Center for American Progress

How Marine Protected Areas Help Fisheries and Ocean Ecosystems

By Margaret Cooney, Miriam Goldstein, and Emma Shapiro June 3, 2019

The 123 million people who live near the U.S. coasts and the 3 million Americans who depend on the ocean for their livelihood are front-row witnesses to dire and unprecedented change.[1] As a result of climate change, unusually warm waters are killing kelp along the West Coast as well as coral off of Hawaii, fueling toxic algae blooms in Florida and California, and threatening the nation's $212 billion commercial and recreational fishing industries.[2] Wastewater and agricultural runoff, along with plastic pollution, are also major dangers; in 2017, scientists measured the ocean's largest dead zone ever—an area the size of New Jersey—in the Gulf of Mexico,[3] and plastic pollution is so prevalent that it has been found in the most remote areas of the deep sea.[4]

While the United States currently has a strong fisheries management system, the legacy of past overfishing, combined with climate change and habitat destruction, has severely threatened some of the nation's most iconic fisheries. For example, rapidly warming waters in the Gulf of Maine have impeded efforts to rebuild the New England cod fishery.[5] In other fisheries, such as that of the Alaskan red king crab, climate-related changes have led to overfishing concerns as target species cluster in the few cold areas that remain.[6] And in Florida, toxic algae linked to coastal pollution and climate change killed so many snook and redfish in 2018 that officials banned their harvest.[7]

One of the most powerful and effective methods for protecting fisheries resources and ocean life is the marine protected area (MPA)—a clearly defined geographic space managed for long-term conservation.[8] While some Pacific island nations have historically closed areas to manage their coastal fisheries,[9] in the 20th century, European and American nations relied on inaccessibility, remoteness, rocky terrain, or the deepness of areas to serve as de facto MPAs.[10] As technology improved and these areas became more accessible to fisheries, the need to protect specific areas and habitats in order to protect fish populations became apparent.

For the past decade, the global community has set ocean protection goals through multiple international mechanisms—mainly Aichi Target 11 in the Convention on Biological Diversity and the United Nation's Sustainable Development Goal 14—with the aim of increasing overall global ocean protection.[11] Each country has the autonomy to designate and manage MPAs within their exclusive economic zone (EEZ), which refers to the area of ocean extending 200 nautical miles from shore in which a coastal nation has jurisdiction over the natural resources. To coordinate this effort and track progress toward national and global goals, countries have taken steps to set common standards. The recently released MPA Guide—a collaboration between the U.N. Environment World Conservation Monitoring Centre and other organizations—outlines the stages of MPA establishment, the varying levels of MPA protection, and the expected conservation outcomes based on an MPA's level of protection.[12]

This issue brief provides an overview of the specific associated benefits that MPAs offer fisheries; discusses when the use of MPAs is and is not appropriate; and details ways to mitigate the economic challenges that MPAs can pose to commercial fishermen. The brief also presents a new analysis of U.S. MPAs—which examines their geographic distribution, size, and level of protection—to make the case for an expansion of the MPA system in the United States.

Spectrum of protections

Similar to land-based protected areas, MPAs exist along a spectrum of protection. The following four classifications—recently described by marine ecologist Kirsten Grorud-Colvert and her colleagues—delineate MPAs based on their level of biodiversity protection and extractive activities.[13]

Minimally protected

Minimally protected MPAs are designated as "protected" but may either allow extensive extraction or lack enforcement, implementation, and active management. While minimally protected MPAs do provide some conservation benefit to an area, it is relatively minimal, as the name implies.[14] For example, Pirajubaé, a marine reserve south of Sao Paulo, Brazil, is considered minimally protected because, post-designation, there have been ongoing and poorly regulated government-approved infrastructure projects that have damaged the area's coastal habitats and fishing grounds, dramatically undermining the MPA's effectiveness.[15]

Lightly protected

Lightly protected MPAs prohibit some extractive activities—such as oil and gas drilling and seabed mining—but allow commercial fishing in some form. The level of protection for this type of MPA is most similar to that of fisheries management areas, which may protect certain species and habitats but still allows for commercial fishing activity.

For example, 160 of the 161 MPAs on the Pacific coast of Canada allow some commercial fishing within their borders but restrict particular types of fishing gear.[16] Similarly, most of the United States' 16 national marine sanctuaries allow some commercial fishing regulated under the Magnuson-Stevens Fishery Conservation and Management Act[17] but prohibit oil and gas drilling.[18] For example, Olympic Coast National Marine Sanctuary off the coast of Washington state prohibits oil and gas drilling, seabed mining, and the U.S. Department of Defense from conducting bombing activities within the area.[19] Another example is the Florida Keys National Marine Sanctuary, where vessel traffic is heavily regulated and oil and gas drilling is prohibited.[20]

Highly protected and fully protected

Both highly protected and fully protected MPAs prohibit any industrial extractive activities within their boundaries, including oil and gas drilling, seabed mining, and commercial fishing. Highly protected MPAs, including the United States' marine national monuments, allow for light extractive activities such as subsistence and recreational fishing. The type and amount of activity allowed is specified in each monument's establishing proclamations, such as the protections put forth in the Papahānaumokuākea proclamation.[21] (see text box below)

Fully protected MPAs—such as the Stewarts Point State Marine Reserve in Northern California[22] and the network of marine reserves in Oregon[23]—prohibit all extractive activity.

The United States' five marine national monuments were designated by presidential proclamation under the Antiquities Act of 1906, which allows the president to set aside public areas for protection.[24]

The Papahānaumokuākea Marine National Monument, initially designated by President George W. Bush in 2006 as the Northwest Hawaiian Islands Marine National Monument, was the first MPA to use the term "marine national monument" and is currently the world's third-largest MPA.[25] Each monument's designation proclamation determines its level of protection from extractive activities, and there is nothing inherent to the designation process that requires certain levels of protection. However, the five existing marine monuments all prohibit commercial extractive activities, which means they are classified as highly protected MPAs.

Protected ocean waters in the United States

Only 4.8 percent of the global ocean is protected by MPAs, with 2 percent of that total designated as highly or fully protected areas.[26] In comparison, more than 15 percent of the world's land area has some form of management or protection.[27]

Approximately 26 percent of the United States' EEZ is protected, of which 23 percent is at least highly protected.[28] However, 97 percent of that area is located in the remote U.S. western Pacific Ocean territory. The 2016 designation of the Northeast Canyons and Seamounts Marine National Monument added some representation on the East Coast, but this area accounts for only slightly more than 1 percent of the entire U.S. Atlantic Ocean territory.[29] While the United States is a global leader in MPA designation, there remains a vast potential for future MPA designations to be spread out among representative habitats and bioregions within U.S. waters.

