Macrophytes' amelioration of seawater acidity: Water residence time and irradiance of Saccharina latissima from the Gulf of Maine in November 2018

Website: https://www.bco-dmo.org/dataset/922819
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2024-08-22

Project
» REU Site: Bigelow Laboratory for Ocean Sciences - Undergraduate Research Experience in the Gulf of Maine and the World Ocean (Bigelow REU GOM)

Contributors	Affiliation	Role
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Abstract
An experiment examining the effects of water residence time upon Saccharina latissima capacity to ameliorate seawater acidity under ambient and simulated future scenarios of climate change in a gradient of irradiance was conducted indoors using tanks with a flow-through seawater system based at the Bigelow facilities in November 2018. In a previous experiment (experiment 1), we explored the individual capacities of four species of marine macrophytes (Ulva lactuca, Zostera marina, Fucus vesiculosus and Saccharina latissima) to ameliorate seawater acidity in experimentally elevated pCO2. Then in this experiment 2, we used the most responsive species (i.e., Saccharina latissima) to assess the effects of high and low water residence time on the amelioration of seawater acidity in ambient and simulated future scenarios of climate change across a gradient of irradiance. This dataset includes data from experiment 2, residence time and irradiance, described in the manuscript: Optimizing marine macrophyte capacity to locally ameliorate ocean acidification under variable light and flow regimes: Insights from an experimental approach (Ricart, A. M. et al. 2023).

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Coverage

Location: Gulf of Maine, US
Spatial Extent: **Lat**:43.860556 **Lon**:-69.57825
Temporal Extent: 2018-11-01

Dataset Description

Data from a related experiment (experiment 1, comparison among species) is available through BCO-DMO at https://www.bco-dmo.org/dataset/922818.

Methods & Sampling

Methodology summary: The experiment in aquaria measured changes in dissolved oxygen, pH, and total alkalinity, and derived resultant changes to dissolved inorganic carbon (DIC) and calcium carbonate saturation state (Ω).

Values of temperature, salinity and oxygen were measured using a multiparameter meter (HQ40D, Hach Lange). Discrete water samples were acquired from each tank for analysis of pH and total alkalinity (AT) that were run the same day of the experiment. Seawater pH of the discrete water samples was determined on the total scale as per Dickson et al. 2007 with a high-precision spectrophotometer (Agilent Cary 8454 with PCB 1500 Water Peliter System) using unpurified m-cresol purple dye (Alfa Aesar A180025-06). Water samples were kept in a temperature-controlled water bath at 20°C before analysis, and during analysis using a thermostatic cell holder, to minimize temperature-induced errors in absorbance measurements. The spectrophotometer was validated by analyzing TRIS buffer revealing that the system was accurate to within 0.005 pH units. Seawater AT was measured using a CONTROS HydroFIA TA® instrument (4H-Jena GmbH, Jena Germany), which performed a single-point titration of seawater with 0.1N HCl, using bromocresol green as the indicator for spectrophotometric pH detection. HCl titrant was calibrated with Certified Reference Material (Batch 172) from A. Dickson's laboratory. Instrumental precision was within 5 µmol kg -1.

See detailed methodology described in the manuscript: Optimizing marine macrophyte capacity to locally ameliorate ocean acidification under variable light and flow regimes: Insights from an experimental approach (Ricart, A. M. et al. 2023).

Data Processing Description

DIC and Ω, as aragonite saturation state, were calculated from pH and AT.

Carbonate system calculations were performed using the seacarb R package and assuming published values for constants K1 and K2, KF, and KS. Uncertainties of the derived parameters (DIC, pCO2, and Ω) were quantified using a Monte Carlo analysis (100 simulations). For each simulation, normally distributed errors were introduced into pH (± 0.01) and AT (± 5 µmol kg−1). The overall uncertainties of the derived parameters were calculated as one standard deviation of the simulations. On average, uncertainties for DIC were 0.28 %, for pCO2 were 2.5 % and for Ω 0.01 %. For pCO2, uncertainty is higher at lower pCO2, whereas uncertainty is lower for Ω at lower Ω. The uncertainty for DIC was similar to the uncertainty in AT, that is ± 5 µmol kg−1.

BCO-DMO Processing Description

Loaded the submitted file data_to_publish_exp2.csv into Laminar (BCO-DMO data file processor)

The first column of the submitted dataset file, data_to_publish_exp2.csv, did not have a parameter name, and it stood for the row number of each line of the file. Removed this parameter column from the final dataset since a spreadsheet viewer will show the row numbers.

