Eye lens chemistry of Lake Erie fishes (goby and perch) collected June to October 2019 for Project Breathless

Website: https://www.bco-dmo.org/dataset/982386
Version: 1
Version Date: 2025-08-12

Project
» Collaborative Research: Shifting the Hypoxia Paradigm – New Directions to Explore the Spread and Impacts of Ocean/Great Lakes Deoxygenation (HypoxiDigm / Project Breathless)

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Abstract
This dataset contains Lake Erie fish eye lens chemistry from round goby (Neogobius melanostomus) and yellow perch (Perca flavescens) collected in 2019 for Project Breathless. Lake Erie in the Laurentian Great Lakes is one of the study systems for the project since the Central Basin is chronically hypoxic, whereas the Western Basin is largely normoxic. We have been studying round goby, a bottom-dwelling (benthic) fish species, and yellow perch, a demersal (low water column) species.

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Coverage

Location: Lake Erie central and western basins
Spatial Extent: **N**:42.00286 **E**:-80.58483 **S**:41.47523 **W**:-83.2636
Temporal Extent: 2019-06-08 - 2019-10-19

Dataset Description

This dataset is part of Project Breathless, which brings together an interdisciplinary team of ecologists, economists and communication scholars to increase understanding of the impact of low oxygen dead zones in lakes and oceans. The project team focuses on how low oxygen conditions influence fish, their habitats and the food webs that support them, as well as ecosystem services, including fisheries production.

This dataset is one of three examining Lake Erie fishes using data collected during routine surveys for monitoring the status of fish stocks:

- Dataset 982348 (Lake Erie fishes capture data) summarizes capture data as well as basic biological information; it also includes all stable isotopic ratio and total mercury data collected from muscle tissue and eye lenses.
- Dataset 982372 (Lake Erie fishes otolith chemistry) contains all of the Lake Erie fish (round goby and yellow perch) otolith chemistry data.
- **Dataset 982386 (this dataset of Lake Erie fishes eye lens chemistry)** contains all of the eye lens chemistry data for round goby and yellow perch.

(See Related Datasets section below for links)

Methods & Sampling

Fish sampling, basic biological data, and tissues collection

Fish samples were provided from routine monitoring surveys by the Ohio Department of Natural Resources (Fairport Harbor, OH) and by the USGS Lake Erie Biological Station (Sandusky, OH). Dates and locations of trawling are provided. Fish were caught by trawl or by gillnet sets. Fish were frozen for later processing.

In the lab, fish were measured (length, weight); sex was determined if possible. Otoliths and eye lenses were removed, cleaned, and stored dry until workup. Samples of dorsal muscle tissue were collected (away from the skin) for mercury and stable isotope analysis and were dried to constant weight, then freeze-dried.

Eye lens preparation and analysis

Similar to otoliths, eye lenses were cleaned (by gentle rolling on a sponge or paper towel) then air-dried. One lens from each fish was embedded in Struers EpoFix epoxy and subsequently sectioned to expose the core. Trace elemental concentrations were quantified via laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) at SUNY ESF. The surfaces of lenses were ablated by a 193 nm Teledyne CETAC Analyte Excite Excimer Laser Ablation System which was coupled to a Thermo iCAP TQ ICPMS instrument. by running a laser ablation transect across the polished sections from one edge to the other; the ablated material was swept via a helium carrier gas into an argon plasma, which ionized the material that was subsequently counted by a mass spectrometer in single-quadrupole mode. Samples were sectioned and polished to expose the interior cores; analyses were made by running the laser across the surface from one edge, through the core, and out on an intact axis to complete the edge-to-edge analysis. (Lenses have a tendency to crack, so it was not always possible to run the laser straight across the lens; but since lenses grow radially, it is possible to select another axis to continue the transect.) Only the most intact axis (core to outer edge) was selected for this archival dataset.

Eye lenses were analyzed with a laser spot of 110 microns, at scan speed of 4 microns/second and 10 Hz repetition rate, and with a fluence of 0.9 J/cm^2 to account for the softer material compared to otoliths. A material-appropriate standard, DORM-4 protein standard, National Research Council of Canada, Certified Reference Material (Willie et al., 2012) was run at the start and end of the run, and then periodically during each analysis day to calibrate and correct for instrument drift.

Eye lenses were analyzed for total mercury which is expressed in nanograms per gram dry weight. Distances are expressed as micrometers from the core, but also normalized to 1 so that they can be compared to the otoliths **(not normalized to 1, but can be done by a user). [??]**

Data Processing Description

Otolith and eye lens trace elemental data were processed in Excel files. Calibrations made over the course of the day were fit to plots of the calibrants as a function of time to produce drift corrections. Processing of the raw data included removal of spurious spikes (> 2 SD) and subsequent interpolation. Raw data were then calibrated and drift-corrected simultaneously, to produce data as parts per million.

BCO-DMO Curation Notes

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Problem Description

The workflow was slowed down considerably by the Covid-19 pandemic. The LA-ICP-MS system was turned off for four months at the beginning of the outbreak, and it was difficult to get it running smoothly for a while. However, after that it ran well, with periodic service or preventive maintenance calls. Quality flags consisted of running standards and monitoring RSD values, as well as calculating limits of detection.

