Vulnerability of coral reefs to bioerosion from land-based sources of pollution using parameters quantified by computerized tomography.

Website: https://www.bco-dmo.org/dataset/739309
Data Type: Other Field Results
Version: 1
Version Date: 2018-06-27

Project
» Collaborative Research: Identifying the Role of Basin-scale Climate Variability in the Decline of Atlantic Corals (Coral climate effects)

Contributors	Affiliation	Role
Cohen, Anne L.	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator, Contact
Prouty, Nancy	United States Geological Survey (USGS)	Co-Principal Investigator
Ake, Hannah	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Coral Growth Parameters Quantified by Computerized Tomography (CT) for Growth Rate (cm/yr), Density (g/cm3), and Calcification Rates (g/cm2/yr), Percent Volume Erosion (%), Measured Bioerosion Rate (mg/ cm2/ yr), Predicted Bioerosion Rate (mg/cm2/ yr) Based on DeCarlo et al (2015).

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Coverage

Spatial Extent: **Lat**:20.9386 **Lon**:-156.6933
Temporal Extent: 2013-07-10 - 2013-07-11

Dataset Description

Coral Growth Parameters Quantified by Computerized Tomography (CT) for Growth Rate (cm/yr), Density (g/cm3), and Calcification Rates (g/cm2/yr), Percent Volume Erosion (%), Measured Bioerosion Rate (mg/ cm2/ yr), Predicted Bioerosion Rate (mg/cm2/ yr) Based on DeCarlo et al (2015).

Methods & Sampling

Coral cores (n57) were collected in July 2013 from the shallow reef at Kahekili in Kaanapali, West Maui, Hawaii, from scleractinian Porites lobata (Figure 1) in water depths of between 1 and 3 m and in the vicinity of brackish SGD "seeps" near Kahekili Beach Park (Glenn et al., 2013), approximately 0.5 km southwest of the LWRF (Table 1). All cores were collected from living Porites spp., except for adjacent to the seep where the coral colony was dead upon collection. Colonies were selected based on several criteria including distance from shore, distance from seep, coral shape, and water depth. Metrics of coral reef health (bioerosion,calcification, and growth rate) were quantified at the Woods Hole Oceanographic Institution’s CT Scanning Facility (Crook et al., 2013) where CT scan images (supporting information Figure S1) were used to calculate the proportion of the skeleton eroded (>1 mm boring diameter) by boring organisms and calculated as the total volume of CaCO3 removed relative to the total volume of the individual Porites coral core (Barkley et al., 2015; DeCarlo et al., 2015) using coral CT (DeCarlo & Cohen, 2016). The average growth rate reported in this study is the average linear extension rate and respective standard deviation for the length of cores analyzed per site. Pearson correlation coefficients and respective p values were calculated in Excel. Significance levels were tested at the 95% and 90% confidence level. The number of years for analysis ranged from the upper 10–26 years and was calculated as linear extension (mm) per year. The range (i.e., length of core analyzed) reflects the fact that the quality/preservation of banding was not consistent across the collection sites due to differences in boring and erosion (supporting information Figure S1). In comparison to measured bioerosion rates, predicted bioerosion rates were calculated using the equation from DeCarlo et al. (2015) where bioerosion rate5211.96 * Xarag143.52. Coral life spans were calculated based on annual growth rate and core length. Coral life span for the dead specimen was determined by comparing bomb-derived radiocarbon (14C) values measured at five depth intervals to reference bomb-curves from Hawaii (Andrews et al., 2016). Samples were prepared for Accelerator Mass Spectrometry (AMS) radiocarbon(14C) dating at the National Ocean Sciences Accelerator Mass Spectrometry (NOSAMS) facility.

Coral nitrogen isotope (d15N) values were determined by collecting skeletal material (300 mg) from the upper 4.0–5.6 mm of growth. Approximately 18 mg of material was placed into tin capsules with an approximately equivalent mass of vanadium oxide (V2O5) catalyst to ensure complete combustion for analysis using a Costech elemental analyzer—Isotope Ratio Mass Spectrometry (EA-IRMS) at the University of California at Santa Cruz and the USGS Stable Isotope Lab to determine d15N composition. Analytical uncertainty of0.16&is reported based on replicate analysis of the international nitrogen standard, acetanilide.

