Winter growth and lipid accumulation in juvenile Black sea bass exposed to varying food and temperature conditions during lab experiments conducted from September 2021 to April 2022 at UConn Avery Point

Website: https://www.bco-dmo.org/dataset/897895
Data Type: experimental
Version: 1
Version Date: 2023-07-18

Project
» Collaborative research: Understanding the effects of acidification and hypoxia within and across generations in a coastal marine fish (HYPOA)

Contributors	Affiliation	Role
Baumann, Hannes	University of Connecticut (UConn)	Principal Investigator
Zavell, Max D.	University of Connecticut (UConn)	Student
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
The northern stock of Black sea bass (BSB, Centropristis striata) has greatly expanded over the past decade, potentially due to warming Northwest Atlantic shelf waters affecting overwintering especially in juveniles. To gather better empirical data we quantified winter growth and lipid accumulation in BSB juveniles from Long Island Sound using two complementing experiments. The data from Experiment 1 are presented here. Experiment 1 measured individual length growth (GR), weight-specific growth (SGR), growth efficiency, and lipid content at constant food and three static temperatures: 6°, 12°, and 19° Celsius (C). Average GR (SGR) decreased from 0.24 millimeters per day (mm d-1) at 19°C (0.89% d-1) to 0.15 mm d-1 at 12°C (0.54% d-1) to 0.04 mm d-1 at 6°C (0.17% d-1). Even at the coldest temperature, most juveniles sustained positive GRs and SGRs; hence, the species' true thermal growth minimum may be below 6°C. However, lipid accumulation was greatest at 12°C, which is close to what overwintering juveniles likely encounter offshore. The data from Experiment 2 are presented in a related dataset (https://www.bco-dmo.org/dataset/898012). In both experiments, juveniles disproportionally accumulated lipid over lean mass, with lipid proportions tripling in Exp2 from 4% at 65 mm to 12% at 120 mm.

Table of Contents

Coverage

Spatial Extent: **Lat**:41.323611 **Lon**:-72.001944
Temporal Extent: 2021-09-21 - 2022-02-11

Methods & Sampling

Juvenile Black sea bass (BSB) were caught on September 3rd (collection 1) and 21st 2021 (collection 2) via beach seine (30 × 2 meters) in Mumford Cove (41° 19' 25"N, 72° 01 '07"W), a shallow protected bay with extensive eelgrass cover in eastern Long Island Sound, USA.

Experiment 1 quantified juvenile BSB growth and lipid accumulation at constant food rations and 3 static temperature treatments. On November 5, 2021, we determined initial total length (TL) and wet weight (wW) on briefly anesthetized specimens (20 milligrams per liter MS-222) and selected 72 juveniles of similar size for the experiment (mean ± SD TL = 70.2 ± 5.5 millimeters (mm), wW = 5.2 ± 1.4 grams (g), 2^{nd} collection). The remainder was euthanized as a baseline sample for subsequent lipid analyses (n = 32, mean ± SD TL = 85.6 ± 10.5 mm, wW = 8.8 ± 2.9 g). Each juvenile was placed into a round 20-liter (L) rearing container equipped with mesh-screened (250-micrometer (µm)) holes and a PVC shelter (15.2 x 3.8 centimeters internal diameter). We randomly placed each rearing container into one of nine 600 L recirculating tanks (8 containers per tank mean maximum stocking density = 0.07 kilograms per cubic meter (kg m^{-3}) that were independently controlled for temperature (via LabView®, National Instruments™ triggering heaters or chillers) and assigned to one of three temperature treatments: 6, 12, 19° Celsius (C) (3 tanks per temperature treatment). Initially, all juveniles experienced 20°C for 7 days, then conditions were decreased by 0.5°C per day until target temperatures were reached. To achieve approximately similar cumulative temperature conditions, the total rearing period differed among treatments, i.e., 51 days (19°C treatment, 976 degree days), 71 days (12°C treatment, 936 degree days), and 99 days (6°C treatment, 783 degree days). The photoperiod was gradually decreased from 16L:8D to 9L:15D.

Response traits. Initial, monthly (Exp2 only), and final measurements of individual fish (TL, wW) were used to calculate total (final – initial), cumulative (end of month – initial), and/or serial (end of month – start of month) growth (e.g., cumulative and serial DTL for month 2 = TLd61 – TLd0 and TLd61 – TLd31), respectively) and average daily growth rates (growth/days in growth interval). Specific growth rates (SGR; % wW per day) were calculated similarly but used ln(wW) at each time period (e.g., 100*[ln(wWd61)-ln(wWd31)]). Growth efficiency (GE, %) was calculated cumulatively (Exp1, Exp2) and monthly (Exp2 only) as the change in body dry weight (DdWb, g) divided by total food consumed (DF, g) during a given time interval. (In Exp2, three GE values > 100% were excluded as outliers). Q_{10} values (Exp1) were calculated for GR, SGR, and GE between 6-12°C and 12-19°C.

