Brooded coral larval size, protein content, symbiont (Symbiodinium) densities, maximum photochemical efficiency of PSII (Cumbo, 2012) from Taiwan, 2010 (Cumbo, 2012) (MCR LTER project, Climate_Coral_Larvae project)

Website: https://www.bco-dmo.org/dataset/528661
Version: 2014-09-08

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
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Dataset Description

The physiological development of brooded larvae from the pocilloporid corals *Pocillopora damicornis* and *Seriatopora caliendrum* in southern Taiwan was examined.

These data include larval size, protein content, symbiont (Symbiodinium) densities, maximum photochemical efficiency of PSII from experiments conducted in June and July, 2010.

Related datasets:
brooded coral - carbonate chemistry
brooded coral - release
brooded coral - respiration
brooded coral - settlement competency
brooded coral - size_July
brooded coral - size_protein_symbionts_photosynth

These data are published in Cumbo, VR, Fan TY, Edmunds PJ. (2012) Physiological development of brooded larvae from two pocilloporid corals in Taiwan. Marine Biology 159: 2853-2866. DOI 10.1007/s00227-012-2046-y. See Figs. 1b, 1c, 3b, 3c, 3d.

Download complete data for this publication (Excel file)

Methods & Sampling

Protein content of the larvae was determined spectrophotometrically using the microtiter plate protocol of the Bio-Rad protein assay with Coomassie brilliant blue dye (Bio-Rad, CA). At each sampling, four groups of larvae (40 group-1 in June and 10 group-1 in July) were frozen in liquid nitrogen and stored until processed. Proteins were solubilized by placing the larvae in 0.1 M NaOH, disrupting them with ultrasonic vibrations (Branson Digital Sonifier S-250D, USA), and warming at 50C for 5 h. The protein extract was neutralized with HCl, diluted where necessary, and processed in triplicate with the addition of the dye reagent on a microtiter plate. Following 30-min incubations, absorbances were measured at 595 nm using a plate reader (Biotek Synergy H4 Hybrid Reader, USA) and converted to protein using a calibration prepared from bovine serum albumin. Protein content was expressed as mg larva-1.

Maximum quantum yield (Fv/Fm) of Symbiodinium within the larvae: To assess the condition and number of Symbiodinium, larvae were processed for maximum photochemical efficiency of PSII (Fv/Fm) and Symbiodinium density. Fv/Fm was measured using pulse amplitude modulation fluorometry (PAM) with a Diving-PAM (Walz, GmbH) fitted with an 8-mm-diameter probe and operated at constant settings for measuring intensity and gain (both set at 10). Four replicates of 8 larvae were dark-adapted for 2 h and transferred under weak red light to the tip of the sensor where they were retained within a drop of water. Previous experiments demonstrated that fluorescent measures could be obtained reliably with C6 larvae. Larvae processed for Fv/Fm were removed from the tip of the sensor and used to evaluate size.

Larval size and *Symbiodinium* densities: To determine the size, larvae were placed individually on a microscope slide in a drop of seawater and photographed using a digital camera fitted to a dissecting microscope. Larval area (mm^2) was measured using ImageJ 1.42q software (Abramoff et al. 2004), and mean larval area (n = 8) from each tank at each time point was used for statistical analysis. Finally, these larvae were analyzed for *Symbiodinium* densities by preserving 4 replicates of 8 larvae in 10 % formalin, and later macerating them with a Teflon pestle. The Symbiodinium in the slurry were counted using a hemocytometer (4 replicate counts) and the algal population expressed as cells larva-1.

Data Processing Description

BCO-DMO processing notes:

- added conventional header with dataset name, PI name, version date, reference information
- added lab, lat, lon, expt columns
- renamed parameters to BCO-DMO standard
- combined data from Figures 1b, 1c, 3b, 3c, 3d

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Data Files

File
brood_protein.csv (Comma Separated Values (.csv), 14.31 KB) MD5:5f7cf1af6cbccfb839d079c0ac2f7241 Primary data file for dataset ID 528661

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Parameters

Parameter	Description	Units
expt	experiment id	unitless
lab	laboratory	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
species	coral species name	unitless
date	local date of measurement	yyyy-mm-dd
lunar_day	lunar day of measurement	integer
release	larval release relative to full moon: early peak late	unitless
sample	sample number	integer
larval_size	larval area	mm^2
protein_larva	protein content per larva	mg/larva
num_larvae_density	number of larvae examined for symbiont density	integer
vol	the volume in which the cells were resuspended prior to counting	ml
vol_grid	volume of grid on hemocytometer	ml
rep_1	number of symbionts in replicate 1 of hemocytometer slide	integer
rep_2	number of symbionts in replicate 2 of hemocytometer slide	integer
rep_3	number of symbionts in replicate 3 of hemocytometer slide	integer
rep_4	number of symbionts in replicate 4 of hemocytometer slide	integer
num_larvae_FvFm	number of larvae examined for photochemical efficiency	integer
Fv_Fm	maximum photochemical efficiency of PSII	unitless

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Instruments

Dataset-specific Instrument Name	Hemocytometer
Generic Instrument Name	Hemocytometer
Generic Instrument Description	A hemocytometer is a small glass chamber, resembling a thick microscope slide, used for determining the number of cells per unit volume of a suspension. Originally used for performing blood cell counts, a hemocytometer can be used to count a variety of cell types in the laboratory. Also spelled as "haemocytometer". Description from: http://hlsweb.dmu.ac.uk/ahs/elearning/RITA/Haem1/Haem1.html.

