CHAPTER EIGHT

Establishment, Management, and Maintenance of the Phoenix Islands Protected Area

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Abstract

The Republic of Kiribati's Phoenix Islands Protected Area (PIPA), located in the equatorial central Pacific, is the largest and deepest UNESCO World Heritage site on earth. Created in 2008, it was the first Marine Protected Area (MPA) of its kind (at the time of inception, the largest in the world) and includes eight low-lying islands, shallow coral reefs, submerged shallow and deep seamounts and extensive open-ocean and ocean floor habitat. Due to their isolation, the shallow reef habitats have been protected *de facto* from severe exploitation, though the surrounding waters have been continually fished for large pelagics and whales over many decades. PIPA was created under a partnership between the Government of Kiribati and the international non-governmental organizations—Conservation International and the New England Aquarium. PIPA has a unique conservation strategy as the first marine MPA to use a conservation contract mechanism with a corresponding Conservation Trust established to be both a sustainable financing mechanism and a check-and-balance to the oversight and maintenance of the MPA. As PIPA moves forward with its management objectives, it is well positioned to be a global model for large MPA design and implementation in similar contexts. The islands and shallow reefs have already shown benefits from protection, though the pending full closure of PIPA (and assessments thereof) will be critical for determining success of the MPA as a refuge for open-ocean pelagic and deep-sea marine life. As global ocean resources are continually being extracted to support a growing global population, PIPA's closure is both timely and of global significance.

Keywords: Kiribati, Open ocean, Phoenix, Reef, Zone, Protection, Fisheries

1. INTRODUCTION TO THE PHOENIX ISLANDS PROTECTED AREA

The Phoenix Islands Protected Area (PIPA) is a unique Marine Protected Area (MPA) in many regards, but is most known for its size

and innovative conservation strategy. First created in 2008, PIPA has accomplished much in a short period. At the time of creation, it was the world's largest MPA, and as of 2014 still remains the largest and deepest UNESCO World Heritage site. It was the first MPA to contain substantial deep-water, pelagic and seamount habitat in addition to shallow reefs and critical terrestrial habitat for nesting seabirds. PIPA was established by the Republic of Kiribati, an UN-designated Least Developed Country, through a collaboration between the government and two partner institutions—the New England Aquarium (NEAq) and Conservation International (CI). In less than a decade since its inception, PIPA has achieved a number of key milestones. These include the creation of the PIPA Conservation Trust to support a sustainable financing mechanism for the MPA, and the signing of a conservation contract between Kiribati and the PIPA Trust, which has accelerated the timeline of PIPA's planned phased closure from an original 12,714 km^2 (3.1%) no-take to 405,755 km^2 (99.4%) no-take effective 1 January 2015. The remaining ~0.6% will remain a restricted use zone around Kanton Island to accommodate subsistence fishing for a small caretaker population. Below, the details of PIPA geography, protection, extraction and remaining challenges are reviewed.

2. GEOGRAPHY AND ECOSYSTEMS

Kiribati is an ocean nation covering 3,500,000 km^2 in the central Pacific on both sides of the equator, approximately midway between Australia and Hawaii (Figure 8.1). Kiribati's marine area encompasses three island archipelagos, the Gilbert, Phoenix and Line Islands. These total 33 islands with a combined land area of only 811 km^2. With its land area well less than 1% of its sovereign domain, Kiribati is truly an oceanic nation.

The Phoenix Island group straddles the central region of Kiribati (where the equator crosses the International Dateline), positioned distantly between the Gilbert Islands to the west and the Line Islands to the east. Two of the Phoenix group members, Howland and Baker, are low-reef islands in adjacent territory of the United States to the north of Kiribati. Located directly north of the Tonga-Kermadec ocean trench, the Phoenix Islands sit atop the Tokelau Ridge, incorporating some of the many Tokelau volcanoes aligned along the ridge. Beyond the Tokelau seamounts there is a well-defined cluster of volcanoes to the east. Beyond these volcanoes lies a typical flat terrain mid-ocean sea floor. Rising from an average depth of 4500 m and a maximum depth of 6147 m, a dozen of these massive volcanoes host shallow reefs and the highest peaks reach the surface, capped by low-elevation islands and atolls. Four are

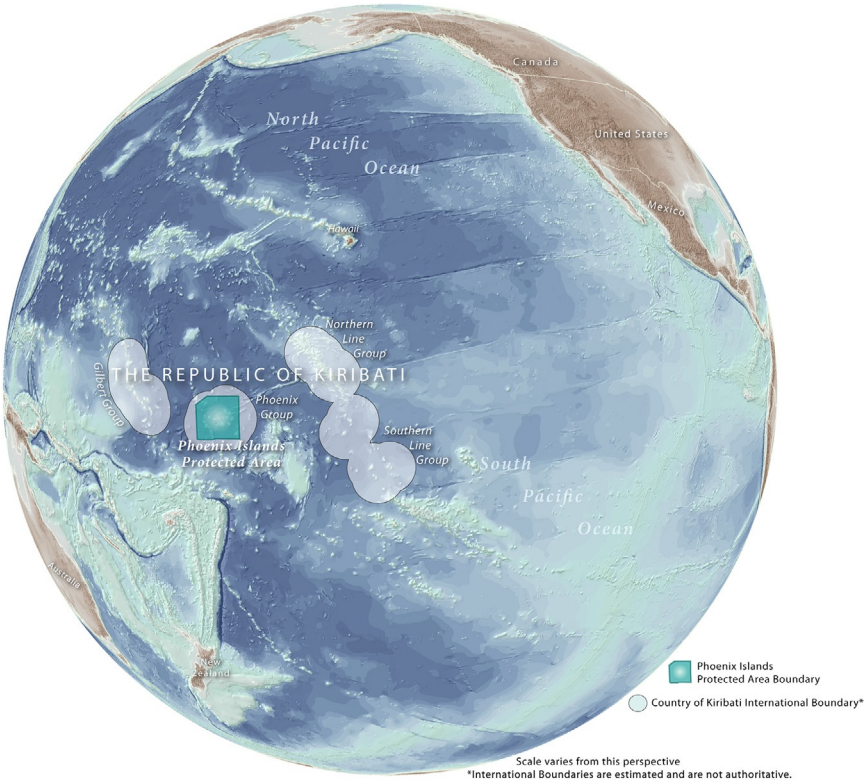

Figure 8.1 The Phoenix Islands protected area (teal box) (dark grey in the print version) is located in the central of Kiribati's three archipelagos.

topped by true coral atolls (Orona, Manra, Kanton and Nikumaroro), six present as low-reef islands (Birnie, Rawaki, McKean and Enderbury in Kiribati and Baker and Howland in U.S. territory) and two are shallow submerged reefs (Carondelet and Winslow). The eight atolls and low-reef islands and the two submerged reefs of PIPA (Figure 8.2) represent only the highest of numerous large- and long-extinct volcanoes. Most of the large volcanoes are greater than 200 m below the surface and are therefore technically classified as seamounts. The catalogued seamounts include Fautasi, Siapo, Polo, Tai, Tanoa, Tau Tau, Gardner and four unnamed seamounts.

The terrestrial habitats range from simple plant herb–shrub communities on the low-reef islands to forest communities on the atolls, especially on the three southern islands which experience the highest rainfall. Atolls and low-reef islands in PIPA are small, ranging from 1.03 to 17.5 km across, but are surrounded by some of the most untouched coral reefs in the world (Obura

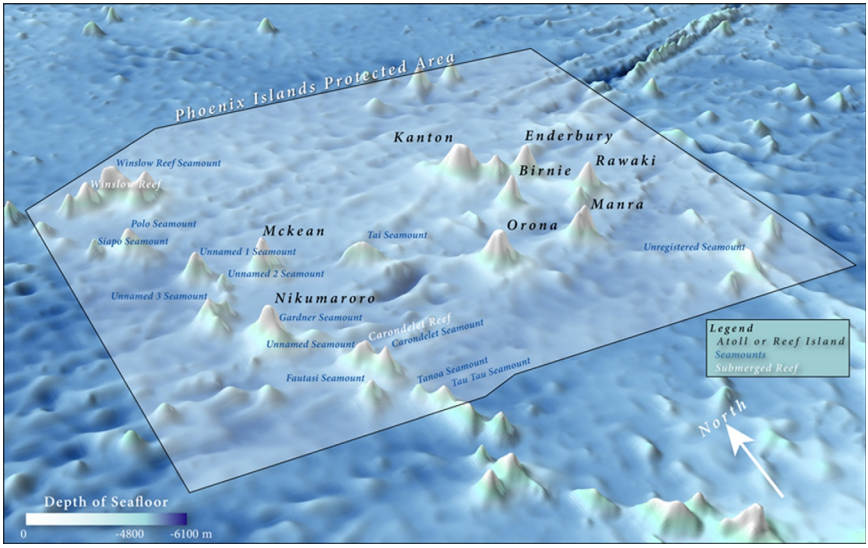

Figure 8.2 Three-dimensional view of PIPA (box) showing surface islands, seamounts and submerged reefs.

et al., 2011a,b). These support a remarkable abundance of marine life (Obura, 2011). Over 500 fish species have been recorded, including abundant populations of large parrotfishes and wrasses that have elsewhere been severely overfished (Allen and Bailey, 2011). The coral species assemblage is typical of the Central Pacific region and expeditions to the Phoenix Islands early in this century found the reefs to be in excellent condition with coral cover averaging 45.1% and 58.1%, respectively, with a maximum cover of 100% live coral (Obura and Stone, 2002; Obura et al., 2011). This is twice the recent average for southern and western Pacific coral reefs, and broadly overlapping with what can be considered near pristine conditions (Bruno and Selig, 2007; Sandin et al., 2008). The same can be said of the fish biomass, which averaged in the vicinity of 250 gm/m^2 during 2009 surveys (values for historically fished coral reefs range from 60 to as low as 20 gm/m^2, (Ssandin Pers.comm)).

