Zooplankton biomass measured from net tows conducted during ongoing monthly cruises, from April 1994 to December 2024, at the Bermuda Atlantic Time-series Study (BATS) site in the Sargasso Sea

Website: https://www.bco-dmo.org/dataset/881861
Data Type: Cruise Results
Version: 6
Version Date: 2025-07-16

Project
» Bermuda Atlantic Time-series Study (BATS)

Programs
» U.S. Joint Global Ocean Flux Study (U.S. JGOFS)
» Ocean Time-series Sites (Ocean Time-series)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
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Abstract
This dataset includes measurements of zooplankton biomass from net tows conducted during ongoing monthly cruises, from April 1994 to December 2024, at the Bermuda Atlantic Time-series Study (BATS) site (31° 40' N 64° 10'W) in the Sargasso Sea. Mesozooplankton were collected by oblique tows using a rectangular frame net with 202 micrometer (µm) mesh. Samples from tows were immediately split on board for subsequent wet and dry weight measurements.

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Coverage

Location: Bermuda Atlantic Time-series Study (BATS)
Spatial Extent: **N**:31.975 **E**:-63.779 **S**:31.411 **W**:-64.505
Temporal Extent: 1994-04-06 - 2024-12-15

Methods & Sampling

Sampling was conducted on ongoing monthly cruises, starting in April 1994, at the Bermuda Atlantic Time-series Study (BATS) site (31° 40' N 64° 10'W) in the Sargasso Sea. Mesozooplankton were collected with a

rectangular frame (0.8 x 1.2 meters) net with 202 micrometer (µm) mesh. Two replicate double oblique tows through the euphotic zone at a ship speed of 1 nautical mile per hour (nm/h) were made during the day (between about 0900 and 1500 h) and night (between about 2000 and 0200 h) on each BATS cruise. The targeted maximum net depth was between 150 and 200 meters (m) and absolute depth was recorded with a temperature-depth recorder. The volume of water filtered by the net (m^3) was measured with a General Oceanics flowmeter.

Samples from the tows were split immediately on board. One half-split was fractionated by wet sieving through nested sieves with mesh sizes of 5.0, 2.0, 1.0, 0.5, and 0.2 millimeters (mm), with individual fractions transferred to preweighed disks of 0.2 mm nitex netting and frozen for subsequent wet and dry weight (in milligrams) analyses.

Data Processing Description

BCO-DMO Processing
Dataset Version 1:
- Added 'Z' to end of date-time string to indicate time zone of UTC, as per ISO 8601 standard.

Dataset Version 2:
- Received new data file on 2023-06-06 (this version extends the dataset to December 2022; previous version ended in March 2022).
- Added 'Z' to end of date-time string to indicate time zone of UTC, as per ISO 8601 standard.

Dataset Version 3:
- Received new data file on 2023-12-21 (this version extends the dataset to June 2023; previous version ended in December 2022).
- Added 'Z' to end of date-time string to indicate time zone of UTC, as per ISO 8601 standard.
- Saved the final file as "881861_v3_bats_zooplankton_biomass.csv".

Dataset Version 4:
- Received new data file on 2024-06-17 (this version extends the dataset to December 2023; previous version ended in June 2023).
- Added 'Z' to end of date-time string to indicate time zone of UTC, as per ISO 8601 standard.
- Saved the final file as "881861_v4_bats_zooplankton_biomass.csv".

Dataset Version 5:
- Received new data file on 2024-12-20 (this version extends the dataset to June 2024; previous version ended in December 2023).
- Marked 'nd' as a missing data value (missing data are empty/blank in the final CSV file).
- Added 'Z' to end of date-time string to indicate time zone of UTC, as per ISO 8601 standard.
- Saved the final file as "881861_v5_bats_zooplankton_biomass.csv".

Dataset Version 6:
- Received new data file on 2025-06-26 (this version extends the dataset to December 2024; previous version ended in June 2024).
- Marked 'nd' as a missing data value (missing data are empty/blank in the final CSV file).
- Saved the final file as "881861_v6_bats_zooplankton_biomass.csv".

