Measurement site locations from RAPDGALPGS project in the Eastern Tropical Pacific, Galapagos Islands, Ecuador in 2015 and the SPONGERAPDGALPGS project in 2016 and 2017

Website: https://www.bco-dmo.org/dataset/628159
Data Type: Other Field Results
Version:
Version Date: 2017-03-03

Project
» RAPID: Understanding Thresholds and regime shifts in marine ecosystems: effects of the 2014-2015 El Nino in the Galapagos rocky subtidal (RAPDGALPGS)
» 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
Witman, Jon D.	Brown University	Principal Investigator, Contact
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Gegg, Stephen R.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager
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Coverage

Spatial Extent: **N**:-0.23696 **E**:-90.14065 **S**:-1.32879 **W**:-90.74908

Dataset Description

Measurement Sites for Subtidal Temperature Data and barnacle percent cover observations made in the central Galápagos Islands (6 and 12-15 m depth), Ecuador during 2015, 2016, and 2017.

Methods & Sampling

Generated from original file: "witman_temperature_sites.csv" contributed by Franz Smith.

Data Processing Description

BCO-DMO data manager processing notes:
- Generated from original file: "witman_temperature_sites.csv" contributed by Franz Smith

- version 10 Feb 2017: Updated the previous version (03 Dec 2015) by adding more site locations

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Data Files

File
Sites.csv (Comma Separated Values (.csv), 381 bytes) MD5:4e37dce1821e23d10f20d8d0fbeff7a9 Primary data file for dataset ID 628159

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Related Datasets

IsSupplementTo

Witman, J. D. (2022) **Sea urchin (Eucidaris) quadrat counts at twelve sites in the Galápagos Islands in 2016-2017.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-04-11 doi:10.26008/1912/bco-dmo.872905.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
site	Site Name	text
lat	Site Latitude (South is negative)	decimal degrees
lon	Site Longitude (West is negative)	decimal degrees

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Deployments

RAPDGALPGS_Champion-15m

Website	https://www.bco-dmo.org/deployment/628044
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-12
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Champion Site, 15 meter depth

RAPDGALPGS_Cuatro_Hermanos-15m

Website	https://www.bco-dmo.org/deployment/628047
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-13
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Cuatro Hermanos Site, 15 meter depth

RAPDGALPGS_Daphne_Menor-15m

Website	https://www.bco-dmo.org/deployment/628050
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-09
End Date	2015-07-15
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Daphne Menor Site, 15 meter depth

RAPDGALPGS_Islote_Gardner-15m

Website	https://www.bco-dmo.org/deployment/628056
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-12
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Islote Gardner Site, 15 meter depth

RAPDGALPGS_Las_Cuevas-15m

Website	https://www.bco-dmo.org/deployment/628062
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-12
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Las Cuevas Site, 15 meter depth

RAPDGALPGS_La_Botella-15m

Website	https://www.bco-dmo.org/deployment/628059
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-13
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - La Botella Site, 15 meter depth

RAPDGALPGS_Pinzon-15m

Website	https://www.bco-dmo.org/deployment/628065
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-14
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Pinzon Site, 15 meter depth

RAPDGALPGS_Rocas_Beagle-15m

Website	https://www.bco-dmo.org/deployment/628068
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-09
End Date	2015-07-14
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Rocas Beagle Site, 15 meter depth

RAPDGALPGS_Guy_Fawkes-15m

Website	https://www.bco-dmo.org/deployment/628053
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-08
End Date	2015-07-15
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Guy Fawkes Site, 15 meter depth

RAPDGALPGS_Champion-12m

Website	https://www.bco-dmo.org/deployment/628219
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-07
End Date	2015-07-12
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Champion Site, 12 meter depth

RAPDGALPGS_Daphne_Menor-6m

Website	https://www.bco-dmo.org/deployment/628223
Platform	RAPDGALPGS Temperatures
Start Date	2015-01-09
End Date	2015-07-15
Description	Subtidal temperature data from 2015 at sites in the central Galápagos Islands (12-15 m depth), Ecuador - Daphne Menor Site, 6 meter depth

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Project Information

RAPID: Understanding Thresholds and regime shifts in marine ecosystems: effects of the 2014-2015 El Nino in the Galapagos rocky subtidal (RAPDGALPGS)

Website: http://www.witmanlab.com

Coverage: Eastern Tropical Pacific, Galapagos Islands: 00.41100 S, 90.27525 W

The question addressed in this project is: Does the 2014-2015 El Niño cause a regime shift in Galapagos subtidal ecosystems? And if so, what thresholds are crossed to drive the change from rocky subtidal communities with abundant corals to a barnacle dominated regime? Regime shifts are non-linear "ecological surprises" in the sense that the endpoint is not predictable as a linear outcome of a driver variable. The working hypothesis for this project is that the forthcoming 2014-2015 El Niño will create non-linear effects that are negative for corals which bleach during extreme temperature variability of the El Niño Southern Oscillation (ENSO), but are positive for the benthic (bottom dwelling) food chain dependent on barnacles for food. The specific work in the Galapagos will contribute to the general understanding of non-linear effects of climate stress in marine ecosystems, which has been highlighted as a critical information gap needed to understand the effects of climate change on ecosystems. The study will also inform best practices for the conservation of corals, which are threatened worldwide by multiple stressors and cumulative direct, and indirect impacts.

Perturbations such as El Niños can drive ecosystems to a tipping point as thresholds are exceeded and a sudden transition to a different state (regime) occurs. Since the frequency of extreme El Niños is projected to increase with climate change, there is a pressing need to develop a more comprehensive understanding of how ENSOs affect marine communities in the context of climate change. Currently, the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center predicts a 70-80 % chance of an El Niño occurring during the northern hemisphere summer-winter of 2014-2015. This project leverages an existing quantitative baseline on benthic community structure in the Galapagos subtidal to address 12 predictions about community-ecosystem level impacts of the oncoming 2014-2015 El Niño. The research employs an observational-experimental approach to test the predictions and to discern if additional bleaching stress to corals and further increases in barnacles associated with this ENSO ultimately leads to an ecosystem state (regime) characterized by declining coral populations and increasing barnacles and their predators.

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-1450214
NSF Division of Ocean Sciences (NSF OCE)	OCE-1623867

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