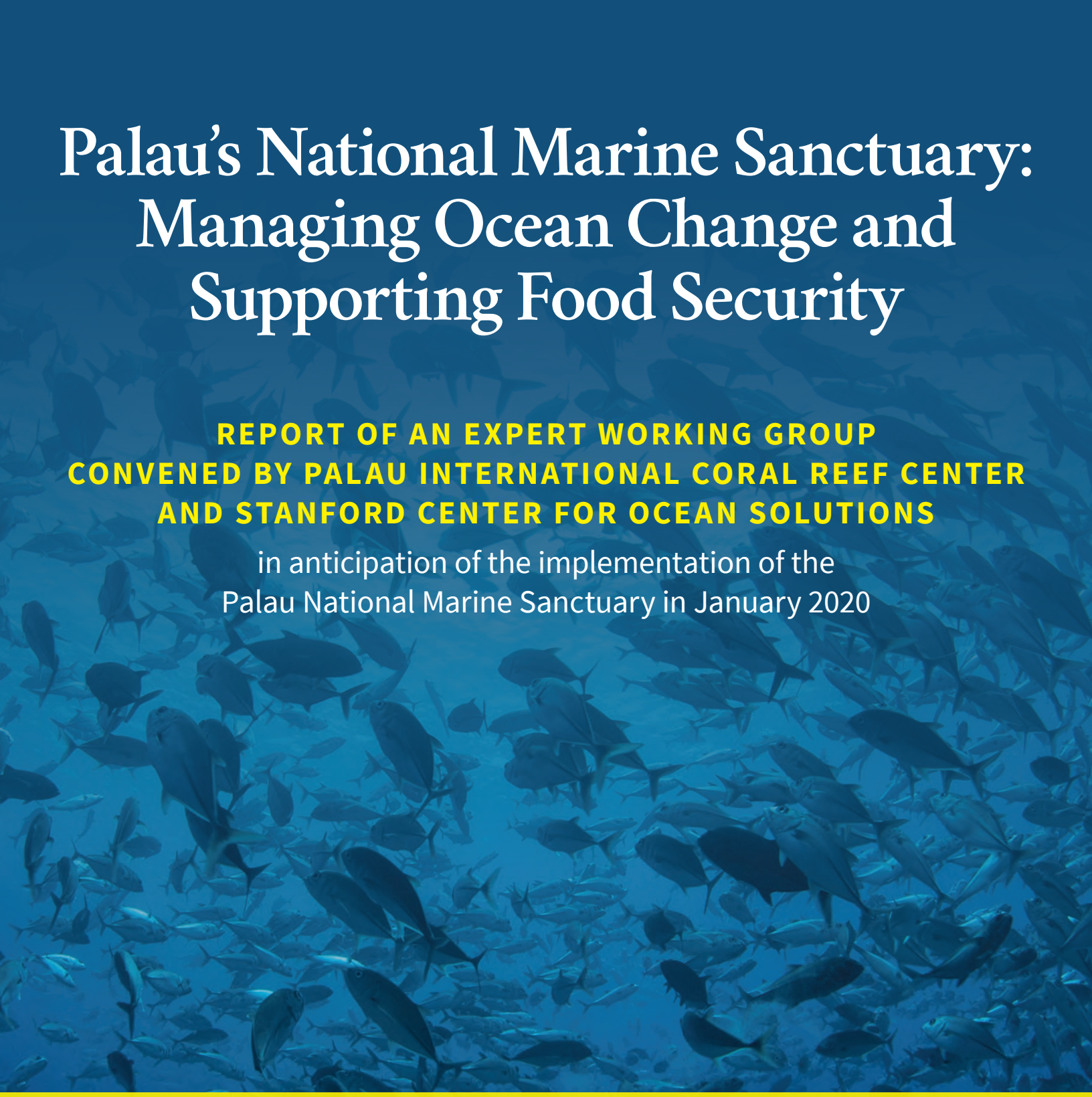
Palau's National Marine Sanctuary: Managing Ocean Change and Supporting Food Security

