

# Settling and mortality measurements of brooded coral larvae at high and ambient temperature and pCO<sub>2</sub>, Taiwan, March 2011 (MCR LTER project, Climate\_Coral\_Larvae project)

Website: <https://www.bco-dmo.org/dataset/535462>

Data Type: experimental

Version: 1

Version Date: 2014-10-07

## 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)

Contributors	Affiliation	Role
<a href="#">Edmunds, Peter J.</a>	California State University Northridge (CSUN)	Principal Investigator
<a href="#">Cumbo, Vivian R.</a>	California State University Northridge (CSUN)	Co-Principal Investigator
<a href="#">Fan, Tung-Yung</a>	National Museum of Marine Biology and Aquarium (NMMBA)	Co-Principal Investigator
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## Abstract

The physiological development of brooded larvae from the pocilloporid corals *Pocillopora damicornis* in southern Taiwan under elevated temperature and pCO<sub>2</sub> was examined. These data include settling and mortality rates of brooded coral larvae at high and ambient temperature and pCO<sub>2</sub> conducted in March 2011. These data were published in Cumbo et al, JEMBE, 2013.

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## Coverage

**Spatial Extent:** Lat:21.93817 Lon:120.74602

**Temporal Extent:** 2011-03-02 - 2011-03-18

## Methods & Sampling

Survival of the two groups of 20 larvae allocated to each tank for this purpose was determined at 10:00 h each sampling day by carefully removing the tubs from each tank and inspecting the seawater for larvae. Larvae were scored as swimming, settled and metamorphosed recruits (on the plastic of the tub), or missing; missing larvae were assumed to have died and broken down. Survivorship was calculated as the number of swimming larvae on each of the four days, divided by the number of larvae initially added, less the number that settled. Settled larvae (i.e., recruits) were removed from the analysis on the day they were noted as settled because the objective of the analysis was to evaluate survivorship of the swimming larvae. Importantly, recruits did not contribute to the larvae scored as dead, but they did reduce the sample size for the assessment of survival at each sampling interval; this effect was small.

The 'ambient' and 'high' pCO<sub>2</sub> levels: 49.4 Pa versus 86.2 Pa

The 'ambient' and 'high' temperatures: 24.00 °C [ambient] versus 30.49 °C

Data also available from PANGAEA: [doi:10.1594/PANGAEA.823582](https://doi.org/10.1594/PANGAEA.823582)

## Data Processing Description

### BCO-DMO processing notes:

- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- added lab, lat, lon columns
- reformatted date from m.d.yyyy to yyyy-mm-dd

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## Data Files

File
<b>brood3_mortality.csv</b> (Comma Separated Values (.csv), 6.12 KB) <small>MD5:d4e9f106ef6f028898863df38297a27</small>
Primary data file for dataset ID 535462

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## Supplemental Files

File
<b>Biological data for "brooded coral larvae expt. 3" datasets</b> filename: Cumbo_eta_2012_JEMBE_data1_BCODMO.xls (Octet Stream, 154.50 KB) MD5:e6c5e6012df9bfc581b9f769f7e52a98
Original biological data for Cumbo et al 2013 including respiration raw data, respiration by mg protein, symbiont densities, protein content, % mortality
<b>Tank physical data</b> filename: Cumbo_eta_2012_JEMBE_Tank_Parameters_BCODMO.xlsx (Octet Stream, 57.05 KB) MD5:0170402805d7c1fe4784a51d2b26fb66
Tank physical data for "brooded coral larvae 3" experiment including seawater chemistry, light and temperature data.

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## Related Publications

Cumbo, V. R., Fan, T. Y., & Edmunds, P. J. (2013). Effects of exposure duration on the response of Pocillopora damicornis larvae to elevated temperature and high pCO<sub>2</sub>. Journal of Experimental Marine Biology and Ecology, 439, 100–107. doi:[10.1016/j.jembe.2012.10.019](https://doi.org/10.1016/j.jembe.2012.10.019)  
*Results*

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## Related Datasets

### IsRelatedTo

- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Light data in tanks from experiment on brooded coral larval, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535219> [[view at BCO-DMO](#)]
- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Protein content of brooded coral larvae at high and ambient temperature and pCO<sub>2</sub>, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535425> [[view at BCO-DMO](#)]
- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Respiration and protein content of brooded coral larvae at high and ambient temperature and pCO<sub>2</sub>, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535328> [[view at BCO-DMO](#)]
- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Respiration of brooded coral larvae at high and ambient temperature and pCO<sub>2</sub>, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535266> [[view at BCO-DMO](#)]
- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Seawater carbonate chemistry from experiment on brooded coral larval, March 2011, Taiwan (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535163> [[view at BCO-DMO](#)]
- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Symbiont Symbiodinium density in brooded coral larvae at high and ambient temperature and pCO<sub>2</sub>, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535358> [[view at BCO-DMO](#)]
- Edmunds, P. J., Cumbo, V. R., Fan, T. (2014) **Temperature data from tanks from experiment on brooded coral larval, Taiwan, March 2011 (Cumbo et al, JEMBE, 2013) (MCR LTER & Climate Coral Larvae projects)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2014-10-07 <http://lod.bco-dmo.org/id/dataset/535244> [[view at BCO-DMO](#)]

