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Expansion of the **Pacific Remote Islands Marine National Monument**

Honoring Cultural and Biological Legacies

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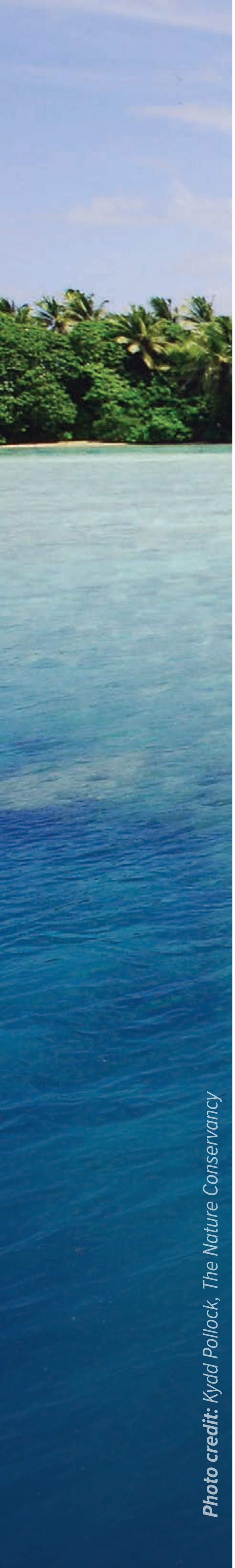
Hillary Young, James Murphy, Robin Baird, David Benavente, Alan Friedlander, Yimnang Golbuu, Mark Hixon, Sol Kahoʻohalahala, Kekuewa Kikiloi, Brian Kennedy, Douglas McCauley, Lance Morgan, Robert Richmond, Randi Rotjan, Scott Shaffer, Enric Sala, Gorka Sancho, and Sara Maxwell



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AUTHORS

Hillary Young, Professor, UC Santa Barbara. Expertise in community ecology, ecosystem connectivity, avian ecology, and wildlife conservation.

James W Akana Murphy, Researcher and Consultant. Expertise in marine biology, molecular biosciences, and coral and coral reef ecology.

Robin W. Baird, Research Biologist, Cascadia Research Collective, and Associate Faculty, Hawai'i Institute of Marine Biology. Expertise in cetacean behavior, ecology and management.

David Benavente, Program Manager, Mariana Islands Nature Alliance. Expertise in coral reef fish ecology, marine management, marine conservation, local capacity building.

Alan Friedlander, Chief Scientist, National Geographic Pristine Seas and Researcher, Hawai'i Institute of Marine Biology. Expertise in marine ecology, fisheries, ocean exploration and technology, and conservation.

Yimnang Golbuu, Chief Executive Officer, Palau International Coral Reef Center. Expertise in coral reef ecology, climate change, marine conservation.

Mark Hixon, past chair of the MPA Federal Advisory Committee, Professor and Hsiao Endowed Chair of Marine Biology, University of Hawai'i at Mānoa. Expertise in marine ecology, marine conservation biology, coral reef conservation.

Sol Kaho'ohalahala, Native Hawaiian Community Group Member, Pacific Remote Islands National Marine Monument; Member of Papahānaumokuākea National Marine Monument Reserve Advisory Council; and Chairman and Lanai Island Representative for the Humpback Whale National Marine Sanctuary Advisory Council. Expertise in Hawaiian resource management, indigenous knowledge, and cultural resource management.

Kekuewa Kikiloi, Associate Professor, Hawai'inuiākea School of Hawaiian Knowledge. Expertise in Hawaiian resource management, indigenous knowledge, traditional society, genealogies, cultural revitalization, and community empowerment.

Brian R.C. Kennedy, PhD researcher, Biology Department Boston University. Expertise in deep-sea ecology, ocean exploration and technology.

Douglas McCauley, Professor, UC Santa Barbara and Director, Benioff Ocean Initiative. Expertise in behavior, ecosystem ecology, marine biology, population and community ecology, and zoology.

Lance Morgan, President, Marine Conservation Institute. Expertise in marine conservation biology, marine ecology, zoology.

Robert Richmond, Director, Kewalo Marine Laboratory, University of Hawai'i at Mānoa. Expertise in marine conservation biology, coral reproductive biology, ecotoxicology, coral reef ecology, large-scale MPAs, the impacts of climate change.

Randi Rotjan, Research Assistant Professor and Senior Lecturer, Boston University and co-Chief Scientist, Phoenix Islands Protected Area Conservation Trust. Expertise in marine ecology, conservation biology, behavioral ecology, organismal physiology, coral reefs.

Scott Shaffer, Professor, San Jose State University. Expertise in physiological ecology of marine vertebrates, biologging, habitat use of marine predators, and coastal and pelagic ecology.

Enric Sala, National Geographic Explorer in Residence and Executive Director, National Geographic Pristine Seas. Expertise in marine ecology, conservation biology, ocean exploration and technology, marine protected areas.

Gorka Sancho, Professor, College of Charleston. Expertise in fish behavioral ecology, fisheries, marine ecology and conservation biology.

Sara Maxwell, Associate Professor, University of Washington. Expertise in marine biology, spatial ecology of large marine species, satellite tracking, oceanographic modeling, and conservation and natural resource management.

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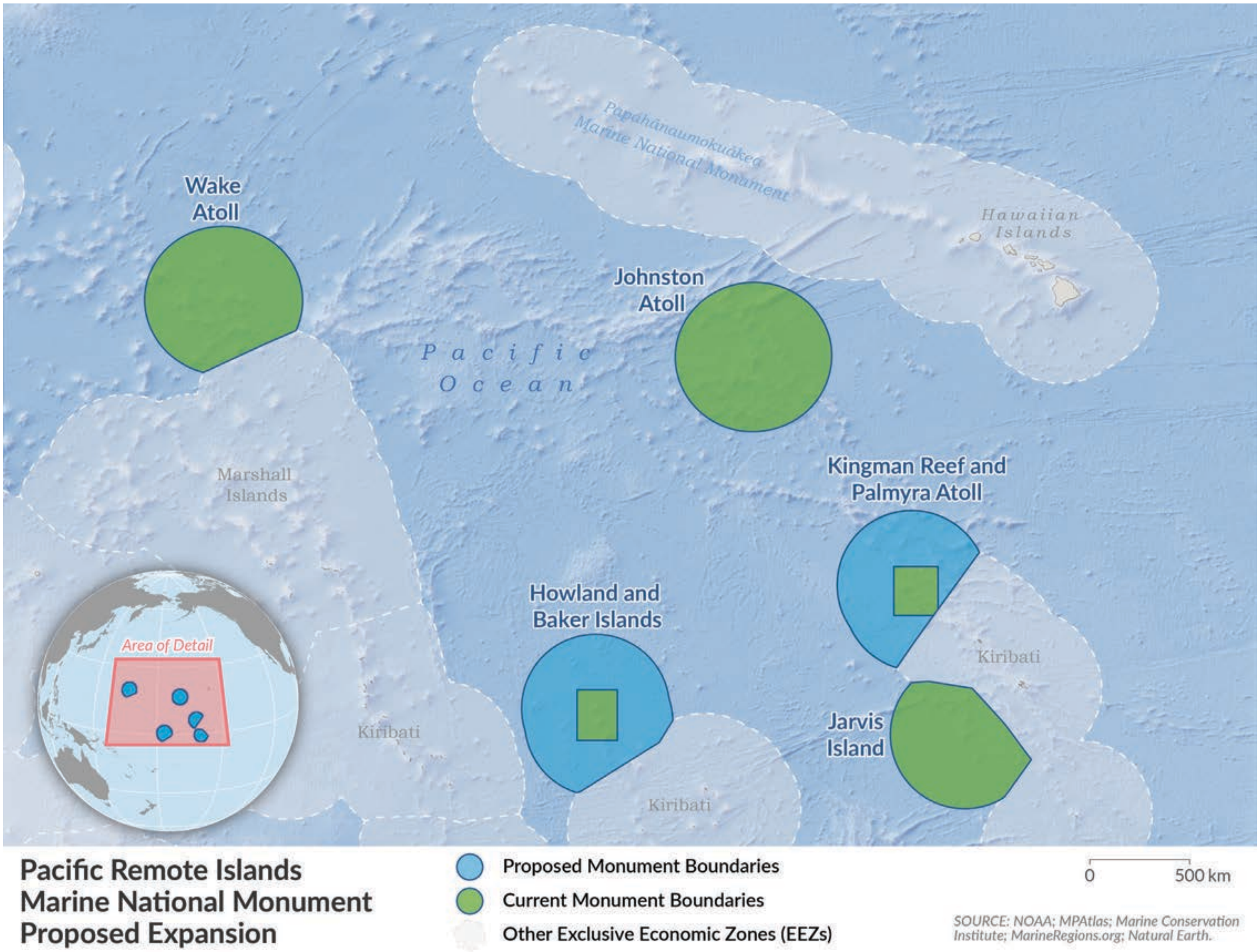
EXECUTIVE SUMMARY

The Pacific Remote Islands contain some of the last wild and healthy ecosystems in the world's ocean. They are places where human activity is distant and habitats teem with life. Here natural processes define where sharks, turtles, whales, and birds roam. These waters were split by the handmade canoes of Indigenous Peoples who used the stars, winds, currents, and life on land and sea to connect with distant resources, cultures, and lands. The bravery and sacrifice of 130 Native Hawaiian young men who colonized these lands of strategic importance before and during World War II helped define the footprint of the United States' ocean. Today, these waters are home to resilient coral reef ecosystems reliant on the healthy open ocean ecosystems around them, threatened and endangered wildlife, and deep-sea species found nowhere else on Earth.

The world's ocean faces a biodiversity and climate crisis. The window of opportunity to halt and reverse the worst impacts of climate change is closing. Nature is declining globally at rates unprecedented in human history. Intact natural ecosystems such as the Pacific Remote Islands are more resilient to the effects of climate change and can help in the fight against biodiversity loss.

There is also a global cultural awakening that recognizes the importance of Indigenous knowledge, stories, and cultural connections between lands and peoples, and celebrates the individual nature of cultures. However, the ecosystems on which these cultures depend are at risk, and in many places are disappearing.

In the face of the mounting climate and biodiversity crises and in line with the administration's priority to honor Indigenous and Tribal cultures and practices, President Biden has the authority and opportunity to make history, and honor history. In his first week in office President Biden said, "We have a narrow moment to pursue action at home and abroad in order to avoid the most catastrophic impacts of that crisis and to seize the opportunity that tackling climate change presents." Protecting the area to the full extent of the Exclusive Economic Zone (EEZ) will result in the largest highly protected marine protected area (MPA) in the world. Expanding the remaining two areas of the Pacific Remote Islands Marine National Monument (PRI) will add 686,839 square kilometers of MPA. It will protect blue whales and green sea turtles, and critically endangered species like Newell's shearwater and oceanic whitetip shark. It will allow us to better understand the effects of climate change in a system driven by nature alone. And by protecting these waters, President Biden will honor a critical cultural voyaging seascape that connects traditional navigating practices from centuries before with people of today and for generations to follow.



CURRENT PROTECTIONS

President George W. Bush established the Pacific Remote Islands Marine National Monument in 2009 under the Antiquities Act in recognition that these areas encompass pristine coral reefs and deep reefs of global ecological importance. PRI encompasses five management units: Wake Island, Johnston Atoll, Palmyra Atoll and Kingman Reef, Howland and Baker Islands, and Jarvis Island. The original 2009 monument extended 50 nautical miles around each site for a total of 86,888 square miles. In 2014, recognizing the importance of the deep sea and pelagic environments as the site of slow-growing, rare, and diverse species and ecosystems, President Barack Obama expanded three of these five management units (Wake, Johnston and Jarvis) to 200 nautical miles (or the edge of the U.S. EEZ waters), creating a monument totaling 495,189 square miles. The monument waters are permanently closed to resource extraction, such as deep-sea mining and commercial fishing, and open to limited amounts of permitted recreational fishing. With this and other U.S. Pacific monument expansions, the United States has shown that the world's best-managed fisheries and large protected areas can co-exist. Recent evidence shows that these monument designations have not harmed U.S. fisheries, and likely benefited them.

When President Obama expanded protection for PRI in 2014, the original 50 nautical mile boundary remained in place at two management units (Palmyra Atoll and Kingman Reef, and Howland and Baker Island), leaving the majority of the waters in the EEZ around these sites open to future exploitation. There was no clear biological justification for the lack of expansion in these important pelagic and deep water ecosystems. Given new research strengthening our understanding of the connections between these ecosystems and the nearshore, protected portion of the units, and new data on the biological value and richness of the deep-sea environment, it is critical to provide additional protection for these resources now.

INTERCONNECTED ECOSYSTEMS

The pelagic communities in the 50-200 nautical mile U.S. EEZ of the two remaining units contribute significantly to the continued health of nearshore protected ecosystems within PRI. Underwater seamounts create chlorophyll-rich productivity hotspots that drive bottom-up effects across ecosystems, providing benefits to both pelagic and nearshore fish communities. Seabirds that forage on pelagic fish bring vital nutrients back to their island nesting grounds, fertilizing these remote islands with their guano and transforming and promoting diversity in both terrestrial and inshore ecosystems. Coral reefs and their communities then take up these seabird nutrients, causing reef-building corals to grow four times faster in reefs with seabirds than those without, and contributing to larger populations of herbivorous fish. This in turn increases grazing and bioerosion processes that are essential to the long-term health of coral reefs.

The currently protected coral reefs of PRI are vulnerable to disruptions in pelagic productivity in the unprotected waters beyond its boundaries. The seabirds that connect these disparate ecosystems often entirely depend on tuna and other large predators to drive small pelagic food sources to the surface where seabirds can forage. Commercial fisheries target many of these open ocean predators, and seabirds themselves can be caught as bycatch by longline vessels. In addition, the many species of threatened and endangered sharks and manta rays that range between coral reefs and open ocean are often caught as bycatch in the commercial longline and purse seine fisheries in the region. The deeply interconnected nature of terrestrial, reef, pelagic, and deep-sea ecosystems in this region underscores the importance of meaningfully protecting each of these systems, and the dynamic processes linking them to each other, to the fullest extent possible. It is simply not possible to provide meaningful protection to the inshore coral reef ecosystems of PRI without also protecting the pelagic ecosystems on which they intimately depend.

CONSERVATION VALUE

In addition to their importance to nearshore protected areas of PRI, the unprotected waters themselves contain ecosystems and species of significant global conservation importance. They are home to robust populations of top predators such as several tuna species and at least ten endangered or critically endangered sharks and rays. These waters provide critical information on baseline functioning of reef and pelagic systems with predator communities. They are also home to more than 50 species of seabirds—many considered threatened or endangered—including more than a dozen species known to breed on the protected islands within PRI. The region is an important habitat for a large number of cetaceans, such as sperm whales and spinner dolphins, including the blue whale and many other species considered threatened and endangered. The area also serves as an important migration route for the critically endangered leatherback sea turtle, the largest sea turtle in the world. While many of these species do have large home ranges, there is increasing data to suggest that very large protected areas can effectively protect and even recover these populations.

Most of the deep-sea diversity remains unexplored in this area, with recent expeditions discovering new species on every dive. The data that does exist suggests high density and diverse benthic communities are common, with a great deal of undiscovered and sensitive biodiversity—much of which may be endemic to the region. Expansion of PRI would protect 98 additional seamounts (22 are currently protected within these two units' protected waters), which serve as ecological hotspots for biodiversity and habitat complexity. In addition to their intrinsic value as ancient and unique lifeforms on our planet, deep-sea biodiversity is also the source for a number of important products for biomedicine, discovered and produced using non-exploitative sampling techniques. Discoveries of new species and new habitats suitable for deep-sea communities, in addition to recent biomedical discoveries and those yet to be made, emphasize the value of unprotected deep-sea environments in this region and strongly support the need for extending protection surrounding Palmyra Atoll, Kingman Reef, and Howland and Baker Islands.

CULTURAL AND HISTORICAL VALUE

The Pacific Remote Islands have connected nature and culture since time immemorial. These islands served as stopping points during cross-Pacific migration and voyaging for Native Pacific Islanders pre-colonization, and for commercial and military interests in the modern era. Their distance from populated land and minimal human impact to their biological resources uniquely positions them as a critical location in the Pacific for the learning and practice of traditional voyaging, which is dependent on healthy ecosystems with intact biological indicators such as animal movements and behaviors. Expanding PRI's boundaries to the legal limit of the U.S.

EEZ is an important commitment to the preservation and prosperity of Indigenous cultures, traditional voyaging, and to Pacific Island Nations and neighbors.

In modern history, these waters served as passageways for guano traders and hunting grounds for whalers, the final resting places for ships, the maritime amphitheater for battle in WWII, and the territorial fruits of the dedication of brave Native Hawaiian young men who successfully colonized Howland, Baker, and Jarvis islands. However, the existing protection of this monument is not enough to fully preserve the historical landscape of this region. Expanding PRI to the full boundaries of the U.S. EEZ would afford recognition of these efforts and services in currently unprotected waters, while also facilitating further characterization, documentation, and protection of these activities within the extended monument.

The unprotected waters have to date experienced relatively few local anthropogenic impacts. It is therefore critical to work quickly to permanently protect these intact areas of ocean wilderness against future exploitation now, while impacts and pressure for extraction remain low. Such precaution is especially warranted given the increasing likelihood of deep-sea mining in the future and the rapidly increasing threats of climate change.

THREATS

This area is among the highest valued areas in the world by those with mining interests for its mineral rich crusts and nodules. The Kingman Reef and Palmyra Atoll unit is directly adjacent to the Prime Fe-MN Crust Zone (PCZ), and both units contain "prospective crust zones" within their boundaries— meaning thick crust formations may also have formed and are thus considered to be priority areas for further exploration. As deep-sea mining involves complete removal of the top layer of sediment, it will result in total mortality of deep-sea benthic organisms and the creation of toxic wastewater tailings that will likely have widespread impacts on mid-water pelagic communities. Given the extremely slow recovery of deep-sea benthic communities, expansion of protection prior to this disturbance is key to retaining the integrity of these ecosystems.

Additionally, climate change threatens the integrity of ocean ecosystems globally. Recent studies have suggested that large marine protected areas increase resiliency and the adaptive capacity of ocean ecosystems in the face of climate change by removing additional stressors. Further, these regions in particular offer a nearly unparalleled opportunity to understand the effects of climate change in very healthy tropical marine ecosystems.

With regard to industrial fishing, there is currently a high amount of fisheries pressure just outside the EEZ boundaries of these two units of PRI, with purse seine and longline fisheries making up the primary fishing interests concentrated in the area. There may also be some significant 'flow-through' fishing by purse seine vessel-released drifting fish aggregating devices in protected areas, although this has not yet been quantified and is likely illegal. Protecting this area is ideal because it is both biologically extremely valuable and would cause minimal economic hardship, as the current economic impact of a commercial fisheries closure within the proposed expansion area would likely be minimal.

President Biden has the opportunity to honor Indigenous cultures and practices, bolster the resilience of these important ocean ecosystems in the face of climate change, and protect marine biodiversity from threats poised to grow in the future. Expanding the two remaining areas of PRI to the full extent of the U.S. EEZ would serve as a gift to future generations, and ensure the U.S. continues its strong record of ocean conservation leadership.

***Photo credit:** Kydd Pollock, The Nature Conservancy*

1 | CONNECTED AND DIVERSE MARINE ECOSYSTEMS

The proposed expansion area around Palmyra Atoll and Kingman Reef, and Howland and Baker Islands would protect areas between 50 and 200 nautical miles from any landmass—essentially, an area of open ocean. The open ocean environment is often conceptualized as a homogenous and sometimes barren landscape. In reality, the open ocean is highly heterogeneous across and within geographic areas, with a mix of seamounts, abyssal plains, hadal troughs, and shifting ocean plates. Across these ecosystems are dynamic currents, winds and topography creating varied conditions that are further changed by annual climate variation and interannual El Niño-Southern Oscillation states. The

Photo credit: *Kydd Pollock, The Nature Conservancy*

ecosystems of the open ocean are highly and intricately interconnected both with each other and with the inshore and terrestrial communities. New data—discussed at length below—is bringing into focus the deep dependence of inshore and nearshore environments on pelagic ecosystems.