REPORT OF AN EXPERT WORKING GROUP CONVENED BY PALAU INTERNATIONAL CORAL REEF CENTER AND STANFORD CENTER FOR OCEAN SOLUTIONS

in anticipation of the implementation of the Palau National Marine Sanctuary in January 2020



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Foreword from Co-Chairs

Four years ago, Palau embarked on an extraordinary journey, announcing protection of 80% of the waters in its domain. In creating the Palau National Marine Sanctuary, Palau once again asserted its visionary leadership in ocean conservation and its determination to chart its own destiny.

The Palau National Marine Sanctuary is one of the largest marine protected areas (MPAs) in the world. Crucially, unlike many large-scale MPAs, the Sanctuary has the entire population of the country residing at its heart. Thus, implementation of the Sanctuary provides both the opportunity and the imperative to demonstrate how ambitious protection of ocean resources can enable an island nation to ensure its food security and grow its economy in an era of tumultuous change in the climate and in the ocean.

This Working Group brought together diverse experts from Palau and around the world to address those questions. Over the past year, we have collaborated to marshal what is known about the resources in Palau's waters and the challenges and opportunities that lie ahead, and to outline options for the Government and others to consider as they implement the Sanctuary.

We hope this report will provide the Government and the people of Palau with a strong foundation for full implementation of the Palau National Marine Sanctuary policies. We hope it will also inspire a commitment to continue learning along the way—through an ongoing investment in monitoring, research, and exploration, and a continual commitment to consultation and engagement with all of those who have a stake in the process and outcomes.

Embodying a deep tradition of ocean stewardship, the PNMS is a legacy of immeasurable value for the people of Palau. It is also a beacon for the rest of the world. In the coming year, the global community will gather to drive progress in achieving the ocean agenda embodied in Sustainable Development Goal 14, to set new ambitions for protecting the earth's biodiversity, and to step up efforts to fight climate change. It is our hope that Palau's leadership, in declaring the Sanctuary and in now translating that declaration into action, will inspire other nations to rise to these pressing challenges. We submit this report in support of that cause.

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Objectives

The goal of this report is to support implementation and decision making for the Palau National Marine Sanctuary (PNMS). Specific objectives are to:

- Distill and clarify the PNMS legislation
- Synthesize knowledge about social, ecological, and economic dimensions of the PNMS
- Conduct new analyses to begin filling knowledge gaps
- Present informed policy options for achieving desired outcomes
- Identify priorities for future research, monitoring, and evaluation

We have prepared this report for the Government of Palau and decision makers tasked with developing policies and regulations surrounding implementation of the PNMS. However, we hope the report is also a resource for other stakeholders working on fisheries management, marine conservation, and sustainable development in Palau, including the broader public interested in understanding impacts of the PNMS. These audiences include non-governmental organizations, the research community, women's and cultural groups, educators, and others. This report is based on best available knowledge, while recognizing that new information will always appear that can inform additional decision making. This document is also relevant to the broader Pacific Region and for governments, practitioners, researchers, and other groups interested in understanding the Palauan process and insights that could be applied in other large-scale marine protected area contexts.

Executive Summary

In 2015, Palau enacted the Palau National Marine Sanctuary (PNMS) Act, establishing a strictly protected sanctuary covering 80% of its exclusive economic zone (EEZ) and instituting reforms to foster a stronger domestic pelagic fishery sector. The PNMS fully enters into force on January 1, 2020 with the full closure of the 80%. This report provides analyses and options for the Government of Palau and decision makers tasked with developing policies, institutions, and regulations for implementation of the PNMS legislation, and a resource to the public and other stakeholders working on fisheries management, marine conservation, and sustainable development in Palau.

