Benthic cover data photoquadrat images from patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i from 2015 to 2022

Website: https://www.bco-dmo.org/dataset/897403
Data Type: Other Field Results
Version: 1
Version Date: 2023-06-09

Project
» RAPID: Collaborative Research: Disentangling the effects of heat stress versus bleaching phenotype on coral performance (Mcap pairs time series)

Contributors	Affiliation	Role
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Abstract
Increasingly frequent marine heatwaves are devastating coral reefs. Corals that survive these extreme events must rapidly recover if they are to withstand subsequent events, and long-term survival in the face of rising ocean temperatures may hinge on recovery capacity and acclimatory gains in heat tolerance over an individual's lifespan. To better understand coral recovery trajectories in the face of successive marine heatwaves, we monitored the responses of bleaching-susceptible and bleaching-resistant individuals of two dominant coral species in Hawai'i, Montipora capitata and Porites compressa, over a decade that included three marine heatwaves. This dataset contains benthic cover data and photoquadrat images including point counts and organism identifications from patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i from 2015 to 2022.

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Coverage

Spatial Extent: **Lat**:21.4509 **Lon**:-157.7954
Temporal Extent: 2015-10-01 - 2022-09-30

Dataset Description

This dataset and other data from this study will be published in the results paper "Divergent bleaching and recovery trajectories in reef-building corals following a decade of successive marine heatwaves." (see pre-print Brown, et al. (2023), doi: 10.1101/2023.07.16.549193).

All BCO-DMO datasets related to this publication can be found on the page https://www.bco-dmo.org/related-

resource/915300.

Methods & Sampling

Location:
patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i (21.4509, -157.7954).

This dataset provides benthic cover data. The following section also describes the closely related dataset "Colony level bleaching severity and mortality" https://www.bco-dmo.org/dataset/897415 which provides the community composition point counts and images.

Coral colony selection:

All colonies followed in this study were first categorized as bleaching-susceptible (severely bleached) or bleaching-resistant (fully pigmented) based on their bleaching phenotype during the peak of the 2015 heatwave and coral bleaching event (1). For this study, ten pairs of adjacent conspecific colonies of M. capitata and P. compressa with contrasting bleaching susceptibilities (N=10 colonies per species per phenotype) were selected. Adjacent pairs of bleaching-resistant and bleaching-susceptible colonies of the same species were selected in order to minimize the influence of microenvironment on the bleaching response. Individual colonies were monitored for bleaching (color/pigmentation) and partial mortality from 2015–2017 (1) and 2019–2023 (this study), and sampled for physiological assessments from 2019–2023 (Brown et al., 2023 Tables S3 and S4). An additional pair of M. capitata and two pairs of P. compressa were added to the time series in 2022 to supplement our observations after three pairs could no longer be located; all of these colonies had been assessed for bleaching, mortality and recovery from 2015–2017.

Nearly all of the M. capitata colonies used in this study (20 of the 22 colonies) were identified as unique genotypes in an earlier study (2). In general, clonality in M. capitata in Kāneʻohe Bay is very low (3), with a bay-wide genet-ramen ratio of 0.917. Caruso et al (2022) included two sites at the same reef investigated in this study (Patch Reef 13), identifying a genet-ramen (G:R) ratio of 0.95 (i.e., 21 genotypes in 22 colonies sampled). For P. compressa, the bay-wide genet-ramen ratio is approximately 0.875, but clonality is rare in low wave energy (inner bay) environments (4). Similarly, P. compressa from sheltered South Bay sites have a genet-ramen ratio of 0.96 (5). The likelihood of there being more than three clones in P. compressa is very low (0.92 [average of two papers G:R] * 24 colonies = 22 genotypes), especially considering the physiological variation observed. Overall, these studies indicate infrequent asexual reproduction at the study site for either species.

