Sponge volume from repeated surveys in St. Thomas, U.S. Virgin Islands, before and after the 2017 hurricane season

Website: https://www.bco-dmo.org/dataset/889972
Data Type: Cruise Results
Version: 1
Version Date: 2023-02-24

Project
» RAPID: Collaborative Research: Sponge resilience in the face of multiple stressors (Sponge resilience)

Contributors	Affiliation	Role
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Abstract
Prior to the 2017 hurricanes, six shallow (8-15 meter depth) reef sites had been selected from the Virgin Islands Territorial Coral Reef Monitoring Program's (TCRMP) permanent monitoring sites to study variation in sponge communities - Black Point (BP), Coculus Rock (CR), and Magens Bay (MB), which are in embayments with heavily developed watersheds. Buck Island (BI) and Savana Island (SI) are located near undeveloped offshore cays. Botany Bay (BB) is a nearshore site in a bay with a low level of watershed development. This dataset represents sponge volume from these repeated surveys before and after the 2017 hurricane season. We used three randomly selected transects out of the six permanently established 10-meter TCRMP transects at each site. The same three transects at each site were re-surveyed repeatedly in August 2016 (pre-hurricanes), December 2017 (10 weeks post-hurricanes), March 2018 (24 weeks post-hurricanes), November 2018 (61 weeks post-hurricanes), and July 2019 (93 weeks post-hurricanes).

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Coverage

Spatial Extent: **N**:18.3743 **E**:-64.0345 **S**:18.2786 **W**:-64.9851
Temporal Extent: 2016 - 2019

Methods & Sampling

Prior to the 2017 hurricanes, six shallow (8-15 meter depth) reef sites had been selected from the Virgin Islands Territorial Coral Reef Monitoring Program's (TCRMP) permanent monitoring sites to study variation in sponge communities in St. Thomas, U.S. Virgin Islands. These sites included Black Point (N18° 20.665', W64°

59.107'), Coculus Rock (N18° 18.734', W64° 51.613'), and Magen's Bay (N18° 22.459', W64° 56.077'), which are in embayments with heavily developed watersheds. Buck Island (N18° 16.717', W64° 53.925') and Savana Island (N18° 20.437', W65° 04.939') are located near undeveloped offshore cays. Botany Bay (N18° 21.433', W65° 02.071') is a nearshore site in a bay with a low level of watershed development.

For this study, we used three randomly selected transects out of the six permanently established 10-meter TCRMP transects at each site. The same three transects at each site were re-surveyed repeatedly in August 2016 (pre-hurricanes), December 2017 (10 weeks post-hurricanes), March 2018 (24 weeks post-hurricanes), November 2018 (61 weeks post-hurricanes), and July 2019 (93 weeks post-hurricanes).

Sponge assemblages were surveyed on each transect using multiple measures. Sponge density was quantified by a diver in situ by counting every sponge individual (i.e., ramet) within 0.5 meters (m) of each transect (resulting in 0.5 x 10 m belt transects) for all sites except Black Point in 2016, where 0.5 m on both sides of the transects (1 x 10 m belt transects) were surveyed. Density (sponges/m2) was calculated as the total number of individual sponges per transect, divided by the transect area (Gochfeld et al. 2020).

At each site, sponge volume was calculated within permanent 1 square meter (m2) quadrats centered on the transect line within the initial and/or final meter of the transect. Sponge volume was calculated for 3-5 quadrats per site. As there were over 80 species of sponges within our survey areas, representing a wide diversity of morphologies, we used a standardized measurement approach for all sponges, rather than calculating the true volumetric measurement for each sponge based on its actual morphology. Thus, sponges were essentially treated as cuboids. We used a flexible sewing tape to measure the longest dimension of the sponge, then one to several width measurements perpendicular to the initial length measurement, and one to several height measurements, as needed to represent the shape and dimensions of each sponge. Multiple measurements for each dimension were averaged and length x width x height was calculated. For large tubes, of which there were relatively few, we subtracted the dimensions of the interior cavity from the exterior dimensions of the sponge. Generated data were in centimeters cubed (cm3) of sponge per meter squared (Gochfeld et al. 2020).