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Related Publications

Willie, S., Brophy, C., Clancy, V., Lam, J., Sturgeon, R., & Yang, L. (2012). DORM-4: Fish protein certified reference material for trace metals (Version 1). National Research Council of Canada. https://doi.org/10.4224/CRM.2012.DORM-4 https://doi.org/10.4224/crm.2012.dorm-4
Methods

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Related Datasets

IsRelatedTo

Limburg, K., Razavi, R., Miraly, H., Duskey, E., Kraus, R., Gorman, A. (2025) **Otolith chemistry of Lake Erie fishes (goby and perch) collected June to October 2019 for Project Breathless.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-08-12 http://lod.bco-dmo.org/id/dataset/982372 [view at BCO-DMO]

Limburg, K., Razavi, R., Miraly, H., Duskey, E., Kraus, R., Gorman, A. (2025) **Stable isotope analyses, mercury measurements, and capture data from two Lake Erie fish species collected from June to October 2019 for Project Breathless.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-08-12 http://lod.bco-dmo.org/id/dataset/982348 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Fish_ID	Unique fish sample identification	unitless
Species	Scientific name of the collected fish	unitless
Water_Body	Water body in this study system	unitless
CRN	Cruise number for the collecting trip, either Ohio Dept of Natural Resources (OHDNR) or the US Geological Survey (USGS)	unitless
Basin	Indicates which basin in Lake Erie was sampled (Central Basin or Western Basin)	unitless
Lake_Erie_Sampling_Grid	Number for the sample location based on the sampling grid laid out by New York, Pennsylvania, and Ohio fisheries agencies	unitless
Latitude_mid	Latitude for the midpoint of the trawl survey	decimal degrees
Longitude_mid	Longitude of trawl (either midpoint or start)	decimal degrees
Year	Year of collection	year
Date_Collection	Date of collection	unitless
Eye_lens_distance_from_core	Distance along analytical transect from the center of the eye lens	micrometers (um)
Proportion_of_total_lens	Eye lens distance normalized to 1	unitless
Eye_lens_Hg	Total mercury concentration of the fish eye lens	nanograms per gram dry weight (ng/g dw)
Agency_ID	Fish ID for OH-DNR or USGS	unitless

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Instruments

Dataset-specific Instrument Name	NC2500 Elemental Analyzer
Generic Instrument Name	Carlo Erba NC 2500 elemental analyzer
Dataset-specific Description	At Cornell, an isotope ratio mass spectrometer was interfaced to a NC2500 elemental analyzer (EA).
Generic Instrument Description	A laboratory instrument that simultaneously determines total nitrogen, total hydrogen, and total carbon in a solid sample. The sample is completely and instantaneously oxidized by flash combustion, which converts all organic and inorganic substances into combustion products. The resulting combustion gases pass through a reduction furnace and are swept into the chromatographic column by the helium carrier gas. The gases are separated in the column and quantified or they can be introduced into another instrument, such as an isotope ratio mass spectrometer, for further analysis. The instrument was originally manufactured by CE instruments (formerly Carlo Erba) and has since been replaced by Thermo Scientific (part of Thermo Fisher Scientific). This model is no longer in production.

Dataset-specific Instrument Name	Milestone DMA-80 tri-cell unit atomic absorption spectrophotometer
Generic Instrument Name	Milestone Direct Mercury Analyzer
Dataset-specific Description	Mercury analyses of tissues were made with a Milestone DMA-80 tri-cell unit atomic absorption spectrophotometer.
Generic Instrument Description	The Milestone DMA-80 is a mercury analyzer used to determine mercury concentrations in liquid and solid samples. The DMA-80 is based on the principles of sample thermal decomposition, mercury amalgamation, and atomic absorption detection. See more: https://milestonesci.com/direct-mercury-analyzer/

Dataset-specific Instrument Name	PDZ Europa 20-20 isotope ratio mass spectrometer
Generic Instrument Name	PDZ Europa 20-20 isotope ratio mass spectrometer
Dataset-specific Description	Light stable isotopes of C and N were analyzed at UC Davis with elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK).
Generic Instrument Description	The PDZ Europa 20-20 is a dedicated continuous flow isotope ratio mass spectrometer for hyphenated stable isotope analyses able to measure 15N, 13C, 18O, and 34S in a host of applications. The analyzer has been purposely designed to measure 2H by continuous flow methodology and is also suitable to analyze the light stable isotopes in all the commonly measured gases: H2, N2, NO, N2O, O2, CO, CO2, SO, and SO2.

