Size-binned particle abundance and biovolume from FlowCam runs on the "SalpPOOP" cruise on R/V Tangaroa during October and November 2018

Website: https://www.bco-dmo.org/dataset/881656
Data Type: Cruise Results
Version: 1
Version Date: 2023-05-11

Project
» Collaborative Research: Quantifying trophic roles and food web ecology of salp blooms of the Chatham Rise (Salp Food Web Ecology)

Contributors	Affiliation	Role
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Abstract
This dataset includes size-binned particle abundance and biovolume from FlowCam runs on the "SalpPOOP" cruise on R/V Tangaroa during October and November 2018.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Data Files
- Related Publications
- Related Datasets
- Parameters
- Instruments
- Deployments
- Project Information
- Funding

Coverage

Spatial Extent: **N**:-42.6622 **E**:-179.812 **S**:-45.5557 **W**:174.095
Temporal Extent: 2018-10-24 - 2018-11-18

Dataset Description

Note: A less condensed dataset containing all particle size, volume, and converted biomass values from each FlowCam run is also available in the related dataset "FlowCam Particle Sizes" (https://www.bco-dmo.org/dataset/881563).

Methods & Sampling

Samples were collected during October and November 2018 on R/V Tangaroa cruise TAN1810 ("SalpPOOP" cruise) in the Chatham Rise (subtropical and subantarctic waters off the coast of New Zealand). Samples were collected from Niskin bottles of CTD deployments to the base of the mixed layer and the deep chlorophyll

maximum. 250 mL subsamples were concentrated by gravity filtration to 10 mL over a 2 µm 47 mm filter, and 2 mL of this concentrate was imaged using a FlowCam's 10X objective lens to quantify the larger (>3 µm) phytoplankton (Sieracki et al. 1998).

FlowCam image analyses were conducted using FlowCam's dedicated classification software VisualSpreadsheet (v. 4.18.5). First, duplicate images resulting from parabolic flow within the flow cell were manually removed. The particles within the remaining images were then classified based on the quality with which VisualSpreadsheet detected their outlines. For particles where the outline appeared to provide good estimates of length and width (classes "Other", "Pennates", "Chaeto", and "Ciliate"), size was calculated for a prolate spheroid using the minimum feret as width and maximum feret as length.

Four categories of particles imaged by the FlowCam proved problematic due to poorer outline quality and had to be treated specially. For such pennate diatoms (class "BadPen"), we manually measured the caliper width of every such pennate diatom in the first CTD cast of each of the four cycles to derive the average pennate width for that cast, and applied this average retroactively to all poorly detected pennates within that cycle. Equivalent spherical diameter (ESD) and biovolume (BV) for the resulting prolate spheroid were then calculated as normal. For semi-transparent dinoflagellates (class "ClearDino"), we recalculated the width using the recorded length and mean aspect ratio for well-detected dinoflagellates in the first CTD cast of each cycle and then calculated ESD and BV normally. For *Chaetoceros* (class "BadChaeto") we recalculated the length and width of these particles using the recorded aspect ratio and area. Each *Asterionelopsis* colony (class "Aster") was saved as an individual image file, and representative single cells within a colony that were parallel to the camera's field of view were manually analyzed using ImageJ (v. 1.52a). This procedure was repeated for all colonies in the first cast of each cycle and the mean width and length taken to produce an "average" *Asterionelopsis* cell. We then manually counted the number of individual cells present in each image and applied them to the averaged cell sizes to estimate the total biovolume.

The biomass of ciliates (class "Ciliate") was estimated as 0.19 pg C μm^{-3} Putt and Stoecker 1989). The biomass of diatoms (classes "Chaeto", "BadChaeto","Pennate", "BadPen", and "Aster") was estimated allometrically as 0.288*Biovolume^0.811 while other protists and unidentified particles (classes "Other" and "ClearDino") were estimated using 0.216*Biovolume^0.939 (Menden-Deuer and Lessard 2000).

Data Processing Description

Data Processing:
This dataset was achieved by splitting the particles in the companion dataset "FlowCam Particle Sizes" for a given FlowCam run into discrete size bins (see Related Dataset https://www.bco-dmo.org/dataset/881563). To calculate "X-Y Abundance", the sum of the particles larger than X and smaller than Y within a run was divided by the "Fluid Volume Imaged" for that run multiplied by 25 (to account for the 250 mL concentration down to 10 mL). This was then divided by the bin width, or Y-X. The resulting columns represent the Normalized Abundance Size Spectrum, or NASS. Biomass was similarly calculated with the exception of rather than summing the particle counts from "FlowCam Particle Sizes", we sum the converted carbon biomass (column "Biomass" in "FlowCam Particle Sizes"). The result is the Normalized Biomass Size Spectrum, or NBSS.

