Percentage cover of the benthos by live coral at 10 m depth at sites in Moorea Moorea, French Polynesia from 2008 to 2021

Website: https://www.bco-dmo.org/dataset/918265
Data Type: Other Field Results
Version: 1
Version Date: 2024-01-23

Project
» Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)

Program
» Long Term Ecological Research network (LTER)

Contributors	Affiliation	Role
Edmunds, Peter J.	California State University Northridge (CSUN)	Principal Investigator
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Abstract
Data Abstract: These data describe the percentage cover of the benthos by live coral at 10 m depth at sites LTER1 and LTER2 in Moorea. Results paper abstract, Edmunds et al. (2024, doi:10.1007/s00442-024-05517-y): * [See "Related Datasets" section for access to related datasets discussed here] Understanding population dynamics is a long-standing objective of ecology, but the need for progress in this area has become urgent. For coral reefs, achieving this objective is impeded by a lack of information on settlement versus post-settlement events in determining recruitment and population size. Declines in coral abundance are often inferred to be associated with reduced densities of recruits, which could arise from mechanisms occurring at larval settlement, or throughout post-settlement stages. This study uses annual measurements from 2008 to 2021 of coral cover, the density of coral settlers (S), the density of small corals (SC), and environmental conditions, to evaluate the roles of settlement versus post-settlement events in determining rates of coral recruitment and changes in coral cover at Moorea, French Polynesia. Coral cover, S, SC, and the SC:S ratio (a proxy for post-settlement success), and environmental conditions, were used in generalized additive models (GAMs) to show that: (a) coral cover was more strongly related to SC and SC:S than S, and (b) SC:S was highest when preceded by cool seawater, low concentrations of Chlorophyll a, and low flow speeds, and S showed evidence of declining with elevated temperature. Together, these results suggest that changes in coral cover in Moorea are more strongly influenced by post-settlement events than settlement. The key to understanding coral community resilience may lie in elucidating the factors attenuating the bottleneck between settlers and small corals.

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Coverage

Location: Moorea, French Polynesia
Spatial Extent: **N**:-17.388 **E**:-149.808 **S**:-17.472 **W**:-149.84
Temporal Extent: 2008 - 2021

Methods & Sampling

The ecological methods are described in detail in Edmunds et al. (2024, doi:10.1007/s00442-024-05517-y), and are briefly summarized below.

The study utilized the time series of the Moorea Coral Reef LTER, as they relate to coral community dynamics on the north shore fore reef. Annual measurements of coral cover, the density of coral settlers, and the density of small corals were used together with records of the environmental conditions to which they were exposed. Analyses focused on 2008–2021, which captured the final years of the last population outbreak of the crown of thorns (COTs) sea star, the coral population recovery that took place between 2010 and 2019, and coral mortality attributed to bleaching in 2019. Biological data came from two sites (LTER1 and LTER2) that are ~ 3 km apart, with environmental data from the same or similar sites (temperature), one of the two sites (flow at LTER1), or from 4.5 km resolution remote sensing data (Chlorophyll a).

Coral cover was measured annually (April except for 2020 [August] and 2021 [May]) at 10-m depth along a 50 m, permanently marked transect at LTER 1 and LTER 2. Along each transect, 40 photoquadrats (0.5 × 0.5 m) were photographed at positions that were randomly selected in 2005, but fixed thereafter. Pictures were illuminated with strobes, and analyzed using CPCe or CoralNET software with manual annotation of 200 randomly located points on each image. Substrata beneath the points were categorized to coral genus, and the percentage cover for all corals (scleractinians and *Millepora*) and *Pocillopora* spp., is reported. The changes in cover of corals (scleractinians and *Millepora*) provided a holistic summary of the coral community consistent with how we have described it elsewhere and how it is described in the broader scientific literature on coral reefs. The separate summary for *Pocillopora* spp. provided a measure of coral cover that is the product of the most abundant coral settlers found on tiles deployed in the same habitat (i.e., pocilloporids). The density of small corals (≤ 4-cm diameter) was quantified in the field annually, shortly after the photoquadrats were recorded (but not in 2020 due to COVID-19), and was completed using quadrats (0.5 × 0.5 m) placed in the same positions as the photoquadrats. The benthos, including beneath branching corals, was inspected for small corals that were recorded to genus, and the densities of all corals and *Pocillopora* spp. are reported in units of corals 0.25 m^{-2}.

