Lengths of organisms recorded during emergent and rapid emergent surveys conducted in the subtidal zone of northern California, Sonoma and Mendocino counties, from 1999 to 2023

Website: https://www.bco-dmo.org/dataset/929286
Data Type: Other Field Results
Version: 1
Version Date: 2024-06-04

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

Contributors	Affiliation	Role
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Abstract
The Kelp Forest Monitoring data record span surveys across 24 years from 1999 through 2023 at 20 locations on the Sonoma-Mendocino Coast, Northern California. Years without data, inclusive: 2002, 2020, 2021. These surveys are ongoing and are conducted by the California Department of Fish and Wildlife dive team with participation from dive program partners at UC Davis, UC Santa Cruz, Cal Poly Humboldt, Sonoma State and other dive programs and volunteers. Not all sites were surveyed in all years. Surveys prior to 2003 were not conducted by the same teams or with the same methods except that all surveys were done using Scuba along 30-meter x 2-meter transects randomly placed in the subtidal zone in rocky habitats dominated by bull kelp, Nereocystis luetkeana, forests. These randomly placed band transect surveys were stratified by depth (A=0-15, B=16-30, C=31-45, D=46-60 ft) as we know sea urchin and abalone populations differ by depth. Organisms along the transect were identified and measured on the longest axis to the nearest millimeter by the divers. Sea urchin and abalone species were identified and measured for every dive transect. However, data on associated species differed depending on resources, the year, and the focus of the studies in response to ecosystem conditions.

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Coverage

Location: Sub-tidal zone, North Coast of California, Sonoma and Mendocino counties
Spatial Extent: **N**:39.428584 **E**:-123.071539 **S**:38.315361 **W**:-123.82905
Temporal Extent: 1999-06-23 - 2023-09-18

Methods & Sampling

Data were collected during day-trips aboard California Department of Fish and Wildlife or NOAA patrol boats, generally 2-5 days at select survey locations in 1999, 2000, 2001, 2003-2020, 2022, 2023.

All surveys were done using SCUBA along 30x2 meter (m) transects (60 square meters total area) randomly placed in the subtidal zone in rocky habitats dominated by bull kelp (*Nereocystis luetkeana*) forests. These randomly placed band transect surveys were stratified by depth (A=0-15, B=16-30, C=31-45, D=46-60 ft) as we know sea urchin and abalone populations differ by depth. Two divers (a dive team) work together to count and measure organisms.

Divers were deployed as teams to randomly-selected GPS waypoints within designated depth strata (A, B, C, D). As with other surveys, the patrol boats provide support to the small boats and logistical support to divers. Divers typically complete multiple transects within each of the four depth strata ranging from 0-60 feet at each site. Divers swim along transect tapes measuring 30 x 2m in area across the rocky reef. All transects are in habitat which is dominated (>70% rock) by rocky reef. Two divers (a dive team) work together to count and measure organisms.

Emergent Surveys:
Emergent sampling focused on emergent, exposed, or cryptic animals in rock crevices or under rock ledges but visible without turning rocks or the use of a flashlight. Organisms were identified and measured on the longest axis to the nearest millimeter by the divers as time allowed. Size data (and other physical and biological data) from each dive are recorded on waterproof datasheets which the divers fill out along the transect. Upon return to the boat, data sheets are checked by the lead diver to ensure accuracy and readability for the first quality control check.

Rapid Emergent Surveys:
In response to the extreme purple sea urchin population increase and abalone mortality event in 2016-18, divers conducted a rapid assessment sampling technique: Rapid Emergent Abalone Surveys (REAS). REAS are similar to standard emergent surveys but focus on purple sea urchin and red abalone counts, allowing divers to survey more area. Measurements of organisms are recorded as time allows. Divers conduct two to four rapid emergent transects per dive.

The data specific to this dataset are the lengths (mm) of red abalone, flat abalone, pinto abalone, red sea urchin, and purple sea urchin along each transect.

Data Processing Description

Data were entered from the field data sheets into a Microsoft Access database, where they were sorted and exported to Excel files. Once data were proofed, they were given a version number and also saved in a file as comma-separated values (CSV).

BCO-DMO Processing Description

- Imported original files "NSF_OCE_2023664_KelpForestSurveys_Species_CODES_v2_20240119.csv" (species code list) and "NSF_OCE_2023664_KelpForestSurveys_LOCATIONS_v4_20240105.csv" (site code list) into the BCO-DMO system.
- Imported original file "NSF_OCE_2023664_KelpForestSurveys_Species_SIZES_v4_20240411.csv" (species size data) into the BCO-DMO system.
- Added the following columns from the site code list to the species size data: SiteName.
- Added the following columns from the species code list to the species size data: CommonName, ScientificName.
- Converted the SurveyDate column to YYYY-MM-DD format.
- Saved the final file as "929286_v1_kelp_forest_species_sizes.csv".

