

# Environmental data from experimental aquaria during a laboratory experiment testing the effects of pH, light availability and biotic interaction on coralline algae calcification and productivity at the Sitka Sound Science Center in 2017

**Website:** <https://www.bco-dmo.org/dataset/856902>

**Data Type:** experimental, Other Field Results

**Version:** 1

**Version Date:** 2021-07-30

## Project

» [CAREER: Energy fluxes and community stability in a dynamic, high-latitude kelp ecosystem](#) (High latitude kelp dynamics)

Contributors	Affiliation	Role
<a href="#">Kroeker, Kristy J.</a>	University of California-Santa Cruz (UCSC)	Principal Investigator
<a href="#">Bell, Lauren E.</a>	University of California-Santa Cruz (UCSC)	Contact
<a href="#">Newman, Sawyer</a>	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

## Abstract

Environmental data from experimental aquaria ("tanks") during a laboratory experiment testing the effects of pH, light availability, and biotic interaction on coralline algae calcification and productivity. These tests took place at the Sitka Sound Science Center (SSSC) from August 7, 2017, to September 21, 2017, with algal collection taking place on August 5, 2017.

## Table of Contents

- [Coverage](#)
- [Dataset Description](#)
  - [Methods & Sampling](#)
  - [Data Processing Description](#)
- [Data Files](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Project Information](#)
- [Funding](#)

## Coverage

**Spatial Extent:** Lat:57.032 Lon:-135.277

**Temporal Extent:** 2017-08-18 - 2017-09-15

## Dataset Description

Environmental data from experimental aquaria ("tanks") during a laboratory experiment testing the effects of pH, light availability and biotic interaction on coralline algae calcification and productivity.

## Methods & Sampling

### Methodology:

**Sampling and analytical procedures:** To test the response of the coralline algae *Crusticorallina* spp. and *Bossiella orbigniana* to future OA scenarios, we used an 18-aquaria indoor experimental system with flow-through seawater at the Sitka Sound Science Center to simulate three static pHT levels (current summer = 8.0, future summer/current winter = 7.7, future winter = 7.4) under two seasonal light regimes simulated with full-spectrum aquarium lights (AI Prime HD) (summer = PPFD 55  $\mu\text{mol m}^{-2} \text{s}^{-1}$ , 13h d-1, winter = PPFD 40  $\mu\text{mol m}^{-2} \text{s}^{-1}$ , 6h d-1). We had a total of 3 aquaria for each of the 6 treatment combinations. A full description of the pH control for this system can be found in Kroeker et al. 2021, but in short: pH was regulated using a relay system that controlled mixing of pre-equilibrated low-pH seawater (formed by bubbling pure CO<sub>2</sub> gas into seawater: pH6.0) and ambient pH seawater into 9 header buckets (n=3 headers per pH treatment) that then flowed into the experimental aquaria. Each header bucket was equipped with a pH sensor (DuraFET, Honeywell) communicating with a controller (UDA 2152, Honeywell) to regulate flow of the low pH water through solenoid valves to maintain pre-programmed pH setpoints. Experimental pH levels were chosen to reflect current seasonal minimums of coastal pH measured at Harris Is. (57.032N, 135.277W) from 2016-2017, as well as end-of-century projections for Gulf of Alaska pH levels based on RCP 8.5 (-0.3 pHT from current levels). Experimental light regimes were defined using seasonal averages for day length and measured irradiance level at 10m depth at Harris Is.

Within each pH level and light treatment combination, half of the individual *Crusticorallina* spp. and *B. orbigniana* were randomly assigned to be paired in close proximity with the fleshy red alga *Cryptopleura ruprechtiana* (n=6 species treatment-1). All algal individuals were collected on Aug 5, 2017 at Harris Is. Total experimental duration was 45d (Aug 7-Sept 21, 2017). To monitor treatment conditions, we used a handheld meter (YSI) to take daily temperature readings in the replicate aquaria and measure salinity of incoming seawater daily just upstream of our experimental system. Additionally, discrete water samples were collected from replicate aquaria at four timepoints (Aug 18, 22, 25, and Sept 15) for determination of pH (total scale) and total alkalinity (TA). Discrete samples were collected without aeration in amber glass bottles, immediately poisoned with saturated HgCl<sub>2</sub> (0.025% volume-1), and capped to prevent air exchange.

