Densities of small corals in Diadema halos and temporal stability of D. antillarum clusters from surveys in St. John, US Virgin Islands in 2019 and 2020

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Project
» RUI-LTREB Renewal: Three decades of coral reef community dynamics in St. John, USVI: 2014-2019 (RUI-LTREB)
» Collaborative Research: Pattern and process in the abundance and recruitment of Caribbean octocorals (Octocoral Community Dynamics)

Contributors	Affiliation	Role
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Abstract
Densities of small corals in Diadema halos and temporal stability of Diadema antillarum clusters. These data describe the individual small corals found in each quadrat at Yawzi Point and Cabritte Horn, St. John, US Virgin Islands in 2019 and 2020. These data were published in Stockton & Edmunds (2021).

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Coverage

Spatial Extent: **N**:18.316 **E**:-64.722 **S**:18.309 **W**:-64.726
Temporal Extent: 2019-07-30 - 2020-01-25

Methods & Sampling

Location: St. John, US Virgin Islands 18.316°N, -64.725°W.

Excerpt from Stockton and Edmunds (2021) in the publication Journal of Experimental Marine Biology and Ecology

Overview

Research was completed at < 7-m depth on shallow reefs in Great Lameshur Bay on the south shore of St. John, US Virgin Islands (18.316°N, -64.725°W). Surveys were completed in July and August of 2019 and continued in January 2020. The study sites are in the Virgin Islands National Park, where they have been protected since 1956. The density of small corals inside and outside of *Diadema* halos was measured along the shores of two headlands, Yawzi Point and Cabritte Horn, along which spatially aggressive peyssonnelid algal crusts (PAC) differed in abundance. At the tips of the headlands, a zone of high PAC cover was found, within which in situ surveys using subdivided quadrats (described below) revealed that PAC cover was ≥ ~ 10%, with some areas of benthos fully covered by PAC. Northward of this zone at each headland, the cover of PAC was lower < ~10% (also surveyed using subdivided quadrats), and the distinction between the two zones was visible as a transitional area several meters in width. Surveys were completed along ~ 100 m of shore within each PAC zone, and the transitional area was avoided for sampling. The two PAC hereafter are referred to as "Low-PAC" (< ~10% cover) and "High-PAC" (≥ ~10% cover). The causes of this gradient in PAC distribution remain unclear, but extensive surveys in this location have demonstrated higher abundance at exposed sites, which suggests that growth and recruitment of PAC is promoted by water motion.

Within each PAC zone, *Diadema* clusters were identified based on the presence of ≥ 4 sea urchins located ≤ 0.5 m from one another in shallow water (1.5-7.0 m depth), and they were haphazardly selected for the quantification of small corals in *Diadema* halos and on adjacent substrata. In this experimental design, each *Diadema* halo and the adjacent substrata were treated as plots nested within PAC zones, and they were sampled as encountered while working along each headland. Sampling initially was conducted along each headland to maintain a balanced design between zones, although fieldwork in January 2020 resulted in Cabritte Horn being sampled more extensively. Overall, 60 clusters of *Diadema* were sampled at Cabritte Horn (30 in each PAC zone), and 40 clusters at Yawzi Point (20 in each PAC zone), with each cluster sampled in a paired design with quadrats surveyed within the *Diadema* halo and on adjacent substrata.

Densities of small corals in *Diadema* halos

To test the hypothesis that *Diadema* halos provide a refuge for small corals in habitats dominated by PAC, clusters of *D. antillarum* were haphazardly selected in the Low-PAC and High-PAC zones of each headland. For each cluster, the abundance of small corals was quantified in the *Diadema* halo, and also on adjacent substrata outside the *Diadema* halo. PAC cover was quantified adjacent to the *Diadema* halo using the same quadrats used to determine the abundance of small corals. Although the sizes of the *D. antillarum* were not quantified, the clusters were created by adult sea urchins estimated to have test diameters > ~ 2 cm. Each cluster was surrounded by a halo (~ 50-cm width) of cleared substratum that was conspicuous in locations with high cover of PAC and other macroalgae.

