Supplementary data: fish, bird, and copepod data for California Current winter climate reconstruction, 1948-2010 (California Current upwelling modes project)

Website: https://www.bco-dmo.org/dataset/472727
Version: 2013-12-03

Project
» History and Future of Coastal Upwelling Modes and Biological Responses in the California Current (California Current upwelling modes)

Contributors	Affiliation	Role
Black, Bryan	Oregon State University (OSU-HMSC)	Principal Investigator
Bograd, Steven	National Oceanic and Atmospheric Administration - Southwest Fisheries Science Center (NOAA SWFSC ERD)	Co-Principal Investigator
Sydeman, William	Farallon Institute for Advanced Ecosystem Research	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

Winter copepod index, common murre egg laying date, Cassin’s auklet egg laying date, common murre fledgling success, a splitnose rockfish otolith chronology, and the leading principal component (PC1bio) for all these marine biological time series except copepods.

Methods & Sampling

Rockfish chronologies were generated by applying standard dendrochronology techniques to otolith growth-increment widths (Black et al. 2011). Seabird egg laying dates and breeding success (offspring pair-1) are from the Farallon Islands, approximately 48 km west of San Francisco Bay (37.7°N, 123.0°W) (Black et al. 2011, Schroeder et al. 2010). The Copepod Community Index is the leading axis of a Non-Metric Multidimensional Scaling ordination performed on a matrix of copepod species abundance. Samples were collected 9 km offshore of Newport, Oregon (44.651°N; 124.181°W) on a biweekly to monthly basis beginning in 1996 (Kiester et al. 2011).

Data Processing Description

A nested bootstrapping approach (n=10,000 iterations) was repeated at each change in sample depth (3 to 16). For each iteration, chronologies were randomly selected with replacement and averaged into a composite chronology. Calendar years shared with CCwinter physical data (1948-2003) were randomly sampled with replacement and the CCwinter reconstruction from tree ring data (CCwinter_recon) was predicted using a rise-to-maximum function: CCwinter_recon = a*(1-exp(-b*oak composite chronology)). The Reduction of Error statistic was calculated between predicted CCwinter and sea level (1898-1947, see timeseries-physical) for independent verification; any positive value indicates reconstruction skill. A 21-year running standard deviation was calculated for the length of each iteration to evaluate trends in variance. The 14 ensemble medians were spliced together to form the final nested reconstruction (tree-ring and CCwinter standard deviation datasets). To examine the frequency of extreme events, CCwinter_recon values in each ensemble member were ranked, the 10 highest values retained, and the frequency per century was calculated post- and pre-1950. Note that an identical result was obtained for the extreme events analysis if the composite chronologies were ranked prior to their transformation by rise-to-maximum functions.

We tested various methods to retain inter-annual to long-term variation in the tree-ring data and found results and conclusions to be insensitive. Detrending with 50-year splines did not appreciably change the results of the study. The unusually high frequency of negative events is less pronounced post-1950, but spline detrending reduces the magnitude of extreme values and mutes or eliminates long-term trends. The two methods (negative exponential and signal free detrending) capable of retaining centennial scale variability yielded nearly identical results for the final reconstruction ($R2 = 0.993$). [Given the complexity and experimental nature of the signal-free datasets, negative exponential detrending was used for the final reconstruction]

Related References:

B. A. Black et al., Winter and summer upwelling modes and their biological importance in the California Current Ecosystem. Global Change Biol. 17, 2536 (Aug, 2011).

J. E. Keister, E. Di Lorenzo, C. A. Morgan, V. Combes, W. T. Peterson, Zooplankton species composition is linked to ocean transport in the Northern California Current. Global Change Biol. 17, 2498 (Jul, 2011).

T. M. Melvin, K. R. Briffa, A "signal-free" approach to dendroclimatic standardisation. Dendrochronologia 26, 71 (2008).

I. Schroeder, W. J. Sydeman, N. Sarkar, S. J. Bograd, F. B. Schwing, Winter pre-conditioning of seabird phenology in the California Current. Mar. Ecol. Prog. Ser. 393, 211 (2009).

F. B. Schwing, T. Murphree, P. M. Green, The Northern Oscillation Index (NOI): a new climate index for the northeast Pacific. Prog. Oceanogr. 53, 115 (2002).

