Carbonate chemistry analyses of water collected from near Walpole, ME from zooplankton hatching experiments during 2011

Website: https://www.bco-dmo.org/dataset/3816
Data Type: experimental
Version: 2016-06-05 (V2)
Version Date: 2016-05-26

Project
» Ocean Acidification-Category 1- Impact of ocean acidification on survival of early life stages of planktonic copepods in the genus Calanus in the northern (OA Calanus Survival)

Programs
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Ocean Carbon and Biogeochemistry (OCB)

Contributors	Affiliation	Role
Christensen, John P	Green Eyes LLC	Principal Investigator
Kinkade, Danie	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Coverage

Spatial Extent: **Lat**:43.8 **Lon**:-69.55
Temporal Extent: 2011-05-27 - 2012-07-31

Dataset Description

Previous version date: 2012.12.06

Updated files and metadata from J. Christensen sent on 2015.05.26:

Previous file has been removed and metadata has been updated to reflect new report content. The following text is an excerpt from the summary included in the *Technical Report #15-009 linked under 'Acquisition description':*

Experiments were conducted to test whether reduced pH of the ocean waters would negatively affect the hatching success of several zooplankton species found in northern ocean waters. These experiments were performed at the Darling Marine Center of the University of Maine, using local seawaters (salinities > 30). Each experiment consisted of incubating fresh zooplankton eggs in several 20L seawater tanks at constant temperature for periods of up to 6 days. Each tank was maintained at fixed pH, and each experiment consisted of several tanks which covered a range of pH values at and below that of natural seawater. The measure of

hatching success was the number of nauplii which were produced from the total number of incubated eggs. During the incubation, waters were extracted to measure carbonate system parameters and other key concentrations (titration alkalinity, total carbon dioxide, salinity, nitrate plus nitrite, ammonium, inorganic phosphate, and dissolved silicate), which were used to calculate the real pH of seawater in the incubation tanks. In addition, a ten day cruise covering the Gulf of Maine was taken in 2012 for the purpose of determining the distribution of carbonate species and pH in these waters. Analysis of these chemistry samples was performed at the Green Eyes LLC laboratory.

Methods & Sampling

* The following text is an excerpt from the Technical Report #15-009, linked below: *

* The details of the preparation and execution of the hatching experiments are being described in reports in preparation (Preziosi, 2012; Preziosi et al., 2012, 2013; Preziosi, Runge, Christensen and Jones, in prep.). In brief, female zooplankton, freshly caught or reared in the lab with plentiful food, were maintained in a healthy condition and their released eggs separated. When the numbers of eggs required in an experiment were sufficient, the eggs were sorted into individual hatching dishes, each containing natural seawater and 30 eggs. Local seawaters were collected, filtered and used to fill several 20 L hatching tanks. Each tank was consisted of a polycarbonate tank and lid, and an aeration tube into which was bubbled a premixed gas, consisting of 20% oxygen, the preselected concentration of CO2 (ranging from ambient local atmospheric levels to 50000 ppm in the dry gas), and the remainder nitrogen gas (N2). A siphon mounted within the tank allowed for sampling of the waters without opening the tank. A 1-inch diameter hole in the tank lid, normally stoppered, allowed for immersion of the pH and temperature electrodes occasionally throughout the incubation. After the pH stabilized to its quasi-equilibrium value for the bubbled gas, several hatching dishes containing the eggs were immersed in the tank. The tank was closed and hatching allowed to proceed. At an appropriate time, all hatching dishes were removed for determination of hatching success and the experiment then ended. During the incubation, either once (for incubation times less than 2 days) or twice, at the beginning and near the end of the longer 4-6 day experiments, about 2 liters of tank water were withdrawn for collection of the chemistry samples, as described below. The chemical results were used to determine the tank's pH. P-3
*
*At each sampling event during hatching experiments, about 2 L of the tank waters were siphoned for samples of salinity, titration alkalinity (TA), total carbon dioxide (TCO2), and nutrients. All bottles for TA, TCO2, and nutrients had been previously acid cleaned and dried. Nevertheless, all bottles were rinsed four times with tank water prior to filling. Salinity was stored in tightly capped 0.5 L bottles at room temperature for later measurement. TA and TCO2 samples were drawn in a manner identical to the collection of dissolved oxygen samples. An air bubble of about 1% of the volume of the bottle was left in the top of the bottle and 0.10 ml of a 0.100 mole-Hg/L solution of HgCl2 was added as preservative, yielding a mercury concentration of about 100 µmol/L dissolved in the sample. The sample bottles were tightly capped and stored at room temperature until measurement. Nutrients were collected in plastic vials and frozen at -20°C until analyzed. The temperature of the cold room in which the experiment was being conducted was monitored continuously. All concentrations are reported relative to the weight of the final solution (kg of solution).
*
*In addition to the hatching experiments, we sampled the offshore waters of the Gulf of Maine during a 10-day cruise in autumn of 2012. Seawater was sampled using a vertically profiling CTD with rosette containing 24 30-liter Niskin water sampling bottles. collected. These CTD casts collected waters from the seasurface to within a few meters of the seafloor (depths as great as about 300 m). After the CTD/Rosette had returned from a cast, water from each Niskin was sampled for alkalinity, total carbon dioxide, dissolved oxygen (Carpenter et al., 1965), nutrients, and salinity. Alkalinity and TCO2 were sampled in a manner identical to the collection procedure used for Carpenter oxygen samples. Each alkalinity and total CO2 sample were preserved and stored as described for the hatching experiments. Nutrients and salinities were stored and measured identically to those from the hatching experiments. *