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Data Files

File
881861_v6_bats_zooplankton_biomass.csv (Comma Separated Values (.csv), 205.65 KB) MD5:26fa00d10d0e7037816704d2da907ebf Primary data file for dataset ID 881861, version 6

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Related Publications

Ivory, J. A., Steinberg, D. K., & Latour, R. J. (2018). Diel, seasonal, and interannual patterns in mesozooplankton abundance in the Sargasso Sea. ICES Journal of Marine Science, 76(1), 217–231. https://doi.org/10.1093/icesjms/fsy117
General

Lomas, M. W., Bates, N. R., Johnson, R. J., Knap, A. H., Steinberg, D. K., & Carlson, C. A. (2013). Two decades and counting: 24-years of sustained open ocean biogeochemical measurements in the Sargasso Sea. Deep Sea Research Part II: Topical Studies in Oceanography, 93, 16–32. doi:10.1016/j.dsr2.2013.01.008
General

Madin, L. P., Horgan, E. F., & Steinberg, D. K. (2001). Zooplankton at the Bermuda Atlantic Time-series Study (BATS) station: diel, seasonal and interannual variation in biomass, 1994–1998. Deep Sea Research Part II: Topical Studies in Oceanography, 48(8–9), 2063–2082. https://doi.org/10.1016/s0967-0645(00)00171-5
Results

Steinberg, D. K., Carlson, C. A., Bates, N. R., Johnson, R. J., Michaels, A. F., & Knap, A. H. (2001). Overview of the US JGOFS Bermuda Atlantic Time-series Study (BATS): a decade-scale look at ocean biology and biogeochemistry. Deep Sea Research Part II: Topical Studies in Oceanography, 48(8–9), 1405–1447. https://doi.org/10.1016/s0967-0645(00)00148-x
General

Steinberg, D. K., Lomas, M. W., & Cope, J. S. (2012). Long-term increase in mesozooplankton biomass in the Sargasso Sea: Linkage to climate and implications for food web dynamics and biogeochemical cycling. Global Biogeochemical Cycles, 26(1). https://doi.org/10.1029/2010gb004026
Results

Stone, J., & Steinberg, D. (2014). Long-term time-series study of salp population dynamics in the Sargasso Sea. Marine Ecology Progress Series, 510, 111–127. https://doi.org/10.3354/meps10985
General

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Parameters

Parameter	Description	Units
cruisetow_number	unique combination of cruise+tow numbers as xxxyzz, where xxx = Cruise Number, y = Bloom Number (cruise_type = 2 for bloom cruises), and zz = Tow number.	unitless
cruise_number	BATS cruise number listed as a 5 digit ID. The first digit is cruise type: 1 = BATS core; 2 = BATS bloom A; 3 = BATS bloom B. Digits 2-5 are cruise number. e.g., 10218 = BATS 218.	unitless
cruise_type	type of cruise: 1 = BATS core; 2 = BATS bloom A; 3 = BATS bloom B.	unitless
R2R_cruise_ID	R2R cruise ID	unitless
tow_number	tow number	unitless
ISO_datetime	date and time (UTC) of tow in ISO8601 format	unitless
duration	duration of tow	minutes

lat	latitude at start of tow (North = positive values; South = negative values)	decimal degrees
lon	longitude at start of tow (East = positive values; West = negative values)	decimal degrees
depth	maximum depth of tow	meters (m)
vol_filt	volume of water filtered through the net	cubic meters (m^3)
wetwt_0200	zooplankton wet weight; 200 to 500 microns	milligrams (mg)
wetwt_0500	zooplankton wet weight; 500 to 1000 microns	milligrams (mg)
wetwt_1000	zooplankton wet weight; 1000 to 2000 microns	milligrams (mg)
wetwt_2000	zooplankton wet weight; 2000 to 5000 microns	milligrams (mg)
wetwt_5000	zooplankton wet weight; gt 5000 microns	milligrams (mg)
drywt_0200	zooplankton dry weight; 200 to 500 microns	milligrams (mg)
drywt_0500	zooplankton dry weight; 500 to 1000 microns	milligrams (mg)
drywt_1000	zooplankton dry weight; 1000 to 2000 microns	milligrams (mg)
drywt_2000	zooplankton dry weight; 2000 to 5000 microns	milligrams (mg)
drywt_5000	zooplankton dry weight; gt 5000 microns	milligrams (mg)

