Mesozooplankton grazing rates from samples collected in the oceanic Gulf of Mexico on R/V Nancy Foster cruises NF1704 and NF1802 in May 2017 and May 2018

Website: https://www.bco-dmo.org/dataset/835091
Data Type: Cruise Results
Version: 1
Version Date: 2021-01-12

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 (UCSD-SIO)	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset is from zooplankton net tows in the Gulf of Mexico on R/V Nancy Foster cruises in May 2017 and May 2018, which were part of a NOAA RESTORE project (aka: BLOOFINZ-GoM) led by Dr. John Lamkin 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. This dataset contains mesozooplankton grazing rates.

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Coverage

Spatial Extent: **N**:28.3463 **E**:-84.3171 **S**:24.9727 **W**:-90.1851
Temporal Extent: 2017-05-10 - 2018-05-19

Methods & Sampling

This dataset is from zooplankton net tows in the Gulf of Mexico on R/V Nancy Foster cruises in May 2017 and May 2018, which were part of a NOAA RESTORE project (aka: BLOOFINZ-GoM) led by Dr. John Lamkin 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.

Oblique net tows were taken to obtain estimates of mesozooplankton standing stocks and grazing over the depth range of the euphotic zone. Generally, we sampled during midday (1100-1400 h) and midnight (2200-0100 h) hours following a drogued drifter, allowing estimates of diel vertical migrant biomass by difference. We used a 1-m ring net with 202-µm Nitex mesh and a General Oceanics flow meter to measure volume filtered. Depth of tow was controlled by a depth sensor on the hydrowire. Net tow contents were anesthetized with ice-cold carbonated water and split with a Folsom splitter, with half preserved in 4% buffered formalin and half size-fractionated using nested sieves into five size classes: 0.2-0.5, 0.5-1, 1-2, 2-5 and >5 mm. Each size fraction was concentrated on a preweighed 202-m Nitex filter, rinsed with isotonic ammonium formate to remove sea salt, and frozen at -85°C for lab analysis.

In the laboratory, frozen size-fractioned zooplankton on the Nitex filters were thawed, set briefly on blotting paper to remove excess water, and weighed moist for total sample wet weight (WW). Wet samples were subsampled for gut pigment analyses by removing replicate portions of the biomass and recording weights before and after each subsampling (fraction of total WW removed). The remaining wet biomass on the filters was oven dried at 60°C for 24 h before weighing dry (DW:WW ratio). For each size fraction, zooplankton dry weight (mg m-2) was calculated from the measured WW (less initial filter weight), DW:WW ratio, measured volume and depth of tow, and fraction of sample analyzed. The remaining dried sample was subsequently scraped off the filter, ground to a power with a mortar and pestle, and subsampled by weight for carbon (C), nitrogen (N).

Wet weight subsamples were placed in borosilicate glass tubes with 7 mL of 90% acetone and homogenized (multiple 20-sec bursts) in an ice bath with a Vibracell sonicator probe. They were then extracted overnight (18-24 h) in a -20°C freezer and warmed to room temperature in a dark container prior to analysis. The homogenate was shaken and centrifuged (5 min at 3000 rpm) to remove particulates. Concentrations of chlorophyll a (Chla) and phaeopigments (Phaeo) were then measured by the acidification method using a 10AU fluorometer. Water-column estimates of depth-integrated Chla for the euphotic zone were made similarly from analyses of duplicate 0.25 L samples collected from CTD hydrocasts, extracted for 24 h in 90% acetone, and measured on the same fluorometer.

For each size-fraction analyzed, we computed the depth-integrated concentration of gut pigment as GPC = [Phaeo] * D / (vol * f), where GPC is gut pigment content (mg m-2), [Phaeo] is the measured Phaeo value (mg), f is fraction of sample analyzed, D is depth of tow (m) and vol is the volume of water filtered (m^3).

We estimated grazing rates (G, mg pigment m-2 h-1) for each size fraction and for the total zooplankton assemblage as G = GPC * 60 * K, where K (min-1) is the gut evacuation rate constant. For K, we used a gut passage rate of 2.1 h-1 measured under similar surface water temperatures in the equatorial Pacific. To compute dry-weight or carbon-specific rates of phytoplankton grazing by the zooplankton assemblage and individual size classes, we divided G by DW or carbon biomass (mg m-2).