3. ESTABLISHMENT OF THE MPA

3.1. Placement and zonation

The Phoenix Islands are located within the Kiribati 200-mile Exclusive Economic Zone (EEZ). PIPA comprises 54.9% of the EEZ surrounding

the Phoenix Islands, and 11.3% of the total Kiribati EEZ. The first phase of MPA management was established in 2008, with multiple use zones. In addition to full protection of all the terrestrial resources, no-take zones were initially established around seven of the eight islands, totalling 3.1% of the MPA (12,714 km^2). There was also a 12-nautical mile restricted use zone around Kanton Island totalling 0.6% of the MPA (2495 km^2) that allowed for subsistence fishing by Kanton inhabitants. Finally, there was a Kanton Purse Seine Exclusion Zone totalling 9.1% of the MPA (37,197 km^2). At the time of inception, the rest of the MPA was open to commercial tuna fishing, with plans for phased increases in no-take zone areas (planned to increase from 3.1% to 28.1% in the second phase). In February 2014, the Kiribati cabinet re-affirmed a decision to accelerate the timeline of no-take protection and to bypass the originally planned phased approach. The decision of the Kiribati government to enact full closure of PIPA to all commercial fishing, including distant-water-fishing-nations (DWFNs), will be effective from 1 January 2015 (Figure 8.3).

3.2. Partnerships and legislation

The collaboration between the Government of Kiribati, NEAq and CI first developed in the early 2000s after exploratory expeditions by the NEAq to the Phoenix Islands under its 'Primal Oceans' project—a project led by Dr. Gregory S. Stone to find some of the last virtually untouched areas in the global ocean. The results of these expeditions, including film and underwater photography, were presented to Kiribati officials and a dialogue on the protection of the Phoenix Islands was initiated. Later, CI was brought in for technical expertise and funding support and a Memorandum of Understanding was signed between the three entities in 2005 and is still in use today.

PIPA is managed by a Management Committee (PIPA MC), a government multi-ministerial committee with representatives from the government stakeholders with jurisdiction over the various aspects of the protected area. The PIPA Office, established within the Ministry of Environment, Lands, and Agriculture Development (MELAD) and based in the capital Tarawa, provides logistical support.

PIPA was the first and is still the only formal MPA in Kiribati. Because there was no precedent for creation or management of MPAs, Kiribati legislation could not accommodate or legally recognize special status for PIPA. Consequently, MELAD, in coordination with the Office of the Attorney General and the Kiribati Cabinet, undertook a major revision of Kiribati

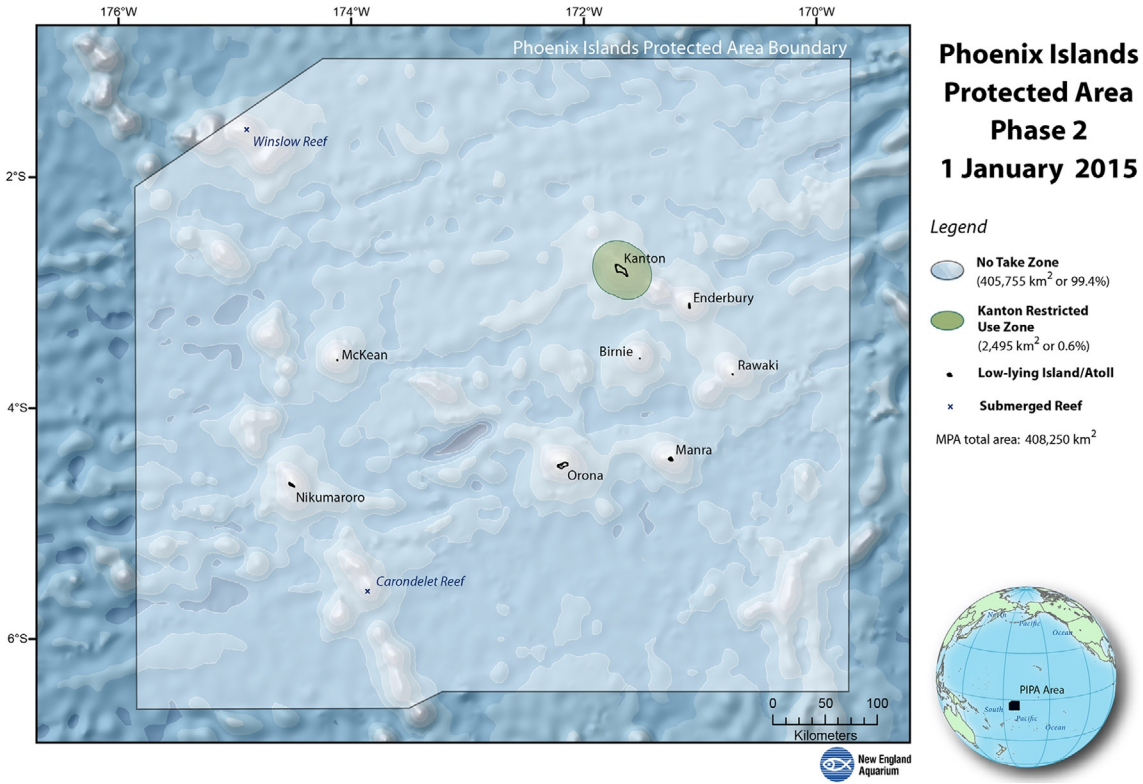

Figure 8.3 PIPA map showing the pending Phase 2 zonation, effective 1 January 2015.

law, beginning in 2005 and culminating in the passage of the Environmental (Amendment) Act 2007, which took effect on 4 September 2007. Acting under this new authority, then MELAD Minister Tetabo Nakara, acting on the advice of the Kiribati Cabinet formally declared the boundaries and enacted the new legal framework for PIPA with the formal adoption of the PIPA Regulations 2008. These regulations defined the boundaries of PIPA, approved the nomination for the area to be inscribed on the list of World Heritage sites, identified PIPA as a Category 1b Wilderness Area under IUCN's 1994 Guidelines for Protected Area Management Categories and required the development of a PIPA Management Plan which was completed in 2009. These 2008 regulations also created the PIPA MC, which oversees and enforces that all persons and public authorities undertaking any activities within the protected area boundary acts in accordance with the Environment (Amendment) Act, the PIPA Regulations and the PIPA Management Plan.

3.3. Sustainable financing

To embrace the idea of creating a large MPA in the Phoenix Islands, the Kiribati Government stipulated that the MPA should not have any negative impacts to the national economy, which was highly dependent on fishing revenues. In 2011, issuing of fishing licenses to foreign fleets accounted for over 40% of Kiribati's national revenue (International Monetary Fund Kiribati, 2011). Creating a sustainable financing mechanism to replace any lost revenue Kiribati might experience from closing the Phoenix Islands to commercial fishing, while simultaneously compensating Kiribati for any increased costs for PIPA management activities, was central to the strong political support from Kiribati and its people. The model of the forest conservation concession was proposed: instead of leasing land to logging companies, landowners are paid not to log their forests (e.g. de Koning et al., 2011). Under this model, compensation and management costs could be covered by the revenues earned from a conservation endowment, securing dedicated funding for the long-term management of the MPA that was not subject to volatility of government budgets. This idea led to the enactment of the PIPA Trust Act by Parliament in 2009, which legalized the establishment of the PIPA Conservation Trust as the 'financing mechanism' of the MPA as a charitable non-government organization.