Fisheries management cannot provide all the conservation benefits of highly and fully protected MPAs

In the United States, there has been considerable debate over the usefulness of highly and fully protected MPAs for fisheries management.[30] Essentially, the question has been whether MPAs are necessary given the United States' existing fisheries management system.[31] This current system has been successful in implementing fishery management plans and rebuilding previously depleted fishery stocks, and these plans play a significant role in ensuring that commercially important species are harvested at sustainable levels.[32]

However, the science is clear: Even the best fisheries management cannot provide all the benefits of a highly or fully protected MPA.[33] As ocean conservation scientist Ellen Pikitch summarized in a 2016 report, highly and fully protected MPAs serve a fundamentally different, and complementary, purpose than fisheries management:

> *"MPAs conserve biodiversity, enhance resilience, enhance fisheries, and act as an insurance policy if other types of fisheries management do not work. They protect and restore endangered species and ecosystems. They are sites for education and research. They can attract tourists and provide alternative livelihoods for communities. The reserves are capable of bringing back life and restoring key processes like water purification and carbon capture. In addition, they play a significant role in protecting and bringing back the large old fish that have always been the engines of reproduction and population replenishment. Animals that live longer are capable of producing more progeny. Reserves can bring them back; conventional fisheries management will not. The more larval and adult offspring there are, the farther afield they will travel, promoting fisheries and building resilience over large areas."*[34]

A healthy ocean with robust, economically viable fisheries requires all the available management tools. Just as MPAs cannot replace fisheries management, fisheries management cannot replace MPAs. Both systems must be used in concert to achieve sustainable and economically viable ocean protections.

How highly to fully protected MPAs benefit fisheries

By providing a refuge for targeted species, a highly to fully protected MPA gives animals inside its boundaries time to grow larger than their counterparts outside of the area. For example, larger fish generally produce more offspring, and this surplus of fish will exit the MPA and help to stock fisheries.[35] This effect is termed "spillover" and can be thought of in similar terms to interest on a savings account: The highly or fully protected MPA protects the "principal," and the fish exiting the MPA are the "interest." One study of spillover from more than a dozen highly and fully protected MPAs found that, in almost all cases, the fisheries outside the MPAs were likely unsustainable without the spillover from populations inside highly or fully protected MPAs.[36]

The beneficial effects of MPAs to fisheries can be best quantified by measuring biomass, numerical density, and organism size.[37]

Biomass

Biomass is the total mass of living biological organisms in a given area at a given time. Abundant evidence has shown that highly and fully protected MPAs promote large, rapid, and sustained buildup of biomass of commercially important species within their boundaries.[38] One meta-analysis of scientific studies showed that biomass of whole fish groups in highly and fully protected MPAs is, on average, six to seven times greater than in adjacent unprotected areas and three to four times greater than in lightly protected MPAs.[39]

Numerical density

Numerical density refers to the number of individuals of a targeted species in a given area. As the number of individuals increases, more and more will exit the protected area and be available to fisheries. One study showed that the density of organisms within highly or fully protected MPAs is more than 1 1/2 times greater than the density in unprotected areas nearby.[40] In Tsitsikamma National Park in South Africa, one of the oldest fully protected MPAs in the world, the density of commercially important fish is around 42 times higher than in the nearby fishing grounds.[41] And on Georges Bank in the Gulf of Maine, after just five years of protection, the densities of legal-sized scallops reached nine to 14 times those of scallops in fished areas.[42]

Another commonly used measure of density is the catch per unit effort (CPUE), which is the total catch divided by the total amount of effort used to harvest the catch.[43] This is considered to be an indirect measure of fisheries stock abundance.

For example, if CPUE is decreasing, fishermen are spending more time catching fewer fish, indicating that stocks are declining. If CPUE is increasing, fishermen are catching more fish in less time, indicating a recovering or healthy stock. One large global study found that fished areas near highly to fully protected MPAs experienced a fourfold increase in CPUE.[44] Another study found that the CPUE of fish traps outside a network of fully protected MPAs in waters off the island nation of St. Lucia increased between 46 and 90 percent within five years of designation.[45]

Organism size

Highly and fully protected MPAs increase average organism size by 28 percent.[46] Organism size is important to fisheries sustainability, since in many commercially important species, larger females release eggs that are larger, more numerous, and higher quality than those of smaller females.[47] This result does not scale with mass, meaning that one large female reproduces more than two smaller females with the same total body mass. For example, in the commercially important Atlantic cod fishery, a single, large 30-kilogram (kg) female produces more eggs than 28 small 2-kg females combined. Moreover, the batch of eggs of the large 30-kg female has 37 times more energy content, which increases the survival of the newly hatched fish.[48]

In another example, the New Zealand snapper fishery saw the benefit of 14 times more fish in fully protected MPAs than in fished areas, making egg production an estimated 18 times higher than outside of the protected area.[49] Similarly, in Edmonds Underwater Park, a fully protected area in the state of Washington, lingcod produced 20 times more eggs and copper rockfish produced 100 times more eggs than their species counterparts outside of the marine park boundary.[50]

For commercially important species, the benefits of a highly to fully protected MPA can mean the difference between a collapsed local fishery and a rapidly recovered one. In Baja California, the local economy is primarily supported by fishing for pink abalone. However, when warming waters and reduced oxygen killed most of the species in 2010, the larger, highly reproductive abalone that survived in the nearby fully protected MPA replenished the abalone stocks for the entire region.[51]

To sum up, highly to fully protected areas provide significant biological benefits, fostering an environment that allows for the growth of larger females that produce more offspring. In turn, these offspring grow up into larger fish, some of which will move away from home and replenish the supply of fish in the surrounding waters. The fish in these replenished waters will attract fishermen who will catch them, thus reaping the benefits of a sustainable supply of larger fish. It is a beneficial circle that starts with a highly or fully protected MPA.

Highly to fully protected MPAs increase biodiversity, which fosters resilience

Highly to fully protected MPAs have been shown to foster greater biodiversity, which is helpful to overall ecosystem health and productivity. In a meta-analysis looking at the role of biodiversity loss on ecosystem services, the data showed that post-designation, levels of biodiversity of fully protected MPAs increased by an average of 23 percent. At the same time, areas adjacent to the MPAs were associated with large increases in fisheries productivity.[52]

Biodiversity has also been shown to enhance the ability of ecosystems to withstand a stress event and recover relatively quickly afterwards.[53] In one example, a fully protected area in New Zealand was able to go from a sea urchin barren—an ecosystem destroyed by overgrazing from an unchecked and exploding population of sea urchins—back to its original kelp forest ecosystem within 12 years of its designation.[54] The shelter offered by the fully protected MPA allowed for an increase in the abundance of sea urchin-eating fish, resulting in an overall increase in local biodiversity.