Clusters of *Diadema* were common at Yawzi Point and Cabritte Horn, and were composed of 4–28 sea urchins. Twenty clusters of *Diadema* (and their halos) were surveyed in the Low-PAC and High-PAC zones at Yawzi Point and Cabritte Horn in July and August 2019. At Cabritte Horn, 10 additional *Diadema* clusters in each PAC zone were surveyed in January 2020, with these surveys were completed in areas differing from those surveyed in the previous summer. Summer and winter samplings at Cabritte Horn were considered a single sampling, based on the assumption that the 5 months between them was not ecologically meaningful in terms of changes in density of small corals.

The density of small corals was measured using quadrats (0.25 × 0.25 m) that were haphazardly placed on the substratum, either within the *Diadema* halo, or on adjacent substrata outside of the halo (n = 5 within the *Diadema* halo, n = 5 on adjacent substrata). Haphazard placement was ensured by deploying the quadrat without looking at the substratum, and in the halos, haphazard placement was modified with the restriction that one side of the quadrat was in contact with the tips of the spines of the sea urchins; this ensured the quadrats were within the halos. Outside the halo, quadrats were randomly located < 5 m from the halo margin. Small corals were counted when ≥ 50% of their area was within each quadrat, and their densities were expressed per square meter, which assumes that the density in the 0.25 × 0.25 m quadrats is 1/16th of that recorded in 1 x 1 m areas. In each quadrat, the density of small corals (≤ 4-cm diameter) was recorded by genus or species depending on the capacity to identify each taxon based on morphology. The percentage cover of PAC outside the halo was quantified using the same quadrats, which were subdivided into 25 sub-squares (each 5 × 5 cm). Sub-squares were scored for dominance of PAC, thereby allowing this substratum category to be quantified with 4% resolution.

Temporal stability of *D. antillarum* clusters

Testing of the hypothesis that *Diadema* halos provided refuges for small corals in PAC-dominated seascapes relies on *Diadema* clusters (and their halos) remaining in the same location long enough for corals to recruit to this microhabitat. To quantify the persistence of *Diadema* halos (hereafter "cluster stability"), the positions of haphazardly selected clusters were recorded over 9 days in January 2020 at Yawzi Point, and over 6 months at Cabritte Horn. At Yawzi Point, the positions of *Diadema* clusters (n = 6) were temporarily recorded with markers to allow subsequent relocation; their positions were evaluated every few days using photographs, and at the end of the 9 day period. Longer-term cluster stability was evaluated at Cabritte Horn where two *Diadema* clusters were photographed in July 2019 so that physical features of the benthos could be used to identify the same locations in January 2020. Over both time scales, it was not possible to determine whether the clusters of *D. antillarum* were composed of the same individuals, but this possibility was not relevant to evaluating whether the product of clustering (i.e., *Diadema* halos) remained in the same location.

Pooled data

See Supplementary Files for access to the data tables published in Stockton and Edmunds (2021) which aggregated this dataset. These data were aggregated by site, zone, and taxon and published as table S1 "Taxa Specific Densities" and aggregated by Site, Zone, Cluster, Position, and Quadrat and published as Figure 2 "Pooled taxa for both sites."

See Stockton & Edmunds (2021) for results and a description of the statistical analyses performed on this dataset.

Data Processing Description

BCO-DMO data manager processing notes:
* Imported Sheet "Total" from Excel file "JEMBE_Data Release_wMetadata_Edmunds Stockton_April 14.xlsx" into the BCO-DMO data system.
* Converted date to ISO 8601 format yyyy-mm-dd
* renamed fields to match BCO-DMO naming conventions (spaces->underscores).
* Attached the two other data tables from sheets "FigS1_taxon-specific_densities" and "Fig2_pooled_taxa_densities" as supplemental files attached to this dataset.
* Latitude and Longitude columns were added from site locations provided by email.