The areas in which these particular monuments are set are unique and diverse. Specifically, Howland Island and Baker Island, associated with the Phoenix Island archipelago, are located at the western edge of the equatorial cold tongue, characterized by strong trade wind-driven equatorial upwellings. The combination of cool nutrient-rich waters in a very sunlit surface on these equatorial islands makes these waters very productive, with very high chlorophyll-a levels relative to the rest of the Pacific. In contrast, Palmyra Atoll and Kingman Reef of the Line Island Chain sit at the intersection of the North Equatorial Countercurrent (NECC) and at the northernmost boundary of this tropical zone of increased productivity, and experience moderate levels of productivity and significantly warmer temperatures compared to Howland Island and Baker Island (reviewed in Brainard et al 2019). Palmyra Atoll, in particular, experiences strong upwelling from the NECC, and the island mass effect.

In general, atolls and reefs dramatically increase productivity in otherwise low-productivity tropical ocean landscapes. This phenomenon, deemed the island mass effect, is likely driven by a combination of physical (e.g., upwellings caused by reefs) and biotic factors (e.g. increased nutrient inputs from reef and terrestrial associated organisms—such as fish and seabirds). The island mass effect drives increases in phytoplankton biomass by over 86% near these habitats, providing critical energetic resources (Gove et al 2016). While this island mass effect dissipates before the 50-200nm zone of the proposed expansion area, recent work (Leitner et al 2020) shows that seamounts in open ocean areas like those of the proposed area can also drive long-term chlorophyll enhancements of up to 56% (although this is not universal, as reviewed in Clark et al 2010).

Consequences of such increased phytoplankton and productivity have bottom-up effects across ecosystems. For instance, corals and crustose coralline algae are both known to increase when phytoplankton increases, and these effects trickle up to species such as sharks, squid, and fish (Nadon et al 2012, Williams et al 2015). Fisheries around seamounts showing these increases in productivity exhibit catch rates two fold higher than seamounts without them (Leitner et al 2020)—demonstrating how these chlorophyll-derived subsidies create bottom-up effects on the pelagic fish community. Given that climate change is already predicted to drive significant declines in ocean production in Pacific island areas (e.g. Asch et al 2018), protecting these seamounts that can drive increased productivity is likely an important part of protecting pelagic ecosystems as a whole.

There is also increasing awareness of the importance of pelagic environments to coral reef ecosystems (Graham et al 2018, Morais et al 2019, Skinner et al 2021). For example, planktonic production from offshore pelagic environments has recently been shown to form the overwhelming majority of the carbon biomass of reef predators (Skinner et al 2021). The consistency of this result across species and both inshore and outer coral reef environments suggests that these subsidies likely have system-wide importance, providing an answer to long standing questions about how coral reefs persist in such nutrient poor tropical settings (Skinner et al 2021). Similar results from Palmyra Atoll show that sharks seem to be important in transferring nutrients from more offshore environments to coral reef ecosystems (Williams et al 2018).

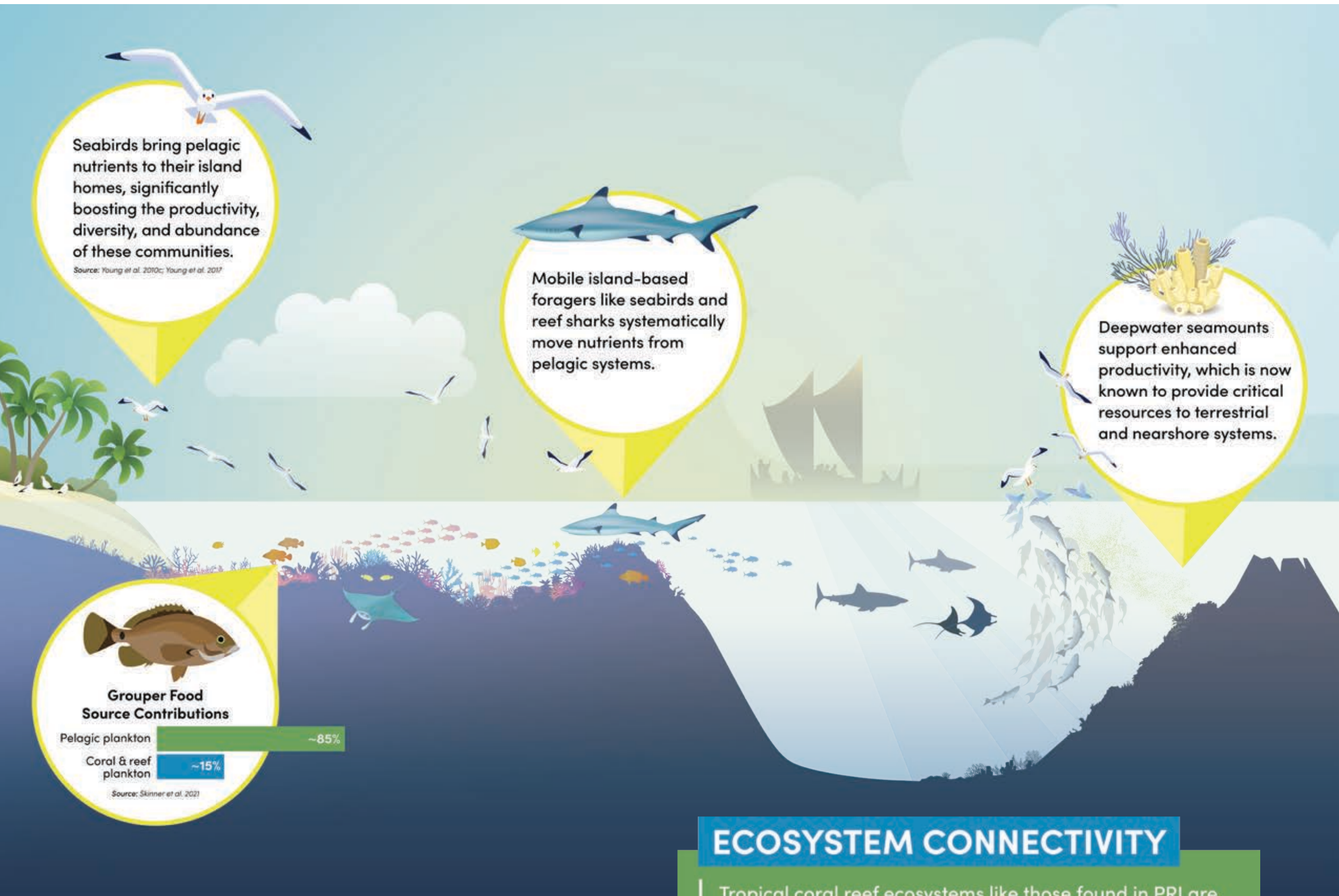
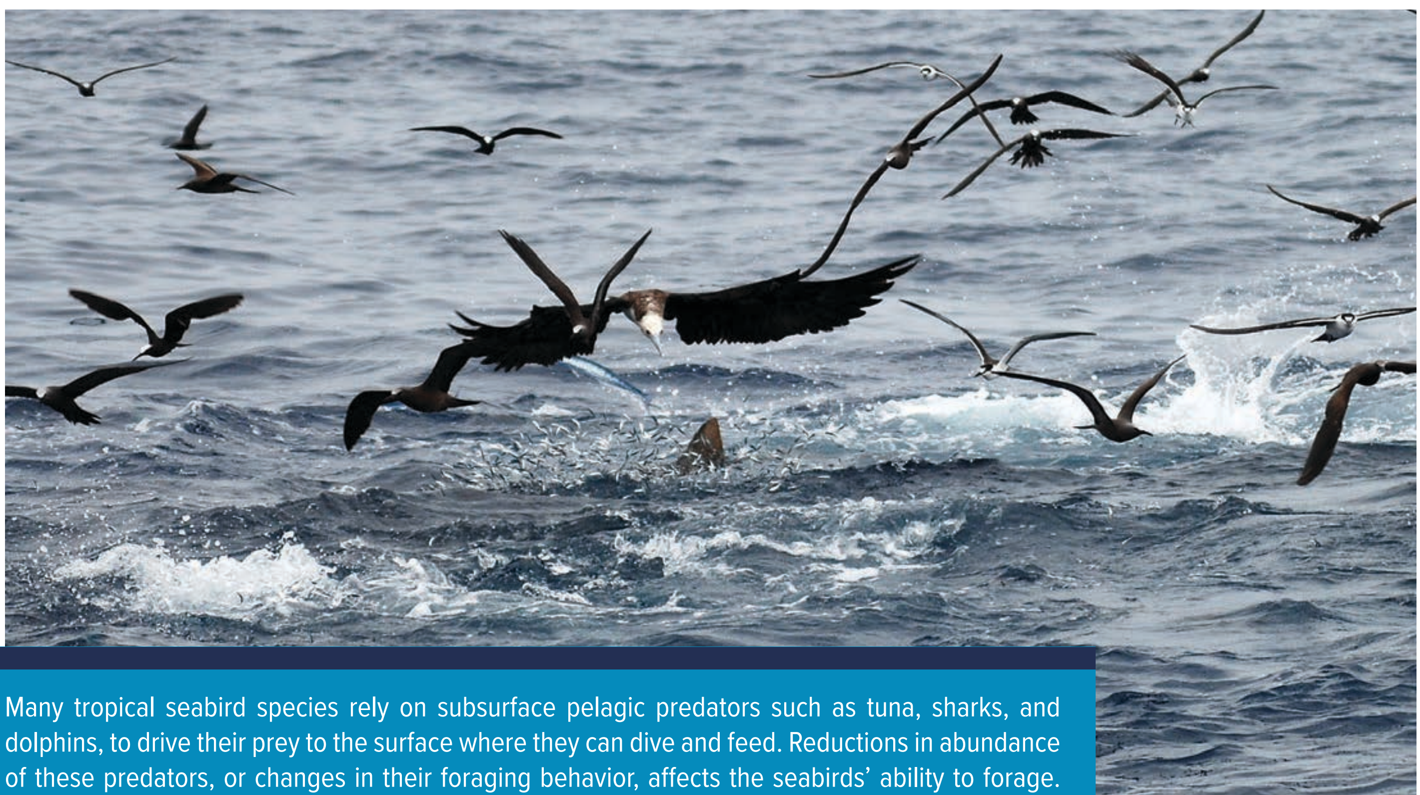


Figure 1. The pelagic communities in the 50-200 nautical mile U.S. EEZ are tightly connected with those of the Palmyra and Kingman Reef and Howland and Baker Island units of PRI. These pelagic areas contribute significantly to the continued health of nearshore protected ecosystems.

This body of work also emphasizes how vulnerable these reefs might be to disruptions in pelagic productivity. Far from being a 'hot-spot' that supports the pelagic environment in a desert of low productivity, coral reefs may be deeply dependent on a healthy pelagic ecosystem (Graham et al 2018, Morais et al 2019, Skinner et al 2019, Skinner et al 2021). These findings echo results from other studies and methods (e.g. McCauley et al 2012c, Bradley et al 2017) that have suggested that even species thought to be fairly obligately tied to coral reefs may in fact be deriving a large portion of their energy from more pelagic areas.

The mechanism by which pelagic ecosystems may subsidize reef productivity is unclear. Some may be by direct foraging—e.g. reef sharks moving to pelagic systems to forage there, or pelagic prey moving onto the reef. However, given the sedentary nature and inshore environments of some of the fish studied, much of this is likely to be indirect or through abiotic movement—e.g. through bottom-up incorporation of pelagic productivity into these food webs through entry points such as planktivorous reef fish consuming plankton originating from pelagic ecosystems, detritus—particularly guano—being consumed and processed in terrestrial or inshore areas and leaching back to reef environments, and/or settlement and predation of pelagic larval fishes by reef consumers. In most cases, mechanisms remain uncertain, and this remains a ripe area for future research.



Many tropical seabird species rely on subsurface pelagic predators such as tuna, sharks, and dolphins, to drive their prey to the surface where they can dive and feed. Reductions in abundance of these predators, or changes in their foraging behavior, affects the seabirds' ability to forage.

Photo credit: *Kydd Pollock, The Nature Conservancy*

Other research has long shown the importance of marine resources to subsidizing both terrestrial and inshore environments. For instance, seabirds in particular are known to transform both terrestrial and inshore ecosystems. These seabirds nest on islands, but travel long distances to forage in surrounding waters. Within Palmyra Atoll, reductions in seabird abundance have been shown to cause reductions in productivity and diversity of plants, and changes in composition, diversity and body condition of both plants and arthropod consumers (Young et al 2010c, 2013, 2017). Their guano also is suggested to drive changes in terrestrial processes such as rates of decomposition and pollination (Fukami et al 2006, Lee et al personal comm). Moreover, the runoff of guano-enriched water into lagoon environments drives increased phytoplankton in these environments, affecting abundance and behavior of rays that are known to be highly pelagic in much of their life (McCauley et al 2012a).

Work in similar systems has also shown that seabird nutrients are assimilated by coral reefs (Lorrain et al 2017), for example, causing reef-building species *Acropora formosa* to grow up to 4 x faster in reefs with seabirds than those without seabirds (Savage 2019). These nutrients also seep into benthic communities—such as turf algae and sponges—which causes a bottom-up subsidy to the fish community and has beneficial cascading effects on ecosystem stability. For instance, herbivorous damselfishes grow faster and have nearly 50% higher biomass overall in sites with seabirds than adjacent sites without seabirds (Graham et al 2018). This in turn causes herbivore-facilitated grazing and bioerosion rates—which are critical processes for the long-term persistence of coral reefs—to be more than 3 times higher on sites with seabirds than sites without large seabird colonies (Graham et al 2018).

The seabirds that connect these disparate ecosystems are often entirely dependent on pelagic food sources, with some species regularly foraging hundreds of miles offshore (e.g. Young et al. 2010a, b, Maxwell and Morgan 2013). Furthermore, many of these species are considered to be obligately dependent on the presence of subsurface predators (Au and Pitman, 1986; Maxwell and Morgan, 2013)—especially, in this system, pelagic sharks and tuna that chase their prey to the surface where they are accessible to the seabirds (Maxwell and Morgan 2013). Thus, the integrity of even the terrestrial and reef ecosystems is tightly and reciprocally linked to the integrity of the pelagic predator community.

Although our awareness of the degree of importance of movement of nutrients across horizontal space—specifically linking pelagic to inshore and nearshore environments—is more recently appreciated, the linkages between pelagic and deep sea environments—across vertical space—have long been recognized. We are well aware of the critical value of daily vertical migrations of zooplankton from deep sea to pelagic zone to deep waters (Hays 2003). Large animals such as cetaceans are also critical in moving volumes of nutrients from deep sea to surface in an upwards nutrient pump, dramatically affecting carbon budgets (Williams et al 2018). Similarly, grey reef sharks dive to depths of at least 120 m in this area (Papastamatiou et al 2018) and yellowfin tuna forage up to two hundred meters in depth (Fonteneau and Hallier 2015, Lam et al 2020). The downward flow of nutrients, detritus and carcasses are thought to be critical in supporting deep-sea biodiversity. The reduction of mesopelagic fish by fishing is thought to decrease deep-sea bottom dwelling organisms by the loss of prey in these food-limited ecosystems.

The deeply interconnected nature of terrestrial, reef, pelagic, and deep-sea ecosystems in this region further demonstrates the importance of meaningfully protecting each of these systems, and the dynamic processes linking them to each other, as anthropogenic disturbance has been to frequently decouple these important linkages (Williams et al 2015).

Manta rays travel great distances through the open ocean and nearshore environments like the lagoons at Palmyra Atoll. Mantas feed exclusively on phytoplankton, and their movements between phytoplankton-rich environments connect the open ocean ecosystems within the U.S. EEZ to the inshore communities of PRI.

LEFT: *Giant oceanic manta rays feeding in phytoplankton-rich waters of Palmyra Atoll.*
Photo credit: *Alex Wegman, The Nature Conservancy*

RIGHT: *Giant oceanic manta rays soar through the open ocean.*
Photo credit: *Shawn Heinrichs, SeaLegacy.*

2 | CONSERVATION VALUE OF THE REGION BY ECOSYSTEM AND TAXA

The ecosystems of Palmyra Atoll, Kingman Reef, Howland Island, and Baker Island are highly biodiverse and are of high global conservation value (Maragos et al 2008). The islands and their surrounding waters host very healthy shallow water coral reef ecosystems (e.g. Sandin et al 2020) surrounded by a diverse and still largely unexplored range of deep water ecosystems.

The deeper water systems between 50 and 200 nautical miles—the area of focus for potential expansion of protections—host rich communities of pelagic and benthic organisms including many vulnerable and endangered species, and many largely unexplored communities. It holds ecosystems that are diverse and valuable, and new species are being discovered on nearly every dive. There are 98 additional seamounts that would be protected with this expansion.

A coral reef around Palmyra Atoll. The coral reefs of Palmyra Atoll, Kingman Reef, and Howland and Baker Islands are large and overall extremely healthy, dominated by reef-building corals and crustose coralline algae.

Photo credit: *Kydd Pollock, The Nature Conservancy*

While some pelagic predator species found in these areas appear to be at a fraction of their historical norms, likely due to regional fishing pressure (e.g. yellowfin tuna, oceanic whitetip and bigeye tuna) other parts of the predator community is still relatively intact with high biomass of top predators, especially reef sharks and some tuna species (e.g. skipjack) (Sandin et al 2008, McCauley et al 2018). PRI is providing critical information on baseline functioning of reef and pelagic systems with robust predator communities. Notably, more than 50 species of seabirds, many considered threatened or endangered, are known to use the waters around the islands, including more than a dozen species known to breed on these sites (Depkin 2002, USFWS 2007 a, b, c, d, Rauzon 2016). These waters are also important habitat for a large number of cetaceans, including many species considered threatened and endangered (Kennedy et al 2021).

While the inshore reef habitats of these sites are variable, they include some of the highest reported cover of live coral, rates of coral recruitment, and diversity of coral in the Pacific as well as regionally rare species of finger corals; coral health is generally high with low levels of disease and coral predation (Brainard et al 2005, Sandin et al 2008, Obura et al 2011, Smith et al 2016). They also have the largest populations of giant clams in the Pacific, as well as over 400 fish species in at least 47 families (Mundy et al 2010, Allen and Bailey 2011).

These taxa and ecosystems are described in more detail in the following sections.

2.1 DEEP SEA

The deep sea floor in the central Pacific is dotted with hundreds of undersea mountains, or seamounts, which serve as ecological hotspots for biodiversity and habitat complexity between large swaths of mostly barren deep ocean seascapes far from land (Bohnenstiehl et al 2018; Cantwell, Elliott, and Kennedy, 2018; Demopoulos et al 2018; Kennedy et al 2019). Like the rich biodiversity observed on the shallow water coral reefs surrounding near-shore environments, these largely unexplored deep-sea habitats act as biological refuges for unique organisms, of which many can be found nowhere else (Pitcher et al 2007, Kennedy et al 2019, Auscavitch et al 2020). Additionally, given the numbers of seamounts dotting the ocean floor and associated high levels of endemism, seamounts may well harbor the largest number of undiscovered marine species left on Earth (Roark et al 2009). As of 2014, PRI waters around Howland and Baker Islands, Kingman Reef, and Palmyra Atoll included 22 seamounts within their protected boundaries. However, 98 unprotected, mostly unexplored, seamounts remain within the proposed expansion area surrounding these islands (Sala et al 2014).