Research has found that as ocean waters warm and become more acidic, biodiversity can also provide a buffer to climate change. One study that synthesized global, fishery-independent data to test the importance of biodiversity to fish production showed that more diverse fish communities also had a greater resilience to temperature variations.[55]

How highly to fully protected MPAs benefit coastal economies

Economic studies of the value of highly and fully protected MPAs show considerable returns on investment. One comprehensive economic study found that the total value of protecting these areas included benefits to neighboring fisheries, reduced greenhouse gas emissions, establishment of storm buffers, profitable eco-tourism, new MPA management jobs, and gains from new scientific discoveries.[56] Essentially, each $1 invested returns approximately $20 in benefits. This economic study also found that fisheries in medium- to high-decline gained the most from spillover from highly and fully protected MPAs. Another study that looked at the combined economic benefits of MPAs found that both tourism and neighboring fishery profits increased within as little as five years after the reserve was established.[57]

Highly to fully protected MPAs are not a panacea

MPAs—even those that are highly to fully protected—are not a panacea for ocean health or even improved fisheries. They cannot, for instance, protect against invasive species, pollution, or climate change other than through increased ecosystem resilience.[58] For that reason, MPAs are most effective when they are designed and scaled properly to solve a specific goal.

In order to provide benefits to fisheries, successful MPAs across the globe share all or most of the following five key features:

- They are highly to fully protected.
- They are well-enforced.
- They have been established for 10 years or more.
- They are large in size.
- They are isolated by deep water and sand.[59]

MPAs that meet only one or two of these criteria do not provide significant fisheries benefits. Strong fisheries management outside of the highly to fully protected MPA is also necessary to accrue the maximum possible benefits for fisheries and conservation.[60]

When all of these criteria are met and properly implemented, MPAs provide exceptional environmental and economic benefits and are one of the most effective overall methods of sustainable fisheries and marine conservation.

How to engage and support coastal communities and ocean conservation over the long term

Recognize and mitigate the short-term costs to fisheries

MPA supporters tend to focus on the potential long-term benefits to the environment and the economy. However, the short-term costs experienced most acutely by the fishing community are very real and can lead to income losses.[61] One way to gain support from the fishing community is to acknowledge the role of short-term costs; work to mitigate the transitional economic risks associated with highly to fully protected MPAs; and make clear that the long-term viability of fishing is not threatened by designations.

The fishing community often views the long-term benefits of MPAs as high risk since there is no guarantee that the increased productivity associated with MPAs will provide a benefit within a time frame that allows them to remain in business. Moreover, there is little that can be done to prevent some of the major negative effects that can, and often do, result from a temporary loss of income—for example, housing troubles and insurance issues.[62] However, studies have shown that post-designation, income can equal and even surpass pre-designation income within as little as five years.[63]

One approach to alleviating short-term income loss is benefit-sharing between stakeholders. In this method, user fees from nonextractive groups such as tourists provide a source of stabilizing income to local fishermen during the first seasons of designation.[64] For example, in Tubbataha Reefs Natural Park in the Philippines, the benefit share was financed through user fees from divers and dive operators, as well as through grant payments from outside donors.[65] These fees included compensation payments to local

fishermen for lost access to the fully protected MPA. Another crucial component of this model is that local fishermen were granted exclusive access rights to fish in the areas outside the MPA in exchange for their support in enforcing the fully protected MPA.[66]

Other risk-mitigating finance mechanisms can come in the form of short-term government subsidies, low-interest loans, or buyouts. During the late 1990s and early 2000s, as local MPAs were becoming more prevalent, the various states and commonwealths in Australia implemented programs to alleviate lost income due to displaced fishing efforts. Some programs amended fisheries regulations to include compensation programs; others offered voluntary fishing license buyouts; and a few developed complicated structural adjustment programs, which were a combination of financial assistance packages that targeted short-term losses and license buyouts with longer-term effects.[67]

Understand the problems with buyouts and compensation programs

Fishermen are not the only stakeholders in these areas. Seafood processors, equipment suppliers, and related industries within the community may also experience negative outcomes from a designation. As with fishery disaster designation, potential compensation programs must therefore consider how large a social safety net should be cast. The opportunity costs of not designating MPAs should also be considered—for example, how much income the tourism industry is forgoing or the impact that the closure could have on the local indigenous community. The designation process should therefore include all stakeholders and determine the most fair methods for meeting their needs and addressing their concerns.[68]

Take time to build trust

Including local communities and fishermen in the designation process is key. As discussed above, the fishing community was part of the success of Tubbataha Reefs Natural Park in the Philippines. After a few years of faltering success post-designation, stakeholder workshops and listening sessions were able to move past grievances and begin to lay the groundwork for eventual buy-in.[69]

In the case of the highly protected Marianas Trench Marine National Monument, designation was done with significant support from indigenous and local communities as well as the government.[70] After substantial public input, the monument was designed to allow for subsistence, recreational, and traditional indigenous fishing as long as the activity was determined to be sustainable. Although it was not unanimous, many small-boat fishermen in the islands were supportive of this level of protection.[71] However, the Western Pacific Regional Fishery Management Council (WESPAC), which largely represents the interests of the Pacific longline fleet, was not supportive, despite minimal levels of commercial fishing in the monument area.[72] There was also pushback from the Washington, D.C.-based recreational fishing lobby.[73] The successful designation of the Marianas Trench Marine National Monument shows that strong local support can overcome resistance from nonlocal interests.

However, local process has its limits. The designation of the Northeast Canyons and Seamounts Marine National Monument was a huge step forward for protection in the New England region, which up until that point, had no highly to fully protected areas. Following numerous meetings with representatives of the commercial fishing industry, designators incorporated fishermen's suggestions, including the removal of the Cashes Ledge area from monument status consideration; the division of the Northeast Canyons and Seamounts area into two separate components rather than a single unit; a 60 percent decrease in the size of the Canyon Unit compared with the original proposal; and an unprecedented seven-year phase-in of regulations for lobstermen and crabbers.[74] Yet despite these significant changes, there was and continues to be considerable pushback from the local fishing community, with one fishing association even questioning the legality of the monument in court.[75]

Even with strong scientific evidence for the benefits for MPAs and integrated consultation, there will likely always be those who cannot be persuaded to support MPA designations. In the Pacific, WESPAC has argued that vessels have lost tens of millions of dollars as a result of these protected areas, but since the tuna fleets have consistently maximized their fishing capacity and caught all the fish they are allowed to catch each year, the data do not support these claims.[76] In the case of Northeast Canyons and Seamounts, there is deep-rooted, long-standing animosity between federal regulators and commercial fishing interests in New England, so any kind of government action—MPA designation or otherwise—would most likely lack the fishing community's support.

