Annual growth chronologies of Siderastrea siderea and Pseudodiploria strigosa on the Florida Keys Reef Tract, 2015-2016

Website: https://www.bco-dmo.org/dataset/734706
Data Type: Other Field Results
Version: 1
Version Date: 2018-04-30

Project
» Investigating the influence of thermal history on coral growth response to recent and predicted end-of-century ocean warming across a cascade of ecological scales (Thermal History and Coral Growth)

Contributors	Affiliation	Role
Castillo, Karl D.	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Principal Investigator
Rippe, John P.	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student, Contact
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset includes annual measurements of extension, density, and calcification for 39 Siderastrea siderea cores and 31 Pseudodiploria strigosa cores from inner and outer reef sites spanning ~200 km of the Florida Keys Reef Tract.

Table of Contents

Coverage

Spatial Extent: **N**:25.5919 **E**:-80.09561 **S**:24.4956 **W**:-81.64903
Temporal Extent: 2015-05 - 2016-05

Dataset Description

This dataset includes annual measurements of extension, density and calcification for 39 Siderastrea siderea cores and 31 Pseudodiploria strigosa cores from inner and outer reef sites spanning ~200 km of the Florida Keys Reef Tract.

Methods & Sampling

In May 2015 and 2016, skeletal cores were collected from 39 colonies of Siderastrea siderea and 31 colonies of Pseudodiploria strigosa at four pairs of inner-outer reef sites spanning the Florida Keys Reef Tract. All cores were extracted from the vertical growth axis of each coral colony using a CS Unitec model 2 1335 0010 hydraulic drill affixed with hollow extension rods and a 5 cm diameter wet diamond core bit. Collected cores were then stored in capped PVC tubes filled with 100% EtOH and transported to the University of North

Carolina at Chapel Hill where they were air dried in preparation for sclerochronology development. To assess coral skeletal growth histories, all cores were scanned using X-ray computed tomography (CT) on a Siemens Biograph CT scanner at the Biomedical Research Imaging Center, University of North Carolina at Chapel Hill. Coral cores were oriented lengthwise in rows of 4 to 5 on the scanning table, and equipment parameters were set to 120 kV, 250 mAs and 0.6 mm slice thickness with images reconstructed at 0.1 mm increments using the H70h “Very Sharp Spine” window.

All images were exported from the CT scanner as DICOM files, which were then 3-dimensionally reconstructed using the open-access Horos v2.0.2 medical image viewing software. High- and low-density bands were visualized using a 10-mm thick ‘Mean’ projection oriented as a rectangular prism through the center of each core. All boundaries between semiannual density bands were delineated manually and three sets of linear transects were drawn down the length of the cores using the Region of Interest (ROI) tool in Horos. Note, each set of transects was drawn within the exothecal space between corallite walls in order to standardize density measurements and to avoid aberrant density spikes in areas where the transect may otherwise have crossed a high-density corallite wall. Density and calcification measurements are therefore lower than would be expected if all features of the skeletal architecture were taken into account. Additionally, it has been shown that individual colonies may vary in their timing of high- and low-density band deposition due to intraspecific differences in tissue thickness and morphology (Barnes and Lough, 1996; Carricart-Ganivet, 2013). Thus, to approximate a consistent time standard between cores, we begin all chronologies at the top of the first fully deposited density band beneath the band of terminal growth. By-pixel density measurements were extracted from linear transects and average density was calculated for each semiannual high- and low-density band. Following DeCarlo et al (2015), nine coral standards of known density were included in every scanning session to convert density measurements from CT Hounsfield units to g cm-3. Average density of each standard was assessed in Hounsfield units using Horos and a standard curve was created for all cores scanned in the corresponding session. Linear extension (cm) was measured in Horos as the width of each annual density band couplet, and calcification (g cm-2 yr-1) was calculated as the product of density and linear extension.

Note, because cores were collected in subsequent years, the most recent year of growth (2015) was not included for cores collected in 2016 in order to keep the beginning of chronologies uniform throughout.

Analysis was based on previously published methods in Castillo et al (2011), Castillo et al (2012).

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date

[table of contents | back to top]

Data Files

File
coralGrowth_FL.csv (Comma Separated Values (.csv), 292.06 KB) MD5:ed6ed3f51248f1f93ae39daec66628cb Primary data file for dataset ID 734706

[table of contents | back to top]

Related Publications

BARNES, D. J., & LOUGH, J. M. (1996). Coral skeletons: storage and recovery of environmental information. Global Change Biology, 2(6), 569–582. doi:10.1111/j.1365-2486.1996.tb00068.x
Methods

Carricart-Ganivet, J. P., Vásquez-Bedoya, L. F., Cabanillas-Terán, N., & Blanchon, P. (2013). Gender-related differences in the apparent timing of skeletal density bands in the reef-building coral Siderastrea siderea. Coral

Reefs, 32(3), 769–777. doi:10.1007/s00338-013-1028-y
Methods

Castillo, K. D., Ries, J. B., & Weiss, J. M. (2011). Declining Coral Skeletal Extension for Forereef Colonies of Siderastrea siderea on the Mesoamerican Barrier Reef System, Southern Belize. PLoS ONE, 6(2), e14615. doi:10.1371/journal.pone.0014615
Methods

Castillo, K. D., Ries, J. B., Weiss, J. M., & Lima, F. P. (2012). Decline of forereef corals in response to recent warming linked to history of thermal exposure. Nature Climate Change, 2(10), 756–760. doi:10.1038/nclimate1577
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

