

Experimental results of *Plocamium cartilagineum* growth and biomass as a function of pCO₂ and temperature (Seaweed OA Resilience project)

Website: <https://www.bco-dmo.org/dataset/726452>

Data Type: experimental

Version: 1

Version Date: 2018-03-23

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

Experimental results of *Plocamium cartilagineum* growth and biomass as a function of pCO₂ and temperature.

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Coverage

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

Temporal Extent: 2014-06-04 - 2015-02-23

Dataset Description

This dataset includes measurements of frond area of *Plocamium cartilagineum* grown under various temperatures and CO₂ levels. Biomass-specific growth and dynamic average of weekly growth is also calculated.

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 carbonate chemistry](#): Carbonate chemistry in experimental cultures of *Plocamium cartilagineum* cultured at different temperatures and pCO₂ levels (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 pCO₂ and temperature treatment combinations for each culture pot and experimental trial (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 pCO₂ and temperature conditions

Methods & Sampling

Plocamium cartilagineum was collected from Catalina Island in June - Nov. 2014 and Jan. 2015.

Culture pots were placed in large thermally insulated coolers in a temperature-controlled water bath at either 15 or 20°C under saturating illumination of ~150 μmoles photons/m²/s. pCO₂ treatments were supplied to closed culture pots by use of a gas mixing system combining Nitrogen, Oxygen and Carbon Dioxide to specific CO₂ partial pressures, 20.9% oxygen and the balance being Nitrogen.

Areal growth: Frond pieces were placed under glass without overlap of branches adjacent to a ruler for scale and imaged using an Infinity 2 camera with attached macro lens mounted on a copy stand. Images and calibrated and surface area of fronds measured using Image J. Measurements were taken at the start and end of the trial. For all measures of growth (by surface area [adj_growth], and biomass [growth_biom] and [growth_dyn]) the calculations are specific growth rates, meaning $\text{LOG}(\text{measure@t2} / \text{measure@t1}) / (\text{t2} - \text{t1})$. For surface area measures (adj_growth) and biomass (as growth_biom), t1 is the initial measure at the start of the experiment and t2 is the final measure at the end of the experiment. For biomass (asgrowth_dyn), t1 is the measure at the start of each weeklong interval and t2 is the measure at the end of the interval. Thus, there were typically 3 such intervals during a trial in which growth was measured and the datum in the column growth_dyn represents the average of those interval specific measures over the course of a trial.

Note: Since tagging individual fronds compromised frond performance, all fronds in a culture pot were treated as sub-samples that were summed to give the datum for the culture pot that was treated as the replicate.

Biomass: Frond pieces were gently blotted dry with paper toweling to remove surface water and weighed at weekly intervals to estimate biomass specific growth rates (growth_biom and growth_dyn). Note: since tagging individual fronds compromised frond performance, all fronds in a culture pot were treated as sub-samples that were summed to give the datum for the culture pot that was treated as the replicate.

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

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 3 submitted files: CO2trt_x_pot_trial.csv, Plo_areal_growth_CO2_Temp.csv, Plo_bio_growth_CO2_Temp.csv
- added columns for date_start and date_end; moved trial to first column
- reduced precision of area and growth columns from 7 to 2 decimal places and adj_growth from 9 to 5 places.

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Data Files

File
Plocamium_growth_biomass.csv (Comma Separated Values (.csv), 5.31 KB) MD5:5b512b854249b6fcb1f4fa5ae82e815b
Primary data file for dataset ID 726452

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Supplemental Files

File
Table of culture conditions for each of the 8 trials 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 ₂ was set by the supply rate of CO ₂ 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 ₂ 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 ₂ 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 ₂ 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 ₂ , which was not possible with a simple categorical treatment design.

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Parameters

Parameter	Description	Units
pot	culture pot identifier	unitless
pCO ₂	partial pressure of dissolved CO ₂	microatmospheres (uatm)
temp	Temperature	degrees Celsius
trial	experimental trial consisting of 3 PCO ₂ levels with one always ~380 as control	unitless
date_start	start date for trial formatted as yyyy-mm-dd	unitless
date_end	end date for trial formatted as yyyy-mm-dd	unitless
area_t0	frond surface area on day 0 (start)	square centimeters (cm ²)
area_end	frond surface area at expt. end	square centimeters (cm ²)
days	Number of days for experimental trial	days
adj_growth	Area-specific growth rate	square centimeters/square centimeters/day (cm ² /cm ² /day)
growth_biom	biomass-specific growth between t=0 and t=19 or 20 or 21 days	milligrams/gram/day (mg/g/day)
growth_dyn	dynamic average of weekly growth rates over the 3-4 week experiment	milligrams/gram/day (mg/g/day)
pCO ₂ _target_range	Relative range for the target pCO ₂ . See Supplemental Files for the table of culture conditions for each of the 8 trials.	unitless

Instruments

Dataset-specific Instrument Name	Aqua Logic Cyclone Chiller
Generic Instrument Name	Aquarium chiller
Dataset-specific Description	Used to control the temperature of the growth chambers.
Generic Instrument Description	Immersible or in-line liquid cooling device, usually with temperature control.

Dataset-specific Instrument Name	Lumenera Corp. Infinity 2 2.0 Megapixel Color CCD Camera, Navitar TV Zoom 7000 Macro lens
Generic Instrument Name	Camera
Dataset-specific Description	To take images of fronds for area measurements.
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Qubit Systems Mass Flow Controllers (MFC)
Generic Instrument Name	Mass Flow Controller
Dataset-specific Description	Used to mix gasses: Nitrogen, 1 L/min; Oxygen, 250 ml/min; CO ₂ , 2 ml/min.
Generic Instrument Description	Mass Flow Controller (MFC) - A device used to measure and control the flow of fluids and gases

Dataset-specific Instrument Name	Mettler Toledo AG204 Delta Range Analytical Balance
Generic Instrument Name	scale
Dataset-specific Description	To measure biomass of fronds
Generic Instrument Description	An instrument used to measure weight or mass.

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 CO₂, and populations of *Ulva* spp., which have an inducible concentrating mechanism (CCM). The investigators will culture these algae in media equilibrated at 8 different pCO₂ 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 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

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 \(NSF\)](#)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1316198

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