

Abalone and Urchin Recruitment Modules

Website: <https://www.bco-dmo.org/dataset/929812>

Data Type: Other Field Results

Version: 1

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Project

» [Collaborative Research: The effects of marine heatwaves on reproduction, larval transport and recruitment in sea urchin metapopulations](#) (Urchin metapopulations)

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Abstract

An important facet of the Kelp Forest Monitoring project is sampling recruitment of juvenile abalone and sea urchins. Specially designed recruitment modules (RMs) made of stainless steel and filled with ½ concrete cinder blocks as habitat were bolted to the rocky subtidal reef at Van Damme State Park, Mendocino County, California. Twelve RMs were deployed at 10 to 12 meters depth in three groups of four in August of 2000. They were allowed to season for a year before surveys began in August 2001. Each August, SCUBA dive teams collected and measured the organisms inside the modules. The data associated with this dataset are the number and sizes of red abalone (*Haliotis rufescens*), pinto abalone (*H. kamtschatkana*), flat abalone (*H. walallensis*), red sea urchins (*Mesocentrotus franciscanus*), and purple sea urchins (*Strongylocentrotus purpuratus*). Data are presented in tabular format with a row for each RM each year.

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Coverage

Location: Sub-tidal zone, North Coast of California, Sonoma and Mendocino counties

Methods & Sampling

Data were collected during day-trips aboard the California Department of Fish and Wildlife or UC Davis boats, generally 2-3 days to sample the twelve RMs.

We used specially designed recruitment modules (RMs) bolted into the rocky subtidal reef to sample recruitment of larger juvenile abalone and sea urchins (3 to 20 millimeters (mm)). Standardized RMs were deployed at Van Damme State Park (VDSP) (latitude 39°16'08"N, longitude 123°47'58"W), northern California in August 2000. RMs were made of stainless steel cages filled with concrete cinder blocks cut lengthwise resembling the letter M (rectangles measuring 813 mm x 610 mm x 305 mm high) and stacked three levels tall. Each RM had a surface area of approximately 4.8 square meters (m²), of which 2.6 m² was a sheltered area

created by the sides, top, and bottom of each M shape.

Twelve RMs were deployed between 10 and 12 meters (m) depth in three groups of four. The modules were placed 3-6 m apart within the cluster of four. The northern cluster was approximately 140 m from the central cluster. The southern cluster was 710 m from the central cluster.

RMs were deployed and left to season for one year before the first surveys began in August 2001. Each year thereafter in August the RM would be surveyed and if any half cinder blocks were missing they would be replaced. In the year of 2014, half the RM cages were replaced with new cages and in the year 2015, the remaining 6 modules were replaced. In each case, the existing bricks were reused in the same module. In some years fewer than 12 RM were surveyed, due to older RM cages being damaged by winter storms. Each year the numbers of invertebrates are reported per module. During the years 2020 and 2021, no RM surveys were conducted due to field work constraints imposed to reduce the spread of COVID.

The surveys involved one dive team for each RM, opening the lid and carefully removing each block, then counting and measuring all the invertebrates inside the RM. Organisms outside the cage were not sampled. Organisms too numerous to count were gently swept into fine mesh bags (2 mm) to be counted and measured at the surface. Organisms cemented to the brick were measured and quantified underwater. Each block was set to the side while the next block was removed, and the animals quantified. When a survey was completed, divers reassembled the RM and replaced the lid, securing it with wide cable ties. Each RM took two divers approximately 40-50 minutes to survey depending on the contents.

Data Processing Description

Data were entered from the field sheets into an Excel spreadsheet, one year per worksheet. The data were proofed against the field sheets in 2024 and transferred in tabular form to a single Excel sheet. The sheet was given a version number and also saved in a file as comma-separated values (CSV).

BCO-DMO Processing Description

currently being processed

Problem Description

Occasionally a RM was damaged by a storm, and not sampled. Consequently, not all years had 12 RMs. The number of RMs per year is included in the data file.

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	calipers
Generic Instrument Name	calipers
Generic Instrument Description	A caliper (or "pair of calipers") is a device used to measure the distance between two opposite sides of an object. Many types of calipers permit reading out a measurement on a ruled scale, a dial, or a digital display.

Dataset-specific Instrument Name	specially designed recruitment modules (RMs)
Generic Instrument Name	colonization substrata
Generic Instrument Description	Natural or artificial materials deployed in a marine or artificial environment for a given period to act as standardised, passive settlement sampling devices (e.g. settlement plates). They are used to determine the extent of colonization and/or the diversity of settled organisms.

