Juvenile Black Sea Bass (Centropristis striata) winter survival and lipid accumulation from a laboratory mesocosm experiment (Oct 2022 to May 2023) with individuals collected from Long Island Sound

Website: https://www.bco-dmo.org/dataset/965079
Data Type: experimental
Version: 1
Version Date: 2025-06-24

Project
» Collaborative research: Understanding the effects of acidification and hypoxia within and across generations in a coastal marine fish (HYPOA)
» Collaborative research: The genomic underpinnings of local adaptation despite gene flow along a coastal environmental cline (GenomAdapt)

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 under a current ambient (2022/2023) seasonal temperature profile for eastern Long Island Sound, USA. Over the course of this study, winter mortality was low (< 16%) and average specific growth rate (SGR) followed seasonal trends (Fall → Winter → Spring) decreasing from 0.15 millimeters per day (mm d-1) (0.97 % wW d-1) to 0.01 mm d-1 (-0.03 % wW d-1), before rising to 0.03 mm d-1 (0.11 %wW d-1).

Table of Contents

Coverage

Location: Long Island Sound; Northwest Atlantic shelf
Spatial Extent: **Lat**:41.323611 **Lon**:-72.001944
Temporal Extent: 2022-09-09 - 2023-05-16

Methods & Sampling

Juvenile Black sea bass (BSB, *Centropristis striata*) were caught on September 9th via beach seine (30 × 2 meters (m)) in Mumford Cove (41°19'25"N 72°01'07"W), a shallow protected bay with extensive eelgrass cover

in eastern Long Island Sound (LIS).

Experiment. This study quantified juvenile BSB growth and lipid accumulation at constant food rations and over a seasonal temperature profile for Long Island Sound over eight months (10/12/2022 – 5/16/2023). On October 12th, 2022, we determined initial total length (TL) and wet weight (wW) on briefly anesthetized specimens (20 milligrams per liter MS-222) and randomly selected 63 individuals for the experiment. The remaining 35 fish were euthanized as a baseline sample for subsequent lipid analysis. Each juvenile was randomly distributed to an individual 20-liter (L) rearing container with mesh-screened holes, an air stone, and a PVC hide. A total of 9 individual rearing containers were allocated to one of 6 larger 600-liter flow-through tanks (4208-liters per hour; fully replaced 7x hour). Fish were fed Otohime C2 (51% protein, 11% fat, 3.5% fiber, 15% ash) at a target ration of 5% of their wW 3x per week and uneaten food was siphoned 24 hours after feeding. Temperature was recorded every 30 minutes by a HOBO logger in each individual tank (Standard Deviation between tanks = 0.17°C). At the beginning of the experiment, mean daily water temperatures began at 18 degrees Celsius (°C) before rising ~ 5.5-6°C in early February and rising to ~11°C in May. Photoperiod was changed by 30 minutes weekly, to mimic local conditions. At the start of the experiment in October, the photoperiod was 11.5L:12.5D before dropping to a low of 9L:15D in December and rising to 14.5L:9.5D in May of 2023. Throughout the experiment, specimens were briefly anesthetized every 20 to 40 days and re-measured in length (TL; millimeters (mm)) and weight (wW; grams (g)) to calculate monthly absolute and specific growth rates. At the end of the experiment, all surviving fish were euthanized, measured for TL and wW, and frozen for lipid extractions. Throughout the experiment, 10 specimens escaped their rearing containers and were not included in subsequent analyses.

Response traits. Initial, monthly, 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 = TL_{d61} – TL_{d0} and TL_{d61} – TL_{d31}), respectively) and average daily growth rates (growth/days in growth interval). Specific growth rates (SGR; % wW d^{-1}) were calculated similarly but used ln(wW) at each time period (e.g., 100*[ln(wW_{d61})-ln(wW_{d31})]).

Lipid, lean, and ash dry weights of each surviving BSB juvenile and those of the baseline samples were quantified via proximate analysis. 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 (dW_b, 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 h 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 (dW_{Lipid}, 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 (dW_{Lean}, 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 (dW_{Ash}, mg), i.e., the inorganic fraction of each individual. Total energy content (ED; Kcal; Brett and Groves 1979) was then calculated as (dW_{Lean} * 4.8) + (dW_{Lipid} * 9.45) and total energy density (ED) was calculated as EC / dW.

BCO-DMO Processing Description

- Converted original file "BCO-DMO-Datafile.xlsx" to CSV.
- Converted date columns to YYYY-MM-DD format.
- Renamed fields to comply with BCO-DMO naming conventions.
- Replaced the "#REF!" values on row 352 as specified by submitter ("Lean" = 2016.971; "Prop_Lean" = 68.2793152; "Kcal" = 13.68737; "ED" = 11.07392).
- Saved the final file as "965079_v1_juvenile_bsb_exp.csv".