BATHYMETRIC MAPS OF THE PROPOSED EXPANSION AREA

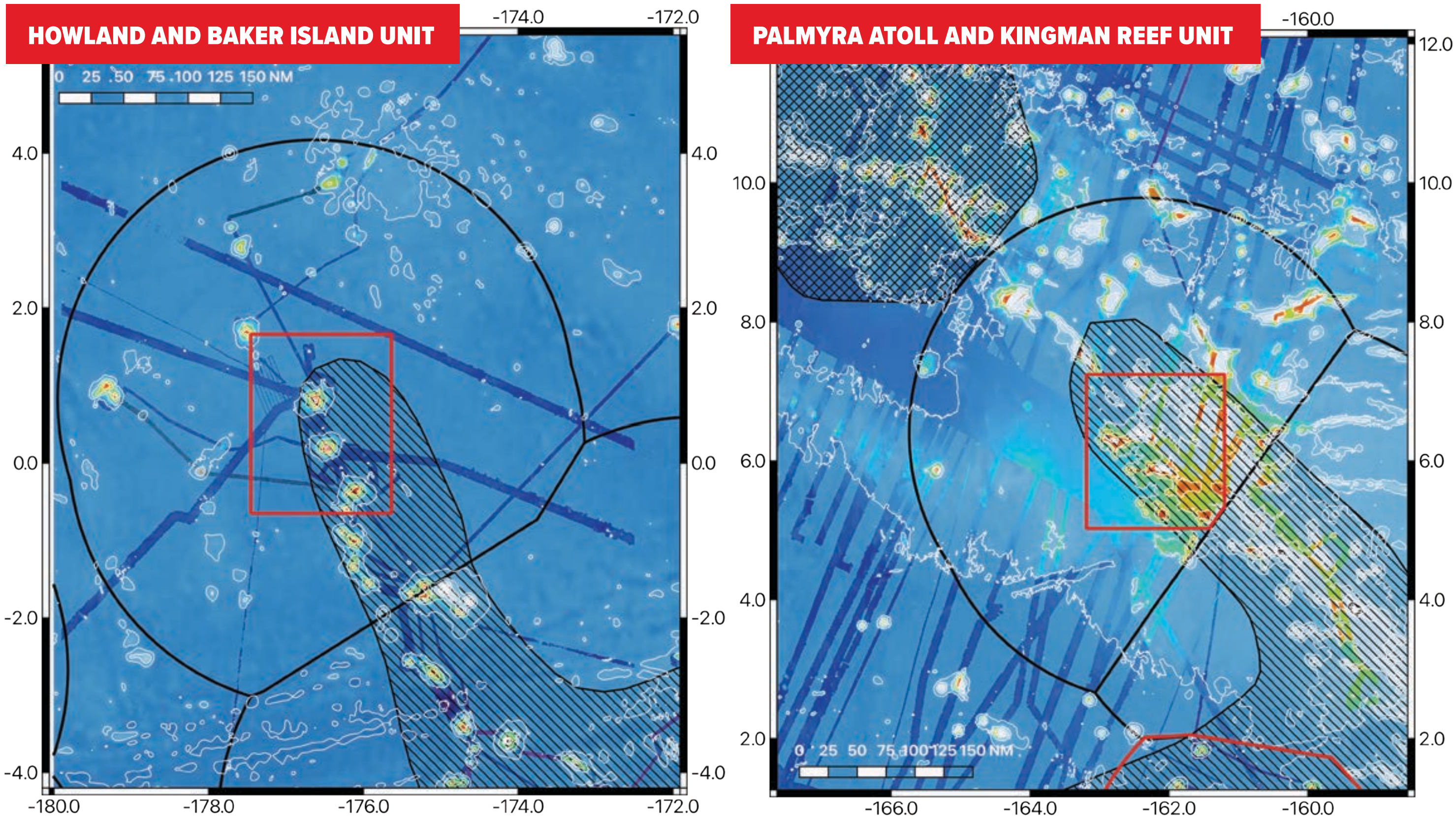


Figure 2. Bathymetric maps of the proposed expansion area, including latest USGS predicted areas for deep-sea mineral resources (Mizell et al 2020). These unprotected waters contain 98 seamounts, which serve as ecological hotspots for biodiversity.

Although the locations and rough sizes of seafloor features in this region are known from satellite altimetry data (resolution of about 1.5 km for imaging the seafloor) (Figure 2), the lack of complete, high-resolution sonar mapping (resolution of 100 m) limits the ability to fully describe deep-sea habitats throughout these waters (Kim and Wessel, 2011; Cantwell, Elliott, and Kennedy 2018; Kennedy et al 2019). For example, sonar mapping data collected during 2017 transits of the Jarvis Unit of PRI revealed errors in previous satellite altimetry seamount depth estimations of about 1700 m (Kennedy et al 2019). Due to these mapping errors, unexplored seamounts within this region may be several hundred feet shallower or deeper than previously thought. As such, there is high potential for the unexplored and poorly-characterized seamounts in the proposed expansion area to harbor more suitable environments for pelagic organisms and marine invertebrates than previously thought.

During the 2015-2017 CAPSTONE Campaign conducted by NOAA Ocean Exploration Ship *Okeanos Explorer* (Maxon et al 2021), exploration of undocumented seamounts within the proposed areas for expansion found unexpected associations of sponges, corals, and other marine invertebrates with different geologic features (Kennedy and Pawlenko 2017a, NOAA 2017b, Kennedy et al 2019). This suggests that not only are deep-sea environments areas of high diversity, but the surveyed environments within and around PRI are not as homogenous as expected. For example, different species of coral were found to grow on shallower island slopes and atolls than those of deeper conical seamounts and guyots (Kennedy et al 2019). Further, distinct differences were also found between habitat diversity and seamount shape (conical versus guyot) suggesting that habitat complexity and associated recruitment may be much more complex than previously understood (Kennedy et al 2019). These findings suggest that the standing protection of nearshore environments and limited seamounts within PRI may leave large swaths of unique taxa and habitats in this region unprotected and vulnerable to various threats.

Additional analyses of data collected by the *Okeanos Explorer* and the Ocean Exploration Trust Exploration Vessel (E/V) *Nautilus* documented previously unobserved species in this region. New discoveries were not limited to the protected waters within the existing monument borders (Ocean Exploration Trust 2019). Dives inside the proposed expansion area found potentially undescribed bamboo corals (Isididae), plexaurid corals, cup corals (Scleractinia), sea stars, and several organisms new to this area, including a rare protist (*Groma sphaerica*) and a massive branching scleractinian coral colony (*Madrepora oculata*) growing below 975 meters (Kennedy and Pawlenko 2017a, b; Demopoulos et al 2018; Kennedy et al 2019; Rotjan 2021).

Recent exploration cruises conducted in 2021 by the Schmidt Ocean Institute and its Research Vessel (R/V) *Falkor* through seamounts within the proposed expansion area south of Howland and Baker Islands have led to the documentation of additional rare species, extensive mesophotic and deep-sea coral reefs, and schools of sharks and skates traversing through this region (Auscavitch 2021, Kagan 2021, Kennedy et al pers comm, Rotjan 2021, Weinning 2021). This range of seamounts spans the border of the unprotected section of the U.S. Howland and Baker EEZ and the Phoenix Islands Protected Area (PIPA), connecting into the Winslow Reef Complex, and has lately served as an important stage for new findings (Rotjan and Teroroko 2016). Partially explored by the *Okeanos Explorer*, R/V *Falkor*, and E/V *Nautilus* during remote operated vehicle (ROV) dives, this complex has been home to the discovery of a new octocoral species (*Narella aurantiaca*) and identification of a rare octocoral previously identified in Indonesia (*Thouarella tydemani*) (Auscavitch et al 2020). Though data from this cruise is still undergoing processing, the high number of traversing skates and rays and unique taxa present suggests that this complex may serve as a corridor for the flow of deep-sea and pelagic organisms across U.S. EEZ and PIPA borders.

DEEP-SEA BIODIVERSITY

The deep-sea ecosystems of the proposed expansion area are home to unique and incredible biodiversity, including rare and slow-growing corals and sponges, invertebrates such as sea stars, pyrosomes, crustaceans, and cephalopods, deep-dwelling sharks and fishes, and more. The images here were captured during ROV dives within the proposed expansion area by the NOAA Ocean Exploration Ship *Okeanos Explore*r in 2017 and the Schmidt Ocean Institute's R/V *Falkor* in 2021. These expeditions have brought to light many novel taxa, records, and behaviors in the area, uncovering new types of species interactions and unveiling critical information around the drivers of deep-sea life.

In addition, outputs from this cruise have not only led to novel species and connectivity discoveries, but also advancements in the field of biomedical science. Deep-sea biodiversity is the source for a number of important products for biomedicine. For example, the medicine Discodermolide was isolated from a deep-sea sponge and shows promise for treatment of drug-resistant cancer; similarly Topsentin, isolated from deep-sea sponges, is being used to treat arthritis and cancer (Schwartsmann et al 2001, Haefner 2003, Kumar and Pal 2016).

Most recently, exploration conducted during these R/V *Falkor* surveys in PIPA have resulted in the discovery of non-toxic molecules for biomedical drug delivery applications (Gauthier et al 2021). Swabbed from lesions on deep-sea coral during dives within PIPA, bacteria were isolated without any exploitation beyond normal scientific exploration efforts conducted throughout the Pacific by NOAA, OET, SOI, and others. Researchers found that 80% of the bacteria examined from coral lesion swabs elicited no inflammatory response from mammalian lipopolysaccharide (LPS) receptors (Gauthier et al 2021). These LPS molecules are among bioactive molecules notably utilized in biomedical drug delivery applications, so evasion of detection in mammalian systems points to non-pathogenic and non-toxic options for drug delivery, such as in cancer treatments, versus current methods (Gauthier et al 2021). Although the bacteria that synthesize this LPS were discovered in neighboring PIPA, recent exploration has now continued the research resulting in similar discoveries in PRI and proposed areas for expansion (Rotjan pers comm). This discovery has immense potential for the development of new biological tools and therapeutics offering novel ways to deliver medicine. However, these results also highlight the ability to both protect areas of the ocean even with strong no-take protection and continue to conduct basic research, non-exploitative sampling, and to make discoveries for major biomedical applications.

It is already clear that deep-sea biodiversity is critical for the health of the oceans, as well as a human resource (Niner et al 2018). The equatorial Pacific is considered a hotspot for productivity and deep sea biodiversity (Smith et al 2008). Although there have only been a limited amount of dives conducted in these areas (40 dives in the EEZ surrounding Howland and Baker Islands, Palmyra Atoll, and Kingman Reef through 2021), exploration has shown that this region is rich with dense beds of corals, sponges, and other invertebrates, most of which are likely undescribed (Kennedy and Pawlenko 2017a, b; Demopoulos et al 2018; Kennedy et al 2019; Rotjan 2021). Discoveries of new species and new habitats suitable for deep sea communities, in addition to biomedical discoveries and those yet to be made, emphasize the value of unprotected deep-sea environments in this region and strongly support the need for extending protection surrounding Palmyra Atoll, Kingman Reef, and Howland and Baker Islands.

2.2 PREDATORY FISHES

There are a large number of predatory fish species in these waters—many of which have declined dramatically in the last century. The proposed expansion area is home to tuna, swordfish and marlin, as well as sharks, which are discussed separately below. These predators are known to have disproportionately strong effects on ecosystem functioning, including altering carbon sequestration and total storage, nutrient cycling and cross-system movement, disease dynamics, and species invasion, among many others (Hammerschlag et al 2019).

A school of big-eyed jacks swirls in the water column near Palmyra Atoll. There are a large number of predatory fish species in these waters—many of which have declined dramatically in the last century.

Photo credit: *Kydd Pollock, The Nature Conservancy*

Predatory fishes present in the region of the proposed expansion area include four tuna of commercial significance: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), and albacore (*Thunnus alalunga*)—with yellowfin and skipjack being the most abundant in the Central Tropical Pacific (CTP). While Western Central Pacific Fisheries Council (WCPFC) data suggests there has been a stabilization of most tuna populations globally, many of which had been in precipitous declines in previous estimates, the biomass and spawning stocks of multiple species are still dramatically lower than historical norms (Senina et al 2018, WCPFC 2021a, b, c, d). Specifically, biomass and spawning potential of yellowfin and bigeye in the region appear to be at <50% of 1950s levels (WCPFC). Notably, four of the regionally important tuna species are still considered by the International Union for Conservation of Nature (IUCN) to be declining, with bigeye tuna considered a globally vulnerable species (IUCN 2021).

A yellowfin tuna feeding frenzy. These pelagic predators chase their prey up to the surface to feed, often alongside sharks, seabirds, and other predators.

Photo credit: *Kydd Pollock, The Nature Conservancy*

The area is also an important tuna spawning ground. Recent work has also shown persistent tuna spawning activity of yellowfin, bigeye and skipjack tuna within the Phoenix Islands archipelago, of which Howland and Baker Islands are a part (Hernández et al 2019). While this work did not actually extend to the proposed expansion area of the Howland and Baker unit of PRI, some of the higher spawning sites especially for skipjack (e.g. near Winslow Reef) directly abut this EEZ and strongly suggest there are high levels of spawning within these areas, with additional data to support this claim available soon (Rotjan et al pers comm).

While tropical tuna are undoubtedly highly mobile, the median distance moved over the *lifetime* of the fish is estimated at 420-470 nautical miles for skipjack and 20% less than that for yellowfin. The median residence time for these species within an EEZ is 3-6 months, suggesting that pelagic MPAs, especially when arranged in a coordinated network (as in PRI) can be effective for conservation (Sibert and Hanson 2003) (see section 5.1 for a more in-depth discussion). In some systems, individual tuna can have residency times of 100-200 days (Richardson et al 2018).

2.3 SHARKS

Sharks are considered the most threatened marine vertebrate group in the world (Dulvy et al 2014, Pimiento et al 2020), with one in four of all evaluated species of sharks and rays now threatened with extinction, and only 37% considered safe (Dulvy et al 2021) (Figure 4). Tropical shark species are experiencing disproportionately strong population declines, with more than half considered to be threatened or near threatened by IUCN (Nadon et al 2012, Dulvy et al 2014, Bradley and Gaines 2014, Bradley et al 2017, Roff et al 2018, Letessier et al 2019). This is of global conservation concern, as sharks are a major component of predator biomass in tropical pelagic and reef environments and play an important role in ecosystem health and function (Roff et al 2016). Notably, under most global extinction scenarios sharks are predicted to experience more functional loss than any other marine group examined, suggesting particularly strong effects on ecosystem function (Pimiento et al 2020).

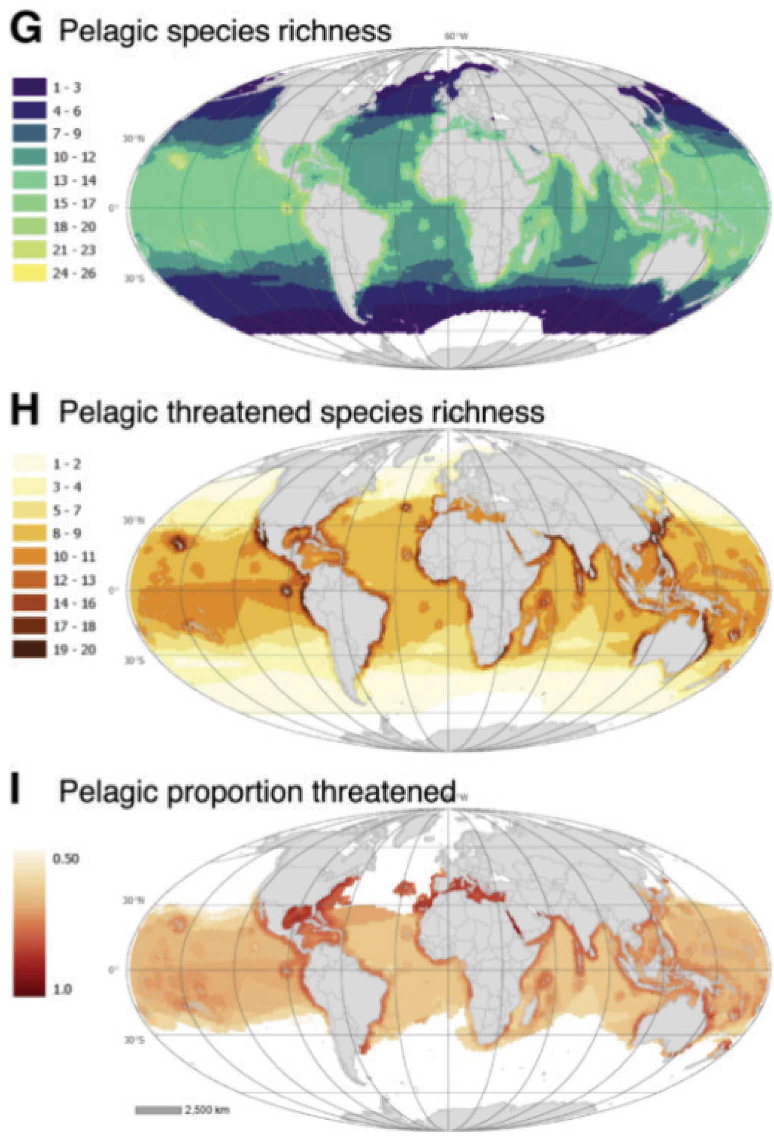


Figure 3. Tropical shark species are experiencing disproportionately strong population declines, with more than half considered to be threatened or near threatened by IUCN. *Figure source: Dulvy et al 2021.*

While there is no analysis across shark species for this region in particular, an analysis in tropical systems globally found declines of 74-92% in sharks across multiple species examined, along with substantial declines in body size (Roff et al 2018). Another global analysis of reef sharks found these sharks to be totally absent on 20% of the world's coral reefs (MacNeil et al 2020). Even the highly abundant grey reef sharks (composing up to 46% of biomass at upper trophic levels of coral reef ecosystems, Bradley et al 2014) are now listed as endangered (IUCN 2020) and have been found to be in global decline even at remote locations (Robbins et al 2006, Graham et al 2010). Even the once common blacktip reef sharks are now listed as vulnerable (IUCN 2020).

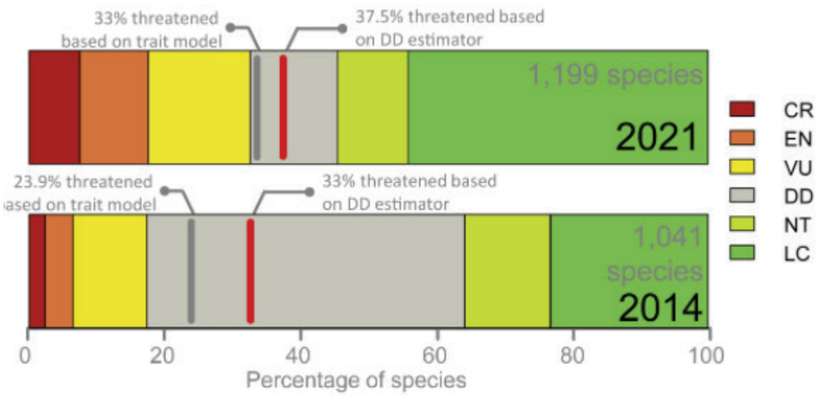
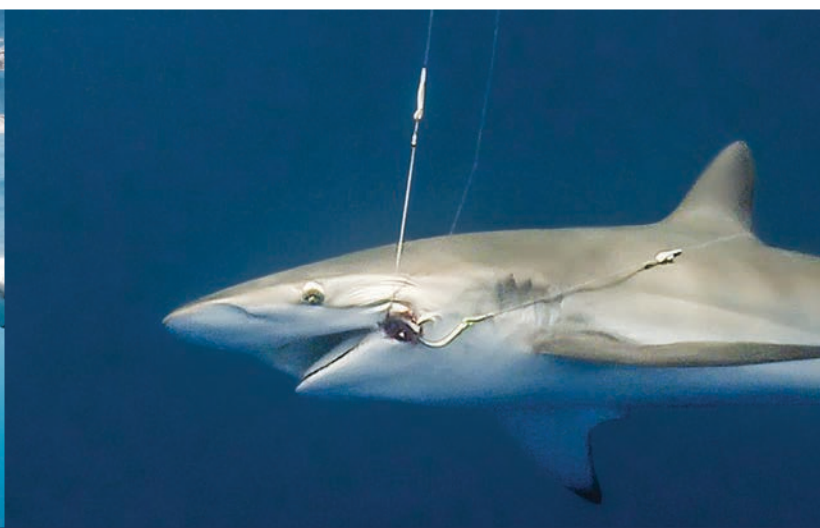


Figure 4. A comparison of the IUCN Red List status of sharks and rays between 2021 (upper bar) and the first assessment (lower bar, 2014), demonstrating the rapid decline of populations worldwide. Currently, over one-third of all sharks and rays are threatened. *Figure source: Dulvy et al 2021.*

Nearly all this decline is likely due to bycatch fishing of sharks (Bradley et al 2014, Dulvy et al 2014). Shark bycatch is a major concern in both the longline and the purse seine fishery, both of which operate in or directly adjacent to the waters of the proposed expansion area. Studies of survivorship of sharks captured in the purse seine fishery around drifting FADs in the equatorial Pacific show 80 to 95% mortality (combining at-vessel and post-release mortality) (Eddy et al 2016). Stock assessments produced by the Western and Central Pacific Fisheries Commission (WCPFC) indicate that some pelagic sharks have experienced population declines of over 95% in this region (WCPFC 2019f).