Dataset-specific Instrument Name	plate reader
Generic Instrument Name	plate reader
Dataset-specific Description	Biotek Synergy H4 Hybrid Reader, USA
Generic Instrument Description	Plate readers (also known as microplate readers) are laboratory instruments designed to detect biological, chemical or physical events of samples in microtiter plates. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed in 6-1536 well format microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200 uL per well. Higher density microplates (384- or 1536-well microplates) are typically used for screening applications, when throughput (number of samples per day processed) and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50 µL per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization. From: http://en.wikipedia.org/wiki/Plate_reader, 2014-09-0-23.

Dataset-specific Instrument Name	sonicator
Generic Instrument Name	ultrasonic cell disrupter (sonicator)
Dataset-specific Description	Branson Digital Sonifier S-250D, USA
Generic Instrument Description	Instrument that applies sound energy to agitate particles in a sample.

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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.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

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 environmental 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 PANGEA: doi.pangaea.de/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 PANGEA: doi.pangaea.de/10.1594/PANGAEA.831612
brooded coral larvae 2 - carbonate chemistry
brooded coral larvae 2 - larval release March 2003-2008
brooded coral larvae 2 - respiration_photosyth_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 PANGEA: doi: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 PANGEA: doi: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 PANGEA: doi: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

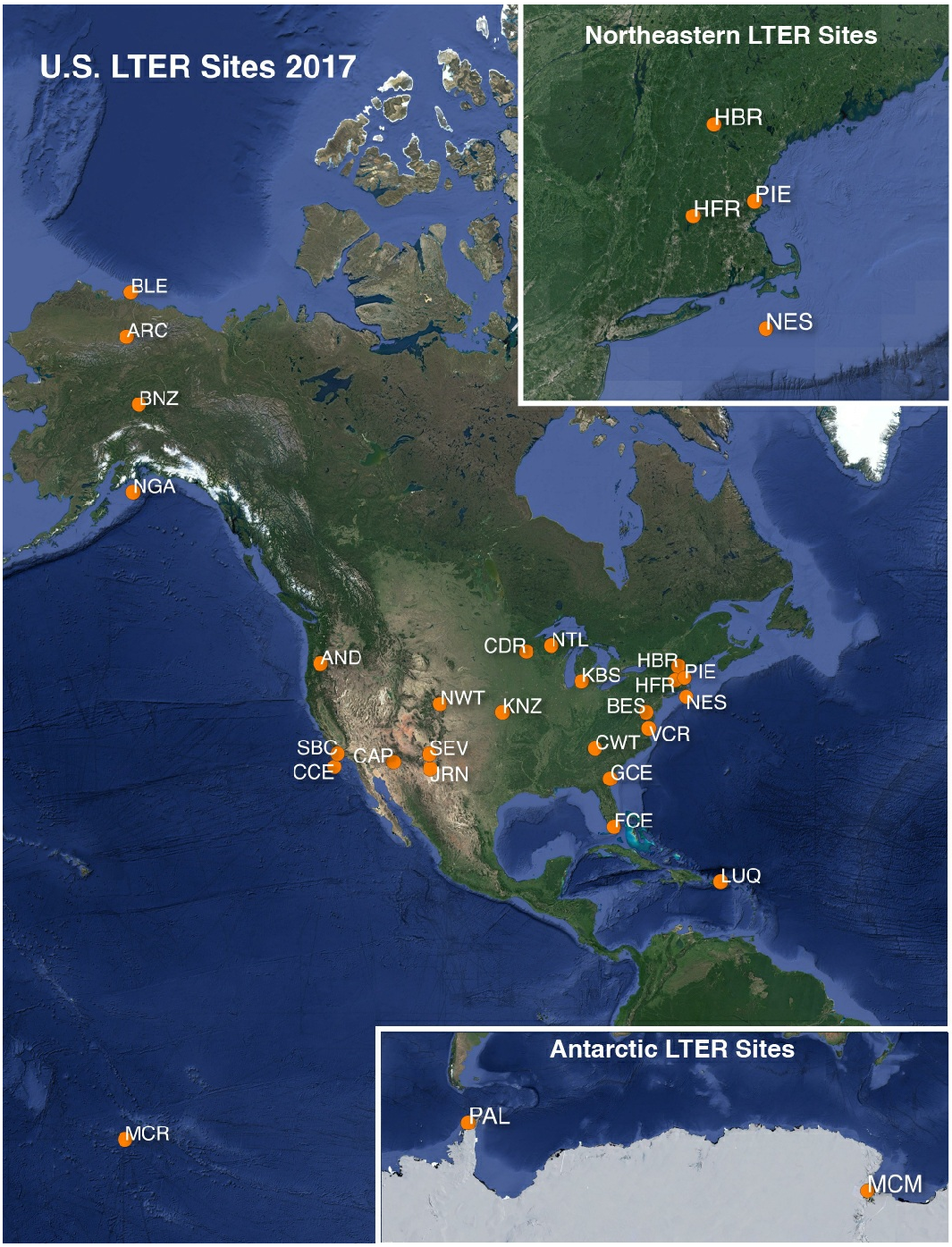
Long Term Ecological Research network (LTER)

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.



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

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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