Problem Description

A total of 10 individuals escaped their individual rearing containers over the course of the study. These are denoted as "jumped" in the notes column and there is no data associated with them. Further, proximate analyses were not conducted on experimental mortalities.

[table of contents | back to top]

Data Files

File
965079_v1_juvenile_bsb_exp.csv (Comma Separated Values (.csv), 94.04 KB) MD5:fa3187e2460623a804373fe4cb059183 Primary data file for dataset ID 965079, version 1

[table of contents | back to top]

Related Publications

Bioenergetics and Growth, vol. 8. (1979). Academic Press. https://www.sciencedirect.com/science/bookseries/15465098/8 https://isbnsearch.org/isbn/978-0-12-350408-1
Methods

Guo, L. W., Jordaan, A., Schultz, E. T., & McCormick, S. D. (2022). Identification of supraoptimal temperatures in juvenile blueback herring (Alosa aestivalis) using survival, growth rate and scaled energy reserves. Conservation Physiology, 10(1). https://doi.org/10.1093/conphys/coac022
Methods

Guo, L. W., McCormick, S. D., Schultz, E. T., & Jordaan, A. (2021). Direct and size-mediated effects of temperature and ration-dependent growth rates on energy reserves in juvenile anadromous alewives (Alosa pseudoharengus). Journal of Fish Biology, 99(4), 1236–1246. Portico. https://doi.org/10.1111/jfb.14824
Methods

Schultz, E. T., & Conover, D. O. (1997). Latitudinal differences in somatic energy storage: adaptive responses to seasonality in an estuarine fish (Atherinidae: Menidia menidia). Oecologia, 109(4), 516–529. https://doi.org/10.1007/s004420050112
Methods

Zavell MD, Mouland MEP, Barnum DF, Chen Z, Siedlecki S, O'Donnell J, De Vos M, Matassa CM, Schultz ET, & Baumann H. (In Prep). Experiments and ocean models predict diminishing benefits of offshore overwinter migration in northern stock black sea bass (Centropristis striata).
Results

Zavell, M. D., Mouland, M. E. P., Matassa, C. M., Schultz, E. T., & Baumann, H. (2023). Temperature- and ration-dependent winter growth in northern-stock Black Sea Bass juveniles. Transactions of the American Fisheries Society, 153(2), 163–179. https://doi.org/10.1002/tafs.10452
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Baumann, H., Zavell, M. D. (2024) **Adult Black Sea Bass (Centropristis striata) winter survival and lipid accumulation in wild-caught fish in Long Island Sound in Sept of 2022 to Apr of 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-23 doi:10.26008/1912/bco-dmo.938012.1 [view at BCO-DMO]

Baumann, H., Zavell, M. D. (2024) **Adult Black Sea Bass (Centropristis striata) winter survival and lipid accumulation under varying diet and temperature conditions from a laboratory mesocosm experiment (Oct 2022 to Apr 2023) with individuals collected in Long Island Sound.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-09-23 doi:10.26008/1912/bco-dmo.938004.1 [view at BCO-DMO]

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]

Zavell, M. D., Baumann, H. (2023) **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.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-07-18 doi:10.26008/1912/bco-dmo.897895.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Collection_Location	Site name; Mumford Cove, Groton, CT	unitless
Longitutde	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
Species	Species name; Black Sea Bass (Centropristis striata)	unitless
Collection_Date	Date of juvenile collection in the wild	unitless
Sample_Date	Date of juvenile sample	unitless
Time_Point	Time Point when fish were measured (0-7)	unitless
Month	Month of sample	unitless
Tank	Experimental Tank Identification (A-F)	unitless
BSB_ID	ID of each BSB individual	unitless
Mean_Temp	Mean temperature in each time point	degrees Celsius
SD_Temp	Standard Deviation of temperature in each time point	degrees Celsius
Days	Number of days since the beginning of the experiment	number of days