"Euotelel a klingil a debel Belau"

This phrase captures the meaning of the Palau National Marine Sanctuary in the Palauan language. *"Euotelel"* is derived from the word *"Euatel,"* meaning refuge or sanctuary; *"klingil"* refers to all life; and *"debel"* signifies ocean with *"debel Belau"* referring to Palauan's ownership or claim to it. This translation was submitted by a young Palauan, Tkerbai Junior, capturing Palau's connection to life in the ocean and the PNMS's role in creating a sanctuary for future generations of Palauans.

The Sanctuary (80% of Palau's EEZ)

The PNMS is one of the largest no-take marine protected areas (MPAs) in the world, covering 475,077 km^2; 38 km^2 for every Palauan citizen (Figure 1). The PNMS closes off waters that are currently fished by longline and purse seine fleets and adjacent to Palauan customary fishing grounds. Implementation of no-take regulations, therefore, will significantly reduce fishing pressure on species and ecosystems that are important to the people of Palau.

The PNMS will protect significant and unique marine biodiversity. The Sanctuary is home to nearly 800 recorded animal species, of which at least nine are endangered, including the critically endangered hawksbill and leatherback sea turtles. It is also home to manta rays, many species of seabirds, whales, sharks, billfishes, and tunas, all of great cultural and socioeconomic importance to Palauans. Given its vast extent, the PNMS encompasses entire home ranges of many of these species and protects essential habitats like seamounts and spawning aggregation sites that fulfill important ecological requirements. In addition to reducing pressure on fish stocks, the PNMS is expected to reduce mortality of seabirds, turtles, sharks, and billfishes that are currently caught as by-catch by industrial vessels. Protection of these pelagic species has both conservation and socioeconomic benefits, as spillover of juveniles and adults from the Sanctuary into the fishing zone and nearshore environment, expected for several of these mobile species, may enhance commerical pelagic fisheries and tourism.

The PNMS may help make Palau's ocean resources more resilient to climate change. Models project that climate change will increase average sea surface temperatures (SST) in the Pacific region by 1–3˚C by 2100 and reduce dissolved oxygen in the surface layer of the ocean by 15–30%. These changes will have major consequences for the physiology, diversity, abundance,

size structure, and distribution of fishes and other ocean animals. In the near term, climate change will also continue to increase the frequency and intensity of extreme events, such as marine heatwaves and tropical storms, leading to acute impacts on ecosystems and species distribution. Droughts and extreme rainfall are expected to further impair agricultural production and increase sediment flowing into coastal waters, increasing reliance on marine resources for food supply and income while also reducing productivity of coastal fisheries. By reducing mortality due to fishing, the PNMS is expected to promote the resilience of both resident and transient exploited populations to these growing stresses.

The success of the PNMS will depend on long-term funding commitments to enable enforcement, monitoring, and research needed to achieve its objectives. Implementing the new policies established by the PNMS legislation will require sustained additional funding to the Ministry of Justice (MOJ), the Ministry of Natural Resources, Environment & Tourism (MNRET), and the Palau International Coral Reef Center (PICRC). The PNMS legislation allocates a share of the Pristine Paradise Environmental Fee (PPEF) to support those functions, in addition to the existing yearly budget allocations, yet it will not fully fund the costs of the PNMS legislation implementation for these institutions.

There is much more that needs to be known about the PNMS. Research is needed to describe its biodiversity, oceanographic features, and geological features and to understand, for example, how species of high conservation and economic importance use and depend on the Sanctuary; the presence and characteristics of seamounts and of reproductive and feeding aggregations for key species; how these features and resources will be affected by climate change; what benefits protection provides to fisheries in the Domestic Fishing Zone (DFZ) and nearshore waters; and the socioeconomic implications of the PNMS for tourism, commerce, and Palau's national identity.

Fishing in Palau's Waters (20% of Palau's EEZ)

The PNMS legislation aims to foster the creation of a more productive domestic pelagic fishery sector to benefit local livelihoods and food security. The pelagic fishery sector is currently dominated by foreign-owned businesses. A foreign-owned and foreign-operated fleet of purse seine and longline vessels fish in the EEZ. They pay licensing fees and buy vessel days but export all of their catch and don't pay tax. A foreign-owned, locally operated fleet of longline vessels, based in Koror, land all of their catch in Palau but export nearly 90% of their fish without local processing. The remaining lower-value fish is sold in Palau, accounting for 84–94% of pelagic fish in the local market. Palau's domestic pelagic fishers supply the remaining 6–16%.

