Regression Mussel Data

Website: https://www.bco-dmo.org/dataset/839455
Data Type: Other Field Results
Version: 1
Version Date: 2021-02-02

Project
» OCEAN ACIDIFICATION - Category 1: COLLABORATIVE RESEARCH: Acclimation and adaptation to ocean acidification of key ecosystem components in the California Current System (OMEGAS-MaS)
» OMEGAS II - Linking ecological and organismal responses to the ocean acidification seascape in the California Current System (OMEGAS-II)

Programs
» Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)
» Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Contributors	Affiliation	Role
Menge, Bruce A.	Oregon State University (OSU)	Principal Investigator, Contact
Raimondi, Peter T.	University of California-Santa Cruz (UCSC)	Co-Principal Investigator
Sanford, Eric	University of California-Davis (UC Davis)	Co-Principal Investigator
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Parameters
- Project Information
- Program Information
- Funding

Dataset Description

Data have not been made public due to unanswered questions and data quality issues. Final review by the data submitter was not received after it was imported into the BCO-DMO data system.

Methods & Sampling

Methods & Sampling

Data Processing Description

Data Processing

[table of contents | back to top]

Parameters

Parameter	Description	Units
ID	Unique numerical identifier	unitless
Site	Site of origin; BC=Bob Creek, BY=Bodega Marine Reserve, LP=Lompoc Landing, SB=Sandhill Bluff	unitless
Buoyant	Weight (to nearest 0.01 grams) of live mussel when suspended in seawater	grams (gr)
Length	Total length of mussel shell (to nearest 0.1mm) measured from umbo to posterior shell margin	millimiters (mm)
Width	Maximum width of mussel shell (to nearest 0.1mm) measured from dorsal to ventral margins	millimiters (mm)
Girth	Maximum breadth of mussel shell (to nearest 0.1mm) measured across the breadth of both shell halves when closed	millimiters (mm)
Tin	Weight (to nearest 0.01 grams) of tin dish in which mussel soft tissue was dried	grams (gr)
Shell	Weight (to nearest 0.01 grams) of dry mussel shell	grams (gr)
Tissue	Weight (to nearest 0.01 grams) of dry soft tissue; Includes tin dish weight since dish was inseparable from desiccated tissue.	grams (gr)
Latitude	Latitude of site, negative is south	decimal degrees
Longitude	Longitude of site, negative is west	decimal degrees

[table of contents | back to top]

Project Information

OCEAN ACIDIFICATION - Category 1: COLLABORATIVE RESEARCH: Acclimation and adaptation to ocean acidification of key ecosystem components in the California Current System (OMEGAS-MaS)

Website: http://omegas.science.oregonstate.edu

Coverage: California Current Large Marine Ecosystem, Oregon, California

In 2010-2012/13, the OMEGAS consortium is investigating the impact of ocean acidification (OA) on two ecologically important, calcification-dependent marine invertebrates (sea urchins *Strongylocentrotus purpuratus* and mussels *Mytilus californianus*) in relation to local-to-coastal variation in carbonate chemistry in the California Current Large Marine Ecosystem (CCLME). An interdisciplinary team of investigators with expertise in physical and chemical oceanography, marine ecology, biochemistry, molecular physiology, and

molecular genetics carry out integrated, lab and field, multi-site investigations of the ecological, physiological, and evolutionary responses of sea urchins and mussels to spatial and temporal variation in OA.

The research takes place in the context of a mosaic of variable oceanography, including recently documented latitudinal variation in carbonate chemistry along the upwelling-dominated US west coast. Variation in upwelling regimes from Washington to southern California generates spatial and temporal gradients in concentration of CO2 that shoal to surface waters during upwelling events, extending shoreward into the inner shelf region. Because calcifiers in the upwelling-dominated CCLME probably have historically experienced wide fluctuation in pH, many likely are adapted to a variable carbonate chemistry environment. The new challenge to these organisms is that they may have limited ability to respond to additional increases in CO2. It is this challenge, the mechanistic ability of calcifying invertebrates to acclimate or adapt to increasing CO2 and aragonite saturation states < 1.0, that is addressed in this program.

