Seawater carbonate chemistry, and length and survival of Menidia beryllina during experiments conducted at Southampton Marine Station from 2011-2015

Website: https://www.bco-dmo.org/dataset/552111
Version: 25 Feb 2015
Version Date: 2015-02-25

Project
» Will rising pCO2 levels in the ocean affect growth and survival of marine fish early life stages? (OA Fish)

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

Table of Contents

Dataset Description

The investigators show that the exposure of early life stages of a common estuarine fish (*Menidia beryllina*) to CO2 concentrations expected in the world's oceans later this century caused severely reduced survival and growth rates. When compared with present-day CO2 levels (~400 ppm), exposure of *M. beryllina* embryos to ~1,000 ppm until one week post-hatch reduced average survival and length by 74% and 18%, respectively. The egg stage was significantly more vulnerable to high CO2-induced mortality than the post-hatch larval stage.

This dataset provides the source data to:
Baumann, Hannes; Talmage, Stephanie C; Gobler, Christopher J. 2012. Reduced early life growth and survival in a fish in direct response to increased carbon dioxide. *Nature Climate Change*, 2, 38-41, doi:10.1038/nclimate1291

Note: This dataset has also been contributed to Pangaea and can be found at http://doi.pangaea.de/10.1594/PANGAEA.773850

Methods & Sampling

Refer to the Methods section of:
Baumann, Hannes; Talmage, Stephanie C; Gobler, Christopher J. 2012. Reduced early life growth and survival in a fish in direct response to increased carbon dioxide. *Nature Climate Change*, 2, 38-41, doi:10.1038/nclimate1291

Data Processing Description

BCO-DMO Processing:
- Modified parameter names to conform with BCO-DMO naming conventions.
- Replaced spaces with underscores.
- Replaced blanks (missing data) with 'nd' to indicate 'no data'.

[table of contents | back to top]

Data Files

File
carbonate_chem.csv (Comma Separated Values (.csv), 7.79 KB) MD5:2175664fddc8d9b21bbcbd6b351da31a Primary data file for dataset ID 552111

[table of contents | back to top]

Parameters

Parameter	Description	Units
experiment	Experiment number/description.	unitless
sal	Salinity.	psu
sal_stddev	Standard deviation of salinity.	psu
temp	Water temperature.	degrees Celsius
temp_stddev	Standard deviation of temperature.	degrees Celsius
treatment	Treatment type.	unitless
sample_id	Sample identification number.	unitless
survival	Survival rate.	percent (%)
length	Length of Menidia beryllina; weighed mean.	millimeters (mm)
length_stddev	Standard deviation of length of Menidia beryllina.	millimeters (mm)
pH_orion	pH measured by Orion pH meter; in micromoles per liter.	NBS scale; H+ ions in umol/l
pH_orion_stddev	Standard deviation of pH measured by Orion pH meter.	NBS scale; H+ ions in umol/l
pH	pH; in micromoles per kilogram.	NBS scale; H+ ions in umol/kg
pCO2	Partial pressure of carbon dioxide (water) at sea surface temperature (wet air); Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	microatmospheres (uatm)
pCO2_stddev	Standard deviation of the partial pressure of carbon dioxide (water) at sea surface temperature (wet air).	microatmospheres (uatm)
omega_Cal	Calcite saturation state; Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	unitless
omega_Cal_stddev	Standard deviation of calciate saturation state.	unitless
omega_Arg	Aragonite saturation state; Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	unitless
omega_Arg_stddev	Standard deviation of aragonite saturation state.	unitless
DIC	Dissolved inorganic carbon.	micromoles per liter (umol/l)
TIC_stddev	Standard deviation of total inorganic carbon.	micromoles per liter (umol/l)
C_tot	Total carbon.	micromoles per kilogram (umol/kg)
carbonate	Carbonate ion concentration; Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	micromoles per liter (umol/l)
carbonate_stddev	Standard deviation of carbonate ion concentration.	micromoles per liter (umol/l)
TALK_mmol	Total alkalinity; Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html).	millimoles per liter (mmol(eq)/l)
TALK_mmol_stddev	Standard deviation of total alkalinity (TALK_mmol).	millimoles per liter (mmol(eq)/l)
TALK_umol	Total alkalinity; Calculated using CO2SYS (URI: http://cdiac.ornl.gov/oceans/co2rprt.html) from mean pH and DIC.	micromoles per kilogram (umol/kg)

[table of contents | back to top]

Deployments

lab_Baumann_Gobler_SMS

Website	https://www.bco-dmo.org/deployment/551848
Platform	Southampton Marine Station
Start Date	2011-09-01
End Date	2015-02-01

[table of contents | back to top]

Project Information

Will rising pCO2 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 CO2 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 CO2 oceans is less certain as CO2-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 CO2 levels while strictly adhering to current "best practice" guidelines for ocean acidification research. At 1,000 ppm CO2, average *M. beryllina* survival ~1wk post-hatch significantly and consistently (five experiments) declined by ~75% compared to current day CO2 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 CO2 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 CO2 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 CO2 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 CO2, temperature (21, 27°C) and feeding conditions (low, ad libitum), thus permitting the affects of CO2 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 CO2 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 CO2. Repeating this approach over several generations will demonstrate the extent to which CO2 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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1129622

[table of contents | back to top]