Seasonal data on productivity, characteristics, and community composition of tidepools on the California coast from 2017 to 2018

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Data Type: Other Field Results
Version: 1
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Project
» Collaborative Research: Context-dependency of top-down vs. bottom-up effects of herbivores on marine primary producers (CalCoast Grazer TDBU)

Contributors	Affiliation	Role
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Abstract
This dataset includes information on tide pool attributes by date as well as measurements of oxygen concentrations and fluorescence. Sampling took place in 2017 and 2018 at tide pools located in three regions along the California (USA) coast: (1) Bodega Head, Sonoma County (38.31°N, 123.07°W); (2) Kenneth Norris Rancho Marino Reserve and Hazards Canyon Reef, San Luis Obispo County (35.54°N, 121.09°W and 35.29°N, 128.88°W, respectively); and (3) Corona del Mar State Beach, Orange County (33.59°N, 117.87°W). In the fall of 2017, initial surveys and measurements were conducted quantifying physical attributes, including surface area, volume, and height on the shore. Surveys were repeated every three months until immediately prior to the establishment of grazing experiments at each site in the summer of 2018. During the quarterly surveys, consumer abundances, nutrient fluxes, oxygen fluxes, and photosynthetic biomass in each tide pool were quantified.

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Coverage

Spatial Extent: **N**:38.31948 **E**:-117.865514 **S**:33.5867361 **W**:-123.07452

Temporal Extent: 2017-09-21 - 2018-04-26

Dataset Description

Users of these data are requested to contact Matthew Bracken (m.bracken@uci.edu) prior to use.

Acquisition Description

Methodology:
High-intertidal pools are common in all three regions, allowing us to work at two spatially separated sites in each region. At each site, we identified 18 tide pools, marking each pool and quantifying physical attributes, including surface area, volume, and height on the shore. We also anchored TidbiT temperature datalogger (Onset; Bourne, Massachusetts, USA) in most pools. In the fall of 2017, we identified tide pools and conducted initial surveys and measurements. We repeated surveys every three months until immediately prior to the establishment of grazing experiments at each site in the summer of 2018. These surveys provided insights into the natural temporal variability in community and ecosystem metrics and provided baseline information on relationships between grazer abundances and producer biomass.

Sampling and analytical procedures:
During the quarterly surveys, we quantified consumer abundances, nutrient fluxes, oxygen fluxes, and photosynthetic biomass in each tide pool. Organism abundances were measured by pumping the water from each pool into a bucket, spreading a flexible mesh quadrat over the bottom of the pool, and censusing the algae and invertebrates present in each pool. Nutrient and oxygen fluxes were measured during whole-pool incubations in the dark and in the light.

Productivity:
These productivity data include information on pool attributes by date as well as measurements of oxygen concentrations and fluorescence. Incubations were ideally conducted on sunny days when underwater photon flux measurements in tide pools were > 500 micromoles of photons per square meter per second (umol photons/m2/s). During each incubation, we made initial measurements of the oxygen concentration in each pool and collected a 50 milliliter (ml) water sample from each pool and from the adjacent ocean for nutrient analysis. Then we covered each pool with an opaque plastic sheet for 30 minutes. We repeated our sample collection, then let each pool incubate in the light for another 30 minutes before collecting a third set of samples (Altieri et al. 2009, Sorte and Bracken 2015). Nutrient samples were analyzed for concentrations of NO3-, NO2-, NH4+, and PO43- using standard spectrophotometric and fluorometric methods (Wood et al. 1967, Hansen and Koroleff 1999, Holmes et al. 1999) and used to quantify fluxes of nutrients (micromoles per liter per hour (umol L-1 h-1)) as a function of consumer abundances. Quantifying NO3- and NO2- in addition to NH4+ is important because previous work has highlighted nitrification as an important process during tide pool emersion (Bracken and Nielsen 2004, Pfister 2007). Changes in oxygen concentrations (milligrams per liter (mg L-1), YSI ProODO optical oxygen meter and probe) in the dark and light will be used to calculate rates of community respiration and net and gross community production (Altieri et al. 2009, Noël et al. 2010, O'Connor et al. 2015, Sorte and Bracken 2015).