Discrete water samples for laboratory measurements of pH and/or TA were transported to UCSC for analysis within 8 months of collection. We measured pH spectrophotometrically (Shimadzu, UV-1800) using m-cresol purple dye following best practices (Dickson et al. 2017), with an average standard error of  $\pm 0.0013$  pH units among sample triplicates. TA measurements were performed using open cell titration (Metrohm, 905 Titrando) and corrected against certified reference materials of CO<sub>2</sub> in seawater (Dickson laboratory, Scripps Institution of Oceanography), with an average standard error of  $\pm 0.933 \mu\text{mol kg}^{-1} \text{SW-1}$  among sample triplicates. To calculate pHT in the replicate aquaria at the time of water sampling, we used our measurements of spectrophotometric pH, TA, temperature, and salinity, as well as the dissociation constants as inputs to the program CO<sub>2</sub>SYS. This dataset reflects all of the above-described data, including final carbonate chemistry calculations from CO<sub>2</sub>SYS.

### **Problem report:**

Discrete water samples had to be stored and shipped from Southeast Alaska to Santa Cruz, CA for analysis, and some samples were broken in transit and unusable. Additionally, we recognize that the delay between collection and laboratory analysis of water sample spec pH and TA may have resulted in a measurable amount of drift in these parameters, but we were unable to quantify any drift that may have occurred and thus these values are uncorrected. Lastly, calculated parameters for certain samples did not follow expected relationships (e.g., among spec pH and pCO<sub>2</sub>) and thus were flagged for potentially poor quality, which may have been caused by biological contamination in bottle samples.

### **Data Processing Description**

#### **Data processing notes from researcher:**

All columns with prefix "CO<sub>2</sub>SYS\_" were calculated using the program CO<sub>2</sub>SYS using prior column data as inputs.

#### **BCO-DMO processing notes:**

Renamed field tank.rep to tank\_rep in order to meet BCO-DMO field naming conventions

Converted datetime to ISO 8061 standard

Added UTC formatted datetime

## Data Files

File
<b>exptanks_carbchemdata-1.csv</b> (Comma Separated Values (.csv), 9.23 KB) MD5:5b95d4c6b20250a87e4da94d32d47aa4
Primary data file for dataset ID 856902

## Related Publications

Bell, L., Gómez, J., Donham, E., Steller, D., Gabrielson, P., & Kroeker, K. (2022). High-latitude calcified coralline algae exhibit seasonal vulnerability to acidification despite physical proximity to a non-calcified alga. *Climate Change Ecology*, 3, 100049. <https://doi.org/10.1016/j.ecochg.2022.100049>  
*Results*

Kroeker, K. J., Powell, C., & Donham, E. M. (2020). Windows of vulnerability: Seasonal mismatches in exposure and resource identity determine ocean acidification's effect on a primary consumer at high latitude. *Global Change Biology*, 27(5), 1042–1051. doi:[10.1111/gcb.15449](https://doi.org/10.1111/gcb.15449)  
*Methods*

## Parameters

Parameter	Description	Units
header	ID of experimental header bucket	unitless
tank_rep	alphabetic ID of experimental tank replicate (B or C)	unitless
YSI_timestamp_AKST	datetime (AKST) of YSI and water sample collection; format: YYYY-MM-DD H:M	unitless
YSI_timestamp_UTC	datetime (AKST) of YSI and water sample collection; format: YYYY-MM-DDT%H:MZ	unitless
pH	experimental pH treatment level	unitless
light	experimental light regime treatment (winter or summer)	unitless
YSI_DO	YSI measured dissolved oxygen	mg/L
YSI_pH	YSI measured pH (calibrated to FW standards)	unitless

