Abalone consumption rates from experiment at the Sitka Sound Science Center (SSSC) from June-October 2017 (High latitude kelp dynamics project)

Website: https://www.bco-dmo.org/dataset/855075
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2021-07-02

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
To determine the effect of current and future seasonal differences in carbonate chemistry on abalone bioenergetics, this experiment exposed juvenile, non-reproductive (36 ± 5 mm) H. kamschatkana to three pH/pCO2 levels (i.e., pHT 8.1, 7.8, 7.5) for four months in a flow-through system at the Sitka Sound Science Center (SSSC) from June-October 2017.

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Coverage

Temporal Extent: 2017-06 - 2017-10

Dataset Description

Data have been published “as is”. Final review by the data submitter was not received after it was imported into the BCO-DMO data system.

Acquisition Description

Sampling and analytical procedures:

To determine the effect of current and future seasonal differences in carbonate chemistry on abalone bioenergetics, we exposed juvenile, non-reproductive (36 ± 5 mm) H. kamschatkana to three pH/pCO2 levels (i.e., pHT 8.1, 7.8, 7.5) for four months in a flow-through system at the Sitka Sound Science Center (SSSC) from June-October 2017. We focused on abalone that were close to transitioning to reproductive maturity (~50 mm; Busch et al., 2014 and references therein) so that we could best capture energetic trade-offs during an energetically costly life history period. The four-month long exposure to stable pH conditions was meant to capture seasonal exposures to relatively constant carbonate chemistry conditions during summer and winter that was demonstrated by our environmental monitoring. The pH values were chosen to capture the current seasonal fluctuations in Sitka Sound (7.8-8.2 pHT for winter-summer, respectively) as well as future projections for winter based on RCP 8.5 (i.e., 7.8 – 0.3 = 7.5 pHT; (Mathis et al., 2015)). The temperature and salinity were not manipulated and reflected the seasonal conditions in Sitka Sound from June-October.

At the end of the experiment, we measured the consumption rate and wet weight for the individual abalone. The abalone were starved for two days. After this, half of the abalone in each aquarium were assigned a *M. pyrifera* only diet, and the other half were assigned a mixed algal diet. Each individual was given four equal sized, pre-weighed discs/pieces of either (1) *M. pyrifera*, or (2) *M. pyrifera, H. nigripes, A. clathratum*, and *C. ruprechtiana* collected from the field just prior to the assay. The trials were stopped before the resources were exhausted, after which the time was noted and the algae were reweighed. We also included resource controls (macroalgae without abalone) to determine if there were any losses of algal biomass not associated with consumption. To account for differences in abalone sizes on grazing rates, mass was included as a covariate in the analysis (see below). At the end of the experiment, we assessed growth via measurements of wet weight.

Processing Description

Processing notes from the researcher:

Variation in consumption rates was assessed using linear mixed effects models in R.

BCO-DMO procesing notes:

Field originally titled "Ab.wet.weight" renamed to AbWetWeight to meet BCO-DMO field naming specifications.

Consumption field rounded to 9 digits after the decimal point.

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Related Publications

Busch, D. S., Maher, M., Thibodeau, P., & McElhany, P. (2014). Shell Condition and Survival of Puget Sound Pteropods Are Impaired by Ocean Acidification Conditions. PLoS ONE, 9(8), e105884. doi:10.1371/journal.pone.0105884
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
Results

Mathis, J., Cross, J., Evans, W., & Doney, S. (2015). Ocean Acidification in the Surface Waters of the Pacific-Arctic Boundary Regions. Oceanography, 25(2), 122–135. doi:10.5670/oceanog.2015.36
https://doi.org/https://doi.org/10.5670/oceanog.2015.36
Methods

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Parameters

Parameter	Description	Units
pH	Categorical variable; pH treatments in experiment. FW = 7.5; CS = 8.1; CW = 7.8.	unitless
Bin	Bin that multiple abalone were housed in, to be considered as random factor in analysis	unitless
CritterID	Individual abalone ID	unitless
Diet	Categorical variable; Macrocystis vs mixed algal diet in experiment. All = all; Macrocystis MIX = mixed algal diet.	unitless
Algae	Categorical variable; Species of algae. M# = Macrocystis pyrifera; N = Neoagarum clathratum; H = Hedophyllum nigripes; C = Cryptopleura ruprechtiana.	unitless
Consumption	Continuous response variable	grams (g) per day
AbWetWeight	Abalone mass	grams (g)

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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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