We used pulse amplitude modulated (PAM) fluorometry to quantify the minimal dark-adapted fluorescence (F0) values in each tide pool (DIVING-PAM, Heinz Walz GmbH). PAM fluorometry provides rapid, nondestructive estimates of photosynthetic biomass (Serôdio et al. 1997, Honeywill et al. 2002, Maggi et al. 2013, LaScala-Gruenewald et al. 2016), and dark-adapted fluorescence values are closely correlated with benthic chlorophyll a concentrations (Honeywill et al. 2002, LaScala-Gruenewald et al. 2016; M. Bracken, personal observation). We cross-calibrated PAM units by relating measured F0 values to extracted chlorophyll a values across multiple instrument gain settings at each site, converting all values to chlorophyll a per unit area.

This work was conducted at sites located in three regions along the California (USA) coast: (1) Bodega Head, Sonoma County (38.31°N, 123.07°W); (2) Kenneth Norris Rancho Marino Reserve and Hazards Canyon Reef, San Luis Obispo County (35.54°N, 121.09°W and 35.29°N, 128.88°W, respectively); and (3)

Corona del Mar State Beach, Orange County (33.59°N, 117.87°W).

Known problems/issues:
Some environmentally-related (e.g., tides, darkness) issues caused gaps in the data. These are indicated by "nd".

Processing Description

Data Processing:
Data reported here were recorded in the field, transcribed into a database, then collated using R.

BCO-DMO Processing:
- Converted dates to format: YYYY-MM-DD
- Replaced commas with semi-colons in the "Weather" column
- Replaced years of "2020" with "2018"
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Added a conventional header with dataset name, PI names, version date
- Rounded latitude and longitude columns to 6 decimal places

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Related Publications

Altieri, A. H., Trussell, G. C., Ewanchuk, P. J., Bernatchez, G., & Bracken, M. E. S. (2009). Consumers Control Diversity and Functioning of a Natural Marine Ecosystem. PLoS ONE, 4(4), e5291. doi:10.1371/journal.pone.0005291
Methods

Bracken, M. E. S., & Nielsen, K. J. (2004). DIVERSITY OF INTERTIDAL MACROALGAE INCREASES WITH NITROGEN LOADING BY INVERTEBRATES. Ecology, 85(10), 2828–2836. doi:10.1890/03-0651
Methods

Hansen, H. P., & Koroleff, F. (n.d.). Determination of nutrients. Methods of Seawater Analysis, 159–228. doi:10.1002/9783527613984.ch10
Methods

Holmes, R. M., Aminot, A., Kérouel, R., Hooker, B. A., & Peterson, B. J. (1999). A simple and precise method for measuring ammonium in marine and freshwater ecosystems. Canadian Journal of Fisheries and Aquatic Sciences, 56(10), 1801–1808. doi:10.1139/f99-128
Methods

Honeywill, C., Paterson, D., & Hagerthey, S. (2002). Determination of microphytobenthic biomass using pulse-amplitude modulated minimum fluorescence. European Journal of Phycology, 37(4), 485–492. doi:10.1017/s0967026202003888 https://doi.org/10.1017/S0967026202003888
Methods

LaScala-Gruenewald, D., Miller, L., Bracken, M., Allen, B., & Denny, M. (2016). Quantifying the top-down effects of grazers on a rocky shore: selective grazing and the potential for competition. Marine Ecology Progress Series, 553, 49–66. doi:10.3354/meps11774
Methods

Maggi, E., Jackson, A. C., Tolhurst, T., Underwood, A. J., & Chapman, M. G. (2012). Changes in microphytobenthos fluorescence over a tidal cycle: implications for sampling designs. Hydrobiologia, 701(1), 301–312. doi:10.1007/s10750-012-1291-x
Methods

Noël, L. M.-L. J., Griffin, J. N., Thompson, R. C., Hawkins, S. J., Burrows, M. T., Crowe, T. P., & Jenkins, S. R. (2010). Assessment of a field incubation method estimating primary productivity in rockpool

communities. Estuarine, Coastal and Shelf Science, 88(1), 153–159. doi:10.1016/j.ecss.2010.03.005
Methods

