Marine Protected Areas Building Resilience To Climate Change Impacts

The U.S. has more than 1700 MPAs. These areas vary widely in purpose, legal authorities, managing agencies, level of protection, and restrictions on human uses. *Photo: NOAA*

What are marine protected areas? What types are there in the US?

Marine protected areas (MPAs) are geographically defined areas where natural and/or cultural resources are given greater protection than the surrounding waters. In the US, the formal definition of an MPA in Executive Order 13158 (2000) is: any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein. MPAs include National Marine Sanctuaries, Marine National Monuments, National Estuarine Research Reserves, National Parks, National Wildlife Refuges, and the state and local counterparts to these programs. Coastal protected areas that extend into the marine environment are also considered MPAs.

Where are U.S. MPAs and what do they protect?

In the US, MPAs span a range of habitats, including the open ocean, coastal areas, inter-tidal zones, estuaries, and the Great Lakes. They also vary widely in purpose, legal authorities, managing agencies, management approaches, level of protection, and restrictions on human uses. MPAs protect all types of habitats, flora, and fauna found in U.S. waters, and often protect shipwrecks and other types of cultural resources as well. The National Marine Protected Areas Center works to foster coordination among MPA programs and networks at all levels of government and to help address a wide range of science, stewardship, and outreach issues, including climate change.

What impacts will climate change have on MPAs?

In general, MPAs will experience the same types of climate change impacts that will be felt in the broader marine and coastal environments, including changes in water temperatures and oceanic circulation, rising sea levels, increasing ocean acidification, changes in precipitation and storms, and their associated effects.

Seabirds as Indicators of Global Climate Change? The Cassin's auklet (right) is a seabird that spends the majority of its life in the open ocean. These birds feed on krill and other high-nutrient cold-water plankton. In 2014-2015 a marine heatwave known as "The Blob" caused a shift in the marine plankton community towards smaller, more nutrient-poor warm-water plankton. This change in food led to a mass die-off of seabirds from California to Alaska with over 9,000 dead auklets recorded in Oregon and Washington alone. The number and intensity of marine heatwaves like "The Blob" are expected to increase with climate change. *Photo: NOAA*

What impacts will climate change have on MPAs?

▪ **Changes in water temperature and oceanic circulation** may disrupt coastal upwelling systems and associated productivity, which can in turn produce far-reaching disruptions throughout the marine food web. As oceans warm, populations or entire species may shift their ranges, distributions, and abundances (including both valuable fisheries and invasive species). Species shifts are already being observed in US waters, with high latitude and tropical areas appearing to be most vulnerable to these impacts. The disruption of endangered and threatened species may also shift within, into or out of an MPA. Populations or species that move outside of an MPA may lose the valuable protection provided by that MPA.

Increased warming of ocean temperatures may result in coral reef bleaching, as seen above. Photo credit: Wendy Cover/NOAA

Ocean acidification may reduce the capacity of crustaceans, like this amphipod, to form shells and skeletons. *Photo: Brooke et al, NOAA-OE.*

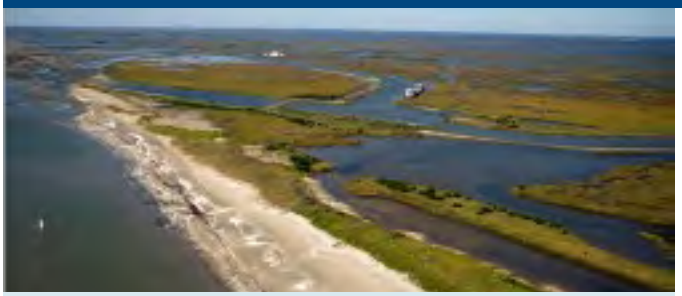
▪ **Changing coastal and marine habitats** will likely be seen as well. Coral reefs often bleach and die during prolonged episodes of ocean warming. Rising sea levels will inundate existing shorelines. Coral reefs, sea grass beds, mangroves, marshes, barrier islands, and other habitats that only exist within a certain temperature or activity zone will shift where they are able. Where shorelines have been hardened (e.g., with seawalls or riprap) or developed, these habitats may not be able to shift and may be lost. Sea level rise may lead to saltwater intrusion affecting estuarine and freshwater habitats, adversely affecting species and habitats that are sensitive to salinity shifts. Sandy beaches, which are critical habitats for some species such as shorebirds and nesting sea turtles, will also erode and be lost in some areas.