BCO-DMO Processing:
- started with file named "FlowCam_ReducedV2.xlsx" received February 2023;
- renamed fields to comply with BCO-DMO naming conventions;
- rounded Lat and Lon fields to 4 decimal places.

[table of contents | back to top]

Data Files

File	
flowcam_reduced.csv	(Comma Separated Values (.csv), 18.34 KB) MD5:adf05d498d0c285c018ebcb821bc6068
Primary data file for dataset ID 881656.	

[table of contents | back to top]

Related Publications

Fender, C. K., Décima, M., Gutiérrez-Rodríguez, A., Selph, K. E., Yingling, N., & Stukel, M. R. (2023). Prey size spectra and predator to prey size ratios of southern ocean salps. Marine Biology, 170(4). https://doi.org/10.1007/s00227-023-04187-3
Results

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

Putt, M., & Stoecker, D. K. (1989). An experimentally determined carbon : volume ratio for marine “oligotrichous” ciliates from estuarine and coastal waters. Limnology and Oceanography, 34(6), 1097–1103. doi:10.4319/lo.1989.34.6.1097
Methods

Sieracki, C., Sieracki, M., & Yentsch, C. (1998). An imaging-in-flow system for automated analysis of marine microplankton. Marine Ecology Progress Series, 168, 285–296. https://doi.org/10.3354/meps168285
Methods

[table of contents | back to top]

Related Datasets

IsDerivedFrom

Fender, C., Selph, K. E., Stukel, M. (2023) **Particle size, volume, and converted biomass from FlowCam runs on the "SalpPOOP" cruise on R/V Tangaroa during October and November 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-05-09 doi:10.26008/1912/bco-dmo.881563.1 [view at BCO-DMO]
Relationship Description: The companion dataset "FlowCam Particle Sizes" (881563) is a less condensed dataset containing all particle size, volume, and converted biomass values from each FlowCam run.

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cycle	Lagrangian experiment number	unitless
Fluid_Volume_Imaged	Volume imaged by FlowCam	milliliters (mL)
Cast	CTD deployment number	unitless
Depth	Sample depth	meters (m)
Rep	Replicate run	unitless
Lat	Latitude; negative values = South	decimal degrees North
Lon	Longitude; negative values = West	decimal degrees East

Date	Date in NZST time zone	unitless
Abundance_quarter_to_half	Particle abundance in size bin 0.25 to 0.5 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_half_to_1	Particle abundance in size bin 0.5 to 1 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_1_to_2	Particle abundance in size bin 1 to 2 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_2_to_4	Particle abundance in size bin 2 to 4 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_4_to_8	Particle abundance in size bin 4 to 8 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_8_to_16	Particle abundance in size bin 8 to 16 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_16_to_32	Particle abundance in size bin 16 to 32 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_32_to_64	Particle abundance in size bin 32 to 64 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_64_to_128	Particle abundance in size bin 64 to 128 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_128_to_256	Particle abundance in size bin 128 to 256 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_256_to_512	Particle abundance in size bin 256 to 512 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Abundance_512_to_1024	Particle abundance in size bin 512 to 1024 micrometers (um) normalized to bin width	number per milliliter per micrometer (#/mL/um)
Biomass_quarter_to_half	Summed biomass in size bin 0.25 to 0.5 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_half_to_1	Summed biomass in size bin 0.5 to 1 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)

Biomass_1_to_2	Summed biomass in size bin 1 to 2 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_2_to_4	Summed biomass in size bin 2 to 4 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_4_to_8	Summed biomass in size bin 4 to 8 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_8_to_16	Summed biomass in size bin 8 to 16 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_16_to_32	Summed biomass in size bin 16 to 32 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_32_to_64	Summed biomass in size bin 32 to 64 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_64_to_128	Summed biomass in size bin 64 to 128 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_128_to_256	Summed biomass in size bin 128 to 256 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_256_to_512	Summed biomass in size bin 256 to 512 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)
Biomass_512_to_1024	Summed biomass in size bin 512 to 1024 micrometers (um) normalized to bin width	picograms C per milliliter per micrometer (pg C/mL/um)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	CTD - profiler
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	
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.