Our research includes several integrated elements that span our three project areas (Moorings and sensors; Genomics, physiology, and larval rearing; and Field transplants and growth experiments):

(1) Document the oceanographic context in which the study organisms operate in four regions of the CCLME with contrasting upwelling regimes.

(2) Examine physiological, genomic, and genetic mechanisms underlying acclimatization and adaptation to OA conditions with coordinated and integrated studies of adults and larvae of sea urchins and mussels collected from each of two sites within each of the four regions. In common-garden experiments culture sea urchins and mussels, respectively, under different CO2 and temperature regimes, and use genomics techniques to determine the tolerance of larvae to present and future OA conditions.

(3) Determine evolutionary responses and adaptational potential to OA using genetic surveys of urchins and mussels across the 8 sites and relate detected variability to the oceanographic conditions.

(4) Examine ecological responses to OA with transplants of mussels and urchins in the field and monitor growth rates and shell accretion rates in relation to oceanographic and physical conditions.

The team will investigate the impact of ocean acidification (OA) on two ecological important, calcification-dependent marine invertebrates (sea urchins *Strongylocentrotus purpuratus* and mussels *Mytilus californianus*) in relation to local-to-coastal variation in carbonate chemistry in the California Current Large Marine Ecosystem (CCLME). An interdisciplinary team of investigators with expertise in physical and chemical oceanography, marine ecology, biochemistry, molecular physiology, and molecular genetics will carry out an integrated, lab and field, multi-site investigation of the ecological, physiological, and evolutionary responses of sea urchins and mussels to spatial and temporal variation in OA. The research will take place in the context of a mosaic of variable oceanography, including recently documented latitudinal variation in carbonate chemistry along the upwelling-dominated US west coast. Variation in upwelling regimes from Washington to southern California generates spatial and temporal gradients in concentration of CO2 that shoal to surface waters during upwelling events, extending shoreward into the inner shelf region. Because calcifiers in the upwelling-dominated CCLME probably have historically experienced wide fluctuation in pH, many likely are adapted to a variable carbonate chemistry environment. The new challenge to these organisms is that they may have limited ability to respond to additional increases in CO2. It is this challenge, the mechanistic ability of calcifying invertebrates to acclimate or adapt to increasing CO2 and decreasing carbonate mineral saturation state, that is addressed in this project.

The OMEGAS Moorings and Sensors team will document the oceanographic context in which the study organisms operate in four regions of the CCLME with contrasting upwelling regimesThis project also coordinates closely with other OMEGAS projects [(i) Genetics, physiology, larval rearing and (ii) Field transplants] to achieve goals of the project to determine acclimatization and adaptational capacity to present and future OA conditions .

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Gaylord, B., T. M. Hill, E. Sanford, E. A. Lenz, L. A. Jacobs, K. N. Sato, A. D. Russell, and A. Hettinger. "Functional impacts of ocean acidification in an ecologically critical foundation species", *Journal of Experimental Biology*, v.214, 2011, p. 2586.

Howarth, R., F. Chan, D. J. Conley, S. C. Doney, R. Marino, and G. Billen. "Coupled biogeochemical cycles: eutrophication and hypoxia in temperate estuaries and coastal marine ecosystems", *Frontiers in Ecology and the Environment*, v.9, 2011, p. 18.

Yu, P. D., P. G. Matson, T. R. Martz, and G. E. Hofmann. "The ocean acidification seascape and its relationship

to theperformance of calcifying marine invertebrates: laboratory experiments on the development of urchin larvae framed by environmentally-relevant pCO2/pH", *Journal of Experimental Marine Biology and Ecology*, v.400, 2011, p. 288.