O'Connor, N. E., Bracken, M. E. S., Crowe, T. P., & Donohue, I. (2015). Nutrient enrichment alters the consequences of species loss. Journal of Ecology, 103(4), 862–870. doi:10.1111/1365-2745.12415
Methods

Pfister, C. A. (2007). INTERTIDAL INVERTEBRATES LOCALLY ENHANCE PRIMARY PRODUCTION. Ecology, 88(7), 1647–1653. doi:10.1890/06-1913.1
Methods

Serodio, J., Silva, J. M., & Catarino, F. (1997). NONDESTRUCTIVE TRACING OF MIGRATORY RHYTHMS OF INTERTIDAL BENTHIC MICROALGAE USING IN VIVO CHLOROPHYLL A FLUORESCENCE1,2. Journal of Phycology, 33(3), 542–553. doi:10.1111/j.0022-3646.1997.00542.x
Methods

Sorte, C. J. B., & Bracken, M. E. S. (2015). Warming and Elevated CO2 Interact to Drive Rapid Shifts in Marine Community Production. PLOS ONE, 10(12), e0145191. doi:10.1371/journal.pone.0145191
Methods

Wood, E. D., Armstrong, F. A. J., & Richards, F. A. (1967). Determination of nitrate in sea water by cadmium-copper reduction to nitrite. Journal of the Marine Biological Association of the United Kingdom, 47(1), 23–31. doi:10.1017/s002531540003352x https://doi.org/10.1017/S002531540003352X
Methods

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Related Datasets

IsRelatedTo

Bracken, M., Martiny, A., Miller, L. P. (2021) **Characteristics of tidepools from seasonal surveys conducted at tidepools along the California coast from 2017 to 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-12-16 http://lod.bco-dmo.org/id/dataset/862207 [view at BCO-DMO]

Bracken, M., Martiny, A., Miller, L. P. (2021) **Tidepool attributes by date and ecological survey data from seasonal surveys conducted at tidepools along the California coast from 2017 to 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-12-16 http://lod.bco-dmo.org/id/dataset/861571 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Site	Site of measurements (BMR = Bodega Marine Reserve; RMR = Rancho Marino Reserve / Hazards Canyon Reef; CDM = Corona del Mar)	unitless
Survey_Date	Date of survey in format: YYYY-MM-DD	unitless
Weather	Weather recorded by surveyors	unitless
Pool	Pool number and station (A or B), including adjacent Ocean	unitless
Latitude	Latitude in decimal degrees North	Decimal Degrees
Longitude	Longitude in decimal degrees East (West is negative)	Decimal Degrees

Tide_Height	Height of pool	meters above MLLW
Max_Depth	Maximum depth of pool	centimeters
Perimeter	Perimeter of pool	meters
Surface_Area	Surface area of pool	Number of squares (0.1 square meters)
Dye_Volume	Volume of pool in Liters estimated using dye method	Liters
Pump_Volume	Volume of pool in Liters estimated using pump method	Liters
Tide_Height2	Height of pool	meters above MLLW
Initial_Light	Light level in tidepool	micromoles per meter squared per second (umol/m2/sec)
Initial_Salinity	Salinity level in tidepool	PSU
Initial_DO	Dissolved oxygen in tidepool	milligrams per liter (mg/L)
Initial_Temp	Temperature of tidepool	degrees celsius (°C)
Initial_pH	pH of tidepool	unitless
Initial_Time	Initial measurement & tarp placement time (24hr time) in format: hh:mm. Time zone is Pacific (PST/PDT).	unitless
Dark_Light	Light level in tidepool	micromoles per meter squared per second (umol/m2/sec)
Dark_Salinity	Salinity level in tidepool	PSU
Dark_DO	Dissolved oxygen in tidepool	milligrams per liter (mg/L)
Dark_Temp	Temperature of tidepool	degrees celsius (°C)
Dark_pH	pH of tidepool	unitless
Dark_PAM1	dark-adapted F0	fluorescence units
Dark_PAM2	dark-adapted F0	fluorescence units
Dark_PAM3	dark-adapted F0	fluorescence units
Dark_PAM4	dark-adapted F0	fluorescence units
Dark_Time	Dark measurement & tarp removal (24 hr time) in format: hh:mm. Time zone is Pacific (PST/PDT).	unitless
Recovery_Light	Light level in tidepool	micromoles per meter squared per second (umol/m2/sec)
Recovery_Salinity	Salinity level in tidepool	PSU
Recovery_DO	Dissolved oxygen in tidepool	milligrams per liter (mg/L)
Recovery_Temp	Temperature of tidepool	degrees celsius (°C)
Recovery_pH	pH of tidepool	unitless
Recovery_Time	Recovery measurement time (24 hr time) in format: hh:mm. Time zone is Pacific (PST/PDT)	unitless