Data Processing Description

BCO-DMO Processing:
- renamed fields;
- added date/time field in ISO8601 format;
- converted Long from positive degrees west to negative degrees east.

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Data Files

File	
mesozoo_grazing.csv	(Comma Separated Values (.csv), 9.94 KB) MD5:3e1f8ec8dcf752eece5d4d8595fd0292
Primary data file for dataset ID 835091	

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Related Publications

Landry, M. R., & Swalethorp, R. (2021). Mesozooplankton biomass, grazing and trophic structure in the bluefin tuna spawning area of the oceanic Gulf of Mexico. Journal of Plankton Research, 44(5), 677–691. https://doi.org/10.1093/plankt/fbab008
Results

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Parameters

Parameter	Description	Units
Cruise	Cruise identifier	unitless
Tow_ID	Tow identifier	unitless
Station	Station number	unitless
Cycle	Cycle number; each cycle is a multi-day experiment following a satellite tracked drifter.	unitless
Date	Date (Central Standard (GMT-6)); format: MM/DD/YYYY	unitless
Month	2-digit month of year	unitless
Day	2-digit day of month	unitless
Year	4-digit year	unitless
Julian_Day	Julian day	unitless
Lat	Latitude	degrees North
Long	Longitude	degrees East
Day_Night	Day or night indicator: 1 = day, 2 = night	unitless
Time_IN	Time in (Central Standard (GMT-6)); format: HH:MM:SS AM/PM	unitless
ISO_DateTime_Local	Date and time in formatted to ISO8601 standard (Central Standard (GMT-6)); format: YYYY-MM-DDThh:mm:ss	unitless
Tow_Duration	Tow duration; format: HH:MM	unitless
Depth	Depth	meters
Vol	Sample volume	cubic meters
Phaeo_0d2_0d5_mm	Phaeopigment gut contents of the 0.2-0.5mm size class	micrograms Phaeo per square meter (µg Phaeo m-2)
Phaeo_0d5_1_mm	Phaeopigment gut contents of the 0.5-1mm size class	micrograms Phaeo per square meter (µg Phaeo m-2)
Phaeo_1_2_mm	Phaeopigment gut contents of the 1-2mm size class	micrograms Phaeo per square meter (µg Phaeo m-2)
Phaeo_2_5_mm	Phaeopigment gut contents of the 2-5mm size class	micrograms Phaeo per square meter (µg Phaeo m-2)
Phaeo_gt_5_mm	Phaeopigment gut contents of the >5mm size class	micrograms Phaeo per square meter (µg Phaeo m-2)
Phaeo_TOTAL	Total phaeopigment gut contents	micrograms Phaeo per square meter (µg Phaeo m-2)

grazing_rate_0d2_0d5_mm	Grazing rate of the 0.2-0.5mm size class	micrograms Chl per square meter per hour (µg Chl m-2 h-1)
grazing_rate_0d5_1_mm	Grazing rate of the 0.5-1mm size class	micrograms Chl per square meter per hour (µg Chl m-2 h-1)
grazing_rate_1_2_mm	Grazing rate of the 1-2mm size class	micrograms Chl per square meter per hour (µg Chl m-2 h-1)
grazing_rate_2_5_mm	Grazing rate of the 2-5mm size class	micrograms Chl per square meter per hour (µg Chl m-2 h-1)
grazing_rate_gt_5_mm	Grazing rate of the >5mm size class	micrograms Chl per square meter per hour (µg Chl m-2 h-1)
grazing_rate_TOTAL	Total grazing rate	micrograms Chl per square meter per hour (µg Chl m-2 h-1)
DW_grazing_rate_0d2_0d5_mm	Dry weight-specific grazing rate of the 0.2-0.5mm size class	nanograms Chl per milligrams dry weight per hour (ng Chl (mg DW)-1 h-1)
DW_grazing_rate_0d5_1_mm	Dry weight-specific grazing rate of the 0.5-1mm size class	nanograms Chl per milligrams dry weight per hour (ng Chl (mg DW)-1 h-1)
DW_grazing_rate_1_2_mm	Dry weight-specific grazing rate of the 1-2mm size class	nanograms Chl per milligrams dry weight per hour (ng Chl (mg DW)-1 h-1)
DW_grazing_rate_2_5_mm	Dry weight-specific grazing rate of the 2-5mm size class	nanograms Chl per milligrams dry weight per hour (ng Chl (mg DW)-1 h-1)
DW_grazing_rate_gt_5_mm	Dry weight-specific grazing rate of the >5mm size class	nanograms Chl per milligrams dry weight per hour (ng Chl (mg DW)-1 h-1)
DW_grazing_rate_TOTAL	Total dry weight-specific grazing rate	nanograms Chl per milligrams dry weight per hour (ng Chl (mg DW)-1 h-1)
C_grazing_rate_0d2_0d5_mm	Carbon-specific grazing rate of the 0.2-0.5mm size class	nanograms Chl per milligrams carbon per hour (ng Chl (mg C)-1 h-1)
C_grazing_rate_0d5_1_mm	Carbon-specific grazing rate of the 0.5-1mm size class	nanograms Chl per milligrams carbon per hour (ng Chl (mg C)-1 h-1)
C_grazing_rate_1_2_mm	Carbon-specific grazing rate of the 1-2mm size class	nanograms Chl per milligrams carbon per hour (ng Chl (mg C)-1 h-1)
C_grazing_rate_2_5_mm	Carbon-specific grazing rate of the 2-5mm size class	nanograms Chl per milligrams carbon per hour (ng Chl (mg C)-1 h-1)
C_grazing_rate_gt_5_mm	Carbon-specific grazing rate of the >5mm size class	nanograms Chl per milligrams carbon per hour (ng Chl (mg C)-1 h-1)

