Alaska: Regional, seasonal and interannual variations. Deep Sea Research Part II: Topical Studies in Oceanography, 165, 192–202. https://doi.org/10.1016/j.dsr2.2018.07.012

Methods

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Related Datasets

IsRelatedTo

Block, L. N., Lenz, P. H. (2025) **CTD (temperature, salinity and fluorescence) from bi-weekly vertical profiles in Resurrection Bay, AK from January to March of 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-02-21 http://lod.bco-dmo.org/id/dataset/954156 [view at BCO-DMO]
Relationship Description: Related data collected as part of the same study published in Block, L. N. (2024, https://hdl.handle.net/10125/108679).

Block, L. N., Lenz, P. H. (2025) **Chlorophyll a and flow cytometry data from bi-weekly vertical profiles in Resurrection Bay, AK from January to March of 2023 from bi-weekly vertical profiles in Resurrection Bay, AK from January to March of 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-02-21 http://lod.bco-dmo.org/id/dataset/954173 [view at BCO-DMO]
Relationship Description: Related data collected as part of the same study published in Block, L. N. (2024, https://hdl.handle.net/10125/108679).

Block, L. N., Lenz, P. H. (2025) **Molecular identification of genetic variants of Neocalanus flemingeri in the Gulf of Alaska from samples collected from 2015 to 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-02-21 http://lod.bco-dmo.org/id/dataset/954181 [view at BCO-DMO]
Relationship Description: Related data collected as part of the same study published in Block, L. N. (2024, https://hdl.handle.net/10125/108679).

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Parameters

Parameter	Description	Units
cruise	Cruise ID	unitless
date	Date (Local time) in ISO 8601 format yyyy-mm-dd	unitless
station	Station ID	unitless
latitude	Station latitude, north is positive	Decimal Degrees North
longitude	Station latitude, west is negative	Decimal Degrees East
depth	Target water collection depth	Meters (m)
sample_volume	Volume of sample processed for microscopy	Milliliters (ml)
group	Broad taxonomic grouping (Diatom, Dinoflagellate, Cilliate)	unitless
taxa	Taxonomic identification to lowest taxonomic level	unitless
cell_count	Number of cells observed in the sample	Integer
abundance	Number of cells per ml of sample per taxa	Cells per milliliter (#/ml)
cell_biovolume	Estimated biovolume per cell	Cubic micrometers (µg^3)
cell_carbon	Estimated carbon per cell based on biovolume estimate	Picograms carbon (pg)
biomass	Biomass per mL of sample per taxa	Picograms carbon per milliliter (pg/ml)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	CTD - profiler
Dataset-specific Description	SBE55 rosette with 6 4-L Niskin Bottles
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	Inverted microscope (Olympus IM)
Generic Instrument Name	Inverted Microscope
Generic Instrument Description	An inverted microscope is a microscope with its light source and condenser on the top, above the stage pointing down, while the objectives and turret are below the stage pointing up. It was invented in 1850 by J. Lawrence Smith, a faculty member of Tulane University (then named the Medical College of Louisiana). Inverted microscopes are useful for observing living cells or organisms at the bottom of a large container (e.g. a tissue culture flask) under more natural conditions than on a glass slide, as is the case with a conventional microscope. Inverted microscopes are also used in micromanipulation applications where space above the specimen is required for manipulator mechanisms and the microtools they hold, and in metallurgical applications where polished samples can be placed on top of the stage and viewed from underneath using reflecting objectives. The stage on an inverted microscope is usually fixed, and focus is adjusted by moving the objective lens along a vertical axis to bring it closer to or further from the specimen. The focus mechanism typically has a dual concentric knob for coarse and fine adjustment. Depending on the size of the microscope, four to six objective lenses of different magnifications may be fitted to a rotating turret known as a nosepiece. These microscopes may also be fitted with accessories for fitting still and video cameras, fluorescence illumination, confocal scanning and many other applications.

Dataset-specific Instrument Name	
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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Project Information

Collaborative Research: Zooplankton restarts in a high-latitude marine ecosystem: species-specific recruitment and development in early spring (Zooplankton recruitment)

Coverage: Sub-arctic marine ecosystem, Gulf of Alaska

NSF Award Abstract
Global climate change and associated extreme weather events are increasingly impacting marine communities at all trophic levels and leading to shifts in the timing of life history events. This project is investigating the annual restart of the spring zooplankton community in the Gulf of Alaska in order to determine the timing of species-specific recruitment and growth. Zooplankton are small pelagic animals that are a critical link between microalgae and protozoans and higher levels in the food web including economically important fishes, birds and marine mammals. While their abundances and species composition have been documented over part of the annual cycle between late spring and fall, this project focuses on winter and early spring. The project integrates traditional methods with modern molecular approaches to characterize the diversity, development, feeding and physiology of zooplankton, especially the early developmental stages of copepods (small crustaceans). The goal is to determine which species are there, how many are present and where they are in the water column, and to reveal indicators of their health. Broader impacts include research training for three graduate students and at least four undergraduates in biological oceanography and physiological ecology. Outreach activities are focusing on broadening the public's understanding of plankton ecology. An illustrated zooplankton guide for the Gulf of Alaska and plankton module for school teachers and students is being produced in collaboration with the Center for Alaskan Coastal Studies. Other plans include sponsorship of nature-drawing workshops on zooplankton and the production of an Art & Science traveling exhibit.

This project is tracking zooplankton population abundances, species composition and developmental stages through the spring restart in a high-latitude fjord in the northern Gulf of Alaska. While the entire zooplankton community is being characterized, the main focus is on the difficult-to-assess early developmental stages of copepods, which dominate the late spring biomass in the region. Three central hypotheses guide the research: 1) high abundances of copepod nauplii are present before any measurable increases in food in surface waters; 2) species diversity increases between winter and spring, with nauplii from large lipid-rich capital-breeding species appearing first, followed by those from income- and hybrid-strategy species and finally nauplii that emerge from dormant eggs; 3) prior to the appearance of food resources, nauplii from capital-breeding species conserve resources by delaying development and entering a state of dormancy in the second and third naupliar stages. The project entails intensive depth-stratified field sampling to characterize the wild community, in combination with laboratory experiments on nauplii to determine their responsiveness to food. The prey are being characterized by measuring chlorophyll a, dietary and prey community DNA sequencing and flow cytometry to establish diversity and abundances. Size-fractionated zooplankton samples are being analyzed using microscopy and community DNA sequencing to ascertain species diversity, developmental stage distribution and abundances. Feeding activity is being measured using dietary DNA sequencing of nauplii followed by comparisons with the prey field. Dormancy in nauplii is being determined by differential gene expression of target genes (RT-qPCR) and high-throughput sequencing of mRNA of individuals (transcriptomics) and community samples (meta-transcriptomics). Short-term and long-term effects of food availability on dormancy, development and growth are being quantified in laboratory experiments. Broader impacts are focused on training of students in interdisciplinary research and state-of-art techniques, and public outreach to introduce plankton ecology to broader audiences.

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Funding

Funding Source	Award
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OCE-2222376
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OCE-2222592
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OCE-2222558

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