F. B. Schwing, M. O'Farrell, J. M. Steger, K. Baltz, "Coastal upwelling indices, West Coast of North America, 1946-1995" (NOAA Technical Memo, NOAA-TM-NMFS-SWFSC, Washington, DC. 144 p., 1996).

D. W. Stahle et al., The ancient blue oak woodlands of California: longevity and hydro-climatic history. Earth Interactions In Press, (2013)

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Data Files

File
timeseries_biol.csv (Comma Separated Values (.csv), 2.17 KB) MD5:3bcee6bcc4ae90ddf268691fd5d5de93 Primary data file for dataset ID 472727

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Parameters

Parameter	Description	Units
year	year	unitless
MuLD	common murre egg laying date	yearday (1-365)
AuLD	Cassin’s auklet egg laying date	yearday (1-365)
MuRS	common murre fledgling success	number of fledged offspring
SRGC	Splitnose rockfish otolith chronology from California coast 35-40°N	unitless
PC1bio	the leading principal component (PC1bio) for all these marine biological time series except copepods	unitless
CoWI	winter copepod index	unitless

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Deployments

Black_model

Website	https://www.bco-dmo.org/deployment/472783
Platform	OSU
Start Date	2011-09-01
End Date	2013-05-31
Description	climate reconstruction model

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Project Information

History and Future of Coastal Upwelling Modes and Biological Responses in the California Current (California Current upwelling modes)

Coverage: North-central California Current between approx 36N, 122W and 39N, 125W

From NSF award abstract:

Climate variability on multiple temporal scales is increasingly recognized as a major factor influencing the structure, functioning, and productivity of the California Current Ecosystem (CCE). Yet, despite many long-term and integrative studies, a detailed understanding of climatic impacts on upwelling and biological processes is still lacking, compromising our abilities to assess important concepts such as ecosystem "health" and "resilience." To address these issues in the central-northern CCE, the PIs have recently collated and analyzed records of rockfish and salmon growth and seabird reproductive success with respect to upwelling variability (NSF award #0929017). These diverse, multi-decadal time series revealed the importance of wintertime upwelling on ecosystem structure and function, even though upwelling, a principal driver of productivity in the CCE, is largely a summertime process. This research led to an unexpected discovery that winter and summer upwelling vary independently of one another in distinct seasonal "modes", with some biological processes affected by the winter mode and others by the summer mode. This is of significance because the summer mode shows a long-term increase (despite inter-decadal variability) while the winter mode does not.

In this new project, the PIs will test the overarching hypothesis that upwelling modes are forced by contrasting atmospheric-oceanographic processes, exhibit contrasting patterns of low- and high-frequency variability, and will be differentially impacted by global climate change with corresponding impacts on biology. To address this hypothesis the PIs propose a three-tiered approach to better understand seasonal upwelling modes and their differential impacts on biology of the CCE. First, they will examine the responses of an entirely new suite of species to upwelling modes, including Pacific sardine (recruitment), black rockfish (growth), rhinoceros auklet and Brandt's cormorant (survival), and coho salmon (survival). Previously, coarsely resolved upwelling indices were used in these analyses, but the PIs now will integrate winds and temperatures from local buoy data to better capture climate variability on finer timescales. Second, they will derive a more mechanistic understanding of seasonal upwelling modes and use this information in combination with global climate models to forecast upwelling responses under various climate-change scenarios. Third, preliminary results indicate that tree-ring data co-vary with the fish and seabirds and are similarly sensitive to a driver of winter upwelling, the Northern Oscillation Index (NOI). The PIs will use tree-ring data to provide a 300-400 year reconstruction of the winter NOI to assess the historical range of variability in upwelling mean and variance. This study will reveal the past, present forcing, and potential future of upwelling and its biological consequences in the California Current.

Related Publications:
García-Reyes, M., W. J. Sydeman, S. A. Thompson, B. A. Black, R. R. Rykaczewski, J. A. Thayer, and S. J. Bograd. 2013. Integrated assessment of wind effects on Central California’s pelagic ecosystem. Ecosystems. DOI: 10.1007/s10021-013-9643-6.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1130125

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