Laboratory study of estimates of per capita sea urchin grazing rates on Clathromorphum nereostratum, evaluated as a function of sea urchin size

Website: https://www.bco-dmo.org/dataset/755712

Data Type: experimental

Version: 1

Version Date: 2019-02-13

Project

» Ocean Acidification: Century Scale Impacts to Ecosystem Structure and Function of Aleutian Kelp Forests (OA Kelp Forest Function)

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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Abstract

Estimates of per capita sea urchin grazing rates on Clathromorphum nereostratum, evaluated as a function of sea urchin size. Assays were performed under ambient conditions in a controlled mesocosm setting, using the urchin Strongylocentrotus polyacanthus.

Table of Contents

Coverage

Temporal Extent: 2015 - 2015

Dataset Description

Estimates of *per capita* sea urchin grazing rates on *Clathromorphum nereostratum*, evaluated as a function of sea urchin size. Assays were performed under ambient conditions in a controlled mesocosm setting, using the urchin *Strongylocentrotus polyacanthus*.

Acquisition Description

We conducted a controlled laboratory experiment to test whether the capacity of *S. polyacanthus* to consume *C. nereostratum* scales with its size. Conducted under ambient light and continuous water flow (mean water temperature ~8.5 degrees C), this feeding experiment consisted of five sea urchin size classes (15-55 mm test diameter; binned in 10 mm size classes, n = 5/size class). Size classes were evenly distributed among blocks (n = 5), with each block including a control alga (i.e., *C. nereostratum* caged alone) to account for algal growth as well as loss due to factors other than herbivory (see calculation below). Urchins were individually housed with a single *C. nereostratum* colony. We assessed the blotted wet mass of each *C. nereostratum* at the beginning of the assay, then again after 10 days. We calculated the (corrected) amount of *C. nereostratum* consumed in each assay using the equation [Ti x (Cf/Ci)] - Tf, where Ti and Tf is the initial and final mass (respectively) of an alga exposed to herbivory and Ci and Cf is the initial and final mass (respectively) of its paired control.

After computing *per capita* grazing rate ("amount.mg.consumed/day") for each urchin, we also standardized each *per capita* grazing rate by the estimated biomass (calculated via a known size-weight relationship) of the individual urchin ("amount.mg.consumed/d/gram.urchin").

Finally, we quantified the maximum depth (mm) to which each urchin grazed *C. nereostratum* by examining each sample under a microscope and measuring the depth of the most significant grazing scar using an ocular micrometer.

Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions

[table of contents | back to top]

Parameters

Parameter	Description	Units
treatment	target size class of sea urchin	millimeters
replicate	replicate individual urchin or alga	unitless
urchin_diameter_mm	actual size (test diameter) of sea urchin	millimeters
urchin_biomass_grams	biomass of sea urchin; estimated using known length-weight relationship	grams
cca_mass_initial_grams	initial mass of coralline alga	grams
cca_mass_final_grams	final mass of coralline alga	grams
correction_factor	correction factor; computed by dividing the final mass of the paired control alga by its initial mass (Cf/Ci)	unitless
corrected_cca_mass_initial_grams	cca_mass_initial_grams * correction_factor	grams
amount_grams_consumed	amount of coralline algae consumed: corrected_cca_mass_initial_grams minus cca_mass_final_grams	grams
amount_mg_consumed	amount of coralline algae consumed	millimeters
amount_mg_consumed_day	rate of algal consumption (per day)	millimeters
amount_mg_consumed_d_gram_urchin	rate of algal consumption (per day): standardized by the biomass of the individual sea urchin	millimeters
max_depth_grazed_mm	maximum depth of sea urchin grazing scar on the coralline alga	millimeters

[table of contents | back to top]

Project Information

Ocean Acidification: Century Scale Impacts to Ecosystem Structure and Function of Aleutian Kelp Forests (OA Kelp Forest Function)

Extracted from the NSF award abstract: Marine calcifying organisms are most at risk to rapid ocean acidification (OA) in cold-water ecosystems. The investigators propose to determine if a globally unique and widespread calcareous alga in Alaska's Aleutian archipelago, Clathromorphum nereostratum, is threatened with extinction due to the combined effects of OA and food web alterations. C. nereostratum is a slow growing coralline alga that can live to at least 2000 years. It accretes massive 'bioherms' that dominate the regions' rocky substrate both under kelp forests and deforested sea urchin barrens. It develops growth bands (similar to tree rings) in its calcareous skeleton, which effectively record its annual calcification rate over centuries. Pilot data suggest the skeletal density of C. nereostratum began to decline precipitously in the 1990's in some parts of the Aleutian archipelago. The investigators now propose to use high-resolution microscopy and microCT imaging to examine how the growth and skeletal density of C. nereostratum has changed in the past 300 years (i.e., since the industrial revolution) across the western Aleutians. They will compare their records of algal skeletal densities and their variation through time with reconstructions of past climate to infer causes of change. In addition, the investigators will examine whether the alga's defense against grazing by sea urchins is compromised by ongoing ocean acidification. The investigators will survey the extent of C. nereostratum bioerosion occurring at 10 sites spanning the western Aleutians, both inside and outside of kelp forests. At each site they will compare these patterns to observed and monitored ecosystem trophic structure and recent C. nereostratum calcification rates. Field observations will be combined with laboratory experiments to determine if it is a decline in the alga's skeletal density (due to recent OA and warming), an increase in grazing intensity (due to recent trophic-level dysfunction), or their interactive effects that are likely responsible for bioerosion patterns inside vs. outside of forests. By sampling C. nereostratum inside and outside of forests, they will determine if kelp forests locally increase pH via photosynthesis, and thus buffer the effects of OA on coralline calcification. The combination of field observations with laboratory controlled experiments, manipulating CO2 and temperature, will help elucidate drivers of calcification and project how these species interactions will likely change in the near future. The project will provide the first in situ example of how ongoing ocean acidification is affecting the physiology of long-lived, carbonate producing organisms in the subarctic North Pacific. It will also be one of the first studies to document whether OA, ocean warming, and food web changes to ecological processes are interacting in complex ways to reshape the outcome of species interactions in nature.

[table of contents | back to top]

Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: http://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 (http://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-FY2011NSF 12-500, FY 2012NSF 12-600, FY 2013NSF 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 â€“ 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)

[table of contents | back to top]

Funding

Funding Source	Award
NSF Arctic Sciences (NSF ARC)	PLR-1316141

[table of contents | back to top]