

RESOLUTION of the  
Greater Farallones National Marine Sanctuary Advisory Council

**To support staff recommendations within the Open Ocean Environment Topic Briefing**

At its meeting on July 14, 2023, the Greater Farallones National Marine Sanctuary Advisory Council suggested edits to the staff recommendations within the Open Ocean Environment Topic Briefing. The council passed a resolution to support the staff recommendations with the suggested edits.

Attachments: Open Ocean Environment Topic Briefing

*This resolution was passed with majority vote by a quorum of primary members (or alternate members serving in place of primary members) at a public meeting on July 14, 2023 held in Point Reyes Station, CA and via Google Meet. Council discussion regarding this resolution can be found in Meeting Highlights documentation at [https://farallones.noaa.gov/manage/sac\\_meetings.html](https://farallones.noaa.gov/manage/sac_meetings.html).*

***The council is an advisory body to the sanctuary superintendent. The opinions and findings of this letter/publication do not necessarily reflect the position of the sanctuary and the National Oceanic and Atmospheric Administration.***



## Briefing on Nearshore and Offshore Open Ocean in Greater Farallones and Cordell Bank National Marine Sanctuaries

This topic briefing focuses on oceanographic conditions and water quality in the coastal and offshore environment. See [https://farallones.noaa.gov/manage/sac\\_meetings.html](https://farallones.noaa.gov/manage/sac_meetings.html) for other topic briefings for seabirds, marine mammals, or fish species found in this habitat and for conditions in estuaries and lagoons.

### State of the Resource

#### Condition Report Data (in preparation)

##### CBNMS (2009-2021)

- Eutrophication was not occurring in CBNMS and risks to human health were not a significant concern for CBNMS.
- Other potential stressors were identified, including plastics, vessel discharges, and oil spills, but they are not a major concern for CBNMS.
- Climate-related changes in water quality are a major concern for CBNMS and impacts were observed, namely increased water temperature at the surface and at depth. The 2014-2016 marine heatwave (MHW) resulted in the highest sea surface temperature (SST) on record for this area so far. Extensive harmful algal blooms (HABs) were present and may be increasing. High variability and periods of anomalous conditions appear to be more extreme and longer in duration than in the past. Short periods of low dissolved oxygen were present at Cordell Bank, but severe hypoxia was not observed. These climate-related changes are notable, because they have been linked to changes in some ecosystem components, including altering abundance and distribution of pelagic species, correlations with abundance and size of krill, and the presence and intensity of HABs and domoic acid.

##### GFNMS (2010-2022)

- Eutrophication was not occurring in GFNMS in offshore waters.
- Species that can produce biotoxins were present; and HABs occurred, especially in 2015–2016. Human impacts from HABs were mitigated by management actions (e.g., shellfish advisories).
- There was improvement in the number of impaired water bodies (waters off of Bolinas Beach were delisted from the 303(d) list as determined by the California State Water Resources Control Board). Beach advisory days for elevated pathogenic bacteria were high in Marin County and low in Sonoma County, as determined by California State Water Resources Control Board and U.S. Environmental Protection Agency.

- Climate-related changes have been documented through several ocean indicators, such as SST and marine heatwaves, dissolved oxygen, and aragonite saturation<sup>1</sup> levels.
  - The 2014-2016 and 2019 MHWs were associated with elevated SST. Habitat compression was observed during the MHWs, limiting the area of prey species for seabirds and marine mammals closer to shore and shifting prey populations into areas of greater risk of whale entanglement and ship strikes.
  - No hypoxic events were observed from sampling at 10 m, 25 m, or 100 m. However, dissolved oxygen was low and near-hypoxic at 25 m and 100 m. Hypoxia occurred only offshore at depths >125 m. Acute effects of the hypoxia events were not detected.
  - Aragonite saturation state reflected corrosive conditions at a depth of 100 m offshore, but these conditions were less frequent nearshore at a depth of 25 m.
- Other stressors to the open ocean ecosystem include microplastics, vessel discharges, oil spills, and dredged material spills. Microplastics were present in GFNMS at levels similar to other ocean environments and can impact wildlife. Large to moderate oil spills did not occur between 2010 and 2021. Small spills of petroleum products from vessel incidents occurred regularly, but data on amounts were limited. No acute impacts were detected. Large amounts of discharges from cruise ships and small amounts of discharges from barges carrying clean dredged sediment occurred.