* See "Related Datasets" section for access to related dataset pages which include dataset-specific methodology.

Data Processing Description

Images analysed with software:

CPCe (Kohler and Gill 2006) Coral point count with excel extensions (CPCe): A visual basic program for the determination of coral and substrate coverage using random point count methodology. Comput Geosci 32:1259-1269 doi: 10.1016/j.cageo.2005.11.009

CoralNET software (Beijbom et al. 2015) Towards automated annotation of benthic survey images: variability of human experts and operational modes of automation. PLoS ONE 10 doi: 10.1371/journal.pone.0130312

Data were aggregated by year and quadrat at each site LTER1 and LTER2.

BCO-DMO Processing Description

* Sheet "Data by quadrat" of file "Coral_Cover.xlsx" was imported into the BCO-DMO data system with values "nd" 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]
* dataset references to Edmunds et al 2023 changed to 2024 since that was the year associated with the DOI after final publication. Edmunds et al. (2024, doi:10.1007/s00442-024-05517-y)

Problem Description

None

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Data Files

File	
918265_v1_coral-cover.csv	(Comma Separated Values (.csv), 33.32 KB) MD5:0cbdeb0903f9ed35b177c0d0c3e9c828
Primary data file for dataset ID 918265, version 1	

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Supplemental Files

File	
Site list	
filename: site_locations.csv	(Comma Separated Values (.csv), 215 bytes) MD5:d13ffaef5e5725529594f401de6a97cc
Site location list in Moorea (LTER0,LTER1,LTER2) for datasets related to Edmunds et al. (2024, doi:10.1007/s00442-024-05517-y) and Edmunds et al. (2020, doi:10.1093/icesjms/fsaa015).	
Columns:	
location, geolocation name	
site, site identifier	
lat_dd, site latitude, decimal degrees	
lon_dd, site longitude, decimal degrees	
lat_deg_decmin, site latitude, degrees decimal minutes	
lon_deg_decmin, site longitude, degrees decimal minutes	

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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

Edmunds, P. J., Maritorena, S., & Burgess, S. C. (2024). Early post-settlement events, rather than settlement, drive recruitment and coral recovery at Moorea, French Polynesia. Oecologia, 204(3), 625–640. https://doi.org/10.1007/s00442-024-05517-y
Results

Kohler, K. E., & Gill, S. M. (2006). Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Computers & Geosciences, 32(9), 1259–1269. doi:10.1016/j.cageo.2005.11.009
Software

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Related Datasets

IsRelatedTo

Edmunds, P. J., Burgess, S., Maritorena, S. (2024) **Benthic seawater temperature at 10m depth in Moorea, French Polynesia from 2005 to 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 doi:10.26008/1912/bco-dmo.918318.1 [view at BCO-DMO]
Relationship Description: Datasets in support of results publication Edmunds et al. (2023).

Edmunds, P. J., Burgess, S., Maritorena, S. (2024) **Density of coral settlers detected on settlement tiles each year at two 10m sites on the north shore of Moorea, French Polynesia from 2008 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 doi:10.26008/1912/bco-dmo.918324.1 [view at BCO-DMO]
Relationship Description: Datasets in support of results publication Edmunds et al. (2023).

Edmunds, P. J., Burgess, S., Maritorena, S. (2024) **Density of small corals at two 10m sites on the north shore of Moorea, French Polynesia from 2005 to 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 http://lod.bco-dmo.org/id/dataset/918330 [view at BCO-DMO]
Relationship Description: Datasets in support of results publication Edmunds et al. (2023).