The PIPA Conservation Trust has multiple activities, including provision of financial support for the management of PIPA and paying any fee that might be required to compensate the government for demonstrated

declines in national fishing revenues as a result of the PIPA closures. These activities are managed and accomplished through the mechanism of a conservation contract, which was signed by the government of Kiribati and the PIPA Conservation Trust in 2014. Performance under the contract is measured by the government's compliance with the provisions of the Management Plan and the success of the government's actions taken to prohibit pelagic or other fishing in the designated PIPA no-take zones. This is the first marine example of such a conservation contract. The PIPA Conservation Trust is governed by a board of directors, with the three founding PIPA partners having permanent seats. In 2011, the Trust hired an executive director and established an office in Tarawa. In October 2013, the PIPA Trust was capitalized with USD $5,000,000, half of which was gifted by the Kiribati government. This contribution was matched by CI through its Global Conservation Fund.

The initial USD $5,000,000 capitalization of the PIPA Trust was a major step towards the goal of reaching a 2014 target of USD $13,500,000, which was originally intended to catalyze the second phase of protection, allowing an increase to the pelagic the no-take zone by an additional 25%. Kiribati President Anote Tong decided to support measures to accelerate the PIPA closure timeline. In January 2014, the Kiribati cabinet re-affirmed its decision to fully close the whole of PIPA to commercial fishing and approved 31 December 2014, as the effective date for full closure of the protected area to all forms of fishing including tuna. As part of the first conservation contract with Kiribati, a Tuna Working Group is being established to analyse the potential revenue impacts of the PIPA closure over the next 5 years.

3.4. International and regional context

The creation of PIPA was a remarkable achievement for a Small Island Developing State (SIDS) and sets an example as the world's largest MPA (at the time of creation) with a novel partnership structure and the first marine model of using a conservation contract with a sustainable financing mechanism. The establishment of PIPA moves Kiribati closer to its commitments under the Convention on Biological Diversity, and Aichi Target 11, which states that 'by 2020, at least 17 percent of all terrestrial and inland water areas, and 10 percent of coastal and marine areas . . . are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures'.

Following the inception of PIPA, a number of other large MPAs have been created, including several in the Pacific. This 'race to protect the oceans' is launching a new era of ocean protection and management (Leenhardt et al., 2013). To date, 28 countries have now exceeded 10% coverage of their waters as designated MPAs, but this area still represents less than 2.3% of the total global ocean area as protected (Spalding et al., 2013). Even within this 2.3%, not all MPAs are governed effectively or with similar conservation goals. A recent meta analysis of 87 MPAs found that conservation benefits increased exponentially with the accumulation of five attributes: no take, well enforced, old (>10 years), large (<100 km^2) and isolated by deep water or sand (Edgar et al., 2014). PIPA will soon meet three of these criteria (no-take, large and isolated). As of 2018, PIPA will formally be a decade old. However, enforcement remains a challenge due to the remoteness of the area (detailed below).

4. WHY PROTECT THE PHOENIX ISLANDS?

Viewed against the background of profound human impacts on oceanic islands and marine ecosystems globally, the relative intactness of PIPA is remarkable (Obura et al., 2011). Notwithstanding evidence of prehistoric and recent failed attempts at human colonization on some of the atolls, the Phoenix group is sufficiently remote and inhospitable to human colonization as to be exceptional in terms of the minimal evidence of the impacts of direct anthropogenic stressors both on the atolls and in the adjacent seas. PIPA is more than 600 km across and covers an area of 408,250 km^2, which is a very large managed area even by marine standards. PIPA's remoteness and the protected status of its reefs make it one of a very few remaining places on earth where it is possible to examine the ecological dynamics of coral reef habitats that remain largely unimpacted by intense local human impacts. Due to their remoteness, PIPA waters have been largely *de facto* protected from typical anthropogenic stressors such as coastal development and sedimentation, pollution, high-human traffic and invasive alien species. Fishing has largely been focused on large pelagic such as tuna, and reef-fish extraction and exploitation have been minimal compared to nearly all other Pacific Islands (NEAq, unpublished data).

Biodiversity on PIPA reefs is high despite the small amount of reef area, and the abundance of commonly overfished organisms is notable (e.g. giant clams, bumphead parrotfish and Napoleon wrasse). The total known shallow reef-fish fauna of the Phoenix Islands now stands at 518 species,

consisting of the following: 192 species originally recorded by Shultz (1943), 100 additional species recorded by the year 2000 expedition (Stone et al., 2001), 9 additional species reported in various generic revisions and 217 new records from the 2002 expedition (Allen and Bailey, 2002a,b). A formula for predicting the total reef-fish fauna based on the number of species in six key indicator families (G. Allen, unpublished data) indicates that at least 576 species, over 50 more than currently listed, can be expected to eventually be found in the Phoenix Islands. A new species of damselfish, *Chrysiptera albata*, was collected in 42–50 m depth at Nikumaroro Island (Allen and Bailey, 2002a). Other previously undescribed species were found in the genera *Eviota* (Gobiidae), *Trimma* (Gobiidae) and *Myripristis* (Holocentridae; Randall et al., 2003).

Given their relative health prior to legal protection, it is reasonable to ask whether and why conservation measures were necessary for the Phoenix Islands. Despite their remoteness, PIPA waters are threatened by climate change, by increasing fishing pressure on declining stocks of large pelagics like tuna and by potential increase in human usage given the acute overcrowding on several islands in Kiribati, plus the general increases in global human population, affluence and mobility (Lambin and Meyfroidt, 2011), all of which have the potential to enable increased traffic and use. Furthermore, because of its large size and relative isolation, PIPA has the ability to act as a critical benchmark for identifying, understanding and evaluating ecological change in tropical oceans, heightening the urgent need to study and protect this remote oceanic baseline. The ambitious creation of PIPA by a SIDS was both timely and of global significance, serving to protect these coral ecosystems and to set a global conservation example for extending MPAs into the pelagic realm to protect deep-water habitats and associated diversity.

4.1. PIPA as a natural laboratory

With ecosystems around the world in a rapid decline due to both local and global anthropogenic impacts (Burke et al., 2011; Doney et al., 2012), the very remote, reasonably intact and legally protected oceanic environments of PIPA are of considerable importance as a baseline for healthy intact ecosystems. PIPA offers opportunities to identify and to monitor the effects of sea level change, acidification and warming on coral reef systems without the confounding influences of pollution, watershed disruption or resource extraction. In this regard, it is notable that within Kiribati there are

otherwise similar reef systems that are subject to varying levels of human occupation (Sandin et al., 2008) that also vary in their historical exposure to severe ocean warming anomalies and coral bleaching. For coral reefs, the nation of Kiribati is a planetary Rosetta Stone, offering the opportunity to translate and to interpret the possibilities and limitations for coral reef resilience in an era of anthropogenic climate change.

4.2. Protection of marine source populations

PIPA is biogeographically situated in the centre of the equatorial Pacific, thus likely playing a pivotal role in the movements and dispersal of marine animals and larvae across the Pacific. Few studies of gene flow and connectivity have been carried out across the whole Pacific that includes samples from the Phoenix Islands. However, the limited data available to suggest that there is some gene exchange between the Central Pacific equatorial regions, although some other Pacific regions, like Hawaii, are strongly isolated (Polato et al., 2010). In *Porites lobata* corals, which have a relatively robust (symbiotic) larval stage, no significant genetic differentiation was detected between the Phoenix Islands (Enderbury) and other equatorial archipelagos in the Central Pacific (Baums et al., 2012). However, evidence of an Eastern Pacific genotype was found in the PIPA samples, suggesting that occasional gene flow is possible even across regions that are thought to be isolated from the Central Pacific (Baums et al., 2012). Thus, PIPA may serve as both a source and a sink for *P. lobata* larvae from various regions.

Little is known about the effect of these islands on the surrounding pelagic marine species and systems. The islands of PIPA support internationally important seabird colonies and numerous migratory birds. Pierce et al. (2006) suggested that the Phoenix Islands are affecting and supporting the pelagic marine life and seabird ecology by increasing nutrient loads, thereby potentially impacting the food chain in the local marine environment.

4.3. Protection of novel habitat

PIPA's marine wilderness contains terrestrial low-lying island habitats, shallow, mesophotic and deep reef habitats, large tracts of open-ocean and ocean seafloor and a large suite of seamounts. Among designated MPAs, this is unusual as most are focused on coastal habitats. At the time of inception, PIPA was the only MPA to contain considerable amounts of blue water, seamounts and abyssal plain.

