

Percent cover of algal habitat types on a by-transect and/or subsample basis 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/929546>

Data Type: Other Field Results

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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

The Kelp Forest Monitoring data record span surveys across 28 years from 1971 through 2023 at 20 locations on the Sonoma-Mendocino Coast, Northern California. Years without data, inclusive: 1972-1985, 1987, 1988, 1993-1998, 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 x 2m transects randomly placed in the subtidal zone in rocky habitats dominated by bull kelp, *Nereocystis luetkeana*, forests. These randomly placed band transects 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. Data collected include the number of live, dying (in some years during the mass mortality events), and dead sea urchins (red-*Mesocentrotus franciscanus* and purple-*Strongylocentrotus purpuratus*), red abalone (*Haliotis rufescens*), pinto abalone (*H. kamtschatica*), flat abalone (*H. walallensis*), as well as empty abalone shells (again in some years). Additional data collected (if Scuba bottom time and/or air allowed): red abalone size, numbers or presence of associated species such as sea stars and predators, algal group quantification, and presence of bull kelp, substrate type. Data on algae and associated species differed depending on the year and the focus of the studies in response to ecosystem conditions but all years quantified sea urchins and abalones. These data provide a baseline of biological conditions in the kelp forest before, during and after the major marine heatwave of 2014-2016 in northern California. These data were used to manage the recreational red abalone fishery by the California Department of Fish and Wildlife from 2002 to the closure of the fishery in 2018. These data are from the two Counties Sonoma and Mendocino County that had 95% of the bull kelp forests in northern California. Algal composition in the subtidal has changed dramatically from the time before 2014 to post marine heatwave and sea urchin population explosion. The substrate is now dominating by encrusting algae including crustose coralline algae and *Ralfsia*, *Hildenbrandia* and other fleshy crusts.

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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 - 2016-09-14

Methods & Sampling

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.

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 to 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. Data collected on the transects include depth of transect, dive number, the number of each species of abalone and sizes of live, dying (in some years during the mass mortality events), and dead abalone (red abalone, *Haliotis rufescens*, pinto abalone, *H. kamtschatkana*, flat abalone, *H. walallensis*), number of sea urchins (red - *Mesocentrotus franciscanus*, purple - *Strongylocentrotus purpuratus*), and size as time allowed, number of associated species and predators, substrate, algal type percent cover. Where needed divers mark abalone shells with yellow forestry crayons to avoid duplicate counts and measures. Data from each dive were recorded on waterproof datasheets which the divers fill out along the transect. Upon return to the boat, data sheets were checked by the lead diver to ensure accuracy and readability for the first field site 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 were similar to standard emergent surveys (see above) but focused on purple sea urchin and red abalone counts of live and dead abalone, allowing divers to survey more area. Divers conduct two to four rapid emergent transects per dive. On average, 30% of the divers working with CDFW divers on the REAS surveys are volunteer citizen science divers or scientific divers belonging to other California science dive programs such as the University of California, California State University system, or NOAA divers <

Primary data collected on each rapid transect are the number of live, dying, and dead red sea urchins, purple sea urchins, red abalone, pinto abalone, and flat abalone, as well as empty abalone shells. Additional data collected (if bottom time and/or air allowed): red abalone size, number of associated species and predators, algal group quantification (Uniform Point Contact), and presence of bull kelp. Abalone that were measured were marked with yellow forestry crayons to avoid duplicate counts and measures. As with the emergent surveys, the divers fill out data on waterproof datasheets 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.

The data specific to this dataset is the percent of bottom coverage by algal types for a transect or transect subsample.

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 files as

comma-separated values (CSV).

BCO-DMO Processing Description

- Imported original files "NSF_OCE_2023664_KelpForestSurveys_ALGAL_HABITAT_CODES_v1_20240122.csv" (algal habitat 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_ALGAL_HABITAT_v3_20240408.csv" (algal habitat coverage data) into the BCO-DMO system.
- Added the following columns from the site code list to the algal habitat coverage data: SiteName.
- Added the following columns from the substrate code list to the algal habitat coverage data: HabitatDefinition.
- Converted the SurveyDate column to YYYY-MM-DD format.
- Saved the final file as "929546_v1_kelp_forest_algal_habitat_coverage.csv".

Problem Description

Data on algal coverage were not collected in 2002. Not all locations were surveyed in every year for the temporal bounds.

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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
Subsample	The left or right side of the transect. Not all transects were subsampled due to time constraints. "L" is left side, "R" is right side, "LR" is the entire 30m x 2m transect, both sides.	unitless
HabitatID	The alphanumeric code for the algal habitat type	unitless
Habitat	The algal habitat type	unitless
PercentCover	The percentage of the particular habitat type over (covering) the transect or transect subsample	unitless (percent)
HabitatDefinition	A description of the algal habitat type	unitless
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: 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.

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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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