Coral reef abundance on shallow reefs of St. John, US Virgin Islands, 1992-2014

Website: https://www.bco-dmo.org/dataset/750513
Data Type: Other Field Results
Version: 1
Version Date: 2018-11-26

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

Contributors	Affiliation	Role
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Abstract
Coral reef abundance on shallow reefs of St. John, US Virgin Islands, 1992-2014. Benthic coral reef communities were monitored on the south shore of St. John. In 1992, six sites were selected using random coordinates constrained to hard bottom on fringing reefs (< 9-m depth) between Cabritte Horn and White Point, and were permanently marked.

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Coverage

Spatial Extent: **Lat**:18.32 **Lon**:-64.723
Temporal Extent: 1992 - 2014

Dataset Description

Benthic coral reef communities were monitored on the south shore of St. John. In 1992, six sites were selected using random coordinates constrained to hard bottom on fringing reefs (< 9-m depth) between Cabritte Horn and White Point, and were permanently marked. Three sites (RS5, RS11 and RS15) resemble gorgonian plains, but the remainder have greater topographic complexity than gorgonian plains due to the presence of igneous boulders and cliffs.

The entire Excel Workbook, which contains two additional datasets (Community Structure: https://www.bco-dmo.org/dataset/750459 and Physical Data: https://www.bco-dmo.org/dataset/750558), can be downloaded from https://datadocs.bco-dmo.org/docs/302/St_John_LTREB/data_docs/Data_for_P...

Methods & Sampling

Sites were treated as statistical replicates, and abundance and cover data from photoquadrats were averaged by site to describe community structure with 6 replicates y^{-1}. To evaluate the implications of increasing the same size (no. of quadrats) from ~ 18 to ~ 40 in 2000, multivariate community structure (scleractinians by species, octocorals by genus, CTB, and macroalgae) was compared between the initial 18 quadrats and the additional quadrats using PERMANOVA. This analysis was conducted with the 2000 census, and data were standardized (z-scores) to address their measurement on different scales, and fourth-root transformed prior to calculating resemblance matrices using Bray Curtis similarities. Univariate contrasts were also conducted between the initial 18 quadrats and the additional quadrats using t-tests with Bonferroni-adjusted alpha values to reduce the risks of Type I errors. Changes over time in the abundance of octocorals and scleractinians are displayed using line graphs showing mean ± SE for untransformed values. Based on the taxonomic resolution described above, community structure was characterized by site using Shannon-Wiener Diversity (H´), Pielou's Evenness (J´), and richness (number of taxa); in this application, these metrics refer to alpha diversity. For scleractinians, H´ and J´ were calculated using percentage cover as a measure of abundance, and for octocorals, abundance was evaluated by density (colonies 0.25 m^{-2}).

PERMANOVA was used to test for changes in community structure among years (repeated measure) and sites (random effect) based on four assemblages: (1) the whole community (scleractinians, octocorals, macroalgae, and CTB), (2) octocorals by genus, (3) scleractinians by species, and (4) octocorals and scleractinians combined, to genus or species, respectively. The same design was used in a univariate mode to test for time and site effects using H´, J´, and richness as dependent variables. Comparisons of scleractinian and octocoral community structure over time were conducted using PERMANOVAs of resemblance matrices composed of Bray Curtis similarities. Analyses were repeated for scleractinians and octocorals combined, and then for each separately. In the combined scleractinian and octocoral analysis, data were normalized and square root transformed. Analyses of scleractinians alone, or octocorals alone, used square root or fourth root transformed data, respectively. Significance was tested in a permutational framework (999 permutations) and evaluated through Pseudo-F and the probability of obtaining the statistic values by chance alone (p_{perm}).

To detect years between which significant changes in community structure occurred, planned contrasts were used between sequential years, and unplanned contrasts were used to compare sites. The same techniques were used for H´, J´, and richness, except values were square-root transformed, and similarities determined using Euclidian Distance. To evaluate rates of change in dependent variables over time, data were tested for temporal autocorrelation using the Durbin-Watson statistic. Model I regressions were used where there was no autocorrelation, and where autocorrelation was detected, Model I linear regressions were adjusted using the Cochrane-Orcutt model.

Multivariate variation in community structure was described using MDS applied to the community structure averaged across sites within years, and described at two resolutions: (1) by functional group consisting of scleractinians (summed among taxa), octocorals (summed among genera), and macroalgae,and CTB, and (2) scleractinians by species, octocorals by genus, macroalgae and CTB. Data were standardized (z-scores) to address their measurement on different scales, and fourth-root transformed prior to calculating resemblance matrices using Bray Curtis similarities. MDS ordinations were prepared using 100 restarts until stress stabilized, and similarity contours were applied where they enhanced the interpretation of groupings. Principle coordinate analyses (PCO) were prepared using the same resemblance matrices, and were overlaid with vectors displaying Spearman correlations between dependent variables and PCO1 and PCO2. The length (scaled to ≤ 1) of the vectors shows the influence of dependent variables in causing separation along each axis.