A path forward: Protecting key ecosystems across the lower 48

Current status of MPAs in the United States

The Center for American Progress analyzed the size, location, level of protection, and designation type for all MPAs in the United States. (see Methodology for more details) After assigning each MPA to geographic regions that approximately correspond to the areas managed by the eight regional fisheries management councils—regional stakeholder councils that assist the National Oceanic and Atmospheric Administration in fisheries management—CAP found that the U.S. MPA system is dominated by a few very large, very remote monuments.[77] Ninety-seven percent of all MPA area is in the West Pacific, and 99 percent of all highly to fully protected MPA area is located in this remote area. (see Figure 1a and 1b)

Only five of the eight major regions have any areas at all that are highly to fully protected. Three areas—the Gulf of Mexico, the mid-Atlantic, and the North Pacific—have no MPAs that are highly to fully protected. The combined area of highly to fully protected MPAs outside of the West Pacific accounts for less than 1 percent of the total. Moreover, 84 percent of that tiny percentage is located in the Northeast Canyons and Seamounts Marine National Monument.

FIGURE 1A

Percentage distribution of marine protected areas (MPAs), by region

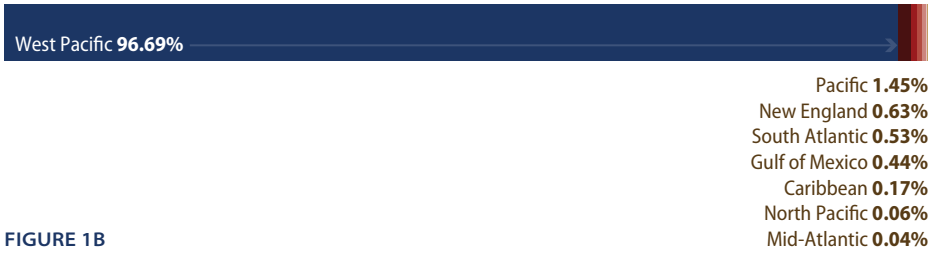


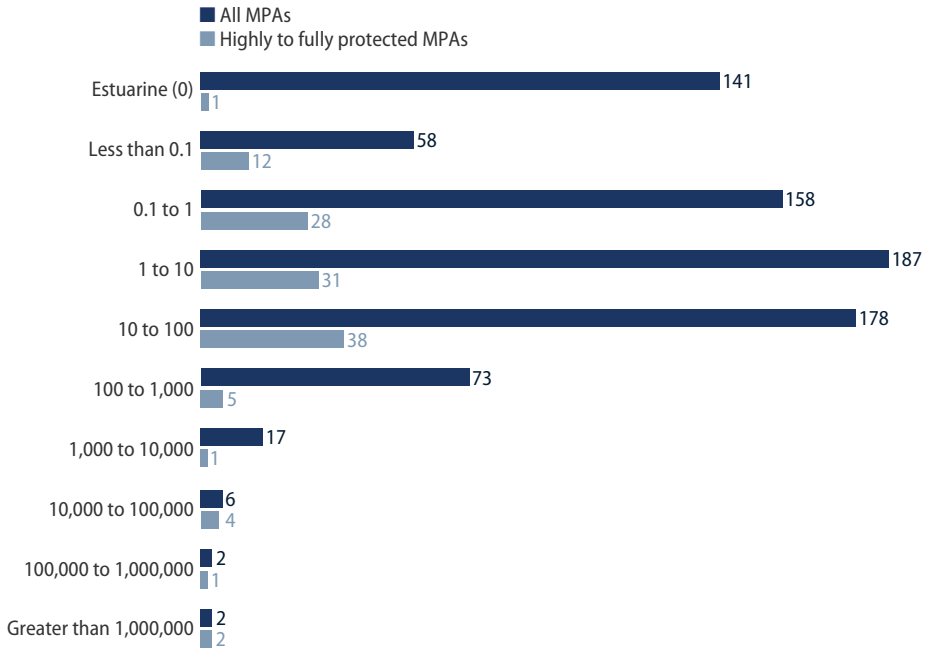
FIGURE 1B

Percentage distribution of highly to fully protected marine protected areas (MPAs), by region

Source: Center for American Progress analysis of Marine Conservation Institute, "MPAtlas," available at http://mpatlas.org/map/mpas/ (last accessed May 2019).

FIGURE 2

The number of U.S. marine protected areas (MPAs), by size range (in square kilometers)

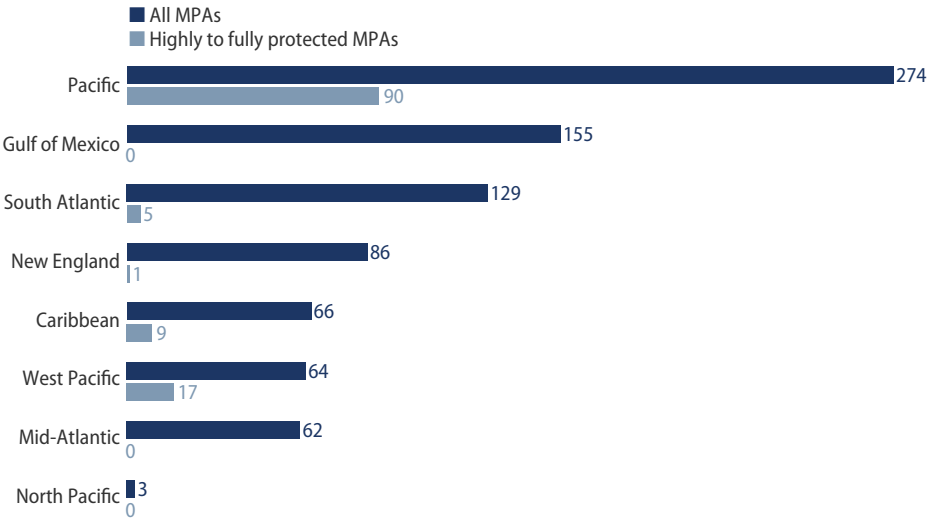


Source: Center for American Progress analysis of Marine Conservation Institute, "MPAtlas," available at http://mpatlas.org/map/mpas/ (last accessed May 2019).

Overall, U.S. MPA size is relatively small. (see Figure 2) Seventy percent of all U.S. MPAs are less than 100 square kilometers in area—smaller than the city of Washington, D.C. Moreover, only 27 out of 822 U.S. MPAs, or 3 percent, are greater than 1,000 square kilometers in area. The Pacific coast—the area off of California, Oregon, and Washington—has the greatest number of total MPAs as well as the greatest number of highly to fully protected MPAs. (see Figure 3) The Gulf of Mexico and the South Atlantic also have relatively high numbers of MPAs, though most are lightly protected.