OMEGAS II - Linking ecological and organismal responses to the ocean acidification seascape in the California Current System (OMEGAS-II)

Website: http://omegas.science.oregonstate.edu

Coverage: California Current Large Marine Ecosystem, Oregon, California

Project abstract:

This project is a renewal of an existing ocean acidification (OA) grant supporting an interdisciplinary research team (called OMEGAS) with expertise in oceanography, ecology, biogeochemistry, molecular physiology, and molecular genetics. Research to date has documented a dynamic oceanographic mosaic in the inner shelf of the California Current System (CCS) that spans 1,200+ km and varies at tidal, diurnal, event, and seasonal temporal scales at local to ocean basin spatial scales. In OMEGAS II, the project seeks to better understand the drivers of this striking time-space variability, and to link the OA seascape to the physiological and ecological performance of a key member of this ecosystem, the mussel Mytilus californianus. In addition, the investigators will explore the influence of this oceanographic mosaic on species interactions and community organization. As a dominant habitat-forming species, strong interactor, and major space occupant, M. californianus is arguably the core component of the rocky intertidal ecosystem along the upwelling-dominated CCS. Using an interdisciplinary, spatially extensive approach integrating inner shelf oceanography with ecology, physiology, and eco-mechanics, the interdisciplinary team will study the response of juvenile mussels M. californianus to OA. The studies span levels of biological organization, thereby allowing assessment of how the cost of forming a shell under field conditions might influence physiological performance and resistance to predation. This investigation will include modeling to link to larger-scale ecosystem and oceanographic dynamics in the CCS and beyond.

Results from OMEGAS I show that the growth, survival, and shell strength of mussel larvae are strongly negatively affected by elevated pCO2, and that growth of adult mussels varied among sites within regions and between regions. Emerging data on natural variability in seawater conditions will allow a deeper exploration of the organismal response of M. californianus, and the ecological consequences of traits, such as reduced shell thickness and strength. The present project will expand and strengthen the existing oceanographic network to increase our understanding of the coastal OA regime, and provide the environmental context for ecological and physiological research. Specifically, this project will (1) conduct field and laboratory experiments on the influence of OA on the growth, shell accretion, and resistance to predation of juvenile mussels collected from 10 sites spanning 1,400 km of coastline, (2) link the OA-sensor oceanographic "backbone" to an existing database of community structure via ecological modeling to assess the influence of OA on coastal variation in community organization, (3) determine the physiological responses of juvenile mussels following field deployments and culture under common garden conditions to evaluate mechanistic underpinnings to the responses observed in mussels from different sites, (4) explore the physiological and transcriptomic response of mussels in lab mesocosms to field-documented variability in pCO2, and (5) using modified ROMS models, evaluate the linkage between basin-scale oceanography and local-scale variation in inner-shelf oceanography to evaluate the relative influences of large-to-local scale factors on OA variability. This research aims to understand how coastal ecosystems will respond to OA, and thus to develop our capacity to predict the future impact of OA on coastal ecosystems.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Hettinger, A., E. Sanford, T. M. Hill, J. D. Hosfelt, A. D. Russell, and B. Gaylord.. "The influence of food supply on the response of Olympia oyster larvae to ocean acidification.," *Biogeosciences*, v.10, 2013, p. 6629.

Hettinger, A., E. Sanford, T.M. Hill, E.A. Lenz, A.D. Russell, and B. Gaylord. "Larval carry-over effects from ocean acidification persist in the natural environment.," *Global Change Biology*, 2013.

Hofmann, G. E., T. G. Evans, M. W. Kelly, J. L. Padilla-Gamiño, C. A. Blanchette, L. Washburn, F. Chan, M. A. McManus, B. A. Menge, B. Gaylord, T. M. Hill, E. Sanford, M. LaVigne, J. M. Rose, L. Kapsenberg, and J. M. Dutton.. "Exploring local adaptation and the ocean acidification seascape ? studies in the California Current Large Marine Ecosystem.," *Biogeosciences Discussions*, v.10, 2013, p. 11825.

