Total alkalinity incubation data for coralline algae from August to September 2017 at the Sitka Sound Science Center (SSSC) (High latitude kelp dynamics project)

Website: https://www.bco-dmo.org/dataset/857255
Data Type: experimental, Other Field Results
Version: 1
Version Date: 2021-08-04

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

Contributors	Affiliation	Role
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Abstract
Total alkalinity incubation data for coralline algae individuals and paired controls, run during the last week of a laboratory experiment testing the effects of pH, light availability and biotic interaction on coralline algae calcification and productivity.

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Coverage

Spatial Extent: **Lat**:57.0498 **Lon**:-135.3235
Temporal Extent: 2017-08-07 - 2017-09-21

Dataset Description

Total alkalinity incubation data for coralline algae individuals and paired controls, ru in the last week of 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 55µmol m-2 s-1, 13h d-1, winter = PPFD 40µmol m-2 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 CO2 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).

Total alkalinity (TA) incubations were run in the last week of the experiment on a subset of coralline algae from each treatment (n=3 individuals treatment-1 species-1) by isolating individuals in 245mL glass chambers filled with seawater from their associated aquaria and sealed airtight. Paired Cryptopleura ruprechtiana were not included in incubation chambers in order to isolate the responses of the coralline algae. Chambers were placed on a magnetic stir plate in a water bath at consistent temperature (13°C), with stir bars able to spin freely underneath coralline algae separated by a mesh screen. All incubations were run under a mean PPFD of 80µmol m-2 s-1 for 3h. At the end of the incubation period, seawater from each chamber was collected to measure endpoint TA. Seawater for TA incubation chamber controls was collected from corresponding aquaria at the beginning of each incubation round and used to measure any background TA variation in empty chambers during the incubation period. All discrete water samples for TA were poisoned and processed as outlined in section 2.4.

TA measurements from coralline algal incubations were used to calculate short-term net calcification (Gnet; µmol g-1 DW h-1) using the equation (Smith et al. 1975, Martin et al. 2006): Gnet(CaCO3) = (ΔTA*ν)/(2*DW*Δt), where ΔTA (µmol kgSW-1) is the change in total alkalinity from the beginning to end of the incubation period corrected to chamber controls, ν (L) is the chamber volume, DW (g) is the dry weight of the alga, and Δt (h) is the total incubation time. Dry weights (DW; g) for the living coralline algae used in TA incubations were estimated from buoyant weight (BW; g) measurements using the equation: DW = BW /(1-(ρSW/ρcalcite)),where we used a seawater density (ρSW) of 1.02g cm-3 (from average T and S data at the time of BW) and a calcite density (ρcalcite) of 2.71g cm-3.

Each coralline algae's buoyant weight (Jokiel et al. 1978) was measured to the nearest 0.0001g on a balanced platform suspended below a microbalance in a

temperature-monitored seawater bath. To ensure precision, buoyant weights were repeated for each individual until measurements differed by less than ±0.005g, and then an average was taken of the measurements falling in this range of precision.

Discrete water samples for laboratory measurements of TA were transported to UCSC for analysis within 8 months of collection. TA measurements were performed using open cell titration (Metrohm, 905 Titrandro) and corrected against certified reference materials of CO2 in seawater (Dickson laboratory, Scripps Institution of Oceanography), with an average standard error of ±0.933µmol kg-1 SW-1 among sample triplicates.

Data Processing Description

BCO-DMO processing notes:

Renamed fields to meet BCO-DMO header naming conventions

Merged time and date fields to datetime fields, and added UTC dates

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Data Files

File
tainc_data-1.csv (Comma Separated Values (.csv), 10.07 KB) MD5:9ea4b3405dc9172bdddb36ae80ca480c Primary data file for dataset ID 857255

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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

Jokiel, P. L., Maragos, J. E., & Franzisket, L. (1978). Coral growth: buoyant weight technique. In D. R. Stoddart & R. E. Johannes (Eds.), Coral reefs: research methods (pp. 529–541). Paris: UNESCO. ISBN 9789231014918. Available from https://www.researchgate.net/publication/285472773_Coral_growth_buoyant_weight_technique_In_Stoddart_DR_Johannes_RE_eds_Coral_reefs_research_methods
Methods

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
Related Research

Martin, S., Castets, M.-D., & Clavier, J. (2006). Primary production, respiration and calcification of the temperate free-living coralline alga Lithothamnion corallioides. Aquatic Botany, 85(2), 121–128. doi:10.1016/j.aquabot.2006.02.005
Methods

Smith, S. V., & Key, G. S. (1975). Carbon dioxide and metabolism in marine environments1. Limnology and Oceanography, 20(3), 493–495. doi:10.4319/lo.1975.20.3.0493 https://doi.org/https://doi.org/10.4319/lo.1975.20.3.0493
Methods

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Parameters

Parameter	Description	Units
species	taxonomic identifier of individuala considered OR indicator of control vessel	unitless
header	numerical ID of experimental tank replicate (#1-9)	unitless
tank_rep	alphabetic ID of experimental tank replicate	unitless
alg_ID	alphabetic ID of individual unique to header/tank.rep OR indicator of control vessel (A-H or CONTROL)	unitless
TAinc_start_datetime_AKST	datetime (AKST) of performed TA incubation round start (vessel sealed); format: YYYY-MM-DD H:M	unitless
TAinc_end_datetime_AKST	datetime (AKST) of performed TA incubation round end (vessel opened); format: YYYY-MM-DD H:M	unitless
ISO_TAinc_start_datetime_UTC	datetime (UTC) of performed TA incubation round start (vessel sealed); format: YYYY-MM-DDTH:MZ	unitless
ISO_TAinc_end_datetime_UTC	datetime (UTC) of performed TA incubation round end (vessel opened); format: YYYY-MM-DDTH:MZ	unitless
pH	experimental pH treatment level	unitless
light	experimental light regime treatment (winter or summer)	unitless
assoc	experimental algal association treatment (w = paired w/ C. ruprechtiana; wo = no pairing)	unitless
TAinc_round	numerical ID of TA incubation round (#1-8)	unitless
TAvessel_ID	numerical ID of incubation vessel used (#1-10)	unitless
header_pH	pH of corresponding header bucket at time of TA start	unitless
bwavg	final mean buoyant weight of experimental individual	g
TA_avg_final	mean TA of seawater in vessel at end of TA incubation, from triplicate measurement	µmol kg-1
TA_se_final	TA standard error of seawater in vessel at end of TA incubation, from triplicate measurement	µmol kg-1

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Instruments

Dataset-specific Instrument Name	Sartorius Entris 224-1S Microbalance
Generic Instrument Name	scale or balance
Dataset-specific Description	Each coralline algae's buoyant weight (Jokiel et al. 1978) was measured to the nearest 0.0001g on a balanced platform suspended below a microbalance in a temperature-monitored seawater bath. To ensure precision, buoyant weights were repeated for each individual until measurements differed by less than ±0.005g, and then an average was taken of the measurements falling in this range of precision.
Generic Instrument Description	Devices that determine the mass or weight of a sample.

Dataset-specific Instrument Name	Metrohm 905 Titrandro titrator
Generic Instrument Name	Titrator
Dataset-specific Description	TA measurements were performed using open cell titration (Metrohm, 905 Titrandro) and corrected against certified reference materials of CO2 in seawater (Dickson laboratory, Scripps Institution of Oceanography), with an average standard error of ±0.933µmol kg-1 SW-1 among sample triplicates.
Generic Instrument Description	Titrators are instruments 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

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1752600

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