

# Protist rates from epifluorescence counts; cyanobacteria rates from flow cytometry; bulk rates from extracted chlorophyll-a from R/V Atlantic Explorer cruises AE1102, AE1118, AE1206, AE1219 in the Sargasso Sea, BATS, 2011-2012

**Website:** <https://www.bco-dmo.org/dataset/545844>

**Data Type:** Cruise Results

**Version:** 1

**Version Date:** 2015-01-16

## Project

» [Plankton Community Composition and Trophic Interactions as Modifiers of Carbon Export in the Sargasso Sea](#) (Trophic BATS)

## Program

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

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## Abstract

Protist rates from epifluorescence counts; cyanobacteria rates from flow cytometry; bulk rates from extracted chlorophyll-a from R/V Atlantic Explorer cruises AE1102, AE1118, AE1206, AE1219 in the Sargasso Sea, BATS, 2011-2012.

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## Coverage

**Spatial Extent:** N:33.5 E:-63.48 S:30.05 W:-65.8

**Temporal Extent:** 2011-02-25 - 2012-07-30

## Dataset Description

Protist rates based on epifluorescence counts; cyanobacteria rates based on flow cytometry data (Mike Lomas' group); bulk rates based on extracted chlorophyll-a. Samples were collected during four cruises in the Sargasso Sea during spring and summer 2011-2012.

## Methods & Sampling

### Water Column Sampling:

Water column sampling was performed on four cruises during the spring and the summer of 2011 and 2012 at the Bermuda Atlantic Time-series Study station (31°40'N 64°10'W, BATS) and in the mesoscale eddies found in the surrounding area of the Sargasso Sea. For each cruise, two stations were sampled, usually in the center of a mesoscale eddy and at BATS. The edge of the eddy was sampled two times, as well. To be able to get a better reproducibility of data, each experiment was replicated.

For each experiment, seawater samples were collected pre-dawn (on deck 2:30-4:00, local time) at four different depths within the euphotic zone (20m, 50m, 80m and the Deep Chlorophyll Maximum, DCM). Twenty-one 10L Niskin bottles were attached to a rosette with conductivity, temperature, depth sensors (CTD), and an *in vivo* fluorometer. This sensor allowed for recording in real time of chlorophyll fluorescence and the DCM for each station. The water that was collected from the 10L Niskin bottles was sampled for abundance and biomass of the plankton community.

### Dilution experiments:

The growth and grazing rates of the phytoplankton community were determined using the dilution method with a two-point modification (Landry et al. 1984, Landry et al. 2008a, Selph et al. 2011). To check the applicability and resolution of the two point modification, two experiments at two different stations (one replicate of C3 and one replicate of B3) were carried out with a complete set of dilutions (25, 50, 75 and 100%) on-deck; the results of these experiments confirmed the validity of the 2 point dilution experiment (data not shown). The Landry-Hassett dilution method was used because it can separate autotrophic and heterotrophic processes with relatively little manipulation (Landry & Hassett, 1982, Landry et al 1984). The method is based on the concept that the dilution lowers the encounter probability of grazer and prey and enables one to calculate from the net phytoplankton population growth ( $k$ ) in the diluted and undiluted incubation bottles the instantaneous growth rate ( $u$ ) and grazing mortality ( $g$ ), where  $k = u - g$  (Landry & Hassett, 1982). This method is based on three assumptions. The first one is that the instantaneous growth rate of any phytoplankton group is not influenced by the dilution of the "seawater/sample" with particle free water. The second assumption is that the probability of a phytoplankton to be grazed by the consumer is directly related to the abundance of the consumer itself, which means that with a higher density of grazers the probability of the prey to be grazed is higher as well, making the grazing a function of the dilution. The third assumption is the sum of the first two assumptions, that the change in the abundance of the phytoplankton community over time can be expressed by the exponential growth equation:

$$P_t = P_0 e^{[(u - xg)t]}$$

where  $P_0$  and  $P_t$  are the initial and the final abundances or biomass of bulk or specific phytoplankton groups,  $t$  is time in day (d),  $u$  is the instantaneous phytoplankton growth rate (d<sup>-1</sup>),  $g$  is the grazing mortality (d<sup>-1</sup>), and  $x$  represents the dilution factor (Landry and Hassett 1982; Landry et al. 1984; Neuer and Cowles 1994).  $M$  and  $g$  are calculated as the y-intercept and the slope of the linear regression plotted against the dilution factors where  $k = 1/t \ln (P_t/P_0)$  (Landry & Hassett, 1982; Landry et al. 1984). For the two-point dilution, this converts mathematically to solving the equations for  $u$  and  $g$  (Landry et al., 2008a).

