Coral bleaching severity and mortality data from patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i from 2015 to 2022

Website: https://www.bco-dmo.org/dataset/897415
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
Barott, Katie	University of Pennsylvania (Penn)	Principal Investigator
Putnam, Hollie	University of Rhode Island (URI)	Principal Investigator
Brown, Kristen	University of Pennsylvania (Penn)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset contains coral colony-level bleaching severity and mortality (coral genotype, bleaching phenotype, bleaching score, mortality percent) from patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i from 2015 to 2022. This data set was collected as part of a study of benthic community composition data from patch reef 13 and colony-level bleaching severity data. See Related Dataset "Benthic cover" for more data from this study. Study 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.

Table of Contents

Coverage

Spatial Extent: **Lat**:21.4509 **Lon**:-157.7954
Temporal Extent: 2015-10-29 - 2022-09-01

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 bleaching score data and mortality. The following section also describes the closely related dataset "Benthic cover" https://www.bco-dmo.org/dataset/897403 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 (Matsuda et al., 2020). 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 (Matsuda et al., 2020) 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 (Drury, 2022). In general, clonality in M. capitata in Kāneʻohe Bay is very low (Caruso, et al., 2022) 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 (Locatelli, et al., 2019). Similarly, P. compressa from sheltered South Bay sites have a genet-ramen ratio of 0.96 (Hunter, 1993). 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 (Innis et al., 2021), 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 (Matsuda et al., 2020). 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 (Matsuda et al., 2020; Innis et al., 2021). 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 (Beijbom, 2015). 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

* After discussion with submitter, mortality and bleaching severity tables were combined. Tables in files "Colony-level mortality data 2015-2023.csv" and "Colony level bleaching severity.csv" were imported into the BCO-DMO data system and combined by performing a full outer join on columns ColonyID, Date, and Species.
* 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]

* Date converted to ISO 8601 format

[table of contents | back to top]

Data Files

File
897415_v1_bleaching_and_mortality.csv (Comma Separated Values (.csv), 64.82 KB) MD5:42bc8025af6ce30a2d8d012e6085b76f Primary data file for dataset ID 897415, version 1

[table of contents | back to top]

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

[table of contents | back to top]

Related Datasets

IsRelatedTo

Brown, K. T., Barott, K., Putnam, H. (2023) **Benthic cover data photoquadrat images 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.897403.1 [view at BCO-DMO]
Relationship Description: Data from the same study.

[table of contents | back to top]

Parameters

Parameter	Description	Units
ColonyID	ColonyID (genotype)	unitless
Species	Species (Genus species)	units
Bleach	Bleach phenotype (Bleach or Non-bleach)	unitless
Date	Date in ISO 8601 format	unitless
Score	Score (where, 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%)	units
Phenotype	Phenotype (Susceptible or Resistant)	
Mortality	Percent mortality	percent (%)

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2102989
NSF Division of Ocean Sciences (NSF OCE)	OCE-2103067

[table of contents | back to top]