

Ocean Climate Indicators

A Monitoring Inventory and Plan for Tracking Climate Change in the North-central California Coast and Ocean Region



Report of a Working Group of the Gulf of the Farallones
National Marine Sanctuary Advisory Council

OCEAN CLIMATE INDICATORS FOR THE NORTH-CENTRAL CALIFORNIA COAST & OCEAN REGION

The impacts of climate change, defined as increasing atmospheric and oceanic carbon dioxide and associated increases in average global temperature and oceanic acidity, have been observed both globally and on regional scales, such as in the North-central California coast and ocean, a region that extends from Point Arena to Point Año Nuevo and includes the Pacific coastline of the San Francisco Bay Area. Because of the high economic and ecological value of the region’s marine environment, the Gulf of the Farallones National Marine Sanctuary (GFNMS) and other agencies and organizations have recognized the need to evaluate and plan for climate change impacts.

Climate change indicators can be developed on global, regional, and site-specific spatial scales, and they provide information about the presence and potential impacts of climate change. While indicators exist for the nation and for the state of California as a whole, no system of ocean climate indicators exist that specifically consider the unique characteristics of the California coast and ocean region.

To that end, GFNMS collaborated with over 50 regional, federal, and state natural resource managers, research scientists, and other partners to develop a set of

ocean climate indicators specific to this region. A smaller working group of 13 regional partners developed monitoring goals, objectives, strategies, and activities for the indicators and recommended selected species for biological indicators, resulting in the Ocean Climate Indicators Monitoring Inventory and Plan. The working group considered current knowledge of ongoing monitoring, feasibility of monitoring, costs, and logistics in selecting monitoring activities and selected species.

PHYSICAL INDICATORS

The physical ocean climate indicators include:

- Ocean Water Properties
 - Sea Surface Temperature
 - Dissolved Oxygen
 - Sea Surface Salinity
 - Ocean Chemistry (pH)
- Sea Level
- Wave Height & Direction
- Atmospheric Properties
 - Air Temperature
 - Alongshore Wind Speed

BIOLOGICAL INDICATORS

The biological ocean climate indicators include:

- Primary Productivity
- Abundance, Biomass, & Phenology of Mid-Trophic Level Species
- Spatial Extent of Habitat-Forming Organisms
- Phenology, Productivity, & Diet of Seabirds



Figure ES-1: Scientist sampling phytoplankton

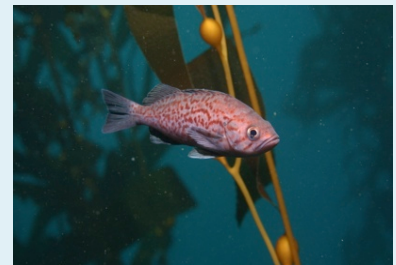


Figure ES-2: Juvenile blue rockfish



Figure ES-3: Surfgrass

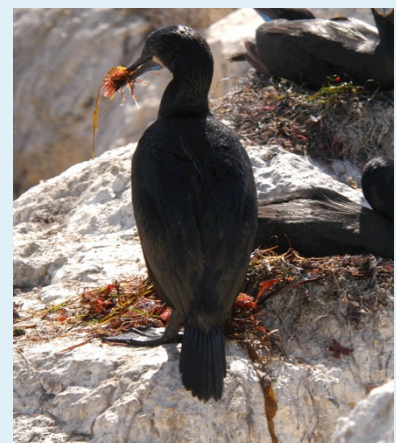


Figure ES-4: Brandt's cormorant

REGIONAL OCEAN CLIMATE INDICATORS MONITORING GOAL AND OBJECTIVES

Monitoring Goal:

Promote comprehensive and coordinated management of marine resources by increasing understanding of the ecological impacts of climate change on the North-central California coast and ocean region, through the monitoring and evaluation of physical and biological ocean climate indicators.