### Bulk measurements:

Chlorophyll-a was extracted from seawater (250 ml and 400 ml depending on the dilution), with 90% acetone and measured after 24hrs at 4 degrees C in the dark onboard the ship using a TD 700 Laboratory Fluorometer using the non-acidification technique (Welschmeyer 1994). These data were used as a proxy for the phytoplankton biomass in the water column and to calculate the bulk growth and grazing rates of the phytoplankton community.

## Data Processing Description

### BCO-DMO Processing Notes:

- Added lat and lon for each station & cast from the metadata form.
- Replaced spaces with underscores.
- Replaced blanks with 'nd' to indicate 'no data'.
- Dates/times assumed to be in UTC/GMT, based on comparison with other Trophic BATS datasets.

## Data Files

File
<b>rates.csv</b> (Comma Separated Values (.csv), 32.27 KB) MD5:0e1abf4dba2080c102d99d3e0b58ad33 Primary data file for dataset ID 545844

## Related Publications

Agatha S. (2004). A Cladistic Approach for the Classification of Oligotrichid Ciliates (Ciliophora: Spirotricha). *Acta protozoologica*, 43(3), 201–217. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2854820/>  
*General*

Agatha, S., & Strüder-Kypke, M. C. (2007). Phylogeny of the order Choreotrichida (Ciliophora, Spirotricha, Oligotrichea) as inferred from morphology, ultrastructure, ontogenesis, and SSrRNA gene sequences. *European Journal of Protistology*, 43(1), 37–63. doi:[10.1016/j.ejop.2006.10.001](https://doi.org/10.1016/j.ejop.2006.10.001)  
*General*

Amacher, J., Neuer, S., Anderson, I., & Massana, R. (2009). Molecular approach to determine contributions of the protist community to particle flux. *Deep Sea Research Part I: Oceanographic Research Papers*, 56(12), 2206–2215. doi:[10.1016/j.dsr.2009.08.007](https://doi.org/10.1016/j.dsr.2009.08.007)  
*General*

Hillebrand, H., Dürselen, C.-D., Kirschtel, D., Pollinger, 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](https://doi.org/10.1046/j.1529-8817.1999.3520403.x)  
*Methods*

Landry, M. R., & Hassett, R. P. (1982). Estimating the grazing impact of marine micro-zooplankton. *Marine Biology*, 67(3), 283–288. doi:[10.1007/bf00397668](https://doi.org/10.1007/bf00397668) <https://doi.org/10.1007%2FBF00397668>  
*Methods*

Landry, M. R., Brown, S. L., Rii, Y. M., Selph, K. E., Bidigare, R. R., Yang, E. J., & Simmons, M. P. (2008). Depth-stratified phytoplankton dynamics in Cyclone Opal, a subtropical mesoscale eddy. *Deep Sea Research Part II: Topical Studies in Oceanography*, 55(10-13), 1348–1359. doi:[10.1016/j.dsr2.2008.02.001](https://doi.org/10.1016/j.dsr2.2008.02.001)  
*General*

Landry, M., Haas, L., & Fagerness, V. (1984). Dynamics of microbial plankton communities: experiments in Kaneohe Bay, Hawaii. *Marine Ecology Progress Series*, 16, 127–133. doi:[10.3354/meps016127](https://doi.org/10.3354/meps016127)  
*General*

Lund, J. W. G., Kipling, C., & Le Cren, E. D. (1958). The inverted microscope method of estimating algal numbers and the statistical basis of estimations by counting. *Hydrobiologia*, 11(2), 143–170. doi:[10.1007/bf00007865](https://doi.org/10.1007/bf00007865) <https://doi.org/10.1007/BF00007865>  
*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](https://doi.org/10.4319/lo.2000.45.3.0569)  
*Methods*

