NATIONAL MARINE SANCTUARY DESIGNATION

FOR THE

MARIANAS TRENCH MARINE NATIONAL MONUMENT

Completing an Environmental Legacy

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This snail photographed off the coast of Pagan is almost certainly a new species. *NOAA Office of Ocean Exploration and Research*

Contents

Executive Summary

- The Marianas Trench Marine National Monument was established by President Bush on January 6, 2009 and protects over 95,000 square miles of seafloor and waters in the Mariana Archipelago.

- The Monument consists of three units: the **Islands Unit** which protects the seafloor and waters around the three northernmost Mariana Islands, Farallon de Pajaros or Uracas, Maug, and Asuncion; the **Volcanic Unit**, which protects the seafloor surrounding 21 volcanic sites of exceptional scientific and conservation value; and the **Trench Unit**, which protects the seafloor east of the archipelago inside the US Exclusive Economic Zone from north of Uracus to south of Guam.

- Only the **Island Unit** includes the water column in its protective scope, protection within both the **Volcanic** and **Trench Units** is limited to the seafloor.

- The Bush Administration's proclamation included a mandate to create a management plan for the Marianas Trench National Monument following establishment. As of December 1, 2016, a management plan has neither been completed nor put forward for public review.

- There is an opportunity for the Obama Administration to use the National Marine Sanctuaries process to create a sanctuary in the Commonwealth of the Northern Mariana Islands (CNMI), building upon a cultural, scientific, and environmental legacy for future generations.

- CNMI Delegate Gregorio Camacho “Kilili” Sablan and Governor Ralph Deleon Guerrero Torres wrote to President Obama in September 2016 asking to begin a sanctuary process in the Northern Mariana Islands, specifically to enhance the existing Marianas Trench Marine National Monument

- Since 2009, The Friends of the Marianas Trench have written several times to NOAA to ask for OMNS involvement in the management of the Marianas Trench Marine National Monument, and to enhance the protections afforded the Marianas Trench and the surrounding area, specifically asking to enhance the scope of the **Volcanic** and **Trench Units** to include the water column as well as the seafloor.

- Key ecosystems that would benefit from protection include blue water pelagic regions, shallow and deep-water coral reefs, seamounts, hydrothermal vents, mud volcanoes, cold seeps, and abyssal and hadal communities.

- The Mariana Trench is a region of significant historic value. It was first sounded by the Challenger Expedition and was the site of the Bathyscaph Trieste dive to the bottom of Challenger Deep, the deepest point in the ocean.

- Marine protected areas are most effective when they are large, remote, and comprehensively protected and managed. Expanding the monument to include the water column would enhance wildlife conservation, improve ecosystem health, and increase climate change resiliency.

- A scientific study published in November 2016 has identified the waters around the Marianas and Samoan Islands as the top marine conservation priorities within the United States Exclusive Economic Zone.

- The Office of National Marine Sanctuaries (OMNS) is one of the few federal programs that has, in their enabling legislation, a mandate to conduct educational and research programs, as well as resource protection. OMNS has the history and experience to operate the visitor centers and volunteer programs that were discussed when the monument was established.

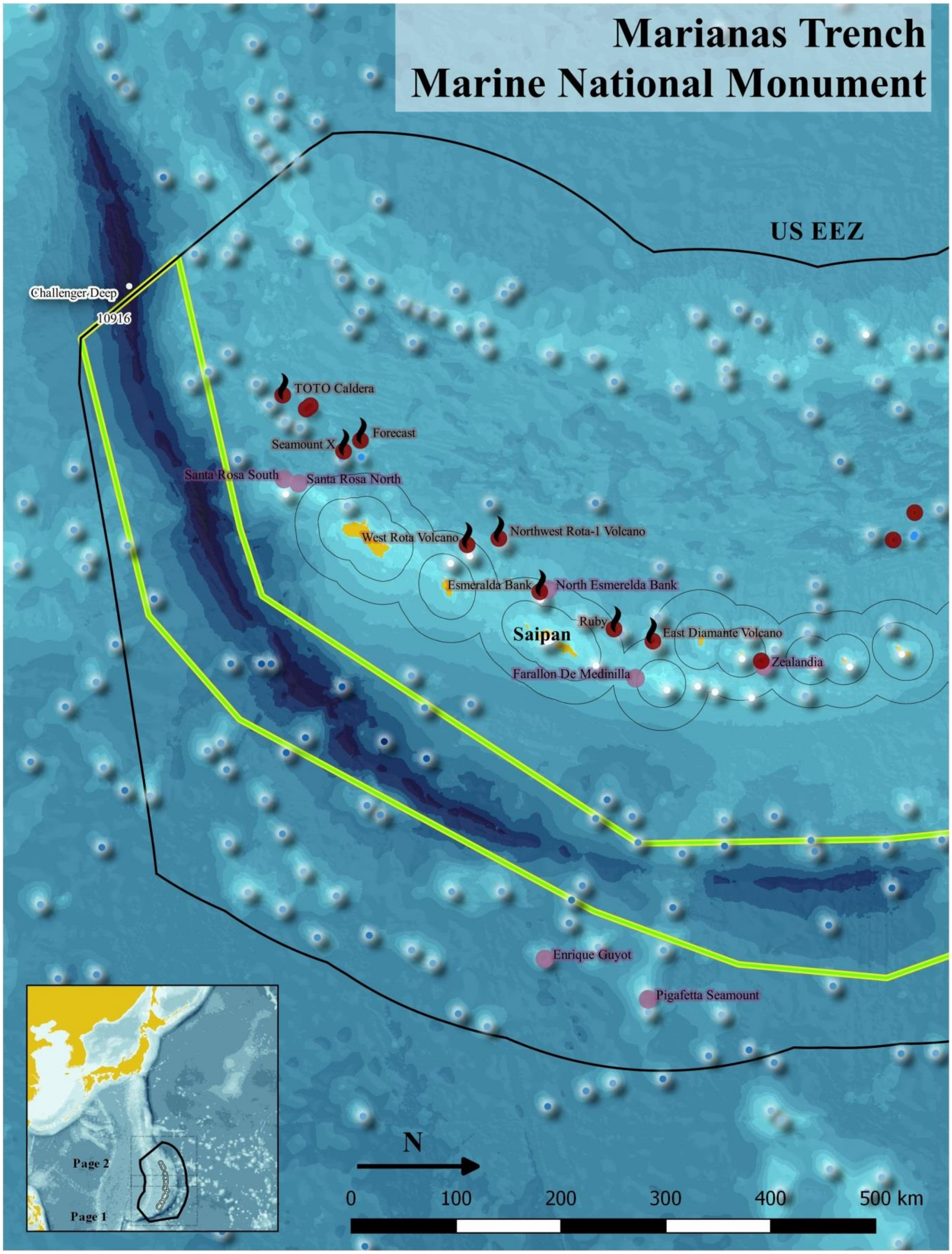

NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas

Background

The Obama Administration built a legacy of ocean protection unrivaled by any president in American history. One of the first acts of his administration was to develop the National Policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes, implemented in 2013. This National Ocean Policy provided a broad framework for interagency cooperation to address critical ocean issues, promote state and community involvement in federal decisions, streamline federal operations, and promote economic growth[1].

The Administration improved and expanded three of the four Pacific marine national monuments designated by former President George W. Bush. In 2012, the Administration expanded the 0.25 square miles Fagatele Bay National Marine Sanctuary into the 13,581 square miles National Marine Sanctuary of American Samoa, now the largest of the 13 national marine sanctuaries. In 2014, the president used his authority under the Antiquities Act of 1906 to expand three of the five marine protected areas managed collectively as the Pacific Remote Islands Marine National Monument, enlarging the area under protection from 225,000 square kilometers to 1.2 million square kilometers. More recently, in August 2016, after receiving nearly 1.4 million comments from constituents and stakeholders around the world, President Obama expanded the Papahānaumokuākea Marine National Monument, creating the world’s largest highly-protected contiguous marine protected area. Within this executive order, President Obama also called upon the Secretary of Commerce to create a national marine sanctuary overlay to support education and research programs.

The president has the opportunity today to build upon these earlier decisions by enhancing the Marianas Trench Marine National Monument, the only marine monument in the Pacific he has yet to improve during his administration. Specifically, the president can begin the national marine sanctuary designation process in the Commonwealth of the Northern Mariana Islands (CNMI) consistent with the National Marine Sanctuaries Act[2]. This will protect and preserve unique aspects of Chamorro and Carolinian culture, as well as internationally significant natural resources inside the US Exclusive Economic Zone. The Islands Unit is one area that has been identified by CNMI leaders for inclusion in the national marine sanctuary program, but there are others that should be explored during the designation process.


Marianas Trench
Marine National Monument
US EEZ
Challenger Deep
10916
TOTO Caldera
Forecast
Seamount X
Santa Rosa South
Santa Rosa North
West Rota Volcano
Northwest Rota-1 Volcano
Esmeralda Bank
North Esmerelda Bank
Ruby
East Diamante Volcano
Saipan
Zealandia
Farallon De Medinilla
Enrique Guyot
Pigafetta Seamount
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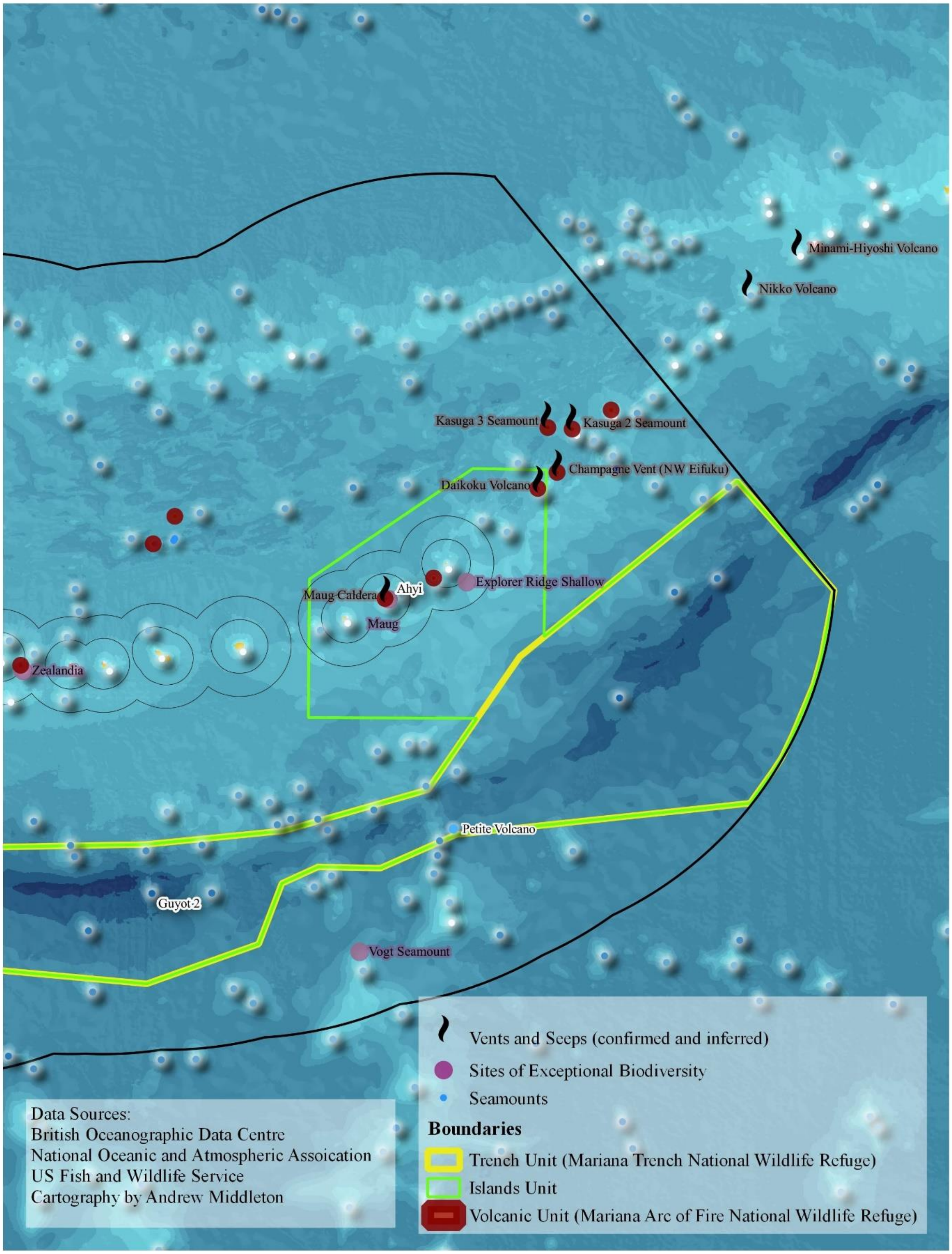
Page 1