Notes	Notes transcribed from data sheets	unitless

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Instruments

Dataset-specific Instrument Name	DIVING-PAM, Heinz Walz GMbH
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	Garmin eTrex handheld GPS unit
Generic Instrument Name	Global Positioning System Receiver
Generic Instrument Description	The Global Positioning System (GPS) is a U.S. space-based radionavigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis. The U.S. Air Force develops, maintains, and operates the space and control segments of the NAVSTAR GPS transmitter system. Ships use a variety of receivers (e.g. Trimble and Ashtech) to interpret the GPS signal and determine accurate latitude and longitude.

Dataset-specific Instrument Name	ProDSS and ProODO optical oxygen meters and probes
Generic Instrument Name	YSI Professional Plus Multi-Parameter Probe
Generic Instrument Description	The YSI Professional Plus handheld multiparameter meter provides for the measurement of a variety of combinations for dissolved oxygen, conductivity, specific conductance, salinity, resistivity, total dissolved solids (TDS), pH, ORP, pH/ORP combination, ammonium (ammonia), nitrate, chloride and temperature. More information from the manufacturer.

Dataset-specific Instrument Name	Self-leveling rotary laser kit, CST/berger
Generic Instrument Name	Laser
Generic Instrument Description	A device that generates an intense beam of coherent monochromatic light (or other electromagnetic radiation) by stimulated emission of photons from excited atoms or molecules.

Dataset-specific Instrument Name	TidbiT temperature datalogger (Onset; Bourne, Massachusetts, USA)
Generic Instrument Name	Temperature Logger
Generic Instrument Description	Records temperature data over a period of time.

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Project Information

Collaborative Research: Context-dependency of top-down vs. bottom-up effects of herbivores on marine primary producers (CalCoast Grazer TDBU)

Coverage: Coast of California, USA

Humans are modifying marine food webs both from the top-down, by reducing consumer abundances, and from the bottom-up, by adding nutrients to coastal habitats. Predicting these impacts is complicated because herbivores affect primary producers both from the top-down, by eating them, and from the bottom-up, by recycling nutrients and facilitating the recruitment of algae into local marine ecosystems. This project uses experimental manipulations along a natural gradient in nutrient availability on the California coast to evaluate the complex interactions between top-down and bottom-up processes in marine communities. This project includes experiments and outreach in a location with substantial exposure to the public, and the investigators will work with community and university outreach personnel to communicate this research to broader audiences. Specifically, the project includes mechanisms for curriculum development and outreach and will train undergraduate and graduate students in marine science.

The investigators are implementing a suite of innovative approaches to understand the multiple roles that herbivores play in marine systems. Traditional experimental methods for herbivore removal result in the loss of both the consumptive and facilitative effects of herbivores. In contrast, the investigators' experimental design allows them to partition the different effects of herbivores on marine primary producers. These methods, including observations, experiments, and modeling approaches, allow researchers to (i) calculate the relative importance of herbivores' consumptive and facilitative effects on algal diversity and abundance; (ii) determine the effects of temperature, nutrients, and herbivores on the microbial community; and (iii) evaluate the relative importance of internal processes and spatial subsidies.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736891
NSF Division of Ocean Sciences (NSF OCE)	OCE-1737065
NSF Division of Ocean Sciences (NSF OCE)	OCE-1904184

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