Sea urchin (Eucidaris) quadrat counts at twelve sites in the Galápagos Islands in 2016-2017

Website: https://www.bco-dmo.org/dataset/872905
Data Type: Other Field Results
Version: 1
Version Date: 2022-04-11

Project
» RAPID: Testing the ability of the 2015-2017 El Nino Southern Oscillation (ENSO) to drive a community-level regime shift in the Galapagos marine ecosystem (SPONGERAPDGALPGS)

Contributors	Affiliation	Role
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Abstract
Sea urchin (E. galapagensis) densities showed high variability across twelve study sites in the Galápagos Islands in 2016-2017. Sea urchin densities ranged from a low of 0.17 individuals per 0.25 square meter quadrat at the Pinzon site to a maximum of 7.7 individuals per quadrat at the Champion site in January 2016.

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Coverage

Spatial Extent: **N**:-0.23696 **E**:-90.14065 **S**:-1.32879 **W**:-90.74908
Temporal Extent: 2016-07 - 2017-07

Methods & Sampling

Quadrat survey techniques were used at twelve sites in the Galápagos Islands in 2016-2017 to determine counts and species density of *Eucidaris* sea urchins. Quadrats were 0.25 square meter areas randomly established following the methods of Witman and Smith (2003). A 'quadrapod' camera framer holding an underwater camera was used to capture digital photo quadrat images (42 megapixel resolution) which were subsequently viewed on a computer. This was the same field sampling method described in Witman and Smith (2003) except this study used a Sony AR digital camera in a Nauticam underwater housing. The sampling was achieved by a diver swimming along the transect tape and taking photo quadrats at the random marks on the tape. The large thick spines of the *Eucidaris galapagensis* enable the sea urchins to be readily recognized and counted. Sea urchins were manually counted from digital images of the quadrats (photo quadrats) displayed on a computer screen. The counts were then entered by quadrat and site into an Excel spreadsheet.

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Data Files

File
sea_urchin_density.csv (Comma Separated Values (.csv), 29.05 KB) MD5:ff8ea725631131a4dee91f13fa67e6e2 Primary data file for dataset ID 872905

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Related Publications

Lamb, R. W., Smith, F., Aued, A. W., Salinas-de-León, P., Suarez, J., Gomez-Chiarri, M., Smolowitz, R., Giray, C., & Witman, J. D. (2018). El Niño drives a widespread ulcerative skin disease outbreak in Galapagos marine fishes. In Scientific Reports (Vol. 8, Issue 1). Springer Science and Business Media LLC. https://doi.org/10.1038/s41598-018-34929-z
Methods

Witman, J. D., & Smith, F. (2003). Rapid community change at a tropical upwelling site in the Galapagos Marine Reserve. Biodiversity and Conservation, 12(1), 25–45. https://doi.org/10.1023/a:1021200831770 https://doi.org/10.1023/A:1021200831770
Methods
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Results

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Related Datasets

IsSupplementedBy

Witman, J. D. (2017) **Measurement site locations from RAPDGALPGS project in the Eastern Tropical Pacific, Galapagos Islands, Ecuador in 2015 and the SPONGERAPDGALPGS project in 2016 and 2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2017-03-03 http://lod.bco-dmo.org/id/dataset/628159 [view at BCO-DMO]
Relationship Description: Measurement site locations for current dataset

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Parameters

Parameter	Description	Units
Year	Year of sample collection	unitless
Month	Month of sample collection	unitless
Latitude	Latitude of sample collection	decimal degrees
Longitude	Longitude of sample collection	decimal degrees
Site	Study site in the central Galapagos archipelago where samples were collected	unitless
Quadrat_number	Quadrat number indicating the independent 0.25 square meter area	unitless
Eucidaris_density	Sea urchin density or number of Eucidaris galapagensis photographed in the quadrat	unitless

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Instruments

Dataset-specific Instrument Name	Sony AR digital camera
Generic Instrument Name	Camera
Dataset-specific Description	A Sony AR digital camera in Nauticam underwater housing was used to capture digital photo quadrat images
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	
Generic Instrument Name	Diving Mask and Snorkel
Dataset-specific Description	The sampling was achieved by a diver swimming along the transect tape and taking photos
Generic Instrument Description	A diving mask (also half mask, dive mask or scuba mask) is an item of diving equipment that allows underwater divers, including, scuba divers, free-divers, and snorkelers to see clearly underwater. Snorkel: A breathing apparatus for swimmers and surface divers that allows swimming or continuous use of a face mask without lifting the head to breathe, consisting of a tube that curves out of the mouth and extends above the surface of the water.

