Data on growth rates, and physiological parameters of Ulva australis under ocean acidification (OA) and eutrophication, from July 2015 (Seaweed OA Resilience project)

Website: https://www.bco-dmo.org/dataset/731368
Data Type: experimental
Version:
Version Date: 2018-03-21

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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Coverage

Spatial Extent: **Lat**:-42.998 **Lon**:147.33
Temporal Extent: 2015-07-31 - 2015-08-07

Dataset Description

This dataset includes growth rates and physiological parameters such as NH4 uptake, chlorophyll a and b, carbon and nitrogen content, and photosynthetic parameters in cultures of Ulva australis under ocean acidification (OA) and eutrophication treatments. The study lasted for a week from 2015-07-31 until 2015-08-07.

Related Datasets:

Ulva pHT monitoring: Time-series of estimating pH in culture tanks of Ulva australis under ocean acidification (OA) and eutrophication (Seaweed OA Resilience project)

Ulva rapid light curves (RLC): Rapid light curves of Ulva australis based on PAM fluorometry under OA and eutrophication (Seaweed OA Resilience project)

Methods & Sampling

Ulva australis was collected from Blackmans Bay, Tasmania, Australia (approx. 42°59'56"S 147°19'8"E) in July 2015 (Austral winter). Three Ulva australis thalli were placed in chambers filled with sterile seawater and circulated with fresh seawater. The pHT of seawater pumped to each tank was maintained using an automated pH control system. Seawater was equilibrated using a membrane contactor where the appropriate mix of N2 and CO2 gas was achieved using three pairs of mass flow controllers (MFCs) set to pHTs of 8.05, 7.85, and 7.65. Each of the three MFCs were randomly assigned to four ambient NH4+ and four enriched NH4+growth chambers for a total of 24 chambers.

Growth rates: Ulva australis thalli were blotted with a tissue to remove excess water and weighed before the start of the experiment and after seven days. The total weight of the three thalli from each chamber was used for the analysis. The RGR, expressed as % day-1, was calculated as RGR = ln(FWf/FWi) x t-1 x 100 where FWi is the initial fresh weight, and FWf is the final fresh weight after t days.

NH4+ uptake rates: At the end of the seven-day incubation period, one of the three Ulva australis thalli (0.43 ± 0.03 g of FW) was removed from each chamber to an Erlenmeyer flask containing 200 mL of filtered seawater with overhead light of 200 µmol photons m-2 s-1. The seawater in each flask was obtained from the automated pH control system shortly before the start of the experiment so the seawater pHT in the flasks was representative of the seawater in the chambers the algae came from. The initial NH4+ concentration of 20 µM was obtained with the addition of NH4Cl to ambient seawater. Flasks were placed on an orbital shaker (RATEK OM7, Victoria, Australia) set to 80 rpm and continuously stirred to induce water motion and reduce boundary layer effects. A 10 mL sample of the water was taken at 0 and 30 minutes, and frozen at -20°C, until defrosted and analyzed for NH4+ concentration using a QuickChem 8500 series 2 Automated Ion Analyzer (Lachat Instrument, Loveland, USA). The uptake rate (V) was determined according to Pedersen [42]] using the formula V = [(Si × voli)-(Sf × volf)]/(t × FW) where Si and Sf are the initial and final NH4+ concentrations (µM) over a period of time (t), vol is the seawater volume in the flask and FW is the fresh weight (g) of the algae.

Internal soluble NH4+ pools: The boiling water extraction method was used to determine the internal soluble NH4+ pool. Ulva australis tissue (0.18 ± 0.01 g FW) was put in a boiling tube with 20 mL of deionized water then placed in a boiling water bath for 40 minutes. The liquid was cooled, decanted, and then filtered through a 0.45 µm Whatman filter (GF/C). This process was repeated on the same algal piece three times and the concentration of internal soluble NH4+ pools was calculated using the sum of the NH4+ concentrations of the three water samples of each algal piece. NH4+ concentrations were measured as stated above.

Photosynthetic pigments: Following the experiment, a 0.04 ± 0.001 g FW piece of Ulva australis from each experimental chamber was kept at -20°C pending analysis. Each sample was then ground in 5 mL of 100% ethanol with a ceramic mortar and pestle in dim light and with the samples shaded. The extract was poured into 10 mL centrifuge tubes and placed in the dark at 4°C for six hours. Samples were then centrifuged for 10 min at 4000 rpm at 4°C. Total Chl a and b concentrations in the supernatant were determined according to the quadrichroic formula from Ritchie [2008] using a spectrophotometer (S-22 UV/Vis, Boeco, Germany).

