

Experimental results of coral recruit survivorship in variable CO2 collected from the Natl Museum Mar. Bio. and Aquar., Taiwan in 2010 (MCR LTER project, Climate_Coral_Larvae project)

Website: <https://www.bco-dmo.org/dataset/516529>
Version:
Version Date: 2014-03-20

Project
» [Moorea Coral Reef Long-Term Ecological Research site](#) (MCR LTER)
» [The ecophysiological basis of the response of coral larvae and early life history stages to global climate change](#) (Climate_Coral_Larvae)

Program
» [Long Term Ecological Research network](#) (LTER)

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Dataset Description

Manipulative studies have demonstrated that ocean acidification (OA) is a threat to coral reefs, yet no experiments have employed diurnal variations in pCO2 that are ecologically relevant to many shallow reefs. Two experiments were conducted to test the response of coral recruits (less than 6 days old) to diurnally oscillating pCO2; one exposing recruits for 3 days to ambient (440 uatm), high (663 uatm) and diurnally oscillating pCO2 on a natural phase (420-596 uatm), and another exposing recruits for 6 days to ambient (456 uatm), high (837 uatm) and diurnally oscillating pCO2 on either a natural or a reverse phase (448-845 uatm).

These data are published in Dufault et al. (2012), Proc. R. Soc. B. doi:10.1098/rspb.2011.2545

Related Datasets:

[recruit_growth_weight](#)
[recruit_growth_area](#)
[recruit_seawater_chemistry](#)

Methods & Sampling

Larvae were obtained from brooding colonies coral *S. caliendrum* collected from 5 to 7 m deep on Hobihu Reef, Nanwan Bay, in March and June of 2010, placed into individual flow-through seawater tanks. Overflow water from each tank passed through mesh-lined (110 mm) cups that captured larvae. Following collection, larvae were settled onto clean pre-weighed glass microscope coverslips. Coverslips with coral recruits (n=18: experiment I; n=36: experiment II) were assigned randomly to the pCO2 treatments.

In experiment I, treatments consisted of steady ambient pCO2, steady high pCO2 and diurnally oscillating pCO2 on a natural phase; this design was augmented in experiment II by including a diurnally oscillating pCO2 on a reverse phase.

Upon completion of the experiments, coverslips with coral recruits were placed in bleach (6% NaOCl) for 8 h to dissolve the tissue on the small corals and leave behind the CaCO3 skeleton. Coverslips were then rinsed with deionized water to remove the bleach and air-dried for 24 h at approximately 278C. Calcification was measured using the summed weight of the CaCO3 deposited by recruits on each coverslip and also as the planar area of the basal plate of each recruit. Coverslips without recruits but subjected to identical treatments served as procedural controls, and these did not change in weight in either experiment. In experiment I, the change in weight of each coverslip was divided by the number of corallites to provide a mean weight that was used as a statistical replicate. As some (approx. 5%) recruits died during the experiment, this technique slightly underestimated calcification. To remove this bias in experiment II, only recruits alive at the end of the experiment were used for growth measurements.

To evaluate survivorship during experiment II, recruits were photographed (Canon 40D, 10 megapixel resolution) every 2 days throughout the 6-day experiment. Images were used to score the recruits as alive or dead based on the presence of tissue, which is easily discernable from photographs. Survivorship was not measured in experiment I owing to logistical constraints.

For detailed description of methods, see Dufault et al. (2012), Proc. R. Soc. B. doi:10.1098/rspb.2011.2545

Data Processing Description

To analyse survivorship in experiment II, a Kaplan-Meier (KM) product-limit analysis was used [33]. For this analysis, the probability of individual recruits surviving is assumed to be independent of all other recruits, and because KM analyses cannot accommodate nested experimental designs, replicate corallites were pooled within each treatment. Survival was analysed using the statistical program JMP (v. 9.0.2, 2010, SAS Institute Inc.) and a log-rank test was used to test for differential survival among treatments.

