Mesocosm study of trophic interactions under ocean acidification, focusing on the consumption of algae by snails in Bodega Bay, California

Website: https://www.bco-dmo.org/dataset/866359
Data Type: experimental
Version: 1
Version Date: 2022-03-09

Project
» Trophic consequences of ocean acidification: Intertidal sea star predators and their grazer prey (BOAR Trophic)

Contributors	Affiliation	Role
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Abstract
This dataset represents a mesocosm study of trophic interactions under ocean acidification, focusing on the consumption of algae by snails in Bodega Bay, California. This dataset is part of a larger experiment to investigate how pH influences trophic links between intertidal sea stars (Leptasterias hexactis), snails (Tegula funebralis), and macroalgae (Mazzaella flaccida).

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Coverage

Spatial Extent: **Lat**:38.33325 **Lon**:-123.04805
Temporal Extent: 2015-07-11 - 2015-07-21

Methods & Sampling

This dataset is part of a larger experiment to investigate how pH influences trophic links between intertidal sea stars (*Leptasterias hexactis*), snails (*Tegula funebralis*), and macroalgae (*Mazzaella flaccida)*. These data were gathered during an experiment at the Bodega Marine Laboratory. Wet weight (hand blotted; grams) of algae was determined before and after the experiment using an analytical balance (Mettler AE 160).

Organisms were placed for 7 days in mesocosms containing seawater at either ambient (~7.9) or low pH (~7.0). The pH was modified using equimolar additions of sodium bicarbonate (NaHCO3) and hydrochloric acid (HCl). The water in each container was changed daily. The mesocosm array consisted of 40, 13-liter (L) circular plastic containers with a mesh barrier down the center to separate predator, prey, and/or basal resource but

allowing for passage of waterborne cue. Mesocosms were filled halfway with seawater, allowing 10 centimeters (cm) of refuge space for snails above the waterline. Mesocosms were held within a seawater table under constant flow to maintain consistent temperatures.

Each mesocosm was assigned to one of four trophic treatments and one of two pH levels, resulting in five replicates per treatment and pH (4 trophic × 2 pH × 5 replicates = 40 mesocosms). The first trophic treatment was a “no-predator” configuration, composed of four snails and four 3-cm-diameter circular pieces of *Mazzaella* macroalgae cut out of blades (four pieces = 0.33 g ± 0.03 in total, with each piece standardized to have similar initial mass), both placed on one side of the central barrier of the mesocosm. The second trophic treatment was a “cue only” treatment in which one sea star was housed on one side of the barrier with four snails and macroalgae on the other side. The third was a “complete interaction” treatment in which one sea star, four snails, and macroalgae were all located on the same side of the barrier. The final trophic treatment was a “no prey/no grazing” configuration, for which one sea star was placed on one side of the barrier with the macroalgae on the other. The final trophic treatment was a “no prey/no grazing” configuration, for which one sea star was placed on one side of the barrier with the macroalgae on the other. It was used primarily as a control for predator behavior in the absence of prey, and also provided a control for any changes in macroalgal mass that might occur without grazing, due, for example, to growth or senescence.

Consequences of pH for the strength of net top-down indirect effects were estimated from relative reductions in mass of macroalgae in the no-predator treatment, the cue-only treatment, and the complete interaction treatment across pH levels. Wet weight (blotted dry) of disks excised from *Mazzaella* blades was measured before and after the 7 days to assess macroalgal mass loss. First-order estimates of macroalgal consumption were calculated as the difference in macroalgal mass loss between each container of a trophic treatment and the group mean from the no-grazing treatment for each pH level (algae eaten).

See Jellison, B.M. & Gaylord, B. *Oecologia* (2019).

Data Processing Description

Algae eaten is calculated as the difference in macroalgal mass loss (g) between each container of a trophic treatment and the group mean from the no-grazing treatment for each pH level.

Algae eaten per snail is calculated as macroalgal consumption (Algae eaten) divided by the number of snails remaining in that container at the end of the experiment.

BCO-DMO processing description:
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Replaced blank values with "nd" (no data)
- Added a conventional header with dataset name, PI names, version date

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Data Files

File	
mesocosm_study_-_algae_eaten.csv	(Comma Separated Values (.csv), 2.69 KB) MD5:87f711679eaf302594a4486669159086
Primary data file for dataset ID 866359	

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Related Publications

Jellison, B. M., & Gaylord, B. (2019). Shifts in seawater chemistry disrupt trophic links within a simple shoreline food web. Oecologia, 190(4), 955–967. doi:10.1007/s00442-019-04459-0
Results

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Related Datasets

IsRelatedTo

Jellison, B., Gaylord, B. (2022) **Mesocosm study of trophic interactions under ocean acidification, focusing on sea star behavior in Bodega Bay, CA.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-03-16 doi:10.26008/1912/bco-dmo.866365.1 [view at BCO-DMO]

Jellison, B., Gaylord, B. (2022) **Mesocosm study of trophic interactions under ocean acidification, focusing on snail responses Bodega Bay, CA.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-03-09 doi:10.26008/1912/bco-dmo.869148.1 [view at BCO-DMO]