Neuer, S., & Cowles, T. (1994). Protist herbivory in the Oregon upwelling system. *Marine Ecology Progress Series*, 113, 147–162. doi:[10.3354/meps113147](https://doi.org/10.3354/meps113147)  
*General*

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](https://doi.org/10.4319/lo.1989.34.6.1097)  
*General*

Selph, K. E., Landry, M. R., Taylor, A. G., Yang, E.-J., Measures, C. I., Yang, J., ... Bidigare, R. R. (2011). Spatially-

resolved taxon-specific phytoplankton production and grazing dynamics in relation to iron distributions in the Equatorial Pacific between 110 and 140°W. Deep Sea Research Part II: Topical Studies in Oceanography, 58(3-4), 358–377. doi:[10.1016/j.dsr2.2010.08.014](https://doi.org/10.1016/j.dsr2.2010.08.014)  
*General*

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## Parameters

Parameter	Description	Units
cruise_id	Official cruise identifier e.g. AE1102 = R/V Atlantic Explorer cruise number 1102.	dimensionless
cast	Cast number.	dimensionless
station	Station number.	dimensionless
location_description	Description of sampling location.	dimensionless
lat	Latitude. Positive values = North.	decimal degrees
lon	Longitude. Positive values = East.	decimal degrees
depth	Sample depth.	meters
taxon	Name of the taxonomic group.	dimensionless
date	2-digit month, 2-digit day, and 4-digit year of sampling. Reported in UTC. Format: mmddYYYY	unitless
experiment_num	Experiment number.	dimensionless
u	Instantaneous growth rate ( $\mu$ ).	per day
g	Grazing mortality; absolute values.	per day

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## Instruments

<b>Dataset-specific Instrument Name</b>	Niskin bottle
<b>Generic Instrument Name</b>	Niskin bottle
<b>Dataset-specific Description</b>	Samples were collected using 10-Liter Niskin bottles attached to a CTD rosette.
<b>Generic Instrument Description</b>	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.

<b>Dataset-specific Instrument Name</b>	TD 700 Laboratory Fluorometer
<b>Generic Instrument Name</b>	Turner Designs 700 Laboratory Fluorometer
<b>Dataset-specific Description</b>	Chlorophyll-a was extracted from seawater (250 ml and 400 ml depending on the dilution), with 90% acetone and measured after 24hrs at 4 degrees C in the dark onboard ship using a TD 700 Laboratory Fluorometer using the non-acidification technique (Welschmeyer 1994).
<b>Generic Instrument Description</b>	The TD-700 Laboratory Fluorometer is a benchtop fluorometer designed to detect fluorescence over the UV to red range. The instrument can measure concentrations of a variety of compounds, including chlorophyll-a and fluorescent dyes, and is thus suitable for a range of applications, including chlorophyll, water quality monitoring and fluorescent tracer studies. Data can be output as concentrations or raw fluorescence measurements.

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## Deployments

### AE1102

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58672">https://www.bco-dmo.org/deployment/58672</a>
<b>Platform</b>	R/V Atlantic Explorer
<b>Start Date</b>	2011-02-23
<b>End Date</b>	2011-03-07
<b>Description</b>	This cruise was the first in a series of four cruises planned to study the trophic interactions and particle export during the winter season in the Sargasso Sea. The researchers focused on several sampling locations including an anticyclonic eddy, slope waters of the eddy, and repeated visits to the Bermuda Atlantic Time Series (BATS) study site. The research focus for the cruise included phytoplankton production, microzooplankton grazing, mesozooplankton grazing and particle export. This process cruise was designed to quantify stocks and rate processes in the Sargasso Sea food web. Work entailed CTD casts, over the stern deployment of in situ primary production arrays and surface tethered sediment traps. Until 26 November 2012 this cruise was identified by BIOS and R2R as AE-X1101. On 26 November 2012, the cruise ID was corrected to AE1102. Original cruise data are available from the NSF R2R data catalog

**AE1118**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58934">https://www.bco-dmo.org/deployment/58934</a>
<b>Platform</b>	R/V Atlantic Explorer
<b>Start Date</b>	2011-07-22
<b>End Date</b>	2011-08-04
<b>Description</b>	AE1118 was a process cruise aboard the R/V Atlantic Explorer to quantify stocks and rate processes in the Sargasso Sea food web. This was the second in a series of cruises for the Trophic BATS project. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Core CTD casts to ~2000 meters and pre-dawn 'Productivity' CTD casts were made at each station. Original cruise data are available from the NSF R2R data catalog.