Dataset-specific Instrument Name	PDZ Europa ANCA-GSL elemental analyzer
Generic Instrument Name	PDZ Europa ANCA-GSL elemental analyzer
Dataset-specific Description	Light stable isotopes of C and N were analyzed at UC Davis with PDZ Europa ANCA-GSL elemental analyzer interfaced to an isotope ratio mass spectrometer.
Generic Instrument Description	The ANCA-GSL module allows samples such as soil, viscous liquids, plant material, and organic compounds, to be analyzed directly by using Dumas combustion for 15N, 13C, and 34S or pyrolysis for 18O and D. It also allows isotope analysis of abundant gases from septum sealed containers. During combustion mode, a capsule containing the sample falls into the combustion tube and is converted in the presence of oxygen to CO2, N2, NOx, and H2O. An elemental copper stage reduces NOx, a MgClO4 trap removes water vapor, a switchable Carbosorb trap can be used to remove CO2 (for 15N only analyses) and a GC column separates CO2 from N2 (allowing dual isotope analysis). Modified packings, a Nafion dryer and different GC column allow 34S analysis. The sample preparation unit consists of a 66-place autosampler for unattended operation (larger options are available), 2 furnaces able to operate to 1100 deg C, and an on-board microprocessor. The analyzer is capable of dual isotope analysis of 15N and 13C. For CO (18O), H2 (2H), N2 (15N), CO2 (13C), CO2 (18O), and SO2 (34S) with precisions between 0.1 and 3 dependent on the element.

Dataset-specific Instrument Name	Thermo Delta V isotope ratio mass spectrometer (IRMS)
Generic Instrument Name	Thermo Fisher Scientific DELTA V Advantage isotope ratio mass spectrometer
Dataset-specific Description	At Cornell, a Thermo Delta V isotope ratio mass spectrometer (IRMS) is interfaced to an elemental analyzer.
Generic Instrument Description	The Thermo Scientific DELTA V Advantage is an isotope ratio mass spectrometer designed to measure isotopic, elemental, and molecular ratios of organic and inorganic compounds. The DELTA V Advantage is the standard model of the DELTA V series of isotope ratio mass spectrometers, which can be upgraded to the DELTA V Plus. The DELTA V Advantage can be operated in Continuous Flow or Dual Inlet mode. The standard collector configuration is the Universal Triple Collector. H2 collectors with online hydrogen capability are optional. The DELTA V Advantage is controlled by an automated, integrated Isodat software suite. A magnet, whose pole faces determine the free flight space for the ions, eliminates the traditional flight tube. The magnet is designed for fast mass switching which is further supported by a fast jump control between consecutive measurements of multiple gases within one run. The sample gas is introduced at ground potential, eliminating the need for insulation of the flow path, ensuring 100 percent transfer into the ion source. The amplifiers register ion beams up to 50 V. The DELTA V Advantage has a sensitivity of 1200 molecules per ion (M/I) in Dual Inlet mode and 1500 M/I in Continuous Flow mode. It has a system stability of < 10 ppm and an effective magnetic detection radius of 191 nm. It has a mass range of 1 - 80 Dalton at 3 kV.

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Project Information

Collaborative Research: Shifting the Hypoxia Paradigm – New Directions to Explore the Spread and Impacts of Ocean/Great Lakes Deoxygenation (HypoxiDigm / Project Breathless)

Coverage: Central Baltic Sea; Lake Erie; and Lavaca Bay, Texas

NSF Award Abstract:
Ocean oxygen loss (deoxygenation) is increasing due to climate warming. This warming, together with nutrient loading, is causing many marine and freshwater systems to experience increasing episodes of hypoxia (low oxygen) of greater duration and intensity. Impacts on fish and fisheries have been difficult to quantify; direct observation has been challenged by a lack of long-term exposure indicators. This team has successfully refined the use of fish chemical biomarkers in fish otoliths (earstones) to directly assess lifetime hypoxia exposure in fishes. This project will those findings to look for additional biomarkers and models, to expand our understanding of how hypoxia affects fish and their food webs, contaminant transfers, and ecosystem services including economic impacts. The project includes a unique way of training students in science communication, posing the question: What forms of media and "messaging strategies" about deoxygenation are most effective at raising public awareness and understanding? Students are developing entries for PlanetForward's Storyfest, which is a contest to tell compelling stories to foster environmental understanding and solutions. Students from historically underrepresented, economically disadvantaged backgrounds are particularly sought out to participate. The investigators will engage with regional, national, and international management agencies and other relevant stakeholder groups to share information.

This project encompasses a novel, linked set of interdisciplinary studies of food webs, and ecosystem services assessment. The thematic questions explored in this project are: 1. How does hypoxia alter habitat use for fishes? 2. How does hypoxia-altered habitat use and habitat productivity change food webs? 3. How does hypoxia affect/enhance trophic transfer of methylmercury? 4. How do hypoxia-induced changes in food webs affect aquatic ecosystem services? The set of linked studies will employ chemical analyses of otoliths and eye lenses, combined with chemical analyses of muscle tissues (Questions 1 and 3), physiologically-structured food web modeling informed by monitoring time-series (Questions 2 and 4), and a scoping workshop to address ecosystem services (Question 4). The investigators are using a "trans-basin" comparative approach to system-specific responses, studying fishes in Lake Erie, the Baltic Sea, and a Gulf of Mexico estuary. They study three species from each system that represent different degrees of benthic reliance, to discern differential responses to the increasingly hypoxic environment. This research provides novel insight about variable biotic responses to oxygen loss and the impacts on ecosystem functioning.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1923965

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