Sampling for water at the primary seep site and in adjacent coastal waters was conducted in September 2014 and March 2016. In 2014, sampling of the submarine springs was conducted using a piezometer point directly inserted into the primary seep site (Swarzenski et al., 2012) and a 12 V peristaltic pump during both high and low tide (supporting information Table S1). At each sampling site, the salinity and temperature of the seep water and bottom water was recorded using calibrated YSI multiprobes. Seawater sampling in March 2016 was conducted near the coral sites every 4 h over a 6 day period for nutrients and carbonate chemistry variables. A peristaltic pump was used to pump seawater from the seafloor and temperature and salinity were recorded using a calibrated YSI multimeter. In situ temperatures were also recorded fromSolonist CTD Divers installed at each sampling tube (Prouty et al., 2017).

Data Processing Description

Coral CT scan code (DeCarlo and Cohen 2016)

BCO-DMO processing notes:

-reformatted dates to yyyy-mm-dd
-reformatted column names to comply with BCO-DMO standards
-replaced blank cells with nd

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Data Files

File
coral.csv(Comma Separated Values (.csv), 798 bytes) MD5:9422c954d0e0c6cbe54e52c0a9255cc2 Primary data file for dataset ID 739309

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Related Publications

Andrews, A. H., Siciliano, D., Potts, D. C., DeMartini, E. E., & Covarrubias, S. (2016). Bomb Radiocarbon and the Hawaiian Archipelago: Coral, Otoliths, and Seawater. Radiocarbon, 58(3), 531–548. doi:10.1017/rdc.2016.32 https://doi.org/10.1017/RDC.2016.32
Methods

Barkley, H. C., Cohen, A. L., Golbuu, Y., Starczak, V. R., DeCarlo, T. M., & Shamberger, K. E. F. (2015). Changes in coral reef communities across a natural gradient in seawater pH. Science Advances, 1(5), e1500328–e1500328. doi:10.1126/sciadv.1500328
Methods

Crook, E. D., Cohen, A. L., Rebolledo-Vieyra, M., Hernandez, L., & Paytan, A. (2013). Reduced calcification and lack of acclimatization by coral colonies growing in areas of persistent natural acidification. Proceedings of the National Academy of Sciences, 110(27), 11044–11049. doi:10.1073/pnas.1301589110
Methods

DeCarlo, T. M., & Cohen, A. L. (2016, July 14). Coralct: Software Tool To Analyze Computerized Tomography (Ct) Scans Of Coral Skeletal Cores For Calcification And Bioerosion Rates (Version 1.1). Zenodo. https://doi.org/10.5281/zenodo.57855
Methods

DeCarlo, T. M., Cohen, A. L., Barkley, H. C., Cobban, Q., Young, C., Shamberger, K. E., Brainard R.E., Golbuu, Y. (2015). Coral macrobioerosion is accelerated by ocean acidification and nutrients. Geology, 43(1), 7–10. doi:10.1130/g36147.1 https://doi.org/10.1130/G36147.1
Methods

Glenn, C. R., Whittier, R. B., Dailer, M. L., Dulaiova, H., El-Kadi, A. I., Fackrell, J., … Sevadjian, L. (2013). Lahaina Groundwater Tracer Study—Lahaina, Maui, Hawaii (final report, 502 p.). Honolulu, HI: State of Hawaii Department of Health, the U.S. Environmental Protection Agency, and the U.S. Army Engineer Research and Development Center. https://hdl.handle.net/10125/50768
Methods

Prouty, N. G., Cohen, A., Yates, K. K., Storlazzi, C. D., Swarzenski, P. W., & White, D. (2017). Vulnerability of Coral Reefs to Bioerosion From Land-Based Sources of Pollution. Journal of Geophysical Research: Oceans, 122(12), 9319–9331. doi:10.1002/2017jc013264 https://doi.org/10.1002/2017JC013264
Results
,
Methods

