Phytoplankton growth and grazing mortality from HPLC pigments sampled in the Gulf of Mexico on R/V Nancy Foster cruises in May 2017 and May 2018

Website: https://www.bco-dmo.org/dataset/851142
Data Type: Cruise Results
Version: 1
Version Date: 2021-04-30

Project
» Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)

Program
» Second International Indian Ocean Expedition (IIOE-2)

Contributors	Affiliation	Role
Landry, Michael R.	University of California-San Diego Scripps (UCSD-SIO)	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset is from CTD hydrocasts in the Gulf of Mexico from R/V Nancy Foster cruises in May 2017 and May 2018, which were part of a NOAA RESTORE project (aka: BLOOFINZ-GoM) to investigate the epipelagic marine nitrogen cycle, plankton dynamics, and impacts on growth and survival of larval Atlantic Bluefin Tuna (ABT). These data are meant to be used in inter-species, interregional comparisons to data from the BLOOFIN-IO study of larval Southern Bluefin Tuna in the Indian Ocean spawning region.

Table of Contents

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

Coverage

Spatial Extent: **N**:28.3358 **E**:-87.3032 **S**:25.721 **W**:-89.6769
Temporal Extent: 2017-05-11 - 2018-05-18

Methods & Sampling

This dataset is from CTD hydrocasts in the Gulf of Mexico from R/V Nancy Foster cruises in May 2017 and May 2018, which were part of a NOAA RESTORE project (aka: BLOOFINZ-GoM) to investigate the epipelagic marine nitrogen cycle, plankton dynamics, and impacts on growth and survival of larval Atlantic Bluefin Tuna (ABT). These data are meant to be used in inter-species, interregional comparisons to data from the BLOOFIN-IO study of larval Southern Bluefin Tuna in the Indian Ocean spawning region.

On each cruise, we conducted multi-day quasi-Lagrangian experiments, called “cycles”, during which we

sampled and measured processes on a repeated daily schedule following a satellite-tracked free-drifting array (Landry et al., 2009). The drift array (Pacific Gyre, San Diego) consisted of a surface float, a 3-m drogue centered at 15 m, coated-wire with stainless-steel attachment rings for in situ bottle incubations, and a separately attached smaller float with iridium transmission (10-min position frequency) and nighttime strobe light.

For each experiment, we collected seawater daily from Niskin bottles on early-morning CTD hydrocasts (~02:00 local time) at 6 depths in the euphotic zone from 5 m to the deep chlorophyll maximum (DCM). Samples for initial concentrations of pigments, flow cytometry (FCM) and microscopy were filled directly from the Niskin bottles via silicone tubing. For each depth, we also prepared a dilution experiment that compared net population growth rates in polycarbonate bottles (2.7 L) containing unfiltered seawater (100%) and a dilution treatment consisting of ~32% whole seawater diluted with filtered seawater from that depth (Landry et al., 2008). Seawater was filtered directly from the Niskin bottles using a peristaltic pump, silicone tubing and an in-line 0.2 µm Suporcap filter capsule that had previously been acid washed (3.7% trace-metal grade HCl; Milli-Q and seawater rinses). Dilution bottles were first given a measured volume of filtered water and then gently filled to the top with unscreened water from the Niskin bottles.

All bottles were secured into coarse net bags with top and bottom attachment clips and incubated in situ for 24 h at the depth of collection on the line below the drifter float. For the first deployment of each cycle, the entire array with bottles attached was laid out on deck before being quickly lowered by hand. For subsequent daily experiments, a new 6-depth experiment was set up in net bags on deck before recovering the drifter. The drifter was then recovered, the previous day's experiments removed, the new experiments attached, and the drifter redeployed – a process that took ~15 min while the ship maintained position. All recovery and deployments were carried out before sunrise. Sampling for daily experiments was done in close proximity (~100 m) to the drifter position. Upon recovery, all bottles were subsampled for assessments of community composition and biomass, as described below.

Concentrations of chlorophyll and carotenoid pigments were determined using high-pressure liquid chromatography (HPLC) on 2.2-L samples filtered onto Whatman GF/F filters, frozen in liquid nitrogen and stored at -85°C. The samples were extracted and analyzed by the Horn Point Analytical Services Laboratory at the University of Maryland Center for Environmental Science using a C8 column and a reversed phase, methanol-based solvent protocol and an automated 1100 HPLC system with temperature-controlled autosampler, peltier temperature-controlled column oven compartment and PDA detector (Van Heukelem and Thomas, 2001; Hooker et al., 2012). Monovinyl and divinyl Chla were detected at 665 nm. Carotenoids and xanthophylls were detected at 450 nm. Concentrations were quantified from chromatograms relative to run standards using Agilent ChemStation software.

