

# Zooplankton biomass measured from net tows conducted during ongoing monthly cruises, from April 1994 to June 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:** 5

**Version Date:** 2025-01-27

## Project

» [Bermuda Atlantic Time-series Study](#) (BATS)

## Programs

» [Ocean Carbon and Biogeochemistry](#) (OCB)

» [U.S. Joint Global Ocean Flux Study](#) (U.S. JGOFS)

» [Ocean Time-series Sites](#) (Ocean Time-series)

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 June 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 - 2024-06-10

## 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 ( $\mu\text{m}$ ) 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 ( $\text{m}^3$ ) 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).
- 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".

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## Data Files

File
<b>881861_v5_bats_zooplankton_biomass.csv</b> (Comma Separated Values (.csv), 202.74 KB) MD5:1cf3a37fdadc22b0d4ef00e93133d840
Primary data file for dataset ID 881861, version 5

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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](https://doi.org/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](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](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 <sup>3</sup> )
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

<b>Dataset-specific Instrument Name</b>	General Oceanics flowmeter
<b>Generic Instrument Name</b>	Flow Meter
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	rectangular depressor plankton net with 202 µm mesh
<b>Generic Instrument Name</b>	Plankton Net
<b>Dataset-specific Description</b>	This type of net was designed by Larry Madin and the company Sea Gear.
<b>Generic Instrument Description</b>	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

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58883">https://www.bco-dmo.org/deployment/58883</a>
<b>Platform</b>	Multiple Vessels
<b>Report</b>	<a href="http://bats.bios.edu/bats-data/">http://bats.bios.edu/bats-data/</a>
<b>Start Date</b>	1988-10-20
<b>Description</b>	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 31-35) Awards OCE-1756105, OCE-1756054, and OCE-1756312)**

#### NSF award abstract

Long-term observations over several decades are a powerful tool for investigating ocean physics, biology, and chemistry, and the response of the oceans to environmental change. The Bermuda Atlantic Time-Series Study, known as BATS, has been running continuously since 1988. The research goals of the BATS program are: (1) to improve our understanding of the time-varying components of the ocean carbon cycle and the cycles of related nutrient elements such as nitrogen, phosphorus, and silicon; and, (2) to identify the relevant physical, chemical and ecosystem properties responsible for this variability. In addition, the BATS program has strong and diverse broader impacts, contributing to the field of ocean sciences by providing high quality ocean observations and data for seagoing scientists and modelers, and a framework through which researchers can conceive and test hypotheses. This award will support the operations of the BATS program for five more years.

The primary BATS research themes are as follows: (1) Quantify the role of ocean-atmosphere coupling and climate variability on air-sea exchange of CO<sub>2</sub>, and carbon export to the ocean interior; (2) Document trends and the controls on the interannual to decadal scale variability in carbon and nutrient cycles to their coupling in the surface and deep ocean via the Redfield Ratio paradigm; (3) Quantify the response of planktonic community structure and function, and impact on biogeochemical cycles to variability in surface fluxes and dynamical processes; (4) Facilitate development, calibration and validation of next generation oceanographic sensors, tools and technologies; and, (5) Generate a dataset that can be utilized by empiricists, modelers and students. This research integrates ocean physics, chemistry and biology into a framework for understanding oceanic processes and ocean change in the North Atlantic subtropical gyre. The existing 29 years of BATS data provide robust constraints on seasonal and interannual variability, the response of the Sargasso Sea ecosystem to natural climate variability, and signal detection of potential ocean changes. This project would extend the BATS program through years 31-35 to address a series of ten interlinked questions through integrated research approaches and a multitude of collaborative efforts. In addition to the themes above, and embedded into the ten questions and approaches, the BATS team will focus on, for example, coupling of particle production and biogeochemistry; revisiting the complexities of the biological carbon pump; oxygen decline; and changes in the hydrography, physics, ocean carbon cycle and biogeochemistry of the Sargasso Sea. The highest quality data observation and collection will be maintained and used to address these questions. Importantly, a wide range of collaborations at the BATS site, spanning the physical and biogeochemical disciplines, will aid these broad goals. Strong links to community stakeholders, and close collaboration (including methods intercomparisons and personnel exchanges) with the Hawaii Ocean Time-series are proposed. This work will extend the research findings of the project into educational and training opportunities within and beyond the oceanographic community, including training and mentorship of both undergraduate and graduate students.

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

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## Program Information

### 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 CO<sub>2</sub> 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.

## **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.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1756105</a>

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