FIGURE 3

The number of U.S. marine protected areas (MPAs), by region



Source: Center for American Progress analysis of Marine Conservation Institute, "MPAtlas," available at http://mpatlas.org/map/mpas/ (last accessed May 2019).

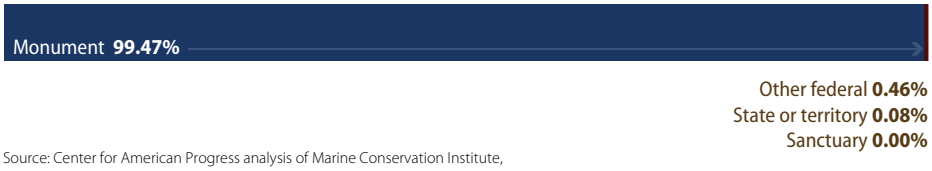
Marine national monuments account for 96 percent of all MPA area in the United States and more than 99 percent of highly to fully protected U.S. MPA area. (see Figures 4a and 4b) State and territorial MPAs are the most numerous, as there are 639, but they tend to be lightly protected and their total area adds up to less than 1 percent of the whole. Other federal mechanisms such as national marine sanctuaries and national wildlife refuges account for the rest of the areas under protection.

FIGURE 4A

Percentage area of U.S. marine protected areas (MPAs), by designation type

FIGURE 4B

Percentage area of highly to fully protected U.S. marine protected areas (MPAs), by designation type



Source: Center for American Progress analysis of Marine Conservation Institute, "MPAtlas," available at http://mpatlas.org/map/mpas/ (last accessed May 2019).

Moving forward

Currently, in the United States, two major MPA policy approaches have found success and been proven to provide benefits to fishermen and other local stakeholder communities. One approach involves large, relatively remote marine national monuments that are mostly highly to fully protected. If highly to fully protected MPAs are well-designed, they will provide environmental and economic benefits.[78] However, large MPAs can encompass entire ecosystems and interdependent habitats.[79] Large MPAs are also better able to resist large-scale disturbances such as those caused by climate change, as well as other man-made and environmental disturbances. Such resiliency can help local fisheries bounce back more rapidly after these events.[80]

Another successful approach includes multiuse networks of small MPAs. The most prominent example is the network of MPAs in California state waters created by the state's Marine Life Protection Act.[81] California's MPAs are much smaller in size than the marine national monuments, but they are notable for their nearness to shore, the significant involvement of the fishing community, and the spectrum of protections that they offer. The West Coast fishing community is beginning to see the benefits of this approach, with heavily overfished rockfish stocks rebuilding faster than anticipated.[82]

As climate change drives unprecedented change across the ocean, MPAs are one of the United States' most powerful tools to protect each region's unique biodiversity, fisheries, and way of life. The international community has been calling for individual countries to protect 30 percent of each marine habitat within their territorial waters by 2030.[83] CAP strongly recommends that the United States move beyond a goal of 30 percent total and toward one that would protect 30 percent of each major geographic region. Given the benefits of highly to fully protected MPAs and the fact that the vast majority of U.S. waters outside the remote Pacific have relatively minimal protection, the focus should be on ensuring that all key regions and ecosystems receive designations that are more representative of the unique and important habitats within U.S. waters.

Margaret Cooney is the campaign manager for Ocean Policy at the Center for American Progress. Miriam Goldstein is the managing director for Energy and Environment and the director of Ocean Policy at the Center. Emma Shapiro is a former intern for Public Lands and Ocean Policy at the Center.

The authors would like to thank Dr. Jane Lubchenco, a university distinguished professor and marine studies adviser to the president at Oregon State University; Amy Kenney, from the National Ocean Protection Coalition; Angelo O'Connor Villagomez, a senior officer for Pew Bertarelli Ocean Legacy at the Pew Charitable Trusts; Alexandra Carter, a policy analyst at the Center; Michael Madowitz, an economist at the Center; Beth Pike, database manager for the Atlas of Marine Protection at the Marine Conservation Institute; and Carl Chancellor, Christian Rodriguez, Steve Bonitatibus, and Chester Hawkins on CAP's production team for their contributions.

Methodology

The authors' analysis of the current state of MPAs in the United States is based on data provided both by the MPAtlas database and directly by the Marine Conservation Institute (MCI).[84] These data include a list of every MPA in the United States and each MPA's calculated marine area, its highly to fully protected status, and the area that is highly to fully protected within the MPA in cases where it differs from the MPA's overall calculated marine area.

Using maps of the eight U.S. regional fishery management councils and the MPAtlas tool, the authors assigned each MPA to the most appropriate regional council area.[85] They also assigned each MPA to a designation type: "monument," "sanctuary," "state or territory," and "other federal." The "other federal" category includes federal designation types such as national wildlife refuges (NWRs) and the National Estuarine Research Reserve System.

For several of the Pacific monuments, NWRs are nested within various areas of the monuments' units. These include two of the Marianas Trench Marine National Monument's three units, Rose Atoll Marine National Monument, and Papahānaumokuākea Marine National Monument. In the base data, these are counted as two separate MPAs, but with fully overlapping areas. To avoid double-counting protected areas, the authors used the calculated marine area for the monuments only. While these nested NWRs are excluded from area calculations, they are included in numerical counts. Because the NWR areas were designated independently from the monuments, they are classified as "other federal" in the authors' designation-type analysis.

For the Pacific Remote Islands Marine National Monument, the MCI had separated the associated area protected as NWRs from the area protected by the monument, so these are also separated in the authors' analysis.

Endnotes

1 National Ocean Service, "What percentage of the American population lives near the coast?", available at https://oceanservice.noaa.gov/facts/population.html (last accessed May 2019); Office for Coastal Management, "Ocean Jobs," available at https://coast.noaa.gov/states/fast-facts/ocean-jobs.html (last accessed May 2019).

2 National Marine Fisheries Service, "Fisheries Economics of the United States," available at https://www.fisheries.noaa.gov/national/commercial-fishing/fisheries-economics-united-states (last accessed May 2019); Kendra Pierre-Louis, "California's Underwater Forests Are Being Eaten by the 'Cockroaches of the Ocean'," *The New York Times*, October 22, 2018, available at https://www.nytimes.com/2018/10/22/climate/kelp-climate-change-california.html; Summer Meza, "Half of Hawaii's Coral Reefs Were Damaged in One Year, and the Worst Is yet to Come," *Newsweek*, November 4, 2017, available at https://www.newsweek.com/hawaii-half-coral-reefs-bleached-702058.