We determined rate profiles for phytoplankton growth (µ, d-1) and microzooplankton grazing (m, d-1) from each pair of dilution experiment bottles and for each FCM or pigment-associated population according to the following equations:

$m = (kd - k)/(1 - D)$ and $\mu = k + m$,

where kd and k are the measured net rates of change between initial and final concentrations in the diluted and undiluted treatments, respectively, and D is the portion of unfiltered water in the dilution treatment (Landry et al., 2008; Selph et al., 2011).

Data Processing Description

Data Processing:
ChemStation software.

BCO-DMO Processing:
- changed date form from MM/DD/YY to YYYY-MM-DD.

[table of contents | back to top]

Data Files

File
phyto_growth_grazing_hplc.csv (Comma Separated Values (.csv), 7.16 KB) MD5:c15e07787c74152ce9026e3fa902f311 Primary data file for dataset ID 851142

[table of contents | back to top]

Related Publications

Hooker, S. B., Clementson, L., Thomas, C. S., Schlüter, L., Allerup, M., Ras, J., Claustre, H., Normandeau, C. et al. (2012) The fifth SeaWiFS HPLC analysis round-robin experiment (SeaHARRE-5). NASA/TM-2012-217503, NASA Greenbelt, MD, 98 p.
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
Methods

Landry, M. R., Ohman, M. D., Goericke, R., Stukel, M. R., & Tsyrklevich, K. (2009). Lagrangian studies of phytoplankton growth and grazing relationships in a coastal upwelling ecosystem off Southern California. Progress in Oceanography, 83(1-4), 208–216. doi:10.1016/j.pocean.2009.07.026
Methods

Landry, M. R., Selph, K. E., Stukel, M. R., Swalethorp, R., Kelly, T. B., Beatty, J. L., & Quackenbush, C. R. (2021). Microbial food web dynamics in the oceanic Gulf of Mexico. Journal of Plankton Research. doi:10.1093/plankt/fbab021
Results

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
Methods

Van Heukelem, L., & Thomas, C. S. (2001). Computer-assisted high-performance liquid chromatography method development with applications to the isolation and analysis of phytoplankton pigments. Journal of Chromatography A, 910(1), 31–49. doi:10.1016/s0378-4347(00)00603-4
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise	Cruise identifier	unitless
Station	Station number	unitless
Date	Sampling date (Central Standard (GMT-6)); format: YYYY-MM-DD	unitless
Lat	Latitude	degrees North
Long	Longitude	degrees East

Cycle	Cycle number	unitless
CTD	CTD cast number	unitless
Exp	Experiment number corresponding to in situ dilution incubations	unitless
Depth	Depth of sample	meters (m)
Grow_TChla	Instantaneous rate of growth (d-1) based on net changes of total chlorophyll a in dilution incubation	per day (d-1)
Graz_TChla	Instantaneous rate of grazing mortality (d-1) based on net changes of total chlorophyll a in dilution incubation	per day (d-1)
Grow_Fuco	Instantaneous rate of growth (d-1) based on net changes of the pigment fucoxanthin in dilution incubation	per day (d-1)
Graz_Fuco	Instantaneous rate of grazing mortality (d-1) based on net changes of the pigment fucoxanthin in dilution incubation	per day (d-1)
Grow_But	Instantaneous rate of growth (d-1) based on net changes of the pigment 19'? butanoyloxy fucoxanthin in dilution incubation	per day (d-1)
Graz_But	Instantaneous rate of grazing mortality (d-1) based on net changes of the pigment 19'?butanoyloxy fucoxanthin in dilution incubation	per day (d-1)
Grow_Hex	Instantaneous rate of growth (d-1) based on net changes of the pigment 19'? hexanoyloxy fucoxanthin in dilution incubation	per day (d-1)
Graz_Hex	Instantaneous rate of grazing mortality (d-1) based on net changes of the pigment 19'?hexanoyloxy fucoxanthin in dilution incubation	per day (d-1)
Grow_Per	Instantaneous rate of growth (d-1) based on net changes of the pigment peridinin in dilution incubation	per day (d-1)
Graz_Per	Instantaneous rate of grazing mortality (d-1) based on net changes of the pigment peridinin in dilution incubation	per day (d-1)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	CTD
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	drift array
Generic Instrument Name	Drifter Buoy
Dataset-specific Description	The drift array (Pacific Gyre, San Diego) consisted of a surface float, a 3-m drogue centered at 15 m, coated-wire with stainless-steel attachment rings for in situ bottle incubations, and a separately attached smaller float with iridium transmission (10-min position frequency) and nighttime strobe light.
Generic Instrument Description	Drifting buoys are free drifting platforms with a float or buoy that keep the drifter at the surface and underwater sails or socks that catch the current. These instruments sit at the surface of the ocean and are transported via near-surface ocean currents. They are not fixed to the ocean bottom, therefore they "drift" with the currents. For this reason, these instruments are referred to as drifters, or drifting buoys. The surface float contains sensors that measure different parameters, such as sea surface temperature, barometric pressure, salinity, wave height, etc. Data collected from these sensors are transmitted to satellites passing overhead, which are then relayed to land-based data centers. definition sources: https://mmisw.org/ont/ioos/platform/drifting_buoy and https://www.aoml.noaa.gov/phod/gdp/faq.php#drifter1