Coral bleaching and partial mortality assessments:

Colony-level bleaching severity was determined from photographs of each colony following the methodology of (6), in which colonies were scored as: (1) no signs of paling (0%), (2) mild paling (>20%), (3) moderate paling (20–50%), (4) mostly bleached (50–80%), and (5) fully bleached (80–100%). Cumulative colony-level partial mortality was also determined from these same photographs as described in (1). Observations occurred during peak and off-peak seasonal temperatures in most years. Benthic community composition was determined at the same time as colony-level observations following the same methods as in (1, 6). Specifically, benthic photoquadrats (0.33 m2), were imaged at 2 m intervals along a 40 m transect tape laid parallel to the reef crest at 1 m and 3 m depths (n = 1–2 per depth) at PR13. Benthic community composition was determined from each image via CoralNet using 50 randomly allocated points per photograph (7). Bleaching severity of each coral point was scored as: (1) pigmented (no signs of bleaching), (2) pale (moderately bleached), or (3) severely bleached (white). Reef-wide bleaching prevalence for each species was determined as the proportion of observations of that species showing signs of moderate or severe bleaching (i.e. bleaching score of 2 or 3).

Data Processing Description

See results publication Brown, et al. (2023) for more detailed information on analysis and results.

BCO-DMO Processing Description

* Sheet 1 of file "Benthic cover.csv" was imported into the BCO-DMO data system with values "NA" as missing data values.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]
* column b_year removed as recommended by the submitter.
* Date converted to ISO 8601 format

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Data Files

File
897403_v1_benthic_cover.csv (Comma Separated Values (.csv), 199.95 KB) MD5:871b24c01c5c220d0795231f71fcdc14 Primary data table for dataset 897403 version 1.

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Supplemental Files

File
Benthic Cover and Bleaching Severity Analysis Description filename: benthic_cover_and_bleaching_severity_analysis.txt (Plain Text, 618 bytes) MD5:8631b5f607cec3008c61b945fbc8fc43 Description of how these data were further analyzed for publication.
Benthic cover categories and related taxonomic names and identfiers filename: benthic_cover_categories_and_taxa.csv (Comma Separated Values (.csv), 2.15 KB) MD5:15f165a180f6e14fdb55549594470fe4 Columns: Category_in_dataset, the category name within the 897403_v1_benthic_cover.csv table. Associated_Taxon, taxonomic name associated with the category AphiaID, Taxonomic identifier for the taxa at the World Register of Marine Species (WoRMS, www.marinespecies.org) LSID, Lifesciences Identifier for the taxa Name matching was performed using the WoRMS taxa match tool on 2023-11-09. At that time, all names used were the accepted name for the organism.
Benthic Photoquadrat Image Inventory Table filename: benthic_quadrat_image_inventory.csv (Comma Separated Values (.csv), 289.98 KB) MD5:0460535590424bee3e4ca1239eb43d4f Image Inventory Table for the images within "benthic_images.zip" columns: filename,relative_filepath,filesize_bytes,md5sum (a checksum)
Benthic Photoquadrat Images filename: benthic_cover_images.zip (ZIP Archive (ZIP), 5.58 GB) MD5:cd43ab68e6ce65da3d7b1254642fcffc Benthic Photoquadrat Images (jpg format). See supplemental file "benthic_quadrat_image_inventory.csv" for associated metadata for these images such as collection date and filesize.

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Related Publications

Beijbom, O., Edmunds, P. J., Roelfsema, C., Smith, J., Kline, D. I., Neal, B. P., Dunlap, M. J., Moriarty, V., Fan, T.-Y., Tan, C.-J., Chan, S., Treibitz, T., Gamst, A., Mitchell, B. G., & Kriegman, D. (2015). Towards Automated

Annotation of Benthic Survey Images: Variability of Human Experts and Operational Modes of Automation. PLOS ONE, 10(7), e0130312. https://doi.org/10.1371/journal.pone.0130312
Methods

Brown, K. T., Lenz, E. A., Glass, B. H., Kruse, E., McClintock, R., Drury, C., Nelson, C. E., Putnam, H. M., & Barott, K. L. (2023). Divergent recovery trajectories in reef-building corals following a decade of successive marine heatwaves. bioRxiv preprint. https://doi.org/10.1101/2023.07.16.549193
Results

Caruso, C., Rocha de Souza, M., Ruiz-Jones, L., Conetta, D., Hancock, J., Hobbs, C., Hobbs, C., Kahkejian, V., Kitchen, R., Marin, C., Monismith, S., Madin, J., Gates, R., & Drury, C. (2022). Genetic patterns in Montipora capitata across an environmental mosaic in Kāne'ohe Bay, O'ahu, Hawai'i. Molecular Ecology, 31(20), 5201–5213. Portico. https://doi.org/10.1111/mec.16655
Methods