The percent cover of sponges was determined from videos of the three transects at each site following established methods from the Virgin Islands Territorial Coral Reef Monitoring Program (Smith et al. 2016). A diver swam at uniform speed while videoing the substrata from a height of approximately 0.4 m (the height of a guide wand). Consecutive, non-overlapping images, each approximately 0.64 x 0.48 m in planar area, were captured for each transect, for an average of 21 images per transect. Twenty random points were superimposed on each image (average of 1282 points per site, per sampling period) and the benthic cover underneath each point was identified to the lowest identifiable taxonomic level and used in the calculation of percent cover by transect. Specific sponges were not identified in the benthic cover analysis and were instead grouped into the overarching category of "Sponge". The number of points per image required to adequately characterize the percent cover of each of the benthic categories (sponges, hard corals, macroalgae, epilithic algal community [EAC; i.e., diminutive turf algae and other low complexity filamentous algal communities; Smith et al. 2016], non-living substrata, calcareous algae, cyanobacterial mats, gorgonians, zoanthids, and other/unknown living substrata) was determined by visual inspection of the running means. For all categories, the mean value stabilized at no more than 17 points per image per transect, indicating that the 20 points analyzed per image were sufficient to accurately reflect the percent cover at these sites (Gochfeld et al. 2020).

To determine whether different sponge morphologies were differentially affected by hurricanes, each sponge from each transect was assigned to a broad morphological category (sensu Wulff 2006). These categories included excavating sponges ("excavating"); low relief encrusting sponges ("encrusting"); thicker cushions, massive, tube, vase, or other amorphous shapes of medium relief ("massive"); and upright, branching, and rope sponges ("upright"). These groupings differ slightly from those used by Wulff (2006) but represent the morphotypes found within our transects in St. Thomas. The percent of the entire sponge community represented by each morphological category was calculated as the number of individuals in each category divided by the total number of individuals for each transect and multiplied by 100 (Gochfeld et al. 2020).

To describe the sponge assemblages across dates and sites, all sponges recorded in each transect were identified to the lowest possible taxonomic level. For those that could not be identified in situ, photographs and voucher samples collected into 90 percent ethanol were used for spicule preparations and sectioning and identified with the help of collaborator Dr. M. Cristina Diaz. For each transect, the abundance of each sponge taxon was converted into a proportion (number of individuals/total number of sponges in that transect) for analysis.

Data Processing Description

To test for effects of the hurricanes (2016 vs. 2017), subsequent recovery (2017-2019) and resilience (2016 vs. 2019) on various metrics of the sponge community at the six sites, repeated-measures analyses of variance (RMANOVAs) were performed on sponge density, volume, species richness and Shannon index [H+] in JMP. Square-root transformations were performed in order to meet the assumptions for parametric analysis. For significant effects of time, site or time x site interactions, post-hoc comparisons were performed using Tukey's HSD tests in JMP.

Sponge percent cover was not fully blocked in 2019 (i.e., some sites were surveyed in July 2019, while others were surveyed in November 2019, both months or neither), so a 2-way ANOVA was performed on percent cover with site and date as fixed factors, followed by Tukey's HSD post-hoc tests.

To characterize hurricane effects and recovery for sponges with differing morphologies, a RMANOVA was performed on arcsin transformed proportions of each morphotype to test for the main effects of site and year, followed by Tukey's HSD post-hoc tests where warranted.

Sponge species composition was characterized using the species-specific sponge counts on each transect. Proportional sponge abundances were entered into PRIMER v6 + PERMANOVA (Clarke and Warwick 2001). Diversity indices (species richness [S], Shannon index [H']) were calculated in PRIMER and compared using RMANOVAs, followed by Tukey's least square means post-hoc tests in JMP.