### **Climate Vulnerability Assessment Findings**

- Vulnerability is calculated from exposure to climate and non-climate stressors, sensitivity to those stressors, and the resource's ability to adapt to the impacts caused by those stressors. Ratings presented are from the original GFNMS and CBNMS 2015 report and from 2023 revisions to some of the indicators in that report.
- Pelagic habitat has moderate vulnerability driven by high exposure to increased temperatures, low dissolved oxygen levels, low pH, changes to upwelling, and altered currents and mixing. Though overall sensitivity is moderate due to low sensitivity to non-climate stressors (e.g., harvest, pollution), sensitivity to climate change is high due to pH, dissolved oxygen, disturbance regimes, dynamic ocean conditions, and upwelling. Pelagic habitat has a high capacity to adapt because of the geographic extent and continuity of the habitat, diversity of component species and functional groups, and structural and functional integrity of the habitat.

### **Pressures on Open Ocean**

Human activities and natural processes can affect the condition of coastal and offshore waters through a variety of pathways. This section has been included to inform the public about the most significant overarching pressures, past, present, and potential, that may impact the open ocean environment. While some pressures are beyond the scope of what ONMS can address, the sanctuaries are monitoring and working on efforts to respond to the following pressures:

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<sup>1</sup>“Aragonite is a specific form of calcium carbonate that many organisms produce and use to build their skeletons and shells, and the saturation state is a measure of how easily aragonite can dissolve in the water. The lower the saturation level, the more difficult it is for organisms to build and maintain their protective skeletons and shells.” epa.gov

- Vessel Traffic (discharges)
- Climate Change
- Marine Debris (on the surface and in the water column)

## Summary of Relevant Regulations

See links to full text, definition, exceptions, and exemptions on the regulations pages of the [GFNMS](#) and [CBNMS](#) websites.

The following GFNMS and CBNMS prohibitions can prevent impacts to the open ocean from listed prohibited activities:

1. Exploring for, developing, or producing oil, gas or minerals.
2. Discharging or depositing from within or into the Sanctuary any material or other matter.
3. Discharging or depositing, from beyond the boundary of the Sanctuary, any material or other matter that subsequently enters the Sanctuary and injures a Sanctuary resource or quality.

The following GFNMS regulation can prevent additional impacts to the open ocean:

1. Deserting a vessel aground, at anchor, or adrift in the Sanctuary.
2. Leaving harmful matter aboard a grounded or deserted vessel in the Sanctuary.

## Summary of Relevant Sanctuary Projects

### Conservation Science

- The sanctuaries' science projects study water column biota and oceanographic conditions as part of the Applied California Current Ecosystem Studies (ACCESS; water temperature, salinity, dissolved oxygen, pH, aragonite saturation, phytoplankton and zooplankton abundance and composition, and biodiversity through sampling environmental DNA), and the oceanographic monitoring buoy at Cordell Bank. The NOAA noise reference station measures ocean acoustics (e.g., ships and whale vocalizations). Kelp forest ecosystem health is measured with partners at CDFW, PISCO and GFA, to inform restoration activities. Science staff also interpret NOAA remote sensing data and products to inform understanding of local and regional conditions, such as habitat compression, and upwelling conditions.
- The conservation science team works with partners including Point Blue Conservation Science, UC Davis Coastal and Marine Sciences Institute's Bodega Marine Laboratory, and San Francisco State University, Estuary & Ocean Science Center to collect and interpret data, and works with the resource protection team to identify issues and with the education team to share findings.

### Resource Protection

- The sanctuaries review project proposals, including proposed actions from other agencies that could potentially violate sanctuary regulations or are likely to destroy, cause the loss of, or injure sanctuary resources in the open ocean.

