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

Website: https://www.bco-dmo.org/dataset/938004
Data Type: experimental
Version: 1
Version Date: 2024-09-23

Project
» 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
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset contains measurements from a laboratory mesocosm experiment (Oct 2022 to Apr 2023) with adult Black Sea Bass (Centropristis striata) collected in Long Island Sound. Fish in this experiment were collected concurrently with fish sampled for a related wild-caught dataset (see 'Related Datasets' section). Study description: We experimentally examined overwintering potential of adult Black Sea Bass (Centropristis striata), an ecologically and economically important fish that seasonally migrates from offshore overwintering grounds to coastal feeding and nursery areas. We collected adults from Long Island Sound in September 2022 and reared them in a laboratory-mesocosm experiment under a contemporary seasonal temperature profile for Long Island Sound (LIS; October 2022 – April 2023) to assess their potential to survive and accumulate lipids throughout the winter. We also fed experimental adults two diet items (blue mussels and Atlantic herring), which are commonly found in Long Island Sound. In addition, we sampled fish from the same reef in LIS at the start (October) and end (April) of the experiment to identify lipid dynamics in wild fish that migrate offshore (see "Related Datasets" section for wild fish data). Experimental C. striata growth throughout the winter was negligible with high mortality (> 50% observed). While survivors fed herring had higher tissue lipid contents, mortality was 2x higher than for fish fed mussels. In contrast, to the experimental fish, wild-captured fish in the spring had higher gonadosmatic indices than that for survivors across both diet treatments, which was most similar to fall-captured fish. While some fish survived throughout the winter, current winter bottom temperatures still preclude a year-round C. striata presence within Long Island Sound. Overwintering inshore is still disadvantageous compared to seasonally migrating due to surviving experimental fish having lower gonadosomatic indices, suggesting that the offshore overwintering period is a time to build energy reserves. However, as coastal waters continue to warm, changing conditions could lead populations to become year-round residents of Long Island Sound, thus increasing C. striata abundance.

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- Funding

Coverage

Location: Long Island Sound; Northwest Atlantic shelf
Spatial Extent: **Lat**:41.3045 **Lon**:-71.9332
Temporal Extent: 2022-09-15 - 2023-04-28

Methods & Sampling

Experimental setup:

50 adult specimens were collected by boat off Stonington Borough, CT (41° 20’37.8” N 71° 54’51.4” W) between September 15th and October 10th, 2022. Individuals were collected via hook and line angling and were transported in aerated coolers to the Rankin seawater laboratory where adults were acclimated and equally split between two 3785-l tanks. Each tank was supplied with flowing, sand-filtered seawater from eastern LIS which naturally ranges in temperature from 25 to 4°C and a salinity between 28 to 33 ‰. Prior to the start of the experiment adults were fed previously frozen loligo squid (Seafreeze LLC, North Kingstown RI) 3× a week ad libitum.

Experimental design:

The adult experiment assessed the inshore overwintering potential of adult BSB under two distinct diets and a current inshore temperature regime for 200 days (October 10th, 2022, to April 28th, 2023). Following each specimen collection period, a subset of individuals was immediately euthanized with an overdose of MS-222 to act as a wild ‘pre-migratory’ baseline (‘fall’, n = 17) and dissected (“see methods in “Adult black sea bass winter survival and lipid dynamics: Wild fish”).

At the start of the experiment (October 10th, 2022) 50 specimens were briefly anesthetized, measured in length (TL = 32.8 ± 6.6 cm) and weight (wW = 514.7 ± 250), tagged with monofilament Floy-tags, and randomly allocated to one of two 3785-l tanks which was allocated a diet treatment; ‘mussels’ (Mytilus edulis; American Mussel Harvesters, North Kingston RI) and ‘herring’ (Clupea harrengus; Seafreeze ltd., North Kingston RI).

Fish were then fed 2% of the initial stocked biomass 3× a week throughout the experiment. Experimental tanks were flow-through (9060 l h-1), with conditions ambient to local LIS conditions and had a set of lights whose photoperiod was gradually changed weekly (11.5 h light: 12.5 h dark to 9 h light: 15 h dark and back up). Temperature was monitored in one tank by a Eureka Manta probe which recorded tank temperature every 30 minutes, while pH was monitored twice weekly via a handheld pH probe (Hach Handheld HQ40D), ammonia and salinity were measured once a week, and each tank was siphoned twice weekly to remove detritus. Over the course of the experiment there was no ammonia (0 ppm), while the mean pH and salinity were 8.04 ± 0.12 pH units and 31.8 ± 1.07 ‰, respectively.

Over the course of the experiment, fish were examined twice daily for mortalities or loss of equilibria. In the case of lost equilibria, specimens were immediately removed, euthanized with an overdose of MS-222, and dissected as previously described. Over the course of the experiment three individuals from the Herring diet treatment jumped overnight and weren’t included in subsequent analyses.