Minami-Hiyoshi Volcano
Nikko Volcano
Kasuga 3 Seamount
Kasuga 2 Seamount
Champagne Vent (NW Eifuku)
Daikoku Volcano
Explorer Ridge Shallow
Ahyi
Maug Caldera
Maug
Zealandia
Petite Volcano
Guyot-2
Vogt Seamount
Vents and Seeps (confirmed and inferred)
Sites of Exceptional Biodiversity
Seamounts
Boundaries
Trench Unit (Mariana Trench National Wildlife Refuge)
Islands Unit
Volcanic Unit (Mariana Arc of Fire National Wildlife Refuge)
Data Sources:
British Oceanographic Data Centre
National Oceanic and Atmospheric Assoication
US Fish and Wildlife Service
Cartography by Andrew Middleton

Cultures Connecting Across Oceans

Archeological evidence indicates the Marianas may have been settled as early as 4,000 years ago by people from Southeast Asia (modern day Indonesia and the Philippines) arriving in seafaring canoes. These accounts establish that early Chamorros were in contact with one another across the archipelago and engaged in commerce with far reaching islands across Oceania. The modern historical records supports this, as well. In 1815, Refaluwasch settlers from the island of Satawal arrived in Saipan using traditional navigation and canoes. Later voyages between Saipan and Satawal, as well as the islands of Puluwat and Yap, kept this tradition alive until modern times.

A century and a half later, master navigator Pius “Mau” Pialug, who has strong familial ties to Saipan, shared his knowledge of traditional navigation with the Polynesian Voyaging Society and thus contributed to the second Hawaiian cultural renaissance and the revival of traditional navigation and canoe building across the entire Pacific[3].

All of the Mariana Islanders share cultural and linguistic characteristics and archaeological findings show continuity in ceramic production on the different islands from 900-1700 CE. Similarity in early ceramic styles, decoration, and technique are indicative of areas with “strong inter-community and inter-island ties.[4]” The Chamorro natives were expert seafarers and skilled craftspeople familiar with intricate weaving and detailed pottery-making.

It is likely that support from the larger, resource-rich islands to the south was needed to sustain intermittent settlements on the remote northern islands of Maug, Asuncion, and Farallon de Pajaros, the area that is now the Islands Unite of the monument. In return, the far northern islands provided the more populated southern islands with basalt and other volcanic rocks for use in mortars (lusong) and adzes[5].

There is a strong tradition still practiced in the Northern Mariana Islands today that has helped maintain the richness of the Northern Islands. Natural resources, particularly coconut crabs (*ayuyu*) and fruit bats (*fanihi*) can be utilized while visiting the islands, but these resources must be consumed before returning to the south. This tradition often times conflicts with local and federal laws, but these laws are used to punish those who violate the tradition when poachers bring these resources back to Saipan or Guam. Being able to utilize these resources is a privilege afforded community members who have braved a visit to the Northern Islands, but along with this privilege comes the responsibility to protect the resource and ensure that future generations can benefit from them.

Celestial voyaging is another tradition that is practiced in the Northern Islands and the Marianas Trench Marine National Monument. Chamorro and Carolinian maritime skills evolved in local contexts over time and constitute what is now a rich navigational legacy in the Mariana Archipelago, as evidenced in chants still sung among the Refaluwasch people on Saipan today. Maintaining ancient maritime skill sets, including navigation by the stars, has become a source of pride amongst Pacific Islanders everywhere and has spurred Epeli Hau’ofa’s theories about the great ocean networks that bridge the Pacific[6]. This is only possible today because the ancient routes between the Mariana Islands and Caroline Islands to the south were kept open.

Micronesian voyaging and wayfinding evolved from a system of non-instrument navigation to make long distant voyages across thousands of miles of open-ocean. This traditional practice and art of wayfinding relied upon observations of the natural environment such as the sun, moon and stars which rise and set in predictable star lines, cloud clusters and movement, wind direction and ocean swells or wave pilots.

Biological indicators such as migratory seabirds and/or sea marks provide distinctive natural occurrences at predictable places along sea routes, including regions where certain fish species leap above the water's surface, or zones of innumerable marine or avian life, all of which help to guide voyagers and expand island targets. The practice of traditional wayfinding requires protection of the entire marine environment, not just the target islands, because it then allows for the full use of biological signs and natural phenomena that help to expand the target island, and training navigators to use the full range of signs needed for the wayfinding.

Chamorro and Carolinian people living on Saipan have ambitions to reignite traditional voyaging and wayfinding in the archipelago. In June 2016, five navigators from the Federated States of Micronesia were named master navigators in a *pwo* traditional ceremony during the Festival of Pacific Arts in Guam. All five belong to the Werieng School of navigation. There is also a new NGO on Saipan called 500 Sails that hopes to train a new generation of indigenous sailors.

500 Sails has received a three-year, half million dollar grant from the Administration for Native Americans to create a resurgence of traditional navigating by constructing more than 500 Chamorro proas by 2030, a number that matches the size of the first fleet observed by European explorers. In addition, 500 Sails is in talks with The Okeanos Foundation for the Sea to fund the delivery of a double hulled voyaging canoe to Saipan and are planning a voyage to Maug. This effort will aid in reclaiming the traditional maritime heritage lost when locals were forbidden to access the reefs during the Spanish colonial era[7].

A Culture of Conservation

The cultures of many Pacific islands have centuries, as opposed to decades, of experience in conserving the coral reefs and other natural resources on which their populations depend[8]. This is especially true in the Northern Mariana Islands, home of the Marianas Trench Marine National Monument. Over time, faced with a changing modern world and the threat of industrial fishing and other harmful activities, many of these ancient beliefs have experienced a cultural evolution, such that the framers of the Constitution of the Northern Mariana Islands guaranteed all citizens the right to a clean and healthful environment:

“Each person has the right to a clean and healthful public environment in all areas, including the land, air, and water. Harmful and unnecessary noise pollution, and the storage of nuclear or radioactive material and the dumping or storage of any type of nuclear waste within the surface or submerged lands and waters of the Northern Mariana Islands, are prohibited except as provided by law[9].”

CNMI already has a locally-based system of marine protected areas. Preservation and protection were also enshrined in the founding documents of the Commonwealth, as several islands were set aside as uninhabited places in the Constitution:

“The islands of Maug, Uracas, Asuncion, Guguan, and other islands specified by law shall be maintained as uninhabited places and used only for the preservation and protection of natural resources, including but not limited to bird, wildlife, and plant species[10].”

Generations of Chamorros and Carolinians have understood the need for wilderness areas in preserving the indigenous identify of the island community. Nearly a decade ago, The Friends of the Marianas Trench formed to express the voice of the local community and consists of a cross-section of indigenous and resident people of the CNMI who are dedicated to the conservation, preservation and protection of marine flora, fauna and geological features of the oceans; and the creation and proper management of a Marianas Trench Marine National Monument. Inspired by the Commonwealth’s founding fathers and the CNMI Constitution, they successfully petitioned former President George W. Bush to declare the Marianas Trench Marine Monument in 2009.

The vision for the Marine National Monument program, initiated in 2008, seeks to understand and protect the unique natural and cultural resources within the marine national monuments through the advancement of scientific research, exploration, and public education by building strong partnerships that promote healthy ecosystems through science based management. This vision included the explicit goals of developing collaborative, adapted management structures, scientific and exploration research programs, and to increase public awareness, engagement, and support for these monuments by 2016[11].

The existing monument covers almost 95,000 square miles of submerged lands and waters in the Mariana Archipelago and includes the Marianas Trench, the “Grand Canyon of the ocean” (though it is almost 120 times larger than the Grand Canyon). Comprised of three units, the Trench Unit, the Island Unit, and the Volcanic Unit, the Monument is jointly managed by NOAA and the US Fish and Wildlife Service in cooperation with the Government of the Commonwealth of the Northern Mariana Islands.

Despite the success in creating this monument, local people feel that a lot of conservation opportunities were missed with the declaration of the Marianas Trench Marine National Monument, and have been advocating for increased protections since 2009[12]. Recently, the declaration of the Palau National Marine Sanctuary and the expansion of the Papahānaumokuākea Marine National Monument, has invigorated people living on the islands of Saipan and Guam to again call for expanding the Mariana Trench Monument, or to create a National Marine Sanctuary adjacent to the existing monument. Island leader and former lawmaker Cinta Kaipat wrote a letter to the editor in November 2015 outlining how the Marianas could follow Palau’s model of creating a large scale marine protected area[13].

> “With the amount of development our islands are expected to experience in the coming years, we need to start thinking like our brothers and sisters in Palau. So perhaps it is time to take another look at the Monument. This is a good thing. In many ways, the Monument we got was not the monument we asked for. The designation was opposed by some otherwise reasonable people for all the wrong reasons, and as a result not all of the many potential benefits were realized.”

Currently, protection of the Trench and Volcanic Units only extends to the immediate seafloor, not the water column above. Seafloor ecosystems are significantly and critically influenced by changes in the surrounding water column. Marine ecosystems, particularly deep-sea ecosystems, are vertically mediated, with food, oxygen, and other resources flowing downward into the deep sea. The deep-sea also functions as a buffer and sink for ocean impacts, absorbing and sequestering thermal energy, carbon dioxide, and organic matter. Thus, protecting the seafloor is necessary, but not sufficient in establishing full protection for deep-sea ecosystems, the connected water column up to the surface must also be protected.

Protecting the water column above the Trench Unit would make the monument the fourteenth largest highly protected area in the world, the deepest marine protected area in the world, and the only marine protected area which encompasses a complete cross-section of the ocean, from the surface and pelagic zones to the abyssal and hadal regions.

This document lays out the cultural and scientific justification for the president to begin the National Marine Sanctuary designation process in the Northern Mariana Islands. Additionally, this document highlights how the current levels of protection for the Trench and Volcanic Units do not allow for the proper care and management for populations of migratory birds, fish, mammals, and sea turtles, and newly discovered and little understood deep sea ecosystems found in the area, and explores areas that could be identified for further protections once the sanctuary designation process beings.

This coral and brittle star were seen at Farallon de Medinilla. The green filamentous material hanging off of the coral is hypothesized to be algae that has drifted down from the sea surface. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas*.

Protect the Trench and Volcanic Units

Currently only about 3% of the ocean is strongly (all commercial activity prohibited, only light recreational and subsistence fishing allowed) or fully protected (no extractive activities allowed[14]. The International Union for Conservation of Nature recommends protecting 30 percent of the ocean, based on a recent scientific re-evaluation of coverage targets for marine protected areas showing that protection of at least 30 percent of each marine habitat globally is necessary to achieve conservation goals and broader management targets[15]. One leading scientist recommends as much as 50 percent[16].

The Islands Unit of the Marianas Trench Marine National Monument is the smallest of the world's large scale marine protected areas. At 42,000 square kilometers (16,000 square miles), it encompasses only 4% of the United States EEZ surrounding Guam and the Northern Mariana Islands. The Volcanic and Trench Units of the monument are not marine protected areas as they protect only the submerged lands in the deepest part of the ocean and none of the water or marine life swimming above them.

Should the water column above the Trench Unit be included a national marine sanctuary, in addition to protecting species and ecosystems that are known, such as tuna, sharks, and whales, protection will also be extended to those species which are yet to be discovered. The Marianas Trench is one of the least studied areas in the world, and recent scientific expeditions have found staggering amounts of biodiversity previously unknown to science. The potential for discovery is astounding, and protecting this unique habitat now would protect these species for future study.

