SNAPSHOT REPORT | VOLUME 1

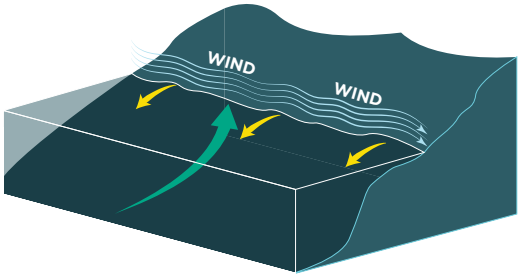
BASELINE HIGHLIGHTS FROM
NORTH COAST OCEANOGRAPHIC CONDITIONS

Monitoring Life During a Series of Unusual Events

ABOUT THIS SNAPSHOT REPORT This report highlights some key scientific findings from the Oceanographic Conditions Project, one of eleven baseline projects in California's North Coast region.[1] This project characterized the environmental conditions around the time of marine protected area (MPA) implementation. Facts and figures are derived from the project's peer-reviewed technical report and associated references,[2] which can be found, along with the related data, at **OceanSpaces.org.**

Setting the Scene: An Oceanographic Context

Oceanographic conditions along the North Coast of California are highly dependent on seasonal upwelling that brings cold, nutrient rich water to the surface, yet vary widely from season to season and year to year. Fluctuations in ocean temperature, currents, and other ocean conditions play an important role in shaping ecosystems and marine populations along the North Coast. Considering ocean conditions prior to and at the time of MPA implementation is crucial to understanding and tracking changes inside and outside of MPAs in the region over time. A team of researchers from National Oceanic and Atmospheric Administration Fisheries, Southwest Fisheries Science Center, Humboldt State University[3], Farallon Institute for Advanced Ecosystem Research[4], and Bodega Marine Laboratory brought together oceanographic information for the waters off the North Coast to provide this critical oceanographic context as a foundation for other studies in the region.



UPWELLING

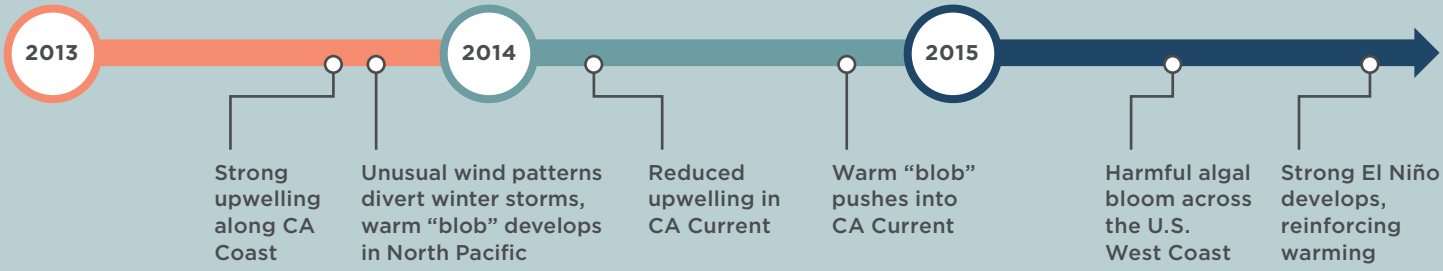
Along the California coast, the prevailing wind direction is from north to south. The wind displaces surface water offshore (yellow arrows) due to the earth's rotation. This displacement draws cold, nutrient- rich water to the surface (green arrow) through a process called upwelling.

A SUITE OF ENVIRONMENTAL VARIABLES MEASURED

- Sea Surface Temperature
- Sea Level
- Sea Level Pressure
- Air temperature
- Multivariate ENSO Index
- Pacific Decadal Oscillation
- North Pacific Gyre Oscillation
- Wind Stress
- Chlorophyll Concentration
- Upwelling Index
- Freshwater flow
- Northern Oscillation Index
- California Current flow