* For detailed explanation of methods for all chemical determinations and calculations, please refer to ... Report #15-009 Green Eyes LLC, Easton MD, 13pp. *

Data Processing Description

For detailed explanation of methods for all chemical determinations and calculations, please refer to Technical Report #15-009 Green Eyes LLC, Easton MD, 13pp.

BCO-DMO Processing Notes 2016.06.05:

updated files sent by PI included:
DATASET-christensen.pdf Metadata file
PROJECT-christensen.pdf Metadata file
OAZHAT5R.pdf Methods report including data in tables
OAZHAT5R.CSV Data file
OAZTCH-9.pdf Technical report from Green Eyes Lab

The following edits were made to OAZHAT5R.CSV:
-Added BCO-DMO header:
edited the following terms to adhere to BCO-DMO convention:
-'HTCEXP' to 'exp_id'
-'GASCO2' to 'CO2_gas'
-'ALKALIN' to 'TALK'
-'NO3+2KG' to 'NO3_NO2'
-'NH4KG' to 'NH4'
-'PO4KG' to 'PO4'
-'SIKG' to 'SIO4'
-'PHTTL' to 'pH'

Included sampling location (lat,lon) in file header (not data)
Included deployment_id (of lab) in file hearder (not data)

BCO-DMO Processing Notes 2012.12.06:

Data were received as 5 individual files:
HDAT01-4.CSV
HDAT02-4.CSV
HDAT03-4.CSV
HDAT04-4.CSV
HDAT05-4.CSV

These files were combined into one file: carbonate_chemistry_zoo_exp.dat
The following edits were made to resultant file:
-Added BCO-DMO header
-Edited parameter names to conform to BCO-DMO convention where possible.
-Edited '-99' to 'nd'
-Split date into component 'month_local', 'day_local', 'year'
-Added columns for 'lat' and 'lon' using coordinates of where seawater samples

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Data Files

File
zoo_hatch_chemistry.csv *(Comma Separated Values (.csv), 13.35 KB)* *MD5:03b19fc5b6a8d164ff45c4d2f323fc3a*   *Primary data file for dataset ID 3816*

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Parameters

Parameter	Description	Units
year	Four-digit year corresponding to date of chemical sampling of each experimental tank, originally reported as part of date YYMMDD.	YYYY
exp_id	Unique identifier for each zooplankton hatching experiment, originally reported as 'HTCEXP'.	dimensionless
event	Sampling event where chemical measurements were collected from all tanks, each containing a different CO2 content.	dimensionless
month	Month of the year in local time corresponding to date of chemical sampling of each experimental tank, originally reported as part of date YYMMDD.	
day_local	Day of the month in local time, corresponding to date of chemical sampling of each experimental tank, originally reported as part of date YYMMDD.	
tank	Unique number within each sampling event identifying each tank sampled (1-5).	dimensionless
temp	Temperature of water sample.	degrees Celsius
sal	Salinity of sample taken from each tank from during each sampling event (measured as parts per thousand, not PSU).	gram/Kiloggram
TALK	Alkalinity determined via titration.	micromoles per Kilogram
CO2_gas	Preselected concentration of CO2 (ranging from ambient local atmospheric levels to 15000 ppm in the dry gas) used to create a premixed gas, consisting of CO2, 20% oxygen and the remainder of nitrogen gas (N2). This gas mix was employed in each experimental zooplankton hatching tank.	PPM
TCO2	Total CO2 in seawater sample.	micromoles/kg
NO3_NO2	Concentration of nitrate+nitrite {NO3+NO2} per unit mass of the water body. This parameter needs conversion from master parameter units.	micromoles per Kilogram
OM_CA	Calcite saturation state.	dimensionless
OM_AR	Aragonite saturation state.	dimensionless
XCO2	The partial pressure of CO2 in dry air expressed in ppm.	ppm

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Instruments

Dataset-specific Instrument Name	Autosal salinometer
Generic Instrument Name	Autosal salinometer
Dataset-specific Description	Salinity was measured using an Autosal 8400A conductivity salinometer. IAPSO standard seawater was used as standard.
Generic Instrument Description	The salinometer is an instrument for measuring the salinity of a water sample.

