

# Experimental results: Temporal CO<sub>2</sub>-sensitivity in *Menidia menidia*; conducted at Southampton Marine Station from 2011-2015

**Website:** <https://www.bco-dmo.org/dataset/551998>

**Version:** 24 Feb 2015

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## Project

» [Will rising pCO<sub>2</sub> levels in the ocean affect growth and survival of marine fish early life stages?](#) (OA Fish)

Contributors	Affiliation	Role
<a href="#">Baumann, Hannes</a>	University of Connecticut (UConn)	Principal Investigator, Contact
<a href="#">Gobler, Christopher</a>	Stony Brook University - SoMAS (SUNY-SB SoMAS)	Co-Principal Investigator
<a href="#">Rauch, Shannon</a>	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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## Dataset Description

The investigators used a novel experimental approach that combined bi-weekly sampling of a wild, spawning fish population (Atlantic silverside *Menidia menidia*) with standardized offspring CO<sub>2</sub> exposure experiments and parallel pH monitoring of a coastal ecosystem. They assessed whether offspring produced at different times of the spawning season (April to July) would be similarly susceptible to elevated (1100 uatm, pH<sub>NIST</sub> = 7.77) and high CO<sub>2</sub> levels (2300 uatm, pH<sub>NIST</sub> = 7.47). Early in the season (April), high CO<sub>2</sub> levels significantly ( $p < 0.05$ ) reduced fish survival by 54% (2012) and 33% (2013) and reduced 1 to 10 d post-hatch growth by 17% relative to ambient conditions. However, offspring from parents collected later in the season became increasingly CO<sub>2</sub>-tolerant until, by mid-May, offspring survival was equally high at all CO<sub>2</sub> levels.

This dataset provides the source data to:

Murray, Christopher S; Malvezzi, Alex; Gobler, Christopher J; Baumann, Hannes. 2014. Offspring sensitivity to ocean acidification changes seasonally in a coastal marine fish. Marine Ecology Progress Series, 504, 1-11, [doi:10.3354/meps10791](https://doi.org/10.3354/meps10791)

Note: This dataset has also been contributed to Pangaea and can be found at <http://doi.pangaea.de/10.1594/PANGAEA.838990>

## Methods & Sampling

Refer to the Methods section of:

Murray, Christopher S; Malvezzi, Alex; Gobler, Christopher J; Baumann, Hannes. 2014. Offspring sensitivity to ocean acidification changes seasonally in a coastal marine fish. Marine Ecology Progress Series, 504, 1-11, [doi:10.3354/meps10791](https://doi.org/10.3354/meps10791)

## Data Processing Description

BCO-DMO Processing:

- Modified parameter names to conform with BCO-DMO naming conventions.
- Replaced spaces with underscores.
- Replaced "Menidia menidia (fish)" with "Menidia menidia" in the species column.

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## Data Files

File
<b>CO2_sensitivity_M_menidia.csv</b> (Comma Separated Values (.csv), 4.08 KB) MD5:43195ff0d0f322916ebbe3da3ffc0b58
Primary data file for dataset ID 551998

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## Parameters

Parameter	Description	Units
species	Name of the species.	unitless
experiment	Experiment number/description.	unitless
date	Date of fertilization in mm/dd/yyyy format.	unitless
treatment	Treatment type.	unitless
replicates	Number of replicates.	unitless
survival_fert_to_1d	Survival rate (%) from fertilization date to 1 day post hatch (dph).	percent (%)
survival_stderr_fert_to_1d	Standard error of survival rate (%) from fertilization date to 1 day post hatch (dph).	+/- percent (%)
survival_1_to_10d	Survival rate (%) from 1 to 10 days post hatch (dph).	percent (%)
survival_stderr_1_to_10d	Standard error of survival rate (%) from 1 to 10 days post hatch (dph).	+/- percent (%)