Edmunds, P. J., Burgess, S., Maritorena, S. (2024) **Flow speed on the north shore of Moorea, French from 2007 to 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 doi:10.26008/1912/bco-dmo.918306.1 [view at BCO-DMO]
Relationship Description: Datasets in support of results publication Edmunds et al. (2023).

Edmunds, P. J., Burgess, S., Maritorena, S. (2024) **Seawater chlorophyll concentration offshore from Moorea, French Polynesia from 2008 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 doi:10.26008/1912/bco-dmo.918299.1 [view at BCO-DMO]
Relationship Description: Datasets in support of results publication Edmunds et al. (2023).

Edmunds, P. J., Burgess, S., Maritorena, S. (2024) **Seawater clarity in Moorea, French Polynesia from 2003 to 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 doi:10.26008/1912/bco-dmo.918312.1 [view at BCO-DMO]
Relationship Description: Datasets in support of results publication Edmunds et al. (2023).

Moorea Coral Reef LTER (n.d.). Moorea Coral Reef LTER: Coral Image Viewer. Accessible from http://mcrlter.msi.ucsb.edu/data/db/census/coralImage.php

IsDerivedFrom

Moorea Coral Reef LTER, & Edmunds, P. (2024). MCR LTER: Coral Reef: Long-term Population and Community Dynamics: Corals, ongoing since 2005 [Data set]. Environmental Data Initiative. https://doi.org/10.6073/PASTA/15D5120FB4F7B79811B16287EAE15A35 (Accessed 2024-02-21). https://doi.org/10.6073/pasta/15d5120fb4f7b79811b16287eae15a35

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Parameters

Parameter	Description	Units
Year	Year in which data were collected	unitless
Site	Site where data were collected, either LTER1 or LTER2	unitless
Depth	Depth from which data originated, 10 = 10 m depth	meters (m)
Quad	Quadrat identifier	unitless
Pocillopora	Percentage cover of Pocillopora corals	percent (%)
All_stony_corals	Percentage cover of all stony corals (scleractinians + Millepora)	percent (%)

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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

Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)

Website: http://mcr.lternet.edu/

Coverage: Island of Moorea, French Polynesia

NSF Award Abstract:

Coral reefs provide important benefits to society, from food to exceptional biodiversity to shoreline protection and recreation, but they are threatened by natural perturbations and human activities, including those causing global-scale changes. These pressures increasingly are causing coral reefs to undergo large, often abrupt, ecological changes where corals are being replaced by seaweeds or other undesirable organisms. Historically, the major agent of disturbance to coral reefs has been powerful storms, but in recent decades, episodes of mass coral bleaching from marine heat waves have become more frequent and severe as the temperature of ocean surface waters continues to rise. Coral reefs are further stressed by local human activities that cause nutrient pollution and deplete herbivorous fishes that control growth of seaweeds. Studying how coral reefs respond to these two types of disturbance under different levels of nutrient pollution and fishing provides essential information on what affects the ability of coral reefs to buffer environmental change and disturbances without collapsing to a persistent, degraded condition. The fundamental goals of the Moorea Coral Reef Long Term Ecological Research program (MCR LTER) are to understand how and why coral reefs change over time, to assess the consequences of these changes, and to contribute scientific knowledge needed to sustain coral reef ecosystems and the important societal services they provide. This research improves understanding and management of coral reefs, which benefits all groups concerned with the welfare of this ecologically, economically and culturally important ecosystem. In addition to academic communities, scientific findings are communicated to interested individuals, non-governmental organizations, island communities and governmental entities. These findings also are integrated into K-12, undergraduate, graduate and public education activities through a multi-pronged program that includes inquiry-based curricula, interactive and media-based public education programs, and internet-based resources. MCR?s research, training, education and outreach efforts all emphasize broadening participation in STEM fields and strengthening STEM literacy.

