Nutrients, nitrate isotopes, and DON isotopes data from samples collected in the 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/834984
Data Type: Cruise Results
Version: 1
Version Date: 2020-12-31

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
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Abstract
This data set includes water column inorganic nutrient and dissolved organic nitrogen (DON) concentration and nitrate+nitrite d15N and d18O and DON δ15N measurements from May 2017 and May 2018 cruises in the North/Central Gulf of Mexico that were used together with sinking particulate N data to construct δ15N budgets.

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Coverage

Spatial Extent: **N**:28.355 **E**:-87.207 **S**:25.6642 **W**:-90.1875
Temporal Extent: 2017-05-11 - 2018-05-19

Methods & Sampling

Water column samples were collected by Niskin bottle on a CTD rosette ("CTD profile") in the North/Central Gulf of Mexico during Nancy Foster cruises (NF17-04, NF18-02) in May 2017 and May 2018, as part of the NOAA RESTORE (aka BLOOFINZ-GoM) project. All samples were 0.2 µm filtered into pre-washed HDPE bottles which were frozen at -20 degrees Celsius until analysis on land.

Acquisition and associated instruments:
Nitrate+nitrite concentration was measured on a Thermo 42i NOx analyzer

Nitrate+nitrite d15N was measured using a Thermo Finnigan Delta V isotope ratio mass spectrometer.
Phosphate concentration was determined using a Shimadzu UV-1800 uv-vis spectrophotometer.
Ammonium concentration was determined using a Turner Trilogy fluorometer.

Data Processing Description

Sample Processing:
NO3-+NO2- concentration was measured using a chemiluminescent method described by Braman and Hendrix, 1989, with a detection limit of 0.1 µM. NH4+ concentration was measured using the fluorescent method of Holmes et al., 1999 with a lower detection limit of 0.025 µM. Phosphate (soluble reactive phosphorus) concentration was measured using the colorimetric method of Koroleff (1983) with a lower detection limit of 50 nM. Dissolved organic nitrogen concentration was determined by subtracting the concentrations of nitrate, nitrite, and ammonium from the concentration of total dissolved nitrogen, determined using persulfate oxidation according to Knapp et al. (2005). NO3-+NO2- d15N and d18O analyses were by the “denitrifier method” and followed the methods described by Sigman et al., 2001, Casciotti et al., 2002, McIlvin and Casciotti, 2011, and Weigand et al., 2016. Briefly, NO3-+NO2- was quantitatively reduced to N2O by Pseudomonas aureofaciens and Pseudomonas chlororaphis, which was then cryogenically focused and analyzed on an isotope ratio mass spectrometer. A volume of sample was added to each bacterial vial to achieve a final quantity of 10 or 20 nmols N2O, which was then purged from the vial using a helium carrier gas. The d15N of N2O in samples was calibrated with the international isotopic reference materials. The δ15N of DON was determined using persulfate oxidation of DON to nitrate and then using the denitrified method as described above.

Precision:
The average precision of the nitrate+nitrite concentration measurement was <0.2 µM.
The average precision of the soluble reactive phosphorus concentration measurement was <0.03 µM.
The average precision of the ammonium concentration measurement was <0.02 µM.
The average precision for DON concentration was 0.3 µM.
The average precision for DON δ15N was 0.3 per mil.
The average precision of nitrate+nitrite δ15N measurements was <0.2 per mil and for d18O was <0.3 per mil.
NO3-+NO2- δ15N δ18O analyses were calibrated with IAEA N3 and USGS 34 NO3- d15N isotopic reference materials as described in McIlvin and Casciotti, 2011. NO3-+NO2- d18O were also calibrated with the USGS 35 isotopic reference material as described in McIlvin and Casciotti, 2011.