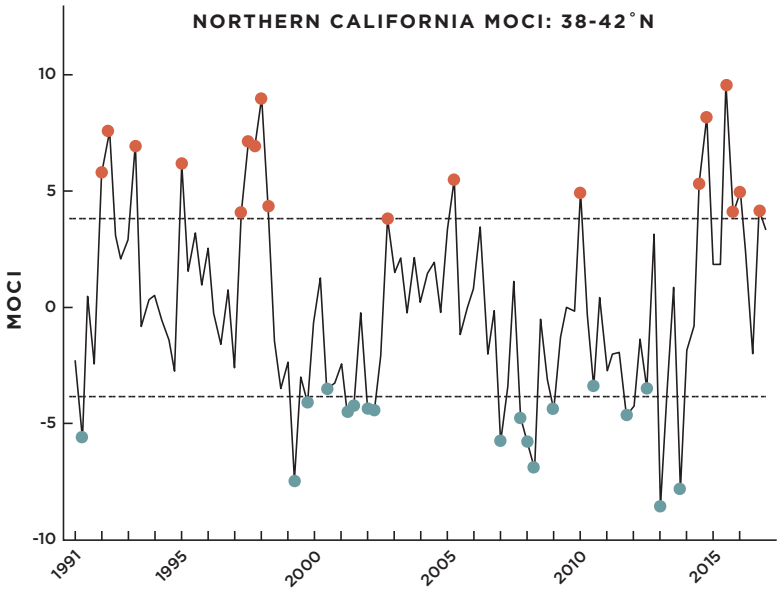
A Series of Unusual Events

The baseline study period for the North Coast region took place from 2013 to 2017, including a period (2014 – 2016) marked by unprecedented oceanographic conditions. The region was impacted by a "North Pacific Marine Heatwave" that has never previously been seen in the historical record. The origins of this event lie in highly unusual wind patterns that changed ocean currents and reduced water mixing in the Northeast Pacific Ocean. This gave rise to a vast "blob" of surface waters that were much warmer than usual. The "blob" drifted east and ultimately impinged on the California Current in late 2014. Warm surface waters likely set the stage for the persistent harmful algal bloom that emerged along the entire U.S. West Coast in 2015—which had pervasive effects throughout marine ecosystems, including impacting Dungeness crab and other shellfish fisheries. Development of a strong El Niño then reinforced warming in the California Current in late 2015. These unique conditions might have important consequences for species abundances, where species are found, and how ecosystems function in nearshore environments.