Pelagic shark species like those shown here are often caught as unintentional bycatch. Shark bycatch is a major concern in both the longline and the purse seine fisheries, both of which operate in or directly adjacent to the waters of the proposed expansion area.

Photo credit: *Shawn Heinrichs, SeaLegacy*

Only very large closed areas are effective in protecting sharks from these threats (MacNeil et al 2020), including reef sharks—many of which range more widely than are traditionally thought. For instance, one study in the Palmyra and Kingman Reef unit of PRI showed that grey reef sharks' range includes the areas between 50 and 200 nautical miles outside of the current protected area (White et al 2017). Further, remote areas like this one have been shown to be the most effective at protecting sharks (Letessier et al 2019). Comprehensive surveys of a few shark populations in PRI and surrounding region suggest abundances here are among the highest reported anywhere—a testament to the value of these remote and protected areas for conserving these species (Sandin et al 2008, McCauley et al 2012b, Nadon et al 2012, Bradley et al 2017). However, it should be noted that recent analysis suggests that previous estimates of shark abundance in this region overall are likely severely inflated, suggesting that even these relatively robust populations may be significantly more vulnerable to exploitation because they are smaller than previously thought (Bradley et al 2017). Critically, a recent analysis found that large closures in the U.S. Pacific have some of the highest conservation potential for sharks anywhere in the world, suggesting critical gains could be made for shark populations using large closures such as those discussed here (MacNeil et al 2020).

Gray reef sharks (*Carcharhinus amblyrhynchos*) in the pelagic waters outside the PRI. Recent work at Palmyra Atoll suggests protecting the full EEZ of this unit would strengthen protection for this pelagic species in particular (Gilmour et al 2022).

Photo credit: *Kydd Pollock, The Nature Conservancy*

Species of sharks known in the expansion area are listed below. These waters are known to contain ten endangered or critically endangered elasmobranch species (including both sharks and rays), and five vulnerable species. This is an incomplete list, as observations are driven mainly by sightings in reef environments, emphasizing common and easily visible species (Mundy et al 2010, McCauley et al 2012c). There is much to be learned about shark biodiversity in the area, and it is likely much higher than reflected here—for instance, a single recent effort of deploying deep water dropcams in just one of the PRI units added five new shark species records to this list (Tholan et al 2020).

SCIENTIFIC NAME	COMMON NAME	IUCN STATUS
Carcharhinus amblyrhynchos	Gray reef shark	Endangered
Carcharhinus galapagensis	Galapagos shark	Least Concern
Carcharhinus melanopterus	Blacktip reef shark	Vulnerable
Carcharhinus altimus	Bignose shark	Near Threatened
Carcharhinus longimanus	Oceanic whitetip shark	Critically Endangered
Rhincodon typus	Whale shark	Endangered
Carcharhinus albimarginatus	Silvertip reef shark	Vulnerable
Triaenodon obesus	Whitetip reef shark	Vulnerable
Sphyrna lewini	Scalloped hammerhead	Critically Endangered
Sphyrna mokarran	Great hammerhead	Critically Endangered
Taeniurops meyeni	Round ribbontail ray	Vulnerable
Aetobatus narinari	White spotted eagle ray	Endangered
Aetobatus ocellatus	Spotted eagle ray	Vulnerable
Mobula birostris	Giant manta ray	Endangered
Nebrius ferrugineus	Tawny nurse shark	Vulnerable
Negaprion acutidens	Sharptooth lemon shark	Endangered
Echinorhinus cookei	Prickly shark	Data Deficient
Etmopterus pusillus	Smooth lanternshark	Least Concern
Hexanchus griseus	Bluntnose sixgill shark	Near Threatened
Odontaspis ferox	Smalltooth sand tiger shark	Vulnerable
Galeocerdo cuvier	Tiger shark	Near Threatened

Table 1: IUCN status of sharks and rays with species records within the expansion area. When available characterizations are

for local rather than global populations

2.4 MARINE MAMMALS

A large number of protected marine mammals have been observed or acoustically detected in this area, including a species of beaked whale new to science (Dalebout et al 2007, Baumann-Pickering et al 2010). Frequently observed species in these areas include bottlenose dolphins, melon headed whales, and beaked whales. Models also suggest high relative densities of rough-toothed dolphins (*Steno bredanensis*), bottlenose dolphins (*Tursiops truncatu*s), short-finned pilot whales (*Globicephala macrorhynchus*), and sperm whales (*Physeter macrocephalus*), and moderate densities for pantropical-spotted dolphins (*Stenella attenuata*), spinner dolphins (*Stenella longirostris*), striped dolphins (*Stenella coeruleoalba*), and false killer whales (*Pseudorca crassidens*) (Becker et al 2021). Historical data suggests that these waters were once some of the most productive in the world for sperm whales, which were heavily depleted by whaling and have still not recovered; protection of pelagic MPAs in their prime habitat would likely play a key role in fostering their recovery (Kennedy et al 2021).




These waters are home to many marine mammal species, including bottlenose dolphins (top left), melon-headed whales (top right and bottom left), and the rare Deraniyagala's beaked whale (bottom right, with calf).

Photo credits: *Kydd Pollock, The Nature Conservancy (TOP RIGHT), and Simone Baumann-Pickering, Scripps Institution of Oceanography (TOP LEFT AND BOTTOM)*

Cetaceans perform myriad critical roles in ecosystem functioning, ranging from nutrient and carbon cycling to benthic food sources (as whale falls) (Roman et al 2014). For example, the body of a single large whale may provide carbon flux equal to nearly 2,000 years of natural background carbon flux to a deep seafloor area (Smith 2006, Roman et al 2014). One particularly important function in this ecosystem is likely their role as subsurface predators, which chase prey fish (e.g. squid, flying fish) to the surface, making them available to tropical seabirds, which cannot dive to great depths. In this way, these species directly regulate prey abundances while also facilitating persistence of obligate surface feeding seabirds by affecting behavior of prey.

SCIENTIFIC NAME	COMMON NAME	IUCN STATUS
Mesoplodon densirostris	Blainville's beaked whale	Least Concern
Balaenoptera musculus	Blue whale	Endangered
Tursiops truncatus	Common bottlenose dolphin	Least Concern
Ziphius cavirostris	Cuvier's beaked whale	Least Concern
Kogia simus	Dwarf sperm whale	Least Concern
Pseudorca crassidens	False killer whale	Near Threatened
Balaenoptera physalus	Fin whale	Vulnerable
Monachus schauinslandi	Hawaiian monk seal	Endangered
Megaptera novaeangliae	Humpback whale	Least Concern
Orcinus orca	Killer whale	Data Deficient
Peponocephala electra	Melon-headed whale	Least Concern
Eubalaena japonica	North Pacific right whale	Endangered
Mesoplodon hotaula	Deraniyagala's beaked whale	Data Deficient
Stenella attenuata	Pantropical spotted dolphin	Least Concern
Grampus griseus	Risso’s dolphin	Least Concern
Steno bredanensis	Rough-toothed dolphin	Least Concern
Balaenoptera borealis	Sei whale	Endangered
Globicephala macrorhynchus	Short-finned pilot whale	Least Concern
Physeter macrocephalus	Sperm whale	Vulnerable
Stenella longirostris	Spinner dolphin	Least Concern
Stenella coeruleoalba	Striped dolphin	Least Concern

Table 2: IUCN status of marine mammals reported from this region

Cetaceans face a number of threats ranging from habitat loss, direct harvest (both intentional and as bycatch), to entanglement in fishing and other gear. A particularly relevant threat to cetaceans is noise pollution, by which acoustic noise from anthropogenic sources masks vocalization used for communication and feeding and even causes hearing damage (Weilgart 2007, Gómez et al 2016, Avila et al 2017). Currently, the Central Pacific remains a relatively quiet zone (Sirovic et al 2013) and is thus a critical acoustic refuge for these noise-sensitive animals. All vessels make some noise, and seabed mining would likely be an exceptionally noisy activity (Levin et al 2016, Martin and Entrup 2021). Thus seabed mining or increased fishing vessel traffic would both likely negatively impact this acoustic refuge for cetaceans, including endangered cetaceans that may directly interact with ecosystems being targeted for mining (Marsh et al 2018). Increased vessel traffic could of course also increase the likelihood of ship strikes, and increasing fishing activity increases the likelihood of bycatch or entanglement in fishing gear.

2.5 Sea turtles

Turtle populations have declined dramatically at a global scale in the last few centuries—a result of direct harvest of adults and eggs, and of bycatch in fisheries. Longline fisheries are an important source of mortality for turtle populations of multiple species (Lewison and Crowder 2007, Wallace et al 2013, Savoca et al 2020). They are also harmed by entanglement in marine debris and fishing gear, destruction of habitat, and pollution. All sea turtles are now classified as threatened or endangered. While there is little data on turtle abundance from within PRI, data from nearby Phoenix Island Protected Area has reported long-term substantial declines in sea turtle abundance (Maison et al 2010).

There are multiple species of protected sea turtles in these regions, including the endangered green sea turtle (*Chelonia mydas*) and the critically endangered hawksbill turtle (*Eretmochelys imbricata*) (Balazs 1975, 1985; IUCN 2004, 2008; Naro-Marciel et al 2009), the olive ridley (*Lepidochelys olivacea*), the loggerhead sea turtle (*Caretta caretta*) and the leatherback sea turtle (*Dermochelys coriacea*)—the largest sea turtle in the world and critically endangered in the Pacific Ocean.

Importantly, these waters are known to be important to the migration patterns of the leatherback sea turtle. Tracking data (Benson et al 2011) has shown that leatherbacks are actively foraging or transiting the EEZs of the PRI—including the unprotected EEZ waters of the proposed expansion area—throughout the year, and has suggested that these EEZs serve as critical migration routes between Indonesia and California. Pacific leatherback sea turtle populations are currently at high risk for extinction (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2020) and are in critical decline (90% or greater in the Pacific).

Of the 11 populations of green sea turtles listed by USFWS under the Endangered Species Act (ESA), three are endangered, and PRI straddles the habitat of two of these three endangered populations—the Central West Pacific and the Central South Pacific (Fed Reg. 2016). These areas are used both for migratory and feeding grounds, and there has been increasing observation of nesting activity in recent years (Wegmann pers. comm). Tracking of green sea turtles has shown that both juvenile and adults often stay in these sites year round, suggesting the importance of this area as a foraging ground (Luke et al 2004, Naro-Maciel et al 2018). Protecting intact foraging grounds is important for turtle conservation (Wallace et al 2010, Sterling et al 2013). Indeed, tracked turtles in this area show extremely small home ranges while present.

A green sea turtle (*Chelonia mydas*) visiting the coral reefs of Palmyra Atoll. This endangered species is one of the many sea turtle species that call these waters home.

Photo credit: *Kydd Pollock, The Nature Conservancy*

In addition to their intrinsic conservation values, sea turtles are known to be important in helping maintain low algal covers on coral reefs and are thus likely important in helping reef resilience in the face of climate change and other disturbance (Wabnitz et al 2010, Goatley et al 2012, Burkholder et al 2013). Work from British Indian Ocean Territory (BIOT) has shown strong increases in green sea turtle clutches after prolonged periods of protection, some of which is suggested to be linked to protection (Hays et al 2020, Mortimer et al 2020).

2.6 Seabirds

Among bird species worldwide, seabirds and shorebirds are experiencing particularly rapid declines and are vulnerable from multiple threats—notably including declining food availability at sea as a result of fisheries extraction (Cury et 2011, Grémillet et al 2018), invasive species on land (Pierce et al 2008, Spatz et al 2017), loss of breeding habitat, direct mortality in fisheries bycatch (Gianuca et al 2017), and climate change and associated sea level rise at their nesting sites (Weeks et al 2013, Reynolds et al 2015, Nicoll et al 2017).

Tropical seabird populations are, in general, poorly monitored given their often aseasonal nesting behavior and remote locations, including at these sites (VanderWerf and Young 2017). However, the studies that do exist suggest rapid declines. For instance 45% of monitored colonies across tropical species in the Great Barrier Reef showed declines (Woodworth et al 2020). Similarly petrel populations in Hawaii are thought to have declined from ~200,000 individuals immediately prior to human contact, to perhaps a tenth of that size when last assessed (Spear et al 1995).

Palmyra's red-footed booby (*Sula sula*) populations are estimated at 6250 breeding pairs, the second largest colony in the world.

Photo credit: *Andrew Wright, The Nature Conservancy*

There are 16 species of seabirds breeding at these sites, with nearly 40 other species—including multiple endangered species—known to use these waters (See Table 3). Notably, the endangered and declining phoenix petrel (*Pterodroma alba*) and white throated storm-petrel (*Nesofregetta fuliginosa*) may occur on Baker and Howland Islands, although this is unconfirmed (Depkin 2002; Rauzon 2016; USFWS 2007 a, b, c). There are also a number of migratory shorebirds recorded in these sites, including species such as the endangered bristle thighed curlew (*Numenius tahitiensis*), that use this as an important stopover location during migration. Stopover locations are known to be key to the survival of shorebird species and their loss is a major cause of decline in this group, as they provide critical areas to rest and forage to facilitate these long journeys (Studds et al 2017).

A breeding colony of sooty terns (Onychoprion fuscatus) on Palmyra Atoll, one of the largest in the world. Breeding colonies at Howland Island can be even larger. These seabirds rely on the unprotected pelagic waters outside of PRI to forage.

Photo credit: *Kydd Pollock, The Nature Conservancy*

Not only are numerous species present in these areas, but the two units also include some of the world's largest breeding colonies. Sooty tern (*Onychoprion fuscatus*) breeding colonies at Palmyra alone range up to 750,000 nests at a time, and 150,000 nests at Howland Island. Black noddy (*Anous minutus*) colonies range up to 20,000 birds at Palmyra, the largest colony in the Pacific, and Palmyra's red-footed booby (*Sula sula*) populations are estimated at 6250 pairs, the second largest colony in the world.

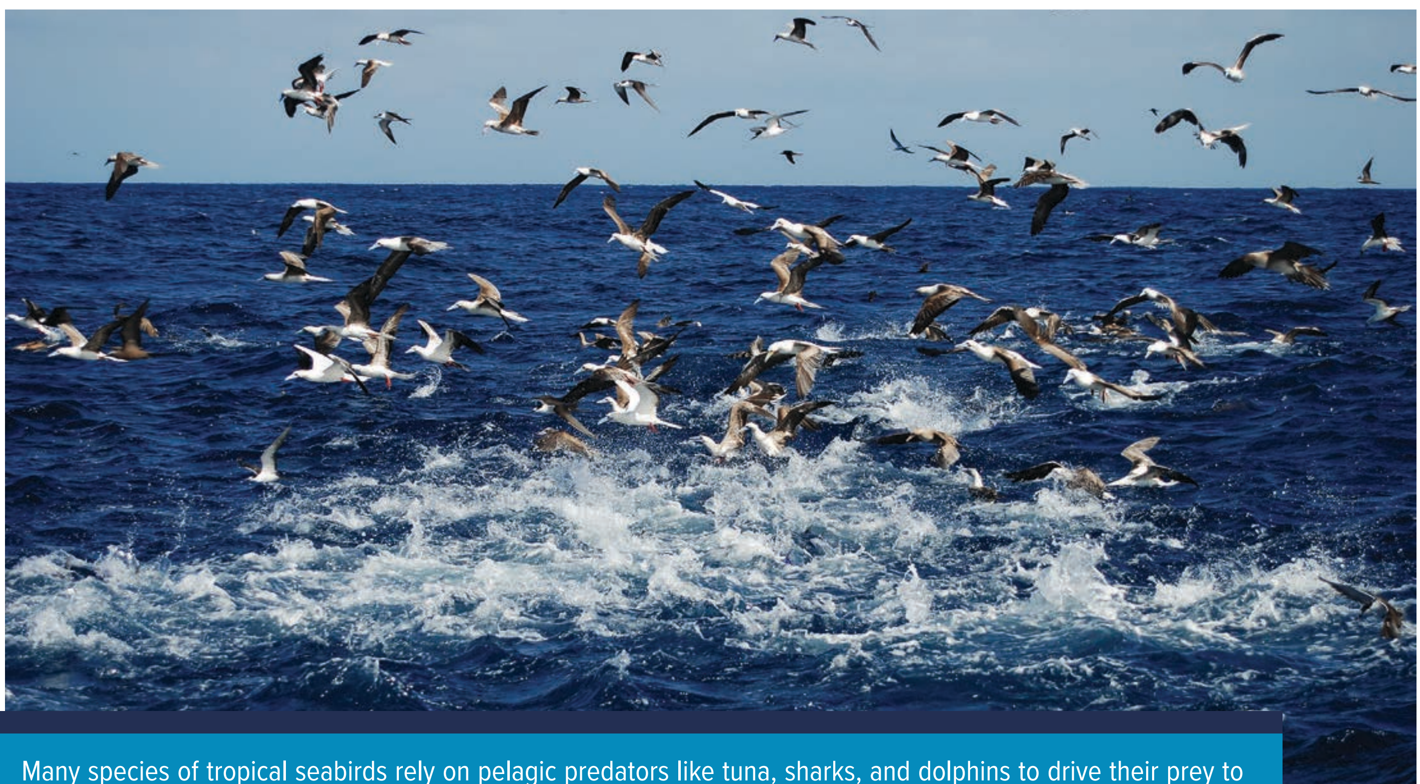
Table 3: IUCN status, breeding status and breeding numbers of seabirds recorded from these sites (*sourced from: Flint pers comm; Depkin 2002; Rauzon 2016; USFWS 2007 a, b, c*).

SCIENTIFIC NAME	COMMON NAME	IUCN STATUS	BREEDING	NUMBER BREEDING
Anous minutus	Black noddy	Least Concern	YES	6,498
Anous stolidus	Brown noddy	Least Concern	YES	5,164
Ardenna bulleri	Buller's shearwater	Vulnerable		
Ardenna carneipes	Flesh-footed shearwater	Near Threatened		
Ardenna creatopus	Pink-footed shearwater	Vulnerable		
Ardenna grisea	Sooty shearwater	Near Threatened		
Ardenna tenuirostris	Short-tailed shearwater	Least Concern		
Bulweria bulwerii	Bulwer's petrel	Least Concern		
Fregata ariel	Lesser frigatebird	Least Concern	YES	20,050
Fregata minor	Great frigatebird	Least Concern	YES	1,850
Gygis alba	Common white tern	Least Concern	YES	596
Larus pipixcan	Franklin's gull	Least Concern		
Leucophaeus atricilla	Laughing gull	Least Concern		
Nesofregetta fuliginosa	Polynesian storm-petrel	Endangered		
Oceanites oceanicus	Wilson's storm-petrel	Least Concern		
Oceanodroma castro	Band-rumped storm-petrel	Least Concern		
Oceanodroma leucorhoa	Leach's storm-petrel	Vulnerable		
Onychoprion fuscatus	Sooty tern	Least Concern	YES	2,626,000
Onychoprion lunatus	Gray-backed tern	Least Concern	YES	4,000
Phaethon lepturus	White-tailed tropicbird	Least Concern	YES	9
Phaethon rubricauda	Red-tailed tropicbird	Least Concern	YES	829
Phoebastria immutabilis	Laysan albatross	Near Threatened		
Phoebastria nigripes	Black-footed albatross	Near Threatened		
Procelsterna cerulea	Blue noddy	Least Concern	YES	37
Pseudobulweria rostrata	Tahiti petrel	Near Threatened		
Pterodroma alba	Phoenix petrel	Endangered		

SCIENTIFIC NAME	COMMON NAME	IUCN STATUS	BREEDING	NUMBER BREEDING
Pterodroma brevipes	Collared petrel	Vulnerable		
Pterodroma cervicalis	White-necked petrel	Vulnerable		
Pterodroma cookii	Cook's petrel	Vulnerable		
Pterodroma externa	Juan Fernandez petrel	Vulnerable		
Pterodroma heraldica	Herald petrel	Least Concern		
Pterodroma inexpectata	Mottled petrel	Near Threatened		
Pterodroma leucoptera	White-winged petrel	Vulnerable		
Pterodroma longirostris	Stejneger's petrel	Vulnerable		
Pterodroma neglecta	Kermadec petrel	Least Concern		
Pterodroma nigripennis	Black-winged petrel	Least Concern		
Pterodroma pycrofti	Pycroft's petrel	Vulnerable		
Pterodroma sandwichensis	Hawaiian petrel	Endangered		
Pterodroma ultima	Murphy's petrel	Least Concern		
Puffinus bailloni	Tropical shearwater	Least Concern	YES	1
Puffinus nativitatis	Christmas shearwater	Least Concern	YES	4
Puffinus newelli	Newell's shearwater	Critically Endangered		
Puffinus pacificus	Wedge-tailed shearwater	Least Concern	YES	4
Stercorarius parasiticus	Arctic jaeger	Least Concern		
Stercorarius longicaudus	Long-tailed jaeger	Least Concern		
Stercorarius pomarinus	Pomarine jaeger	Least Concern		
Sterna anaethetus	Bridled tern	Least Concern		
Sterna sumatrana	Black-naped tern	Least Concern		
Sula dactylatra	Masked booby	Least Concern	YES	6,967
Sula granti	Nazca booby	Least Concern		
Sula leucogaster	Brown booby	Least Concern	YES	1,392
Sula sula	Red-footed booby	Least Concern	YES	26,539
Thalasseus bergii	Greater crested tern	Least Concern		

As detailed in earlier discussion on connectivity, seabirds are land place-based foragers, returning to and from regular sites—and thereby drive strong directional movements of nutrients—gathering resources at sea and depositing them on land where they rest, breed, and defecate (Young et al 2010c, 2013). This nutrient movement has been shown to be critical to supporting healthy functioning of both terrestrial and coral reef ecosystems. Loss of seabirds from ecosystems can drive whole scale state change of ecosystems (Croll et al 2005). Seabirds themselves are also an important food source for inshore communities; for instance, at Palmyra Atoll 29% of blacktip sharks were shown to eat seabirds (Papastamatiou et al 2009).