YSI_sal	YSI measured salinity	parts per thousand (ppt)
YSI_temp	YSI measured temperature	degrees C
titrator_TA	mean total alkalinity from triplicate sample measurement	$\mu\text{mol kg}^{-1}$
spec_pH	mean spec pH from triplicate sample measurement	unitless
CO2SYS_pH	calculated pH	unitless
CO2SYS_fCO2	calculated fugacity of carbon dioxide	$\mu\text{atm}$
CO2SYS_pCO2	calculated partial pressure of carbon dioxide	$\mu\text{atm}$
CO2SYS_HCO3	calculated bicarbonate concentration	$\mu\text{mol/kgSW}$
CO2SYS_CO3	calculated carbonate concentration	$\mu\text{mol/kgSW}$
CO2SYS_CO2	calculated carbon dioxide concentration	$\mu\text{mol/kgSW}$
CO2SYS_B	calculated boron concentration	$\mu\text{mol/kgSW}$
CO2SYS_OH	calculated hydroxide concentration	$\mu\text{mol/kgSW}$
CO2SYS_CaOMEGA	calculated calcite saturation state ( $\Omega$ )	unitless
CO2SYS_ArgOMEGA	calculated aragonite saturated state ( $\Omega$ )	unitless
quality_flag	indicator of data quality (n = no flag - quality good; m = potential flag; y = bad data)	unitless

[ [table of contents](#) | [back to top](#) ]

---

## Instruments

<b>Dataset-specific Instrument Name</b>	18-aquaria indoor experimental system with flow-through seawater at the Sitka Sound Science Center
<b>Generic Instrument Name</b>	Aquarium
<b>Dataset-specific Description</b>	To test the response of the coralline algae <i>Crusticorallina</i> spp. and <i>Bossiella orbigniana</i> to future OA scenarios, we used an 18-aquaria indoor experimental system with flow-through seawater at the Sitka Sound Science Center to simulate three static pHT levels (current summer = 8.0, future summer/current winter = 7.7, future winter = 7.4) under two seasonal light regimes simulated with full-spectrum aquarium lights (AI Prime HD) (summer = PPFD 55 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> , 13h d <sup>-1</sup> , winter = PPFD 40 $\mu$ mol m <sup>-2</sup> s <sup>-1</sup> , 6h d <sup>-1</sup> ). We had a total of 3 aquaria for each of the 6 treatment combinations.
<b>Generic Instrument Description</b>	Aquarium - a vivarium consisting of at least one transparent side in which water-dwelling plants or animals are kept

<b>Dataset-specific Instrument Name</b>	YSI handheld meter
<b>Generic Instrument Name</b>	Discrete water sampler
<b>Dataset-specific Description</b>	To monitor treatment conditions, we used a handheld meter (YSI) to take daily temperature readings in the replicate aquaria and measure salinity of incoming seawater daily just upstream of our experimental system. YSI handheld meter used to measure dissolved oxygen, pH, salinity, and temperature.
<b>Generic Instrument Description</b>	A device that collects an in-situ discrete water sample from any depth and returns it to the surface without contamination by the waters through which it passes, such as a water bottle.

<b>Dataset-specific Instrument Name</b>	Honeywell DuraFET and UDA 2152
<b>Generic Instrument Name</b>	pH Sensor
<b>Dataset-specific Description</b>	Each header bucket was equipped with a pH sensor (DuraFET, Honeywell) communicating with a controller (UDA 2152, Honeywell) to regulate flow of the low pH water through solenoid valves to maintain pre-programmed pH setpoints.
<b>Generic Instrument Description</b>	An instrument that measures the hydrogen ion activity in solutions. The overall concentration of hydrogen ions is inversely related to its pH. The pH scale ranges from 0 to 14 and indicates whether acidic (more H <sup>+</sup> ) or basic (less H <sup>+</sup> ).