S_or_M	Denotes whether specimen survived (S) until the end of the experiment of was sampled before as a mortality (M)	unitless
Days_Alive	Number of days that a specimen was alive	number of days
TL_ini	Total length at each experiment time point	degrees Celsius
TL_final	Total length at experiment end	millimeters (mm)
wW_ini	Wet weight at each experiment time point	grams (g)
wW_final	Wet weight at experiment end	grams (g)
estdW_ini	Estimated dry weight at each time point (estdW = 0.0269 + wW_ini*0.2448)	grams (g)
dW_final	Dry weight of experiment survivors following freeze drying	grams (g)
estdW_final	Estimated dry weight of mortalities at time of death (estdW_final = 0.0269 _ wW_final*0.2448)	grams (g)
Days_Between_Measurements	Number of days between each time point	number of days
D_TL	Change in total length between time points	millimeters (mm)
D_wW	Change in wet weight between time points	grams (g)
SGR_wW	Specific growth rate in wet weight (SGR_wW = [ln(wW_final)-ln(wW_ini)]*100	percent per day (% d^-1)
GR	Absolute growth in total length (GR = [Δ TL_ini between time points] / Days_Between_Measurements)	millimeters per day (mm/d)
Lipid	Specimen lipid content	milligrams (mg)
Prop_Lipid	Lipid / dW_final * 100	percent (%)
Lean	Specimen protein (aka lean) content	milligrams (mg)

Prop_Lean	Lean / dW_final * 100	percent (%)
Ash	Specimen ash (aka inorganic) content	milligrams (mg)
Prop_Ash	Ash / dW_final *100	percent (%)
Kcal	Specimen caloric content (Kcal = [Lean*4.8] + [Lipid*9.45]	kilocalorie (kcal)
ED	Kcal / dW_final	Kcal per gram dW (Kcal gram dW ^-1)
Notes	Notes	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Soxhlet apparatus
Generic Instrument Name	Soxhlet extractor
Dataset-specific Description	Custom-designed Soxhlet apparatus for Lipid/Lean analyses
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 MX®)
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

Collaborative research: The genomic underpinnings of local adaptation despite gene flow along a coastal environmental cline (GenomAdapt)

Website: https://befel.marinesciences.uconn.edu/2018/03/07/research-news-new-nsf-grant-to-study-silverside-genes/

Coverage: Eastern coastline of North America

NSF Abstract:

Oceans are large, open habitats, and it was previously believed that their lack of obvious barriers to dispersal

would result in extensive mixing, preventing organisms from adapting genetically to particular habitats. It has recently become clear, however, that many marine species are subdivided into multiple populations that have evolved to thrive best under contrasting local environmental conditions. Nevertheless, we still know very little about the genomic mechanisms that enable divergent adaptations in the face of ongoing intermixing. This project focuses on the Atlantic silverside (Menidia menidia), a small estuarine fish that exhibits a remarkable degree of local adaptation in growth rates and a suite of other traits tightly associated with a climatic gradient across latitudes. Decades of prior lab and field studies have made Atlantic silverside one of the marine species for which we have the best understanding of evolutionary tradeoffs among traits and drivers of selection causing adaptive divergence. Yet, the underlying genomic basis is so far completely unknown. The investigators will integrate whole genome sequencing data from wild fish sampled across the distribution range with breeding experiments in the laboratory to decipher these genomic underpinnings. This will provide one of the most comprehensive assessments of the genomic basis for local adaptation in the oceans to date, thereby generating insights that are urgently needed for better predictions about how species can respond to rapid environmental change. The project will provide interdisciplinary training for a postdoc as well as two graduate and several undergraduate students from underrepresented minorities. The findings will also be leveraged to develop engaging teaching and outreach materials (e.g. a video documentary and popular science articles) to promote a better understanding of ecology, evolution, and local adaptation among science students and the general public.

The goal of the project is to characterize the genomic basis and architecture underlying local adaptation in M. menidia and examine how the adaptive divergence is shaped by varying levels of gene flow and maintained over ecological time scales. The project is organized into four interconnected components. Part 1 examines fine-scale spatial patterns of genomic differentiation along the adaptive cline to a) characterize the connectivity landscape, b) identify genomic regions under divergent selection, and c) deduce potential drivers and targets of selection by examining how allele frequencies vary in relation to environmental factors and biogeographic features. Part 2 maps key locally adapted traits to the genome to dissect their underlying genomic basis. Part 3 integrates patterns of variation in the wild (part 1) and the mapping of traits under controlled conditions (part 2) to a) examine how genomic architectures underlying local adaptation vary across gene flow regimes and b) elucidating the potential role of chromosomal rearrangements and other tight linkage among adaptive alleles in facilitating adaptation. Finally, part 4 examines dispersal - selection dynamics over seasonal time scales to a) infer how selection against migrants and their offspring maintains local adaptation despite homogenizing connectivity and b) validate candidate loci for local adaptation. Varying levels of gene flow across the species range create a natural experiment for testing general predictions about the genomic mechanisms that enable adaptive divergence in the face of gene flow. The findings will therefore have broad implications and will significantly advance our understanding of the role genomic architecture plays in modifying the gene flow - selection balance within coastal environments.

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.

[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

[table of contents | back to top]