C_grazing_rate_TOTAL	Total carbon-specific grazing rate	nanograms Chl per milligrams carbon per hour (ng Chl (mg C)-1 h-1)

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Instruments

Dataset-specific Instrument Name	centrifuge
Generic Instrument Name	Centrifuge
Dataset-specific Description	The homogenate was shaken and centrifuged (5 min at 3000 rpm) to remove particulates.
Generic Instrument Description	A machine with a rapidly rotating container that applies centrifugal force to its contents, typically to separate fluids of different densities (e.g., cream from milk) or liquids from solids.

Dataset-specific Instrument Name	CTD hydrocasts
Generic Instrument Name	CTD - profiler
Dataset-specific Description	Water-column estimates of depth-integrated Chla for the euphotic zone were made similarly from analyses of duplicate 0.25 L samples collected from CTD hydrocasts, extracted for 24 h in 90% acetone, and measured on the same fluorometer.
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	General Oceanics flow meter
Generic Instrument Name	Flow Meter
Dataset-specific Description	We used a 1-m ring net with 202-µm Nitex mesh and a General Oceanics flow meter to measure volume filtered.
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	Folsom splitter
Generic Instrument Name	Folsom Plankton Splitter
Dataset-specific Description	Net tow contents were anesthetized with ice-cold carbonated water and split with a Folsom splitter.
Generic Instrument Description	A Folsom Plankton Splitter is used for sub-sampling of plankton and ichthyoplankton samples.

Dataset-specific Instrument Name	1-m ring net
Generic Instrument Name	Ring Net
Dataset-specific Description	We used a 1-m ring net with 202-µm Nitex mesh and a General Oceanics flow meter to measure volume filtered.
Generic Instrument Description	A Ring Net is a generic plankton net, made by attaching a net of any mesh size to a metal ring of any diameter. There are 1 meter, .75 meter, .25 meter and .5 meter nets that are used regularly. The most common zooplankton ring net is 1 meter in diameter and of mesh size .333mm, also known as a 'meter net' (see Meter Net).

Dataset-specific Instrument Name	10AU fluorometer
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	Concentrations of chlorophyll a (Chla) and phaeopigments (Phaeo) were then measured by the acidification method using a 10AU fluorometer.
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer. (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA)

Dataset-specific Instrument Name	Vibracell sonicator probe
Generic Instrument Name	ultrasonic cell disrupter (sonicator)
Dataset-specific Description	Wet weight subsamples were placed in borosilicate glass tubes with 7 mL of 90% acetone and homogenized (multiple 20-sec bursts) in an ice bath with a Vibracell sonicator probe.
Generic Instrument Description	Instrument that applies sound energy to agitate particles in a sample.

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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).

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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.

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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/.

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Funding

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

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