> "The deep sea is the last great unexplored wilderness. Every expedition yields new and surprising discoveries which often fundamentally challenge our understanding of life on Earth."

It is estimated that ninety-one percent of all species in the ocean are unknown to science[17]. Globally, on both land and sea, scientists have identified barely 2 million species to date, but as many as 8.7 million are thought to exist, with as many as 2.2 million in the seas alone[18]. Many of these discoveries are likely to be found in unprotected areas within the US EEZ around the Mariana Islands.

Protecting the waters above the Trench Unit, or expanding the Islands Unit out to the extent of the US EEZ will also build resilience against the effects of climate change, which the President has identified as a major threat to national security[19]. Additionally, an enlarged protected area will serve as a refuge for species faced with warming and increasingly acidic seas[20,21]

Furthermore, scientists have suggested that attempts to protect coral reefs from the impacts of climate change by solely reducing emissions have little impact unless protected areas are also established[22].

A 2014 article published in Nature concluded that the effectiveness of marine protected areas (MPAs) yields the greatest conservation benefits when they are large, remote, strongly protected, protected for a long time, and enforced[23].The authors found that the conservation benefits of marine reserves "increase exponentially" with the accumulation of these features. The most effective reserves had twice as many large fish, five times as much fish biomass, and fourteen times more shark biomass than fished areas. By comparison, those with just one or two of the essential characteristics were ecologically indistinguishable from fished areas.

Beginning the sanctuary designation process in the Northern Mariana Islands is timely based on recent science. A 2016 survey of global ocean priorities for marine biodiversity identified the Marianas and Samoan Islands as the top marine conservation priorities within the United States EEZ[24].

Shallower moray eels like this one seen at a depth of 279 meters at Supply Reef are nocturnal and live in holes and crevices to avoid predators. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Economic Benefits

Marine protected areas (MPA) deliver substantial benefits to people and the global economy. It is widely established through numerous studies and peer-reviewed publications that the social and economic benefits of establishing and operating MPAs exceed their costs, from 3:1 for 10% protection, up to 20:1 for 30% protection[25].

For example, in Hawaii, a review of six marine protected areas showed that they generated benefit-cost ratios ranging from 3.8 to 41.5[26]. Another example from Vanuatu showed a mean return on investment of 1.8 was achieved for five MPAs only five years after the initial investment[27]. Another study demonstrated that economic benefits from establishing new MPAs can offset costs in as few as five years[28].

MPAs contribute to climate change adaptation and to some extent mitigation. Investing in MPAs can reduce community, national, and global vulnerability by increasing resilience and reducing risk[29]. It can support adaptation efforts against climate-related impacts at various scales, and contribute somewhat to climate change mitigation via the maintenance of healthy oceans[30].

Investments in MPAs can provide direct benefits such as coastal protection, including the protection or restoration of mangroves and coral reefs. These investments will enhance resilience by protecting ecosystems, and thus improving food security and securing livelihoods options[31]. This will be increasingly important in helping communities adapt to climate change and in minimizing damages and losses.

MPAs can strengthen the provision of marine ecosystem services. As marine biodiversity loss disproportionately affects vulnerable populations, investments in MPAs, by helping to protect biodiversity, will help secure the long-term provisioning of key services and access to essential marine resources that support food security, economic opportunities, and human well-being of the world's poor populations[32].

MPAs provide insurance and protection from risk. MPAs as the 'conservative' part of our ocean portfolio serve as insurance against our mistakes in management[33]. Investments in MPAs can provide insurance against uncertain and accelerating future marine ecosystem change, and maintain and enhance future development options. Investments made now will reduce future costs and preserve opportunities for current and future generations.

MPAs are also a way to share ocean values with future generations. Effective MPAs are a powerful mechanism for delivering sustainable fisheries objectives for coastal marine ecosystems at varying scales, including sustainable food security, livelihoods, climate change, and disaster risk reduction, far into the future.

MPAs, especially those that connect to deep, relatively unexplored, portions of the ocean, can also contribute to fundamental scientific advancement, which often yields unexpected future economic gains as well as promoting international cooperation and collaboration. Currently American geologists are working aboard a Japanese research vessel exploring hydrothermal vent fields in the Trench Unit[34]. Staging major research expeditions can also yield significant local economic gains in ports-of-call, such as Saipan.

Beginning the sanctuary process in the Northern Mariana Islands should also provide a level of federal spending, which is one of the major pillars of the CNMI economy. Once a sanctuary designation process is begun, it is assumed that the Office of National Marine Sanctuaries would hire local staff to open an office in Saipan and create an advisory council that is more inclusive than just federal oversight.


A Long-Tail Red Snapper spotted on Pagan. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Begin the Sanctuary Process Now

While the existing structure of the Marianas Trench Marine National Monument provides some structure for how the sanctuary designation process could proceed, there are areas and additional ecosystems in need of protection, beyond the Islands Unit. Some of these areas are both inside and outside of the Trench and Volcanic Units.

Expanding the protections during the sanctuary designation process offers an opportunity to conserve an unprecedented cross section of the most volcanically active region on Earth. The spectacular geology and associated rare ecology of the region arise from the subduction of the world's largest tectonic plate, the Pacific Plate, under the smaller, slower moving Philippine Plate. Protecting an expansive habitat like this on land would be nearly impossible to achieve, as it is the equivalent of protecting a cross section of the Rocky Mountains from Nebraska to Utah. The Volcanic and Trench Units of the existing monument only protect the substrate at the bottom of the ocean, but the President could extend protections to the diverse and mostly unknown life swimming in the waters above.

Masked Booby, *Sula dactylatra*, with chick on Tern Island, French Frigate Shoals. Duncan Wright, USFWS Hawaiian Islands NWR.

Seabirds

The Commonwealth of the Northern Mariana Islands is home to abundant populations of seabirds and shorebirds, including the Pacific Reef Heron, the Pacific Golden Plover, Whimbrel, Ruddy Turnstone, Wandering Tattlers, Cattle Egrets, Marianas Mallards, White Terns, Black Noddies, and Great Frigate Birds. Several species of Booby, including the common Brown Booby, Red-footed Booby, and Masked Booby, have major nesting colonies throughout the CNMI. There are past records of several species of albatross in the Marianas, but they have not been found on recent scientific surveys.

Seabirds are some of the most threatened species on the planet and taken as a whole have declined by approximately 70% since 1950[35]. The largest declines were observed in families containing wide-ranging pelagic species, such as albatross, suggesting that pan-global populations may be more at risk than shorter-ranging coastal populations[36].

Many tropical seabird species are unable to dive to great depths. As a result, many species found in the Marianas such as noddies, terns, boobies, and frigatebirds are highly dependent on subsurface predators, particularly tunas and dolphins, to drive forage fish to the surface where they are then accessible to seabirds to take as food[37,38]. In some parts of the Pacific, diet estimates from lethally sampled seabirds suggest that greater than 75% of prey consumed by some seabird species may be taken during facilitated foraging[39]. Thus the maintenance of robust fish and dolphin populations is critical for the maintenance of many seabird populations.

Breeding seabirds are likely to forage near to colonies, though the distance they travel to feed varies depending on chick size and dependence. Furthermore, smaller seabird species have been shown to forage further from breeding colonies than larger birds (likely as a result of interspecies competition). Thus, many species are likely to be foraging in unprotected waters, including white-tailed tropicbirds, red-tailed tropic birds, masked boobies, great frigatebirds, sooty terns, and wedge-tailed shearwaters[40].

Whales

Very little is known about the whales and dolphins that live in the waters surrounding CNMI. As recently highlighted by Fulling et al. (2011)[41], this is problematic for effective management under the Marine Mammal Protection Act, the Endangered Species Act, and the National Environmental Policy Act. As charismatic, yet understudied species, whale research in a National Marine Sanctuary would serve as a unique, collaborative target for future studies.

Common name	**Scientific Name**	**Occurrence**	**IUCN status**
North Pacific right whale*	*Eubalaena japonica*	Rare	Endangered
Humpback whale (Western North Pacific Distinct Population Segment)*	*Megaptera novaeangliae*	Regular	Least Concern
Minke whale	*Balaenoptera acutorostrata*	Rare	Least Concern
Sei whale*	*Balaenoptera borealis*	Extralimital	Endangered
Fin whale*	*Balaenoptera physalus*	Rare	Endangered
Blue whale*	*Balaenoptera musculus*	Rare	Endangered
Bryde’s whale	*Balaenoptera edeni/brydei*	Regular	Data Deficient
Sperm whale*	*Physeter macrocephalus*	Regular	Vulnerable
Pygmy sperm whale	*Kogia breviceps*	Regular	Data Deficient
Dwarf sperm whale	*Kogia sima*	Regular	Data Deficient
Cuvier’s beaked whale	*Ziphius cavirostris*	Regular	Least Concern
Blainville’s beaked whale	*Mesoplodon densirostris*	Regular	Data Deficient
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	Rare	Data Deficient
Hubbs’ beaked whale	*Mesoplodon carlhubbsi*	Extralimital	Data Deficient
Longman’s [Indo-pacific] beaked whale	*Indopacetus pacificus*	Regular	Data Deficient
Rough-toothed dolphin	*Steno bredanensis*	Regular	Least Concern

Bottlenose dolphin	*Tursiops truncatus*	Regular	Least Concern
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	Extralimital	Data Deficient
Pantropical spotted dolphin	*Stenella attenuata*	Regular	Least Concern
Spinner dolphin	*Stenella longirostris*	Regular	Data Deficient
Striped dolphin	*Stenella coeruleoalba*	Regular	Least Concern
Short-beaked common dolphin	*Delphinus delphis*	Rare	Least Concern
Risso's dolphin	*Grampus griseus*	Regular	Least Concern
Melon-headed whale	*Peponocephala electra*	Regular	Least Concern
Fraser's dolphin	*Lagenodelphis hosei*	Regular	Least Concern
Pygmy killer whale	*Feresa attenuata*	Regular	Data Deficient
False killer whale	*Pseudorca crassidens*	Regular	Data Deficient
Killer whale	*Orcinus orca*	Regular	Data Deficient
*Listed as Endangered by the National Marine Fisheries Service.			

What little scientific data exist suggest high diversity for CNMI. A report for the Navy in 2005 included 29 cetacean species which potentially inhabit CNMI's waters. In 2007, an initial scientific survey of cetacean distribution and estimates was undertaken, covering 11,000 km², over depths ranging from 114 to 9,874 meters. Despite unfavorable survey conditions, this survey recorded 13 cetacean species, including sperm whales, baleen whales, four species of blackfish (false killer whales, short-finned pilot whales, melon-headed whales, and pygmy killer whales), and five species of dolphins. Or particular interest was the occurrence of sei whales, since they had not previously been confirmed south of 20°N in the Northern Pacific. An aerial survey later in 2007 detected several other more cryptic species, including dwarf/pygmy sperm whales (*Kogia* spp) and a Cuvier's beaked whale (*Ziphius cavirostris*)[42]. The complex bathymetry of this region, including the Mariana Ridge, the Mariana Trench, and multiple seamounts, seem to be very important to the diversity of cetaceans in the region, with different species associating with different habitats[43].

Although no marine mammals were observed during the 2016 expedition 'Deepwater Exploration of the Marianas' by the NOAA Ship *Okeanos Explorer*, there may have been evidence of deep-diving cetaceans observed at approximately 3300 meters at a site known as Unnamed Forearc Seamount, located in the Trench Unit of the Marianas Trench Marine National Monument. There were a number of elongate furrows, most about 0.5 meter deep and 1-2 meters in length that were reminiscent of the gouges made by deep-diving whales observed elsewhere in the world. If this were the case, this would indicate that there are marine mammals that utilize and likely influence the entire water column (from surface to benthos) in some deep-sea areas of the Marianas Trench Marine National Monument.