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## Parameters

Parameter	Description	Units
lab	laboratory	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
date	local date	yyyy-mm-dd
tank_group	tank id plus subsample group number	tank
temp	target temperature	degrees Celsius
treatment_pCO2	pCO <sub>2</sub> treatment: ambient (47.5 - 49.3 Pa) or high (85.2 - 87.2 Pa)	unitless
swim	number of larvae swimming in tank	larvae
metamorph	number of larvae that have metamorphosed	larvae
settled	number of larvae that have settled	larvae
in_lip	number of larvae found on lip of tank	larvae
missing_dead	number of larvae found dead or not found and presumed dead	larvae
prop_mort	proportion mortality	unitless

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## Instruments

<b>Dataset-specific Instrument Name</b>	Aquarium chiller
<b>Generic Instrument Name</b>	Aquarium chiller
<b>Dataset-specific Description</b>	Aquatech Ac11 or Shyeh Duwai Enterprise
<b>Generic Instrument Description</b>	Immersible or in-line liquid cooling device, usually with temperature control.

<b>Dataset-specific Instrument Name</b>	Gas Analyzer
<b>Generic Instrument Name</b>	Gas Analyzer
<b>Dataset-specific Description</b>	Infra Red gas analyzer (S151, Qubit Systems)
<b>Generic Instrument Description</b>	Gas Analyzers - Instruments for determining the qualitative and quantitative composition of gas mixtures.

<b>Dataset-specific Instrument Name</b>	Immersion heater
<b>Generic Instrument Name</b>	Immersion heater
<b>Dataset-specific Description</b>	300 W heaters, Taikong Corporation
<b>Generic Instrument Description</b>	Submersible heating element for water tanks and aquaria.

<b>Dataset-specific Instrument Name</b>	LI-COR LI-192 light sensor
<b>Generic Instrument Name</b>	LI-COR LI-192 PAR Sensor
<b>Dataset-specific Description</b>	cosine-corrected quantum light meter (Li-Cor LI-192 attached to an LI-1400)
<b>Generic Instrument Description</b>	The LI-192 Underwater Quantum Sensor (UWQ) measures underwater or atmospheric Photon Flux Density (PPFD) (Photosynthetically Available Radiation from 360 degrees) using a Silicon Photodiode and glass filters encased in a waterproof housing. The LI-192 is cosine corrected and features corrosion resistant, rugged construction for use in freshwater or saltwater and pressures up to 800 psi (5500 kPa, 560 meters depth). Typical output is in $\mu\text{m}^{-2}$ . The LI-192 uses computer-tailored filter glass to achieve the desired quantum response. Calibration is traceable to NIST. The LI-192 serial numbers begin with UWQ-XXXXX. LI-COR has been producing Underwater Quantum Sensors since 1973. These LI-192 sensors are typically listed as LI-192SA to designate the 2-pin connector on the base of the housing and require an Underwater Cable (LI-COR part number 2222UWB) to connect to the pins on the Sensor and connect to a data recording device. The LI-192 differs from the LI-193 primarily in sensitivity and angular response. 193: Sensitivity: Typically 7 $\mu\text{A}$ per 1000 $\mu\text{mol s}^{-1} \text{m}^{-2}$ in water. Azimuth: $< \pm 3\%$ error over $360^\circ$ at $90^\circ$ from normal axis. Angular Response: $< \pm 4\%$ error up to $\pm 90^\circ$ from normal axis. 192: Sensitivity: Typically 4 $\mu\text{A}$ per 1000 $\mu\text{mol s}^{-1} \text{m}^{-2}$ in water. Azimuth: $< \pm 1\%$ error over $360^\circ$ at $45^\circ$ elevation. Cosine Correction: Optimized for underwater and atmospheric use. ( <a href="http://www.licor.com">www.licor.com</a> )

<b>Dataset-specific Instrument Name</b>	optrode
<b>Generic Instrument Name</b>	Optode
<b>Dataset-specific Description</b>	A Ruthenium-based optrode (FOXY-R, 1.58 diameter, Ocean Optics) connected to a spectrophotometer (USB2000, Ocean Optics) and interfaced with a computer running the manufacturers software (OOISensor, version 1.00.08). The optrode was calibrated using a zero solution (0.01 M Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·10H <sub>2</sub> O supersaturated with Na <sub>2</sub> SO <sub>3</sub> ) and 100% air saturation using water-saturated air at the treatment temperature.
<b>Generic Instrument Description</b>	An optode or optrode is an optical sensor device that optically measures a specific substance usually with the aid of a chemical transducer.