The success of these islets as breeding colonies is, in part, due to the great success of terrestrial conservation efforts related to the terrestrial environments for seabirds. Cats, rats, or both were historically present on all three emergent islands (Palmyra, Baker, Howland) but have now been eradicated on all sites, providing an important refuge from invasive predators and some recovery of seabird populations (Pierce et al 2008, Rauzon et al 2011). A new habitat restoration program at Palmyra Atoll promises to further restore terrestrial habitats for seabirds. Therefore, the main immediate threats to these populations are likely from disruption to their ocean food sources—both directly (e.g. removal of prey or predators that make that prey available) and indirectly via climate change—and direct negative interactions with fisheries.



Many species of tropical seabirds rely on pelagic predators like tuna, sharks, and dolphins to drive their prey to the surface where it is more available to them. Reductions in abundance of these predators also impacts seabirds.

Photo credit: *Kydd Pollock, The Nature Conservancy*

Tropical seabirds in particular are energetically constrained in foraging in low productivity environments and lack deep diving capabilities; instead, many species rely on subsurface pelagic predators such as tuna, sharks, and dolphins, to drive their prey to the surface where it is more available to them. Reductions in abundance of these predators, or changes in their foraging behavior may dramatically reduce the ability of seabirds to effectively forage (Maxwell and Morgan 2013).

Longline fisheries in particular may pose an important bycatch threat to seabirds. Seabirds can get caught on baited hooks on the miles of line laid out by longline fisheries. More than 160,000 seabirds are killed annually on longlines with strongest effects on petrels, albatrosses, and shearwaters (all found in these waters); this rate is likely to drive population declines for many of these long-lived, slow-reproducing species (Anderson et al 2011). While much of the bycatch of seabirds occurs in higher latitudes and recent improvement in fishing practices have reduced bycatch, the Hawaiian longline fishery alone may catch hundreds of birds a year (Gilman et al 2016).

2.7 Inshore and Island Resources

While terrestrial and inshore ecosystems are not directly affected by expansion from 50 to 200 nautical miles, Section 1 above details the strongly interconnected relationship between the proposed expansion area and these nearshore ecosystems. Additional pelagic protections would likely provide indirect benefits to nearshore areas and the wildlife relying on them, as these ecosystems are intricately dependent on subsidies from offshore environments for their functioning. For this reason, inshore and terrestrial and taxa and resources are described briefly below.

The coral reefs of PRI, like those shown here at Palmyra Atoll, are among the healthiest in the world.

Photo credit: *Kydd Pollock, The Nature Conservancy*

The coral reefs of Palmyra Atoll, Kingman Reef, and Howland and Baker Islands are large and overall extremely healthy, dominated by reef building corals and crustose coralline algae. For comparison, up to 71% coral cover was reported at

Kingman Reef, while more disturbed reefs in the same island chain exhibited 21-38% coral cover. Coral reef species richness, coral density and coral recruitment are also notably high at these sites, while disease prevalence is low (Sandin et al 2008, Obura et al 2011). Reef fish biomass at these sites is higher than at other sites in the Central Tropical Pacific (Sandin et al 2008, Brainard et al 2019). However, despite the high health of these reefs, two of these sites have still reported some declines in coral cover (13% at Kingman Reef and Baker Island) during the last surveys (Brainard et al 2019), highlighting the delicate nature of these globally-threatened ecosystems and the need for all protections possible to preserve them.

Giant clams, absent or rare throughout most of the Pacific, are abundant and dominate the reef landscape at Kingman Reef in PRI.

Photo credit: *Amanda Pollock, USFWS*

The terrestrial ecosystems in these units, while small, harbor a number of endemic species—many of which are newly discovered. A recent survey of invertebrates at Palmyra Atoll, for instance, found 16 arthropod species entirely new to science. These arthropods span 11 orders and likely include numerous endemic species. They include a large picture wing fly, a large Thysanopteran, a new cricket, and a common isopod (Young et al unpublished data). There are also multiple locally adapted plant subspecies, and important populations of coconut crabs—a threatened charismatic invertebrate. These habitats are also being considered for introduction or reintroduction of globally threatened passerine species, notably the Bokikokiko. Studies in this area have shown that terrestrial biodiversity declines substantially when seabird subsidies are reduced, again highlighting the dependence of these regions on healthy pelagic ecosystems (Young et al 2015).

Similarly, a recent survey of sandflats of Palmyra Atoll has shown 86 new records for parasites, including some in bonefish *Albula glossodonta*, one of the regionally best-studied fishes (McLaughlin et al 2020). The bonefish, heavily targeted by recreational fisheries elsewhere, is found in very high numbers at Palmyra Atoll, including spawning aggregations (Friedlander 2007). Lagoons across many of these sites are utilized by a range of highly-mobile and pelagic species, potentially even serving as nursery habitat for some elasmobranch species (Papastamatiou et al 2010).


Photo credit: *Kydd Pollock, The Nature Conservancy*

3 | CONSERVATION FOR HISTORICAL AND CULTURAL VALUES

There is a current global cultural awakening that recognizes traditional knowledge, stories, cultural connections between lands and peoples, and celebrates the individual nature of cultures. However, while these attributes are finally receiving value and recognition at this scale, the ecosystems that originally inspired these values are at risk, and in many places, are disappearing.

The protections conferred by PRI can help maintain these baseline ecosystems and elevate their cultural value. Further, fully protecting the two units recognizes that the area may contain artifacts of historic and scientific interest from previous eras, such as whaling, colonization, and World War II–and could prompt continued exploration and protection of these areas from disturbance.

The protection of these waters, however, does not mean that access will be permanently restricted. Instead, protection could afford continued use of these waters through standing regulations and can even expand access to those across the globe. As has been seen through the coverage of existing protected waters by various media, protection can enable scientists, film makers, story tellers, cultural practitioners, and ambassadors to be among those to visit these protected places, to study them, revive and perpetuate cultural traditions, and to share their teachings with the world. As such, especially with the advent of modern technology, global audiences can engage with the wonders of the ocean without leaving their homes.

3.1 Indigenous and Cultural Roots

> **Aloha ʻāina, mālama ʻāina, and mālama ke kai**
>
> Love of the land, protect and care for the land, and protect and care for the ocean

The sea far beyond the artificial monument boundaries in which the islands of PRI lie is equally valuable for protection. Currently, Papahānaumokuākea serves as the only 'intact cultural voyaging seascape [with]in the Hawaiian Islands' (Kerr et al 2016, Kikiloi et al 2017). However, PRI can serve as the premier classroom for ancestral voyaging in remote, pristine oceans by expanding areas of PRI to include all unprotected seas up to the limits of the U.S. EEZ.

As a practice, teaching and practicing traditional open-ocean navigation is limited to specific areas like those in PRI. It is a stage in which ancestral voyages far from land, crossing between distant islands, can be replicated and perfected. Given its distance from heavily populated islands, PRI acts as an open water lab for voyaging since voyagers can remain fully out of sight from land and its associated traits (Finney et al 1986, Hawaiian Voyaging Traditions 2009, Buente et al 2020). As such, areas of pristine ocean outside of the current 50 nautical mile monument limits around Palmyra Atoll, Kingman Reef, and Howland and Baker Islands are invaluable for continuing the progress in revitalizing traditional navigation.

Expanding PRI boundaries to the legal limit of the U.S. EEZ would be a strong and significant signal of U.S. commitment to culture, voyaging, and to Pacific Island nations and neighbors. The ocean exists as an ever changing, but living being; a cultural seascape across which ocean people are connected through sinews of ocean channels, currents, and fauna spread between their islands. It is a vast, thriving body of water holding godly reverence to Pacific Islanders as genealogical and creation chants, such as the Hawaiian Kumulipo, tie the sea, the sky above, and all the organisms seen and unseen within it to their people (Pukui et al 1972, *The Kumulipo* 1981, Maly and Maly 2004, Kerr et al 2016, Takata 2021b, Villagomez and McGuire 2021).

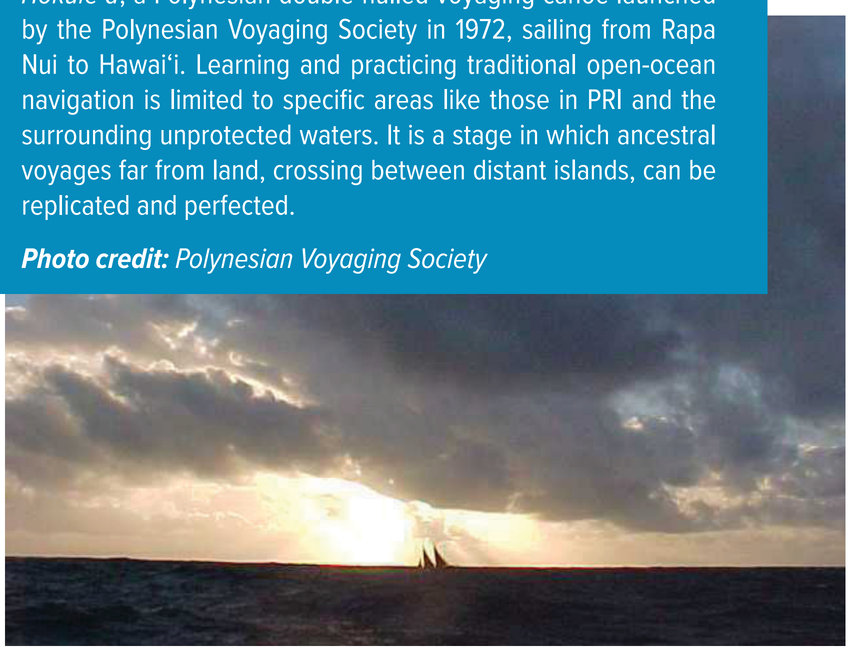
Each system within these waters, whether referring to a series of currents bringing nutrients up the slopes of remote seamounts to feed corals and fish, or the schools of pelagic fish traveling from feeding ground to feeding ground, has function and meaning belonging to a greater corporeal body requiring delicate management and humble understanding to properly function (Pukui et al 1972, Kerr et al 2016). The remote waters of PRI far from land and the influence of anthropogenic factors best represent the areas which gave inspiration to these foundations of cultural knowledge. It is due to these qualities that the regions outside of the currently protected monument act as reservoirs for cultural inspiration and open-water classrooms for teaching activities, such as traditional voyaging.

Specifically, in Native Hawaiian culture the Kumulipo serves as an ever-growing foundation of such stories, songs, and protocols that describe these relationships with the gods, land, sky, ocean, and associated organisms that give people on 'Island Earth' their pulse of life (Liliuokalani 1897, *The Kumulipo* 1981). It provides direction and outlines responsibilities from the findings and interpretations of kūpuna (elders and ancestors), while recording familial lines and describing spiritual ancestral knowledge relating to creation and the first organisms to emerge from the depths of darkness; ʻākoʻakoʻa (coral) (Liliuokalani 1897, *The Kumulipo* 1981).

Through its texts, the Kumulipo describes views of holistic and careful respect for ecosystems and their responsible management. These are not only tales of how previous ancestors perceived and managed lands and seas, but guidance for how future generations can learn to utilize far-reaching spaces, including those holistically and harmoniously within PRI, to preserve what is there, better understand their ecosystems through modern science and exploration, and equitably manage it for the future.

As such, management plans cannot ignore cultural input. The experiences and knowledge of native peoples can be beneficial to other efforts in conservation, exploration, and research, and often hold the empirical observations of these places when they were first explored, settled, and utilized for resources (Liliuokalani 1897, *The Kumulipo* 1981). These findings are no different from those derived from the academic research conducted today. As research is enshrined in modern journals, findings and suggestions for discovery and management were recorded in the Kumulipo and continue to be added in modern knowledge as advancements in technology help to reexamine and retest themes.

The Kumulipo is the foundation of being that ties Native Hawaiians to the shared ancestor that is the ocean, which has allowed for the accomplishment of activities, such as wayfinding to connect ocean peoples. Voiced through the writings of the Native Pacific Islander scholar, Epeli Hau'ofa, he reminds us not to simply focus on land as the only valuable asset as "there is a world of difference between viewing the Pacific as 'islands in a far sea' and as 'a sea of islands'" (Hau'ofa 1994). It is from this central knowledge that Pacific Islanders do not only see islands as destinations for place-to-place access, but as nodes within a thriving sea within which reverence and respect is paid to those organisms and resources in the open expanses that connect them.



Hōkūleʻa, a Polynesian double-hulled voyaging canoe launched by the Polynesian Voyaging Society in 1972, sailing from Rapa Nui to Hawaiʻi. Learning and practicing traditional open-ocean navigation is limited to specific areas like those in PRI and the surrounding unprotected waters. It is a stage in which ancestral voyages far from land, crossing between distant islands, can be replicated and perfected.

***Photo credit:** Polynesian Voyaging Society*

As seafaring people, Pacific Islanders understood these connections, and through their interpretation of the function of the ocean as a living entity, were able to navigate its waters far from the sight of land for millennia (Finney 1977, 1992; Kikiloi 2010; Irwin and Flay 2015; Thompson n.d.). Examples of stewardship in the areas considered for PRI expansion, the application of ancestral knowledge, and continued cultural growth within PRI can be found in this voyaging history.

Oral histories and more recent archeological evidence and voyaging simulations document traditional seafarer's utilization of marine corridors to reach islands throughout the Pacific; including those within PRI, for cultural practices and exchanges (Di Piazza and Pearthree 2001b; Di Piazza, Pearthree, and Paillé 2014; Irwin and Flay 2015; Kerr et al 2016; Bautista and Smith 2018; Villagomez 2018). As stopping points for resources, temporary shelter, and cultural duties, the islands within PRI prior to colonization by the United States were functional nodes within a water highway utilized by voyagers throughout the Pacific (Finney 1977, Di Piazza and Pearthree 2001a, 2001b).

To accomplish this feat of open-ocean navigation without modern technological means for wayfinding, Pacific Islanders relied upon a deep knowledge of the stars, marine life far from any land, currents, weather, and other factors to provide confirmation of the direction towards land (Lewis 1974, Finney 1992, Thompson n.d.). This ability to purposefully traverse widely distributed islands was dependent on a cohesive suite of biotic and abiotic factors stretching far from the shores of their destinations, unaltered from pristine conditions such that cues to land would be undiminished. Some voyages required passage through oceanscapes over 300 nautical miles long without any land in sight, while others necessitated the knowledge of cycles of lulls in prevailing trade winds in order to reach specific islands (Finney 1977, 1992; Di Piazza and Pearthree 2001b; Irwin and Flay 2015).

This ability to read subtle signs across the oceanscape not only afforded them the skills to utilize immense stretches of unoccupied waters as voyaging avenues, but intrinsically provided them with the role as stewards caring for the environment that made this travel possible to accomplish (Thompson n.d.). Reading the sea, sky, and their associated fauna enabled voyagers to accurately target low-lying, small islands and shoals, such as those in PRI, hundreds of nautical miles before they were visible on the horizon.

Polynesian and Micronesian oral history describes voyaging to PRI for cultural duties and traditions, such as the Marshallese voyaging to Eneen-Kio (Marshallese after the plentiful kio flower) or Wake Atoll, for seabird bones utilized in tattooing (Bautista and Smith 2018, Villagomez and McGuire 2021). Further, their names, many of which given in modern times by Hawaiian cultural scholars of the Kōmike Huaʻōlelo (Hawaiian Language Lexicon Committee), are referential to how Native Pacific Islanders utilized these islands, the native flora, conditions of the islands, and namesakes of vessels utilized to transit the region (Bautista and Smith 2018, Takata 2021a).

Kalama/Moku Kuaʻau ʻo Ionatana (Johnston Atoll) refers to the vessel used to sail to Johnston Atoll when it was claimed for the Kingdom of Hawaiʻi. Nalukākala (Kingman Reef) references the frothing surf that crests over its shallow reefs. Named by Native Hawaiian laborers on both islands, Ulukou, or 'kou tree grove(s),' was given to Howland Island in recognition of its kou trees, while Puakaʻilima,

Ka Huakaʻi a Pele

Mai Kahiki mai ka wahine ʻo Pele,
Mai ka ʻāina o Polapola,
Mai ka pūnohu a Kāne,
Mai ke ao lalapa i ka lani, mai ke ao ʻōpua.
Lapakū i Hawaiʻi ka wahine ʻo Pele.
Kālai i kona ka waʻa Honua-i-ākea,
Kō waʻa, e Ka-moho-aliʻi, holoa mai ka moku.
Ua ʻoki, ua paʻa ka waʻa o ke akua,
Kō waʻa o Kālai-honua-mea,
Holo mai ke au.

The Coming of Pele

From Kahiki came the woman Pele,
from the land of Polapola,
from the rising reddish mist of Kāne,
from the clouds blazing in the sky, horizon clouds.
Restless desire for Hawaii seized the woman Pele.
Ready-carved was the canoe, Honuaiākea,
your own canoe, O Kamohoaliʻi,
for sailing to distant lands.
Well-lashed and equipped, the canoe of the high gods,
your canoe, Sacred-hewer-of-the-land,
stood ready to sail with the ocean current

An excerpt from the **mo'olelo (story)** of the goddess Pele on her migration to Hawai'i from which Palmyra Atoll received its name; translated by Mary Pukui and Alfons Korn, 1973.

the ʻilima flower, was given to Baker Island in reference to the similar beauty and conditions shared with islands reminding them of home. Similarly, Paukeaho (Jarvis Island) or 'out of breath/ exhausted' was indicative of the difficult working conditions on the island, especially during the era of guano mining (Bautista and Smith 2018). Additionally, though its name is of contemporary origins and was chosen for Palmyra Atoll instead of being named by past voyagers and native laborers, Honuaiākea was given to this island and describes the name for the canoe from the chant in which the Hawaiian goddess Pele sailed to Hawaiʻi (Bautista and Smith 2018, Kikiloi pers comm).