Whale falls are a further way that cetaceans may impact the deep ocean of the US EEZ surrounding the Commonwealth of the Northern Mariana Islands and Marianas Trench Marine National Monument. Once a cetacean dies, it may sink to the deep-sea floor where it is termed a 'whale fall', and can provide a resource to the deep-sea community for decades[44]. Whale falls provide a large amount of organic enrichment, shelter and substrate to the deep-sea floor producing a distinct habitat[45]. It is estimated that a 40-tonne whale carcass provides the equivalent organic carbon as that which would sink from the euphotic zone to a hectare of abyssal seafloor over 100-200 years, representing a very large transfer of nutrients from the ocean surface to its depths[46]. The sediments directly under a carcass (which covers roughly $50m^2$) may experience an initial pulse of organic material equal to 2000 years of organic carbon flux. During the life of the carcass on the deep-sea floor, it transitions through three phases represented by distinct communities that are highly diverse and abundant. The communities are also comprised of both specialist (many species are endemic to whale falls) and opportunist organisms. Some of these species are also thought to use cetacean falls as stepping stones between other chemosynthetic communities such as wood falls, hydrothermal vents, and cold[47]. Although no whale falls have been found within the US EEZ surrounding the Commonwealth of the Northern Mariana Islands so far, they are known from the eastern and central Pacific Ocean, and are thought to occur abundantly worldwide[48,49].


“A sixgill shark paid us a visit, and even stuck around for a minute. Note the high diversity of coral species in the foreground. Look closely, and you can see brittle starfish hiding in the corals.” *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Sharks

Sharks are more than an order of magnitude denser around the uninhabited islands of the Marianas archipelago, and one site in the western arc–that is not currently under protection–has one of the highest densities of sharks in the Pacific. Seamounts within the expansion concentrate fish in a desert of deep ocean. Sharks and other apex predators drive smaller fish to the surface, creating the bait balls upon which many species of pelagic seabirds feed.

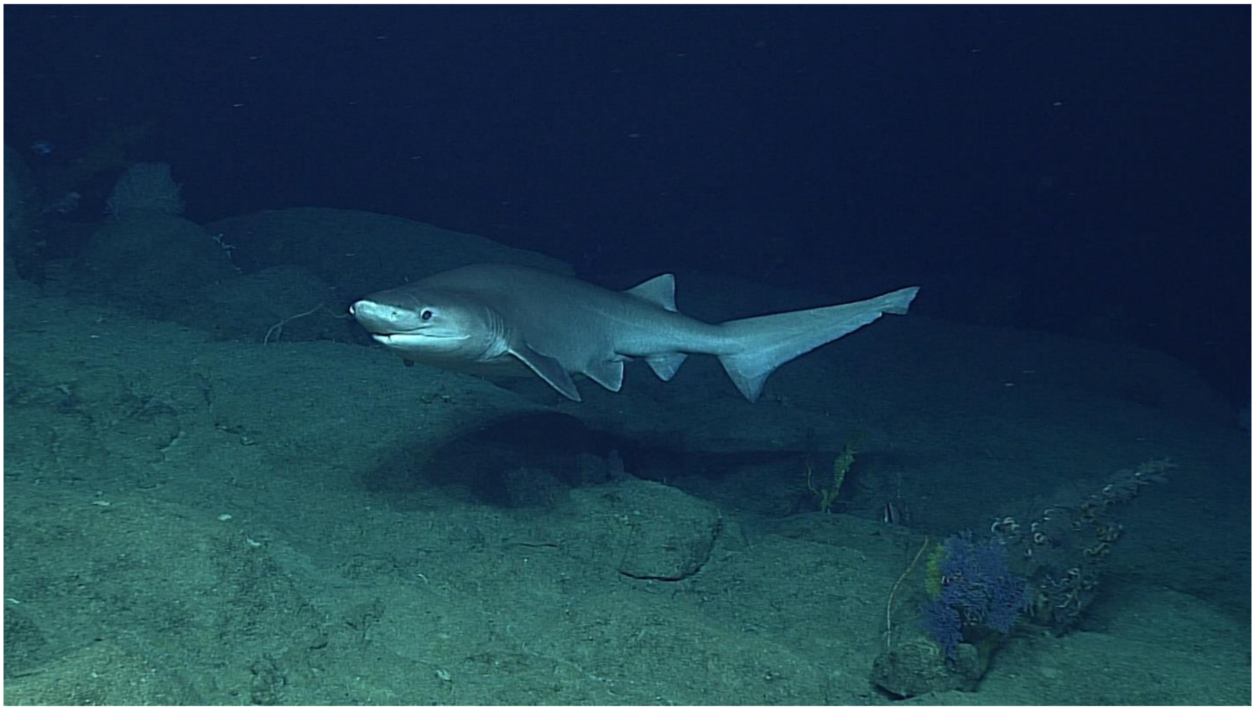
Ocean predators such as sharks are some of the most important species in the marine environment, and now, are among the most threatened. Globally, shark populations have declined, 100 million sharks and killed each year and half of all shark species assessed by scientists are now threatened or near threatened with extinction[50]. Most sharks are unable to withstand pressures from commercial fishing because, like the great whales, they are grow slowly, take many years to reach sexual maturity, and produce few young[51].

Sharks influence the abundance and diversity of the species below them in the food web, and their removal can have severe ecological consequences[52]. They are a keystone species in decline whose protection is required for a functioning reef system[53]. As an area of intrinsic high shark diversity[54], the expansion of the monument would safeguard important priority areas for sharks.

In the Pacific, oceanic whitetip sharks (*Carcharhinus longimanus*) and silky sharks (*Carcharhinus falciformis*), highly migratory species that were once categorized as two of the most abundant species of large marine animals, have declined significantly[55]. Populations of these species have dropped to such low levels that fishing vessels are now prohibited from retaining them[56,57]. Despite this ban, both species are still incidentally caught and killed on longlines[58]. Bycatch rates in Hawaii, for example, show one shark caught for every two tuna. Since the monument is within the core habitat for both oceanic whitetip and silky shark[59], an expanded protected area from fishing can ensure that populations of these vulnerable sharks are safeguarded.

During the 2016 *Okeanos Explorer* expedition, there were a number of sightings of a variety of large sharks. These included several smalltooth sandtiger sharks (*Odontaspis ferox*), including a pregnant female, and a sixgill shark (*Hexanchus griseus*) observed at depth, as well as a whale shark at the sea surface (*Rhincodon typus*).

The Western Cental Pacific Regional Fisheries Management Council has proposed a directed shark fishery for the Northern Mariana Islands and Guam, despite local bans on the sale of shark fins[60]. A National Marine Sanctuary could many species of sharks.


Sixgill shark seen while exploring Santa Rosa Reef, south of Guam, during the first dive of the Deepwater Exploration of the Marianas expedition. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Turtles

Four species of sea turtles have been recorded in the waters surrounding Guam and the Northern Mariana Islands: green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), and olive ridley (*Lepidochelys olivacea*)[61]. Green turtles are the only species known to currently nest on the islands, although hawksbill nesting has been recorded very rarely[62]. Non-nesting leatherbacks inhabit the pelagic environment.

All four are listed as threatened by the IUCN Red List of Threatened Species. Hawksbill sea turtles are Critically Endangered, green are Endangered, and leatherbacks and olive ridleys are Vulnerable. Globally, mortality from fisheries bycatch (including longlines) is a threat for green, leatherback, and olive ridley turtles[63].

Tuna

Skipjack are the most commonly landed commercial tuna in CNMI, followed by bigeye and yellowfin. Tuna landings in the Pacific have generally declined throughout the Pacific region of the US EEZ over the last 10 years. Lacking a sufficient fleet to exploit its own fishery, in recent years CNMI has sold a portion of its tuna fishing quota to the Hawaiian Longliners Association[64].

Tagging studies of individual yellowfin tuna in the western and central Pacific have found that most have lifetime movements on the order of hundreds, not thousands of miles, although some individuals do make some very long distance movements[65]. Estimates of median lifetime displacements range from 411-471 nautical miles for skipjack (*Katsuwonus pelamis*) and 337-380 nautical miles for yellowfin (*Thunnus albacares*)[66]. Another study, using stable isotopes, suggests that bigeye and yellowfin tuna are not 'highly migratory' and suggests a high degree of regional residency on the order of several months in the equatorial Pacific Ocean[67].

Most tuna species are assumed to be panmictic, mating randomly across entire ocean basins, but recent studies have shown evidence of site-specific discrete populations[68]. Scientists have found genetically distinct subpopulations of yellowfin tuna in the Pacific Ocean. This result challenges the single stock paradigm for highly migratory species, and for fisheries management suggests that stocks should be assessed and managed at smaller scales.

These findings suggest that individual tuna from different species could spend their entire life history inside the borders of a marine reserve if the area is large enough. It has been shown that female fish that are older and of larger size produce a higher number and a higher quality of eggs[69] These tuna would grow large and produce exponentially more eggs than smaller, unprotected individuals swimming outside the area of protection. Spillover effects of the fish that do swim outside of the area of protection would benefit fishermen.

A small octopus made an appearance on the dive. You can see how small it is compared to the crinoid stalks it is next to. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

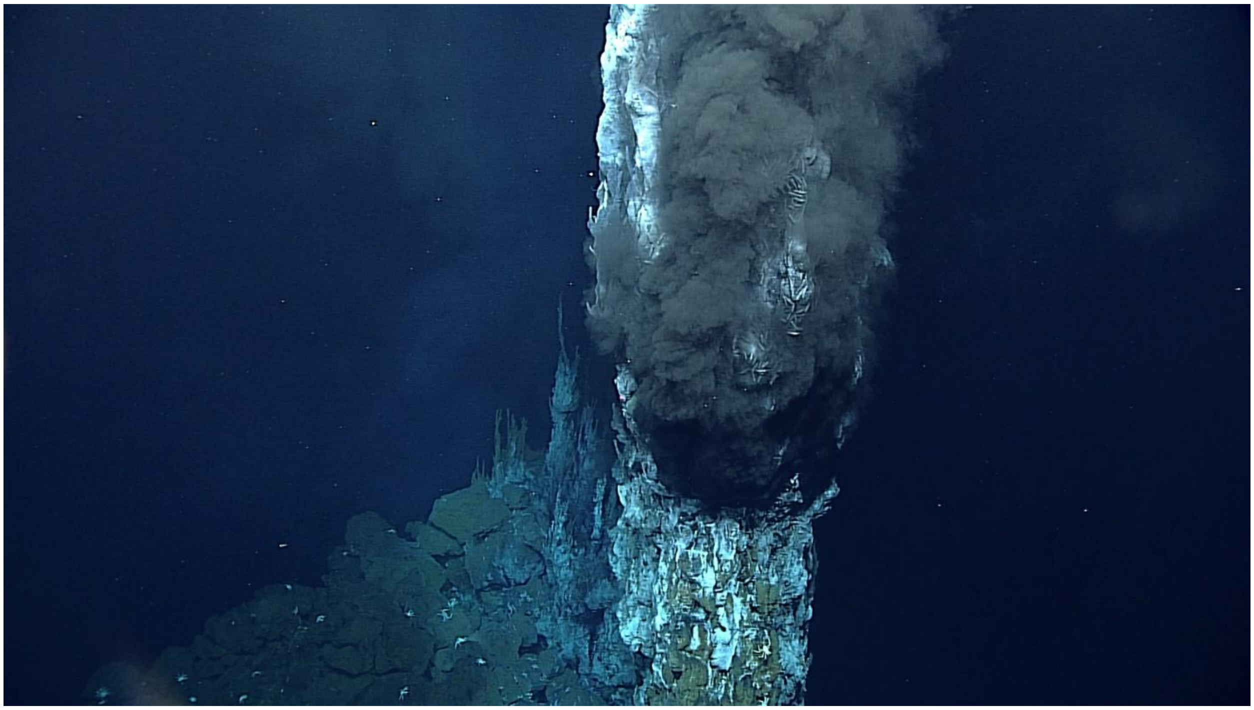
Deep Ocean

Undoubtedly, the most well-known area of the Marianas Trench region is Challenger Deep, the deepest point in our world's oceans at 10,989 meters. The vast majority of deep-sea research (>200 meters) within the Marianas Trench has been focused on this one region. This has meant that most of the deepwater of the US EEZ surrounding the Commonwealth of the Northern Mariana Islands and Marianas Trench Marine National Monument have remained relatively unexplored, especially the water column and its inhabitants. Since 2003, there has been an increase in research activity in this area. NOAA sponsored nine expeditions to the CNMI region; eight of those were focused on volcanic activity and the most recent, the 'Deepwater Exploration of the Marianas' expedition by the NOAA ship *Okeanos Explorer,* collected baseline biological and geological information from a variety of deepwater habitats. There have also been expeditions undertaken by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Schmidt Ocean Institute (SOI) and the DeepSea Challenge expedition of James Cameron. These expeditions have contributed to improved scientific knowledge and provided a small window into the amazing and unique geology that abounds here, as well as the fascinating biology that accompanies it.