Dataset-specific Instrument Name	Agilent 1100 HPLC system
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	Agilent 1100 HPLC system with temperature-controlled autosampler, Peltier temperature-controlled column oven compartment and PDA detector.
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

Dataset-specific Instrument Name	Niskin bottles
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.

[table of contents | back to top]

Deployments

NF1704

Website	https://www.bco-dmo.org/deployment/834975
Platform	R/V Nancy Foster
Report	https://datadocs.bco-dmo.org/docs/302/BLOOFINZ_IO/data_docs/cruise_reports/NF1704_CRUISE_REPORT.pdf
Start Date	2017-05-07
End Date	2017-06-02
Description	R/V Nancy Foster cruise in May 2017 as part of a NOAA RESTORE project (aka: BLOOFINZ-GoM).

NF1802

Website	https://www.bco-dmo.org/deployment/834976
Platform	R/V Nancy Foster
Report	https://datadocs.bco-dmo.org/docs/302/BLOOFINZ_IO/data_docs/cruise_reports/NF1802_CRUISE_REPORT.pdf
Start Date	2018-04-27
End Date	2018-05-20
Description	R/V Nancy Foster cruise in May 2018 as part of a NOAA RESTORE project (aka: BLOOFINZ-GoM).

[table of contents | back to top]

Project Information

Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)

Coverage: Eastern Indian Ocean, Indonesian Throughflow area, and the Gulf of Mexico

NSF Award Abstract:

The small area between NW Australia and Indonesia in the eastern Indian Ocean (IO) is the only known spawning ground of Southern Bluefin Tuna (SBT), a critically endangered top marine predator. Adult SBT migrate thousands of miles each year from high latitude feeding areas to lay their eggs in these tropical waters, where food concentrations on average are below levels that can support optimal feeding and growth of their larvae. Many critical aspects of this habitat are poorly known, such as the main source of nitrogen nutrient that sustains system productivity, how the planktonic food web operates to produce the unusual types of zooplankton prey that tuna larvae prefer, and how environmental differences in habitat quality associated with ocean fronts and eddies might be utilized by adult spawning tuna to give their larvae a greater chance for rapid growth and survival success. This project investigates these questions on a 38-day expedition in early 2021, during the peak time of SBT spawning. This project is a US contribution to the 2nd International Indian Ocean Expedition (IIOE-2) that advances understanding of biogeochemical and ecological dynamics in the poorly studied eastern IO. This is the first detailed study of nitrogen and carbon cycling in the region linking Pacific and IO waters. The shared dietary preferences of SBT larvae with those of other large tuna and billfish species may also make the insights gained broadly applicable to understanding larval recruitment issues for top consumers in other marine ecosystems. New information from the study will enhance international management efforts for SBT. The shared larval dietary preferences of large tuna and billfish species may also extend the insights gained broadly to many other marine top consumers, including Atlantic bluefin tuna that spawn in US waters of the Gulf of Mexico. The end-to-end study approach, highlights connections among physical environmental variability, biogeochemistry, and plankton food webs leading to charismatic and economically valuable fish production, is the theme for developing educational tools and modules through the "scientists-in-the-schools" program of the Center for Ocean-Atmospheric Prediction Studies at Florida State University, through a program for enhancing STEM learning pathways for underrepresented students in Hawaii, and through public outreach products for display at the Birch Aquarium in San Diego. The study also aims to support an immersive field experience to introduce talented high school students to marine research, with the goal of developing a sustainable marine-related educational program for underrepresented students in rural northwestern Florida.