Within PRI, these sacred islands and ocean highways connect Native Hawaiians and other Pacific Islanders that have voyaged through this region to their past (Finney 1977; Di Piazza and Pearthree 2001a, 2001b; Thompson n.d.; Villagomez 2018; Villagomez and McGuire 2021). Their roles as navigational beacons assisted voyagers as stopping points during cross-ocean voyages for trade and settlement (Di Piazza and Pearthree 2001a, 2001b; Villagomez 2018; Bautista and Smith 2018; Villagomez and McGuire 2021). Limited in resources, PRI never housed permanent populations, but instead provided food in the form of seabird and turtle eggs, fish and limu (seaweed) from their reefs, a place to rest, areas to cultivate small crops of plants, and burial grounds for those that did not survive ocean journeys (Di Piazza and Pearthree 2001a, 2001b; Bautista and Smith 2018).

Archeological research throughout neighboring islands in the Phoenix and Line Archipelagos have also pointed to even wider utilization of these atolls and reefs by Pacific voyagers, as small structures, basalt artifacts, spears, stones, and axes have been discovered linking to quarries in Samoa, Hawai‘i, Society Islands, Tuamotu Archipelago, and Marquesas (Di Piazza and Pearthree 2001b). Additional archeological work during the Whippoorwill Expedition in the mid-1920s pointed to coral walls and mounding structures on Howland Island that shared common traits with those of the far south-east Tuamotu Archipelago, while artifacts of Tahitian origin were also found (Bautista and Smith 2018).

It has only been within the past 50 years that cultural traditions, specifically of Native Hawaiians, have found rebirth, following years of colonization by other nations and religions (Kanahele 1979). The rebirth of the Native Hawaiian language, study and reverence of the Kumulipo, reinstitution of wayfinding and voyaging through the efforts of the Hawaiian voyaging canoe *Hōkūle‘a* (a replica of ancient Polynesian voyaging canoes), and reconnection of communities throughout Oceania through wayfinding has led to a wave of reclamation of traditional protocols and knowledge once lost to native Hawaiian peoples (Kanahele 1979, Finney 1992, Thompson n.d.).

Beginning with relearning lost knowledge from traditional Pacific navigators on the islands of Polowat and Satawal, the sharing of traditional seafaring skills and understanding of ancient

“

Aia ka nani i Puaka‘ilima
Kēlā ‘ailana noho i ke kai
No kai ka makani Pāulukona
Ha‘iha‘i lau lā‘au o ka uka
No uka ka ‘iwa i kiani mai
Ke hea mai nei lā i ku‘u kino
I naue paha wau me ku‘u hoa
Me ku‘u komo kaimana i ka la‘i
Ha‘ina ka inoa i lohe
Ke Kuini ‘Emalani he inoa.

The beauty is there at Puaka‘ilima
That island that dwells in the sea
From the sea comes the Pāulukona wind
Crackling the branches of the shoreland regions
From the highlands the frigate bird glides and wheels
Beckoning to my person
That I should perhaps move along with my companion
With my diamond ring in the serene calm
Tell of the name, that it be heard
Queen Emmalani, a name song

”

Mele (chant/song) composed by Native Hawaiian guano laborers working on Baker Island in the late 1850s; mele translated by Mary Kawena Pukui in 1937 and 1952, and Marvin Puakea Nogelmeier in 2001.

canoe designs have led to recreations of these vessels and inaugural voyages (Finney 1992; Cunningham, Kranz, and Sikau 2006). This has also led to breakthroughs in archeological research simulating and replicating the performance and voyaging of canoes through these regions, including currently unprotected areas of PRI, confirming oral accounting of transits throughout the Pacific (Finney 1977; Di Piazza and Pearthree 2001a, 2001b; Di Piazza, Pearthree, and Paillé 2014; Irwin and Flay 2015).

This renaissance has also permitted Native Hawaiians and other Pacific Islanders to look back through the eyes of their ancestors and to view the management of this oceanic basin through a different lens. Relevant to the region surrounding PRI, as Dr. Kekuewa Kikiloi stated in support of expanding Papahānaumokuākea Marine National Monument, much of the area protected within the monument is underwater and should be viewed from the vantage point of it being a sea-dominated area (Kerr et al 2016). Through this vision, protection and management become nearsighted when failing to include the full extent of a cultural space.

As a source for the past, present, and future, Native Hawaiians knew from the Kumulipo that this knowledge of place and the wide-reaching areas around them were important to preserve, expand upon, and pass on to future generations. Such inspiration and examples for these values come from leaders of the Native Hawaiian people. While under house arrest in ʻIolani Palace following the illegal overthrow of the Hawaiian Kingdom in 1893, Queen Liliʻuokalani recognized the importance of such generational knowledge and duties to continue adding to the fabric of Hawaiian culture (Liliuokalani 1897).

She devoted much of her time in isolation to translating the Kumulipo from Hawaiian to English. She recognized that not all Hawaiian people in the future would be mānaleo (Hawaiian speakers), but that the knowledge and responsibilities of kūpuna must be made available for the future. Otherwise, intangible and less understood language or traditions affording insight into the past practices and environmental management of the land and sea would be lost, as would the ability to add new findings and genealogies.

This threat mirrors the opportunity to proactively fully protect open expanses of the U.S. EEZ surrounding PRI for future generations of Native Hawaiians and other Pacific Islanders. This also builds into the dynamic nature of the Kumulipo, as setting aside and designating healthy, rarely exploited seas as kapu (off-limits) for industrial exploitation allows for future Hawaiian and Pacific Islander explorers, scientists, and observers the opportunity to continue the discovery of species and habitats, and to record ecosystem health management while preserving moana (ocean), papakū (seafloor), and lewa (sky) as sacred no-take areas for the growth of future traditional practices.

The deep ocean of PRI is abundant with life and culture, tightly braided together as the cordage utilized to construct the voyaging canoes sailing its waters. Native Hawaiians and other Pacific Islanders were not people who simply existed by colonizing islands and remaining there. Further, travel across the Pacific was not a single-directional migration and settlement of unfamiliar places (Soares et al 2011; Finney 1991, 1992; Polynesian Migrations n.d.;). The passage through PRI was a cultural byway for Polynesians, Micronesians, and possibly Melanesians (Finney 1991, 1992; Polynesian Migrations n.d.). As such, the protection and responsible management of these areas allows for the expansion and cultural renewal of this region through rebuilding of connectivity across shared pristine oceanic paths.

Existing permitting through NOAA and U.S. Fish and Wildlife Service (USFWS) allows for cultural practitioner access to these waters and islands for voyaging, so expansion of PRI would not hamper access when protection is extended. Additionally, monument management through NOAA and USFWS has already implemented traditional fishing and consumption exceptions for cultural practitioners in Papahānaumokuākea (Papahānaumokuākea Marine National Monument 2020). A revision of monument management with public comment has been conducted in early 2022 with submissions requesting additional access and cultural practice allowance within protected waters (Fed Reg. 2021).

As their sacred duty, Pacific Islanders have lived by the principles of working in harmony, conserving, responsibly managing, and protecting their seas to safeguard their traditions and preserve connections to the past while fostering the growth of their culture and enable their practices to persist in the future (Pukui et al 1972, Maly and Maly 2004, Thompson n.d.). Oceans are already changing due to myriads of threats, leading to the loss of wildlife and even inundation and loss of islands due to climate change (Roberts et al 2017, O'Leary et al 2018, Freestone & Çiçek 2021). There is an opportunity to fully protect these areas to limit impacts from these factors and provide large-scale examples evocative of what the ocean looked like to the people who first utilized these areas. The U.S. expansion of PRI would highlight the U.S. commitment to these ancient and traditional values. If extended, PRI would secure protection of the Mo (Marshallese for 'sacred area') or Ākea (Hawaiian for the pristine 'expanses of space') currently lying unprotected for the expansion of cultural rejuvenation, advancement of traditional voyaging, and preservation of physical and biological resources for future generations.

3.2 Modern History

In addition to the Native Hawaiian and Pacific Islander cultural connection with the Pacific Remote Islands, areas within and outside the current bounds of PRI exist as shared monuments to maritime, military, and native history. These waters stood as passageways for guano traders and hunting grounds for whalers, the final resting places for ships, the maritime amphitheater for battle in World War II, and the territorial fruits of the dedication of 130 brave Native Hawaiian colonists claiming land and sea in service to the U.S. However, the existing protection of this monument is insufficient to fully preserve the historical landscape of this region.

As with other monument designations, expanding PRI will invite further mapping and seafloor characterization, which may bring lost history to light with the recovery of military ordinance and other objects that thus far have had no recognition (Keogh 2017; NA101 2017; NOAA Ocean Exploration 2021, 2022). To honor the brave Americans who served in these waters, expansion of PRI would likely help reconstruct their brave acts, and bring closure to some military MIA persons and their surviving family members as well as World War II-era mysteries in these parts of the elusive Pacific. Expansion of PRI to the full boundaries of the U.S. EEZ would afford recognition of these efforts and services in currently unprotected waters, while also facilitating further characterization, documentation, and protection of these activities within the extended monument.

Beginning in the 1500s and 1600s, Europeans began sailing through and mapping the region (Magier and Morgan 2012, Bautista and Smith 2018) and by the 1800s, whalers from New England began pursuing Pacific sperm whales as Atlantic populations declined (Magier and Morgan 2012, Smith et al 2012, Bautista and Smith 2018, Kennedy et al 2021). Though whales were hunted within the current boundaries of PRI, significant effort was expended outside of the PRI, but within the current U.S. EEZ (Kennedy et al 2021).

Towards the end of the 19th century and continuing until the early part of the 20th century, the undisturbed and dense bird populations on the islands attracted the exporters of highly prized seabird feathers to feed fashion trends into the early 1900s (Magier and Morgan 2012). Further, ship traffic across the region expanded from the 1800s through the early 1900s as the islands became sources for copra, or dried coconut kernels, and guano mining, which led to the establishment of working populations on these islands to gather, process, and load materials onto vessels for export (Tengan 2008, Magier and Morgan 2012, Bautista and Smith 2018). During these times, the islands became homes for laborers from Niue, Cook, and Hawaii, and made the PRI region a major shipping corridor for this growing economy.

During this period, both Howland and Baker Islands witnessed the destruction of ships due to accidental groundings, fires, and damaged, leaking hulls creating a wealth of historic objects of interest (Magier and Morgan 2012, Bautista and Smith 2018). However, in addition to those lost near shore, logs document ships being lost at sea within the surrounding waters that have yet to be discovered (Bautista and Smith 2018). Lack of modern discovery is partially due to the lack of high-resolution mapping of the seafloor in much of the EEZ surrounding PRI, leading to features, such as ships and planes, being too small to detect with current satellite imaging (Kim and Wessel 2011; Cantwell, Elliott, and Kennedy 2018; Kennedy et al 2019). These wrecks would prove difficult to find in the wide expanses of the abyssal plain, but could potentially lay beyond current PRI bounds.

Most notably in the modern Hawaiian history of PRI was the dedicated colonization of Howland, Baker, and Jarvis Islands following the guano mining era. From the late 1800s to 1930s these islands were relatively forgotten before U.S. interest was piqued in utilizing their location for air travel stop-overs during flights between Hawaiʻi and Australia (Danielle 2013). Given its good location for air travel stopovers, Howland Island was the intended destination for Amelia Earhart prior to her theorized disappearance in the surrounding waters (Hancock 2009). With interest in formally establishing these islands and their seas as U.S. territory, the United States set out to colonize the region, recruiting the service of young Native Hawaiian men for continuous occupation in order to lay claim for annexation (Magier and Morgan 2012, Danielle 2013, Bautista and Smith 2018).

Graduates and students of Kamehameha School, later known as the Hui Panalāʻau, onboard the USCGC Itasca, January 1936. Back row, left to right: Luther Waiwaiole, Henry Ohumukini, William Yomes, Solomon Kalama, James Carroll. Front row, left to right: Henry Mahikoa, Alexander Kahapea, George Kahanu, Sr., Joseph Kim.

Photo credit: *Image courtesy of George Kahanu, Sr.; credit: Center for Oral History, Social Science Research Institute, University of Hawaiʻi at Mānoa and Bernice Pauahi Bishop Museum.*

Beginning in 1935, these young men would go on to meticulously document the environmental conditions of the islands and their waters, record weather patterns, and survey seabirds, later gaining recognition as Interior Department employees (Tengan and Kikiloi 2006, Tengan 2008, Hirsh n.d., Magier and Morgan 2012, Danielle 2013, Bautista and Smith 2018). Their occupation of the islands and service to their country proved successful with additional young men rotating through the program annually (Danielle 2013). However, their tenure on the island was not without tragedy and sacrifice. First, in 1938, colonist Carl Kahalewai fell ill and succumbed to appendicitis while transiting back to Honolulu (Tengan and Kikiloi 2006, Danielle 2013, Hirsh n.d.). Several years would pass before tragedy would again visit the islands in the form of World War II.

Following the attack on Pearl Harbor by Japanese forces, the islands withstood numerous bombings by enemy planes and I-22 submarines, leading to the destruction of Kamakaiwi Airfield and forcing residents to hide during the day, only emerging at night to eat and drink (Tengan and Kikiloi 2006, Tengan 2008, Danielle 2013). Due to their remote location, U.S. forces did not rescue the young men until approximately two months later on January 31, 1942 for those on Howland and Baker Islands, and on February 9, 1942 for those occupying Jarvis Island and Enderbury Island in the Phoenix Islands (Kahanu 2006, Tengan and Kikiloi 2006, Danielle 2013, Takata 2021a, Pacific Remote Islands Marine National Monument n.d.). Unfortunately, during the initial attacks, two young men colonizing Howland Island were fatally wounded by bombs dropped on the island. Joseph Keliʻihananui and Richard ʻDickeyʼ Whaley lost their lives and were interred on the island in craters left by the bombings by the other men until the 1950s (Tengan and Kikiloi 2006, Danielle 2013).

Returning from PRI aboard the USS *Helm* while World War II was still being fought, the men were ordered by the U.S. government not to speak about their experiences on the islands. However, in honor of their sacrifices and to perpetuate the fellowship of the Hawaiian youth that served as colonists on these islands, the men formed a lasting hui (group) (Kahanu 2006, Tengan and Kikiloi 2006, Danielle 2013, Takata 2021a). Hui Panalāʻau, or the ʻclub of settlers of the southern islands,ʼ ʻholders of the land society,ʼ and ʻsociety of colonists,ʼ went on to successfully petition the U.S. government for the return of their fallen brothers who were recovered, but then laid to rest with little fanfare or recognition at the Schofield Barracks on Oʻahu Island in 1954 (Tengan and Kikiloi 2006, Kahanu 2006, Danielle 2013). Following renewed petitioning from Hui Panalāʻau and their descendants to the Hawaiʻi congressional delegation, Joseph Keliʻihananui and Richard ʻDickeyʼ Whaley were reinterred in 2003 at the Hawaiʻi State Veterans Cemetery in Kāneʻohe, Oʻahu with Hawaiian ceremonial chants, hula, presentations of gifts, and speeches to acknowledge their contributions and sacrifices (Tengan and Kikiloi 2006, Danielle 2013, Hirsh n.d.).

Through the establishment of PRI in 2009 and the expansion of the monument in 2014, PRI has been effective in preserving the scientific, biological and historical resources and objects defining these islands and surrounding waters for centuries. Additionally, it protects those that have lost their lives traversing its waters in their final resting places and its first expansion in 2014 specifically honored the bravery and sacrifice of the voluntary Native Hawaiian colonists of Hui Panalāʻau.

Military ordinance discovered by the R/V Falkor in the Howland and Baker unit of PRI in 2021, illustrating the types of wartime artifacts that expansion would help to protect.

Photo credit: *Schmidt Ocean Institute*

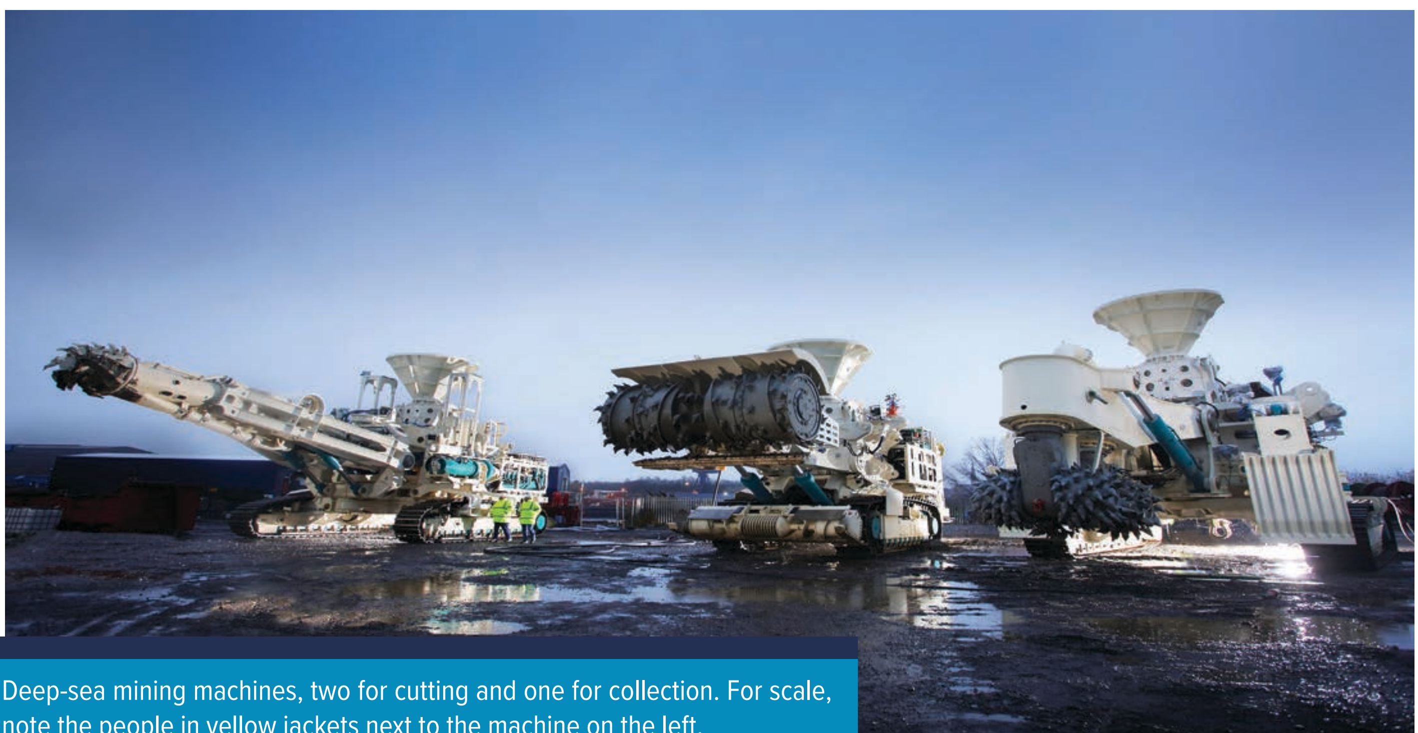
However, the history of this area and commitment of colonists extends far beyond the standing borders of PRI and expansion of the current monument would recognize their actions and service to their country (Kahanu 2006, Tengan and Kikiloi 2006, Magier and Morgan 2012, Bautista and Smith 2018, Takata 2021a). It would also afford expanded protection for the legacies of cartographers, explorers, whalers, and traders, with some spending the majority of their effort in these seas (Magier and Morgan 2012, Smith et al 2012, Bautista and Smith 2018, Kennedy et al 2021). Further, continued exploration within the proposed waters for expansion have revealed new findings relevant to the military heritage of this region. For example, recent deep-sea work in Howland and Baker Islands found previously undocumented military ordnance with only limited time on the sea floor (R/V Falkor 2021); more thorough exploration is warranted to piece together the history and military action in these remote locales. The expansion of PRI to the full extent of its surrounding U.S. waters provides an invaluable opportunity to facilitate these goals and to memorialize the service of those that aided in the economic and territorial growth of this area as well as as the defense of our country for future generations.

4 | THREATS

The two remaining management units, Palmyra Atoll and Kingman Reef, and Howland and Baker Islands, have to date experienced relatively few local anthropogenic impacts in the 50 to 200 nautical mile zone of the EEZ, and are in relatively good health. It is, however, critical to work quickly to permanently protect these intact areas of ocean wilderness, against future exploitation (O'Leary et al 2018). Such precaution is especially warranted given the rapidly increasing threats of climate change—and the evidence that large marine protected areas may help buffer against climate change threats (reviewed by Roberts et al 2017)—as well as the increasing likelihood of deep-sea mining taking place in the region. Below is a discussion of current and future threats to the proposed expansion area and broader region.

