Larval Atlantic Bluefin Tuna prey from gut analysis, collected on NOAA Ship R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico, May 2017 and May 2018.

Website: https://www.bco-dmo.org/dataset/834776
Data Type: Cruise Results
Version: 1
Version Date: 2020-12-30

Project
» Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)
» 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)
» Effects of Nitrogen Sources and Plankton Food-Web Dynamics On Habitat Quality for the Larvae of Bluefin Tuna in the Gulf Of Mexico (GoMex Tuna Foodweb A)

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

Contributors	Affiliation	Role
Shiroza, Akihiro	University of Miami	Principal Investigator
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Abstract
Gut contents of larval Atlantic Bluefin Tuna prey, collected on NOAA Ship R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico, May 2017 and May 2018.

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Coverage

Spatial Extent: **N**:28.33416 **E**:-87.306876 **S**:25.642115 **W**:-88.209598
Temporal Extent: 2017-05-10 - 2018-05-19

Methods & Sampling

Larval sampling:
Larval Atlantic Bluefin Tuna (ABT) were collected during the peak spawning period in the GoM during May of 2017 (NF1704) and 2018 (NF1802). Samples were taken with a dual 90 cm diameter bongo frame (bongo-90) equipped with 500-µm synthetic nylon mesh nets by oblique hauls in the upper 25 m of the water column and towed at an average over-ground speed of 2.22 knots for 10 minutes (Habtes et al., 2014; Laiz-Carrion et al.,2015). Filtered volumes were calculated with a mechanical flowmeter (2030R, General Oceanics Inc.) placed

in the center of the net mouths. Larval patches were located by transect net sampling and real-time sample sorting (every ~10 nautical miles) across favorable habitat (Domingues et al., 2016) with a higher probability of containing ABT larvae. Once larvae were detected, the core of the patch was located and marked with a drogued satellite-tracked drifter equipped with a strobe light, beginning a 3–4 day experimental cycle during which the ABT larvae were sampled close to the drifter every 3 hours. Three cycle experiments (C1, C2, and C3) were conducted on the NF1704 cruise, and two cycles (C4 and C5) were done on NF1802—ABT larvae were only abundant during C1 and C5.

Upon collection, left bongo-90 samples were immediately fixed in 95% EtOH and the right bongo-90 samples were immediately sorted for ABT larvae. Contents were concentrated on a sieve using 50-µm filtered cold seawater and placed in a large petri dish in a Styrofoam box with ice while sorting. Using a dissecting microscope (MZ12, Leica Microsystems), ABT larvae were removed from small portions of the wet sample that could be sorted within 10 minutes and placed in a small petri dish in the cooler. The remaining zooplankton in the sample were immediately fixed with 95% EtOH. The collected zooplankton volume was generally small (<250 mL during the day), but some night samples exceeded 1 L. For larger samples, sorting was halted within 1 hour and fixed to prevent sample degradation; sorting was resumed back in the lab. Fixative was refreshed after 24 hours to prevent sample degradation from dilution.

Gut analysis:
The alimentary canal from pharynx to anus was dissected using tweezers and scalpel by carefully tracing and cutting along the dorsal margin of the gut from anus to operculum, just deep enough to allow access to the organs. Another deeper cut was made under the operculum and gills to separate the pharynx from the head, and tweezers were used to open the lateral muscular membrane and pick out the internal organs. The digestive tract was carefully opened from anus to stomach using sharpened tips of insect pins, and contents were isolated and imaged. We recorded the location of each prey item in three sections of the alimentary canal: foregut (from pharynx to stomach), midgut (anterior intestine, a large ventral pouch), and hindgut (posterior intestine, a narrow tube connecting dorsally over the right side of the stomach to the anus).