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Instruments

Dataset-specific Instrument Name	General Oceanics flowmeter
Generic Instrument Name	Flow Meter
Generic Instrument Description	General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc.

Dataset-specific Instrument Name	rectangular depressor plankton net with 202 µm mesh
Generic Instrument Name	Plankton Net
Dataset-specific Description	This type of net was designed by Larry Madin and the company Sea Gear.
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

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Deployments

BATS_cruises

Website	https://www.bco-dmo.org/deployment/58883
Platform	Multiple Vessels
Report	http://bats.bios.edu/bats-data/
Start Date	1988-10-20
Description	Bermuda Institute of Ocean Science established the Bermuda Atlantic Time-series Study with the objective of acquiring diverse and detailed time-series data. BATS makes monthly measurements of important hydrographic, biological and chemical parameters throughout the water column at the BATS Study Site, located at 31 40N, 64 10W.

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Project Information

Bermuda Atlantic Time-series Study (BATS)

Website: http://bats.bios.edu

Coverage: Northwest Sargasso Sea at 31 deg 40' N, 64 deg 10' W

A full description of the BATS research program (including links to the processed BATS data) is available from the BATS Web site (see above for Project URL/ Project Website links). Any data contributed from selected ancillary projects are listed (linked) in the 'Datasets Collection' section below.

Collaborative Research: The Bermuda Atlantic Time-series Study: Sustained Biogeochemical, Ecosystem and Ocean Change Observations and Linkages in the North Atlantic (Years 36-40)

Awards OCE-2241455, OCE-2241456 and OCE-2241457)
NSF award abstract

Long-term observations of ocean physics, biology, and chemistry across decades provide a powerful lens for understanding the response of the oceans to environmental change. This award will continue the Bermuda Atlantic Time-series Study (BATS) research program, which began in 1988, for another five years. Observations at the BATS site provide crucial information for understanding the ocean?s role in the global climate system and the response of the ocean carbon system and marine ecosystems to climate perturbations. The research goals of the BATS program continue to be to improve our understanding of the time-varying components of the ocean carbon cycle and related elements of interest (such as nitrogen, phosphorus, and silica) and to identify the physical, chemical, and ecosystem properties responsible for this variability. The BATS program has substantial broader impacts, contributing to the field of ocean sciences by providing high-quality ocean observations and a framework in which other researchers can conceive and test hypotheses. In addition, the recent acquisition of the Bermuda Institute of Ocean Sciences by the Global Futures Laboratory of Arizona State University provides new avenues for educational opportunities and innovation.

In the subtropical gyre of the North Atlantic Ocean, warming, salinification, deoxygenation, ocean ecosystem changes, and acidification have accelerated their rate of change. Fundamental questions and challenges remain about understanding present and future ocean function, prediction, and modelling. An overarching question for the BATS program is: Will ocean biogeochemistry and ecosystem functioning continue to change in response to the acceleration of ocean warming, salinification, stratification, deoxygenation and acidification? With this question in mind, the sustained goals for the BATS program are: 1. Quantify the role of ocean-atmosphere coupling and climate variability on air-sea exchange of carbon dioxide (CO2) and carbon export to the ocean interior; 2. Document trends and controls of the following: (a) the interannual to decadal scale variability in carbon and nutrient cycles and their coupling in the surface and deep ocean via the Redfield Ratio paradigm; and, (b) biological community structure in the oligotrophic North Atlantic Ocean in response to low-frequency climate variability; 3. Quantify the response of planktonic and microbial community structure and function and impact on biogeochemical cycles (including new and export productivity) to variability in surface fluxes (e.g., heat, freshwater and momentum) and physical processes (e.g., mesoscale eddies, Rossby Waves, internal waves); 4. Facilitate development, calibration and validation of next-generation oceanographic sensors, tools and technologies; 5. Generate datasets that can be used by empiricists and modelers to test new hypotheses about North Atlantic Ocean biogeochemistry and ecosystem functioning; 6. Use BATS cruise, infrastructure, laboratory and analytical expertise, and data to improve education and training programs for BATS staff, STEM-literate students, and future oceanographers.