Replaced periods with underscores in the parameter names to follow BCO-DMO parameter naming guidelines.

Removed units from the parameter names because they will be noted in the parameters section of the dataset page.

Replaced NA values with blanks in the Inflow_pH, delta_DIC, delta_pH, and delta_omega_ar columns.

Added a Species parameter value with 'Saccharina latissima' and 'Control' whenever the row value of Kelp_Control is 'Control'. This is to join on the parameter Species in a data manager created metadata table with the columns of Species, and lat, lon.

Joined a metadata table created by the data manager to the submitted dataset on the parameter Species to

include metadata in the primary dataset file.

Converted the date format to the ISO 8601 format %Y-%m-%d

Reordered the parameters so the metadata is at the front of the dataset.

Checked taxonomy of dataset.

Checked that all the species names in the dataset file matched those found in WoRMS.

Created a Species WoRMS taxonomy file species_list_experiment_2.csv by using the WoRMS website to create a table of the species name with the following columns: ScientificName, AphiaID, LSID, Authority, Kingdom, Phylum, Class, Order, Family, Genus, Species.

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Data Files

File
922819_v1_macrophytes_amelioration_irradiance.csv (Comma Separated Values (.csv), 16.54 KB) MD5:67b6bdba01e2c8fd06d44308f00d9435 Primary data file for dataset ID 922819, version 1

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Supplemental Files

File
Species WoRMS taxonomy filename: species_list_experiment_2.csv (Comma Separated Values (.csv), 301 bytes) MD5:4cace669aca7b58cbc8188bfac80075a Species taxonomy table from the World Register of Marine Species (WoRMS) with columns: ScientificName, AphiaID, LSID, Authority, Kingdom, Phylum, Class, Order, Family, Genus, Species Parameter, Definition, Units, BCO-DMO term, Type ScientificName, species, unitless, species, String AphiaID, Unique identifier for the listed taxon in the Aphia database., unitless, taxon_code, Integer LSID, Life Science Identifier (LSID) for the listed taxon., unitless, LSID, String Authority, Name of identifier and year, unitless, no_bcodmo_term, String

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Related Publications

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

Ricart, A. M., Honisch, B., Fachon, E., Hunt, C. W., Salisbury, J., Arnold, S. N., & Price, N. N. (2023). Optimizing marine macrophyte capacity to locally ameliorate ocean acidification under variable light and flow regimes: Insights from an experimental approach. PLOS ONE, 18(10), e0288548. https://doi.org/10.1371/journal.pone.0288548
Results

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Related Datasets

IsRelatedTo

Ricart, A. M., Price, N. N., Honisch, B. (2024) **Macrophytes' amelioration of seawater acidity: Comparison among four species of marine macrophytes (Ulva lactuca, Zostera marina, Fucus vesiculosus and Saccharina latissima) from the Gulf of Maine from June to July 2015.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-08-22 doi:10.26008/1912/bco-dmo.922818.1 [view at BCO-DMO]
Relationship Description: Data from a related experiment (experiment 1, comparison among species)

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Parameters

Parameter	Description	Units
Species	The scientific name of the marine macrophyte species used and Control = no kelp present	unitless
lat	Sampling location latitude, south is negative	decimal degrees
lon	Sampling location longitude, west is negative	decimal degrees
Date	date of experiment	unitless
Aquaria	replicate aquaria	unitless
Future_Ambient	environmental conditions treatments (ambient conditions vs future conditions of temperature and pCO2 in seawater). Values of Ambient or Future.	unitless
Kelp_Control	presence of kelp within the aquaria. Kelp = kelp present. Control = no kelp present	unitless
Kelp_biomass_wet	wet biomass of kelp	grams (g)
Kelp_biomass_dry	dry biomass of kelp	grams (g)
PAR	photosynthetic active radiation	micromols m-2 s-1 (uM m-2 s-1)
Flow_level	residence time treatments (High or Low)	unitless
Salinity	salinity of seawater	unitless
Temperature	temperature of seawater	degrees Celsius (°C)
Inflow_Dissolved_oxygen	Initial dissolved oxygen	micromolar per liter (uM/L)
Inflow_pH	initial pH. Empty values = not available	unitless
Inflow_ALK	initial total alkalinity	micromolar per kilogram (uM/kg)
delta_DO	difference in dissolved oxygen between aquaria inflow and outflow	unitless
delta_DIC	difference in dissolved inorganic carbon between aquaria inflow and outflow. Empty values = not available	unitless
delta_pH	The difference in pH between aquaria inflow and outflow. Empty values = not available	unitless
delta_omega_ar	The difference in omega between aquaria inflow and outflow. Omega is the saturation state of calcium carbonate (CaCO3), the degree to which seawater is saturated with CaCO3. This essentially is a measure of carbonate ion concentration. Empty values = not available	unitless