3 National Oceanic and Atmospheric Administration, "Gulf of Mexico 'dead zone' is the largest ever measured," August 2, 2017, available at https://www.noaa.gov/media-release/gulf-of-mexico-dead-zone-is-largest-ever-measured.

4 José G.B. Derraik, "The pollution of the marine environment by plastic debris: a review," *Marine Pollution Bulletin* 44 (9) (2002): 842–852, available at https://doi.org/10.1016/S0025-326X(02)00220-5; Melanie Bergmann and others, "High Quantities of Microplastic in Arctic Deep-Sea Sediments from the HAUSGARTEN Observatory," *Environmental Science & Technology* 51 (19) (2017): 11000–11010, available at https://doi.org/10.1021/acs.est.7b03331.

5 Marianne Lavelle, "Collapse of New England's iconic cod tied to climate change," *Science*, October 29, 2015, available at https://www.sciencemag.org/news/2015/10/collapse-new-england-s-iconic-cod-tied-climate-change.

6 Avery Siciliano and others, "Warming Seas, Falling Fortunes: Stories of Fishermen on the Front Lines of Climate Change" (Washington: Center for American Progress, 2018), available at https://www.americanprogress.org/issues/green/reports/2018/09/10/457649/warming-seas-falling-fortunes/.

7 Florida FISH and Wildlife Conservation Commission, "FWC makes snook, redfish temporarily catch-and-release only in areas affected by red tide," Press release, August 30, 2018, available at https://content.govdelivery.com/accounts/FLFFWCC/bulletins/209b884.

8 World Commission on Protected Areas, "Applying IUCN's Global Conservation Standards to Marine Protected Areas (MPA)" (Gland, Switzerland: International Union for Conservation of Nature, 2018), available at https://www.iucn.org/sites/dev/files/content/documents/applying_mpa_global_standards_final_version_050418.pdf.

9 R.E. Johannes, "Traditional Marine Conservation Methods in Oceania and Their Demise," *Annual Reviews of Ecology, Evolution, and Systematics* 9 (1978): 349–364, available at https://georgehbalazs.com/wp-content/uploads/2019/01/Johannes_1978_TraditionalMarineConservationMethods-OceaniaDemise-2.pdf.

10 National Research Council, *Marine Protected Areas: Tools for Sustaining Ocean Ecosystems* (Washington: National Academies Press, 2001), Chapter 8.

11 Convention on Biological Diversity, "Target 11 - Technical Rationale extended," available at https://www.cbd.int/sp/targets/rationale/target-11/ (last accessed May 2019); U.N. Statistics Division, "Goal 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development," available at https://unstats.un.org/sdgs/report/2016/goal-14/ (last accessed May 2019).

12 U.N. Environment World Conservation Monitoring Centre and others, "An Introduction to the MPA Guide" (2019), available at https://www.dropbox.com/s/fyyttxbg7xuifjf/Introduction%20to%20the%20MPA%20Guide_2019_web_single%20pages.pdf?dl=0.

13 Kirsten Grorud-Colvert and others, "High-profile international commitments for ocean protection: Empty promises or meaningful progress?", *Marine Policy* 105 (2019): 52–66, available at https://www.sciencedirect.com/science/article/pii/S0308597X18307371.

14 Alexis N. Rife and others, "When good intentions are not enough … Insights on networks of 'paper park' marine protected areas. *Conservation Letters* 6 (3) (2013): 200–212, available at https://onlinelibrary.wiley.com/doi/full/10.1111/j.1755-263X.2012.00303.x.

15 Daniel Cressey, "Uncertain sanctuary," *Nature* 480 (7376) (2011): 166–167, available at https://www.nature.com/polopoly_fs/1.9568!/menu/main/topColumns/topLeftColumn/pdf/480166a.pdf.

16 Carolyn K. Robb and others, "Commercial fisheries closures in marine protected areas on Canada's Pacific coast: The exception, not the rule," *Marine Policy* 35 (3) (2011): 309–316, available at https://doi.org/10.1016/j.marpol.2010.10.010.

17 National Marine Fisheries Service, "Laws & Policies: Magnuson-Stevens Act," available at https://www.fisheries.noaa.gov/topic/laws-policies (last accessed May 2019).

18 Office of National Marine Sanctuaries, "National Marine Sanctuaries Socioeconomics Factsheet: National marine sanctuaries are centers for strong local economies and have economic value reaching far beyond the water" (Washington: National Oceanic and Atmospheric Administration, 2011), available at https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/science/socioeconomic/pdfs/onms-socioeconomics-summary.pdf; Office of National Marine Sanctuaries, "National Marine Sanctuaries and Local Economies," available at https://sanctuaries.noaa.gov/science/socioeconomic/factsheets/welcome.html (last accessed February 2019).

19 Office of National Marine Sanctuaries, "Olympic Coast National Marine Sanctuary: Sanctuary Regulations," available at https://olympiccoast.noaa.gov/protect/regulations/regulations.html (last accessed May 2019).

20 Florida Keys National Marine Sanctuary and Protection Act, Public Law 605, 101st Cong., 2nd sess. (November 16, 1990), available at https://floridakeys.noaa.gov/about/fknmsp_act.html (last accessed May 2019).

21 The White House, "Presidential Proclamation -- Papahanaumokuakea Marine National Monument Expansion," Press release, August 26, 2016, available at https://obamawhitehouse.archives.gov/the-press-office/2016/08/26/presidential-proclamation-papahanaumokuakea-marine-national-monument.

22 MPAtlas.org, "Stewarts Point: State Marine Reserve," available at http://mpatlas.org/mpa/sites/7653/ (last accessed February 2019).

23 Oregon Marine Reserves, "Home," available at http://oregonmarinereserves.com/ (last accessed February 2019).

24 American Antiquities Act of 1906, Public Law 209, 59th Cong., 1 sess. (June 8, 1906), available at https://www.nps.gov/history/local-law/anti1906.htm.

25 Protected Planet, "October update of the WDPA," available at https://www.protectedplanet.net/c/monthly-updates/2017/october-update-of-the-wdpa (last accessed May 2019).

26 MPAtlas.org, "Global MPAs," available at http://mpatlas.org/map/mpas/ (last accessed August 2018).

27 U.N. Environment World Conservation Monitoring Centre and International Union for Conservation of Nature, "Protected Planet Report 2016" (Nairobi: U.N. Environment Programme, 2016), available at https://wdpa.s3.amazonaws.com/Protected_Planet_Reports/2445%20Global%20Protected%20Planet%202016_WEB.pdf.