The BEST procedure in PRIMER and DISTLM in PERMANOVA+ were used evaluate the extent to which community structure was associated with physical conditions. The BEST procedure is based on rank correlations (ρ) between the resemblance matrix defining the community structure and a suite of resemblance matrices defining physical conditions. Where community structure included variables measured on multiple scales, values were standardized and square-root transformed. Collinear variables were excluded, and variables were standardized and square-root transformed. Resemblance matrices were prepared for both data types using Bray Curtis similarities (biotic data) or Euclidean Distances (physical conditions). To evaluate associations between biotic and physical data, analyses were conducted first, with data obtained in the year of measurement. To test for delayed responses in community structure, the biotic data for each year were also compared to the physical conditions 1 y earlier, 2 y earlier, and averaged over the 3 y starting with the measurement year and extending back 2 y. Testing for delayed responses was motivated by the possibility that physical conditions in any one year initiated biological responses that were not evident until one or more year had passed. Finally, biotic and environment conditions were compared using 3 y moving averages to smooth stochastic variation from year to year. Significance of ρ was determined within a permutational framework (999 permutations) as the probability of occurrence by chance alone (p_{perm}).

The BEST procedure does not model the multivariate data, rather it detects the best rank order match between dissimilarities in two data sets; often it identifies multiple associations including those with differing numbers of variables. To determine the best linear model between physical conditions and biological data, we used the DISTLM procedure, which distinguished among the multiple associations identified in the BEST procedure. Where BEST identified significant associations, DISTLM was used to identify the most effective combination of variables explaining the biological data in a linear model, with the best fit identified by AIC_c. All possible combinations of predictor variables were considered. Values reported are combinations of physical conditions that are significantly associated with the biological data (i.e., as detected with the BEST procedure), and have the greatest explanatory capacity.

The 6 study sites were censused annually using photoquadrats randomly positioned along a marked transect parallel to the depth contour. From 1992 to 1999, each site was sampled with ~ 18 photoquadrats along a 20-m transect, with images recorded using a Nikonos V camera fitted with a 28 mm lens, strobes, and Kodachrome 64 film. Color slides were scanned at 4000 dpi for analysis. In 2000, each transect was extended to 40 m length, and the sampling was increased to 40 photoquadrats distributed randomly along the transect. Increased sampling was made possible with the advent of digital cameras (3.3 to 16.2 megapixels). All cameras were mounted on a framer and recorded a 0.5 × 0.5 m quadrat that resolved objects ≥ 1 cm.

Photoquadrats were analyzed for the percentage cover of scleractinians, macroalgae, and CTB by identifying the benthic substratum beneath 200 randomly-placed points on each image using CPCe software. Scleractinians were resolved to 26 taxa, and macroalgae were defined as ≥ 1 cm thalli of mostly Lobophora, Halimeda, Padina, and Dictyota. Using the same photoquadrats, octocorals were resolved to 11 genera, and colonies that could not be identified were categorized as “unknown”. Octocorals were counted in each photoquadrat, with arborescent taxa scored by the presence of holdfasts, and encrusting Erythropodium scored based on the number of discrete patches (i.e., colonies). As colonies of Erythropodium caribaeorum undergo fission and fusion, colony abundance could provide a misleading indication of ecological trends affecting this species. To explore this possibility, the percentage cover of E. caribaeorum also was calculated using the same methods as described above for scleractinians, macroalgae, and CTB.

Local- and regional- scale measurements of the physical environment were tested in a multivariate framework for their ability to account for temporal variance in the biotic data. Seawater temperature was measured at 9–11 m depth in Great Lameshur Bay using loggers and was averaged by day to calculate the mean, minimum, maximum temperature, as well as the number of hot days (mean > 29.3°C), and cold days (mean ≤ 26.0°C). The 29.3°C cut-off for defining hot days was based on the local coral bleaching threshold, as determined by the United States National Oceanic and Atmospheric Administration, National Environmental Satellite Data and Information Service (http://coralreefwatch.noaa.gov/vs/index.php). The 26.0°C cut-off for defining cold days is an arbitrary value defined as the 15th percentile of daily temperatures (Edmunds 2004), and it was employed to evaluate the potentially valuable effects of cold winters for promoting elevated coral biomass. Rainfall (cm y-1) was compiled for St. John, and hurricanes were evaluated on a categorical scale (Hindex). Hurricanes impacted the study areas after the annual monitoring, and their effects appear in coral community data from the year following each event. Temporal variation in the regional-scale physical environment was evaluated through a detrended index reflecting the effect of the Atlantic Multidecadal Oscillation (AMO) as reported in and provided courtesy of the first author.

Statistical analysis:

The BEST procedure was used for the regional-scale physical data (i.e., the AMO index), in which one environmental dependent variable was tested, and this was not smoothed further than in the primary analysis in which the AMO was reported.

Multivariate statistics based on resemblance matrices were conducted using PRIMER version 6 (Clarke & Gorley 2006) and PERMANOVA+ for PRIMER. Statistics related to autocorrelation and the correction of Model I regressions against time were conducted using XLStat 2015 (Addinsoft SARL).