4.4. Protection from climate change

The Phoenix Islands are subject to climatic variability associated with the El Niño-Southern Oscillation (ENSO) index and positive ENSO events (El Niños) that occur every 2–7 years and last for 18–24 months. During these events, the westward trade winds are reduced, water currents experience variations and even reversal and the eastern Pacific thermocline deepens. In particular, the Phoenix Islands are located within the region of the Central Pacific in which a warm pool of surface waters develops at the onset of El Niño phases. Consequently, PIPA can experience persistent hotspots, as occurred in 2002–2003. In that case, a sea surface temperature (SST) hotspot developed (Figure 8.4) and remained over the central Pacific from June 2002 to March 2003 (Alling et al., 2007). Data from *in situ* temperature loggers showed the highest maximum SST was recorded in November 2002, being about 0.5–1 °C warmer than the following 2 years (Obura and Mangubhai,

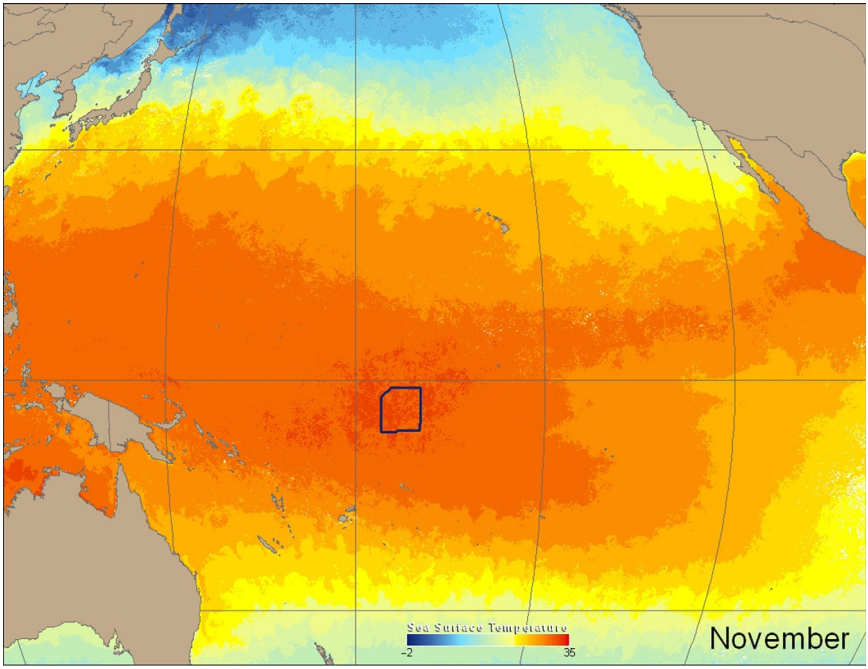

Figure 8.4 Sea surface temperatures (SSTs) in the Phoenix Islands protected area (PIPA; centre box) in 2002–2003, where a prolonged (7 months) high-temperature event occurred in 2002–2003. Red dots (light grey in the print version) denote temperatures at or in excess of Figure 8.1. The PIPA (teal box) (dark grey in the print version) is located in the central of Kiribati's three archipelagos.

2011). The hotspot remained in place for an unprecedented period of 21 Degree Heating Weeks (DHW), where each DHW is equivalent to 1 week of SST 1 °C warmer than the expected summer-time maximum.

Post-bleaching surveys in 2005 documented a reduction in live coral cover to 12.1% overall in the Phoenix Islands, down from 58% in 2000 (Obura and Mangubhai, 2011). This level of coral loss is consistent with those observed in other bleaching events (e.g. Vargas-Ángel et al., 2011). Most likely as a result of this intensive bleaching event, subsequent surveys showed a persistent (consistent across all sites and all fish grouped) decline in reef-fish abundance between 2002 and 2005, with significant declines for the Carangidae, Chaetodontidae and the serranid subfamily Epinephelinae (Mangubhai et al., 2014). Interestingly, changes in fish abundance varied spatially within and across islands, suggesting that there are critical lessons to be learned about differential resilience and recovery in natural (relatively untouched) environments (Mangubhai et al., 2014). The exposure to warm water pools may also exert unusual selective pressures on marine organisms relevant to climate change adaptation.

The establishment of the protected area so soon after significant bleaching will ensure that the future trajectory of PIPA reefs should be unimpaired by fishing-induced loss of reef-fish diversity, abundance or biomass. Post-bleaching re-growth of corals and crustose coralline algae (a necessary precursor for settlement of many coral species) was observed in 2009, suggesting that PIPA reefs have both resilience and rapid recovery potential (Stone et al., 2009). As noted above, PIPA is also a valuable natural laboratory. The successional dynamics of fast-growing and brooding coral species as the dominant re-colonists post-bleaching is a prime example of what can be learned regarding the natural dynamics of reef recovery in the absence of confounding disturbance. However, ongoing thermal stress and associated habitat loss will continue to be important players in determining the future fate PIPA reefs. A 2010 bleaching event in the U.S. Phoenix Islands (Vargas-Ángel et al., 2011) and corresponding high-temperature event in the Kiribati Phoenix Islands (Mangubhai et al., 2012) will likely impact the recovery trajectory of the Phoenix Islands post-2002–2003, but also heightens the importance of this region for the opportunity to examine long-term reef response to repeated disturbance in the absence of local human stressors.

4.5. Protection of indigenous populations/traditional rights

The Kiribati Phoenix Islands have no permanent inhabitants, although most islands have a recent cultural history extending over the past 150 years.

Kanton is the only atoll that has a non-permanent population of usually less than 50 people comprising government employees and their families engaged in protection and management of Kiribati interests in the region. To recognize the importance of marine life as a critical protein source for the highly remote Kanton population, allowance of subsistence fishing was an important initial consideration in the creation of the phased MPA closure for PIPA (detailed in later sections).

4.6. Protection from extraction and exploitation

Protection of remote areas is increasingly important as the global human population grows (Lee, 2011). While potential settlement of uninhabited lands everywhere becomes increasingly possible as technology enables remote living, the biggest threat from rising population comes from increased need for ocean resources, for example, to ensure food security (e.g. Brewer et al., 2013). Increased global wealth can also give rise to new and niche markets, for example, tourism, that have the potential to induce habitat loss and degradation. In the past decade alone, several foreign interests have expressed the desire to develop tourism in the Phoenix Islands, for example, as a site for recreational fishing of bonefish or amateur radio destination. Thus far, the Phoenix Islands have remained relatively intact in the region due to their remoteness and isolation, but the global reach of commercial fishing, settlement and development did not wholly bypass the Phoenix Islands (detailed below). The creation of PIPA was thus both timely and necessary to prevent future exploitation and extraction. Under the management plan, a sustainable use plan will be developed for Kanton to ensure that any increase in population (i.e. for planned research stations, increased management staffing and ecotourism) will be well considered.

5. EXTRACTION, EXPLOITATION AND USE OF PHOENIX ISLANDS RESOURCES

Archaeological evidence indicates that there have been a few settlements in the Phoenix Islands and that because of their isolation from larger population centres, these early settlers never stayed for very long. For the canoe explorers who originally mapped the South Pacific some 3000–5000 years ago, the Phoenix Islands must have been diminutive in comparison to the lushness and largesse offered by other Pacific Island groups such as Fiji, Samoa and Hawaii. The Phoenix Islands exhibit a legacy of temporary and sporadic human use and settlement over several hundred years, with species introductions both of plants (e.g. coconuts), animals (e.g. rats,

rabbits and cats) and remnants of guano mining. None of the islands have hosted long-term human settlements due to the scarcity of fresh water and terrestrial resources.

The early Polynesian settlers who came and went in varying periods between AD 950 and 1500 left stone building foundations that resembled the *marae* of eastern Polynesia. Ancient stone weirs and fish traps were also discovered on some of the Phoenix Islands. There is also evidence that the Phoenix Islands were visited by Caroline Islanders (Micronesians). Most archaeological structures have been found on Orona and Manra. However, though the Phoenix Islands were repeatedly deemed uninhabitable and therefore abandoned, remoteness and Spartan conditions failed to dissuade later attempts to use the Phoenix Islands as a locale for whaling, shark finning, guano extraction, copra harvesting and tuna fishing, all prior to the establishment of PIPA.

5.1. Whaling

Great whales, and in particular sperm whales (*Physeter macrocephalus*), once abounded in the Central Pacific including in the Phoenix Islands. The islands may have been visited as early as 1794 by European and North American whaling vessels and developed in earnest with the expansion of the American whale fleet into the Pacific in the early 1800s, when American whalers from Nantucket and New Bedford, Massachusetts discovered the rich concentration of sperm whales in the Pacific. Much of the historic Pacific whaling grounds were located along the 'on-the-line' grounds, which cut through what were to become Kiribati territorial waters. At times, more than 600 whale ships plied these waters and whalers were so effective that even today the Phoenix Islands appear to be largely devoid of sperm whales. Hutchinson (1950) compared sperm whale population with zooplankton density across the equatorial Pacific. Zooplankton densities were the highest at about 2°S (the latitude passing through the Phoenix Islands) and that corresponded with the peak in sperm whale abundance.