28 MPAtlas.org, "United States (USA)," available at http://www.mpatlas.org/region/country/USA/ (last accessed October 2018).

29 Bureau of Ocean Energy Management, "Atlantic OCS Facts and Figures," available at https://www.boem.gov/Atlantic-OCS-Facts-and-Figures/ (last accessed January 2019).

30 Robert L. Shipp, "A Perspective on Marine Reserves as a Fishery Management Tool," *Fisheries* 28 (12) (2003): 10–21, available at https://doi.org/10.1577/1548-8446(2003)28[10:APOMRA]2.0.CO;2.

31 Sean Horgan, "Fish reps to Trump: Marine monuments make it harder to manage industry, fish reps say," *Gloucester Daily Times*, March 27, 2017, available at https://www.gloucestertimes.com/news/fishing_industry_news/fish-reps-to-trump-marine-monuments-make-it-harder-to/article_6547b82b-1a4d-583e-8e00-74ea046a6b3f.html.

32 National Marine Fisheries Service, "Laws & Policies: Magnuson-Stevens Act."

33 Graham J. Edgar, Trevor J. Ward, and Rick D. Stuart-Smith, "Rapid declines across Australian fishery stocks indicate global sustainability targets will not be achieved without an expanded network of 'no-fishing' reserves," *Aquatic Conservation: Marine and Freshwater Ecosystems* 28 (6) (2018): 1337–1350, available at https://onlinelibrary.wiley.com/doi/pdf/10.1002/aqc.2934.

34 Ellen Pikitch, "A Primer on Marine Protected Areas: Background for the 10x20 Conference" (Ocean Sanctuary Alliance, 2016), available at https://www.sprep.org/attachments/VirLib/Regional/mpa-primer2016.pdf.

35 Diego R. Barneche and others, "Fish reproductive-energy output increases disproportionately with body size," *Science* 360 (6389) (2018): 642–645, available at https://science.sciencemag.org/content/sci/360/6389/642.full.pdf; Raquel Goñi, Fabio Badalamenti, and Mark H. Tupper, "Fisheries — Effects of marine protected areas on local fisheries: evidence from empirical studies," in Joachim Claudet, ed., *Marine Protected Areas: A Multidisciplinary Approach* (Cambridge, United Kingdom: Cambridge University Press, 2001), available at https://www.academia.edu/34045857/Effects_of_marine_protected_areas_on_local_fisheries_evidence_from_empirical_studies.

36 Benjamin S. Halpern, Sarah E. Lester, and Julie B. Kellner, "Spillover from marine reserves and the replenishment of fish stocks," *Environmental Conservation*, 36 (4) (2010): 268–276, available at https://darchive.mblwhoilibrary.org/bitstream/handle/1912/3891/Halpern_etal_2010_EnvCons.pdf?sequence=1.

37 Sarah E. Lester and others, "Biological effects within no-take marine reserves: a global synthesis," *Marine Ecology Progress Series* 384 (2009): 33–46, available at https://www.int-res.com/articles/meps2009/384/m384p033.pdf.

38 Fiona R. Gell and Callum M. Roberts, "Benefits beyond boundaries: the fishery effects of marine reserves," *Trends in Ecology and Evolution* 18 (9) (2003): 448–455, available at https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(03)00189-7?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0169534703001897%3Fshowall%3Dtrue; Lester and others, "Biological effects within no-take marine reserves: a global synthesis."

39 Enric Sala and Sylvaine Giakoumi, "No-take marine reserves are the most effective protected areas in the ocean," *ICES Journal of Marine Science* 75 (3) (2018): 1166–1168, available at https://academic.oup.com/icesjms/article/75/3/1166/4098821.

40 Lester and others. "Biological effects within no-take marine reserves: a global synthesis."

41 C.D. Buxton, and M.J. Smale, "Abundance and Distribution Patterns of Three Temperate Marine Reef Fish (Teleostei: Sparidae) in Exploited and Unexploited Areas Off the Southern Cape Coast," *Journal of Applied Ecology* 26 (2) (1989): 441–451, available at https://www.jstor.org/stable/pdf/2404072.pdf?seq=1 - page_scan_tab_contents.

42 S.A. Murawski and others, "Large-scale closed areas as a fisheries management tool in temperate marine systems: the Georges Bank experience," *Bulletin of Marine Science* 66 (2000): 775–798.

43 Food and Agriculture Organization of the United Nations, "Section 4. Effort and Catch per Unit Effort," available at http://www.fao.org/docrep/x5685e/x5685e04.htm (last accessed October 2018).

44 Boris Worm and others, "Impacts of Biodiversity Loss on Ocean Ecosystem Services," *Science* 314 (2006): 787–790, available at https://www3.epa.gov/region1/npdes/schillerstation/pdfs/AR-024.pdf.

45 Callum M. Roberts and others, "Effects of Marine Reserves on Adjacent Fisheries," *Science* 294 (5548) (2001): 1920–1923, available at https://science.sciencemag.org/content/294/5548/1920.

46 Lester and others, "Biological effects within no-take marine reserves: a global synthesis."

47 Barneche and others, "Fish reproductive-energy output increases disproportionately with body size."

48 Ibid.

49 Trevor J. Willis, Russell B. Millar, and Russ C. Babcock, "Protection of exploited fishes in temperate regions: high density and biomass of snapper *Pagrus auratus* (Sparidae) in northern New Zealand marine reserves," *Journal of Applied Ecology* 40 (2003): 214–227, available at https://pdfs.semanticscholar.org/9194/e92309612dba1a183153dff7bb40eba6a7e9.pdf.

50 Wayne A. Palsson and Robert E. Pacunski, "The Response of Rocky Reef Fishes to Harvest Refugia in Puget Sound," in Elizabeth Robichaud, ed., *Puget Sound Research '95 Proceedings* (Olympia, WA: Puget Sound Water Quality Authority, 1995).

51 Fiorenza Micheli and others, "Evidence That Marine Reserves Enhance Resilience to Climatic Impacts," *PLoS ONE* 7 (7) (2012): e40832, available at https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0040832&type=printable.

52 Worm and others, "Impacts of Biodiversity Loss on Ocean Ecosystem Services."

53 A. Randall Hughes and John J. Stachowicz, "Genetic diversity enhances the resistance of a seagrass ecosystem to disturbance," *Proceedings of the National Academy of Sciences* 101 (24) (2004): 8998–9002, available at https://www.pnas.org/content/pnas/101/24/8998.full.pdf; Thorsten B.H. Reusch and others, "Ecosystem recovery after climatic extremes enhanced by genotypic diversity," *Proceedings of the National Academy of Sciences* 102 (8) (2005): 2826–2831, available at https://www.pnas.org/content/pnas/102/8/2826.full.pdf.