Dataset-specific Instrument Name	Handheld GPS (WGS84 datum)
Generic Instrument Name	Global Positioning System Receiver
Generic Instrument Description	The Global Positioning System (GPS) is a U.S. space-based radionavigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis. The U.S. Air Force develops, maintains, and operates the space and control segments of the NAVSTAR GPS transmitter system. Ships use a variety of receivers (e.g. Trimble and Ashtech) to interpret the GPS signal and determine accurate latitude and longitude.

Dataset-specific Instrument Name	
Generic Instrument Name	Self-Contained Underwater Breathing Apparatus
Generic Instrument Description	The self-contained underwater breathing apparatus or scuba diving system is the result of technological developments and innovations that began almost 300 years ago. Scuba diving is the most extensively used system for breathing underwater by recreational divers throughout the world and in various forms is also widely used to perform underwater work for military, scientific, and commercial purposes. Reference: http://oceanexplorer.noaa.gov/technology/diving/diving.html

Dataset-specific Instrument Name	dive slates, underwater data sheets, pencils, and erasers
Generic Instrument Name	Underwater Writing Slate
Generic Instrument Description	Underwater writing slates and pencils are used to transport pre-dive plans underwater, to record facts whilst underwater and to aid communication with other divers.

Project Information

Collaborative Research: The effects of marine heatwaves on reproduction, larval transport and recruitment in sea urchin metapopulations (Urchin metapopulations)

Coverage: Coastal California Waters from San Diego through Mendocino Counties

NSF Award Abstract:

Rapid and extreme warming events such as El Niño and marine heatwaves have had ecological and economic impacts on nearshore marine ecosystems. These impacts include reductions in biomass and collapses in commercial fisheries. For many species, population booms and busts are controlled by shifts in reproduction and juvenile dispersal related to warmer temperatures and ocean circulation. However, how population fluctuations are shaped by interacting processes that control adult reproduction and larval survival remains unclear. Marine heatwaves often accompany major disruptions in ocean circulation, which can affect survival and the distribution of species that produce free-floating, planktonic larvae. As a result, species can be impacted directly by temperature effects on organismal reproduction and survival, and indirectly by shifts in ocean circulation that affect larval success. This project is examining how the joint effects of temperature and ocean circulation are controlling populations of purple sea urchins (*Strongylocentrotus purpuratus*). To address project objectives, the team is developing oceanographic models to predict dispersal of planktonic larvae in combination with controlled experiments on adult reproductive success. This project is advancing the understanding of how ecologically important species respond to ocean temperature and circulation, which are forecast to shift under future climate change scenarios. Broader impacts of the project include training of students and post-docs in STEM and educational outreach. Curriculum development and implementation is occurring in collaboration with existing K-12 outreach programs that focus on underserved communities and under-represented groups. The goal is to empower the next generation of scientists to use integrative approaches to predict ecological consequences of climate change.

Purple sea urchins are an ideal species for studying the coupled impacts of warming and ocean circulation on recruitment and survival given a wealth of ecological and organismal data. The species has a mapped genome, can be transported large distances as larvae by ocean currents, and larval abundances in California exhibit orders of magnitude variation with heatwaves and El Niño fluctuations. To quantify the processes that shape spatial and temporal variability in larval supply, researchers are applying a novel combination of biophysical modeling, experiments and statistical modeling of long-term, high-resolution data on larval settlement across the Southern California Bight (SCB). Research module 1 is quantifying spatial and temporal patterns of larval transport using a 3D-biophysical model of the SCB. The model is testing how interactions among historical changes in ocean circulation and temperature, larval life history, and larval behavioral traits affect variation in larval supply in space and time. Research module 2 is focused on how temperature could affect spatial and temporal variation in egg production. Experiments are characterizing reproductive thermal performance curves and quantifying how these vary among populations and organismal history. A novel assay is assessing epigenetic regulation of gene expression associated with performance curves. Finally, Module 3 will integrate mechanistic models from Modules 1 and 2 to statistically assess their ability to explain spatial and temporal trends in a nearly three-decade dataset of larval settlement from six sites in the SCB. This is one of the first studies that integrates models of larval transport, reproductive performance and settlement data to empirically test how physical and biological processes affect local recruitment patterns in complex marine meta-populations.

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.

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2023664

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