In recent years, opportunistic sightings of sperm whales near the Phoenix Islands have been rare. For example, Stone et al. (2001) noted that during the 2000 NEAq expedition to the Phoenix Islands, few cetaceans of any sort were seen. Odontocetes were the most common sub-order observed and bottlenose dolphins (*Tursiops truncatus*) the most common species. Pierce et al. (2006) recorded no whales during a period of 27 days, which is a

concern considering the extensive time spent observing pelagic seabirds in Phoenix Island waters. Bottlenose and spinner dolphins were the most commonly observed cetaceans during five trips by Pierce et al. in 2006–2013 with only one whale, a probable beaked whale, being seen within PIPA waters (R. Pierce, pers. comm.). It should be noted, however, that no dedicated surveys for cetaceans have been carried out, a gap in survey effort that needs to be remedied. To gain more insight into the spatial distribution of sperm whales in PIPA, researchers at NEAq are currently studying historic vessel logbooks, which feature detailed records of the New Englanders' whaling voyages in the 1800s. Building on the previous studies that compiled and digitized such records (Smith et al., 2012), these researchers are mapping data of whale sightings and catches in the central Pacific to determine potential sperm whale hotspots throughout PIPA waters where special whale conservation strategies may be needed. PIPA, by virtue of its large size, could offer significant potential benefit for cetacean conservation. However, as for any other migratory species, the potential contribution of PIPA to cetacean conservation remains to be assessed.

5.2. Shark finning and exploitation

Early accounts of shark populations within the Phoenix Islands speak of incredible abundance, with little or no exploitation. A 1929 eyewitness account from a stranded shipwreck passenger aboard the *Norwich City* (Nikumaroro) writes '... the lagoon and the whole of this inland water was absolutely infested by sharks ...'. A 1937 report (Maude) notes that on Kanton Island, 'sharks were plentiful everywhere'. The Waikiki Aquarium of Hawaii found it easy to collect baby blacktip sharks from Kanton Island in the 1980s, likely facilitated by their abundance in the lagoon and shallow reef areas, and by the presence of a then-functioning air strip.

Early expeditions (2000) to the Phoenix Islands by NEAq noted substantial populations of grey reef (*Carcharhinus amblyrhynchos*), whitetip reef (*Triaenodon obseus*) and blacktip reef (*Carcharhinus melanopterus*) sharks on all of the shallow reefs, and especially on Nikumaroro Island, which had the highest overall abundances (Stone et al., 2000a,b). Deep-water sharks including six-gill (*Hexanchus griseus*) and Pacific sleeper (*Somniosus pacificus*) sharks were also observed via baited camera deployments—the first confirmed records for these species in the Central Pacific (Stone et al., 2000a,b). However, in 2002, the NEAq noted severe depletions of shark

populations due to a single foreign fishing vessel (the *Maddee*, based in American Samoa) that was permitted to harvest shark fins by longlining around four islands for ~9 months (Obura and Stone, 2002). As a result, the frequency of blacktip reef shark sightings decreased from 64% (across all sites) in 2000 to 16% in 2002. Orona may have suffered additional exploitation from a short-lived government resettlement scheme begun in early 2001 (the Kakai settlement scheme, which ended in 2004), with 200 people harvesting island resources, including shark fins, for market sale. However, no quantitative data on extraction from that time are available. Yet, the 2002 NEAq Expedition noted that not a single shark was recorded in their circular transects on Orona (Obura and Stone, 2002). The differences in abundance between 2000 and 2002 were staggering. Overall shark densities at fished islands were much lower than at those that were not fished (Figure 8.5; Obura and Stone, 2002). This demonstrates the extreme vulnerability of small-island populations—and PIPA in particular—to shark extraction lasting only a few months and may be regarded as a proxy for the likely impacts of increased resource exploitation there. This level of exploitation is typical of the far-reaching impacts of the shark fin market, which has expanded the elasmobranch hunt to the most remote regions of the globe (Dulvy et al., 2008). Now, over a third of elasmobranch species in the southwest Pacific region are at risk of extinction (Jupiter et al., 2014).

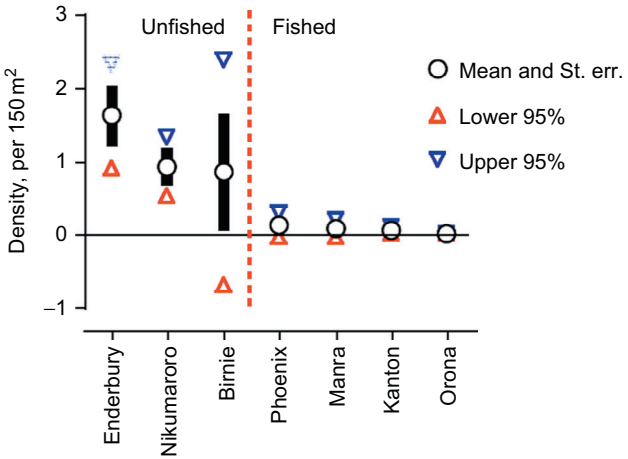

Figure 8.5 Densities of reef sharks (whitetip, blacktip and grey reef sharks) sampled in 150 m^2 circular transects, Phoenix Islands, 2002 (mean, standard error and upper/lower 95% confidence intervals). *Reproduced with permission from Obura and Stone (2002).*

5.3. Seabird colonies and guano extraction

As is typical for remote bits of land in a vast ocean, the Phoenix Islands are important for nesting seabirds. PIPA hosts forested and arid seabird islands of high-global significance (>40 breeding colonies with several of the world's largest seabird breeding populations), including at least 19 breeding species, 51 species reported and a total population exceeding 1 million birds (Pierce and Teroroko, 2011). In particular, the islands support globally important breeding colonies or concentrations of the following species: Audubon's Shearwater (*Puffinus l'herminieri*), Christmas Shearwater (*Puffinus nativitatis*), Phoenix Petrel (*Pterodroma alba*), White-throated Storm petrel (*Nesofregetta fuliginosa*), Great Frigatebird (*Fregata minor*), Lesser Frigatebird (*Fregata ariel*), Brown Booby (*Sula leucogaster*), Masked Booby (*Sula dactylatra*), Sooty Tern (*Sterna fuscata*), Greybacked Tern (*Sterna lunata*) and Blue Noddy (*Procelsterna cerulea*). Most of these species forage primarily within PIPA waters reflecting the local diversity and abundance of marine resources. Over centuries, these birds deposited guano that was later extracted from the Phoenix Islands in the late 1800s for use in the United States and Europe mainly as fertilizer. Guano was first discovered and used as an effective fertilizer in Peru. However, Peruvian supplies were tightly regulated and highly priced and thus could not meet international demand. This spawned a global search for new and rich guano deposits. Guano exploitation in the Phoenix Islands began in 1870 but lasted for only a decade, by which time over 70,000 tonnes of guano were extracted, representing more than 20% of all imported sources to the United States (Skaggs, 1995).

5.4. Commercial tuna fishing

Reef-associated tuna species (dogtooth tuna) were likely spared from severe exploitation until the early 2000s, when legal fishing was permitted for sharks (detailed above) and reef tuna in 2001. Post-extraction, the decline in tuna was highly noticeable with, for example, dogtooth tuna decreasing from being present in 75% of surveys in 2000 down to 0% in 2002 (Obura and Stone, 2002).

Longline and purse seine fishery licenses constitute an important part of the Kiribati economy. Starting when under the United States and British control, what are today Kiribati waters were extensively fished for tuna and other large pelagics. Kiribati grants the majority of its licenses to foreign fishing vessels flying the flags of the United States, EU countries, South Korea, China, Japan and other nations. Purse seine tuna fishing is the major

extraction method, with a purse seiner catching on average 32 tonnes of tuna per day, mostly skipjack (Fonteneau et al., 2000). Tuna purse seine licensing is currently regulated under the Nauru Agreement, a subregional agreement spanning eight countries including Kiribati that make up the Parties to the Nauru Agreement (PNA) established in February 1982. The Nauru Agreement was created and signed in part to address fisheries stock exploitation through the cooperation and coordination of licensing and EEZ regulations by the eight nations who signed the international agreement; these countries control 25–30% of the global tuna supply (Jupiter et al., 2014). Since 2007, most foreign fishing vessels are able to fish Kiribati waters subject to the PNA under the so-called vessel day scheme (VDS) whereby vessel owners can purchase and trade days fishing at sea as set and allocated between PNA nations for 1-year periods, up to 3 years in advance. United States vessels are controlled under a multilateral treaty that is still being finalized at the present time; EU vessels are controlled under an agreement between Kiribati and the EU that came into effect in 2012. Both the United States fishery and the EU fishery are based on the VDS approach as well.