54 Nick T. Shears and Russell C. Babcock, "Continuing trophic cascade effects after 25 years of no-take marine reserve protection," *Marine Ecology Progress Series* 246 (2003): 1–16, available at https://www.int-res.com/articles/meps2003/246/m246p001.pdf.

55 J. Emmett Duffy and others, "Biodiversity enhances reef fish biomass and resistance to climate change," *Proceedings of the National Academy of Sciences* 113 (22) (2016): 6230–6235, available at https://www.ncbi.nlm.nih.gov/pubmed/27185921.

56 Luke Brander and others, "The benefits to people of expanding Marine Protected Areas" (Amsterdam: Institute for Environmental Studies, 2015), available at https://www.issuelab.org/resources/25951/25951.pdf?download=true&_ga=2.227198557.1167454837.1558640107-1857028723.1558640107.

57 Enric Sala and others, "A General Business Model for Marine Reserves," *PLoS ONE* 8 (4) (2013): e58799, available at https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0058799&type=printable.

58 Gary W. Allison, Jane Lubchenco, and Mark H. Carr, "Marine Reserves are Necessary but not Sufficient for Marine Conservation," *Ecological Applications* 8 (1) (1998), S79–S92, available at https://doi.org/10.2307/2641365.

59 Graham J. Edgar and others, "Global conservation outcomes depend on marine protected areas with five key features," *Nature* 506 (7487) (2014): 216–220, available at https://doi.org/10.1038/nature13022.

60 Bethan C. O'Leary and others, "Addressing Criticisms of Large-Scale Marine Protected Areas," *BioScience* 68 (5) (2018): 359–370, available at https://academic.oup.com/bioscience/article/68/5/359/4953612.

61 Sala and others, "A General Business Model for Marine Reserves."

62 Martin D. Smith and others, "Political economy of marine reserves: Understanding the role of opportunity costs," *Proceedings of the National Academy of Sciences* 107 (43) (2010): 18300–18305, available at https://www.pnas.org/content/pnas/107/43/18300.full.pdf.

63 Manfredi Di Lorenzo, Joachim Claudet, and Paolo Guidetti, "Spillover from marine protected areas to adjacent fisheries has an ecological and a fishery component," *Journal for Nature Conservation* 32 (2016): 62–66, available at https://www.sciencedirect.com/science/article/pii/S1617138116300255.

64 Jane Lubchenco and Kirsten Grorud-Colvert, "Making waves: The science and politics of ocean protection," *Science* 350 (6259) (2015): 1–7, available at https://www.researchgate.net/publication/282913037_Making_waves_The_science_and_politics_of_ocean_protection.

65 Edgardo E. Tongson, "Payments for Seascape Beauty: The Case of Tubbataha Reef National Marine Park," in Jose E. Padilla, Edgardo E. Tongson, and Rodel D. Lasco, eds., *PES, Sustainable Financing for Conservation and Development: Proceedings from the National Conference-Workshop on Payments for Environmental Services: Direct Incentives for Biodiversity Conservation and Poverty Alleviation* (2005), pp. 133–143.

66 Florian Matt and Ronny Gebser, "Benefit sharing as key to conserving the Tubbataha Reefs, Philippines" (Geneva: The Economics of Ecosystems and Biodiversity, 2011), available at https://www.cbd.int/financial/fiscalenviron/philippines-fiscalfee.pdf.

67 Sevaly Sen, "Developing a framework for displaced fishing effort programs in marine protected areas," *Marine Policy* 34 (6) (2010): 1171–1177, available at https://www.researchgate.net/publication/227420122_Developing_a_framework_for_displaced_fishing_effort_programs_in_marine_protected_areas.

68 Ibid.

69 Marivel Dygico, "Tubbataha Reefs: A Marine Protected Area That Works" (Quezon City, Philippines: WWF-Philippines, 2006), available at https://www.mpaaction.org/sites/default/files/WWF_Ph_TubbatahaCaseStudy_2008.pdf.

70 Angelo O'Connor Villagomez, senior officer, Pew Bertarelli Ocean Legacy at the Pew Charitable Trusts, personal communication via email, May 1, 2019, on file with author.

71 Ibid.

72 The American longline fleet is based 4,000 miles away out of Honolulu and rarely ventures even close to the waters in question. See Ibid.

73 Villagomez, personal communication with author.

74 Michael Conathan and Avery Siciliano, "Big Oil Could Benefit Most from Review of Northeast Canyons and Seamounts Monument" (Washington: Center for American Progress, 2017), available at https://www.americanprogress.org/issues/green/reports/2017/07/25/436441/big-oil-benefit-review-northeast-canyons-seamounts-monument/.

75 *Massachusetts Lobstermen's Association v. Ross*, complaint against all defendants, U.S. District Court for the District of Columbia, No. 1:17-cv-00406 (May 7, 2017), available at https://www.courtlistener.com/docket/4614951/massachusetts-lobstermens-association-v-ross-jr/.

76 Pacific Islands Fisheries Science Center, "The Hawaii-based Longline Logbook Summary Report January–December 2013" (Honolulu: 2014), available at https://www.pifsc.noaa.gov/library/pubs/DR-14-016.pdf.

77 U.S. Regional Fishery Management Councils, "Conserving and Managing the Fisheries of the United States," available at http://www.fisherycouncils.org/ (last accessed February 2019).

78 Benjamin S. Halpern, "The Impact of Marine Reserves: Do Reserves Work and Does Reserve Size Matter?", *Ecological Applications* 13 (1) (2003): S117–S137, available at https://pdfs.semanticscholar.org/d85a/38449c445ccd224a47c88b5092ab3ea53984.pdf.

79 Edgar and others, "Global conservation outcomes depend on marine protected areas with five key features."

80 O'Leary and others, "Addressing Criticisms of Large-Scale Marine Protected Areas."

81 California Legislative Information, "Chapter 10.5. Marine Life Protection Act [2850 - 2863] (Chapter 10.5 added by Stats. 1999, Ch. 1015, Sec. 1.)," available at http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=FGC&division=3.&title=&part=&chapter=10.5.&article= (last accessed May 2019).

82 Lois Sahagun, "Rockfish make a remarkable recovery off California coast, prompting federal officials to raise catch limits," *Los Angeles Times*, December 11, 2018, available at https://www.latimes.com/local/california/la-me-rockfish-restrictions-lifted-20181211-story.html.

83 World Commission on Protected Areas, "Applying IUCN's Global Conservation Standards to Marine Protected Areas (MPA)."

84 MPAtlas.org, "Global MPAs."

85 U.S. Regional Fishery Management Council, "Conserving and Managing the Fisheries of the United States."