[table of contents | back to top]

Parameters

Parameter	Description	Units
species	Code for coral species sampled: ssid=Siderastrea siderea ; pstr=Pseudodiploria strigosa	unitless
reefZone	Inner vs outer reef	unitless
transect	Inner-outer reef site pair: ir or or	unitless
site	Sampling site identifier	unitless
coreID	Unique identifier for each coral core	unitless
lat	Latitude; north is positive	decimal degrees
lon	Longitude; east is positive	decimal degrees
year	Year corresponding to each density band	unitless
linext	Annual measurement of linear extension	centimeters/year (cm/yr)
density	Annual measurement of density	grams/centimeter^3 (g/cm3)
calc	Annual measurement of calcification	grams/centimeter^2/year (g/cm2/yr)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Siemens Biograph CT scanner
Generic Instrument Name	Computerized Tomography (CT) Scanner
Dataset-specific Description	Used to collect coral slice densities measurements. Settings: 120 kV, 250 mAs, 0.6 mm slice thickness with images reconstructed at 0.1 mm increments using the H70h “Very Sharp Spine” window.
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.

Dataset-specific Instrument Name	CS Unitec model 2 1335 0010 hydraulic core drill
Generic Instrument Name	Drill Core
Dataset-specific Description	Used to collect coral cores.
Generic Instrument Description	A core drill is a drill specifically designed to remove a cylinder of material, much like a hole saw. The material left inside the drill bit is referred to as the core. Core drills are used frequently in mineral exploration where the coring may be several hundred to several thousand feet in length. The core samples are recovered and examined by geologists for mineral percentages and stratigraphic contact points. This gives exploration companies the information necessary to begin or abandon mining operations in a particular area.

[table of contents | back to top]

Project Information

Investigating the influence of thermal history on coral growth response to recent and predicted end-of-century ocean warming across a cascade of ecological scales (Thermal History and Coral Growth)

Website: http://www.unc.edu/~kdcastil/research.html

Coverage: Western Caribbean

Description from NSF award abstract:
Rising global ocean surface temperatures have reduced coral growth rates, thereby negatively impacting the health of coral reef ecosystems worldwide. Recent studies on tropical reef building corals reveal that corals' growth in response to ocean warming may be influenced by their previous seawater temperature exposure - their thermal history. Although these recent findings highlight significant variability in coral growth in response to climate change, uncertainty remains as to the spatial scale at which corals' thermal history influences how they have responded to ocean warming and how they will likely respond to predicted future increases in ocean temperature. This study investigates the influence of thermal history on coral growth in response to recent and predicted seawater temperatures increases across four ecologically relevant spatial scales ranging from reef ecosystems, to reef communities, to reef populations, to an individual coral colony. By understanding how corals have responded in the past across a range of ecological scales, the Principal Investigator will be able to improve the ability to predict their susceptibility and resilience, which could then be applied to coral reef conservation in the face of climate change. This research project will broaden the participation of

undergraduates from underrepresented groups and educate public radio listeners using minority voices and narratives. The scientist will leverage current and new partnerships to recruit and train minority undergraduates, thus allowing them to engage high school students near field sites in Florida, Belize, and Panama. Through peer advising, undergraduates will document this research on a digital news site for dissemination to the public. The voice of the undergraduates and scientist will ground the production of a public radio feature exploring the topic of acclimatization and resilience - a capacity for stress tolerance within coral reef ecosystems. This project will provide a postdoctoral researcher and several graduate students with opportunities for field and laboratory research training, teaching and mentoring, and professional development. The results will allow policy makers from Florida, the Mesoamerican Barrier Reef System countries, and several Central American countries to benefit from Caribbean-scale inferences that incorporate corals' physiological abilities, thereby improving coral reef management for the region.

Coral reefs are at significant risk due to a variety of local and global scale anthropogenic stressors. Although various stressors contribute to the observed decline in coral reef health, recent studies highlight rising seawater temperatures due to increasing atmospheric carbon dioxide concentration as one of the most significant stressors influencing coral growth rates. However, there is increasing recognition of problems of scale since a coral's growth response to an environmental stressor may be conditional on the scale of description. This research will investigate the following research questions: (1) How has seawater temperature on reef ecosystems (Florida Keys Reef Tract, USA; Belize Barrier Reef System, Belize; and Bocas Del Toro Reef Complex, Panama), reef communities (inshore and offshore reefs), reef populations (individual reefs), and near reef colonies (individual colonies), varied in the past? (2) How has seawater temperature influenced rates of coral growth and how does the seawater temperature-coral growth relationship vary across these four ecological spatial scales? (3) Does the seawater temperature-coral growth relationship forecast rates of coral growth under predicted end-of-century ocean warming at the four ecological spatial scales? Long term sea surface temperature records and small-scale high-resolution in situ seawater temperature measurements will be compared with growth chronologies for the reef building corals Siderastrea siderea and Orbicella faveolata, two keystone species ubiquitously distributed throughout the Caribbean Sea. Nutrients and irradiance will be quantified via satellite-derived observations, in situ measurements, and established colorimetric protocols. Field and laboratory experiments will be combined to examine seawater temperature-coral growth relationships under recent and predicted end-of-century ocean warming at four ecologically relevant spatial scales. The findings of this study will help us bridge the temperature-coral growth response gap across ecologically relevant spatial scales and thus improve our understanding of how corals have responded to recent warming. This will lead to more meaningful predictions about future coral growth response to climate change.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459522

[table of contents | back to top]