▪ **Ocean acidification**, caused by increased levels of carbon dioxide (CO_2) in the oceans, may reduce the capacity of corals, crustaceans, shellfish, and plankton to form shells and skeletons, impeding their survival. Over the past century, ocean pH has increased by 30%, with higher increases in some coastal areas following upwelling events. Declines in plankton would create consequences for species throughout higher levels of the food chain. As the degree of ocean acidification intensifies, it could lead to the decline of economically important crustacean and shell-fish fisheries and have impacts on all living marine resources.

How will climate change affect other problems facing marine protected areas and the marine environment?

The impacts from sea level rise, ocean warming, changes in oceanic circulation, ecosystem/biome shifts, and ocean acidification will compound problems that already degrade ocean and coastal ecosystems. Although the degree to which they are affected varies depending on their location, most MPAs are contending with stressors such as water pollution, habitat degradation and loss, and the impacts of current or past overfishing. Climate change requires a more concerted effort to restore, preserve, and protect the ecological integrity and resilience of ocean and coastal

Sea level rise and other climate change affects can compound problems that already degrade coastal ecosystems, like habitat loss. *Photo: NOAA*



Barrier Islands, like this one in Barataria Bay, Louisiana, protect the coast from storm surge. *Photo: NOAA*

ecosystems so they can withstand the additional stress of climate change. Healthy ecosystems will likely be more resilient to ocean warming, sea level rise and other climate change impacts. To help maintain the health of the marine environment, the US Global Change Research Program recommends increasing the resilience of MPAs by managing other anthropogenic stressors that degrade ecosystems, and by protecting key functional groups of marine species.

How can MPAs and MPA networks help address climate change?

The long-term, place-based nature of MPAs provides an advantage in addressing the impacts of climate change by providing a focal area for management and science to reduce stressors, monitor conditions and trends, and engage the public. MPA networks are collections of MPAs that work together to meet objectives beyond those of a single area. Ideally, networks are designed to maximize ecological connectivity between marine protected areas, increasing protection for marine resources.

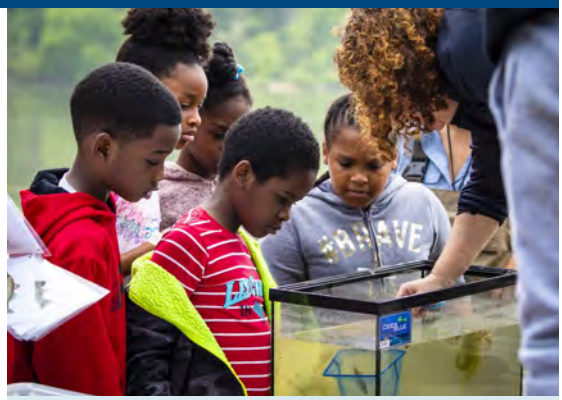
▪**Protected areas reduce other ocean stressors.** Generally, MPAs have a stable, permanent legal and management infrastructure to protect their resources. These provide opportunities for the implementation of management measures to mitigate climate change impacts, or at a minimum, reduce other stressors. Protective actions within MPAs also have beneficial effects outside the MPA, such as the protection of bordering or buffering habitats and the production of larval, juvenile, and adult marine species that "spillover" into outside areas. MPAs can also serve as an important carbon sink. Over half (55%) of the biological carbon stored globally is stored by living marine organisms. MPAs that protect habitats such as salt marshes, mangroves, and algal and seagrass beds, all of which store carbon, help mitigate climate change impacts.

Networks of MPAs can provide continued protection for mobile species if their distribution and ranges shift due to climate change. *Photo: NOAA*

▪ **Networks provide corridors for shifting species and habitats.** Well-developed, functionally connected MPA networks provide added protection by having multiple examples of a range of protected habitats as an "insurance policy" against climate change and other impacts (replication). Networks of MPAs can create ecologically connected corridors that facilitate the range shifts of populations and ecosystem types, as well as the movement of individuals in response to adverse impacts in one MPA. MPAs and MPA networks need to be adaptively designed and managed to address altered coastal and ocean conditions and habitat shifts due to climate change, which may affect future boundaries, locations, and sizes.

