

# Carbonate chemistry in experimental cultures of *Plocamium cartilagineum* cultured at different temperatures and pCO<sub>2</sub> levels (Seaweed OA Resilience project)

**Website:** <https://www.bco-dmo.org/dataset/726664>

**Data Type:** experimental

**Version:** 1

**Version Date:** 2018-02-07

## Project

» [Ocean Acidification: Scope for Resilience to Ocean Acidification in Macroalgae](#) (Seaweed OA Resilience)

## Program

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

Contributors	Affiliation	Role
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## Abstract

Carbonate chemistry in experimental cultures of *Plocamium cartilagineum* cultured at different temperatures and pCO<sub>2</sub> levels.

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## Coverage

**Spatial Extent:** N:34 E:-118 S:33 W:-119

**Temporal Extent:** 2014-06 - 2015-02

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## Dataset Description

This dataset includes carbonate chemistry measurements in the *Plocamium cartilagineum* growth chambers.

### Related Datasets:

[Plocamium carbon nitrogen and stable isotopes](#): Plocamium carbon and nitrogen content and stable isotope values, 2014-2015 (Seaweed OA Resilience project)

[Plocamium culture: seawater delta13C](#): Stable isotope ratio and concentration of carbon in seawater during Plocamium culture experiments, 2014-2015 (Seaweed OA Resilience project)

[Plocamium cultures pH and temperature](#): Plocamium culture pot pH and temperature time-series at 10 minute

sampling intervals from 2014-2015 (Seaweed OA Resilience project)

[Plocamium exptl treatments summary](#): Summary of pCO<sub>2</sub> and temperature treatment combinations for each culture pot and experimental trial (Seaweed OA Resilience project)

[Plocamium growth and biomass](#): Experimental results of Plocamium cartilagineum growth and biomass as a function of pCO<sub>2</sub> and temperature (Seaweed OA Resilience project)

[Plocamium pigments](#): Photosynthetic pigment concentrations in Plocamium cartilagineum, trials 3-8, 2014-2015 (Seaweed OA Resilience project)

[Plocamium: pH drift](#): Carbonate chemistry over a time-course in pH drift experiments with Plocamium growth collected at Catalina Island, 2014-2015 (Seaweed OA Resilience project)

[Rapid Light Curves\\_PAM](#): Measurements of fluorescence of photosystem II in Plocamium cartilagineum under various and pCO<sub>2</sub> and temperature conditions

## Methods & Sampling

*Plocamium cartilagineum* was collected from Santa Catalina Island and Leo Carollo, CA in June - Nov. 2014 and Jan. 2015.

Carbonate chemistry parameters were measured by sampling pH and total alkalinity (TA) of water samples. Seawater samples from each culture pot during all 7 trials were collected approximately every other day in 50 ml Falcon tubes to verify experimental treatment conditions. Water samples were measured usually within 1-2 hours of sample collection. pH was determined using the m-cresol indicator dye method in a spectrophotometer (Dickson et al. 2007). TA samples were analyzed by potentiometric titration coupled to a pH electrode calibrated using certified reference material (CRM) from the Dickson laboratory at Scripps Oceanographic Institute and the pH electrode calibrated using TRIS buffer (Dickson et al. 2007). TA and carbonate parameters were calculated from potentiometric titration data and spectrophotometric pH data.

Note: Trial 1 was a pilot test of culture system and methodological procedures so was not used for data collection in the testing of hypotheses.

See Supplemental Files for a table of culture conditions for each of the 8 trials (pdf).

## Data Processing Description

Carbonate chemistry parameters (CO<sub>2</sub> concentration, CO<sub>2</sub> partial pressure, CO<sub>2</sub> fugacity, HCO<sub>3</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup>, DIC, Omega Aragonite, Omega Calcite) and total scale pH at in situ temperature were calculated using the seacarb package (V3.0.14) in R (Lavigne et al. 2011).

### BCO-DMO Processing Notes:

- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- combined data from 8 separate trial files
- reduced precision to meet sampling precision methods

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## Data Files

File
<b>carb_chem.csv</b> (Comma Separated Values (.csv), 178.55 KB) MD5:7958d68cf2f3ba0cf77d59ec8e9b96bd
Primary data file for dataset ID 726664

## Supplemental Files

File	
<b>Table of culture conditions for each of the 8 trials</b>	
filename: Dudgeon_seaweed_trial_meta_2018-01.pdf	(Portable Document Format (.pdf), 429.04 KB) MD5:5a4a9cbd3cb5092a419b4883c96979b8
Notes: Trial 1 was a pilot test of culture system and methodological procedures so was not used for data collection in the testing of hypotheses. In each culture pot, pCO <sub>2</sub> was set by the supply rate of CO <sub>2</sub> in the corresponding mass-flow controlled gas mixing system to be within a target range of either near ambient, moderately elevated or highly elevated in each trial. The near-ambient range was narrower than the other target ranges (set points typically ~380 - 390 micro-atm) as it served as the control range in each trial. However, actual pCO <sub>2</sub> in solution in each culture pot varied slightly from constant target values on a diurnal cycle associated with the metabolic activities of the algae contained within each pot. Unique average values of pCO <sub>2</sub> in each culture pot based on different set values for each mass-flow controlled mixer within the qualitative ranges of ambient, moderate and highly increased pCO <sub>2</sub> levels that were replicated in each trial of the experiment enabled a more powerful regression-type experimental design. With a regression type approach we could estimate the functional relationship between response variables and pCO <sub>2</sub> , which was not possible with a simple categorical treatment design.	

## Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO<sub>2</sub> measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. URL: [https://www.nodc.noaa.gov/ocads/oceans/Handbook\\_2007.html](https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html) <https://hdl.handle.net/11329/249>  
*Methods*

Lavigne H, Epitalon, JM, Gattuso JP, 2011. Seacarb: seawater carbonate chemistry with R. <https://cran.r-project.org/web/packages/seacarb/index.html>  
*Software*

Lavigne H, Gattuso JP (2014) Seacarb: seawater carbonate chemistry with R, R package version 3.0. Available from <http://CRAN.R-project.org/package=seacarb>  
*Methods*

## Parameters

Parameter	Description	Units
trial	experimental trial identifier	unitless
expt_day	days from beginning of trial when data were collected	day number
date	date of measurment formatted as yyyy-mm-dd	unitless
sample	Sample replicate ID in each pot	unitless
pH25	pH in Total scale at 25 deg C	unitless
sal_insitu	Salinity in situ	parts per thousand (ppt)
temp_insitu	Temperature in situ	degrees Celsius
pH_insitu	pH-Total scale in situ temperature	unitless
CO2	Carbon dioxide concentration	??mol/kilogram
pCO2	CO2 partial pressure	??atmospheres (atm)
fCO2	CO2 fugacity	??atmospheres (atm)
HCO3	Bicarbonate ion concentration	??mol/kilogram
CO3	Carbonate ion concentration	??mol/kilogram
DIC	Total carbon dissolved inorganic	??mol/kilogram
ALK	Total Alkalinity measured	??mol/kilogram
OmegaAragonite	Aragonite saturation state	unitless
OmegaCalcite	Calcite Saturation State	unitless

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## Instruments

<b>Dataset-specific Instrument Name</b>	
<b>Generic Instrument Name</b>	Multi Parameter Portable Meter
<b>Dataset-specific Description</b>	YSI 556 MPS (Trials 1-5) and Thermo Fisher Orion Star 329 (trials 6-8) used to measure salinity and temperature.
<b>Generic Instrument Description</b>	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

<b>Dataset-specific Instrument Name</b>	Shimadzu UV-2450 UV-visible spectrophotometer
<b>Generic Instrument Name</b>	Spectrophotometer
<b>Dataset-specific Description</b>	Used to measure pH (at temperature 25 C)
<b>Generic Instrument Description</b>	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

<b>Dataset-specific Instrument Name</b>	Mettler Toledo T50
<b>Generic Instrument Name</b>	Titration
<b>Dataset-specific Description</b>	Used to measure total alkalinity; equipped with Rondolino automated titration stand.
<b>Generic Instrument Description</b>	Titration is an instrument that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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## Project Information

### Ocean Acidification: Scope for Resilience to Ocean Acidification in Macroalgae (Seaweed OA Resilience)

**Coverage:** Temperate coastal waters of the USA (30 - 45 N latitude, -66 to -88 W and -117 to -125 W longitude)

Benthic macroalgae contribute to intensely productive near shore ecosystems and little is known about the potential effects of ocean acidification on non-calcifying macroalgae. Kübler and Dudgeon will test hypotheses about two macroalgae, *Ulva* spp. and *Plocamium cartilagineum*, which, for different reasons, are hypothesized to be more productive and undergo ecological expansions under predicted changes in ocean chemistry. They have designed laboratory culture-based experiments to quantify the scope for response to ocean acidification in *Plocamium*, which relies solely on diffusive uptake of CO<sub>2</sub>, and populations of *Ulva* spp., which have an inducible concentrating mechanism (CCM). The investigators will culture these algae in media equilibrated at 8 different pCO<sub>2</sub> levels ranging from 380 to 940 ppm to address three key hypotheses. The first is that macroalgae (such as *Plocamium cartilagineum*) that are not able to acquire inorganic carbon in changed form will benefit, in terms of photosynthetic and growth rates, from ocean acidification. There is little existing data to support this common assumption. The second hypothesis is that enhanced growth of *Ulva* sp. under OA will result from the energetic savings from down regulating the CCM, rather than from enhanced photosynthesis per se. Their approach will detect existing genetic variation for adaptive plasticity. The third key hypothesis is to

be addressed in short-term culture experiments is that there will be a significant interaction between ocean acidification and nitrogen limited growth of *Ulva* spp., which are indicator species of eutrophication. Kübler and Dudgeon will be able to quantify the individual effects of ocean acidification and nitrogenous nutrient addition on *Ulva* spp. and also, the synergistic effects, which will inevitably apply in many highly productive, shallow coastal areas. The three hypotheses being addressed have been broadly identified as urgent needs in our growing understanding of the impacts of ocean acidification.

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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](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](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 \(NSF\)](#)

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1316198</a>

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