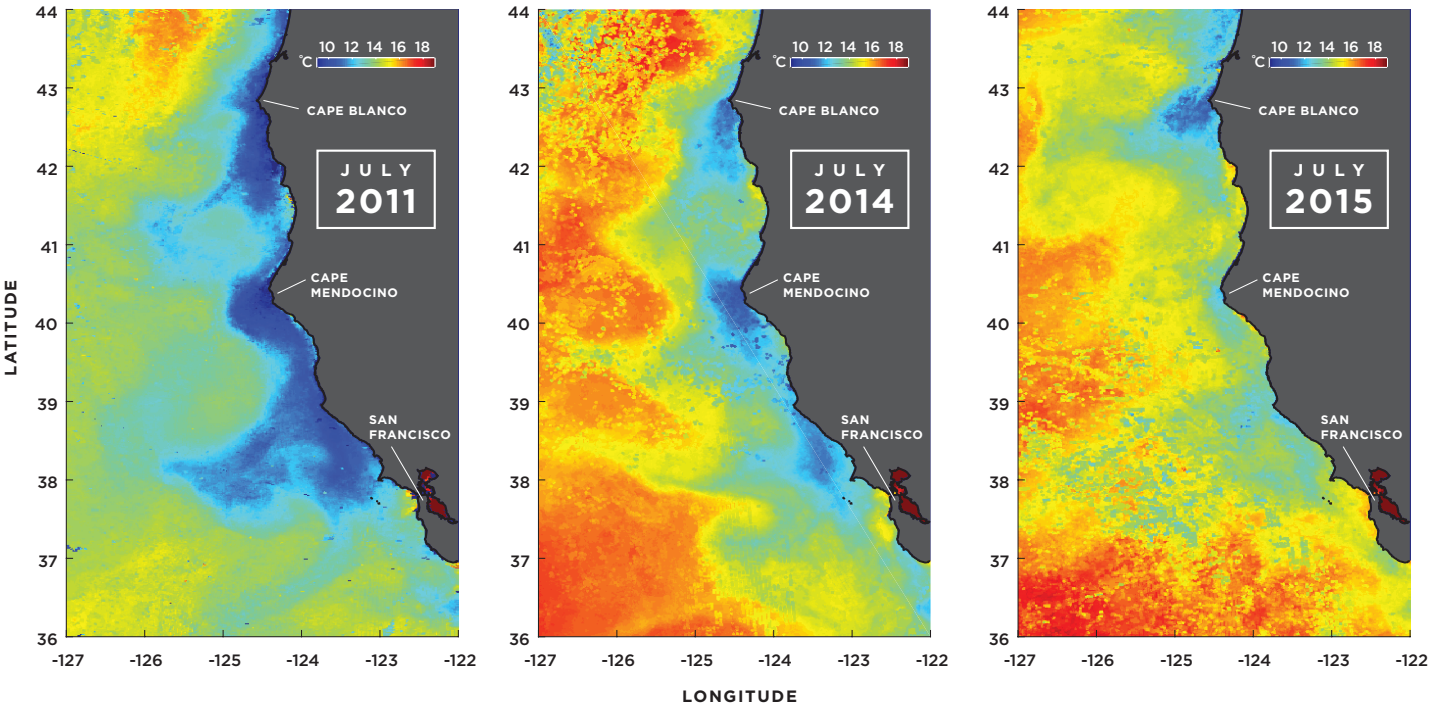
Regional Ocean Trends

To provide a long-term regional perspective on ocean conditions, the research team compiled and analyzed a suite of oceanic and atmospheric measurements spanning a 26-year period (1991-2016). From these data, they developed a seasonal indicator called the "Multivariate Ocean Climate Indicator (MOCI)." The MOCI blends information about large-scale ocean conditions across the Northeast Pacific Ocean with a collection of local observations from the waters along the North Coast to provide regional-scale information on whether the marine environment is trending towards warmer, less productive conditions or cooler, more productive conditions. The indicator captures patterns in ocean conditions over time and shows the intensity of the unusual conditions that occurred during the North Coast MPA baseline monitoring period.



MULTIVARIATE OCEAN CLIMATE INDICATOR (MOCI)

Multivariate Ocean Climate Indicator (MOCI) for the North Coast of California. Red points indicate warmer than usual temperatures and weak upwelling, blue points indicate unusually cool temperatures and strong upwelling. Source: Figure adapted from García-Reyes and Sydeman 2017.[5]



SEA SURFACE TEMPERATURE

Sea surface temperature (14-day average) along the North Coast for July of 2011 (left), 2014 (middle), and 2015 (right). Temperatures in 2011 reflect strong upwelling conditions, whereas 2014 shows the approach of the warm "blob" on the California Current and 2015 shows the impacts of persistent warm water plus the building El Niño conditions. Source: Prepared by Eric Bjorkstedt (NOAA's SWFSC), data processed and served by the NOAA CoastWatch Program.

Tiny, but Dangerous: Algal Bloom Delays the Dungeness Crab Season

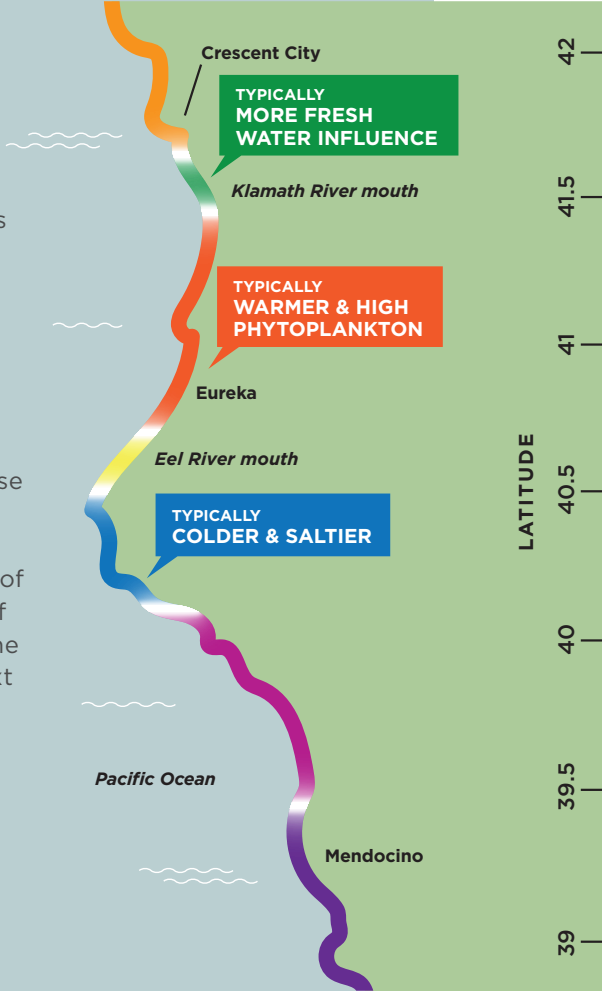
Harmful algal blooms (HABs) occur when algae – tiny plant-like organisms that live in fresh or salt water – grow out of control and produce toxins that can harm wildlife and humans. In 2015, unusual ocean conditions along the California Coast led to an unprecedented HAB in the region. High domoic acid concentrations from this bloom pervaded the foodweb, accumulating in animals like crabs. Dungeness crabs tested high for the domoic acid toxin, and were deemed unsafe for human consumption by the Department of Public Health. In response, managers severely delayed the opening of the fishery.[6] Coastal surveys of the event and ongoing sampling suggest that waters off the North Coast are a potential hotspot for such blooms.