Data Processing Description

BCO-DMO Processing Notes:
- data submitted in Excel file "201016145704_BLOOFINZ_GoM_ABT_prey_Shiroza_BCO-DMO.xlsx" sheet "Data" extracted to csv
- added conventional header with dataset name, PI name, version date
- renamed columns to conform with BCO-DMO naming conventions (removed units and special characters)
- added column ISO_DateTime by combining Date and Time columns
- reduced precision of Prey_to_Larval_length, Weight_ug_C, Total_weight_ug_C to 4 digits to reflect sampling precision methods
- replaced blank cells with no data value 'nd', the default missing data identifier in the BCO-DMO system.

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Data Files

File
gut_analysis.csv (Comma Separated Values (.csv), 369.71 KB) MD5:3dc5c0b7597155c5123cd11125f7a044 Primary data file for dataset ID 834776

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Parameters

Parameter	Description	Units
Cruise	Sampled cruise	unitless
Date	Sampled date	unitless
Time	Sampling start time	unitless
ISO_DateTime	description	unitless
Station	Sampled station	unitless
Latitude	Position	decimal degrees
Longitude	Position	decimal degrees
Sample_no	Bongo-90 sample number	unitless
ABT_ID	Atlantic bluefin tuna larval ID	unitless
ABT_SL_EtOH	Larvae Standard Length in EtOH	millimeters
Flexion_stage	Preflexion; Flexion; Postflexion	unitless
Items_per_gut	Total number of prey items found from this larvae	items
Vial	Isolated prey vial number	unitless
Taxonomic_level	For those who are not familiar with zooplankton taxa	unitless
Taxa	Identified prey taxa	unitless
Taxa_group	Grouping for analysis	unitless
No_of_prey	Number of prey in vial	individual prey
Prey_location	1=fore gut; 2=mid gut; 3=hind gut	unitless
Length_mm	Dorsal prey length	millimeters
Prey_to_Larval_length	For analysis	unitless
Weight_ug_C	Carbon weight of taxa group	micrograms Carbon
Total_weight_ug_C	Total carbon weight in vial	micrograms Carbon
Size_group_um	Size grouping; for analyses	micrometers
Size_group_2	Size grouping 2; for analyses	micrometers
Size_group_2_midpoint	Midpoint of size group 2; for analyses	micrometers
Accept_Reject	Missing data identifier	unitless
ID_taxa	Taxa identifier; for analyses	unitless
ID_size	Size identifier; for analyses	unitless

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Instruments

Dataset-specific Instrument Name	Bongo net
Generic Instrument Name	Bongo Net
Dataset-specific Description	Samples were taken with a dual 90 cm diameter bongo frame (bongo-90) equipped with 500-µm synthetic nylon mesh nets.
Generic Instrument Description	A Bongo Net consists of paired plankton nets, typically with a 60 cm diameter mouth opening and varying mesh sizes, 10 to 1000 micron. The Bongo Frame was designed by the National Marine Fisheries Service for use in the MARMAP program. It consists of two cylindrical collars connected with a yoke so that replicate samples are collected at the same time. Variations in models are designed for either vertical hauls (OI-2500 = NMFS Pairovet-Style, MARMAP Bongo, CalVET) or both oblique and vertical hauls (Aquatic Research). The OI-1200 has an opening and closing mechanism that allows discrete "known-depth" sampling. This model is large enough to filter water at the rate of 47.5 m3/minute when towing at a speed of two knots. More information: Ocean Instruments, Aquatic Research, Sea-Gear

Dataset-specific Instrument Name	
Generic Instrument Name	Drifter Buoy
Dataset-specific Description	a drogued satellite-tracked drifter equipped with a strobe light used to track the larval tuna patch.
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	2030R, General Oceanics Inc.
Generic Instrument Name	Flow Meter
Dataset-specific Description	Used to calculate volume filtered by the bongo nets
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	Dissecting microscope: MZ12, Leica Microsystems
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Used to sort samples
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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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:

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".

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

Coverage: Gulf of Mexico

Amendment #66: 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".

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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)	NA16NMF4320058
National Oceanic and Atmospheric Administration (NOAA)	NA15OAR4320071

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