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Instruments

Dataset-specific Instrument Name	PCB 1500 Water Peliter System
Generic Instrument Name	circulating water bath
Generic Instrument Description	A device designed to regulate the temperature of a vessel by bathing it in water held at the desired temperature. [Definition Source: NCI]

Dataset-specific Instrument Name	multiparameter meter (HQ40D, Hach Lange)
Generic Instrument Name	Multi Parameter Portable Meter
Dataset-specific Description	Designed for water quality applications measuring pH, Conductivity, TDS, Salinity, Dissolved Oxygen (DO), ORP and ISE, the Hach HQ40D portable multi meter is a two channels advanced handheld digital meter.
Generic Instrument Description	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.

Dataset-specific Instrument Name	Agilent Cary 8454
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	The Agilent Cary Diode Array Spectrophotometer 8454 measures a full spectrum, in as little as 0.1 seconds.
Generic Instrument Description	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.

Dataset-specific Instrument Name	CONTROS HydroFIA® TA
Generic Instrument Name	Total alkalinity flow through analyzer
Dataset-specific Description	A defined amount of seawater is acidified by injection of a fixed amount of hydrochloric acid (HCl). After acidification the generated CO_2 in the sample is removed by means of a membrane based degassing unit resulting in a so-called open-cell titration. The subsequent pH determination is carried out by means of an indicator dye (Bromocresol green) and VIS absorption spectrometry. Together with salinity and temperature, the resulting pH is directly used for the calculation of total alkalinity.
Generic Instrument Description	A flow through system for the determination of the total alkalinity in seawater. Its general principle is based on open-cell single-point titration with spectrophotometric pH determination. It can be used for continuous monitoring during surface water applications as well as for discrete sample measurements.

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Project Information

REU Site: Bigelow Laboratory for Ocean Sciences - Undergraduate Research Experience in the Gulf of Maine and the World Ocean (Bigelow REU GOM)

Coverage: Gulf of Maine, US

NSF Award Abstract:

Bigelow Laboratory for Ocean Sciences, in West Boothbay Harbor - Maine, plans to implement an REU site that will support 10 students each year, for the next 5 years. This REU program will combine group learning and guided individual research to help students address societal issues concerning the oceans. The goals of this REU Program are i) to provide undergraduate students from around the United States mentoring and access to high quality, hands on research opportunities in Oceanography and the opportunity to understand its interdisciplinary nature, ii) improve the capability and confidence of students to learn independently, iii) help to prepare undergraduates for their professional careers, and iv) increase the participation of underrepresented minorities in marine science careers. REU students will be incorporated into research groups consisting of technicians, post-docs, and junior and senior scientists, gaining exposure to the suite of activities and personalities involved in a science career. The recruitment goal is to engage students from all groups underrepresented in ocean sciences, such that cohorts are ~ 40% underrepresented students (including 1st generation college students). To achieve the recruitment goals, the principal investigator will work with partner organizations, like the Institute for Broadening Participation and Maine Community College System. Program content and delivery will continually be refined based on feedback from students and mentors in the form of pre-program, midpoint and final evaluations.

As a group, students will participate in a sampling cruise on the local estuary, and attend weekly meetings to learn the fundamentals of the scientific process, such as how to form testable hypotheses, critically evaluate data, and present information in a scientific manner to their peers and to the public. Students will attend an ethics in science discussion, a laboratory safety course with risk assessment training and a concept mapping workshop during the early stages of their project. Students participate in and become familiar with public outreach through attendance at Bigelow's weekly Café Scientifique talks (for the general public), participation in the Lab's Open House and frequent public tours.

Continuing Award

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Funding

Funding Source	Award
NSF Division of Earth Sciences (NSF EAR)	EAR-1460861
NSF Division of Ocean Sciences (NSF OCE)	OCE-1156740

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