Jellison, B., Gaylord, B. (2022) **Mesocosm study of trophic interactions under ocean acidification, focusing on the consumption of snails by sea stars in Bodega Bay, CA.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-03-09 doi:10.26008/1912/bco-dmo.869189.1 [view at BCO-DMO]

Jellison, B., Gaylord, B. (2022) **Water chemistry during mesocosm study of trophic interactions under ocean acidification in Bodega Bay, CA.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-03-09 doi:10.26008/1912/bco-dmo.869110.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Container	Container number	unitless
pH	pH treatment level of the container; Low pH ~ 7.0 total pH, Ambient pH ~7.9 total pH	unitless
Trophic_Treatment	Trophic treatment condition; “no-predator” = four snails and four circular pieces of macroalgae on one side of the barrier, “cue only" = one sea star was housed on one side of the barrier with four snails and macroalgae on the other side, "complete interaction" = one sea star, four snails, and macroalgae all placed on one side of the barrier together, “no prey/no grazing” = one sea star was placed on one side of the barrier with the macroalgae on the other.	unitless
Initial_Weight	wet weight (g) of all four macroalgae circular pieces weighed together for each container at the beginning of the experiment	grams
End_Weight	Wet weight in grams (g) of all four macroalgae circular pieces weighed together for each container at the end of the experiment. Two blanks are present in which mesocosms were excluded from the macroalgal analysis, because the macroalgae fragmented during extraction, preventing assessment of the quantity consumed by the snails.	grams
Mass_loss	The difference in wet mass in grams (g) of algae at the beginning and end of the experiment for each container Two blanks are present in which mesocosms were excluded from the macroalgal analysis, because the macroalgae fragmented during extraction, preventing assessment of the quantity consumed by the snails.	grams
Algae_Eaten	First-order estimates of macroalgal consumption calculated as the difference in the macroalgal mass loss in grams (g) between each container of a trophic treatment and the group mean from the no-grazing treatment for each pH level. Blanks are present for the no-grazing treatments which did not contain grazers and in which estimates of macroalgal consumption were not calculated. Two additional blanks are present in which mesocosms were excluded from the macroalgal analysis, because the macroalgae fragmented during extraction, preventing assessment of the quantity consumed by the snails.	grams
Number_of_snails_end	The number of snails remaining at the end of the experiment for each contianer. Each container that contained snails began with 4 snails each.	number
Algae_Eaten_per_snail	First-order estimates of macroalgal consumption (Algae eaten) divided by the number of snails remaining in that container at the end of the experiment. Blanks are present for the no-grazing treatments which did not contain grazers and in which estimates of macroalgal consumption were not calculated. Two additional blanks are present in which mesocosms were excluded from the macroalgal analysis, because the macroalgae fragmented during extraction, preventing assessment of the quantity consumed by the snails.	grams

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Instruments

Dataset-specific Instrument Name	Mettler AE 160 balance
Generic Instrument Name	scale
Generic Instrument Description	An instrument used to measure weight or mass.

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Project Information

Trophic consequences of ocean acidification: Intertidal sea star predators and their grazer prey (BOAR Trophic)

Coverage: Central California coast, USA

NSF Award Abstract:
The absorption of human-produced carbon dioxide into the world's oceans is altering the chemistry of seawater, including decreasing its pH. Such changes, collectively called "ocean acidification", are expected to influence numerous types of sea creatures. This project examines how shifts in ocean pH affect animal behavior and thus interactions among species. It uses a case study system that involves sea star predators, snail grazers that they eat, and seaweeds consumed by the latter. The rocky-shore habitats where these organisms live have a long history of attention, and new findings from this work will further extend an already-large body of marine ecological knowledge. The project provides support for graduate and undergraduate students, including underrepresented students from a nearby community college. The project underpins the development of a new educational module for local K-12 schools. Findings will moreover be communicated to the public through the use of short film documentaries, as well as through established relationships with policy, management, and industry groups, and contacts with the media.

Ocean acidification is a global-scale perturbation. Most research on the topic, however, has examined effects on single species operating in isolation, leaving interactions among species underexplored. This project confronts this knowledge gap by considering how ocean acidification may shift predator-prey relationships through altered behavior. It targets as a model system sea stars, their gastropod grazer prey, and macoalgae consumed by the latter, via four lines of inquiry. 1) The project examines the functional response of the focal taxa to altered seawater chemistry, using experiments that target up to 16 discrete levels of pH. This experimental design is essential for identifying nonlinearities and tipping points. 2) The project addresses both consumptive and non-consumptive components of direct and indirect species interactions. The capacity of ocean acidification to influence such links is poorly known, and better understanding of this issue is a recognized priority. 3) The project combines controlled laboratory experiments with field trials that exploit tide pools and their unique pH signatures as natural mesocosms. Field tests of ocean acidification effects are relatively rare and are sorely needed. 4) A final research phase expands upon the above three components to address effects of ocean acidification on multiple additional taxa that interact in rocky intertidal systems, to provide a broad database that may have utility for future experiments or modeling.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1636191

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