New research activities build on MCR LTER?s powerful foundation of long-term observations and broad ecological understanding of oceanic coral reefs to address the following core issues: How is the changing disturbance regime (recurrent heat waves in addition to cyclonic storms) altering the resilience of coral reefs, and what are the ecological consequences of altered resilience? Research activities are organized around a unifying framework that explicitly addresses how reef communities are affected by the nature and history of coral-killing disturbances, and how those responses to disturbance are influenced by the pattern of local human stressors. New studies answer three focal questions: (1) How do different disturbance types, which either remove (storms) or retain (heat waves) dead coral skeletons, affect community dynamics, abrupt changes in ecological state, and resilience? (2) How do local stressors interact with new disturbance regimes to create spatial heterogeneity in community dynamics, ecosystem processes, and spatial resilience? And (3) What attributes of coral and coral reef communities influence their capacity to remain resilient under current and future environmental conditions? These questions provide an unparalleled opportunity to test hypotheses and advance theory regarding ecological resilience and the causes and consequences of abrupt ecological change, which is broadly relevant across aquatic and terrestrial ecosystems.

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.

From http://www.lternet.edu/sites/mcr/ and http://mcr.lternet.edu/:
The Moorea Coral Reef LTER site encompasses the coral reef complex that surrounds the island of Moorea, French Polynesia (17°30'S, 149°50'W). Moorea is a small, triangular volcanic island 20 km west of Tahiti in the Society Islands of French Polynesia. An offshore barrier reef forms a system of shallow (mean depth ~ 5-7 m), narrow (~0.8-1.5 km wide) lagoons around the 60 km perimeter of Moorea. All major coral reef types (e.g., fringing reef, lagoon patch reefs, back reef, barrier reef and fore reef) are present and accessible by small boat.

The MCR LTER was established in 2004 by the US National Science Foundation (NSF) and is a partnership between the University of California Santa Barbara and California State University, Northridge. MCR researchers include marine scientists from the UC Santa Barbara, CSU Northridge, UC Davis, UC Santa Cruz, UC San Diego, CSU San Marcos, Duke University and the University of Hawaii. Field operations are conducted from the UC Berkeley Richard B. Gump South Pacific Research Station on the island of Moorea, French Polynesia.

MCR LTER Data: The Moorea Coral Reef (MCR) LTER data are managed by and available directly from the MCR project data site URL shown above. The datasets listed below were collected at or near the MCR LTER sampling locations, and funded by NSF OCE as ancillary projects related to the MCR LTER core research themes.

This project is supported by continuing grants with slight name variations:

- LTER: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR II - Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR IIB: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR III: Long-Term Dynamics of a Coral Reef Ecosystem
- LTER: MCR IV: Long-Term Dynamics of a Coral Reef Ecosystem