Dataset-specific Instrument Name	*Benchtop pH Meter*
Generic Instrument Name	*Benchtop pH Meter*
Dataset-specific Description	*The pH of the samples were determined using a Ross Ultra semimicroelectrode (Orion #8103BNUWP) connected to an op-amp circuit (unity-gain follower) whose output voltage matches the electrode output. This op-amp output was continuously monitored via a 14 bit A-to-D converter and computer.*
Generic Instrument Description	*An instrument consisting of an electronic voltmeter and pH-responsive electrode that gives a direct conversion of voltage differences to differences of pH at the measurement temperature. (McGraw-Hill Dictionary of Scientific and Technical Terms) This instrument does not map to the NERC instrument vocabulary term for 'pH Sensor' which measures values in the water column. Benchtop models are typically employed for stationary lab applications.*

Dataset-specific Instrument Name	*Gas Chromatograph*
Generic Instrument Name	*Gas Chromatograph*
Dataset-specific Description	*A Shimadzu Model GC-6A gas chromatograph (gc) with a thermal conductivity detector was used to determine concentrations of total carbon dioxide (TCO2).*
Generic Instrument Description	*Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)*

Dataset-specific Instrument Name	*Water Temperature Sensor*
Generic Instrument Name	*Water Temperature Sensor*
Dataset-specific Description	*A Dostmann electronic P-655-PT precision thermometer calibrated accurate to 0.01°C was employed for all titrations.*
Generic Instrument Description	*General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).*

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Deployments

lab_Christensen_GreenEyes

Website	*https://www.bco-dmo.org/deployment/58900*
Platform	*Green Eyes LLC*
Start Date	*2011-05-27*
End Date	*2011-07-05*
Description	*Chemical analyses to determine carbonate system components as part of experiments associated with the project: ' Impact of ocean acidification on survival of early life stages of planktonic copepods in the genus Calanus'.*

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Project Information

Ocean Acidification-Category 1- Impact of ocean acidification on survival of early life stages of planktonic copepods in the genus Calanus in the northern (OA Calanus Survival)

***Coverage**: Gulf of Maine*

The project description is a modification of the original NSF award abstract.

This research project is part of the larger NSF funded CRI-OA collaborative research initiative and was funded as an Ocean Acidification-Category 1, 2010 award. While attention concerning impacts of predicted acidification of the world's oceans has focused on calcifying organisms, non-calcifying plankton may also be vulnerable. In this project, the investigator will evaluate the potential for impacts of ocean acidification on the reproductive success of three species of planktonic copepods in the genus Calanus that are prominent in high latitude oceans. C. finmarchicus dominates the mesozooplankton biomass across much of the coastal and deep North Atlantic Ocean. C. glacialis and the larger C. hyperboreus are among the most abundant planktonic copepods in the Arctic Ocean. Previous research showed that hatching success of C. finmarchicus eggs was severely inhibited by increased CO2 and lower pH in seawater, but only tested at an extreme level. Preliminary results in the investigator's laboratory indicate that hatching success of C. finmarchicus is substantially reduced at increased seawater CO2 concentrations corresponding to pH levels between 7.9 and 7.5. Predictions of likely decline of surface pH levels to 7.7-7.8 over the next century raise questions about impacts on Calanus population dynamics if these preliminary results are confirmed. C. finmarchicus, for example, is presently at the southern edge of its range in the Gulf of Maine. The combination of higher surface layer temperature and lower pH may inhibit reproductive success during the late summer/fall bloom, which the PI hypothesize is critical to sustain the overwintering stock in this region. The investigators will collect C. finmarchicus females from the Gulf of Maine and, with the assistance of Canadian colleagues, C. glacialis and C. hyperboreus females from the deep lower St. Lawrence Estuary. They will conduct laboratory experiments in which hatching success, development and growth of Calanus nauplius stages are measured in controls of natural seawater and at a series of treatments in which CO2 concentrations, pH and temperature are rigorously controlled to represent possible future states of the northern ocean. The investigators will measure present surface and deep pCO2 and pH across the Gulf of Maine, including its deep basins, during a research cruise. The study will evaluate the hypothesis that predicted levels of CO2 increase in the northern ocean will impact population dynamics of the Calanus species. Using the results from the research cruise and a recently developed 1-D, Individual-Based life cycle model, the PI will explore in detail scenarios of impact of higher temperature and lower surface and deep pH on population dynamics of C. finmarchicus in the Gulf of Maine.

The lipid-rich Calanus species are considered key intermediary links between primary production and higher trophic levels in North Atlantic and Arctic Ocean food webs. Impacts of higher surface temperature and lower pH on reproductive success may potentially lead to profound changes in energy transfer and structure of pelagic ecosystems in the northern oceans. In the Gulf of Maine, C. finmarchicus serves as primary prey for herring, sand lance, and mackerel, as well as the endangered northern right whale, warranting thorough evaluation of ocean acidification effects on its population dynamics.

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Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

***Website**: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477*

***Coverage**: global*

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

Ocean Carbon and Biogeochemistry (OCB)

***Website**: http://us-ocb.org/*

***Coverage**: Global*

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on

and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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Funding

Funding Source	***Award***
NSF Division of Ocean Sciences (NSF OCE)	*OCE-1041081*

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