▪ **Networks help reduce risk and promote resiliency.** Faced with significant uncertainty about where, when and which species, habitats, and ecosystems are most vulnerable and likely to change, MPAs and MPA networks can be designed to reduce the risk of catastrophic loss due to the more extreme impacts of climate change by providing protection for as much diversity as possible (representation), and for replication of specific species, habitats, or ecosystems. MPAs can be designed and managed to help reduce the risk of losing key species and habitats.

▪ **MPAs serve as sentinel sites to monitor changes.** MPAs, with their place-based focus, long-term data sets, and controlled activities, are also able to serve as control areas or "sentinel sites" for monitoring climate change and other impacts. Real-time results from monitoring programs; advice and feedback from stakeholders; and long-term synthesized information from condition reports all feed into decision-making for an MPA. MPA managers can react relatively quickly to this information and address existing or emerging threats and impacts. Examples of such adaptive management mechanisms include revisions to regulations and management plans, emergency regulations, permitting activities, consultation requirements, and habitat restoration and land acquisition strategies that improve ecosystem resilience.



MPAs help educate the public and local communities about climate change impacts. *Photo: NOAA*

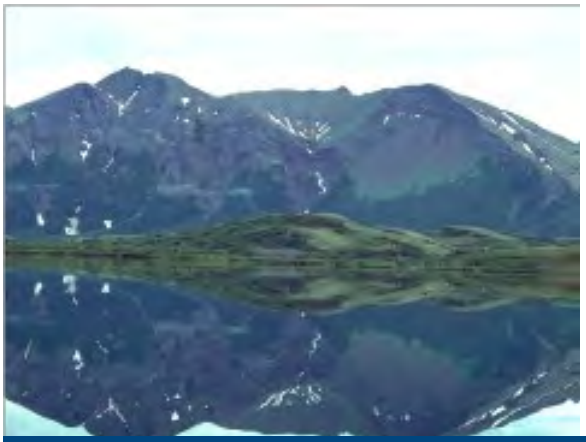
▪ **MPAs educate the public and local communities.** MPAs with onsite managers and staff, local offices and visitor facilities, educational programs, and advisory groups are often an established and trusted presence in local communities. Information coming from an MPA, including information about climate impacts, may be trusted more than from other sources of information, and may help make climate change "real" for local residents. Many MPAs are demonstrating greening techniques, clean energy technologies, and other innovations. This neighborhood approach can help motivate individual citizens, local communities, and coastal decision makers to take action through MPA volunteer efforts, advisory and friends groups, and other mechanisms.

By reducing non-climate stressors on the environment, providing protection to those coastal and marine resources most at risk, and reducing risk in the face of uncertainty, MPAs can foster the resilience and health of marine ecosystems in order to improve their ability to resist and recover from the impacts of climate change in the ocean and directly contribute to public health, safety, and economic welfare of coastal communities. MPAs and networks of MPAs are valuable tools that, with proper management, can help buffer impacts, create climate change refugia, and sustain ecologically, culturally, historically, socially, and economically valuable coastal and marine resources throughout the nation's waters and beyond.

Climate Change References and Resources

▪ NOAA Climate Portal: http://www.climate.gov

▪ NOAA Sentinel Site Program: http://oceanservice.noaa.gov/sentinelsites/



▪ IPCC Special Report on the Ocean and Cryosphere in a Changing Climate, https://www.ipcc.ch/srocc/home/ (2019)

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▪ Commission for Environmental Cooperation, Scientific Guidelines for Designing Resilient Marine Protected Area Networks in a Changing Climate, http://www3.cec.org/islandora/en/item/10820-scientific-guidelines-designing-resilient-marine-protected-area-networks-in-changing-en.pdf (2012)

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https://marineprotectedareas.noaa.gov/sciencestewardship/climatechangeimpacts/
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