Problem Description

Surveys were not conducted 2002, 2020, 2021. Not all locations were surveyed in every year.

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Data Files

File
929286_v1_kelp_forest_species_sizes.csv (Comma Separated Values (.csv), 14.24 MB) MD5:0fd40e1f9db6d2db5eb7f4f5732c9281 Primary data file for dataset ID 929286, version 1

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Related Publications

Arafeh-Dalmau, N., Schoeman, D. S., Montaño-Moctezuma, G., Micheli, F., Rogers-Bennett, L., Olguin-Jacobson, C., & Possingham, H. P. (2020). Marine heat waves threaten kelp forests. Science, 367(6478), 635–635. https://doi.org/10.1126/science.aba5244
General

Hamilton, S. L., Saccomanno, V. R., Heady, W. N., Gehman, A. L., Lonhart, S. I., Beas-Luna, R., Francis, F. T., Lee, L., Rogers-Bennett, L., Salomon, A. K., & Gravem, S. A. (2021). Disease-driven mass mortality event leads to widespread extirpation and variable recovery potential of a marine predator across the eastern Pacific. Proceedings of the Royal Society B: Biological Sciences, 288(1957), 20211195. https://doi.org/10.1098/rspb.2021.1195
Results

McPherson, M. L., Finger, D. J. I., Houskeeper, H. F., Bell, T. W., Carr, M. H., Rogers-Bennett, L., & Kudela, R. M. (2021). Large-scale shift in the structure of a kelp forest ecosystem co-occurs with an epizootic and marine heatwave. Communications Biology, 4(1). https://doi.org/10.1038/s42003-021-01827-6
Results

Rogers-Bennett, L., & Catton, C. A. (2019). Marine heat wave and multiple stressors tip bull kelp forest to sea urchin barrens. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-51114-y
Methods

Rogers-Bennett, L., & Catton, C. A. (2022). Cascading impacts of a climate-driven ecosystem transition intensifies population vulnerabilities and fishery collapse. Frontiers in Climate, 4. https://doi.org/10.3389/fclim.2022.908708
Results

Rogers-Bennett, L., Kashiwada, J. V., Taniguchi, I. K., Kawana, S. K., & Catton, C. A. (2019). Using Density-Based Fishery Management Strategies to Respond to Mass Mortality Events. Journal of Shellfish Research, 38(2), 485. https://doi.org/10.2983/035.038.0232
General

Rogers-Bennett, L., Kawana, S.K., Catton, C.A., Klamt, R., Dondanville, R., Maguire, A., and D. Okamoto. (In revision). Abalone recruitment patterns before and after sea urchin barrens formation in northern California: Incorporating climate change. New Zealand Journal Marine and Freshwater Research.
Results

Rogers-Bennett, L., Klamt, R., & Catton, C. A. (2021). Survivors of Climate Driven Abalone Mass Mortality Exhibit Declines in Health and Reproduction Following Kelp Forest Collapse. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.725134
Results

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Parameters

Parameter	Description	Units

Survey_Num	The unique identifier used for each dive transect. For example, ALB18-A1-1 where ALB is the DFW_short_code for Albion Bay; 18 is the year (2018); A1-1 is the randomized transect. For those years with a letter preceding a number, the letter refers to a depth stratum in feet: A=0-15, B=16-30, C=31-45, D=46-60 ft.	unitless
DFW_short_code	An alphanumeric code for the location	unitless
SiteName	The name of the location, e.g., Albion Bay	unitless
Lat	The latitude of the location	decimal degrees
Lon	The longitude of the location; negative values = West	decimal degrees
SurveyType	There are two survey types: Emergent surveys do not involve rolling over boulders or picking up rocks and do involve looking in rock crevices and under rocky overhangs. Transect-30m x 2 m (Emergent) - pre-2016. Transect-30m x 2 m (Rapid Emergent) - post-2017	unitless
SurveyDate	The date of the dive survey	unitless
Year	4-digit year of the dive survey	unitless
Month	Month of the dive survey	unitless
Day	Day of month of the dive survey	unitless
Timezone	Time zone; all surveys were conducted in the Pacific Standard Time Zone	unitless
SpeciesID	The alphanumeric code for the species encountered and/or measured	unitless
ScientificName	The scientific name of the species per the World Register of Marine Species (WoRMS)	unitless
CommonName	The common name of the species used by the researchers	unitless
Size	Measurement of the longest axis of the observed species.	millimeters (mm)
Comments	The divers' comments regarding conditions and other observations that may affect the data.	unitless

ProtectionStatus	The special regulations for the location of the transect, e.g., no take MPA is a no take Marine Protected Area	unitless
AverageDepth	The average depth of the transect	feet
MinimumDepth	The shallowest depth of the transect	feet
MaximumDepth	The deepest part of the transect	feet

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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	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: https://oceanexplorer.noaa.gov/technology/technical/technical.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.

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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.

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Funding

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

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