Barnacle consumption of Nucella lamellosa that either displayed behavioral or morphological fear responses or not in the presence of predators within laboratory mesocosms at Bodega Marine Lab in 2019

Website: https://www.bco-dmo.org/dataset/948228
Data Type: experimental
Version: 1
Version Date: 2025-01-09

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

Contributors	Affiliation	Role
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Abstract
To examine the impacts of fear removal on the strength of trophic cascades, we measured the number of barnacles (Balanus glandula) consumed by Nucella lamellosa that either displayed either an anti-predatory response to its predator Pisaster ochraceus or ignored the predator. We tested the removal of two types of anti-predatory responses, a behavioral fear response and an inducible morphological defense, to also examine how the type of fear response can influence the strength of trophic cascades. The experiment was conducted within laboratory mesocosms at Bodega Marine Lab in 2019.

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Coverage

Location: Collections along coastline of Sonoma County and Washington Park, CA; mesocosms at Bodega Marine Lab, CA
Spatial Extent: **N**:48.50219 **E**:-122.691865 **S**:38.3180548 **W**:-123.076438
Temporal Extent: 2019-04-08 - 2019-04-18

Dataset Description

See "Related Datasets" section for other datasets to be published in Ng & Gaylord (2025, in-prep). These datasets are also listed on the "Related-Resource" page for that results publication https://www.bco-

dmo.org/related-resource/948176

All datasets in this project can be viewed from the "Dataset Collections" of the project page https://www.bco-dmo.org/project/712799

Methods & Sampling

We collected Nucella lamellosa at Washington Park in Anacortes, Washington (48.502190 N, -122.691865 W) in July 2018 and Balanus glandula at Campbell Cove, California (38.305586 N, -123.057861 W). Pisaster ochraceus were collected along the coastline of Sonoma County, California in 2018.

We used 20 mesocosms with five Nucella each along with Balanus glandula as the basal resource. Half of the mesocosms were used for the fear treatment where Pisaster cue was added to elicit a behavioral fear response in Nucella. Additionally, of the ten mesocosms in the fear treatment, five of the mesocosms contained morphologically induced Nucella and the other five had non-induced individuals. The morphologically induced Nucella were culled at 13% per day and the non-induced Nucella were culled at 16% per day to simulate predation events. The remaining ten mesocosms were used for the no-fear treatment and were also divided into five replicates with induced Nucella and five with non-induced snails. No predator cues were added to the no-fear treatment, and both induced and non-induced Nucella were culled at the enhanced rate of 24% per day. We enumerated the number of Balanus both before and after the experiment.

We used a generalized mixed effects linear model to analyze the number of barnacles consumed by Nucella with morphological induction and the presence of fear behavior as fixed effects. The containers the Nucella were housed in previously for the induction period were added as a random effect. A Poisson distribution was used for this model.

Organism identifiers (taxonomic names used in dataset metadata):

Scientific Name, Life Science Identifier (LSID)
Nucella lamellosa, urn:lsid:marinespecies.org:taxname:404218
Pisaster ochraceus,urn:lsid:marinespecies.org:taxname:240755
Balanus glandula, urn:lsid:marinespecies.org:taxname:394848

Data Processing Description

See "Supplemental Files" for analysis package (R-language).

BCO-DMO Processing Description

* Raw data and analysis script were bundled into file barnacle_consumption_analysis_package.zip with no file changes. Attached as a supplemental file.

* Data table from submitted file "Barnacle consumption.csv" was imported into the BCO-DMO data system. Table will appear on this dataset page as Data File:
948228_v1_barnacle_nucella_consumption.csv (with other download format options).

* Bounding box for dataset determined by sampling locations provided and location of experiment at Bodega Bay Marine Laboratory (38.3180548,-123.0743098).

* Any column names with characters other than letters, numbers and underscores were renamed to meet BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

Missing Data Identifiers:
* In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Taxonomic identifiers added to the metadata (Life Science Identifiers (LSID)). Names matched using the World Register of Marine Species (WoRMS) on 2024-01-02.