- Through permitting actions the sanctuaries manage, reduce, or eliminate injury to the open ocean.
- The sanctuaries work with NOAA's Office of Law Enforcement and the U.S. Coast Guard to document and enforce sanctuary regulations that protect the open ocean, work with NOAA's General Council to issue fines, conduct damage assessments, and work with responsible parties to address impacts to the open ocean.
- Emergency Response.
  - The sanctuaries participate as a member of two U.S. Coast Guard led Area Committees and participate in sub-committees to help identify sensitive sites and resources at risk, develop response strategies, provide ecological information for potential places of refuge for vessels in distress, review draft planning documents, and participate in drills.
- Marine Debris.
  - The sanctuaries remove grounded and sunken vessels, aircraft or other objects when feasible by working with emergency responders, responsible parties, and enforcement personnel.
  - The sanctuaries conducted the Baseline Data Gathering and Beach Marine Debris Assessment monitoring and recorded all marine debris at six beach sites in or adjacent to GFNMS and posted data collected to the NOAA MDMAP Online Database between 2012-2019.
  - The sanctuaries conducted a Beach-Source Marine Debris Prevention and Reduction project in 2019-2020, surveying and researching effective ways to address a top source of debris, shotgun wads, and developing a report with strategies to reduce this debris.
  - The sanctuaries conducted the Fishing Source Marine Debris Prevention and Reduction: Reel In and Recycle project to reduce lost and abandoned fishing gear.
  - Staff participate in multiple committees and working groups with partner agencies and the public devoted to addressing vessel incidents and have worked with the NOAA Marine Debris Grant Program to track debris, identify potential salvage funding sources, and strategize future management actions.

## **Education and Outreach**

- School Programs
  - GFNMS Visitor Center Field Trips: Pass the Plankton (4th grade) includes upwelling, plankton, and food webs and Plankton Lab (11th grade-University) provides a deeper dive into plankton sampling methods, studies live samples of phytoplankton and zooplankton, and discusses plankton's role in ocean ecosystems and vulnerability to ocean acidification.
  - At Your School Programs: Ocean Acidification: a Sea of Change (7th-12th grade) covers how increasing ocean acidity affects ocean food webs and larval stages of organisms.
  - Ocean Afterschool Programs: Plankton, Sea Turtle, and Squid modules (3rd-5th grades).

- Virtual Plankton and Ocean Acidification (OA) programs for high school science classes (50 Programs in 50 States project), include streaming live plankton samples to high school students across the nation and discussing the effects of OA.
- Teacher Professional Development workshops: climate change in the open ocean, ocean acidification and food web impacts.
- Teacher at Sea (with ACCESS program)
- Community Programs
  - Community lectures about the offshore environment include messages about upwelling and oceanographic seasons and conditions.
  - Plankton, Leatherback Sea Turtle, and Squid Family Workshops in the Pier Classroom.
  - Plankton Workshops for Community Partners in the Pier Classroom.
  - Sanctuary Naturalist Training program includes content about offshore ecosystems.
  - Sanctuary Soirées have included a Squid Soirée, Leatherback Sea Turtle Soirée, and Octopus Soirée.
- Exhibits
  - The Oakland Museum of California exhibit about El Niño, plankton productivity, and upwelling. The Point Reyes National Seashore exhibit about upwelling, plankton, and drifting community. The Greater Farallones Visitor Center exhibits on upwelling, plankton, krill (including a microscope exhibit for plankton viewing). Guided plankton viewing from the naturalist station.
- Media and Outreach Activities.
  - ACCESS media, web stories about hypoxia, social media posts about the open ocean/offshore environment, and Ocean Currents radio program episodes about the open ocean environment.

### **Infrastructure and Vessels**

Sanctuary infrastructure supports open ocean work through office infrastructure, at sea assets, and specialized tools.