Since C. striata tend to have a high site-fidelity, beginning of April 2023, sampling occurred weekly on the same reef that the experimental and fall baseline specimens were collected on in order to collect ‘post-migratory’ baseline specimens (‘spring’, n = 21), upon their first entry into LIS (April 27th, 2023; see methods in “Adult black sea bass winter survival and lipid dynamics: Wild fish”). Specimens were immediately euthanized, measured, and dissected as previously described and the experiment ended the following day (April 28th, 2023). Upon ending the experiment all surviving specimens were measured for length (TL; 33.7 ± 4.4 cm), body depth (BD; 8 ± 0.9 cm), and wet weight (wW; 532.6 ± 227 g). During dissections, the stomach was removed to calculate a stomachless whole weight to standardize for consumed prey items, and the liver and gonad was then removed, individually weighed (0.01 g) and frozen at -20°C for future lipid extractions. A subsample of dorsally located white muscle tissue was also removed and frozen.

Response traits:

For experimental adults, we only calculated cumulative growth in length (GR), and specific growth rates (SGR).

For all adults, we calculated gonadosomatic (GSI; %) and hepatosomatic (HSI; %) indices using stomachless fish mass (wW – stomach mass), to standardize for stomach contents, as {e.g., 100 × [(gonad or liver mass, g) / (stomachless fish mass)].

We quantified gonad, liver, and white muscle, storage lipid, lean-mass, and ash weights of each surviving experimental individual and baseline specimen. Samples were frozen at -50°C for 1 week and remeasured for whole body dry weight (dWb, 0.001 g). Following published protocols (Schultz and Conover 1997, Guo et al. 2021, 2022, Zavell et al. 2023), dried specimens were loaded into preweighed Alundum medium-porosity extraction thimbles and transferred to a custom-designed Soxhlet apparatus, where they were bathed in petroleum ether for 3.5 h to extract all metabolically available lipids. Samples were then dried overnight (60°C) and re-measured, with the change in pre- and post-extraction weights (ΔdW), representing the storage-lipid fraction (dWLipid). Samples were then muffle furnaced for 4 h at 550°C and reweighed with ΔdW, representing the lean-mass fraction (dWLean) and the remaining mass represents the inorganic fraction (dWAsh).

Organism Identifier (LSID, Life Sciences Identifier)
Centropristis striata, urn:lsid:marinespecies.org:taxname:159348

Data Processing Description

See methods section.

BCO-DMO Processing Description

* Sheet "Experiment" of submitted file "Adult-BSB-Overwintering-Experiment-BCO-DMO-V4.xlsx" was imported into the BCO-DMO data system as the primary data table for this dataset. Sheet "Temperature" of file "Adult-BSB-Overwintering-Exp-BCO-DMO-V3.xlsx" was imported as a supplemental table.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Dates converted to ISO 8601 format
* Latitude and Longitude converted to decimal degree format (South and west are negative). example lon 71.9332°W to -71.9332

Problem Description

Three fish from the “Herring” diet treatment either jumped (n=2) or were cannibalized (n = 1), these fish were not included in any analyses in the subsequent publications.

Experimental mortalities were not worked up for lipid / lean analysis, resulting in the blanks within the “experiment” dataset.

The gonads from one experimental fish in the “mussel’ diet treatment (ID = 47) were lost prior to lipid / lean analysis resulting in the blanks within the “experiment” dataset.

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Data Files

File	
938004_v1_bsb-survival-lipids-experiment.csv	(Comma Separated Values (.csv), 12.89 KB) MD5:e1f92432005cb17bed74b2e938b5d5f9
Primary data file for dataset ID 938004, version 1. See supplemental file "Temperature (mesocosm experiment)" for additional temperature measurements taken during the experiment.	

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Supplemental Files

File	
Temperature (mesocosm experiment) filename: bsb-survival-lipids-mesocosm-temperature.csv	(Comma Separated Values (.csv), 4.70 KB) MD5:cf3eb7f6bd8ba62a60f7c908ff8aca85
Temperature measurements from the mesocosm experiment.	

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Related Publications

Fulton, T. W. "The Rate of Growth of Fishes. 20th Annual Report of the Fishery Board of Scotland." (1902): 326-446.
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

Ricker, W. E. (1975). Computation and interpretation of biological statistics of fish populations. Fish. Res. Board Can. Bull., 191, 1-382.
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, 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. Portico. https://doi.org/10.1002/tafs.10452
Methods

Zavell, M.D., Mouland, E.P., Barnum, D.L., Matassa, C.M., Schultz, E.T., and Baumann, H. (Submitted). Can adult Black Sea Bass overwinter in Long Island Sound, USA? Submitted to Marine and Coastal Fisheries
Results

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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]
Relationship Description: Data from the same study. Fish were collected from the same reef.