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Data Files

File
948228_v1_barnacle_nucella_consumption.csv (Comma Separated Values (.csv), 588 bytes) MD5:f87027c229775b029dfbd8132fc743c2 Primary data file for dataset ID 948228, version 1

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Supplemental Files

File
Barnacle consumption analysis package (R-language) filename: barnacle_consumption_analysis_package.zip (ZIP Archive (ZIP), 3.68 KB) MD5:5c254affc0f5909be48c145cc9640d89 This analysis and plotting package contains scripts for analyzing the laboratory data. Note that the csv data tables included in this package are the exact format of the data required to import into the supplied R-scripts. They differ slightly form the data provided from the BCO-DMO data system due to column naming requirements and date formats (see "BCO-DMO Processing" section). Zip file files: * Barnacle consumption.csv = Raw data of barnacle consumption by Nucella. Data with the filename and column names required for the analysis R-script. This is the source file imported into the BCO-DMO data system for dataset 948228 version 1 (https://www.bco-dmo.org/dataset/948228). * Barnacle consumption stats final.R = Code to analyze barnacle consumption data

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Related Publications

Ng, G., & Gaylord, B. (2025). Identifying the role of fear in trophic cascades. Ecosphere. Manuscript in preparation.
Results

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Related Datasets

IsRelatedTo

Ng, G., Gaylord, B. (2025) **Algal consumption data from Tegula in the presence of the predator Cancer productus, displaying anti-predatory responses or not within mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-01-02 doi:10.26008/1912/bco-dmo.947753.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Algal consumption data from Tegula in the presence of the predator Pisaster ochraceus, displaying anti-predatory responses or not within mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-01-02 doi:10.26008/1912/bco-dmo.947757.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-

prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Behavioral data of Nucella lamellosa in the presence of predators within laboratory mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-01-09 doi:10.26008/1912/bco-dmo.948204.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Behavioral data of Tegula funebralis in the presence of predator Cancer productus within laboratory mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-01-09 doi:10.26008/1912/bco-dmo.948210.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Behavioral data of Tegula funebralis in the presence of predator Pisaster ochraceus within laboratory mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-01-09 doi:10.26008/1912/bco-dmo.948216.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Nucella lamellosa morphometric measurements after induction in the presence of predatory Pisaster ochraceus at Bodega Marine Laboratory in 2018 and 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-04-21 doi:10.26008/1912/bco-dmo.959533.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Predation data of tethered Nucella lamellosa in the presence of predator Pisaster ochraceus within laboratory mesocosms at Bodega Marine Lab in 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-01-09 doi:10.26008/1912/bco-dmo.948222.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Predation data of tethered Tegula funebralis in the presence of predator Cancer productus within laboratory mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-04-21 doi:10.26008/1912/bco-dmo.959435.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

Ng, G., Gaylord, B. (2025) **Predation data of tethered Tegula funebralis in the presence of predator Pisaster ochraceus within laboratory mesocosms at Bodega Marine Lab in 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-04-21 doi:10.26008/1912/bco-dmo.959441.1 [view at BCO-DMO]
Relationship Description: Data from experiments to be published in results publication Ng & Gaylord (2025, in-prep). See "Related-Resource" page for that results publication https://www.bco-dmo.org/related-resource/948176

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Parameters

Parameter	Description	Units
Container_past	a unique identifier for past mesocosms the snails were housed in.	unitless
Container	mesocosm identfier. A unique identifier for individual mesocosm.	unitless
Induction	denotes whether the Nucella in the mesocosms were morphologically induced or not;	unitless
Cue	denotes whether Pisaster cue was used for the treatment;	unitless
Total	indicates total number of barnacles used for the experiment	unitless
Consumed	indicates the total number of barnacles consumed for the experiment.	unitless

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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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