Objectives to Meet the Monitoring Goal:

1. Determine the status and trends of ocean climate indicators along the North-central California coast and ocean region through existing monitoring programs and by identifying needs and opportunities for new or expanded monitoring efforts.
2. Assess the vulnerability of specific geographic areas, ecosystems, and ecosystem components within the North-central California coast and ocean region to the impacts of climate change.

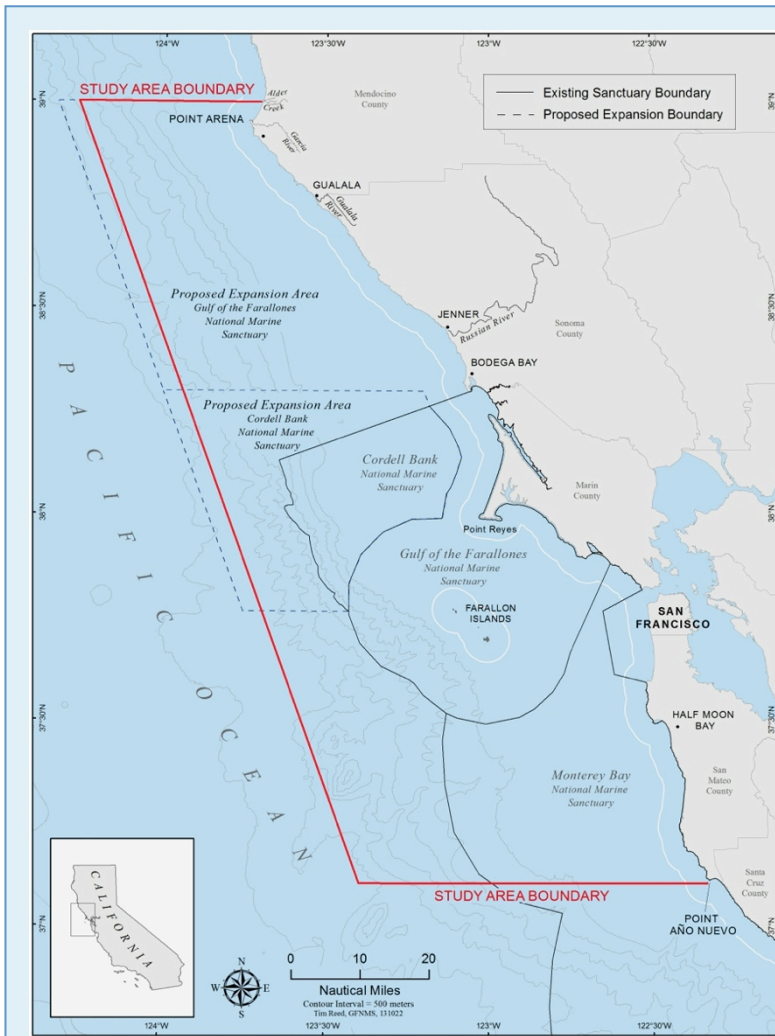


Figure ES-5: Map of study region (thick red lines), with related sanctuary boundaries (black solid lines) and proposed sanctuary expansion areas (black dashed lines)

INDICATORS MONITORING STRATEGIES & ACTIVITIES

The Indicators Working Group identified several overarching indicator monitoring recommendations:

1. Continued and/or expanded financial support for ongoing indicator monitoring is vital for science-based climate change decision-making because it allows for identification of long-term, climate-scale changes in the region's ecosystems.
2. Expanded or new indicator monitoring would provide important information for natural resource managers.
3. Synthesis of existing regional climate change research is key to ensuring that monitoring is as efficient and useful as possible.
4. There is a need for increased communications with regional and local government agencies to ensure that natural resource managers have access to the information, partners, and resources that they need to assess and reduce their vulnerability to climate change.

ADDITIONAL CONTENT

The Indicators Monitoring Inventory and Plan also contains the following for each ocean climate indicator:

- An inventory of the best available current and historical monitoring
- Unique monitoring strategies and activities
- Case studies to provide specific examples of the indicators' utility in a decision-making context



Figure ES-6: Shoreline along North-central California coast