For detailed description of processing see Dufault et al. (2012), Proc. R. Soc. B. doi:10.1098/rspb.2011.2545

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Data Files

File
CoralRecruit_survival.csv (Comma Separated Values (.csv), 3.02 KB) MD5:f416b6045f8266939c09c0200beb99d
Primary data file for dataset ID 516529

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Related Publications

Dufault, A. M., Cumbo, V. R., Fan, T.-Y., & Edmunds, P. J. (2012). Effects of diurnally oscillating pCO₂ on the calcification and survival of coral recruits. *Proceedings of the Royal Society B: Biological Sciences*, 279(1740), 2951–2958. doi:[10.1098/rspb.2011.2545](https://doi.org/10.1098/rspb.2011.2545)
Results

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Parameters

Parameter	Description	Units
laboratory	Laboratory where experiments were conducted.	unitless
lat	Latitude component of geographic position where experiments were conducted.	decimal degrees
lon	Longitude component of geographic position where experiments were conducted.	decimal degrees
coverslip	Unique coverslip the coral was settled upon.	dim
treatment_CO2	Individual CO ₂ treatment (A=ambient, H=High, D=Diurnal, DX=Reverse-phase Diurnal). Originally reported as "CO ₂ ".	dimensionless
tank	Unique tank the coverslips with settled corals were placed in (a decimal number represents 2 tanks used for the diurnal treatments - corals were placed in the first tank during the day (1st number) and into the second tank at night (2nd number), eg Tank 1.8= tank 1 during day, tank 8 at night).	dimensionless
month	Month of coral colony collection.	dimensionless
year	Year of coral colony collection.	
count_initial	Number of alive corals counted on day 0.	dimensionless
count_day2	Number of alive corals counted on day 2.	dimensionless
count_day4	Number of alive corals counted on day 4.	dimensionless
count_day6	Number of alive corals counted on day 6.	dimensionless

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Instruments

Dataset-specific Instrument Name	camera
Generic Instrument Name	Camera
Dataset-specific Description	Canon 40D, 10 megapixel resolution was used to photograph coral recruits.
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

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Deployments

lab Edmunds NMMBA

Website	https://www.bco-dmo.org/deployment/58892
Platform	Natl Museum Mar. Bio. and Aquar. Taiwan
Start Date	2010-03-18
End Date	2010-03-24
Description	Experiments related to the research project: 'RUI- The ecophysiological basis of the response of coral larvae and early life history stages to global climate change' were conducted at the laboratories of the National Museum of Marine Biology and Aquarium in Southern Taiwan.

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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.ikernet.edu/sites/mcr/> and <http://mcr.ikernet.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

The ecophysiological basis of the response of coral larvae and early life history stages to global climate change (Climate_Coral_Larvae)

Coverage: Moorea, French Polynesia; Southern Taiwan; California State University Northridge

Tropical coral reefs face a suite of environmental assaults ranging from anchor damage to the effects of global climate change (GCC). The consequences are evident throughout the tropics, where many coral reefs have lost a substantial fraction of their coral cover in a few decades. Notwithstanding the importance of reducing the impacts of environmental stresses, the only means by which these ecosystems can recover (or simply persist) is through the recruitment of scleractinians, which is a function of successful larval development, delivery, settlement, metamorphosis, and post-settlement events. Despite wide recognition of the importance of these processes, there are few pertinent empirical data, and virtually none that address the mechanisms mediating the success of early coral life stages in a physical environment varying at multiple spatio-temporal scales.

The objective of this research is to complete one of the first comprehensive ecophysiological analyses of the early life stages of corals through a description of: (1) their functionality under 'normal' conditions, and (2) their response to the main drivers of GCC. These analyses will be completed for 2 species representative of a brooding life history strategy, and the experiments will be completed in two locations, one (Taiwan) that provides unrivalled experience in coral reproductive biology, and superb microcosm facilities, and the other (Moorea), with access to a relatively pristine environment, a well described ecological and oceanographic context (through the MCR-LTER), and the capacity to bring a strong biogeographic contrast to the project. The results of the study will be integrated through modeling to explore the effects of GCC on coral community structure over the next century.

The following publications and data resulted from this project:

2013 Wall CB, Fan TY, Edmunds PJ. Ocean acidification has no effect on thermal bleaching in the coral *Seriatopora caliendrum*. Coral Reefs 33: 119-130.

[Symbiodinium_Seriatopora_photosynthesis](#)
[Symbiodinium_Seriatopora_PI_curve](#)
[Symbiodinium_Seriatopora_temp-salinity-light](#)
[Symbiodinium_Seriatopora_water_chemistry](#)
[- Download complete data for this publication \(Excel file\)](#)

2013 Wall CB, Edmunds PJ. *In situ* effects of low pH and elevated HCO₃⁻ on juvenile *Porites* spp. in Moorea, French Polynesia. Biological Bulletin 225:92-101.