A complete description of methods for implementation and monitoring of experimental treatments, and sampling methods to estimate response variables provided in the following publication:

Related Reference:

Reidenbach LB, Fernandez PA, Leal PP, Noisette F, McGraw CM, Revill AT, et al. (2017). Growth, ammonium metabolism, and photosynthetic properties of Ulva australis (Chlorophyta) under decreasing pH and ammonium enrichment. PLoS ONE 12(11): e0188389. https://doi.org/10.1371/journal.pone.0188389

Data Processing Description

BCO-DMO Processing Notes:
- added a conventional header with dataset name and description, PI names, version date

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Data Files

File
pCO2_NH4_enrichment_Ulva_australis.csv (Comma Separated Values (.csv), 2.63 KB) MD5:2f00290cc6afabdea5fc5a687c605db7 Primary data file for dataset ID 731368

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Related Publications

Reidenbach, L. B., Fernandez, P. A., Leal, P. P., Noisette, F., McGraw, C. M., Revill, A. T., ... Kübler, J. E. (2017). Growth, ammonium metabolism, and photosynthetic properties of Ulva australis (Chlorophyta) under decreasing pH and ammonium enrichment. PLOS ONE, 12(11), e0188389. doi:10.1371/journal.pone.0188389 *Results*

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Parameters

Parameter	Description	Units
Tank_valve	Tank valve ID for culture treatment	unitless
MFC_ID	Mass-flow controller ID	unitless
Light_Cycle_pHT	Average of all total pH values between 0700-1900 during the experiment for a tank	unitless
Dark_Cycle_pHT1	Average of all total pH values between 1900-0700 during the experiment for a tank	unitless
Whole_Day_pHT	Average of all total pH values during the experiment for a tank	unitless
NH4_Trt	Designated level of treatment of ammonium enrichment categorical descriptor	unitless
Growth_Rate	Biomass specific growth -	percent/day
NH4_uptake	Uptake rate of ammonium	micromoles/gram fresh weight/hour (µmol/g/h)

NH4_pools	Internal soluble ammonium pools in Ulva cells	micromolar/gram fresh weight (µM/g)
Chl_a	Chlorophyll a concentration	milligrams/gram fresh weight (mg/g)
Chl_b	Chlorophyll b concentration	milligrams/gram fresh weight (mg/g)
Tot_Chl	Total chlorophyll concentration (a+b)	milligrams/gram fresh weight (mg/g)
Percent_N	Percent of dry biomass as nitrogen	unitless
Percent_C	Percent of dry biomass as carbon	unitless
C_N_ratio	Biomass ratio of carbon to nitrogen	unitless
rETRmax	Relative maximum electron transport rate at light-saturating photon flux densities	unitless
Ek	Light saturation point	micromoles photons/meter^2/second (µmol photons/m2/s)
alpha	Relative photosynthetic efficiency-slope relative fluorescence/µmol photons/m2/s	relative fluorescence/micromoles photons/meter^2/second (relative fluorescence/µmol photons/m2/s)
beta	Photoinhibition parameter relative fluorescence/µmol photons/m2/s	relative fluorescence/micromoles photons/meter^2/second (relative fluorescence/µmol photons/m2/s)
Fv_Fm	Variable fluorescence (Fm-Fo)/Fm	unitless

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Instruments

Dataset-specific Instrument Name	high-precision data logger (PT-104, PICO Technology, UK)
Generic Instrument Name	Data Logger
Dataset-specific Description	Used to record temperature data during the time-series.
Generic Instrument Description	Electronic devices that record data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors.

Dataset-specific Instrument Name	Omega Engineering, models FMA5418A and FMA545C
Generic Instrument Name	Mass Flow Controller
Dataset-specific Description	Three pairs of MFC's were used to achieve the appropriate mix of N2 and CO2 gas.
Generic Instrument Description	Mass Flow Controller (MFC) - A device used to measure and control the flow of fluids and gases

Dataset-specific Instrument Name	Peristaltic pumps - Omega Engineering, model FPU500; auto-dosing peristaltic pump (Jebao DP-4); syringe pump (V6 pump with valve 24090, Norgren, UK)
Generic Instrument Name	Pump
Dataset-specific Description	Peristaltic pumps (FPU500, Omega Engineering, USA) were used to provide fresh seawater to each of the 24 growth chambers at a rate of 6–8 mL/min. The elevated concentration of NH4+ (n = 12) was achieved using an auto-dosing peristaltic pump (Jebao DP-4) programmed to deliver 12 mL of a 1000 µM NH4Cl solution to growth chambers every two hours. A syringe pump (V6 pump with valve 24090, Norgren, UK) and two 12-port rotary valves (23425 valve driver with valve 24493, Norgren, UK) were used to sample seawater directly from each growth chamber for pH and alkalinity measurements.
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

Dataset-specific Instrument Name	UV-vis Spectrometer - Ocean Optics, USA, BluLoop and USB2000+
Generic Instrument Name	Spectrometer
Dataset-specific Description	Used to measure pH and alkalinity.
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

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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 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
NSF Office of International Science and Engineering (NSF OISE)	OISE-1515267

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