For each experiment, we also determined the lipid, lean, and ash dry weights of each surviving BSB juvenile and those of the baseline samples. Whole specimens were first transferred to -80°C for one week, then freeze-dried at -50°C for one week and re-measured for whole body dry weight (dWb, 0.001 g). Dried specimens were then loaded into pre-weighed Alundum medium-porosity extraction thimbles and transferred into a custom-designed Soxhlet apparatus, where they were bathed in petroleum ether for a total of 3.5 hours to extract all metabolically accessible lipids (15-minute cycles of bathing, flushing, and ether replacement). After extraction, thimbles were dried overnight at 60°C and re-weighed to determine DdW, which equaled the total lipid content (dWLipid, milligrams (mg)) of each specimen after accounting for any tissue loss during transfer from vial into thimble. Thimbles were then placed in a muffle furnace for 4 hours at 550°C and re-weighed, with DdW during this second step corresponding to a fish's lean mass (dWLean, mg), again after accounting for any tissue loss during transfer from vial into thimble. The difference between the final weight and the pre-weighed empty thimble equaled ash (dWAsh, mg), i.e., the inorganic fraction of each individual.

Data Processing Description

BCO-DMO Processing:
- Imported original file named "BCO-DMO-Source-BSB-Juvenile-Overwintering-V2.xlsx" sheet 2 into the BCO-DMO data system;
- renamed fields to comply with BCO-DMO naming conventions (replaced spaces with underscores);
- converted dates to YYYY-MM-DD format;
- added columns for latitude and longitude in decimal degrees;
- named the final file "897895_v1_bsb_experiment1.csv".

[table of contents | back to top]

Data Files

File
897895_v1_bsb_experiment1.csv (Comma Separated Values (.csv), 14.31 KB) MD5:84937672978ebe17c3e08d5a61fda056 Primary data file for dataset ID 897895, version 1

[table of contents | back to top]

Related Publications

Zavell, M.D., Mouland, M.E.P., Matassa, C.M., Schultz, E.T., and Baumann, H. (in review) Temperature- and ration-dependent winter growth in Northern stock Black Sea Bass juveniles. Transactions of the American Fisheries Society.
Results

[table of contents | back to top]

Related Datasets

IsRelatedTo

Zavell, M. D., Baumann, H. (2023) **Temperature-dependence of juvenile Black sea bass growth and lipid accumulation determined through lab experiments conducted from September 2021 to February 2022 at UConn Avery Point.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-07-18 doi:10.26008/1912/bco-dmo.898012.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Collection_site	Site name; Mumford Cove, CT - all fish	unitless
Longitude	Longitude of collection site in decimal degrees (negative values = West)	decimal degrees
Latitude	Latitude of collection site in decimal degrees (positive values = North)	decimal degrees
Collection_date	Date of juvenile collection in the wild	unitless
Sample_date	Date of final sample, followed by euthanization	unitless
Species	Name of species (Black Sea Bass - Centropristis striata)	unitless
BSB_ID	ID of each BSB individual	unitless
Group	Experiment 1 OR Baseline (sacrificed at the beginning of the experiment)	unitless
Temp	Temperature treatment	degree Celsius
Days_W	Number of days of experimental exposure at winter temperature	number of days
DD_W	Degree days of experimental exposure at winter tempreratur e	degree-days (°C × days)
DD_all	Degree days of entire experiment	degree-days (°C × days)
S_or_M	Denotes whether specimen survived (S) until the experiment or was sampled before as a mortality (M)	unitless
wW_ini	Wet weight at the begin of the experiment	grams (g)
wW_final	Wet weight at experiment end	grams (g)
dW_final_g	Dry weight at experiment end	grams (g)
estdW_ini	Estimated dry mass at experiment start	grams (g)
DdW	Change in dry mass from the start and end of the experiment	grams (g)
TL_ini	Total length at begin of experiment	millimeters (mm)
TL_final	Total length at experiment end	millimeters (mm)
GR	Total length growth rate	millimeters per day (mm/d)
SGR	Weight-specific growth rate	percent (%) per day
Cons	Average amount of food consumed per feeding	percent body wet weight (% body wW)
GE	Gross growth efficiency (dryweight-based)	percent (%)
dW_final_mg	Dry weight at experiment end	milligrams (mg)
Lipid	Lipid content of the specimen	milligrams (mg)
Lean	Muscle/lean = protein content of the specimen	milligrams (mg)
Ash	Inorganic = ash content of the specimen	milligrams (mg)
Prop_Lipid	Lipid / dW_final	percent (%)
Prop_Lean	Lean / dW_final	percent (%)
Prop_Ash	Ash / dW_final	percent (%)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Automated Larval Fish Rearing System (ALFiRiS)
Generic Instrument Name	Automated Larval Fish Rearing System
Generic Instrument Description	The Automated Larval Fish Rearing System (ALFiRiS) was self-designed and assembled in the Rankin Lab at the University of Connecticut Avery Point. It consists of a 3 x 3 array of recirculating units (600 liters/150 gallons) that have independent computer-control over their temperature, oxygen, and pH conditions. The system was designed to sequentially monitor tank conditions via industrial-grade oxygen and pH sensors (Hach) and then control gas solenoids (air, N2, CO2) to maintain and modulate environmental conditions. The system can apply static as well as fluctuating conditions on diel and tidal scales. Computerized temperature control allows simulating heatwaves and other non-static thermal regimes. More information can be found at https://befel.marinesciences.uconn.edu/alfiris/