Data at MCR and PANGAEA: [doi:10.1594/PANGAEA.833913](https://doi.org/10.1594/PANGAEA.833913)
[- Download complete data for this publication \(Excel file\)](#)

2013 Vivian R Cumbo, Peter J Edmunds, Christopher B Wall, Tung-Yung Fan. Brooded coral larvae differ in their response to high temperature and elevated pCO₂ depending on the day of release. Marine Biology DOI 10.1007/s00227-013-2280-y.

Data also at PANGAEA: [doi:10.1594/PANGAEA.831612](https://doi.org/10.1594/PANGAEA.831612)
[brooded coral larvae 2 - carbonate chemistry](#)
[brooded coral larvae 2 - larval release March 2003-2008](#)
[brooded coral larvae 2 - respiration_photosynth_mortality](#)
[- Download complete data for this publication \(Excel file\)](#)

2013 Edmunds PJ, Cumbo VR, Fan TY. Metabolic costs of larval settlement and metamorphosis in the coral *Seriatopora caliendrum* under ambient and elevated pCO₂. Journal Experimental Marine Biology and Ecology 443: 33-38 Data also at PANGAEA: [doi:10.1594/PANGAEA.821644](https://doi.org/10.1594/PANGAEA.821644)

[Coral post-settlement physiology](#)
[- Download complete data for this publication \(Excel file\)](#)

2013 Aaron M Dufault, Aaron Ninokawa, Lorenzo Bramanti, Vivian R Cumbo, Tung-Yung Fan, Peter J Edmunds. The role of light in mediating the effects of ocean acidification on coral calcification. Journal of Experimental Biology 216: 1570-1577.

[coral-light expt.- PAR](#)
[coral-light expt.- carbonate chemistry](#)
[coral-light expt.- temp_salinity](#)
[coral-light expt.- growth](#)
[coral-light expt.- protein](#)
[coral-light expt.- survival](#)

[- Download complete data for this publication \(Excel file\)](#)

2012 Cumbo, VR, Fan TY, Edmunds PJ. Effects of exposure duration on the response of *Pocillopora damicornis* larvae to elevated temperature and high pCO₂. J Exp Mar Biol Ecol 439: 100-107.

Data is also at PANGAEA: [doi:10.1594/PANGAEA.823582](https://doi.org/10.1594/PANGAEA.823582)

[brooded coral larvae 3 - carbonate chemistry](#)

[brooded coral larvae 3 - light](#)

[brooded coral larvae 3 - mortality](#)

[brooded coral larvae 3 - protein](#)

[brooded coral larvae 3 - respiration and protein](#)

[brooded coral larvae 3 - respiration raw data](#)

[brooded coral larvae 3 - symbiont density](#)

[brooded coral larvae 3 - tank temperature](#)

[- Download part 1 of data for this publication \(Excel file\)](#)

[- Download tank parameters data for this publication \(Excel file\)](#)

2012 Cumbo, VR, Fan TY, Edmunds PJ. Physiological development of brooded larvae from two pocilloporid corals in Taiwan. Marine Biology 159: 2853-2866.

[brooded coral - carbonate chemistry](#)

[brooded coral - release](#)

[brooded coral - respiration](#)

[brooded coral - settlement competency](#)

[brooded coral - size July](#)

[brooded coral - size protein symbionts photosynth](#)

[- Download complete data for this publication \(Excel file\)](#)

2012 Dufault, Aaron M; Vivian R Cumbo; Tung-Yung Fan; Peter J Edmunds. Effects of diurnally oscillating pCO₂ on the calcification and survival of coral recruits. Royal Society of London (B) 279: 2951-2958. doi:10.1098/rspb.2011.2545

Data is also at PANGAEA: [doi:10.1594/PANGAEA.830185](https://doi.org/10.1594/PANGAEA.830185)

[recruit growth area](#)

[recruit growth weight](#)

[recruit seawater chemistry](#)

[recruit survival](#)

[- Download complete data for this publication \(Excel file\)](#)

2011 Edmunds PJ, Cumbo V, Fan TY. Effects of temperature on the respiration of brooded larvae from tropical reef corals. Journal of Experimental Biology 214: 2783-2790.

