Nitrate uptake from short-term 6-hour deckboard incubations on R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico in May of 2017 and 2018

Website: https://www.bco-dmo.org/dataset/836181
Data Type: Cruise Results, experimental
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)
» Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico (GoMex Tuna Foodweb B)

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

Contributors	Affiliation	Role
Stukel, Michael R.	Florida State University (FSU)	Principal Investigator
Kelly, Thomas	Florida State University (FSU)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Nitrate uptake from short-term 6-hour deckboard incubations on R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico in May of 2017 and 2018.

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**:28.354 **E**:-87.209 **S**:25.5061 **W**:-89.396
Temporal Extent: 2017-05-11 - 2018-05-16

Dataset Description

In addition to the funding sources listed in the "Funding Source" section, this dataset was partially funded by:

National Oceanic and Atmospheric Administration's RESTORE Program Grant (Project Title: Effects of nitrogen sources and plankton food-web dynamics on habitat quality for the larvae of Atlantic bluefin tuna in the Gulf of Mexico) under federal funding opportunity NOAA-NOS-NCCOS-2017-2004875, including NOAA JIMAR Cooperative Agreement, award #NA16NMF4320058, NOAA CIMAS Cooperative Agreement, award #NA15OAR4320064, and NOAA CIMEAS Cooperative Agreement, award #NA15OAR4320071.

Methods & Sampling

We conducted short term (6-h) NO3- uptake experiments in deckboard incubators. Each incubator was uniformly shaded using clear or blue-tinted acrylic sheets to achieve three light levels as determined by simultaneously using a 2-π LI-COR photosynthetically active radiation (PAR) sensor to measure downwelling irradiance and a 4-π water-proof LI-COR PAR sensor to measure ambient irradiance within the incubator. These calibrations were done on the ship to account for light reflection or ship shading. Incubation light levels for the NF17 cruise were determined to be 145% (clear, surface), 79% (mixed layer), and 21% (lower mixed layer) of surface irradiance. For the NF1802 cruise, the clear incubator was replaced with one screened to 1.7% surface irradiance to mimic deep chlorophyll maximum light. All incubators were cooled with mixed-layer seawater. Samples were drawn from depths near these light levels (as determined from noon CTD casts with CTD-mounted PAR sensor).
To determine patterns of nitrate uptake with depth, three 2.7-L samples from each of the three incubator light levels (e.g. 5 m, 15 m, 45 m for surface, 79% and 21% light levels, respectively) were collected near dusk and placed in the incubators until dawn (ship schedule and CTD water budget did not allow dawn sampling for these experiments). At dawn triplicate samples from each depth were spiked with 15NO3- (final concentration of 10 or 8 nmol L-1 on NF17 and NF18, respectively) and incubated for 6-h (dawn to roughly local noon). At the end of the incubation bottles were immediately vacuum filtered onto pre-combusted 25-mm GF/F filters in the dark. Filters were rinsed with filtered seawater, wrapped in foil and stored at 80°C. On land, samples were fumigated with HCl vapor to remove inorganic carbon, dried, and placed inside a tin cup for C/N and isotopic analysis at the UC Davis stable isotope facility. NO3- uptake rates in each incubation bottle (and associated uncertainties) were determined using equations in Stukel (2020).

Data Processing Description

In situ nitrate uptake rates were estimated using either equation ρkan,is (Eq. 6) or ρreg,is (Eq. 14) from Stukel (2020). ρkan,is was used if there was not evidence for high recycling within the incubation bottle (Φ<0.6). ρreg,is was used if there was evidence for high recycling within the incubation bottle (Φ>0.6). See Fig. 4 of Stukel (2020).

BCO-DMO Data Manager Processing Notes:
* Data in original excel file "Deckboard Nitrate Uptake.xlsx" exported as csv with the formatting that was set in Excel.
* Converted Date to ISO 8601 format yyyy-mm-dd
* modified parameter names to conform with BCO-DMO naming conventions: only A-Za-z0-9 and underscore allowed. Can not start with a number. (spaces, +, and - changed to underscores).
* Removed percent character "%" from the values in the Light_Level column so it could be typed as numeric. The units (percent) are described in the parameter description section.