The US EEZ surrounding the Commonwealth of the Northern Mariana Islands is one of most geologically-diverse places on Earth. Within this relatively small area, there are seamounts with and without ferromanganese crusts, hydrothermal vents, cold seeps, sedimented plains, active and extinct volcanoes, carbonate platforms and mountains, mud volcanoes, as well as the deepest trench on the planet. During a NOAA expedition in 2006, a number of volcanoes in the back-arc were confirmed to be hydrothermally active, many in ways never seen before and found nowhere else on the planet. A hydrothermally-active area is one where seawater percolates downward through oceanic crust becoming superheated and chemical-rich. It eventually becomes so hot and buoyant that it rises back to the seafloor surface. When this super-hot vent fluid meets the very cold water (2°C) of the deep sea, minerals that are carried in the fluid precipitate out of solution, forming spectacular vent chimneys that emanate clear, white or black fluid[70].

The vent fluid is then used by chemoautotrophic bacteria as a source of energy to produce organic material and fuel much of the food web at these sites[71]. The process, called chemosynthesis, occurs in a similar way to which plants use sunlight via photosynthesis. Chemosynthetic bacteria are then grazed on by heterotrophs, which in turn are eaten by larger predators. Some of these bacteria even live inside vent fauna or grow on specialized appendages[72]. Hydrothermal-vent communities are extremely important for understanding how animals live in extreme conditions, the origin of life on Earth, and connectivity between these 'patchy' habitats.

There are numerous hydrothermally active, scientifically important sites within both the Trench and Volcanic Units.



A “black smoker”. Where super-hot vent fluid meets very cold ambient sea water (2°C) of the deep sea, minerals that are carried in the fluid precipitate out of solution, forming spectacular vent chimneys. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

The black-smoker vent communities in the Mariana Arc are some of the most spectacular in the deep sea, as they feature very high abundances of a high diversity of animals, many of which are vent endemic[73]. These include *Chorocaris* shrimp, *Gandalfus* crabs, actinarians, barnacles, *Bathymodiolus* mussels, *Paralvinella* tubeworms and many others[74]. One of the most enigmatic animals observed at these vents is the deep-sea vent-endemic snail, *Alviniconcha hessleri*. Not only does it have blue blood due to the respiratory pigment hemocyanin and gets its food symbiotically from bacteria that live in its gills, but it also has hair-like projections on its shell, the purpose of which is unknown[75,76]. During the 2016 *Okeanos Explorer* expedition, a new active vent field was visualized for the first time after discovery during an R/V *Falkor* expedition. This extraordinary site outside of the Marianas Trench Marine National Monument at 3292 meters included a 30-m (or ten-story tall) black-smoker chimney. The chimney is amongst the hottest vents in world at 339°C and hosted large communities of chemosynthetic animals similar to other high-temperature vent communities observed by the submersibles *Shinkai* and *Alvin* at vent fields between 1,500 and 4,000 meters in this area.

Close-up of “hairy snails;” these snails are known to live on hydrothermal vents in the Marianas. *NOAA Office of Ocean Exploration and Research*.

NW Eifuku Volcano, located within the Islands Unit of the Marianas Trench Marine National Monument at approximately 1600 meters, is characterized by large-scale venting of both gaseous and liquid carbon dioxide[77]. This phenomenon is only known to exist at one other site in the world, in the Okinawa Trough. The white-smoker vents also found at this location provide hydrogen sulfide that supports a community of chemosynthetic organisms, despite acidic waters caused by the high levels of carbon dioxide. During the 2016 *Okeanos Explorer* expedition, new areas of hydrothermal activity were discovered here.

There have been liquid sulfur flows and lakes observed at Nikko Seamount, a site outside of the Marianas Trench Marine National Monument. This was first seen in 2005 during a JAMSTEC expedition. The chemosynthetic life in Nikko's crater and on its upper flanks is probably at the highest density observed to date on any seafloor volcano despite the very dynamic, unstable and acidic environment[78].

> "Within the crater of Maug, found in the Volcanic Unit of the Marianas Trench Marine National Monument, shallow hydrothermal venting acidifies the surrounding coral reef. The location is now used as a proxy for our future oceans (given rising ocean temperatures due to global warming) to help scientists gain an understanding of the effects of ocean acidification on marine organisms[79]."

The first location deep-sea eruption to ever be observed directly was at NW Rota Seamount in 2006, also located in the Volcanic Unit of the Marianas Trench Marine National Monument. The eruption was observable as an effusion of lava issuing from a pit crater at the summit of the volcano[80].

Daikoku Seamount in the Islands Unit of the Marianas Trench Marine National Monument also hosts a remarkable high-sulfur hydrothermal system characterized by large numbers of a previously-unknown species of vent-dwelling flatfish. Nowhere else in the world other than in the US EEZ surrounding the Commonwealth of the Northern Mariana Islands and off Japan have flatfish been seen as part of the vent community[81].

The first and only petite-spot volcano in U.S. waters is in the Trench Unit of the Marianas Trench Marine National Monument and was discovered during the 2016 *Okeanos Explorer* expedition. These volcanoes are found at stress cracks in tectonic plates rather than at plate boundaries. This is the only known record of this type of volcano outside of Japan (Hirano 2011) and Costa Rica[82] and is the first evidence that the petite-spot phenomenon could be much more widespread than originally hypothesized.

One of the deepest cold seeps in the world is found at 5861 meters within the Trench Unit of the Marianas Trench Marine National Monument during a JAMSTEC expedition in 2010[83]. This indicated that serpentinite-hosted low-temperature-fluid vents can sustain high-biomass chemosynthetic communities.

There are also many areas that are not of volcanic origin in the US EEZ surrounding the Commonwealth of the Northern Mariana Islands. Several carbonate areas were observed during the 2016 expedition by the *Okeanos Explorer*, many with numerous fossils. These included the first observations of Cretaceous rudist coral beds in the ocean at Subducting Guyot 1 and Hadal Ridge, two sites in the Trench Unit of the Marianas Trench Marine National Monument and carbonate platforms that may be Pleistocene reefs at Santa Rosa outside of the Marianas Trench Marine National Monument. The site at Hadal Ridge also featured never-before-seen white mountains that were reminiscent of the Alps whereas the site known as Subducting Guyot 1 was the first visited seamount that was being subducted and cracked open.

The US EEZ surrounding the Commonwealth of the Northern Mariana Islands and Marianas Trench Marine National Monument abound with seamounts, some of which are flat-topped, covered in thick ferromanganese crusts, and known as guyots. Seamounts are thought to be hotspots of biodiversity, both in the pelagic and benthic realms[84,85]. The 2016 expedition by the *Okeanos Explorer* visited five guyots, Vogt, Pigafetta, Del Cano, Fryer and Enrique Guyots, all of which were outside of the Marianas Trench Marine National Monument. These will be used as a proxy for those guyots that may be mined east of US EEZ surrounding the Commonwealth of the Northern Mariana Islands (see section 'Deep-sea Mining').

The high geological diversity in the deepwater of the Mariana region lends itself to a large biological diversity. Prior to the 2016 *Okeanos Explorer* expedition, areas that were not volcanically-active had been poorly explored, many never, resulting in little known about the non-vent-endemic, deep-sea communities. As a result, there were hundreds of new species observed and many collected during the *Okeanos Explorer* expedition. These included several new species of jellyfish, nudibranch, slit-shell gastropod (an ancient type of snail), holothurians, carnivorous cladorhizid sponges of the most fascinating morphologies, an electric-blue tilefish and many more. There were also several new species of hexactinellid sponges including one that could not be identified past the taxonomic level of class! Additionally, there were many rarely-seen species and new records observed both within and outside of the Marianas Trench Marine National Monument. This included the first records for the region of the family, Ateleopodidae (jellynose eels), a slit-shell gastropod (cf. *Bayerotrochus teramachii*) and an anemone-like cnidarian (*Relicanthus* sp.) with 8-foot long tentacles. Another highlight of the *Okeanos Explorer* expedition was the first-ever live sighting of a fish from the family Aphyonidae (ghostfish). It was observed while exploring a ridge feature at a depth of approximately 2500 meters, and was about 10 cm in length with transparent gelatinous skin, which lacked scales, and highly reduced eyes that lacked pigment. But even if an organism was not a new species, new record or rare, many were still extremely strange; from the numerous walking fish to the candelabra-shaped sponges and the hermit crabs with actinarians that replaced their shells.

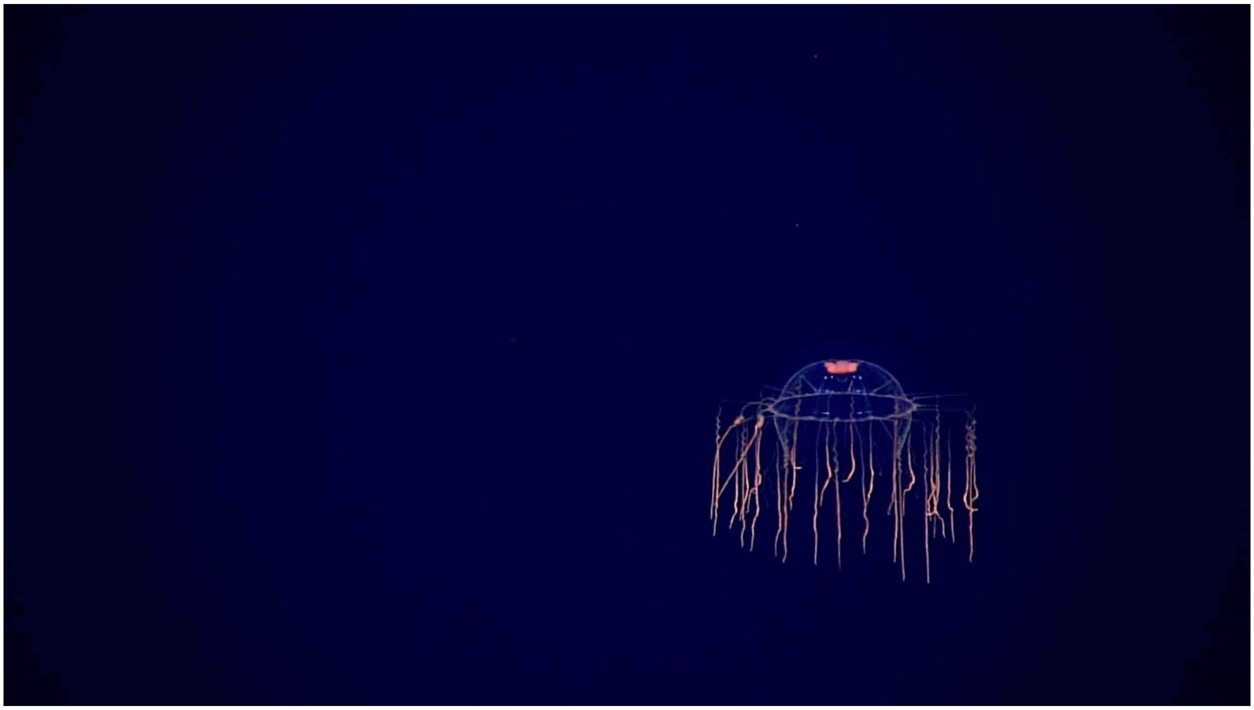
Ten high-density communities were documented during the 2016 *Okeanos Explorer* expedition, most of which were comprised of deep-sea corals and sponges. This was the first effort to document these communities in the US EEZ surrounding the Commonwealth of the Northern Mariana Islands. Many of these communities were also high diversity, comprised of high abundances of many orders and families of corals and sponges, as well as commensal echinoderms and crustaceans. These high-density coral and sponge gardens are extremely important, as just like in shallow coral reefs, these habitats are homes to many different types of animals including commercial fish species[86]. Many of these coral and sponges are new species and are also very slow growing, possibly hundreds to thousands of years old, making them vulnerable to fishing pressures[87]. Some of the corals and sponges, especially at Vogt Seamount, were very large (over one meter across) indicating healthy and stable communities. Some of these were within the Marianas Trench Marine National Monument such as Maug and Explorer Ridge (Islands Unit), but several were outside (Vogt Seamount and Farallon De Medinilla). One of the most exciting observations was a community of thousands of individuals of gorgonocephalid basket stars (likely a new species) and crinoids at Zealandia Bank in the Volcanic Unit of the Marianas Trench Marine National Monument. Aggregations of this size have never been seen before.