Dataset-specific Instrument Name	Custom-designed Soxhlet apparatus for Lipid/Lean analyses
Generic Instrument Name	Soxhlet extractor
Generic Instrument Description	A Soxhlet extractor is a piece of laboratory apparatus designed for the extraction of a lipid from a solid material. The solid is placed in a filter paper thimble which is then placed into the main chamber of the Soxhlet extractor. The solvent (heated to reflux) travels into the main chamber and the partially soluble components are slowly transferred to the solvent.

Dataset-specific Instrument Name	HOBO temperature loggers (Onset)
Generic Instrument Name	Temperature Logger
Generic Instrument Description	Records temperature data over a period of time.

[table of contents | back to top]

Project Information

Collaborative research: Understanding the effects of acidification and hypoxia within and across generations in a coastal marine fish (HYPOA)

Coverage: Eastern Long Island Sound, CT, USA

Description from NSF award abstract:
Coastal marine ecosystems provide a number of important services and resources for humans, and at the same time, coastal waters are subject to environmental stressors such as increases in ocean acidification and reductions in dissolved oxygen. The effects of these stressors on coastal marine organisms remain poorly understood because most research to date has examined the sensitivity of species to one factor, but not to more than one in combination. This project will determine how a model fish species, the Atlantic silverside, will respond to observed and predicted levels of dissolved carbon dioxide (CO2) and oxygen (O2). Shorter-term experiments will measure embryo and larval survival, growth, and metabolism, and determine whether parents experiencing stressful conditions produce more robust offspring. Longer-term experiments will study the consequences of ocean acidification over the entire life span by quantifying the effects of high-CO2 conditions on the ratio of males to females, lifetime growth, and reproductive investment. These studies will provide a more comprehensive view of how multiple stressors may impact populations of Atlantic silversides and potentially other important forage fish species. This collaborative project will support and train three graduate

students at the University of Connecticut and the Stony Brook University (NY), two institutions that attract students from minority groups. It will also provide a variety of opportunities for undergraduates to participate in research and the public to learn about the study, through summer research projects, incorporation in the "Women in Science and Engineering" program, and interactive displays of environmental data from monitoring buoys. The two early-career investigators are committed to increasing ocean literacy and awareness of NSF-funded research through public talks and presentations.

This project responds to the recognized need for multi-stressor assessments of species sensitivities to anthropogenic environmental change. It will combine environmental monitoring with advanced experimental approaches to characterize early and whole life consequences of acidification and hypoxia in the Atlantic silverside (Menidia menidia), a valued model species and important forage fish along most of the US east coast. Experiments will employ a newly constructed, computer-controlled fish rearing system to allow independent and combined manipulation of seawater pCO2 and dissolved oxygen (DO) content and the application of static and fluctuating pCO2 and DO levels that were chosen to represent contemporary and potential future scenarios in productive coastal habitats. First CO2, DO, and CO2 × DO dependent reaction norms will be quantified for fitness-relevant early life history (ELH) traits including pre- and post-hatch survival, time to hatch, post-hatch growth, by rearing offspring collected from wild adults from fertilization to 20 days post hatch (dph) using a full factorial design of 3 CO2 × 3 DO levels. Second, the effects of tidal and diel CO2 × DO fluctuations of different amplitudes on silverside ELH traits will be quantified. To address knowledge gaps regarding the CO2-sensitivity in this species, laboratory manipulations of adult spawner environments and reciprocal offspring exposure experiments will elucidate the role of transgenerational plasticity as a potential short-term mechanism to cope with changing environments. To better understand the mechanisms of fish early life CO2-sensitivity, the effects of temperature × CO2 on pre- and post-hatch metabolism will be robustly quantified. The final objective is to rear silversides from fertilization to maturity under different CO2 levels and assess potential CO2-effects on sex ratio and whole life growth and fecundity.

Related references:

Gobler, C.J. and Baumann, H. (2016) Hypoxia and acidification in ocean ecosystems: Coupled dynamics and effects on marine life. Biology Letters 12:20150976. doi:10.1098/rsbl.2015.0976

Baumann, H. (2016) Combined effects of ocean acidification, warming, and hypoxia on marine organisms. Limnology and Oceanography e-Lectures 6:1-43. doi:10.1002/loe2.10002

Depasquale, E., Baumann, H., and Gobler, C.J. (2015) Variation in early life stage vulnerability among Northwest Atlantic estuarine forage fish to ocean acidification and low oxygen Marine Ecology Progress Series 523: 145–156.doi:10.3354/meps11142

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1536336
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756751
Connecticut Sea Grant (CTSG)	R/LR-30

[table of contents | back to top]