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Parameters

Parameter	Description	Units
Species	Black Sea Bass - Centropristis striata. LSID: urn:lsid:marinespecies.org:taxname:159348	unitless
Collection_Location	Stonington Borough, CT	unitless
Collection_Longitude	Longitude of collection site (Stonington Borough)	decimal degrees
Collection_Latitude	Latitude of collection site (Stonington Borough)	decimal degrees
Collection_Date	Date of fish collection in the wild	unitless
Fish_ID	ID of each individual fish	unitless
Treatment	Diet treatment (Mussels or Herring)	unitless
Exp_Start_Date	Date of experiment start	unitless
Exp_End_Date	Date of Experiment end	unitless
Mortality_Date	Date of an individual mortality	unitless
Total_Exp_Duration	Total duration of the experiment	days
Num_of_Days_Alive	Number of days an individual was alive	days
Survivor_or_Mortality	Denotes whether an individual survived (s) until the end of the experiment (200 days) or was a mortality (m) prior to the end of the expirement	unitless
TL0	Total length at experiment start	centimenter (cm)
TLF	Total length at at experiment end	centimenter (cm)

wW0	Whole body wet weight at experiment start	grams (g)
wWF	Whole body wet weight at experiment end	grams (g)
GR_mm	Total length growth rate	millimeters per day (ml/day)
SGR	Weight-specific growth rate	percent (%) per day
Kwet0	Fulton's condition index using wet weight at experiment start. Kwet0 = (wW0 / TL0^3)*100 (see Fulton, TW (1902); Ricker, WE (1975))	grams per cubic centimeter(g/cm3)
KwetF	Fulton's condition index using wet weight at experiment end. KwetF = (wWF / TLF^3)*100 (see Fulton, TW (1902); Ricker, WE (1975)).	grams per cubic centimeter(g/cm3)
stomach_wW	Stomach weight at at experiment end	grams (g)
stomachless_wW	Stomachless weight at experiment end (wWF - Stomach_wW)	grams (g)
stomach_content_wW	Weight of stomach contants	grams (g)
gonad_wW	Gonad wet weight at experiment end	grams (g)
gonad_dW	Gonad dry weight at experiment end	grams (g)
liver_wW	Liver wet weight at experiment end	grams (g)
liver_dW	Liver dry weight at experiment end	grams (g)
w_muscle_sub_dW	Dry weight of the subsample of white muscle used to run lipid and lean analysis	grams (g)
Sex	Sex via visual observation of the gonads (M = male, F = female, U = unknown)	unitless
GSI	Gonadosomatic Index (gonad_wW / wWF *100)	percent (%)
HSI	Hepatosomatic Index (liver_wW / wWF *100)	percent (%)

gonad_lipid_g	Total gonad lipid content	grams (g)
gonad_lean_g	Total gonad lean content	grams (g)
liver_lipid_g	Total liver lipid content	grams (g)
liver_lean_g	Total liver lean content	grams (g)
P_gonad_lipid	Percent gonad lipid content (gonad_lipid_g /gonad_dW*100)	percent (%)
P_gonad_lean	Percent gonad lean content (gonad_lean_g/gonad_dW*100)	percent (%)
P_liver_lipd	Percent liver lipid content (liver_lipid_g /liver_dW*100)	percent (%)
P_liver_lean	Percent liver lean content (liver_lean_g/liver_dW*100)	percent (%)
w_muscle_lipid_g	Total white muscle lipid in subsample	grams (g)
w_muscle_lean_g	Total white muscle lean in subsample	grams (g)
p_w_muscle_lip	Percent white muscle lipid content (w_muscle_lipid_g/w_muscle_sub_dW*100)	percent (%)
p_w_muscle_lean	Percent white muscle lean content (w_muscle_lean_g/w_muscle_sub_dW*100)	percent (%)
Notes	Notes	unitless

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Instruments

Dataset-specific Instrument Name	Hach Handheld pH and Temperature probe (HQ2200 Multi/2 Channel)
Generic Instrument Name	Multi Parameter Portable Meter
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

Dataset-specific Instrument Name	Mettler Toledo Balance (XPR1202S)
Generic Instrument Name	scale
Generic Instrument Description	An instrument used to measure weight or mass.

Dataset-specific Instrument Name	
Generic Instrument Name	Soxhlet extractor
Dataset-specific Description	Custom-designed Soxhlet apparatus for Lipid/Lean analyzes – UConn Storrs – self designed and assembled
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 Pendant MX Water Temperature Data Logger
Generic Instrument Name	Temperature Logger
Generic Instrument Description	Records temperature data over a period of time.

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Project Information

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.

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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

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