Southern Bluefin Tuna (SBT) migrate long distances from high-latitude feeding grounds to spawn exclusively in a small oligotrophic area of the tropical eastern Indian Ocean (IO) that is rich in mesoscale structures, driven by complex currents and seasonally reversing monsoonal winds. To survive, SBT larvae must feed and grow rapidly under environmental conditions that challenge conventional understanding of food-web structure and functional relationships in poor open-ocean systems. The preferred prey of SBT larvae, cladocerans and Corycaeidae copepods, are poorly studied and have widely different implications for trophic transfer efficiencies to larvae. Differences in nitrogen sources - N fixation vs deep nitrate of Pacific origin - to sustain new production in the region also has implications for conditions that may select for prey types (notably cladocerans) that enhance transfer efficiency and growth rates of SBT larvae. The relative importance of these N sources for the IO ecosystem may affect SBT resiliency to projected increased ocean stratification. This research expedition investigates how mesoscale variability in new production, food-web structure and trophic fluxes affects feeding and growth conditions for SBT larvae. Sampling across mesoscale features tests hypothesized relationships linking variability in SBT larval feeding and prey preferences (gut contents), growth rates (otolith analyses) and trophic positions (TP) to the environmental conditions of waters selected by adult spawners. Trophic Positions of larvae and their prey are determined using Compound-Specific Isotope Analyses of Amino Acids (CSIA-AA). Lagrangian experiments investigate underlying process rates and relationships through measurements of water-column 14C productivity, N2 fixation, 15NO3- uptake and nitrification; community biomass and composition (flow cytometry, pigments, microscopy, in situ imaging, genetic analyses); and trophic fluxes through micro- and mesozooplankton grazing, remineralization and export. Biogeochemical and food web elements of the study are linked by CSIA-AA (N source, TP), 15N-constrained budgets and modeling. The project elements comprise an end-to-end coupled biogeochemistry-trophic study as has not been done previously for any pelagic ecosystem.

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]

Program Information

Second International Indian Ocean Expedition (IIOE-2)

Website: https://web.whoi.edu/iioe2/

Coverage: Indian Ocean

Description from the program website:
The Second International Indian Ocean Expedition (IIOE-2) is a major global scientific program which will engage the international scientific community in collaborative oceanographic and atmospheric research from coastal environments to the deep sea over the period 2015-2020, revealing new information on the Indian Ocean (i.e. its currents, its influence upon the climate, its marine ecosystems) which is fundamental for future sustainable development and expansion of the Indian Ocean's blue economy. A large number of scientists from research institutions from around the Indian Ocean and beyond are planning their involvement in IIOE-2 in accordance with the overarching six scientific themes of the program. Already some large collaborative research projects are under development, and it is anticipated that by the time these projects are underway, many more will be in planning or about to commence as the scope and global engagement in IIOE-2 grows.

Focused research on the Indian Ocean has a number of benefits for all nations. The Indian Ocean is complex and drives the region's climate including extreme events (e.g. cyclones, droughts, severe rains, waves and storm surges). It is the source of important socio-economic resources (e.g. fisheries, oil and gas exploration/extraction, eco-tourism, and food and energy security) and is the background and focus of many of the region's human populations around its margins. Research and observations supported through IIOE-2 will result in an improved understanding of the ocean's physical and biological oceanography, and related air-ocean climate interactions (both in the short-term and long-term). The IIOE-2's program will complement and harmonise with other regional programs underway and collectively the outcomes of IIOE-2 will be of huge benefit to individual and regional sustainable development as the information is a critical component of improved decision making in areas such as maritime services and safety, environmental management, climate monitoring and prediction, food and energy security.

IIOE-2 activities will also include a significant focus on building the capacity of all nations around the Indian Ocean to understand and apply observational data or research outputs for their own socio-economic requirements and decisions. IIOE-2 capacity building programs will therefore be focused on the translation of the science and information outputs for societal benefit and training of relevant individuals from surrounding nations in these areas.

A Steering Committee was established to support U.S. participation in IIOE-2. More information is available on their website at https://web.whoi.edu/iioe2/.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851558
National Oceanic and Atmospheric Administration (NOAA)	NA15OAR4320071

[table of contents | back to top]