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Data Files

File
total_coral_densities.csv (Comma Separated Values (.csv), 61.00 KB) MD5:35f9190df33893e6de0aaf475e7bdae9 Primary data file for dataset ID 850372

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Supplemental Files

File	
FIG. 2 Pooled taxa for both sites filename: Fig2_pooled_taxa_densities.csv	(Comma Separated Values (.csv), 32.12 KB) MD5:1cb5136acb054f4eb577dab895719773
FIG. 2 of Stockton and Edmunds (2021) "Pooled taxa for both sites" These data describe density of small corals at Yawzi Point within and adjacent to Diadema-halos Column descriptions: Site: site (Yawzi Point, Cabritte Horn) Zone: PAC cover (High-PAC ≥ ~10%, Low-PAC <~10%) Cluster: unique cluster number (1-20) Position: quadrat (0.25 × 0.25 m) position in respect to Diadema-halo (in, out) Quadrat: unique quadrat number per cluster and position (1-5) Coral Count: the number of small corals (≤ 4-cm diameter) found in individual quadrat (0.25 × 0.25 m)	
FIG. S1 Taxa Specific Densities filename: FigS1_taxon-specific_densities.csv	(Comma Separated Values (.csv), 23.85 KB) MD5:3d1e650f1b77e9a8f7fedbffac4632f3
FIG. S1 Taxa Specific Densities from Stockton and Edmunds (2021). These data describe density of small corals based on taxon. Column information: "Site": site (Yawzi Point, Cabritte Horn) "Zone": PAC cover (High-PAC ≥ ~10%, Low-PAC <~10%) "Taxon": taxon identification (down to genus and for Siderastrea down to species) "Corals per 0.25 m2": small coral (≤ 4-cm diameter) density (average small coral count per cluster/0.25^2) within Diadema-halo "Location In (1) vs out (2)": small coral (≤ 4-cm diameter) density (average small coral count per cluster/0.25^2) adjacent to Diadema-halo	

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Related Publications

Stockton, L., & Edmunds, P. (2021). Spatially aggressive peyssonnelid algal crusts (PAC) constrain coral recruitment to Diadema grazing halos on a shallow Caribbean reef. Journal of Experimental Marine Biology and Ecology. Volume 541 doi: 10.1016/j.jembe.2021.151569
Results

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Parameters

Parameter	Description	Units
Date	Date of when was survey taken	unitless
Site	Site (Yawzi Point, Cabritte Horn)	unitless
PAC_cover	PAC cover (High-PAC ≥ ~10%, Low-PAC	unitless
Cluster	Unique cluster number	unitless
Position	Quadrat (0.25 × 0.25 m) position in respect to Diadema-halo (in, out)	unitless
Quadrat	Unique quadrat number per cluster and position (1-5)	unitless
Sea_Urchin_Count	Number of Diadema found in cluster (number of sea urchins).	unitless
Coral_Count	Number of small corals (≤ 4-cm diameter) found in individual quadrat (0.25 × 0.25 m). (number of corals).	unitless
PAC	Number of subdivided squares (25 squares, 5 cm x 5 cm) dominated by PAC (>50%) within quadrat (0.25 × 0.25 m), thereby allowing this substratum category to be quantified with 4% resolution.	unitless
Lat	Site latitude.	decimal degrees
Lon	Site longitude (west is negative).	decimal degrees

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Project Information

RUI-LTREB Renewal: Three decades of coral reef community dynamics in St. John, USVI: 2014-2019 (RUI-LTREB)

Website: http://coralreefs.csun.edu/

Coverage: USVI

Describing how ecosystems like coral reefs are changing is at the forefront of efforts to evaluate the biological consequences of global climate change and ocean acidification. Coral reefs have become the poster child of these efforts. Amid concern that they could become ecologically extinct within a century, describing what has been lost, what is left, and what is at risk, is of paramount importance. This project exploits an unrivalled legacy of information beginning in 1987 to evaluate the form in which reefs will persist, and the extent to which they will be able to resist further onslaughts of environmental challenges. This long-term project continues a 27-year study of Caribbean coral reefs. The diverse data collected will allow the investigators to determine the roles of local and global disturbances in reef degradation. The data will also reveal the structure and function of reefs in a future with more human disturbances, when corals may no longer dominate tropical reefs.