Dataset-specific Instrument Name	okogawa Fluid Imaging Technologies FlowCam Model VS-IV
Generic Instrument Name	Yokogawa Fluid Imaging Technologies FlowCam VS particle imaging system
Generic Instrument Description	Imaging cytometers are automated instruments that quantify properties of single cells, one cell at a time. They combine some aspects of flow cytometry with particle imaging capabilities in an automated device to classify small particles, including phytoplankton and protozoa. They can measure a variety of properties: cell size, cell granularity, cell aspect ratio, equivalent spherical diameter (ESD) and area-based diameter (ABD) [to estimate bio-volume, which is used to estimate cell carbon biomass]. Particle images are digitally recorded and sorted into different classes according to training libraries using a support vector machine (supervised learning methods). The instruments particle-size is calibrated using different sizes of latex beads. The FlowCam VS series are automated imaging-in-flow instruments that generate high-resolution digital images for measuring size and shape of microscopic particles. The sample introduced in the system is attracted by a peristaltic or a syringe pump into a flow cell (or flow chamber) with known dimensions, located in front of a microscope objective which is connected to a camera video. The benchtop model is ideally suited to a typical laboratory environment with applications in oceanographic research, municipal water, biopharmaceutical formulations, chemicals, oil and gas, biofuels, and many other markets. FlowCam VS is available in four models, from the imaging-only VS-I (i.e. without excitation wavelength or fluorescence emission wavelengths) to the top-of-the-line VS-IV with two channels of fluorescence measurement and scatter triggering capabilities. The instrument can measure particles between 2µm and 2mm; can analyse in vivo or fixed samples; has a flow rate between 0.005 ml/minute and 250 ml/minute (dependant upon magnification, flow cell depth, camera frame rate, efficiency desired, etc.). It can produce either 8-bit Grayscale (Monochrome Camera) or 24-bit Colour (Colour Camera) images, depending on the model.

[table of contents | back to top]

Deployments

TAN1810

Website	https://www.bco-dmo.org/deployment/757070
Platform	R/V Tangaroa
Start Date	2018-10-23
End Date	2018-11-21

[table of contents | back to top]

Project Information

Collaborative Research: Quantifying trophic roles and food web ecology of salp blooms of the Chatham Rise (Salp Food Web Ecology)

Coverage: East of New Zealand, Chatham Rise area

NSF Award Abstract:
Salps are unique open-ocean animals that range in size from a few millimeters to greater than twenty centimeters, have a gelatinous (jelly-like) body, and can form long chains of many connected individuals. These oceanic organisms act as oceanic vacuum cleaners, having incredibly high feeding rates on phytoplankton and, unusual for consumers of their size, smaller bacteria-sized prey. This rapid feeding and the salps' tendency to form dense blooms, allows them move substantial amounts of prey carbon from the surface into the deep ocean, leading to carbon dioxide removal from the atmosphere. However, salps are often considered a trophic dead-end, rather than a link, in the food web due to the assumption that they themselves are not consumed, since their gelatinous bodies are less nutritious than co-occurring crustacean prey. Along with this, salp populations are hypothesized to be increasing due to climate change. This proposal addresses these questions: 1) Do salps compete primarily with crustaceans (as in the prevailing paradigm) or are they competitors of single-celled protists, which are the dominant grazers of small phytoplankton? 2) Do salp blooms increase the efficiency of food-web pathways from tiny phytoplankton to fisheries production in nutrient-poor ocean regions?

This project will support the interdisciplinary education of a graduate student who will learn modeling and laboratory techniques in the fields of biological and chemical oceanography and stimulate international collaborations between scientists in the United States and New Zealand. Additionally, several Education and Outreach initiatives are planned, including development of a week-long immersive high school class in biological oceanography, and education modules that will serve the "scientists-in-the schools" program in Tallahassee, FL.

It is commonly assumed that salps are a trophic sink. However, this idea was developed before the discovery that protists (rather than crustaceans) are the dominant grazers in the open ocean and was biased by the difficulty of recognizing gelatinous salps in fish guts. More recent studies show that salps are found in guts of a diverse group of fish and seabirds and are a readily available prey source when crustacean abundance is low. This proposal seeks to quantify food web flows through contrasting salp-dominated and salp-absent water parcels near the Chatham Rise off western New Zealand where salp blooms are a predictable phenomenon. The proposal will leverage previously obtained data on salp abundance, bulk grazing impact, and biogeochemical significance during Lagrangian experiments conducted by New Zealand-based collaborators. The proposal will determine 1) taxon- and size-specific phytoplankton growth rate measurements, 2) taxon- and size-specific protozoan and salp grazing rate measurements, 3) compound specific isotopic analysis of the amino acids of mesozooplankton to quantify the trophic position of salps, hyperiid amphipods, and other crustaceans, 4) sediment traps to quantify zooplankton carcass sinking rates, and 5) linear inverse ecosystem modeling syntheses. Secondary production and trophic flows from this well-constrained ecosystem model will be compared to crustacean-dominated and microbial loop-dominated ecosystems in similarly characterized

regions (California Current, Costa Rica Dome, and Gulf of Mexico).

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756465
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756610

[table of contents | back to top]