The sponge assemblages were visualized using nonmetric multidimensional scaling (nMDS) plots generated in the PRIMER 7 + PERMANOVA software package (Plymouth Routines in Multivariate Ecological Research; Clarke et al. 2014) for all sites combined and for each site separately. A Bray-Curtis similarity matrix was calculated for the ranked proportional abundance of each species and analyzed with a permutational ANOVA (PERMANOVA), with site and date as fixed factors, using the PERMANOVA function in PRIMER, followed by pairwise tests among dates. Species contributing to dissimilarity among dates were identified using Similarity of Percentages (SIMPER) analysis in PRIMER. For the species identified as major contributors to dissimilarity among dates in the SIMPER analysis, patterns of change in abundance across sites and dates were analyzed using two way ANOVAs on ranked proportions.

BCO-DMO Processing Description:
- Added columns for "Latitude" and "Longitude" by site

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Data Files

File
spongevolume.csv (Comma Separated Values (.csv), 4.75 KB) MD5:55f6a080ece31afb59066f062edc1175 Primary datafile for dataset 891588, version 1.

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Related Publications

Clarke, K. R., Gorley, R. N., Somerfield, P. J., & Warwick, R. M. (2014). Change in marine communities: an approach to statistical analysis and interpretation.
Methods

Clarke, K., & Warwick, R. (2001). A further biodiversity index applicable to species lists: variation in taxonomic distinctness. Marine Ecology Progress Series, 216, 265–278. doi:10.3354/meps216265
Methods

Gochfeld, D. J., Olson, J. B., Chaves-Fonnegra, A., Smith, T. B., Ennis, R. S., & Brandt, M. E. (2020). Impacts of Hurricanes Irma and Maria on Coral Reef Sponge Communities in St. Thomas, U.S. Virgin Islands. Estuaries and Coasts, 43(5), 1235–1247. doi:10.1007/s12237-020-00694-4
Methods

Smith, T.B., R.S. Ennis, E. Kadison, R.S. Nemeth, and L. Henderson. (2016) The United States Virgin Islands Territorial Coral Reef Monitoring Program. 2016 Annual Report. University of the Virgin Islands, United States Virgin Islands. 286 pp.
Methods

Wulff, J. L. (2006). Resistance vs Recovery: Morphological Strategies of Coral Reef Sponges. Functional Ecology, 20(4), 699–708. http://www.jstor.org/stable/3806619
Methods

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Related Datasets

IsRelatedTo

Gochfeld, D. J., Brandt, M., Olson, J. (2023) **Raw cover of sponges from repeated surveys in St. Thomas, U.S. Virgin Islands, before and after the 2017 hurricane season.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-08 doi:10.26008/1912/bco-dmo.890324.1 [view at BCO-DMO]

Gochfeld, D. J., Brandt, M., Olson, J. (2023) **Sponge Density, Morphology, and Assemblages from repeated surveys in St. Thomas, U.S. Virgin Islands, before and after the 2017 hurricane season.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-02-27 doi:10.26008/1912/bco-dmo.890333.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Year	Year of sampling	unitless
Site	Sample site unique identifier (BP=Black point; BB=Botany bay; BI=Buck Island; CR=Coculus Rocks; MB=Magen's bay; SI=Savana Island	unitless
Latitude	Latitude of sampling site North (South is negative)	decimal degrees
Longitude	Longitude of sampling site East (West is negative)	decimal degrees
quadrat	Quadrat unique identifier	unitless
sponge_volume	volume of sponges	centimeters cubed per square meter (cm3/m2)

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Measuring Tape
Generic Instrument Description	A tape measure or measuring tape is a flexible ruler. It consists of a ribbon of cloth, plastic, fibre glass, or metal strip with linear-measurement markings. It is a common tool for measuring distance or length.

Dataset-specific Instrument Name	
Generic Instrument Name	Self-Contained Underwater Breathing Apparatus
Generic Instrument Description	The self-contained underwater breathing apparatus or scuba diving system is the result of technological developments and innovations that began almost 300 years ago. Scuba diving is the most extensively used system for breathing underwater by recreational divers throughout the world and in various forms is also widely used to perform underwater work for military, scientific, and commercial purposes. Reference: http://oceanexplorer.noaa.gov/technology/diving/diving.html

Dataset-specific Instrument Name	
Generic Instrument Name	Underwater Camera
Generic Instrument Description	All types of photographic equipment that may be deployed underwater including stills, video, film and digital systems.