The most recent stock assessment information on the target tuna species, skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and bigeye (*Thunnus obesus*) and economic information is used to determine the annual tuna harvest levels and to assess the allocation of fishing days. The VDS is apportioned based on vessel length to account for differential fishing power and/or efficiency (catch) of the various vessels in the fleet, and ranges from 0.5 to 1.5 fishing days depending on vessel length. The VDS is implemented as part of the Western and Central Pacific Fisheries Commission's (WCPFC) *Conservation and Management Measure for Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean* (CMM2005-01). The VDS replaces the previous purse seine management scheme that was based on vessel number limits of 205 vessels under Annex 1 of the *Palau Arrangement for the Management of the Western Pacific Purse Seine Fishery* (Palau Arrangement).

The catch of tuna and other large pelagic species in the PIPA area is accomplished using both longlines and purse seines. Catches of highly migratory species are reported by the WCPFC, which monitors fishing efforts that occur in 337 of its $5° \times 5°$ management units. These have been reported on monthly from the 1950s to the present. Eight species are included in the WCPFC Aggregated Catch/Effort data: yellowfin, bigeye, albacore (*Thunnus alalunga*), skipjack tuna, striped marlin (*Kajikia audax*), black marlin (*Istiompax indica*), blue marlin (*Makaira mazara*) and swordfish (*Xiphias gladius*). All other landings by the fleets are reported in the

catch-all category of 'other'. Sumaila et al. (2014) determined that the WCPFC management area tuna fishery was worth USD $4.1 billion in 2009 while also examining the subsidies and incentives that help drive the fishing in this highly productive portion of the ocean.

The closest management block does not perfectly align with the boundaries of the PIPA, but it does give insight into the catch in this small region of the Pacific (Tables 8.1 and 8.2). The 5° × 5° management block used to estimate catch in PIPA spans 175°W 05°S to 180°E 00°N.

While the exact landed value of fish caught in the Pacific is hard to determine due to the various home ports of vessels, transshipping and the multiple markets receiving/selling catch, landed value can be estimated using the U.S. National Marine Fisheries Office of Science and Technology, Annual Commercial Landing Statistics Valuations, for fish brought to market on the U.S. Pacific coast (Table 8.3).

All eight reported species are caught within the management unit that encompasses PIPA. These have produced a landed value ranging from USD $3,960,000 in 2001 to USD $221,360,000 in 2009, the last reported year. This range represents a 40-fold change in effort by the longline fleet as measured by the number of hooks fished and a nearly 17-fold increase by the

Table 8.1 Reported vessel day scheme days and landings in metric tonnes of the three principal tuna species within the PIPA management block

	PIPA purse seine catch in metric tonnes			
Year	**Fishing days**	**Skipjack tuna**	**Yellowfin tuna**	**Bigeye tuna**
2000	166	1763	917	215
2001	68	750	119	41
2002	363	11,440	182	55
2003	156	2731	502	183
2004	139	1669	332	148
2005	305	4685	8129	762
2006	358	16,868	700	372
2007	92	4294	355	88
2008	Not reported	Not reported	Not reported	Not reported
2009	1153	56,704	1710	561

Source: WCPFC (2011).

Table 8.2 Reported hundreds of longline hooks fished and landings in metric tonnes of the seven principal tuna and billfish species within the PIPA management block

	PIPA longline catch in metric tonnes							
Year	**Hundreds of hooks**	**Albacore tuna**	**Yellowfin tuna**	**Bigeye tuna**	**Striped marlin**	**Black marlin**	**Blue marlin**	**Swordfish**
2000	18,151	22	581	264	3	–	32	17
2001	1825	8	28	33	0.2	–	9	2
2002	26,959	69	294	703	8	3	116	38
2003	21,934	18	217	367	4	2	88	29
2004	58,559	54	1063	1167	10	3	186	48
2005	40,442	26	582	829	12	2	66	32
2006	24,035	17	339	636	18	2	127	31
2007	38,018	107	783	800	3	3	56	35
2008	40,281	45	549	890	5	2	63	66
2009	71,971	90	958	1778	20	6	280	124

Source: WCPFC (2011).

Table 8.3 US Pacific port landings valuations for the eight species reported by the WCPFC adjusted for inflation to USD $2010

	Pacific landing prices in 2010 US$ per KG							
Year	**Albacore tuna**	**Yellowfin tuna**	**Bigeye tuna**	**Skipjack tuna**	**Striped marlin**	**Black marlin**	**Blue marlin**	**Swordfish**
2000	2.66	5.45	9.96	2.17	–	–	–	5.72
2001	2.53	5.49	9.72	3.20	–	–	–	5.10
2002	1.88	4.71	7.39	2.50	4.42	3.19	3.21	4.75
2003	1.84	5.50	8.42	1.91	2.27	2.97	2.33	4.58
2004	2.29	4.70	7.69	2.12	3.79	3.85	3.26	5.07
2005	2.71	5.09	8.38	1.71	3.20	2.87	2.55	5.99
2006	2.13	6.23	8.30	3.13	2.64	2.62	2.44	5.15
2007	2.07	5.08	7.80	2.60	4.25	3.04	2.92	5.35
2008	2.75	6.04	8.55	3.00	2.36	1.74	2.55	4.39
2009	2.39	5.75	8.46	3.25	3.40	6.10	2.67	4.48

Source: NOAA Fisheries (2014).

purse seine fishery based on the number of fishing days (WCPFC, 2011). While the value of catch per unit effort (CPUE) by longline vessels in the area was fairly constant throughout the 2000s, with an average of USD $280 for each 100 longline hooks fished, the purse seine fishery saw a dramatic increase in the value of the CPUE with a low of USD $44,738/fishing day in 2004 and a high of USD $182,459/day in 2005 based on landings and effort records from the WCPFC (2011) and valuations from NOAA Fisheries (2014).

The landed value of the PIPA catch is highly skewed, with yellowfin and bigeye tuna accounting for over 93% of the landed value of the longline catch in the region between 2000 and 2009. The value of the purse seine catch, which is dominated by skipjack, is between 4 and 10 times that of the total longline catch in the region (NOAA Fisheries, 2014; WCPFC, 2011).

The direct effect of the pending closure of the PIPA region to the commercial fishing industry is difficult to estimate precisely, but the mobility of both fishes and fishers, and the access that both enjoy to displace any prior PIPA effort to other management units (including around the perimeter of PIPA), likely mean that the PIPA closure will have minimal economic impact on the blue water fleet. The question as to the direct economic impact to the I-Kiribati people is an unknown, as the area to be closed is just 11.3% of the island nation of Kiribati's 3.5 million km^2 EEZ and the loss of funds for licenses to fish in PIPA may be compensated for by increases in the market price of licenses to fish in other areas of the EEZ. Kiribati currently licenses more than 400 foreign flagged vessels (Uwate and Onorio, 2011) to fish within the EEZ, though no data are provided as to the spatial makeup of that fleet other than the number of hooks fished or vessel days at sea reported in each management area cell by the WCPFC.

As far as the longline fishery is concerned, a PIPA closure will likely have a very small effect, if any, on the overall effort in the WCPFC management area as longline fishing within the management unit containing PIPA accounts for on average less than 0.5% of total regional effort as measured by number of hooks fished, and on average less than 0.8% of longline-landed value for the WCPFC region. The proportionate purse seine effort is similar to that of the longline fishery with PIPA accounting for less than 0.25% of the average effort between 2000 and 2007, though a drastic increase in reported vessel days in 2009 resulted in 1.17% of all purse seine fishing effort being directed in PIPA. This is also shown in the landed value of purse seine catch: PIPA accounts for less than 0.6% of average value between 2000 and 2007, but jumps to 3.1% of WCPFC purse seine value in 2009 where 1153

vessel days were reported in just this management unit. As mentioned above, under the Conservation Contract signed in 2014 between Kiribati and the PIPA Conservation Trust, the economic impact of full closure requires more attention and a careful analysis that can only be truly assessed post-closure; these impacts will be studied by the newly formed Tuna Working Group over a 5-year post-closure period.

6. IMPACTS OF THE MPA

6.1. Social impacts

The Phoenix Islands have no permanent inhabitants. The one currently inhabited atoll, Kanton, has a non-permanent population of approximately 40 people comprising government employees including a policeman, a nurse, two primary teachers, a meteorological officer and their families engaged in protection and management of Kiribati interests in the region. As such, the social impacts of PIPA establishment for Kanton local community residents are functionally negligible. On the other hand, the declaration of PIPA has been a source of national pride for all-Kiribati citizens. Great strides have been made to ensure knowledge of PIPA by Kiribati citizens in the 'neighbouring' archipelagos in the Gilbert and Line Islands, where the entire ~110,000-person nation resides (mostly on Tarawa in the Gilbert Islands group).