Close up of a basket star, with commensal ophiuroids. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Some of the most exciting biology in the US EEZ surrounding the Commonwealth of the Northern Mariana Islands is in the Trench Unit of the Marianas Trench Marine National Monument, however it is important to remember that this is not only a trench but also contains many other habitat types, ranging from sedimented plains to cold seeps and seamounts[88]. The deepest-dwelling fauna of the trench have been studied during expeditions by JAMSTEC and the SOI. The ocean floor at such depths consists of biogenous ooze composed of microscopic plankton shells[89]. Xenophyophores (giant single-celled protists), jellyfish, amphipods, and holothurians have found a home in the harsh deepwater environment of Sirena Deep and Challenger Deep[90] but were also seen during the deepwater dives during the 2016 *Okeanos Explorer* expedition. Scientists on the R/V *Falkor* expedition in 2014 discovered 18 new species below 6400 meters. This included the world's deepest fish, a liparid or snailfish, at 8145 meters.

The 2016 *Okeanos Explorer* expedition concentrated its exploration on the abyssal and abyssal-hadal-transition zone and found a low abundance but high diversity of species, many of which were potential new species or new records. Many species of white, pink and red holothurians (sea cucumbers), crinoids, swimming polychaete worms, acorn worms, long-legged isopods, carnivorous cladorhizid sponges, brisingid sea stars, and sea anemones were observed. Most fish observed in the Trench Unit were ophidiid cusk eels including a *Penopus* sp. seen over 1000 meters deeper than the previous deepest record of 3500 – 4000 meters for the genus. The deepest-known bamboo coral (Isididae) was observed at just over 4300 meters, expanding the known depth range for this family by approximately 100 meters.

The least-explored area of the US EEZ surrounding the Commonwealth of the Northern Mariana Islands is the water column. The 2016 *Okeanos Explorer* expedition conducted the first exploration of the water column by performing several midwater transects at depths ranging from 350 meters to 4000 meters to collect critical information in this vast biome. Transects at 4000 meters were also the deepest midwater exploration ever conducted. The majority of organisms identified during these transects were new records for the Mariana region, rare observations, or potential new species indicating an active but largely unknown pelagic community. Midwater transects at the site known as Subducting Guyot 1 within the Trench Unit of the Marianas Trench Marine National Monument yielded very little at 4000 meters but the number and diversity of plankton and organic particles increased at shallower depths. Mid-depth transects (2000 meters and 3000 meters) documented siphonophores and shrimp. During the transects at 800 meters, 1000 meters, and 1200 meters transects, fauna observed included fish, ctenophores, hydromedusae jellyfish, and siphonophores. Larvaceans (pelagic tunicates) were present throughout all depths surveyed. Midwater transects over the petite-spot volcano in the Trench Unit yielded many of the same taxa as seen at Subducting Guyot 1 but also included chaetognaths (arrow worms), foraminifera, radiolarians, siphonophores, and cephalopods.

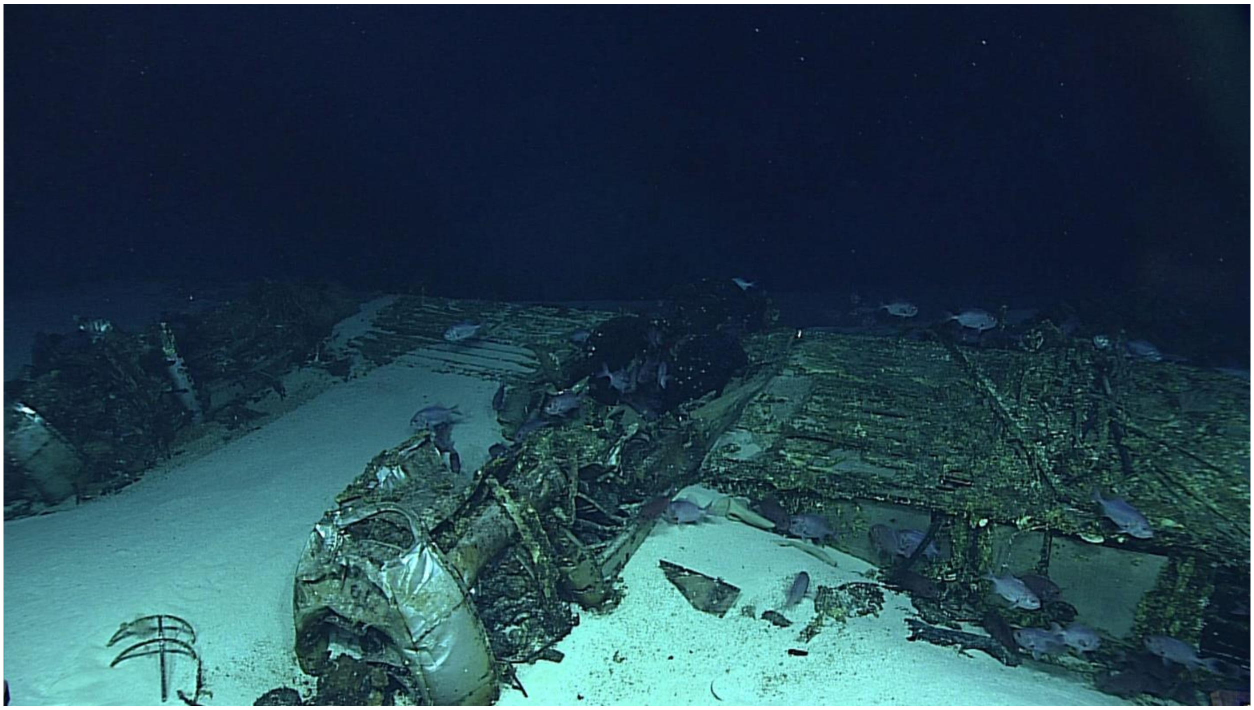

This unidentified jellyfish was spotted during water column exploration at a petit-spot volcano. *NOAA Office of Ocean Exploration and Research.*

Although the trench and other deep ocean areas of the US EEZ surrounding the Commonwealth of the Northern Mariana Islands and Marianas Trench Marine National Monument are remote, they are connected to the atmosphere, sea surface and rest of the ocean in many ways. One of the most important of these is the biological pump, a key ecosystem service provided by the deep ocean, which is essential for sequestering carbon from the atmosphere. The biological pump has been one of the major buffers against climate change, transferring approximately 5-15 GT C yr^{-1} from the surface ocean to the oceans interior worldwide[91] and without it we believe that atmospheric CO_2 would be 200ppm higher[92]. The biological pump consists of the photosynthetic fixation of carbon in the upper ocean by phytoplankton, followed by the sinking of dead and waste material into the deep ocean due to gravitational settling[93]. Any fixed carbon that makes it to the deep seafloor or are decomposed by bacteria during sinking are remineralized to be used again in primary production. The particles that escape these processes are sequestered in the deep sediment and may remain there for thousands of years.

It is this sequestered carbon that is responsible for ultimately lowering atmospheric carbon dioxide[94]. This biological pump is also linked to the supply of most of the food to the deep seafloor. Nearly all of the food of deep-sea organisms, including those living in the depths of the Trench Unit, arrive from the sea surface via this biological pump[95]. Occasionally, larger pieces of food, such as trees, and dead whales or fish sink from the ocean surface, feeding the deep-sea community for as much as 100 years[96]. Ultimately however, the food supply to most of the deep ocean from the surface is low, decreasing with increasing depth, and therefore results in a low abundance of animals relative to much shallower areas[97]. This connectivity of the sea surface with the deep seafloor has other implications also. This results in marine debris (especially plastics) ending up in the deep ocean where the decomposition process can be very slow[98]. There were many pieces of trash observed during the 2016 *Okeanos Explorer* expedition, especially in the Trench Unit. Trenches, like canyons, can act as conduits, concentrating trash in certain areas.

The Marianas Trench Marine National Monument and US EEZ surrounding the Commonwealth of the Northern Mariana Islands are undoubtedly home to many cultural and historical sites. During the 2016 expedition of the *Okeanos Explorer*, a B-29 *Superfortress* bomber plane from World War II was located in the channel between Tinian and Saipan. These are likely quite common given the significance of the region during WWII. This site, and all as yet undiscovered, represent the final stages of the war, a historically significant time in American history, and are of interest to the Department of Defense POW/MIA Accounting Agency, Saipan Historic Preservation Office, National Park Service, U.S. Navy, U.S Air Force, and several universities and foundations working to identify crash sites for the families of lost servicemen. This site was also biologically significant as it housed a large community of sessile and mobile animals, which included many commercially valuable fishes.

The discoveries from the limited deep-sea research expeditions in the US EEZ surrounding the Commonwealth of the Northern Mariana Islands have been numerous, scientifically captivating, and often visually stunning. It is clear that the deep ocean of the CNMI and Marianas Trench Marine National Monument is extremely unique, with geology and biology found nowhere else on the planet, and still much more left to be discovered.



A B-29 Superfortress lost in the vicinity of Saipan. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Notable Deep-sea Species from the Marianas Trench

The deepest reaches of the Marianas Trench are almost completely unexplored. What few expeditions have probed the depths of the planet's deepest canyon have turned up new and surprising species, occasionally redefining our understanding of life on earth.

The hadal snailfish (*Pseudoliparis* sp.), observed at over 5 miles deep, is the deepest-living vertebrate. Prior to its discovery, it was thought the no fish could survive, at that depth, a limit which has since been revised[99].

This fish, of the family Aphyonidae, had never been seen alive before. *NOAA Office of Ocean Exploration and Research.*

During James Cameron's dive to the bottom of Challenger Deep, he observed an undescribed species of sea cucumber at almost 7 miles deep. These animals appear to rely on filter feeding, extending feeding tentacles into the water column to collect particulate organic matter. Currently undescribed, these sea cucumbers almost certainly represent a new species, if not a new genus.

Among some of the most surprising and enigmatic creatures of the deep Marianas Trench are Xenophyophores. These large, sponge-like creatures are actually single-celled protists, similar to amoebas. The size of softballs, they are the largest single-celled organism in the world.

Perhaps the most tantalizing prospect for scientific discovery in the Marianas Trench lies in its stunning microbial biodiversity. Studies of non-extremophilic sediment isolated thousands of microbes, including actinomycetes, fungi, non-extremophilic bacteria, and extremophilic bacteria like alkaliphiles, thermophiles, and psychrophiles[100]. These microbial discoveries have the promise of new and novel pharmaceutical compounds which can only be revealed through fundamental research in protected marine regions.

Microbes aren't the only organisms that may reveal new medical compounds. Spoonworms, common throughout the trench, have been investigated as a potential source of new antibiotic and virucidal compounds as well as for anti-tumor drugs[101]. Meanwhile, the giant amphipods discovered in the nearby Great Britain Trench produce a compound called scyllo-inositol, which, in the ocean allows species to survive at tremendous pressure, but also inhibits the production of brain plaque, which makes it a promising treatment for Alzheimer's disease[102].