LaVigne, M. T.M. Hill, E. Sanford, B. Gaylord, A.D. Russell, E.A. Lenz, J.D. Hosfelt, M.K. Young.. "The elemental composition of purple sea urchin (Strongylocentrotus purpuratus) calcite and potential effects of pCO2 during early life stages.," *Biogeosciences*, v.10, 2013, p. 3465.

Pespeni, M.H., E. Sanford, B. Gaylord, T. M. Hill, J. D. Hosfelt, H. Jaris, M. LaVigne, E. A. Lenz, A. D. Russell, M. K. Young, S. R. Palumbi.. "Evolutionary change during experimental ocean acidification.," *Proceedings National Academy of Sciences*, v.110, 2013, p. 6937.

[table of contents | back to top]

Program Information

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)

Website: http://www.piscoweb.org/

Coverage: West coast of North America from Mexico to Alaska

The Partnership for Interdisciplinary Studies of Coastal Oceans is a long-term ecosystem research and monitoring program established with the goals of:

- understanding dynamics of the coastal ocean ecosystem along the U.S. west coast
- sharing that knowledge so ocean managers and policy makers can make science based decisions regarding coastal and marine stewardship
- producing a new generation of scientists trained in interdisciplinary collaborative approaches

Over the last 10 years, PISCO has successfully built a unique research program that combines complementary disciplines to answer critical environmental questions and inform management and policy. Activities are conducted at the latitudinal scale of the California Current Large Marine Ecosystem along the west coast of North America, but anchored around the dynamics of coastal, hardbottom habitats and the oceanography of the nearshore ocean – among the most productive and diverse components of this ecosystem. The program integrates studies of changes in the ocean environment through ecological monitoring and experiments. Scientists examine the causes and consequences of ecosystem changes over spatial scales that are the most relevant to marine species and management, but largely unstudied elsewhere.

Findings are linked to solutions through a growing portfolio of tools for policy and management decisions. The time from scientific discovery to policy change is greatly reduced by coordinated, efficient links between scientists and key decision makers.

Core elements of PISCO are:

- Interdisciplinary ecosystem science
- Data archiving and sharing
- Outreach to public and decision-making user groups
- Interdisciplinary training
- Coordination of distributed research team

Established in 1999 with funding from The David and Lucile Packard Foundation, PISCO is led by scientists from core campuses Oregon State University (OSU); Stanford University's Hopkins Marine Station; University of California, Santa Cruz (UCSC); and University of California, Santa Barbara (UCSB). Collaborators from other institutions also contribute to leadership and development of PISCO programs. As of 2005, core PISCO activities are funded by collaborative grants from The David and Lucile Packard Foundation and the Gordon and Betty Moore Foundation. Core support, along with additional funding from diverse public and private sources, make this unique partnership possible.

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:
NSF 10-530, FY 2010-FY2011
NSF 12-500, FY 2012
NSF 12-600, FY 2013
NSF 13-586, FY 2014
NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:
1st U.S. Ocean Acidification PI Meeting(March 22-24, 2011, Woods Hole, MA)
2nd U.S. Ocean Acidification PI Meeting(Sept. 18-20, 2013, Washington, DC)
3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA – Tentative)

NSF media releases for the Ocean Acidification Program:

Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification

Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?

Discovery nsf.gov - National Science Foundation (NSF) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation (NSF)

Press Release 12-179 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation (NSF)

Press Release 13-102 World Oceans Month Brings Mixed News for Oysters

Press Release 13-108 nsf.gov - National Science Foundation (NSF) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation (NSF)

Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants

Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation (NSF)

Press Release 14-010 nsf.gov - National Science Foundation (NSF) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation (NSF)

Press Release 14-116 nsf.gov - National Science Foundation (NSF) News - Ocean Acidification: NSF awards $11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation (NSF)

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1041240
NSF Division of Ocean Sciences (NSF OCE)	OCE-1220338

[table of contents | back to top]