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.

Please see the BATS Web site (http://bats.bios.edu) for additional information.

List of References (PDF)

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Program Information

U.S. Joint Global Ocean Flux Study (U.S. JGOFS)

Website: http://usjgofs.whoi.edu/

Coverage: Global

The United States Joint Global Ocean Flux Study was a national component of international JGOFS and an integral part of global climate change research.

The U.S. launched the Joint Global Ocean Flux Study (JGOFS) in the late 1980s to study the ocean carbon cycle. An ambitious goal was set to understand the controls on the concentrations and fluxes of carbon and associated nutrients in the ocean. A new field of ocean biogeochemistry emerged with an emphasis on quality

measurements of carbon system parameters and interdisciplinary field studies of the biological, chemical and physical process which control the ocean carbon cycle. As we studied ocean biogeochemistry, we learned that our simple views of carbon uptake and transport were severely limited, and a new "wave" of ocean science was born. U.S. JGOFS has been supported primarily by the U.S. National Science Foundation in collaboration with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Department of Energy and the Office of Naval Research. U.S. JGOFS, ended in 2005 with the conclusion of the Synthesis and Modeling Project (SMP).

Ocean Time-series Sites (Ocean Time-series)

Coverage: Bermuda, Cariaco Basin, Hawaii

Program description text taken from Chapter 1: Introduction from the **Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop** report published following the workshop held November 28-30, 2012 at the Bermuda Institute of Ocean Sciences. The full report is available from the workshop Web site hosted by US OCB: http://www.whoi.edu/website/TS-workshop/home

Decades of research have demonstrated that the ocean varies across a range of time scales, with anthropogenic forcing contributing an added layer of complexity. In a growing effort to distinguish between natural and human-induced earth system variability, sustained ocean time-series measurements have taken on a renewed importance. Shipboard biogeochemical time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate (Karl, 2010; Chavez et al., 2011; Church et al., 2013). They provide the oceanographic community with the long, temporally resolved datasets needed to characterize ocean climate, biogeochemistry, and ecosystem change.

The temporal scale of shifts in marine ecosystem variations in response to climate change are on the order of several decades. The long-term, consistent and comprehensive monitoring programs conducted by time-series sites are essential to understand large-scale atmosphere-ocean interactions that occur on interannual to decadal time scales. Ocean time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate.

Launched in the late 1980s, the US JGOFS (Joint Global Ocean Flux Study; http://usjgofs.whoi.edu) research program initiated two time-series measurement programs at Hawaii and Bermuda (HOT and BATS, respectively) to measure key oceanographic measurements in oligotrophic waters. Begun in 1995 as part of the US JGOFS Synthesis and Modeling Project, the CARIACO Ocean Time-Series (formerly known as the CArbon Retention In A Colored Ocean) Program has studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin.

The objective of these time-series effort is to provide well-sampled seasonal resolution of biogeochemical variability at a limited number of ocean observatories, provide support and background measurements for process-oriented research, as well as test and validate observations for biogeochemical models. Since their creation, the BATS, CARIACO and HOT time-series site data have been available for use by a large community of researchers.

Data from those three US funded, ship-based, time-series sites can be accessed at each site directly or by selecting the site name from the Projects section below.

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756105

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