[table of contents | back to top]

Data Files

File	
deckboard_nitrate_uptake.csv	(Comma Separated Values (.csv), 17.09 KB) MD5:5c9739c5623293584ad7907fc968f5eb
Primary data file for dataset ID 836181	

[table of contents | back to top]

Related Publications

Stukel, M. R. (2020). Investigating equations for measuring dissolved inorganic nutrient uptake in oligotrophic conditions. Limnology and Oceanography: Methods, 18(11), 656–672. doi:10.1002/lom3.10392
Methods

Yingling, N., Kelly, T. B., Selph, K. E., Landry, M. R., Knapp, A. N., Kranz, S. A. and Stukel, M. R. (2021) Taxon-specific phytoplankton growth, nutrient limitation, and light limitation in the oligotrophic Gulf of Mexico. J. Plank. Res. pre-print doi: 10.1101/2021.03.01.433426
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise	Name of cruise	unitless
Sample	Sample name	unitless
Cycle	Lagrangian Experiment Number	unitless
Date	Date of collection and incubation	unitless
Cast	CTD-Niskin rosette cast number	unitless
Lon	Longitude	decimal degrees
Lat	Latitude	decimal degrees
Depth	Depth	meters (m)
Light_Level	Percent surface irradiance	percent (%)
T	Duration of Incubation in decimal hours	hours
Sigma_T	Estimated measurement uncertainty (sigma, σ) for duration	hours
P	PON, Particulate organic nitrogen (final)	micromoles of nitrogen per liter (µmol N L-1)
Sigma_P	Estimated measurement uncertainty (sigma, σ) for PON	micromoles of nitrogen per liter (µmol N L-1)
Ip_T	Ip(T), Isotope ratio of PON (final)	atom percent (%)
Sigma_Ip_T	Estimated measurement uncertainty (sigma, σ) for Ip(T)	atom percent (%)

Ip_0	Ip(0), Isotope ratio of PON (initial)	atom percent (%)
Sigma_Ip_0	Estimated measurement uncertainty (sigma, σ) for Ip(0)	atom percent (%)
I_spk	Isotope ratio of tracer spike	atom percent (%)
Sigma_I_spk	Estimated measurement uncertainty (sigma, σ) for I_spk	atom percent (%)
I_amb	Isotope ratio of ambient ammonium	atom percent (%)
Sigma_I_amb	Estimated measurement uncertainty (sigma, σ) for I_amb	atom percent (%)
N_spk	Final concentration of tracer spike. [N]spk	micromoles of nitrogen per liter (µmol N L-1)
Sigma_N_spk	Estimated measurement uncertainty (sigma, σ) for [N]spk	micromoles of nitrogen per liter (µmol N L-1)
N_amb	Ambient nitrate concentration	micromoles of nitrogen per liter (µmol N L-1)
Sigma_N_amb	Estimated measurement uncertainty (sigma, σ) for [N]amb	micromoles of nitrogen per liter (µmol N L-1)
a	Assumed ratio of regeneration to uptake	dimensionless
Sigma_a	Estimated measurement uncertainty (sigma, σ) for "a" (Assumed ratio of regeneration to uptake).	dimensionless
L10KS	Assumed log10(half-saturation constant)	micromoles of nitrogen per liter (µmol N L-1)
Sigma_L10KS	Estimated measurement uncertainty (sigma, σ) for L10KS	micromoles of nitrogen per liter (µmol N L-1)
Nitrate_Uptake	Nitrate Uptake	nanomoles of nitorgen per liter per hour (nmol N L-1 h-1)

Sigma_Nitrate_Uptake	Propagated measurement uncertainty (sigma, σ) for nitrate uptake	nanomoles of nitorgen per liter per hour (nmol N L-1 h-1)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
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	PDZ Europa ANCA-GSL elemental analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK). C/N and isotopic analysis at the UC Davis stable isotope facility.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK)
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK). C/N and isotopic analysis at the UC Davis stable isotope facility.
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	
Generic Instrument Name	Photosynthetically Available Radiation Sensor
Dataset-specific Description	2-π LI-COR photosynthetically active radiation (PAR) sensor to measure downwelling irradiance. 4-π water-proof LI-COR PAR sensor to measure ambient irradiance within the incubator. Samples were drawn from depths near these light levels (as determined from noon CTD casts with CTD-mounted PAR sensor).
Generic Instrument Description	A PAR sensor measures photosynthetically available (or active) radiation. The sensor measures photon flux density (photons per second per square meter) within the visible wavelength range (typically 400 to 700 nanometers). PAR gives an indication of the total energy available to plants for photosynthesis. This instrument name is used when specific type, make and model are not known.

[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.

Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico (GoMex Tuna Foodweb B)

Coverage: Gulf of Mexico

Amendment #136: Current stock assessments for the Gulf of Mexico require better ecosystem understanding to effectively evaluate how bottom-up processes limit or enhance Atlantic Bluefin Tuna recruitment. The objective of this proposal is to elucidate the underlying mechanisms that link variability in nitrogen sources and food-web fluxes in the Gulf of Mexico to habitat quality, feeding, growth and survival for Atlantic Bluefin Tuna larvae. This proposal addresses the Program Priority: Comprehensive understanding of living coastal and marine resources, food web dynamics, habitat utilization, protected areas, and carbon flows, specifically "(d) Food web structure and dynamics, trophic linkages, and/or predator-prey relationships, especially projects that develop and/or apply new techniques or technologies".

[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
National Oceanic and Atmospheric Administration (NOAA)	NA16NMF4320058
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851347

[table of contents | back to top]