News of PIPA is now regularly broadcast on the government-owned all-Kiribati radio station, Kiribati Broadcasting and Publications Authority (AM, 1440), and national pride is apparent. Signs celebrating PIPA are displayed in Kiribati International Airports on both Tarawa and Kiritimati Island, and songs, including 'PIPA You Are My Gift To Humanity' have been written and are regularly sung to celebrate major PIPA milestones and events. Outreach initiatives also include messaging in schools that extend beyond PIPA issues alone, with a focus on encouraging a conservation mindset, building in-country capacity and expertise in areas relevant to ocean conservation and research and promoting knowledge of all-of-Kiribati geography, since very few Kiribati citizens have ever been to the Phoenix Islands. The I-Kiribati also are invoking the local word 'okai' with regards to PIPA, which means a traditional storehouse where reserved foods and treasures are kept for future use—especially in times of prolonged draughts and bad times. Considering PIPA as an okai for potential food security as well as a bank of Central Pacific biodiversity has been an important part of the outreach programme to enable Kiribati residents to think about

the multiple local and global benefits of ocean stewardship. Coupled with growing social media outreach and press coverage, PIPA is having an increasing impact on both domestic and international populations.

6.2. Ecological impacts of protection

Scientific research in the Phoenix Islands has historically been limited, but all indications pointed towards the island group's diversity and abundance of marine life. The NEAq's 2000 expedition launched a decade of systematic and repeated exploration, but prior to this there are only a few known examples of science within the Phoenix Islands. These included a visit by the research vessel Bushnell in 1939 that resulted in a taxonomic collection of fishes (Shultz, 1943), studies on seabirds (Clapp, 1964), turtles (Balazs, 1982) and the corals from McKean island in the early 1970s (Dana, 1979). It was not until 1972–1973 that detailed marine surveys were conducted. A comprehensive study of Kanton atoll was undertaken (Smith and Henderson, 1978), including work on lagoon circulation and biogeochemistry (Smith and Jokiel, 1978), coral taxonomy and biogeography (Maragos and Jokiel, 1978) and lagoon and leeward reef coral distributions and assemblages (Jokiel and Maragos, 1978). Since 2000, regular terrestrial and marine expeditions have documented the biodiversity of algae, invertebrates, fishes and corals, as well as their changes in abundance over time (including over two known episodes of high-temperature-induced coral bleaching). Since the implementation of no-take reef areas in 2008, an increase in shark populations have been noted, the most direct impact of protection seen to date (Mangubhai et al., 2012; Stone et al., 2009).

Other major impacts of protection include the ability of reefs to rapidly recover post-bleaching in the absence of local anthropogenic impacts, a phenomenon attributed in part to the persistent abundance of herbivorous reef fishes (chiefly Scaridae and Acanthuridae). Following the 2002–2003 bleaching event, PIPA reefs experienced dramatic coral mortality down to 12.1% overall (Obura and Mangubhai, 2011) from 58.1% reported in 2002 (Obura and Stone, 2002). Yet, expeditions in 2009 and 2012 reported resilience and recovery following bleaching events in 2002–2003 and 2010 (Mangubhai et al., 2012; Stone et al., 2009). Though coral population recovery followed the same timeline as legal protection of PIPA reefs, it is unlikely that reef recovery was a direct result of PIPA protection, since coral habitat degradation was not under threat from local populations during this time period. Instead, the synchrony suggests that the protection of PIPA

was timely and necessary to ensure a natural reef successional trajectory and recovery, as it is well documented on other reefs that local threats can impair recovery processes (e.g. Burke et al., 2011). Fragile reef ecosystems are in no way guaranteed to recover from major disturbances, and recovery potential likely goes down with repeated disturbance. In addition, the removal of terrestrial invasive alien species from three islands has been followed by the recovery of biota there. This has included vegetation recovery particularly on Rawaki post rabbit (*Oryctolagus cuniculus*). Thus, the creation of PIPA offers the best risk-management potential for an already-recovering ecosystem, which cannot be protected from the boundary-free threats of global change.

6.3. Economic impacts of protection

The single-most significant economic issue with respect to PIPA is any potential loss in fishing revenues arising from full closure to commercial pelagic fishing, which, as already discussed above, will be effective from 1 January 2015. The current debate on PIPA has been somewhat polarized by fears of the economic losses that may occur as a result of the closure of PIPA from commercial fishing and all forms of extractive activities. Some Kiribati observers are arguing the case for compensation. Less is understood or being discussed about the potential 'win–win' outcomes and the economic benefits of PIPA for Kiribati, and the global community that will invariably more than offset the losses in fishing revenues. While there is as yet no established or generally agreed figure on the exact amount of fishing revenues derived from PIPA per annum, crude estimates indicate that this could range from USD $1 million to USD $4 million in any given year, depending on seasonality and climatic conditions during the period in which the harvest takes place.

The potential socio-economic benefits that PIPA can bring to Kiribati are an often-overlooked prospective counterbalance to the arguments about potential revenue losses. There are many potential economic benefits of PIPA, including provision of ecosystem services through intact marine food webs and habitats, potential replenishment of fisheries stocks and potential revenue generated by future tourism. By closing off PIPA from all forms of extractive activities including commercial fishing, these protected grounds and related habitats may indirectly benefit neighbouring fishable areas of the Kiribati EEZ. Once fully no-take, the PIPA region may facilitate recruitment and replenishment of tuna stocks, with possible spillover benefits to

adjacent regions. However, the potential costs and benefits of closing PIPA to all commercial fishing have yet to be determined; they will be examined over a 5-year period following the 1 January 2015 full closure, and in any event, will likely emerge over a period of decades.

PIPA also has ecotourism potential that could benefit the Kiribati economy, though reservations have been expressed about the long-term economic viability and sustainability of tourism development in the Phoenix Islands given its isolation and remoteness. A growing niche tourism market might generate enough revenue to support the necessary infrastructure, as there are several potential niche markets. For example, PIPA is believed to be the final resting place of the famous American aviators Amelia Earhart and Fred Noonan lost in the 1930s, and PIPA has historical interests related to WWII, the NASA (Apollo) satellite tracking station, shipping and guano days and as historical whaling grounds. The 2010 UNESCO inscription of PIPA as the largest and deepest World Heritage site may also help to foster a niche tourism market. The presence of a World War II era airstrip on Kanton that remains in fundamentally sound condition makes such an opportunity a realistic future goal for PIPA. Sadly, atolls in such an untouched state are likely to become increasingly scarce elsewhere notwithstanding the growing efforts to protect them, simply because of the unrelenting challenges of population growth and coastal development. While such tourism would have some inherent negative environmental impacts in PIPA, there would also be important benefits from having both additional interests in Kiribati that economically benefit and that would help with the challenge of monitoring and enforcement against illegal fishing and other activities in this remote zone.

It is important to note that, without the PIPA project, most of the islands in the Phoenix group would likely have served as only idle assets. The creation of PIPA therefore represents the government of Kiribati's interest in exploring new development models for Kiribati's natural resources that are less dependent on resource exploitation and consumption.

7. POST-MPA ESTABLISHMENT: REMAINING CHALLENGES

7.1. Fisheries

PIPA was established in 2008 and immediately the shallow reefs were protected as 'no take' around 7 of the 8 islands, equalling about 3.1% of the whole MPA. At this time, fisheries extraction on the shallow reef

environments ceased, though some illegal activity still occurred. For example, a bunker vessel from Singapore, *Hai Soon* 28, was caught and fined $4.73 million USD for conducting bunkering 20 miles south of Nikumaroro without a license. Some illegal shark finning has also likely occurred, as indirectly suggested by smaller-than-expected shark abundance and biomass post-reef closure to fishing. Overall, however, the benefits of reef closure to fishing has already been observed on monitoring trips conducted by the NEAq after the 2008 closure; a seeming resurgence of shark populations (especially small juveniles) was noted on some of the islands, especially at Kanton, which had previously been heavily fished for shark fins (Stone et al., 2009). Continued evidence for resurgence of juvenile sharks continued in 2012, but the marked overabundance of juveniles compared to adults could be an indication of an illegal fishing event between 2009 and 2012 (Mangubhai et al., 2012).

In the surrounding blue water environment, commercial fishing of tuna and large pelagics has remained legal since MPA inception in 2008 and will remain so until 31 December 2014 (when the whole MPA becomes no take). From 2008 to 2014, PIPA waters were fished under the Nauru Agreement (detailed above) and in recent times, license days were sold for Kiribati waters (without exclusion of PIPA). Hundreds of vessels have fished legally inside PIPA under the Nauru Agreement, and no impact of protection for pelagic stocks will be relevant until full closure begins in 2015.