Swarzenski, P. W., Storlazzi, C. D., Presto, M. K., Gibbs, A. E., Smith, C. G., Dimova, N. T., … Logan, J. B. (2012). Nearshore morphology, benthic structure, hydrodynamics, and coastal groundwater discharge near Kahekili Beach Park, Maui, Hawaii (U.S. Geol. Surv. Open-File Rep. 2012-1166, 34 p.). Reston, VA: U.S. Geological Survey.
Methods

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Parameters

Parameter	Description	Units
Date	Date of collection; yyyy-mm-dd	unitless
Latitude	Latitude	decimal degrees
Longitude	Logitude	decimal degrees
Sample_ID	Sample ID number	unitless
Core_Length	Core length	centimeters
Water_depth	Water depth	meters
Lifespan	Life span	years
Tissue_thickness	Tissue thickness	milimeters
Growth_rate	Growth rate	centimeters per year
Density	Density	grams per centimeters cubed
Bioerosion_volume	Bioerosion volume	percent
Calcification_rate	Calcification rate	grams per square centimeter per year
Bioerosion_rate	Bioerosion rate	miligrams per square centimeter per year
delta_N_15	Coral tissue nitrogen isotope	per mil
delta_N_15_error	Standard error for coral tissue nitrogen isotope	per mil

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Instruments

Dataset-specific Instrument Name	Siemens Volume Zoom Spiral computed tomography (CT) scanner
Generic Instrument Name	Computerized Tomography (CT) Scanner
Dataset-specific Description	The cores were passed through the Siemens Volume Zoom Spiral computed tomography (CT) scanner at Woods Hole Oceanographic Institution.
Generic Instrument Description	A CT scan makes use of computer-processed combinations of many X-ray measurements taken from different angles to produce cross-sectional (tomographic) images (virtual "slices") of specific areas of a scanned object.

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Deployments

Dongsha_Atoll_expedition_Cohen_Lab-2014

Website	https://www.bco-dmo.org/deployment/738566
Platform	Unknown Platform
Start Date	2013-06-29
End Date	2013-06-29

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Project Information

Collaborative Research: Identifying the Role of Basin-scale Climate Variability in the Decline of Atlantic Corals (Coral climate effects)

Coverage: Bermuda and wider Caribbean

Text from the NSF award abstract:

Human carbon dioxide emissions are causing measureable changes in ocean conditions. Many of these changes negatively affect coral reef ecosystems, reducing their ability to provide food, arable land, tourist destinations and coastline protection for hundreds of millions of people worldwide. This project focuses on the effects of enhanced stratification, caused by ocean warming, on the growth of reef-building corals across the Caribbean and Bermuda. Enhanced stratification impacts primary productivity which generates food for corals. Initial data generated by the investigators suggest that Atlantic coral growth has declined in the last 5 decades in response to these changes. A laboratory-based experiment is designed to test this hypothesis. If verified, the projected decline in Atlantic primary productivity through the 21st century could potentially rival and will certainly exacerbate the effects of warming and ocean acidification on coral reef ecosystems across the North Atlantic. Support is provided for graduate research, and undergraduate participation is facilitated through the Woods Hole Oceanographic Institution Summer Fellowship and the Bermuda Institute of Ocean Sciences-Princeton Environmental Institute Summer Internship Programs. The results will be presented at national and international meetings and disseminated in a timely manner through peer-reviewed publications. All data produced through this program will be archived in the Biological and Chemical Oceanographic Data Management Office.

Anthropogenic climate change has emerged as a principle threat to coral reef survival in the 21st century. In addition to ocean warming and acidification, global climate models project enhanced stratification of the upper oceans through the 21st century and a consequent decline in productivity, by up to 50%, in the North Atlantic. This project employs controlled laboratory manipulation experiments to test the link between productivity and growth of the dominant reef-building corals across the Caribbean and Bermuda. Preliminary data generated by the investigators, including multi-decade long coral growth histories and nitrogen isotope ratios of coral tissue and skeleton, suggest that coral growth across the region has declined over the past 50 years in response to productivity changes already underway. If the link between ocean circulation, productivity decline, and coral growth is verified, the projected 21st century decline in productivity could rival and will certainly exacerbate the effects of warming and ocean acidification on North Atlantic coral reef ecosystems.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1537338

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