This octopus was seen at Ahyi Seamount. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Current and Future Threats

Climate Change

The amount of carbon in the atmosphere is higher today than at any time in the last 400,000 years[103]. The global concentration of carbon dioxide in the atmosphere surpassed 400 parts per million in 2013[104]. Monthly average data from Mauna Loa over the past five years show the steadily increasing concentration of atmospheric carbon dioxide (figure from Mauna Loa, NOAA)[105]. Further, the atmospheric partial pressure of carbon dioxide, or pCO_2 correlates with a decrease in pH, or increase in acidity of the ocean[106]. Estimates vary, but the ocean absorbs between twenty six percent[107] to half[108] of all carbon dioxide released into the atmosphere.

The chemistry of carbon dioxide dissolving into the ocean is affected by local conditions of temperature, nutrients, ocean circulation and the surrounding biogeochemical community[109,110]. Determining exactly what happens in a particular area is complicated and of course depends on species composition and resilience, however, both field and laboratory experiments point to acidification as responsible for reducing the availability of carbonate to organisms that produce calcium carbonate structures including corals, molluscs, coccolithophores, and calcareous seaweeds[111].

Ocean acidification is the insidious side effect of excess atmospheric carbon dioxide. It promises to disrupt formation of coral reefs and stability of food webs, resulting in ecosystem damage and food security issues[112]. Immediately taking steps to decrease the concentration of atmospheric carbon dioxide is practically the only way to slow the effects of ocean acidification, however, protecting large expanses of reefs from fishing and other extraction activities would also help maintain the biodiversity needed to buffer or ameliorate the effects of ocean acidification[113].

Along with warming, these increases in carbon dioxide are contributing to ocean acidification, deoxygenation, and sea level rise.

Large, strongly protected marine reserves have emerged as important policy solutions which carry the dual benefit of being both marine climate change mitigation and adaptation strategies. By increasing ocean health, marine reserves are one of the most efficient means to protect Earth and its climate. Fully-intact marine ecosystems, such as those protected by marine reserves, are healthy and resilient, better able to withstand the impacts of climate change. On the other hand, damaged ecosystems are weak and susceptible to further destruction and disease.

Scientists have suggested that attempts to spare coral reefs from the impacts of climate change by solely reducing emissions have little impact unless protected areas are also established in lockstep with policies that guard essential fish communities, and thus protect healthy reef functioning[114]. For example, in the large, fully-protected reserve in the Indian Ocean around the Chagos Islands, healthy lagoon habitat was critical to coral reef resilience to a large-scale warming event, enabling these ecosystems to recover from this unanticipated environmental shock[115].

While the Marianas Archipelago coral habitats are relatively isolated, they are still threatened by the effects of climate change. The tropical Pacific has warmed substantially over the past 50 years and the intensified hydrological cycle has reduced the salinity of an area in the Central Pacific Ocean called the Pacific Warming Pool[116], posing a considerable threat to the corals of the region[117].

Additionally, as surface water temperatures and environmental conditions change, we tend to see the ranges of fish and fisheries shift toward cooler waters[118,119,120,121,122] affecting fishery health[123], food security, and the economics of fishing[124]. In a study conducted in 2012, scientists observed a northward range shift in various species of fish in the northeastern U.S. with increases in surface water temperature[125]. In the Pacific, the expansion of the Pacific Warming Pool due to climate change is expected to push fish north and east[126]. Given this observed relationship, climate change can pose a huge threat to species that need very specific environmental conditions (e.g. temperature, prey availability, mates) in order to survive, therefore shifting their ranges could prove disastrous if they are being heavily fished[127]. With these temperature and environmental perturbations expected to intensify in the Pacific[128], creation of the Marianas Trench National Marine Sanctuary could provide a climate refuge for these marine species.

It is also important to note that it will take between 25-50 years for ocean chemistry to reach equilibrium with atmospheric carbon emissions, and that there will be a “stopping distance” between when we curb our carbon emissions and when coral reefs start getting healthier[129]. If we wait until problems are visible and acute, they may become irreversible. We should protect the ecosystem now to the greatest extent possible.

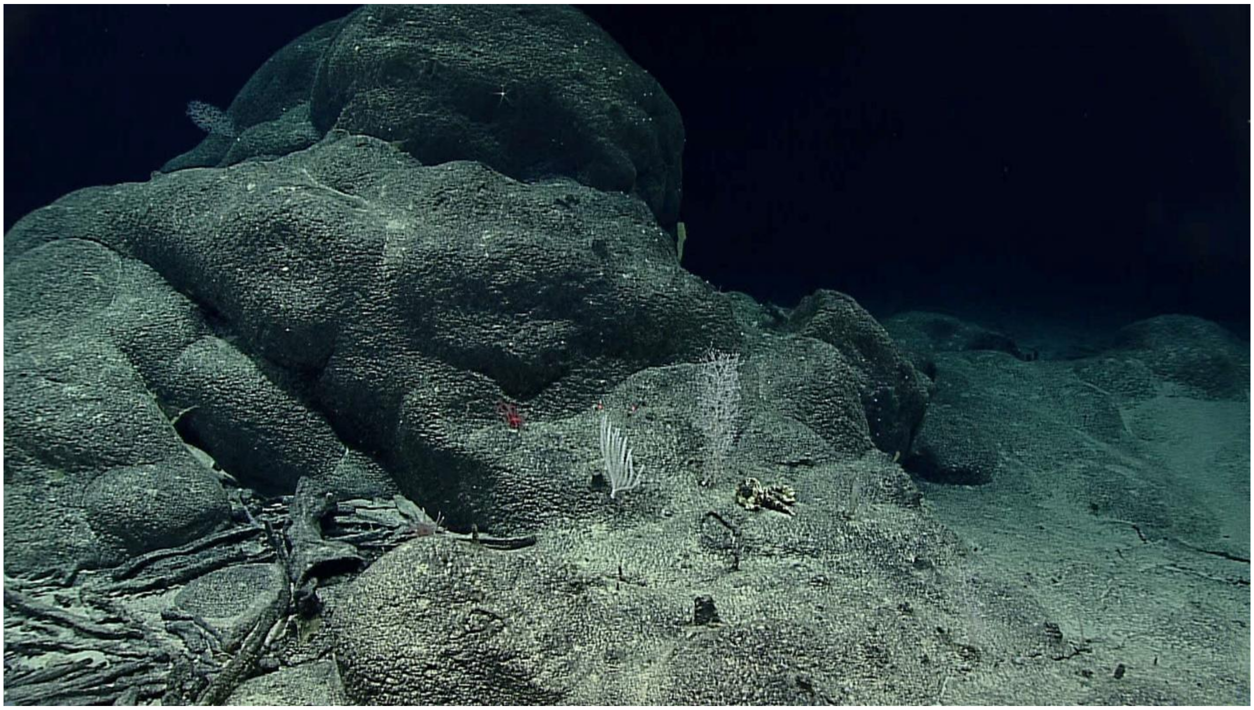
Temperature anomalies present another significant threat to the marine environment. Elevated sea surface temperatures may be linked to coral bleaching events reported throughout the tropical Pacific in recent years. These bleaching events place stress on corals, making them more susceptible to disease.

An additional concern is that the species that inhabit Pacific islands are particularly vulnerable to sea level rise. In a 2012 USGS report, models predicted a rise of approximately one meter in global sea level by 2100, which would result in a loss of 4% of the total island area. In an even more severe scenario, islands would lose up to 26% of land with a two meter increase in global sea level, land which various species of seabird depend on as breeding colonies[130]. Additionally, neighboring coral reef archipelagos in the Pacific, such as the North Western Hawaiian Islands, have on record experienced two episodes of coral bleaching[131]. Threats such as these are a major source of concern in maintaining biodiversity.

Seventy one percent of the Earth's surface is covered by ocean. It is the planet's largest ecosystem and plays a crucial role as a climate regulator. The ocean's role in the global carbon cycle is critical - it is by far the biggest carbon sink in the world; over the past 200 years the ocean has accumulated twenty six percent[132] to half[133] of atmospheric carbon emissions. While it has suffered some damage as a result, the ocean has significantly reduced, and mitigated, the impacts of increasing concentrations of atmospheric carbon dioxide.

To an extent, the impacts of climate change have been set in motion, and will continue to affect the ocean and its ability to withstand environmental stress for years to come. However, scientists are discovering that marine life acts as the "biological pump" of the ocean – converting carbon dioxide into living matter – and could serve just as important of a role, if not more, as a carbon sink as the physical and chemical marine processes that drive the solubility of atmospheric carbon dioxide[134]. In fact, this biological pump accounts for about two-thirds of the flux of carbon within the ocean[135] (see section on 'Deep Ocean').

A new study focuses specifically on the role of marine life in the carbon cycle. The study identifies eight key ways that life ranging from photosynthetic primary producers – that convert sunlight into essential building blocks – to the top predators of marine ecosystems act as carbon sinks. Most notably, this work highlights the role of food web dynamics and marine life biomass in carbon storage[136]. In addition, this study and others have demonstrated that the ability of bony fish to metabolize carbon into calcium carbonate provides a much needed buffer against ocean acidification, accounting for as much as 45 percent of surface ocean carbonate[137]. There is also evidence to suggest that intact predator populations are critical to maintaining or growing reserves of carbon stored in coastal or marine ecosystems, and policy and management need to be improved to reflect these realities[138]. Therefore, using marine reserves as a tool to protect marine life appears to better support the ocean's ability to combat, and recover from, climate change. By keeping marine life in the water, marine reserves also support the ocean's continued role as a biological pump in the carbon cycle.



Ferromanganese crusts draping rocks (and even old sponge stalks) at Fryer Guyot. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Deep-sea Mining

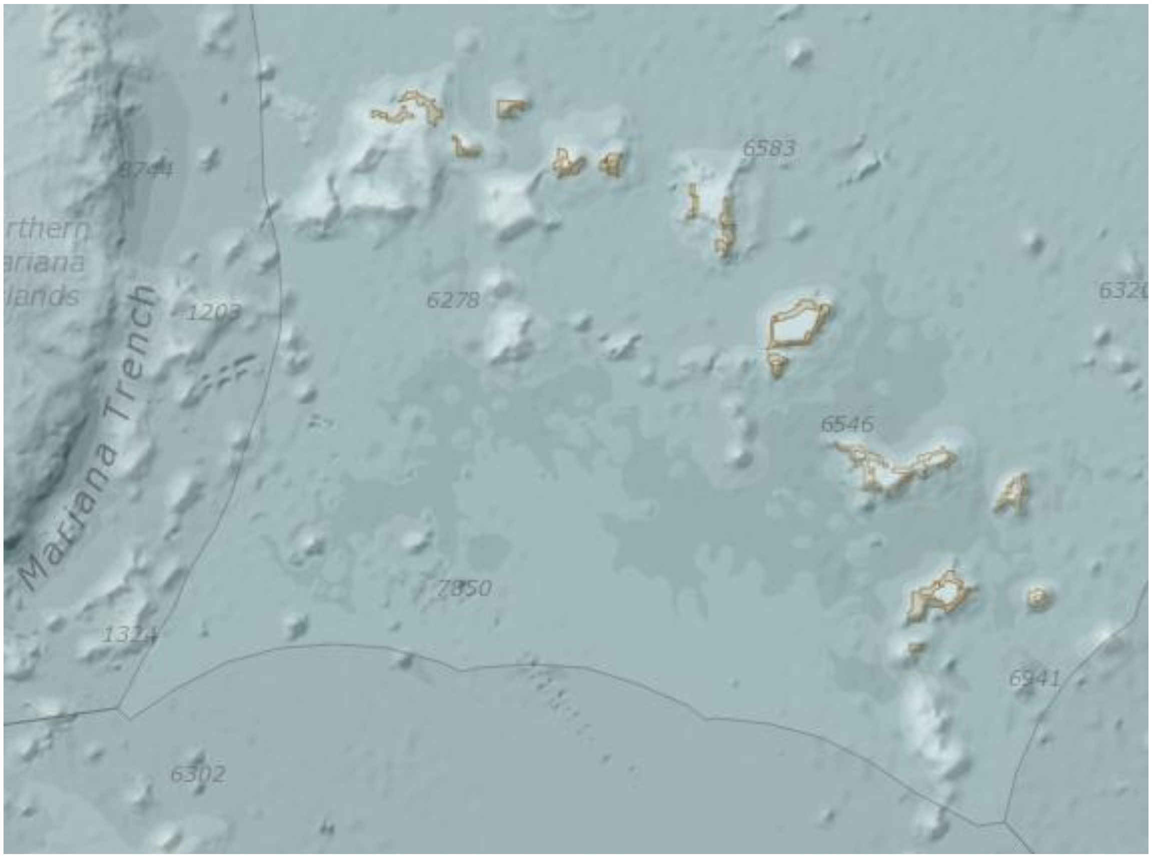
As the worldwide demand for metals increases, humans are seeking these resources in ever more remote places, such as the deep ocean[139]. Although deep-sea mining is prohibited within the Marianas Trench Marine National Monument, the water column and benthos, as well as their inhabitants, are still vulnerable to the severe effects of mining in neighboring waters. Within the EEZ of the CNMI, as well as just outside, there are two sources of metals that could be mined in the future: ferromanganese crusts and seafloor massive sulfides.