BCO-DMO processing:
- Date formats changed to yyyy-mm-dd
- Parameter names adjusted to comply with database requirements
- Longitudes West were converted to negative numbers
- Latitude and Longitude rounded to 4 decimal places
- Added a conventional header with dataset name, PI name, version date
- Units added to parameter description metadata section
- Missing data identifier of 'nd' (no data) used

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Data Files

File
nutrients_isotopes.csv (Comma Separated Values (.csv), 32.21 KB) MD5:d2e4be30247b30fee56cdbf32768fb96 Primary data file for dataset ID 834984

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Related Publications

Braman, R. S., & Hendrix, S. A. (1989). Nanogram nitrite and nitrate determination in environmental and biological materials by vanadium(III) reduction with chemiluminescence detection. Analytical Chemistry, 61(24), 2715–2718. doi:10.1021/ac00199a007
Methods

Casciotti, K. L., Sigman, D. M., Hastings, M. G., Böhlke, J. K., & Hilkert, A. (2002). Measurement of the Oxygen Isotopic Composition of Nitrate in Seawater and Freshwater Using the Denitrifier Method. Analytical Chemistry, 74(19), 4905–4912. doi:10.1021/ac020113w
Methods

Holmes, R. M., Aminot, A., Kérouel, R., Hooker, B. A., & Peterson, B. J. (1999). A simple and precise method for measuring ammonium in marine and freshwater ecosystems. Canadian Journal of Fisheries and Aquatic Sciences, 56(10), 1801–1808. doi:10.1139/f99-128
Methods

Knapp, A. N., Sigman, D. M., & Lipschultz, F. (2005). N isotopic composition of dissolved organic nitrogen and nitrate at the Bermuda Atlantic Time-series Study site. Global Biogeochemical Cycles, 19(1). doi:10.1029/2004gb002320
Methods

Koroleff, F. (1968). Determination of total phosphorus in natural waters by means of persulfate oxidation.
Methods

McIlvin, M. R., & Casciotti, K. L. (2011). Technical Updates to the Bacterial Method for Nitrate Isotopic Analyses. Analytical Chemistry, 83(5), 1850–1856. doi:10.1021/ac1028984
Methods

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Weigand, M. A., Foriel, J., Barnett, B., Oleynik, S., & Sigman, D. M. (2016). Updates to instrumentation and protocols for isotopic analysis of nitrate by the denitrifier method. Rapid Communications in Mass Spectrometry, 30(12), 1365–1383. doi:10.1002/rcm.7570
Methods

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Parameters

Parameter	Description	Units
Cruise_ID	Cruise ID	unitless
Sampling_Date	Date of sampling	yyyy-mm-dd
Latitude	Latitude of sample collection, South is negative	degrees North
Longitude	Longitude of sample collection, West is negative	degrees East
Cycle	Sequentially numbered coordinated deployment of floating sediment traps during each cruise	unitless
Cast	Sequentially numbered cast of the Niskin/CTD rosette	unitless
Bottle	Niskin bottle from which the sample was collected	unitless
Pressure	Pressure at which the sample was collected	decibars (db)
Temperature	Temperature of the sample	degrees Celsius
Salinity	Salinity of the sample	unitless
SigmaTheta	Potential Density of depth at which sample was collected	unitless
Depth	Depth at which the sample was collected	meters
NO3_NO2	Concentration of nitrate+nitrite in a sample	micromolar (µM)
PO4	Concentration of soluble reactive phosphorus	micromolar (µM)
NH4	Concentration of ammonium	micromolar (µM)
DON	Concentration of dissolved organic nitrogen	micromolar (µM)
NO3_NO2_d15N	Nitrogen isotopic composition of nitrate+nitrite in a sample	per mil vs. N2 in air
NO3_NO2_d18O	Oxygen isotopic composition of nitrate+nitrite in a sample	per mil vs. VSMOW
DON_d15N	NItrogen isotopic composition of DON in a sample	per mil vs. N2 in air

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Instruments

Dataset-specific Instrument Name	Thermo 42i NOx analyzer
Generic Instrument Name	Chemiluminescence NOx Analyzer
Generic Instrument Description	The chemiluminescence method for gas analysis of oxides of nitrogen relies on the measurement of light produced by the gas-phase titration of nitric oxide and ozone. A chemiluminescence analyzer can measure the concentration of NO/NO2/NOX. One example is the Teledyne Model T200: https://www.teledyne-api.com/products/nitrogen-compound-instruments/t200

Dataset-specific Instrument Name	Turner Trilogy fluorometer
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	Thermo Finnigan Delta V isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Shimadzu UV-1800 uv-vis spectrophotometer
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Generic Instrument Description	The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufacturers several models of spectrophotometer; refer to dataset for make/model information.

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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-1851347

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