survival_fert_to_10d	Survival rate (%) from fertilization date to 10 dph.	percent (%)
survival_stderr_fert_to_10d	Standard error of survival rate (%) from fertilization date to 10 dph.	+/- percent (%)
length_1dph	Standard length at 1 dph.	millimeters (mm)
length_stderr_1dph	Standard error of standard length at 1 dph.	+/- millimeters (mm)
length_10dph	Standard length at 10 dph.	millimeters (mm)
length_stderr_10dph	Standard error of standard length at 10 dph.	+/- millimeters (mm)
growth_rate	Growth rate from 1 to 10 dph.	millimeters per day (mm/day)
growth_rate_stderr	Standard error of growth rate from 1 to 10 dph.	+/- millimeters per day (mm/day)
temp	Water temperature.	degrees C
sal	Salinity.	?
pH	pH.	pH on the NBS scale
ph_stddev	Standard deviation of pH.	pH on the NBS scale
pCO2	Partial pressure of carbon dioxide (water) at sea surface temperature (wet air). Calculated using CO2SYS (URI: <a href="http://cdiac.ornl.gov/oceans/co2rpert.html">http://cdiac.ornl.gov/oceans/co2rpert.html</a> ).	microatmospheres (uatm)
DIC	Dissolved inorganic Carbon. Determined by Coulometric titration.	micromoles per kilogram (umol/kg)
TALK	Total alkalinity. Calculated using CO2SYS (URI: <a href="http://cdiac.ornl.gov/oceans/co2rpert.html">http://cdiac.ornl.gov/oceans/co2rpert.html</a> ).	micromoles per kilogram (umol/kg)

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## Deployments

lab\_Baumann\_Gobler\_FP

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/551842">https://www.bco-dmo.org/deployment/551842</a>
<b>Platform</b>	Flax Pond Marine Lab
<b>Start Date</b>	2011-09-01
<b>End Date</b>	2015-02-01

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## Project Information

### Will rising pCO<sub>2</sub> levels in the ocean affect growth and survival of marine fish early life stages? (OA Fish)

**Coverage:** Long Island Sound, Shinnecock Bay, Long Island, NY

#### *Description from NSF award abstract:*

Ocean acidification has the potential to affect a broad spectrum of marine organisms and thereby transform the composition and function of our oceans. In contrast to calcifying marine invertebrates, marine fish are widely believed to be unaffected by the CO<sub>2</sub> concentrations projected for the future. While this may be so for juvenile and adult fish stages, the fate of fish embryos and larvae in high CO<sub>2</sub> oceans is less certain as CO<sub>2</sub>-sensitivity data for these stages are largely unavailable. Recognizing this knowledge gap and inspired by the findings of two recent studies on clownfish and sea bass larvae (Munday et al. PNAS 107 (2010); Checkley et al. Science 324 (2009)), the investigators performed a series of experiments exposing eggs and early larvae of inland silversides (*Menidia beryllina*) to elevated CO<sub>2</sub> levels while strictly adhering to current "best practice" guidelines for ocean acidification research. At 1,000 ppm CO<sub>2</sub>, average *M. beryllina* survival ~1wk post-hatch significantly and consistently (five experiments) declined by ~75% compared to current day CO<sub>2</sub> levels (390 ppm), while average length of newly hatched larvae decreased by 22%. Together with prior studies, these results suggest a surprisingly high susceptibility of fish early life stages to the CO<sub>2</sub> increases that are projected to occur this century. Given that the abundance of many fish stocks, including most commercial species, is often regulated by processes affecting early life history growth and survival, ocean acidification may impact the dynamics of future fish populations and become yet another challenge to sustainable fisheries.

The investigators believe that there is now a pressing need to better understand how CO<sub>2</sub> affects the viability of fish embryos and larvae in the ocean. This requires novel approaches involving longer-term, larger-scale experiments across multiple species. The investigators will comprehensively examine the impacts of current and future CO<sub>2</sub> levels (400 - 1,000 ppm) during the egg and larval stages of three model fish species: Atlantic silversides (*M. menidia*), inland silversides (*M. beryllina*) and sheepshead minnows (*Cyprinodon variegatus*). They will also investigate populations of the same species (*M. menidia*) from differing latitudes. These species/populations are ecologically important due to their intermediate trophic position, have comparable life histories to commercial marine fish, offer differences in genetic growth capacity and presumed sensitivity, and are highly amenable to laboratory experimentation. Survival and growth (weight- and length-based) will be measured in experiments performed at different CO<sub>2</sub>, temperature (21, 27°C) and feeding conditions (low, ad libitum), thus permitting the affects of CO<sub>2</sub> to be considered in parallel with thermal stress and food limitation. Quantification of feeding rates, gross growth efficiency, and oxygen consumption will characterize the physiological costs of high CO<sub>2</sub> environments. Changes in calcification of larval fish otoliths and skeletal elements will be determined from weights and a Ca45 radiotracer approach. Finally, surviving *M. menidia* (or *M. beryllina*) will be reared to maturity and their offspring will be challenged with differing levels of CO<sub>2</sub>. Repeating this approach over several generations will demonstrate the extent to which CO<sub>2</sub> resistance may evolve through natural selection. Collectively, this study will make significant advances toward understanding how ocean acidification may challenge the world's most valuable marine resource, fish.

Note that PI Hannes Baumann has since moved to the University of Connecticut. See his [current contact information](#).

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1129622</a>

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