Drury, C., Bean, N. K., Harris, C. I., Hancock, J. R., Huckeba, J., H, C. M., Roach, T. N. F., Quinn, R. A., & Gates, R. D. (2022). Intrapopulation adaptive variance supports thermal tolerance in a reef-building coral. Communications Biology, 5(1). https://doi.org/10.1038/s42003-022-03428-3
Methods

Innis, T., Allen-Waller, L., Brown, K. T., Sparagon, W., Carlson, C., Kruse, E., Huffmyer, A. S., Nelson, C. E., Putnam, H. M., & Barott, K. L. (2021). Marine heatwaves depress metabolic activity and impair cellular acid–base homeostasis in reef-building corals regardless of bleaching susceptibility. Global Change Biology, 27(12), 2728–2743. Portico. https://doi.org/10.1111/gcb.15622
Methods

Locatelli, N., & Drew, J. (2019). Population structure and clonal prevalence of scleractinian corals (Montipora capitata and Porites compressa) in Kaneohe Bay, Oahu. https://doi.org/10.1101/2019.12.11.860585
Methods

Matsuda, S. B., Huffmyer, A. S., Lenz, E. A., Davidson, J. M., Hancock, J. R., Przybylowski, A., Innis, T., Gates, R. D., & Barott, K. L. (2020). Coral Bleaching Susceptibility Is Predictive of Subsequent Mortality Within but Not Between Coral Species. Frontiers in Ecology and Evolution, 8. https://doi.org/10.3389/fevo.2020.00178
Methods

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Related Datasets

IsRelatedTo

Barott, K., Putnam, H., Brown, K. T. (2023) **Coral bleaching severity and mortality data from patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i from 2015 to 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-06-09 doi:10.26008/1912/bco-dmo.897415.1 [view at BCO-DMO]
Relationship Description: Data from the same study.

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Parameters

Parameter	Description	Units
Image_ID	Image identifier	unitless
Image_name	Image name (images are provided in benthic cover images.zip)	unitless
month	Numeric month of year	unitless
day	Day	unitless
year	Year (in format YYYY)	unitless
Date	Date (ISO 8601 date format)	unitless

Annotation_status	Annotation status. 'confirmed' indicates manually annotated	unitless
Points	number of points per image	per point
Coral_Juvenile	Point count of "Coral Juvenile" per image	per point
Diseased_Coral	Point count of "Diseased Coral" per image	per point
Leptastrea_purpurea	Point count of "Leptastrea purpurea" per image	per point
Pigmented_Montipora_capitata	Point count of "Pigmented Montipora capitata" per image	per point
Pavona_varians	Point count of "Pavona varians" per image	per point
Pigmented_Porites_Compressa	Point count of "Pigmented Porites Compressa" per image	per point
Recent_Dead_Coral	Point count of "Recent Dead Coral" per image	per point
Ascidian	Point count of "Ascidian" per image	per point
Mycale_grandis	Point count of "Mycale grandis" per image	per point
Sponge	Point count of "Sponge" per image	per point
Zoanthid	Point count of "Zoanthid" per image	per point
Sand	Point count of "Sand" per image	per point
Sediment	Point count of "Sediment" per image	per point
Dead_coral	Point count of "Dead coral" per image	per point
Rock_Pavement	Point count of "Rock Pavement" per image	per point
Rock_Rubble	Point count of "Rock Rubble" per image	per point
All_other	Point count of "All other" per image	per point
Broken_coral_rubble	Point count of "Broken coral rubble" per image	per point
Dead_coral_with_algae	Point count of "Dead coral with algae" per image	per point
Rubble	Point count of "Rubble" per image	per point
Schizothrix	Point count of "Schizothrix" per image	per point
white_band_disease	Point count of "white band disease" per image	per point
Amphiroa_sp	Point count of "Amphiroa sp" per image	per point
CCA	Point count of "CCA" per image	per point
Dictyosphaeria	Point count of "Dictyosphaeria" per image	per point
Dictyota	Point count of "Dictyota" per image	per point
Halimeda	Point count of "Halimeda" per image	per point
Liagora	Point count of "Liagora" per image	per point
Lobophora	Point count of "Lobophora" per image	per point
Macroalgae	Point count of "Macroalgae" per image	per point
Montipora_capitata_recently_dead	Point count of "Montipora capitata recently dead" per image	per point
Padina	Point count of "Padina" per image	per point
Porites_compressa_recently_dead	Point count of "Porites compressa recently dead" per image	per point
Sargassum	Point count of "Sargassum" per image	per point
Stypopodium_sp	Point count of "Stypopodium sp" per image	per point
Turbinaria_algae	Point count of "Turbinaria algae" per image	per point
Turf_algae	Point count of "Turf algae" per image	per point
Montipora_bleached_and_pale	Point count of "Montipora bleached and pale" per image	per point
Pocillopora	Point count of "Pocillopora" per image	per point