4.1 Seabed mining

Deep-sea mining is poised to become a potentially major threat to these areas and broader region. Mining activities are expected to target one of three different resource types: polymetallic nodules (nodules), cobalt crusts (crusts) and seafloor massive sulfides (SMS). While seabed mining is still in exploratory stages for all of these resource types, the increasing price of strategic minerals and elements is driving increased commercial interest and the likelihood that these



Deep-sea mining machines, two for cutting and one for collection. For scale, note the people in yellow jackets next to the machine on the left.

Photo credit: *Nautilus Minerals*

activities will occur (Cuyvers et al 2018). The expansion of PRI represents a critical opportunity to proactively safeguard the biodiversity and functioning of the ecosystems within these units against this emerging new industry.

Both Kingman Reef and Palmyra Atoll are located near or in the Prime Fe-MN Crust Zone (PCZ) (Figure 2), an area highlighted as among the highest value areas in the world for mining mineral rich crusts, and one that contains some deposits of nodules as well. Kingman Reef, Palmyra Atoll, and Howland and Baker Islands are also located within a "prospective zone;" meaning thick crust formations may also have formed and are thus considered to be priority areas for further exploration. Additionally, analysis of crusts in Howland and Baker Islands from previous collections in 1999 have displayed higher levels of Fe-Mn than adjacent seamounts along the Marshall, Gilbert, Tuvalu, and Samoan chains, drawing further mining interests to areas in the Pacific Remote Islands (Mizell et al 2020, 2022).

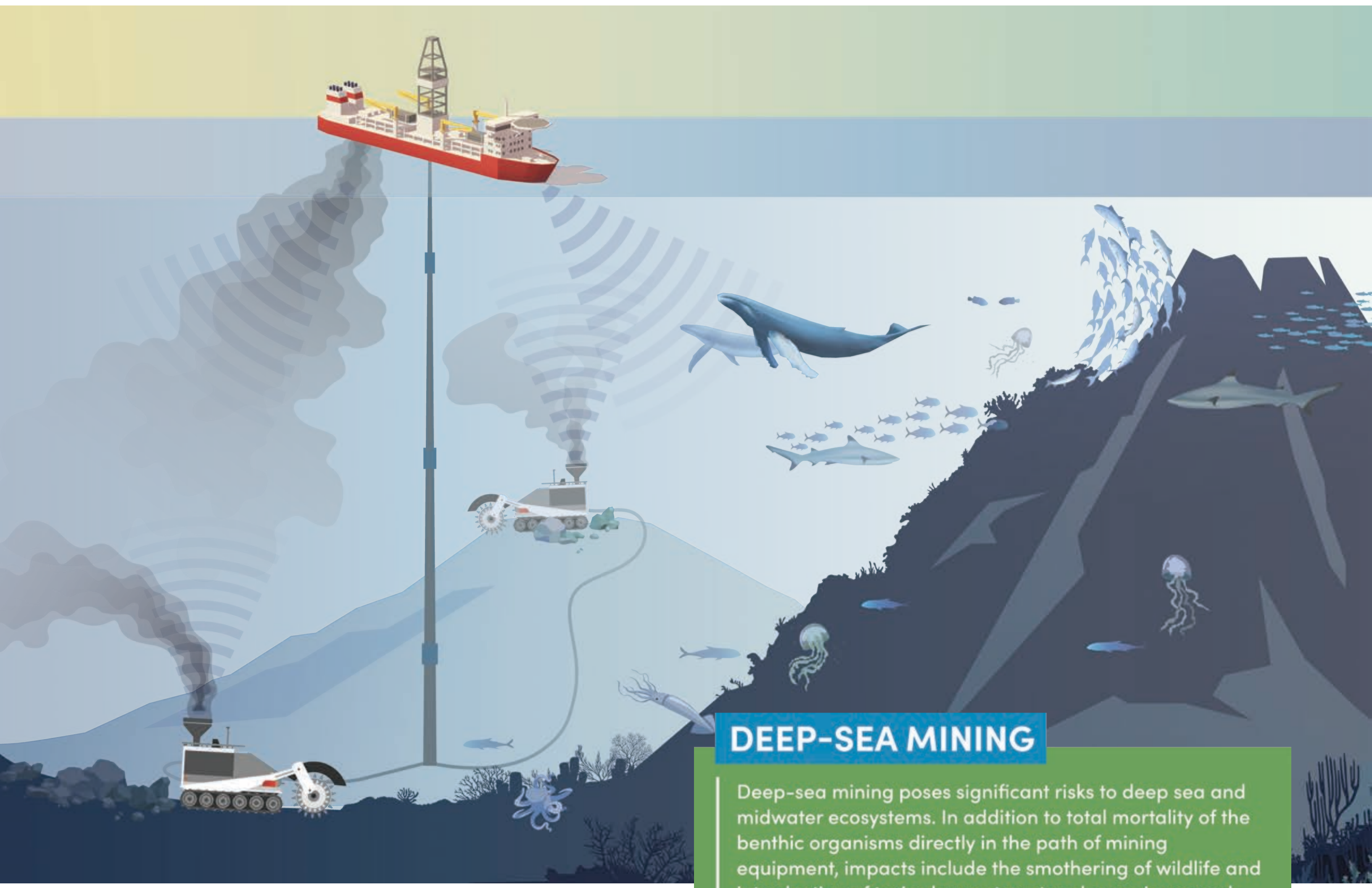


Figure 5. Visualizing the risks of deep sea mining.

Deep-sea mining involves the complete removal of the top layer of seafloor along with all organisms in it—causing complete mortality of organisms in the impacted areas. Moreover, as this crust is piped up to the surface and processed, the mining wastewater and tailings are expected to be released back into the mined marine environment. The effects of these wastewater plumes may be even more impactful than the direct effects of mining seafloor communities. Potential negative impacts include smothering of midwater species that are highly sensitive to sediment loading, reduced productivity and erosion of the forage base for midwater and pelagic communities, and the introduction of harmful toxins in the wastewater plumes that could have deleterious effects on affected ecological communities (Jones et al 2017, Cuyvers et al 2018, Drazen et al 2020, Levin et al 2020, Smith et al 2020). Deep-sea biodiversity is likely to have very slow recovery times given the very low rate at which biological processes occur in these food, light, and temperature limited environments (Smith et al 2008, McClain et al 2012). In fact, this has been demonstrated via small scale, simulated seabed mining disturbances, after which deep-sea benthic communities showed very limited recovery to prior levels of faunal diversity and density—even after more than 20 years of monitoring (Jones et al 2017). Further, some of the oldest marine species on the planet (i.e. deepwater corals) are present in the central Pacific PCZ targeted by mining (Roark et al 2009). With these concerns in mind, over 600 scientists have joined joint calls highlighting the risks posed by seabed mining to ecosystems like those of the proposed expansion area (https://www.seabedminingsciencestatement.org/).

Seabed mining would have catastrophic effects on directly impacted benthic communities like those shown here.

Of the areas of most interest for mining in the Pacific, guyots (flat-topped seamounts) have been identified as areas of highest interest, value, and optimized effort relative to areas on the seafloor and conical seamounts (Hein et al 2009). Currently, the unprotected areas around Palmyra Atoll and Kingman Reef are of major interest for these mining efforts, and additional mining resources on guyots within unprotected waters of Howland and Baker Islands have been identified as well (Hein et al 2009, Demopoulos et al 2018). However, as discussed in more detail in Section 6.1, additional exploration of these areas in recent years has underscored the critical conservation value of these environments and the need for protection prior to disturbance (Cantwell, Elliott, and Kennedy 2018; Demopoulos et al 2018; Kennedy et al 2019). For example, guyots in these areas have been identified as hotspots for biodiversity and harbor higher amounts of slow-growing and threatened corals than surrounding conical and ridge seamounts (Kennedy et al 2019).

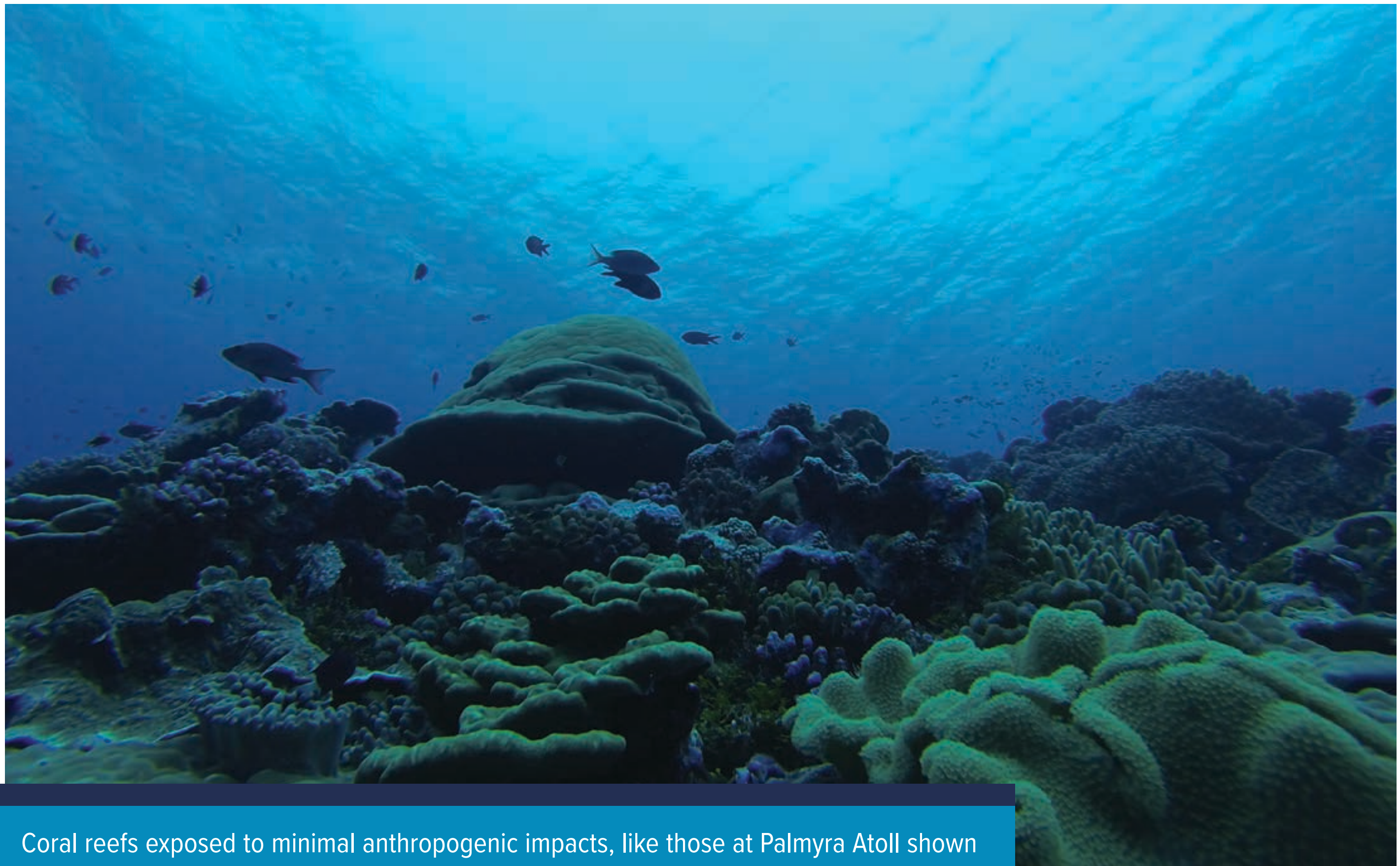
The optimal depth of crust mining is between 1,500 and 2,500 meters. The proposed expansion zone contains extensive area at these depths that could support seabed mining, and dives from the National Oceanic and Atmospheric Administration (NOAA) Ship *Okeanos Explorer* found Manganese crust substrate within the optimal mining depth in all but one of six dives. Notably, these Manganese crust environments were home to two of the three high-density coral communities discovered on these dives.

Seabed mining may also have global impacts in terms of long-term carbon storage. Organic carbon stored in marine sediments can remain for millenia, but disturbing marine sediment can re-mineralize sedimentary carbon, likely reintroducing carbon into marine systems and increasing ocean acidification (Sala et al 2021). For this reason, deep-sea mining is considered an emerging threat to sediment carbon (Sala et al 2021).

Seabed mining would have catastrophic effects on directly impacted benthic communities, and likely severe indirect effects on downcurrent communities—pelagic, benthic and possibly coastal. In most instances, spatial marine protection is put in place to slow or reverse damage already done to marine ecosystems. However, especially in the case of low resilience systems like these deep ocean communities with very long recovery times, enacting protections prior to disturbance is key to retaining the value of these resources (Wedding et al 2015).

4.2 Climate Change

Climate change presents a major challenge to this region. Climate change is expected to increase sea surface temperature (SST), ocean acidification, and wave height, and cause more frequent heat waves and sea level rise (IPCC 2020). Cumulatively, these effects will likely decrease productivity across the tropics and may also push the Intertropical Convergence Zone (ITCZ)—an oceanographic feature that accounts for 32% of global precipitation and shapes the climate in the tropics—closer toward the equator, which may have implications for regional and even global climate patterns (Kang and Xie 2018, Byrne et al 2018). Closer to shore, increased storm events and wave intensity combined with sea level rise may drive erosion and turnover of lagoon water–which at Palmyra Atoll is both anoxic and sulphidic (Gardner et al 2014), thus posing significant threats to coral reef communities. Even in areas with strong management, the tropical Pacific is predicted to show dramatic declines in coral cover under current climate change scenarios (Bell et al 2013). In addition, climate change is projected to diminish tropical pelagic diversity to levels not seen for millions of years (Yasuhara et al 2020).



Coral reefs exposed to minimal anthropogenic impacts, like those at Palmyra Atoll shown here, have been shown to be more resistant and resilient to coral bleaching events.

Photo credit: *Susan White, USFWS*

However, there is some evidence that coral reefs in PRI may be more resistant to climate change than those in more populated areas (Fox et al 2019), likely due to their remote location protecting them from other anthropogenic threats. Additionally, it is possible that these areas offer an area of promise for climate change—the upwelling of cold, deep water and dynamic, mixing currents in the region may provide relative respite from warming ocean temperatures. A recent analysis showed these areas to be some of the best tropical MPAs in terms of being able to resist and persist through the projected effects of climate change (Bruno et al 2018).

With regards to fisheries resources, in the short run, climate change is likely to cause an eastward movement of tuna populations into the region of the proposed expansion area—potentially increasing the relative importance of this area in the near term (Senina et al 2018;

Bell et al 2013, 2021). This may increase pressure to fish these areas, making protection more important. However, this potential increased fishery value may not last, as longer-term models of some tuna suggest their range may shift even further eastward of these sites with time (Bell et al 2013, 2021). This would in turn potentially exacerbate risks to seabirds and other species in the region that depend on tuna. Much depends on how oxygen and water temperatures in the area change—factors around which much uncertainty remains.

In the face of these climate-related changes and threats, this region offers a nearly unparalleled opportunity to understand the effects of climate change in relatively intact tropical marine ecosystems. Free from many of the anthropogenic stressors present in other, nearshore or coastal areas, these sites provide critically-needed end points to understand how climate change alone will act on coral reefs and pelagic ecosystems —and the extent to which these ecosystems can be resilient in the face of rapid change. Indeed, The Nature Conservancy has recently established a new focus of a long-standing science commitment based on Palmyra Atoll called the the Climate Adaptation and Resilience Lab (CARL), which includes a focus on "blue water" species that heavily utilize the 50 to 200 nautical mile zone of the proposed expansion area. The great potential knowledge that may come from this effort and others like it depends on protecting the integrity of the system from other stressors.

4.3 Fishing

While pressure from fisheries is historically and currently still low within the proposed expansion area, future increases in fishing could pose multiple threats to these unprotected waters. The most important effects include: 1) direct effects of harvest on targeted pelagic species, many of which are at historically low abundances, 2) direct effects of bycatch on many declining or listed species including sea turtles, sharks, and seabirds, 3) indirect effects of harvest on other non-targeted species—for instance, declines in major pelagic predators disrupting foraging dynamics of seabirds, food sources to benthic environment, and abundance and behavior of prey fish—and 4) pollution and risk of pollution from these vessels, including noise pollution, derelict fishing gear that includes drifting fish aggregating devices, and risk of oil spills or vessel sinking.

A tuna feeding frenzy in the waters off Palmyra Atoll. Tuna are the primary fishery-targeted species in the region.

Photo credit: *Kydd Pollock, The Nature Conservancy*

Globally, large pelagic fish populations are declining (Myers and Worm 2003) and climate change is predicted to redistribute the world's fisheries in a dramatic way in the near future (Cheung et al 2008). Some of the species commonly caught by fisheries activities—especially bycatch species such as sharks, turtles, and seabirds—have slow life histories and are unable to sustain even modest bycatch pressure. Protected areas help alleviate pressure on these populations by reducing or eliminating fishing mortality. For example, the establishment and expansion of PRI to the 200 nautical mile limit around Johnston Atoll has already been shown to have reduced catch rates of blue sharks and bigeye tuna. There was no similar effect observed for Kingman and Palmyra, which was only protected to 50 nautical miles (Gilman et al 2020).

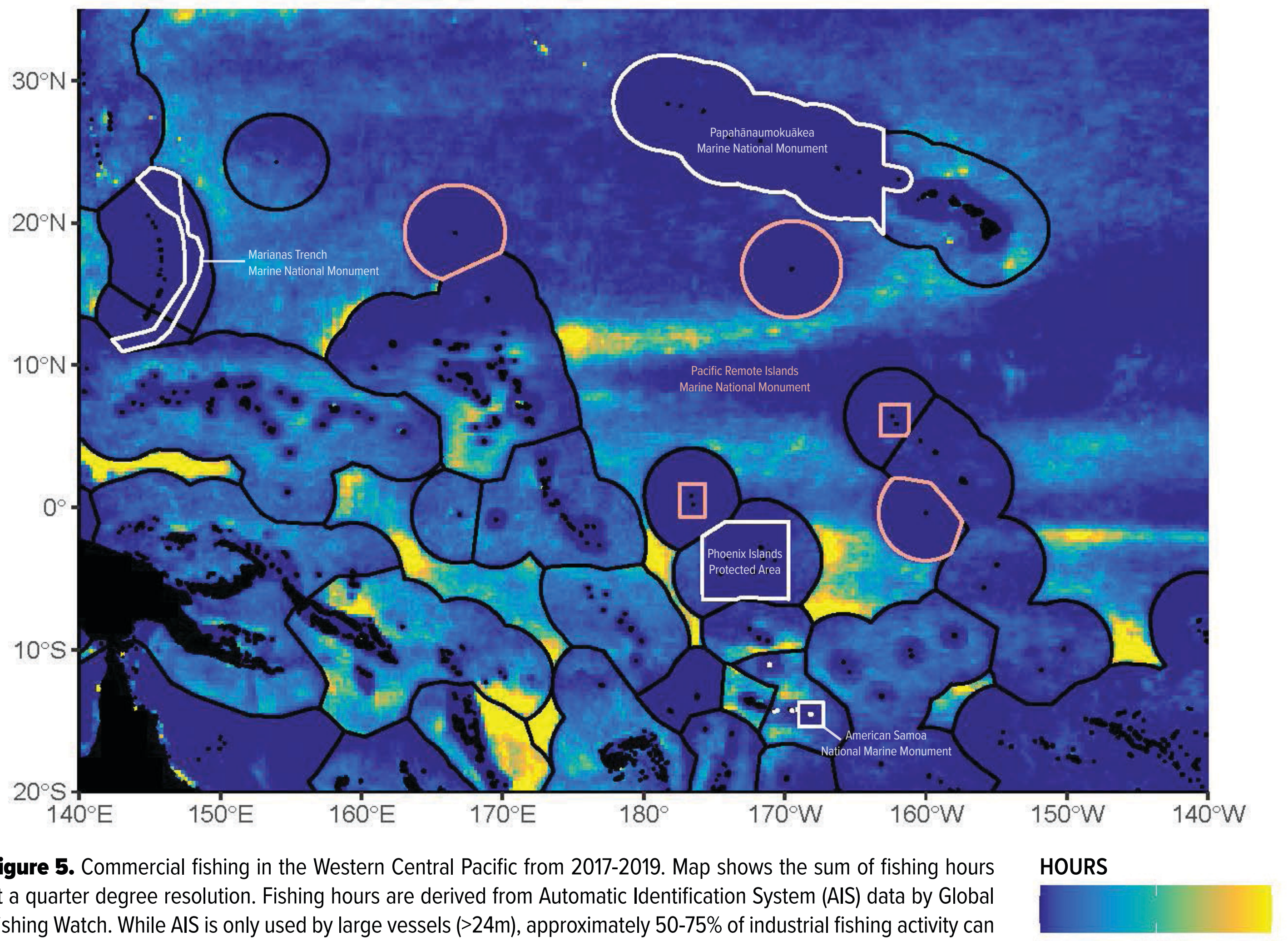


Figure 5. Commercial fishing in the Western Central Pacific from 2017-2019. Map shows the sum of fishing hours at a quarter degree resolution. Fishing hours are derived from Automatic Identification System (AIS) data by Global Fishing Watch. While AIS is only used by large vessels (>24m), approximately 50-75% of industrial fishing activity can be detected via AIS (Kroodsma et al. 2018) and smaller vessels are unlikely to operate in remote waters (White et al. 2017). Exclusive Economic Zones (EEZs) are shown in black, and Marine Protected Areas (MPAs) by shaded colors.