- Research, GIS, Resource Protection, and Education and Outreach staff collaborate on open ocean projects and meet with project partners at the sanctuary offices.
- The Crissy Field Visitor Center delivers ocean productivity education programs utilizing the pier classroom for 2nd grade - high school students.
- GFNMS and CBNMS conduct single- and multi-day oceanographic missions on the regional research vessel *Fulmar* and longer missions on larger NOAA “White Ships” and the exploration vessel *Nautilus*.
- GFNMS and CBNMS use drifter buoys, offshore anchored buoys, XBTs, and other technology to collect oceanographic data.
- Staff monitor greenhouse gas emissions from site-based and on-the-water operations.

## Summary

Open ocean habitat is impacted particularly by climate change, which has resulted in increased temperatures, ocean acidification, marine heatwaves, habitat compression, and has exacerbated harmful algal blooms. Other key pressures include vessel traffic and marine debris. GFNMS and CBNMS work to protect open ocean habitat through regulations, permitting, collaboration on enforcement, emergency response, and marine debris removal. Education staff provide information on climate change and ocean acidification, plankton and other pelagic animals, through school programs, workshops, trainings, soirees, exhibits, and media and outreach. The operations teams supports this work through support for facilities, vessels, and equipment, and monitors greenhouse gas emissions and identifies and implements GHG reducing processes.

## GFNMS and CBNMS Advisory Council Recommendations

*These recommendations were provided during a GFNMS Advisory Council meeting on July 14, 2023 and a CBNMS Advisory Council meeting on November 17, 2023. To view council discussion on this topic, please visit [https://farallones.noaa.gov/manage/sac\\_meetings.html](https://farallones.noaa.gov/manage/sac_meetings.html) and view the meeting's highlights.*

Conservation Science: Continue and expand efforts technologically and geographically with partners including commercial and recreational industry to measure, understand, and monitor open ocean conditions including at-sea monitoring, sensor and hydrophone deployment, water column surveys, and through remote sensing data to: 1) better understand open ocean ecosystem, 2) track status and trends, 3) understand responses to climate change, 4) identify and quantify impacts to water quality from key pressures such as vessel traffic, climate change, and marine debris (e.g., from vessel incidents or pollutants) to inform management efforts.

Resource Protection: Continue to work on a variety of activities to reduce human-induced impacts to the sanctuaries including: 1) track human activities that impact the open ocean, assess which activities have the greatest impacts, and reduce impacts (e.g. work with response partner agencies to prevent and respond to spills and discharges); and 2) work with enforcement partners to educate vessel operators and harbors to promote stewardship of the sanctuary to enforce and reduce violations of sanctuary regulations. Review the effectiveness of sanctuary regulations in protecting open ocean habitat and determine if changes may be needed. Align GFNMS and CBNMS regulations on deserted vessels and leaving harmful matter aboard vessels. Ensure reporting of incidents, violations, or marine debris easily accessible via online reporting.

Education and Outreach: Through all education and outreach programming and communications, continue to connect the state of the ocean with the health of the sanctuaries by incorporating ocean and climate literacy concepts. Make a direct link between changing ocean conditions (e.g. OA and harmful algal blooms) and actions individuals and communities can take to maintain healthy sanctuaries. Refine climate messages around the mechanisms of

climate change to include how sanctuaries are part of building climate resilience and the role the ecosystem plays in the carbon cycle (blue carbon). Climate change messages can be magnified to create awareness, hope, and move audiences behaviors to actions that are healthy for the sanctuaries. Sanctuary ocean ambassador programs should request agencies license professional and/or certified naturalists and organizations that provide access to open ocean; continue to participate and collaborate with MPA collaboratives on outreach; and research management best practices.

Infrastructure: Continue to support open ocean work through offering shared collaboration space at sanctuary offices, provide access to on-the-water sanctuary and partner assets (e.g. vessel, ROVs, and UAS) and update and expand exhibits and public visitor center space to better inform the public on the status of nearshore and open ocean habitats. Reduce greenhouse gas emissions from sanctuary at-sea operations by converting to more efficient fuel (renewable diesel), boat design (propellers), and engine types (hybrid electric) and explore innovative technologies.