East of the Marianas Trench Marine National Monument, both within and outside of the EEZ, there are many deep-sea flat-topped seamounts, known as guyots, covered in thick ferromanganese crusts. These crusts are potential sources of cobalt, copper, manganese, platinum and other metals[140]. These guyots, located in the Prime Crust Zone, are extremely vulnerable to deep-sea mining, as they are among the oldest and thickest in the Pacific Ocean, and therefore potentially some of the most valuable on the planet[141]. In international waters, just to the east of the CNMI, there have already been three exploratory licenses granted to Japan, Russia, and China[142].

> "Because of the great expense involved in exploring the deep sea, industrial exploitation is primed to get there first. Without comprehensive protection for sites of exceptional biological diversity, we may never know the value of what we lost."

West of the Marianas Trench Marine National Monument within the US EEZ surrounding the Commonwealth of the Northern Mariana Islands, there are numerous massive polymetallic-sulphide deposits at sites of hydrothermal venting, another potentially valuable metal resource. These deposits are known to have high concentrations of zinc, copper, cadmium, gold, silver and other metals[143]. A number of both hydrothermal and ferromanganese-encrusted sites within the Marianas Trench Marine National Monument and US EEZ surrounding the Commonwealth of the Northern Mariana Islands were investigated by the NOAA Ship *Okeanos Explorer* in 2016, highlighting the high diversity of animals that live at these unique deep-sea habitats. The guyots appeared to host unique communities which is interesting from a management perspective, however only a small area of each was investigated.

Given the close proximity of the Marianas Trench Marine National Monument to areas that may be mined in the future, adverse ecological impacts are still possible. Deep-sea mining will be extremely destructive; the process involves the removal of the top mineral-rich layer of the substrate along with all of the benthic animals that may be living on it[144]. Sediment and rock particles will be suspended by machinery, forming sediment plumes that travel with currents in the water column and are then deposited on the benthos across wider areas, potentially within the Marianas Trench Marine National Monument[145]. After the processing of mined material on surface support vessels, tailings will likely be deposited at depth in the water column, again creating further large sediment plumes[146]. If done in close proximity to the Marianas Trench Marine National Monument, this could smother both animals in the water column, as well as on the seafloor. The mining machinery will also result in high levels of noise and light pollution in the deep ocean[147,148]. Furthermore, the strategic location of the CNMI may result in some of the islands serving as bases for the mining operations, leading to a large increase in ship traffic within and near to the Marianas Trench Marine National Monument, compounding the issue of noise pollution and possibly resulting in an increase in marine debris and the possibility of accidents. These impacts could impact fisheries, marine mammals, turtles, sharks and other pelagics in the water column.



Current ISA issued lease blocks for deep-sea mining in international waters near the Marianas Trench Marine National Monument. Via https://deepseaminingwatch.msi.ucsb.edu

Fishing

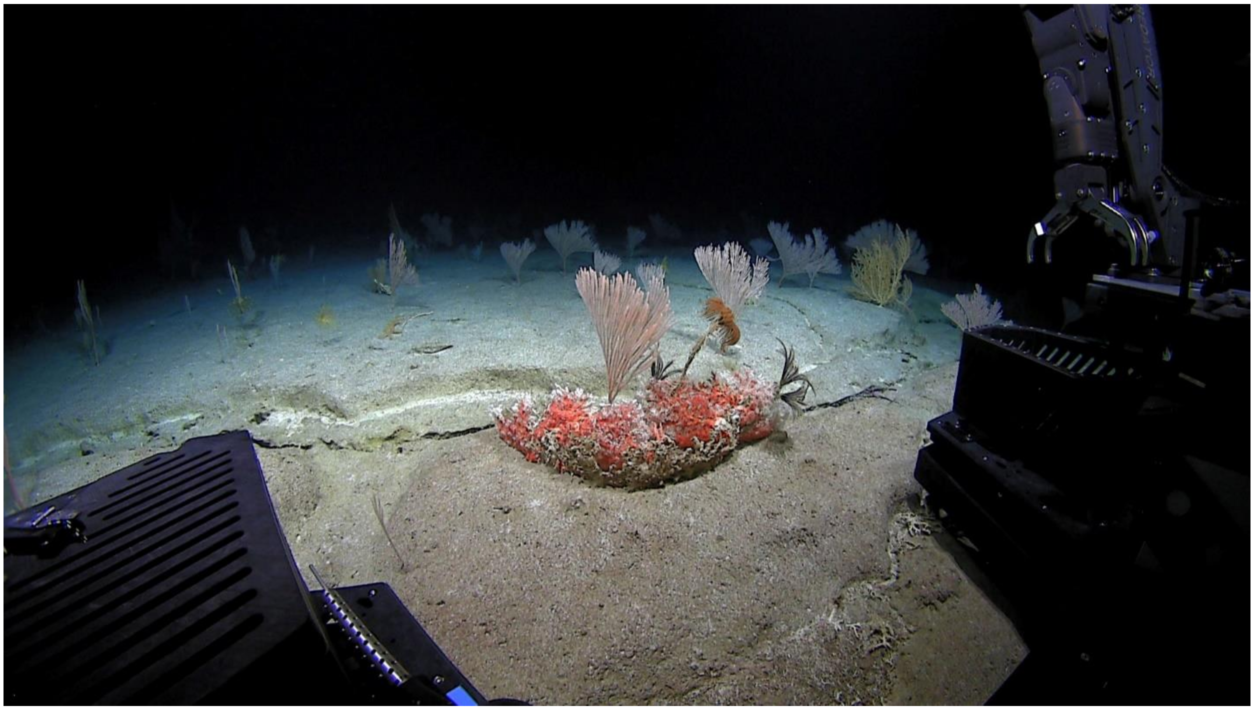
Currently, there is no longline fishing taking place in the CNMI or Guam. Small scale commercial and recreational boats are not active in waters above the trench unit.

Ancient Chamorros [and Carolinians both] relied heavily on the resources of the seas for their subsistence. They had a great variety of fishing equipment and many methods of catching fish. Some of the fishing methods are unique to the aborigines of the Mariana Islands. Juan Pobre de Zamora (1602), Spanish priest, described the Chamorros as "the most skilled fishermen ever to have been discovered[149]."

While the majority of the fishing was coastal, fishing for subsistence while traveling was a necessity. There were restrictions on catches and types of fishing allowed during certain times of year. Any excess catch would be shared with, not sold to, the village and/or salt cured. Different areas were off limits during different times of year and fishing was organized by a caste system with the lowest element forbidden to even touch the sea. Other people were allowed only in the shallows, while yet others (those highest in the system) were granted access rights to the deep sea. Men fished the waters while women would collect sea life from the shallow reefs. Of those granted rights to fish, fishing areas were owned by clans or matrilineages[150].

Today, fishing is still very much a part of Chamorro and Carolinian cultures as with all Pacific island nations. There are fishing derbies and family outings. Fishing for the purposes of subsistence living is inter-mixed with a reliance on store bought canned and boxed foods. There are small scale commercial fisheries focused on catching fish to sell to local restaurants, but they rarely venture to the monument waters. Most fish are caught and sold locally within a confined radius around the southern Mariana Islands. While a couple of attempts have been made at creating a local commercial fishery post WWII, these have not been successful[151].

During the 2016 expedition by the NOAA ship *Okeanos Explorer*, a number of commercially-viable fish species were seen inside and outside the Marianas Trench Marine National Monument. These included the pale snapper (*Etelis radiosus*), deepwater longtail red snapper (*E. coruscans*), deepwater red snapper (*E. carbunculus*), eightbar grouper (*Hyporthodus octofasciatus*), amberjack (*Seriola* sp.), dogtooth tuna (*Gymnosarda unicolor),* monchong or sickle pomfret (*Taractichthys steindachneri)*, roughy (*Hoplostethus* sp.), oblique-banded snapper (*Pristipomoides zonatus)*, ornate jobfish (*Pristipomoides argyrogrammicus)*, goldflag jobfish (*Pristipomoides auricilla*), and golden grouper (*Saloptia powelli)*. There were also a number of precious corals observed (including pink, red, black, gold and bamboo coral), although fewer than expected. Precious corals are extremely long lived (some species have been known to live over 2,000 years) and slow growing. Although the precious-coral fishery is listed as a managed fishery in Guam and the CNMI, no known harvesting in this region of the Pacific is known to occur.



The low, wide coral toward the bottom of the photo is a precious red coral (Corallium sp.). These corals are prized as jewelry and vulnerable to overexploitation. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

This shrimp is a species in the family Stylodactylidae. The strange setose appendages and the long-toothed rostrum are characteristic of the species. *NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.*

Conclusion

President Barack Obama has a unique opportunity to create the only marine protected area in the world that encompasses the full range of vertical regions in the ocean, from the surface to the abyss. Expanding the Trench and Volcanic Units or the Marianas Trench Marine National Monument will meet the United States' commitment to the Micronesia Challenge for the Commonwealth of the Northern Mariana Islands and Guam. The waters around the Northern Marianas Islands are one of the preeminent biodiversity targets for protection within the United States' EEZ.

The proposed expansion contains assets of considerable cultural, historic, and scientific value, from traditional navigational routes to as-yet unexplored deep-sea resources. The area contains essential habitat for resident and migratory birds, whales, sharks, and threatened sea turtles. The seabed, which, though it has direct protection, is still vulnerable to any impact to the overriding water column, contains some of the rarest deep-sea creatures in the world and holds a staggering amount of undiscovered biodiversity. An uncounted number of seamounts, hydrothermal vents, and geologic formations are still waiting to be explored.

These protections can be put in place with almost no disruption to the commercial fishing industry, which has minimal presence in the area. There is no evidence that a marine protected area above the current Monument would reduce fish catches, as longlining efforts are distributed across the Pacific to target migratory species. NOAA data from the Pacific Remote Islands Marine National Monument strongly supports this claim. Upon creation of that monument, fishing effort simply shifted to the 98% of the ocean still open to fishing.

Decades of scientific evidence point to solutions to better manage our ocean fisheries, and that message is clear: large, remote marine reserves work and prove to be beneficial, not a hardship, to fishermen. No negative impacts on US fisheries landings has resulted from previous designations of fully-protected marine reserves throughout Pacific States and Territories. The creation and expansion of the Papahānaumokuākea Marine National Monument as well as the creation of the Pacific Remote Islands Marine National Monument have demonstrated no adverse effects to fisheries bottom line. Rather, these no-take zones serve as insurance policies for commercial fishing viability into the future.

There is rigorous scientific, as well as historic and cultural reasons to expand the Trench and Volcano Units of the Marianas Trench Marine National Monument. The arguments against expansion are unconvincing and driven by the politics and financial incentives of a few who would seek to exploit the scientific and cultural resource of the Commonwealth of the Northern Mariana Islands for short term gains. It is time to finish the work of protecting this precious resource and complete an environmental legacy for the people of the Mariana Islands, the United States, and the world.

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