Currently, there is a high amount of fisheries pressure just outside the EEZ boundaries of PRI, with purse seine fisheries targeting yellowfin and skipjack focused around Howland and Baker

Islands and the eastern edge of Palmyra Atoll and Kingman Reef, and longline fisheries targeting albacore, yellowfin, and bigeye tuna on the western sides of Palmyra and Kingman (White et al 2017, 2020; Global Fishing Watch). Currently the vast majority of fishing activity takes place outside of the U.S. EEZ, and heavy fishing on the perimeters of these areas likely already has a significant impact on the pelagic community by removing fish that exit the boundaries of the EEZ, among other threats (e.g. noise pollution, stranding of equipment, ghost fishing). As discussed in the above section, some studies have suggested that the Central Tropical Pacific, where these sites are located, may become more important fishing grounds in the near-term due to climate change, as warmer waters attract more tuna (Lehodey et al 2013). However, there is great variation in these projections.

Additionally, while to our knowledge there is no significant seamount fishery in the region, this could be a significant future threat. Seamounts are often highly valued fishing grounds, and even very remote seamounts are increasingly targeted for fishing. These deep water areas contain slow-growing species that are highly sensitive to fishing impacts. For instance, heavy fishing efforts of Northwest Hawaiian Ridge and Emperor Seamount Chains in the 1960s and 1980s led to a collapse of the fishery, which is only now showing signs of a limited recovery after 40 years of protection (Baco et al 2019).

There may also be significant 'flow-through' fishing taking place within the protected zone of these two units, with purse seine vessel-released fish aggregating devices (FADs) released outside the borders and drifting through, to be fished on the other side—although this has not yet been quantified and is not legal (Gomez et al 2020). Drifting FADs are an important tool used in purse seine fisheries to attract fish, which are easier to catch when aggregated (Curnick et al 2020b, 2021).

In this region, drifting FADs primarily target tuna; however, they frequently catch high volumes of bycatch including triggerfish, undersize tuna, turtles, and sharks. While percentage rates of bycatch for purse seines (e.g. 2.3% of all landings, Restrepo, 2011) is relatively low compared to other types of gear (e.g. 7.5% for longline, 30% for trawls; Kelleher 2005) the large volume captured by purse seine fleets results in large total volumes of bycatch (IATTC 2013). In particular, bycatch rates on sharks are about twice as high on drifting FADs as they are on purse seines set on free swimming schools (Clarke et al 2011, Hutchinson et al 2015). Drifting FADs also often catch juvenile tuna which are below reproductive age, removing these individuals before they are able to contribute to population growth. Drifting FADs are also often lost or abandoned at sea, becoming an source of marine pollution; for instance, an estimated 10% end up beaching in coastal areas where they may damage reefs or other sensitive ocean resources (Maufroy et al 2015). Further, recent work in the Galapagos suggests that overuse of FADs in the area may diminish effects of protected areas by continuing to harvest recovering fish stocks prior to recovery and spillover (Bucaram et al 2018).

Enlarging the areas of protection would likely make it more difficult for FADs to undermine the value of this reserve. Drifting FADs do not have any form of direction or locomotion to steer them through regions through which they aggregate fish. As such, increasing reserve size in turn discourages FAD use through protected areas, as FAD trajectory and other factors, such as increased time within the reserve extending deployment and collection timelines, reduce FAD efficiency and efficacy.

The presence of even the limited fisheries present to date within the EEZ also poses direct risks to reef ecosystems through vessel shipwrecks. For instance, in 1991, a longline fishing vessel, *Hui Feng*, grounded on the reefs of Palmyra. Over time, iron leaching from the wreck facilitated an outbreak of the corallimorph *Rhodactis howesii*. This corallimorph—a non-calcifying sessile animal—can cause significant harm to corals, and at Palmyra Atoll it facilitated large scale conversion of a coral reef community to a monodominant corallimorph barren across many hectares (Work et al 2008, Kelly et al 2012). Even after the wreck was removed at great expense, and aggressive treatment was implemented, the corallimorph spread has not been stopped—and instead the corallimorph has now spread to multiple other sites around the atoll, causing declines in coral cover (Carter et al 2019). The corallimorph has also had outbreaks at Baker Island and has potential to have outbreaks at Howland Island and Kingman Reef near sites of ship debris (Howland Comprehensive Conservation Plan, 2008).

Fisheries vessel traffic also poses risk for oil spills, increases noise pollution in the area, and can cause direct damage to deeper reefs when ships sink or drag gear. Fisheries are also a significant source of marine debris, especially in remote areas where other sources of marine debris are more limited (Amon et al 2020).

While it is sometimes suggested that legal fisheries are important as 'eyes on the water' to prevent illegal fishing, the lack of significant illegal fishing activity in the area and the increasing use of Automatic Identification System (AIS) tracking by most vessels (McCauley et al 2016) makes this less important in these areas. Indeed, closures in multiple Pacific areas since 2013 have largely been very effective—as measured by the fact that there is no significant fishing activity detected—despite a lack of strong monitoring efforts, likely due to their remote nature (White et al 2020).

It is ideal to place MPAs in areas that are both biologically valuable and that cause minimal economic hardship. Expansion of PRI in this area achieves both goals. As noted elsewhere, there is currently only sporadic fishing activity currently happening in the unprotected EEZ (White et al 2020), so there is little current economic activity to disrupt. However, the potential of future threats does exist, as fisheries in the region are poised to grow—thus, the relative ease of protection now, with minimal disruption to economic livelihoods, is not guaranteed to remain. For comparison, in Papahānaumokuākea, where fisheries effort was also low (though much higher than the proposed expansion areas around PRI), the closure appears to have caused only relatively minor economic impacts (Lynham et al 2020).

There are, however, likely to be strong benefits in conservation if establishment of pelagic MPAs (PMPAs) significantly reduces fishing activity that might otherwise increase in the future. As highlighted in the following section on MPAs, recent work has shown benefits of pelagic MPAs to most of the major fisheries species important in this region (see section 3.1)—potentially creating positive net benefits not only in terms of conservation, but also in terms of spillover increasing total fisheries yield, thus providing important provisioning resources from the ocean (Sala et al 2021).

Photo credit: *Kydd Pollock, The Nature Conservancy*

6 | VALUE OF PELAGIC MPAs

Marine ecosystems globally are threatened by multiple factors including climate change, overfishing, biodiversity declines, pollution, and habitat degradation (e.g. IPBES 2019, McCauley et al 2015). In addition to threatening ocean organisms themselves, the effects of global change on marine ecosystems has strong trickle down effects on large scale processes—such as nutrient cycling and climate regulation via carbon storage—and on human communities, economies, and societies dependent on ocean resources and services (IPBES 2019, Stuchtey et al 2020). One response to these growing threats has been the creation of marine protected areas—where destructive and extractive activities may be prohibited. MPAs, which are consistent with traditional management practices and are an integral part of the U.S. protected areas program since the mid 1900s now cover 26% of U.S. waters and the level of protection is not equal (e.g. the degree of protection across MPAs varies widely (Sullivan-Stack et al 2022).

Decades of research has shown that MPAs can provide enormous benefits to ecosystems, biodiversity, communities, fisheries, and economies (Ban et al 2019, Goñi et al 2010, Angulo-Valdés and Hatcher 2010, Naidoo et al 2019; Wilson et al 2020, Sala et al 2021). Notably, MPAs can increase ecological resilience and adaptive capacity of ocean ecosystems even in the face of climate change (Micheli et al 2012, Barnett and Baskett 2015, Mellin et al 2016, Roberts et al 2017, McLeod et al 2019). However, much of the research to date on the efficacy of MPAs has focused on coastal MPAs, which were the longstanding model of MPAs in conventional Western ocean management. PRI was among the first of a series of very large pelagic MPAs implemented beginning in 2009. While the newness and often remote location and pelagic nature of these MPAs has made it more difficult to assess the value of these MPAs than their coastal or older counterparts, an emerging body of literature, discussed below, suggests that these large pelagic MPAs overall are highly valuable.

Coral reefs protected within large MPAs have been found to recover more quickly after coral bleaching events than other sites in the same region with less protection.

Photo credit: *Andrew S. Wright, USFWS*

5.1 Value of Pelagic MPAs (PMPAs)

Despite its relatively young age, the expansion of PRI has already provided immense conservation value in the form of new discoveries and scientific knowledge—much of which was made possible only through federal investment in exploring this newly-protected area and its resources (see findings from the multi-year NOAA Ocean Exploration Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE), Schmidt Ocean Institute R/V *Falkor*, and Ocean Exploration Trust Research Vessel E/V *Nautilus* expeditions described in more detail in section 2.1). Since the expansion of this protected area in 2014, many novel taxa, records, and behaviors have been observed, uncovering new types of species interactions and unveiling critical information around the drivers of deep-sea life. For instance on the CAPSTONE expedition alone, over 80% of species observed over the 3-year expedition were new to science, including at least 14 new species of deep sea corals (Kennedy et al 2019).

This new type of sea star was spotted at the end of a dive to an unprotected seamount in the U.S. EEZ outside of PRI's Howland and Baker unit

Photo credit: *NOAA Okeanos Explorer*

Other large pelagic MPAs (PMPAs) have exhibited additional signs of conservation value. For instance, recent work on the Chagos Archipelago in the British Indian Ocean Territory (BIOT) PMPA suggests that the protection (both from formal designation and from de facto isolation) has benefits for climate resilience. The archipelago has shown relatively rapid recovery after a significant 1997-1998 coral bleaching event, recovering to pre-bleaching coral cover by 2014, much faster than other regional sites with less protection–some of which actually regime-shifted to macro-algal or rubble dominated reefs (Head et al 2019). More broadly, sites with minimal anthropogenic impacts have been shown to have more resistance and resilience to coral bleaching events than more disturbed sites. For instance, findings indicate that both water quality and intact large fish communities may be important for mediating the effects of climate change on reef ecosystems (Lapointe et al 2019, Donovan et al 2020)—both of which are factors that PMPAs help to protect and maintain.

A major question about the value of pelagic MPAs is if these MPAs can effectively protect the larger and more pelagic species, either by preventing direct mortality or by protecting the resources they need for vitality (for example, zones of high ocean productivity, key spawning grounds, etc). Most PMPAs are relatively new and have been located in areas where there was originally low human activity, both of which complicate efforts to evaluate effects of protection.

New research out of Palmyra Atoll suggests protecting the full EEZ of this unit would strengthen protection for grey reef sharks, like those shown here.

Photo credit: *Kydd Pollock, The Nature Conservancy*

However, there is growing evidence to suggest that pelagic species can be protected by stationary place-based protection, especially when these areas are large enough to contain key habitats for breeding, foraging, resting, or otherwise increase residency of species in protected waters (Gilmour et al 2022). As such, increasing the size of PRI via expansion will directly increase protected habitat for these species.

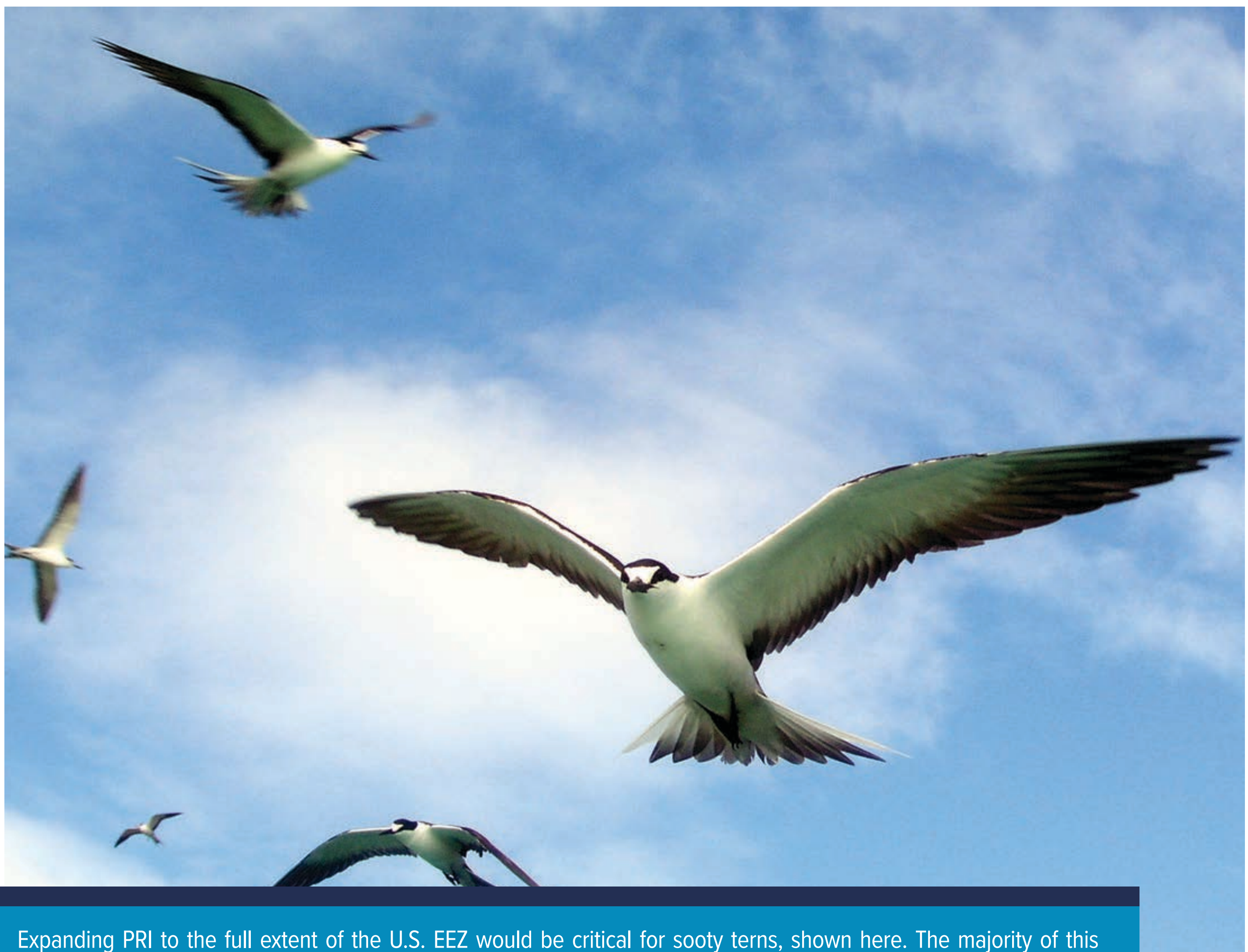
For instance, findings from the Galápagos Marine Reserve have shown spillover benefits for yellowfin and skipjack tuna (Boerder et al 2017, Bucaram et al 2018) suggesting that despite the very pelagic nature of these fish, PMPAs can be effective in providing protection for pelagic species and serve as one conservation solution for tuna fisheries. While these fishes are highly mobile, there is growing awareness that large reserves can dramatically reduce the overall mortality of these species, especially if—as found in other sites—residency of fish in protected areas is higher in MPAs than found in the general seascape (Curnick et al 2020b, Mee et al 2017).

A first study of the impacts of pelagic MPAs on large pelagic species in the equatorial Pacific has just been conducted in the Palau National Marine Sanctuary (PNMS). This study found that blue marlin and sailfish both exhibited site fidelity to the Sanctuary prior to dispersal (Filous et al 2022). While yellowfin tuna had different behaviors, the PNMS was constantly protecting a portion of the stock (Filous et al 2022). Similarly, a study on Ascension Island showed very limited dispersal of yellowfin tuna—which showed a maximum displacement from Ascension Island of 187 km (Richardson et al 2018). If tuna showed similar displacement at PRI, this would suggest the proposed expanded protection of PRI could offer significant protection of this stock. Another recent study (Carlisle et al 2019) from a similar large pelagic MPA—the British Indian Ocean Territory—seeks to examine the effects of pelagic MPAs in protecting pelagic and reef-associated fish. After tracking 6 pelagic species (Blue Marlin, Reef Mantas, Sailfish, Silky Sharks, Silvertip Sharks, and Yellowfin Tuna) as well as the more reef-associated grey reef sharks, they found that all species showed activity spaces much smaller than the area of the MPA, suggesting that the MPA was sufficiently large to provide these species with benefits.

With regards to the proposed expansion area for PRI, work at Palmyra Atoll suggests protecting the full EEZ of this unit would strengthen protection for grey reef sharks, green sea turtles, bottlenose dolphins, red footed boobies, manta rays, melon-headed whales and frigatebirds (Maxwell and Morgan 2013, Young et al 2015). While these smaller ranged species already have significant protection in the EEZ for significant parts of their life histories, expansion would help protect populations during other important life history periods. For example, sooty terns would have the majority of their breeding foraging habitat protected (444 km core range, of which ~370 km would be protected with expansion to the full EEZ) (Gilmour et al 2022). Of the 9 species tracked in this study, only yellowfin tuna would have the majority of their tracked range outside of the expanded MPA (Gilmour et al 2022). This added protection is especially critical for frigatebirds, sooty terns, and melon-headed whales.

While there is concern about the ability to enforce pelagic MPAs in remote locations, recent analyses of AIS vessel tracking data suggests that the creation of MPAs is very effective at keeping fishing effort extremely low (White et al 2020).

These results, combined with those from results highlighted earlier in this section, suggest that an MPA on the scale of an expanded PRI can offer meaningful protection to even highly pelagic species, especially if developed in a coordinated fashion with other MPAs and fishery management efforts regionally.



Expanding PRI to the full extent of the U.S. EEZ would be critical for sooty terns, shown here. The majority of this species' core breeding foraging habitat lies within the unprotected area outside of the monument's current boundaries.

Photo credit: *U.S. Fish & Wildlife Service*

CONCLUSION

President Joe Biden has the opportunity to use the Antiquities Act to fully protect Palmyra Atoll, Kingman Reef, Howland Island, and Baker Island to 200 nautical miles, denying major threats such as seabed mining and increasing the area's resilience to climate change. The unprotected waters contain 98 seamounts, known to be ecological hotspots with yet-to-be discovered species. The waters teem with healthy populations of top predators—from tuna to endangered sharks and rays—to more than 50 species of seabirds. The region boasts important habitat for cetaceans, including a species of beaked whale new to science. The unprotected waters are also a migration route for the critically endangered leatherback sea turtle, the largest sea turtle in the world, as it travels between California and Indonesia.

The waters surrounding the Pacific Remote Islands are known as a cultural seascape, used as passage by Polynesians, Micronesians, and possibly Melanesians who relied on the intact ecosystems for voyaging. Preservation of the area to its full extent is an important commitment to Indigenous cultures—and to the healthy ecological areas that they rely upon.

With the planet's last healthy places in peril, now is the time to take action and fully protect the Pacific Remote Islands.

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