What are Ocean Fronts?

Ocean fronts are relatively sharp transitions between water masses with different characteristics, such as temperature and salinity. Off the North Coast, these fronts most commonly occur where cold, saltier water pushes up from the deep and meets warmer surface waters offshore. By studying these fronts over time, researchers are able to detect seasonal and spatial patterns in where they are likely to occur. These patterns have implications for productivity and where plankton (the base of the marine food web) are likely to be found.

Distinct Subregions Shaped by Large-Scale and Local Factors

Although several abnormal events caused broad shifts in ocean conditions during the baseline study period (e.g., unusually warm coastal waters), researchers found indications of relatively consistent repeating patterns in how North Coast oceanographic conditions varied across space and time. This structure did not appear to be substantially disrupted by the unusual events, even though average conditions changed dramatically. For example, despite clear, large-scale temperature shifts along the entire North Coast, some locations still tended to be consistently cooler or warmer based on the intensity of local upwelling. Transitions between these areas also occurred in generally consistent locations, indicating a pattern of oceanographic subregions. Areas near headlands tend to experience stronger local upwelling and cooler water, while more sheltered stretches of coast are typically marked by warmer waters and higher concentrations of phytoplankton (tiny, floating marine algae that form the base on the marine food web). These patterns can provide a foundation and important context when designing long-term monitoring plans.



REGIONAL CLUSTERING

Map of the potential "subregions" along the North Coast. Due to sea surface temperature, freshwater input, and phytoplankton (tiny algae) abundance, the region appears to break into distinct "subregions" with different oceanographic conditions. Regions near major river mouths, for example, are consistently different than stretches between rivers; Source: adapted from the oceanographic conditions technical report.[2]

Looking Forward

While the baseline study period in the North Coast was marked by unusual oceanographic events, it is not yet clear whether the conditions caused by these events will shift back to more "normal" conditions or indicate a trend likely to have continuing effects. Accounting for oceanographic conditions through ongoing large-scale and local measurements will provide a strong foundation for enhancing our understanding of the patterns emerging from the baseline monitoring period and beyond. Moving forward, understanding the long-term oceanographic trends and tracking trends both inside and outside MPAs is critical in understanding how ecosystems may respond to protection on the North Coast.

ABOUT NORTH COAST MPA BASELINE MONITORING

California Ocean Science Trust, California Department of Fish and Wildlife (CDFW), California Ocean Protection Council (OPC), and California Sea Grant coordinated and collaborated in the implementation of baseline monitoring, which was funded by OPC. Results from this work will inform CDFW management recommendations to the California Fish and Game Commission from the first five years of MPA implementation in the region, anticipated in 2018. MPA monitoring results can also inform the management of fisheries, water quality, and climate change.

FOOTNOTES

1. To learn more about the oceanographic conditions baseline monitoring project, visit OceanSpaces.org: https://goo.gl/dTDh2q
2. EP Bjorkstedt, M. García-Reyes, M. Losekoot, W. Sydeman, J. Largier, and B. Tissot. 2017. Oceanographic context for baseline characterization and future evaluation of MPAs along California's North Coast. California Sea Grant. San Diego, CA. 88 pp. https://goo.gl/qCwZkM
3. Humboldt State University: https://goo.gl/BaBa9C
4. Farallon Institute for Advanced Ecosystem Research: https://goo.gl/sL3CvN
5. M García-Reyes and WJ Sydeman. 2017. California Multivariate Ocean Climate Indicator (MOCI) and marine ecosystem dynamics. Ecological Indicators, 72, 521-529. https://goo.gl/DYx9vg
6. Frequently Asked Questions: Harmful Algal Blooms and California Fisheries, Developed in Response to the 2015-2016 Domoic Acid Event. 2016. California Ocean Science Trust, Oakland, CA. https://goo.gl/PZD6zi

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