<b>Dataset-specific Instrument Name</b>	Water Temp Sensor
<b>Generic Instrument Name</b>	Water Temperature Sensor
<b>Dataset-specific Description</b>	certified digital thermometer (Model 15-077-8, Fisher Scientific, $\pm 0.05^\circ\text{C}$ )
<b>Generic Instrument Description</b>	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

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## Deployments

### lab Edmunds NMMBA

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58892">https://www.bco-dmo.org/deployment/58892</a>
<b>Platform</b>	Natl Museum Mar. Bio. and Aquar. Taiwan
<b>Start Date</b>	2010-03-18
<b>End Date</b>	2010-03-24
<b>Description</b>	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

**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 ( $17^\circ 30'S$ ,  $149^\circ 50'W$ ). 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 calandrum*. *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 HCO<sub>3</sub><sup>-</sup> on juvenile *Porites* spp. in Moorea, French Polynesia. *Biological Bulletin* 225:92-101.

Data at MCR and PANGAEA: [doi.pangaea.de/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 pCO<sub>2</sub> depending on the day of release. *Marine Biology* DOI 10.1007/s00227-013-2280-y.

Data also at PANGAEA: [doi.pangaea.de/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 calandrum* under ambient and elevated pCO<sub>2</sub>. *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 pCO<sub>2</sub>. *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 pCO<sub>2</sub> 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.

[CoralLarvae\\_comparison\\_respir](#)

[CoralLarvae\\_release](#)

[CoralLarvae\\_respir](#)

[CoralLarvae\\_size](#)

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

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## Program Information

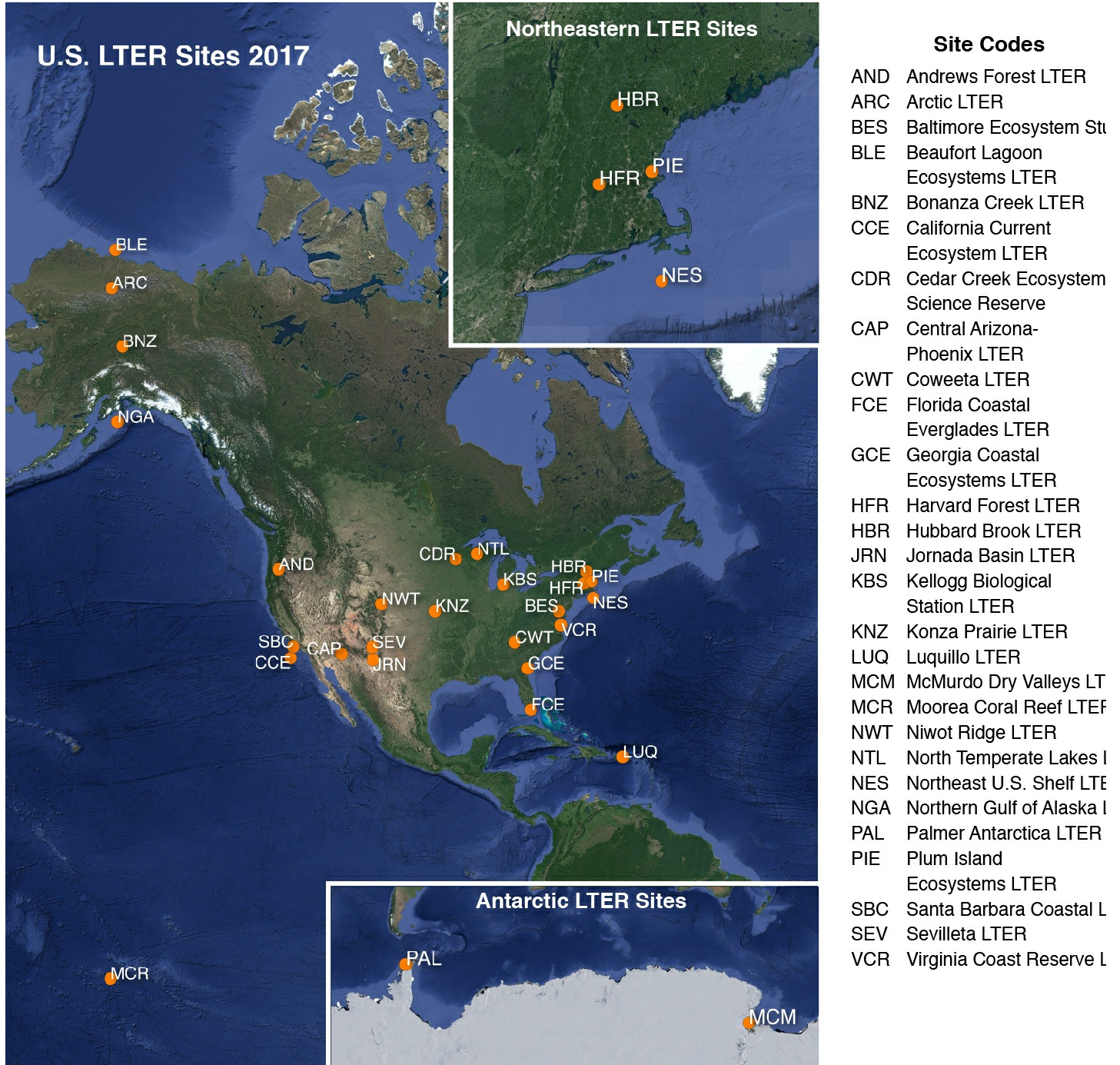
## Long Term Ecological Research network (LTER)

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
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-0844785</a>

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