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Program Information

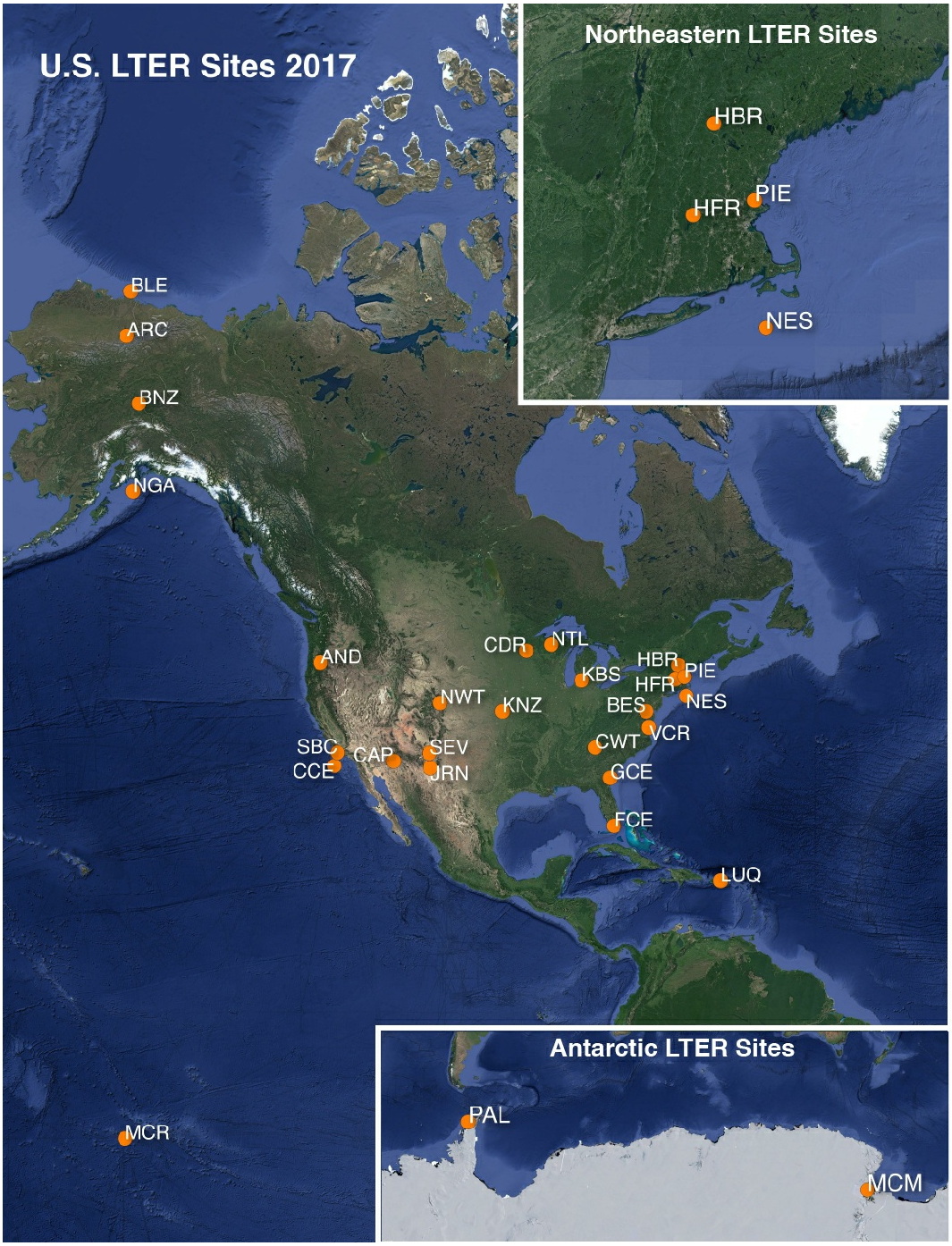
Long Term Ecological Research network (LTER)

Website: http://www.lternet.edu/

Coverage: United States

adapted from http://www.lternet.edu/

The National Science Foundation established the LTER program in 1980 to support research on long-term ecological phenomena in the United States. The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. The LTER Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The LTER research sites represent diverse ecosystems with emphasis on different research themes, and cross-site communication, network publications, and research-planning activities are coordinated through the LTER Network Office.



2017 LTER research site map obtained from https://lternet.edu/site/lter-network/

Site Codes

AND	Andrews Forest LTER
ARC	Arctic LTER
BES	Baltimore Ecosystem Stu
BLE	Beaufort Lagoon Ecosystems LTER
BNZ	Bonanza Creek LTER
CCE	California Current Ecosystem LTER
CDR	Cedar Creek Ecosystem Science Reserve
CAP	Central Arizona-Phoenix LTER
CWT	Coweeta LTER
FCE	Florida Coastal Everglades LTER
GCE	Georgia Coastal Ecosystems LTER
HFR	Harvard Forest LTER
HBR	Hubbard Brook LTER
JRN	Jornada Basin LTER
KBS	Kellogg Biological Station LTER
KNZ	Konza Prairie LTER
LUQ	Luquillo LTER
MCM	McMurdo Dry Valleys LT
MCR	Moorea Coral Reef LTEF
NWT	Niwot Ridge LTER
NTL	North Temperate Lakes I
NES	Northeast U.S. Shelf LTE
NGA	Northern Gulf of Alaska I
PAL	Palmer Antarctica LTER
PIE	Plum Island Ecosystems LTER
SBC	Santa Barbara Coastal L
SEV	Sevilleta LTER
VCR	Virginia Coast Reserve L

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2224354

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