Seawater clarity in Moorea, French Polynesia from 2003 to 2022

Website: https://www.bco-dmo.org/dataset/918312
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
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Abstract
Data Abstract: These data describe seawater clarity (as measured through Kd490) with data accessed 15 March 2022. 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

Spatial Extent: **N**:-17.475083 **E**:-149.8101 **S**:-17.4819 **W**:-149.84833
Temporal Extent: 2003-01-16 - 2022-01-16

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).

Data Processing Description

Water Clarity data obtained by remote sensing. Accessed through ERDAPP:
"Diffuse Attenuation K490, Aqua MODIS, NPP, L3SMI, Global, 4km, Science Quality, 2003-present (Monthly Composite)" NASA/GSFC OBPG (Dataset ID: erdMH1kd490mday)
* Accessed for grid -17.3693 to -17.4693 by -149.9414 to -149.8414, 2003-01-16 to 2022-01-16
* https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1kd490mday.html?k490%5B(2003-01-16):1:(2021-02-16T00:00:00Z)%5D%5B(-17.3693):1:(-17.4693)%5D%5B(-149.9414):1:(-149.8414)%5D
* ERDDAP "Summary": This dataset has Level 3, Standard Mapped Image, 4km, chlorophyll-a concentration data from NASA's Aqua Spacecraft. Measurements are gathered by the Moderate Resolution Imaging Spectroradiometer (MODIS) carried aboard the spacecraft. This is Science Quality data.

The ERDDAP data was subset using the values provided above, and only columns UTC time and Kd490 are provide in this dataset (lat,lon columns omitted).

BCO-DMO Curation Notes

* Sheet 1 of file " " 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.
* dataset references to results publication 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)
* 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]

* "T00:00:00Z" removed from all UTC_time column values. It was all the same. This is an artifact of 0 padding ERDDAP adds. Discussed with the submitter.

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Data Files

File
918312_v1_water-clarity.csv (Comma Separated Values (.csv), 49.51 KB) MD5:c41a8ee22725aae1190516528c32cd41 Primary data file for dataset ID 918312, 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

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

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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) **Percentage cover of the benthos by live coral at 10 m depth at sites in Moorea Moorea, French Polynesia from 2008 to 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-01-23 doi:10.26008/1912/bco-dmo.918265.1 [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).

IsDerivedFrom

NASA/GSFC OBPG (2022) Diffuse Attenuation K490, Aqua MODIS, NPP, L3SMI, Global, 4km, Science Quality, 2003-present (Monthly Composite), Dataset ID: erdMH1kd490mday, version date 2022-06-19 (subset lat: -17.3693 to -17.4693, lon: -149.9414 to -149.8414, date: 2003-01-16 to 2022-01-16) accessed from https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1kd490mday.html?k490%5B(2003-01-16):1:(2021-02-16T00:00:00Z)%5D%5B(-17.3693):1:(-17.4693)%5D%5B(-149.9414):1:(-149.8414)%5D

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Parameters

Parameter	Description	Units
UTC_time	Date for data collection in ISO 8601 format	unitless
Kd490	Measure of water clarity	m-1

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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

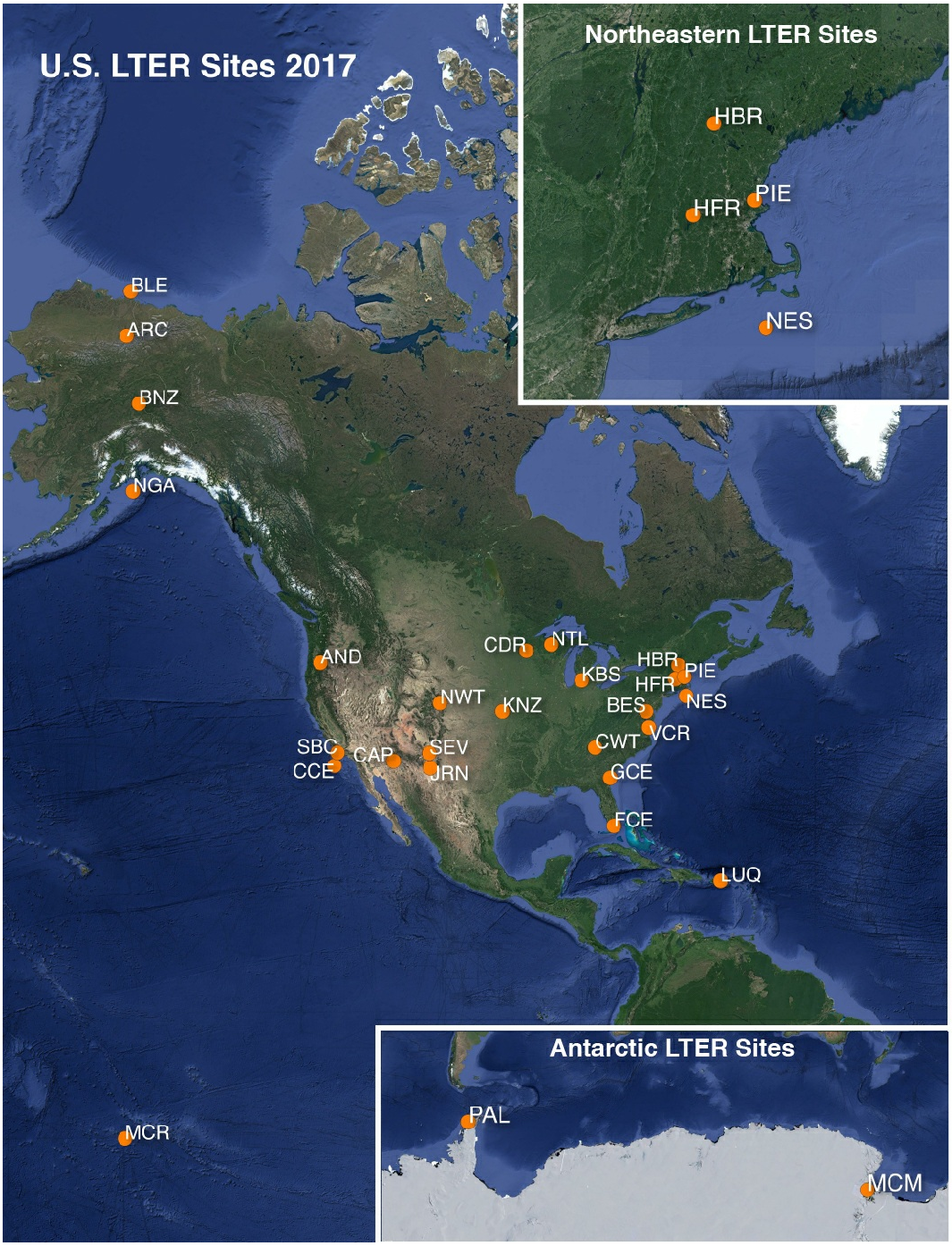
Long Term Ecological Research network (LTER)

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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