[Corall larvae comparison respir](#)

[Corall larvae release](#)

[Corall larvae respir](#)

[Corall larvae size](#)

[- Download complete data for this publication \(Excel file\)](#)

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Program Information

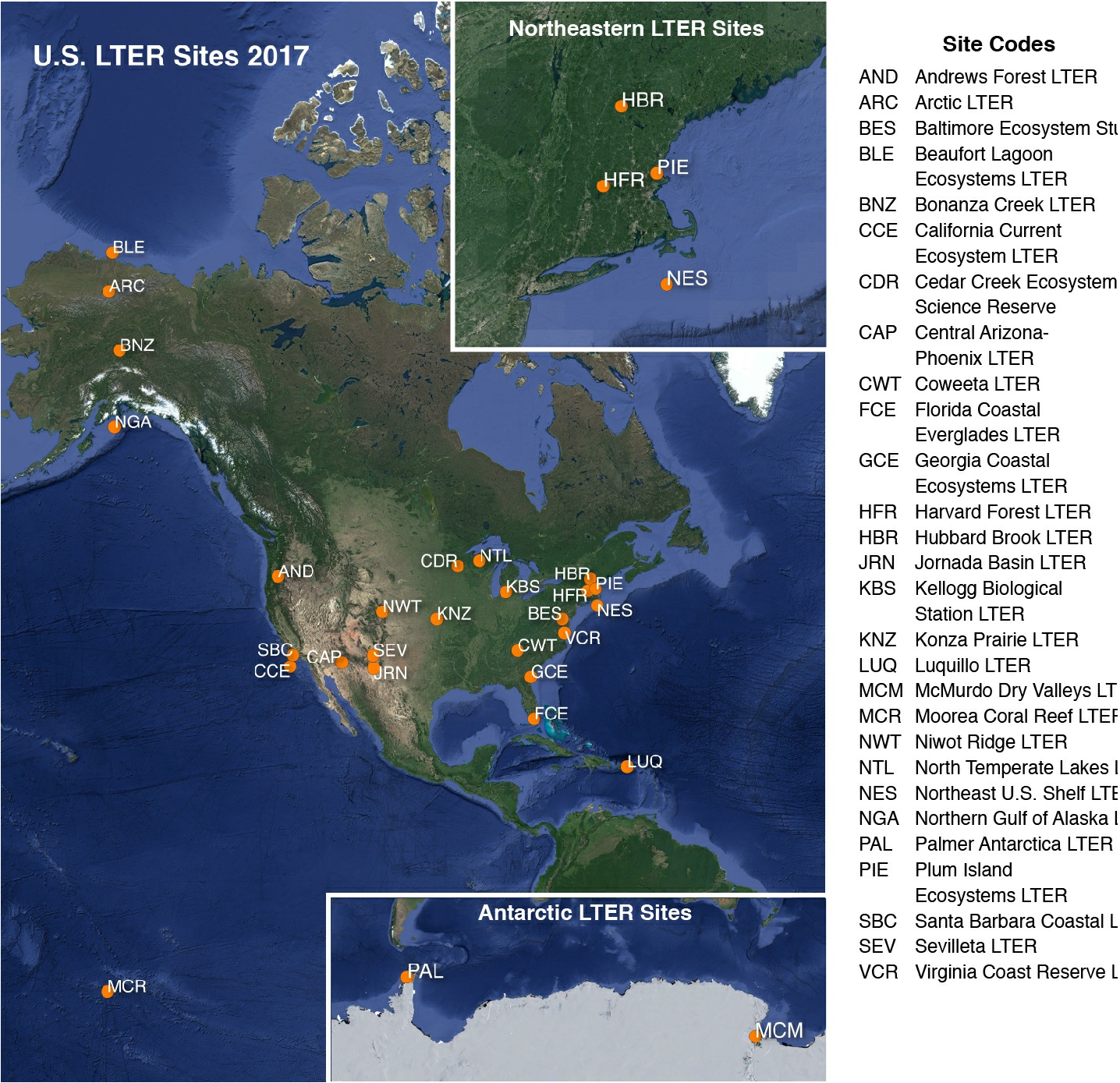
Long Term Ecological Research network (LTER)

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/>

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0844785

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