**AE1206**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58935">https://www.bco-dmo.org/deployment/58935</a>
<b>Platform</b>	R/V Atlantic Explorer
<b>Start Date</b>	2012-03-14
<b>End Date</b>	2012-03-23
<b>Description</b>	AE1206 was the third in a series of four cruises for the Trophic BATS project. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Core CTD casts to ~2000 meters and pre-dawn 'Productivity' CTD casts were made at each station. Cruise information and original data are available from the NSF R2R data catalog.

**AE1219**

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58936">https://www.bco-dmo.org/deployment/58936</a>
<b>Platform</b>	R/V Atlantic Explorer
<b>Start Date</b>	2012-07-19
<b>End Date</b>	2012-07-31
<b>Description</b>	AE1219 was the final cruise in a series of four for the Trophic BATS project. On each cruise, sampling was conducted at three stations: the center and edge of a mesoscale eddy and at one station outside of the eddy. Core CTD casts to ~2000 meters and pre-dawn 'Productivity' CTD casts were made at each station. Cruise information and original data are available from the NSF R2R data catalog.

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## Project Information

### Plankton Community Composition and Trophic Interactions as Modifiers of Carbon Export in the Sargasso Sea (Trophic BATS)

**Coverage:** Sargasso Sea, BATS site

Fluxes of particulate carbon from the surface ocean are greatly influenced by the size, taxonomic composition and trophic interactions of the resident planktonic community. Large and/or heavily-ballasted phytoplankton such as diatoms and coccolithophores are key contributors to carbon export due to their high sinking rates and direct routes of export through large zooplankton. The potential contributions of small, unballasted

phytoplankton, through aggregation and/or trophic re-packaging, have been recognized more recently. This recognition comes as direct observations in the field show unexpected trends. In the Sargasso Sea, for example, shallow carbon export has increased in the last decade but the corresponding shift in phytoplankton community composition during this time has not been towards larger cells like diatoms. Instead, the abundance of the picoplanktonic cyanobacterium, *Synechococcus*, has increased significantly. The trophic pathways that link the increased abundance of *Synechococcus* to carbon export have not been characterized. These observations helped to frame the overarching research question, "How do plankton size, community composition and trophic interactions modify carbon export from the euphotic zone". Since small phytoplankton are responsible for the majority of primary production in oligotrophic subtropical gyres, the trophic interactions that include them must be characterized in order to achieve a mechanistic understanding of the function of the biological pump in the oligotrophic regions of the ocean.

This requires a complete characterization of the major organisms and their rates of production and consumption. Accordingly, the research objectives are: 1) to characterize (qualitatively and quantitatively) trophic interactions between major plankton groups in the euphotic zone and rates of, and contributors to, carbon export and 2) to develop a constrained food web model, based on these data, that will allow us to better understand current and predict near-future patterns in export production in the Sargasso Sea.

The investigators will use a combination of field-based process studies and food web modeling to quantify rates of carbon exchange between key components of the ecosystem at the Bermuda Atlantic Time-series Study (BATS) site. Measurements will include a novel DNA-based approach to characterizing and quantifying planktonic contributors to carbon export. The well-documented seasonal variability at BATS and the occurrence of mesoscale eddies will be used as a natural laboratory in which to study ecosystems of different structure. This study is unique in that it aims to characterize multiple food web interactions and carbon export simultaneously and over similar time and space scales. A key strength of the proposed research is also the tight connection and feedback between the data collection and modeling components.

Characterizing the complex interactions between the biological community and export production is critical for predicting changes in phytoplankton species dominance, trophic relationships and export production that might occur under scenarios of climate-related changes in ocean circulation and mixing. The results from this research may also contribute to understanding of the biological mechanisms that drive current regional to basin scale variability in carbon export in oligotrophic gyres.

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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.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1030476</a>

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