Dataset-specific Instrument Name	millimeter scale for photo images
Generic Instrument Name	ruler
Dataset-specific Description	A scale (mm) on the sides of the quadrat allowed measurement of organisms in the images.
Generic Instrument Description	A device used for measuring or for drawing straight lines, consisting of an elongated piece of rigid or semi-rigid material marked with units for measurement. Device that allows one or more physical dimensions of a sample or specimen to be determined by visible comparison against marked graduations in units of measurement of dimension length.

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Project Information

RAPID: Testing the ability of the 2015-2017 El Nino Southern Oscillation (ENSO) to drive a community-level regime shift in the Galapagos marine ecosystem (SPONGERAPDGALPGS)

Website: http://www.witmanlab.com/responses-to-el-nintildeo-events-in-galapagos-subtidal-ecosystems.html

Coverage: Eastern Tropical Pacific, Galápagos Islands, Ecuador (00.41100 S, 90.27525 W)

NSF Award Abstract:
Changes in the ecological structure, biodiversity and functioning of ecosystems have occurred in all types of habitats. Sometimes the change is so large and abrupt that the ecosystem switches to an alternate state, or regime, that persists for long periods of time (i.e. decades to millennia) such as the switch between a vegetated and desert ecosystem in the Sahara. Since regime changes may drastically alter the ecosystem goods and services provided to humankind, there is a practical as well as theoretical need to understand the conditions and drivers leading to tipping points between alternate regimes. To date, little is known about either the pre-conditions or drivers of regime change, particularly in subtidal habitats where long-term data on the ecological state of communities of interacting species prior to regime change is difficult to obtain. Most of the knowledge about tropical regime shifts in marine habitats has focused on shifts between corals and macroalgae even though these organisms represent only part of a species-rich ecosystem with many possible trajectories and outcomes of regime change. Consequently, the overarching goal of the proposed investigation is to test a conceptual model developed herein predicting how both El Niño and La Niña phases of the unusually strong 2016 ENSO (El Niño Southern Oscillation) may drive a regime shift in the Galapagos rocky subtidal at the whole community level. As the target community involves sponges as a key component, in addition to barnacles, Crustose Coralline Algae (CCA), corals, sea urchins, sea stars and predatory fish, the model tests predictions from the Sponge Reef Hypothesis (SRH), an emerging paradigm predicting that sponges may increasingly dominate space as corals decline from future climate change (representing a coral to sponge regime change). Preliminary data indicate that counter to the SRH, sponges declined during the unusually warm temperatures at the outset of the present ENSO in Galapagos subtidal communities. However, sea urchin predation on sponges and CCA appears to have accelerated at the same time, so manipulative field experiments are proposed to rigorously test and differentiate the effects of ENSO elevated temperature on sponge mortality from the effects of enhanced sea urchin predation on sponges. These experimental results will be evaluated in the context of actual, long-term (13-16 year) changes in the whole community obtained by quantitative re-sampling of the benthic community at 12 sites in the central Galapagos throughout the present ENSO. Re-sampling this baseline will also enable the analysis of indicators leading up to the hypothesized regime change. Broader educational impacts of the project will transpire at all levels from high school students to graduate students and the public.

Although regime changes have been described as abrupt shifts to alternate, persistent states in many ecosystems in response to natural or anthropogenic drivers, research on regime change in bottom-dwelling

communities of tropical oceans has largely focused on a switch from coral-dominated to macroalgal-dominated regimes. This narrow focus overlooks potential influences of the diverse assemblages of sessile invertebrates such as sponges that share space on the hard substrate of reefs with corals and could proliferate as a new regime if corals are diminished. The SRH is an emerging community ecological paradigm that posits that sponges may increasingly dominate space as corals decline from future climate change and ocean acidification, yet it has not been rigorously tested. The exceptionally strong El Niño occurring in the Galapagos Islands presents a unique opportunity evaluate the potential for climate oscillations to create regime shifts at the community level and to test the SRH because subtidal benthic community structure has been quantified at least annually since 1999 at multiple sites in the central Galapagos Islands. Recent 2015 surveys indicated significant mortality of sponges at multiple sites coincident with the present El Niño warming, counter to the SRH. However, sea urchin predation on sponges and Crustose Coralline Algae (CCA) appears to have accelerated at the same time, so manipulative field experiments are proposed to rigorously test and differentiate the effects of ENSO elevated temperature on sponge mortality from the effects of enhanced sea urchin predation on sponges. More specifically, eight main hypotheses along with four alternate hypotheses are developed and proposed from a new conceptual model predicting direct and indirect pathways of regime change in a community of CCA, sponges, barnacles, corals, sea urchins, sea stars and predatory fish. The research will be performed in the rocky subtidal at the 12 community baseline sites in the central Galapagos archipelago during four trips in 2016-2017 bracketing the El Niño and La Niña phases. The proposed combination of experimental and observational (i.e. baseline re-sampling) methods will enable a rigorous evaluation of climate-induced direct and indirect pathways of regime change in tropical benthic ecosystems.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1623867

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