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Deployments

17336

Website	https://www.bco-dmo.org/deployment/891561
Platform	R/V F.G. Walton Smith
Start Date	2017-12-02
End Date	2017-12-18
Description	Sponge Resilience Project

18079

Website	https://www.bco-dmo.org/deployment/891564
Platform	R/V F.G. Walton Smith
Start Date	2018-03-18
End Date	2018-04-03
Description	Sponge resilience project

18325

Website	https://www.bco-dmo.org/deployment/891567
Platform	R/V F.G. Walton Smith
Start Date	2018-11-21
End Date	2018-12-08
Description	Sponge resilience project

19178

Website	https://www.bco-dmo.org/deployment/891569
Platform	R/V F.G. Walton Smith
Start Date	2019-06-27
End Date	2019-07-17
Description	Sponge resilience project

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Project Information

RAPID: Collaborative Research: Sponge resilience in the face of multiple stressors (Sponge resilience)

Coverage: St. Thomas, U.S. Virgin Islands

NSF Award Abstract:
Over the past several decades, coral reefs worldwide have undergone a transition from being dominated by the corals themselves to being dominated by sponges or algae. The causes of these changes are complex, but they include both natural stressors, such as diseases and hurricanes, and impacts from human activities, such as coastal development and climate change. There are over 600 species of sponges on Caribbean coral reefs, and they serve many important ecological roles, including nutrient cycling, providing food and shelter for other reef animals, and producing a tremendous diversity of chemical compounds that are important for controlling species interactions on the reef, and may serve as potential new drugs. In spite of their importance on coral reefs, there are many aspects of sponge biology that remain unknown, including how they respond to different types of stressors. Coral reefs in St. Thomas, in the U.S. Virgin Islands, are exposed to different levels of man-made stressors, depending upon their proximity to coastal development, and the sponge assemblages on these reefs also vary with levels of human impacts. In September 2017, St. Thomas was devastated by two Category 5 hurricanes in a row. Since, unlike corals, virtually nothing is known about what happens to sponge communities in the aftermath of hurricanes, the research team will use a combination of field ecology and population genetics approaches to determine how sponge communities respond and recover from these devastating storms and whether prior exposure to land-based stressors affects their recovery. Researchers at the Universities of Mississippi, Alabama and the Virgin Islands will participate in this RAPID project, and will provide training opportunities for students and postdoctoral researchers, especially from underrepresented groups. Information will be provided to resource managers in the Virgin Islands, along with outreach programs to community groups in St. Thomas.

The goal of this project is to assess the impacts of single (e.g., hurricanes) versus multiple (e.g., hurricanes and land-based sources of pollution) stressors on the resilience, recovery, and recruitment of sponge communities in St. Thomas, U.S.V.I. Given the growing dominance of sponges on coral reefs worldwide, understanding the responses of sponges to natural and anthropogenic stressors is increasingly important. The investigators will leverage multiple years of data on sponge assemblages from several sites around the island of St. Thomas that varied in their levels of exposure to local land-based stressors prior to Hurricanes Irma and Maria, and evaluate changes to these diverse assemblages over time, beginning within 3 months of these devastating storms. Using a combination of natural and experimentally cleared plots, the investigators will assess the progress of sponge succession and whether the presence of algae interferes with sponge recruitment and recovery. Subsamples of recruits and nearby conspecifics will be collected to evaluate population genetic diversity and potential sources of new individuals. The data resulting from this project will provide critical insights into sponge resilience in response to hurricanes at sites previously exposed to land-based stressors, the initiation of succession within sponge communities, potential predictors of successional trajectory, and genetic diversity within sponge populations following a storm event. This information will help identify factors that inhibit coral recovery and potential approaches to enhance resilience of coral reefs.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1807807

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