Data Processing Description

BCO-DMO Processing Notes:

- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions

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Data Files

File
fig_2.csv(Comma Separated Values (.csv), 4.79 KB) MD5:e9d7f7a4d91c6b49e373712ca94ac400 Primary data file for dataset ID 750513

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Related Publications

Edmunds, P., & Lasker, H. (2016). Cryptic regime shift in benthic community structure on shallow reefs in St. John, US Virgin Islands. Marine Ecology Progress Series, 559, 1–12. doi:10.3354/meps11900
Results

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Parameters

Parameter	Description	Units
year	year in YYYY format	unitless
Erythropodium_Mean	Erythropodium mean abundance	colonies per 0.25 meter squared
Erythropodium_Difference	Erythropodium difference between mean abundance and abundance averaged over years	colonies per 0.25 meter squared
Erythropodium_Smoothed	Erythropodium 2 point smoothed mean	colonies per 0.25 meter squared
Eunicea_Mean	Eunicea mean abundance	colonies per 0.25 meter squared
Eunicea_Difference	Eunicea difference between mean abundance and abundance averaged over years	colonies per 0.25 meter squared
Eunicea_Smoothed	Eunicea 2 point smoothed mean	colonies per 0.25 meter squared
Antillogorgia_Mean	Antillogorgia mean abundance	colonies per 0.25 meter squared
Antillogorgia_Difference	Antillogorgia difference between mean abundance and abundance averaged over years	colonies per 0.25 meter squared
Antillogorgia_Smoothed	Antillogorgia 2 point smoothed mean	colonies per 0.25 meter squared
Gorgonia_Mean	Gorgonia mean abundance	colonies per 0.25 meter squared
Gorgonia_Difference	Gorgonia difference between mean abundance and abundance averaged over years	colonies per 0.25 meter squared
Gorgonia_Smoothed	Gorgonia 2 point smoothed mean	colonies per 0.25 meter squared
Pseudoplexaura_Mean	Pseudoplexaura mean abundance	colonies per 0.25 meter squared

Pseudoplexaura_Difference	Pseudoplexaura difference between mean abundance and abundance averaged over years	colonies per 0.25 meter squared
Pseudoplexaura_Smoothed	Pseudoplexaura 2 point smoothed mean	colonies per 0.25 meter squared
pcnt_S_siderea_Mean	S. siderea mean abundance	percent
pcnt_S_siderea_Difference	S. siderea difference between mean abundance and abundance averaged over years	percent
pcnt_S_siderea_Smoothed	S. siderea 2 point smoothed mean	percent
pcnt_O_annularis_Mean	O. annularis mean abundance	percent
pcnt_O_annularis_Difference	O. annularis difference between mean abundance and abundance averaged over years	percent
pcnt_O_annularis_Smoothed	O. annularis 2 point smoothed mean	percent
pcnt_P_aestroides_Mean	P. aestroides mean abundance	percent
pcnt_P_aestroides_Difference	P. aestroides difference between mean abundance and abundance averaged over years	percent
pcnt_P_aestroides_Smoothed	P. aestroides 2 point smoothed mean	percent
pcnt_M_cavernosa_Mean	M. cavernosa mean abundance	percent
pcnt_M_cavernosa_Difference	M. cavernosa difference between mean abundance and abundance averaged over years	percent
pcnt_M_cavernosa_Smoothed	M. cavernosa 2 point smoothed mean	percent
pcnt_Agaricia_Mean	Agaricia mean abundance	percent
pcnt_Agaricia_Difference	Agaricia difference between mean abundance and abundance averaged over years	percent
pcnt_Agaricia_Smoothed	Agaricia 2 point smoothed mean	percent
pcnt_Branching_Porites_Mean	Branching mean abundance	percent
pcnt_Branching_Porites_Difference	Branching difference between mean abundance and abundance averaged over years	percent
pcnt_Branching_Porites_Smoothed	Branching 2 point smoothed mean	percent

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Instruments

Dataset-specific Instrument Name	digital cameras
Generic Instrument Name	Camera
Dataset-specific Description	The positions of photoquadrats were re-randomized at each sampling, and they were recorded using digital cameras (Nikon SLRs, with 6–36 Megapixel resolution) fitted with a zoom lens (Nikon DX 18–70 mm or FX 18–35 mm) and placed in a waterproof housing (Ikelite).
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Onset Temperature Logger
Generic Instrument Name	Temperature Logger
Dataset-specific Description	To provide physical environmental context to enhance the interpretation of coral community dynamics, seawater temperature was recorded at 9-m depth at Yawzi Point using loggers (± 0.2 °C, Model U22-001, Onset Computer Corp., Bourne, MA) recording at 1 mHz.
Generic Instrument Description	Records temperature data over a period of time.

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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.

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Funding

Funding Source	Award
NSF Division of Environmental Biology (NSF DEB)	DEB-0841441
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332915
NSF Division of Environmental Biology (NSF DEB)	DEB-1350146

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