7.2. Enforcement

Effective enforcement is one of the key features of successful MPAs (Edgar et al., 2014). Unfortunately, it remains one of the hardest issues to tackle, especially in remote MPA regions. Isolation notwithstanding, there are several enforcement measures already in place, and more are planned. Kiribati requires 100% observer coverage on all purse seine vessels legally within Kiribati waters, and observers have responsibility of ensuring legality and enforcement of in-country rules, including the PIPA closures and the reporting of illegal activities onboard. Mandatory 100% observer coverage on DWFN vessels is required for all eight signatory nations to the Third Arrangement to the Nauru Agreement, together with seven other Pacific Island states. For PIPA enforcement, this means that all legal vessels will have observer coverage and be able to be tracked via video monitoring systems (VMS) in real time; these legal fishing boats can also act as an additional surveillance tool to detect illegal/non-licensed vessels. In order to assist in the detection of illegal activities, visitors (tourists and researchers) and residents

are also required (under their permit for visitation) to assist with monitoring, control and surveillance and to report any suspicious activities.

The government of Kiribati already undertakes annual patrol visits within PIPA boundaries, and currently Australia, New Zealand and France provide aerial surveillance of the Phoenix Islands area. Kiribati also has a 'ship-riders' agreement with the United States whereby Kiribati enforcement personnel are present on U.S. Navy and Coast Guard vessels operating in the area and the United States fleet participates with Kiribati in investigating, reporting and arresting ships for illegal activities. The aforementioned bunker ship from Singapore was escorted to the Port of Betio in Tarawa by the U.S. Coast Guard under this agreement. Additionally, Kiribati has signed a Declaration on Deep-Sea Bottom Trawling to Protect Biodiversity in the High Seas (Nadi Communiqué, Pacific Islands Forum, October 2006), which commits the members of the Pacific Islands Forum to urgently take actions consistent with international law to prevent destructive fishing practices on seamounts in the Western Tropical Pacific Islands Area.

Additional plans for enforcement are also underway. For example, the recently signed conservation contract between Kiribati and the PIPA Conservation Trust (April 2014) states that the Ministry of Fisheries and Marine Resources Development will submit a request to the Pacific Islands Forum Fisheries Agency to create a virtual electronic perimeter using geofence technology that conforms to the boundaries of the PIPA set forth in the PIPA Regulations 2008. Vessel monitoring and reporting of any vessel movements within PIPA are expected to continue and will be enhanced by this virtual fencing technology. Furthermore, a new Kiribati Fisheries and Wildlife Conservation Unit is planned to be stationed on Kanton Island, which is hoped to significantly contribute to surveillance and enforcement of management rules. In May 2013, a PIPA Community Agreement was signed with Kanton Island caretaker residents whereby suspicious or illegal activities must now be reported. In this agreement, all members of the Kanton community indicated their commitment to safeguarding and protecting the universal values of Kanton Island. Finally, new technologies are being explored to further aid in surveillance and enforcement of PIPA boundaries. These include satellite surveillance and unmanned drone technology, and possibilities for use are currently being scoped to determine costs, feasibility and effectiveness.

7.3. Invasive alien species

Prior to first discovery, the Phoenix Islands had been isolated for millennia, which enabled seabirds and other fauna to live and nest safely in the absence

of invasive pests and exploit the food rich seas around the islands. Biological invasions likely began soon after the discovery of the Phoenix Islands by early Pacific seafarers and continued through the guano mining years and subsequent settlement and development of the islands (detailed above). The deliberate and accidental introductions of invasive species during all of these periods have been significant in the Phoenix Islands, and the faunal invaders include Pacific and Asian rats, rabbits, cats, ants, pigs and dogs; floral invaders include coconuts, lantana and other weeds. Some of the negative impacts of these biological invasions include the elimination of native seabirds through the destruction of eggs and young, and the elimination of native plants via competition for limited resources. Mammalian pests have been the most damaging invasives in PIPA, threatening the bird populations and modifying the entire natural island ecosystem. Rabbits, cats and different rat species have had notable impacts over time, with some birds (e.g. Phoenix petrels and White-Throated storm-petrels) and other biota being reduced to critically low numbers (Pierce, 2013). The most sensitive fauna species survived on only the one island (Rawaki) that escaped rat infestation (Pierce, 2013).

Since 2006 an eradication programme has been implemented to remove invasive mammals from the atolls in PIPA, which has resulted in the gradual restoration of the islands, their habitats and fauna populations (Pierce, 2013). Most recently, in May 2013, a terrestrial team visited five PIPA islands to assess invasive species status, biosecurity issues and biota responses to previous pest eradications in 2008 and 2011 and plan for further work (Pierce, 2013; Pierce and Kerr, 2013). Three islands (Rawaki, Birnie and McKean) are now free of invasive species (Pierce and Teroroko 2011), but the rat eradication efforts on Enderbury conducted in 2011 were unsuccessful. In March 2013, a biosecurity training team visited Kiritimati to work with MELAD staff and community in improving biosecurity and quarantine measures for Kiritimati and Kiribati generally with a big emphasis on protecting the PIPA from further invasions (Nagle et al., 2013). It is hoped that through these eradication and biosecurity programmes, threats to the terrestrial ecology of the islands will be reversed, minimized, mitigated and, most importantly, prevented.

7.4. Impacts of vessel groundings

The Phoenix Islands have had numerous vessel groundings over the years. One of the earliest recorded groundings was the whale ship Canton on Kanton, its namesake, in 1854. The most famous is of the SS Norwich City,

which ran around on Nikumaroro in 1929 and is still prominently visible today. In addition to coral damage during grounding and break-up, it is now also becoming clear that rusting shipwrecks add iron to the surrounding seawater environment. In iron-limited regions such as the Central Pacific, iron addition can result in a phase shift from coral-dominated reefs to reefs dominated by iron-enriched microbial mats and turf algae (Kelly et al., 2012). Oil and other chemical spills remain a persistent threat with ship traffic, though thus far the Phoenix Islands have been spared from any catastrophic oil spills. However, even small and non-commercial vessel groundings have potential negative impacts via nutrient pollution and other forms of plastic pollutants. Shipwrecks also introduce terrestrial dangers, as evidenced by a recent fishing vessel wreck at McKean Island in c. 2001 that resulted in the introduction of the Asian rat (*Rattus tanezumi*), which in turn exterminated many bird species from the atoll. Elimination of commercial fishing may eliminate some risk of vessel grounding due to decreased vessel traffic, though increased tourism traffic may pose even higher threats as they will likely spend more time near islands (instead of in blue water habitats).

8. MEASURES OF SUCCESS/FAILURE

The PIPA has already celebrated many conservation and ecological milestones in the past decade. Most laudably, PIPA is the largest and deepest UNESCO World Heritage site on earth, recognized for its outstanding natural value. As ocean resources are increasingly being called upon to support a growing global population, PIPA's upcoming closure sets an important international precedent. Scheduled for 1 January 2015, full closure to commercial fishing will bring the opportunity to assess the efficacy of this type of management intervention in pelagic fisheries stock improvement, one of the first such experiments in conservation history. One other potential measure of success is that PIPA is no longer the largest marine MPA in the Pacific (as it was at the time of its creation): since then, other MPAs have been announced that have eclipsed PIPA in size, which in essence denotes a 'trend' of ocean protection.

Recognizing and reconciling the many challenges of creating and maintaining large MPAs has become the agenda for a newly formed entity called 'Big Ocean', which is a network of managers and partners of existing and proposed large-scale marine managed areas. The success or failures of PIPA, and of large MPAs in general, will be shared through Big Ocean as part of their objective to use lessons learned to advance and improve the effectiveness of large MPAs (Wagner, 2013). Globally, however, success will

likely be measurable only with time: do stocks of commercially important fishes within PIPA improve? Will PIPA be effectively enforced and maintained? Will the sustainable financing model be successful in the long term? Will PIPA be heralded as a model of marine conservation? And finally, even with all of the protections afforded to PIPA to mitigate habitat loss and overfishing, will the ecosystems succumb to the inevitable impacts of climate change, and even if so, will PIPA ecosystems have at least fared better than their unprotected neighbours as a result of its MPA status? These and many other questions remain to be answered in the coming decades.

9. OVERVIEW AND LOOKING AHEAD

Though there are still objectives to be met, PIPA is well positioned to be a global model for large MPA development and maintenance. Whether attributable to legal protection or simply a product of their extreme remoteness, the shallow reef and terrestrial ecosystems of PIPA have already shown benefits associated with protection. PIPA offers a novel conservation mechanism for protection in the waters of economically challenged but ecologically rich nations like Kiribati. This can serve as a model for island states globally, and indeed, it already has. The pending closure of PIPA, and the rigour of the subsequent assessments of that closure, will be critical for determining success of the MPA as a refuge for open-ocean pelagic and deep-sea marine life. Of the remaining challenges, some are capable of being addressed (e.g. enforcement) and others cannot (e.g. climate change). Though these challenges still remain, the act of creating very large MPAs is still justified under the precautionary principle, and these MPAs (PIPA and others) will together serve as a beacon of hope in marine conservation initiatives now, and in the years to come.

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