Bleached_and_pale_Porites	Point count of "Bleached and pale Porites" per image	per point

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Instruments

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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Project Information

RAPID: Collaborative Research: Disentangling the effects of heat stress versus bleaching phenotype on coral performance (Mcap pairs time series)

Coverage: Coral reefs of Kaneohe Bay, Oahu, Hawaii

NSF Award Abstract:
Coral bleaching has become increasingly common on reefs worldwide as rising sea surface temperatures associated with climate change disrupt the coral-algal symbiosis. This dramatic heat stress response turns the normally colorful corals bright white, and yet during these heat stress events not all corals undergo bleaching. This project focuses on assessing the effects of bleaching by comparing pairs of corals side-byside on the reef during an ongoing heat wave, where one has bleached and the other has not, despite experiencing the same temperatures. These coral pairs have been monitored throughout three bleaching events in the past five years, providing a unique resource to address whether corals with consistently different bleaching susceptibilities have the capacity to acclimate in response to disturbances through epigenetic changes, or changes in gene expression not due to change in DNA bases. To address this, the project will characterize the impacts of bleaching or not bleaching on coral physiology, gene expression, and epigenetic patterns using coral pairs in their natural habitat during a marine heatwave. This project also provides research support for graduate student trainees, as well as data and materials for the research and training of undergraduate and high school students. This project will recruit underrepresented minority students from URI and UPenn area high schools and university undergraduates for work on computer analysis of images (benthic and colony photographs, brightfield and confocal micrographs) and sequencing data. It will also support the training of an undergraduate student at the University of Hawai'i in coral ecology and physiology, and the development of her senior thesis.

This project will investigate the effects of repeated heat stress events on the performance of Montipora capitata, a dominant reef builder throughout Hawai'i. It utilizes the timely context of paired colonies of M. capitata with bleached vs. unbleached histories that have been monitored through two past bleaching events in Hawai'i (2015 and 2019) and the currently ongoing 2020 event. This system allows for the unique opportunity to disentangle the consequences of heat stress versus bleaching on coral performance through time, an essential feature of reef resilience. The contrasting physiological and energetic processes these two phenotypes undergo during a heatwave are likely to result in alterations to the cellular environment within the animal that impacts epigenetic transcriptional regulation. These regulatory and energetic changes, if persistent over time, have the potential to alter coral fitness beyond the duration of the heatwave differentially between corals with contrasting bleaching phenotypes. Specifically, the project will: 1) quantify the effect of the 2020 heatwave on coral physiology during bleaching and recovery, 2) generate a corresponding archive of coral tissues and nucleic acids as a resource for future work characterizing how bleaching phenotype alters energetics and non-genetic inheritance, and 3) characterize how bleaching phenotype alters intra-generational inheritance of epigenetic marks (i.e., DNA methylation) and gene expression, and the duration of these marks and expression patterns following heat stress. This project represents an urgent assessment of an ideal

system to test the legacy of coral bleaching phenotype on coral fitness. The results of this project will therefore lay the foundation for intra and cross-generational effects of bleaching vs. heat stress, which is essential for understanding coral resilience to climate change.

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 Ocean Sciences (NSF OCE)	OCE-2102989
NSF Division of Ocean Sciences (NSF OCE)	OCE-2103067

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