The broad societal impacts of this project include advancing understanding of an ecosystem that has long been held emblematic of the beauty, diversity, and delicacy of the biological world. Proposed research will expose new generations of undergraduate and graduate students to natural history and the quantitative assessment of the ways in which our planet is changing. This training will lead to a more profound understanding of contemporary ecology at the same time that it promotes excellence in STEM careers and supports technology infrastructure in the United States. Partnerships will be established between universities and high schools to bring university faculty and students in contact with k-12 educators and their students, allow teachers to carry out research in inspiring coral reef locations, and motivate children to pursue STEM careers. Open access to decades of legacy data will stimulate further research and teaching.

Collaborative Research: Pattern and process in the abundance and recruitment of Caribbean octocorals (Octocoral Community Dynamics)

Coverage: St. John, US Virgin Islands

NSF Award Abstract:
Coral reefs are exposed to a diversity of natural and anthropogenic disturbances, and the consequences for ecosystem degradation have been widely publicized. However, the reported changes have been biased towards fishes and stony corals, and for Caribbean reefs, the most notable example of this bias are octocorals ("soft corals"). Although they are abundant and dominate many Caribbean reefs, they are rarely included in studies due to the difficulty of both identifying them and in quantifying their abundances. In some places there is compelling evidence that soft corals have increased in abundance, even while stony corals have become less common. This suggests that soft corals are more resilient than stony corals to the wide diversity of disturbances that have been impacting coral corals. The best coral reefs on which to study these changes are those that have been studied for decades and can provide a decadal context to more recent events, and in this regard the reefs of St. John, US Virgin Islands are unique. Stony corals on the reefs have been studied since 1987, and the soft corals from 2014. This provides unrivalled platform to evaluate patterns of octocoral abundance and recruitment; identify the patterns of change that are occurring on these reefs, and identify the processes responsible for the resilience of octocoral populations. The project will extend soft coral monitoring from 4 years to 8 years, and within this framework will examine the roles of baby corals, and their response to seafloor roughness, seawater flow, and seaweed, in determining the success of soft corals. The work will also assess whether the destructive effects of Hurricanes Irma and Maria have modified the pattern of change. In concert with these efforts the project will be closely integrated with local high schools at which the investigators will host marine biology clubs and provide independent study opportunities for their students and teachers. Unique training opportunities will be provided to undergraduate and graduate students, as well as a postdoctoral researcher, all of whom will study and work in St. John, and the investigators will train coral reef researchers to identify the species of soft corals through a hands-on workshop to be conducted in the Florida Keys.

Understanding how changing environmental conditions will affect the community structure of major biomes is the ecological objective defining the 21st century. The holistic effects of these conditions on coral reefs will be studied on shallow reefs within the Virgin Islands National Park in St. John, US Virgin Islands, which is the site of one of the longest-running, long-term studies of coral reef community dynamics in the region. With NSF-LTREB support, the investigators have been studying long-term changes in stony coral communities in this location since 1987, and in 2014 NSF-OCE support was used to build an octocoral "overlay" to this decadal perspective. The present project extends from this unique history, which has been punctuated by the effects of Hurricanes Irma and Maria, to place octocoral synecology in a decadal context, and the investigators exploit a rich suite of legacy data to better understand the present and immediate future of Caribbean coral reefs. This four-year project will advance on two concurrent fronts: first, to extend time-series analyses of octocoral communities from four to eight years to characterize the pattern and pace of change in community structure, and second, to conduct a program of hypothesis-driven experiments focused on octocoral settlement that will uncover the mechanisms allowing octocorals to more effectively colonize substrata than scleractinian corals on present day reefs. Specifically, the investigators will conduct mensurative and manipulative experiments addressing four hypotheses focusing on the roles of: (1) habitat complexity in distinguishing between octocoral and scleractinian recruitment niches, (2) the recruitment niche in mediating post-settlement success, (3) competition in algal turf and macroalgae in determining the success of octocoral and scleractian recruits, and (4) role of octocoral canopies in modulating the flux of particles and larvae to the seafloor beneath. The results of this study will be integrated to evaluate the factors driving higher ecological resilience of octocorals versus scleractinians on present-day Caribbean reefs.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Environmental Biology (NSF DEB)	DEB-1350146
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756678

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