<b>Dataset-specific Instrument Name</b>	Metrohm 905 Titrandro Titrator
<b>Generic Instrument Name</b>	Titration
<b>Dataset-specific Description</b>	Total alkalinity (TA )measurements were performed using open cell titration and corrected against certified reference materials of CO <sub>2</sub> in seawater (Dickson laboratory, Scripps Institution of Oceanography), with an average standard error of $\pm 0.933 \mu\text{mol kg}^{-1} \text{SW-1}$ among sample triplicates.
<b>Generic Instrument Description</b>	Titration is an instrument that incrementally adds quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

<b>Dataset-specific Instrument Name</b>	Shimadzu UV-1800 spectrophotometer
<b>Generic Instrument Name</b>	UV Spectrophotometer-Shimadzu
<b>Dataset-specific Description</b>	We measured pH spectrophotometrically (Shimadzu, UV-1800) using m-cresol purple dye following best practices (Dickson et al. 2017), with an average standard error of $\pm 0.0013$ pH units among sample triplicates.
<b>Generic Instrument Description</b>	The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufactures several models of spectrophotometer; refer to dataset for make/model information.

[ [table of contents](#) | [back to top](#) ]

## Project Information

**CAREER: Energy fluxes and community stability in a dynamic, high-latitude kelp ecosystem (High latitude kelp dynamics)**

**Coverage:** SE Alaskan coastal waters

### *NSF Award Abstract:*

High latitude kelp forests support a wealth of ecologically and economically important species, buffer coastlines from high-energy storms, and play a critical role in the marine carbon cycle by sequestering and storing large amounts of carbon. Understanding how energy fluxes and consumer-resource interactions vary in these kelp communities is critical for defining robust management strategies that help maintain these valuable ecosystem services. In this integrated research and education program, the project team will investigate how consumer populations respond to variability in temperature, carbonate chemistry and resource quality to influence the food webs and ecosystem stability of kelp forests. A comprehensive suite of studies conducted at the northern range limit for giant kelp (*Macrocystis pyrifera*) in SE Alaska will examine how kelp communities respond to variable environmental conditions arising from seasonal variability and changing ocean temperature and acidification conditions. As part of this project, undergraduate and high school students will receive comprehensive training through (1) an immersive field-based class in Sitka Sound, Alaska, (2) intensive, mentored research internships, and (3) experiential training in science communication and public outreach that will include a variety of opportunities to disseminate research findings through podcasts, public lectures and radio broadcasts.

Consumer-resource interactions structure food webs and govern ecosystem stability, yet our understanding of how these important interactions may change under future climatic conditions is hampered by the

complexity of direct and indirect effects of multiple stressors within and between trophic levels. For example, environmentally mediated changes in nutritional quality and chemical deterrence of primary producers have the potential to alter herbivory rates and energy fluxes between primary producers and consumers, with implications for ecosystem stability. Moreover, the effects of global change on primary producers are likely to depend on other limiting resources, such as light and nutrients, which vary seasonally in dynamic, temperate and high latitude ecosystems. In marine ecosystems at high latitude, climate models predict that ocean acidification will be most pronounced during the winter months, when primary production is limited by light. This project is built around the hypothesis that there could be a mismatch in the energetic demands of primary consumers caused by warming and ocean acidification and resource availability and quality during winter months, with cascading effects on trophic structure and ecosystem stability in the future. Through complementary lab and field experiments, the project team will determine 1) how temperature and carbonate chemistry combine to affect primary consumer bioenergetics across a diversity of species and 2) the indirect effects of ocean acidification and warming on primary consumers via environmentally mediated changes in the availability, nutritional quality and palatability of primary producers across seasons. Using the data from the laboratory and field experiments, the project team will 3) construct a model of the emergent effects of warming and ocean acidification on trophic structure and ecosystem stability in seasonally dynamic, high latitude 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.

[ [table of contents](#) | [back to top](#) ]

---

## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1752600</a>

[ [table of contents](#) | [back to top](#) ]