The PNMS legislation significantly changes the opportunities and costs for industrial fishing operations in Palau. The legislation restricts longline and purse seine fishing to a portion of the DFZ, referred to as the Fishing Permitted Area (this term was coined by the Working Group for the purpose of this report), that is 17.8% of the EEZ. The remaining 2.2% of the EEZ, within the DFZ, is Palau's Contiguous Zone, where pole-and-line fishing and small-scale fishing by recreational vessels are permitted. Analysis of Automatic Identification System (AIS) data indicates that between 2012–2018, the Fishing Permitted Area has accounted for only 10.6% of longline fishing activity and 5.9% of purse seine activity within Palau's waters, suggesting it is not a prime fishing ground for these fisheries. The legislation also requires that all foreign fleets now land all their catch in Palau unless exempted, and that they all pay the export tax, set to increase by 40% in 2020. **Closure of productive fishing grounds, landing requirements, and increased tax rates could lead foreign fleets to scale back their operations in Palau or to depart altogether, reducing the supply of pelagic fish in Palau's market.**

A reduction in the pelagic fish supply could have consequences for Palau's reef fish populations and for public health. If the local supply of pelagic fish does not meet demand or if prices increase, consumers will likely shift to eating more reef fish and more processed foods, contrary to the intention of the PNMS legislation. **It is therefore important that the Government consider policy measures to maintain the supply of pelagic fish to Palau in the short term, while also pursuing a long-term strategy for its domestic pelagic fishery sector.**

Several policy options could help to maintain the viability of the current foreign-owned, locally operated

fleet. The Government could consider lowering the recently revised export tax and increasing the vessel days available for the Fishing Permitted Area; it is unclear whether these measures would be sufficient to entice the foreign fleet to stay in Palau's waters. The Government should also consider requiring that a minimum portion of catch from all foreign longline fleets, based on demand, be sold in the domestic market at a price negotiated with the fishing business sector. These options should be weighed against the alternative of importing pelagic fish from neighboring countries to meet demand while the domestic fleet develops.

In pursuing the long-term goal of a strong domestic pelagic fishery sector, Palau will face significant challenges. A domestic pelagic fishery could include industrial boats that use longlines or pole-and-line and/or the current smaller-scale day-boat operations that use trolling and other methods. Experience in other island states demonstrates that building a local industrial pelagic fishery, specifically longline and pole-and-line fleets, is costly and difficult. Incentivizing local small-scale fishers may help to meet local pelagic seafood demands, however, while also generating new employment. Here we highlight the main challenges and possible opportunities going forward.

Climate change is expected to reduce the productivity of Palau's fisheries by changing the distribution, size, and availability of fishes. An ensemble of model projections focused on current and future suitability of the environment for target species indicates that total fisheries catch potential within the Western-Pacific Region will likely decrease by 25% by 2050 and by 30–50% by 2100 (from a baseline year of 2010). For commercially important skipjack, yellowfin, and bigeye tuna species (representing 95% of total tuna catch between 2007–2017), analysis shows that biomass could decrease by up to 33% by 2100 (from a baseline year of 2010). A recent study suggests that less abundant and less profitable species, such as mahi mahi and amberjack, may fare better in a changing ocean. A central challenge for Palau, therefore, will be to manage its fisheries adaptively, informed by monitoring and research, to respond to fluctuations in existing commercial stocks from climate change, and, as tuna decline, to be able to shift to more resilient species.

A domestic pelagic fishery could include industrial boats that use longlines or pole-and-line and/or the current day-boat operations that use various methods, although some of these vessels (i.e., longline and pole-and-line) have higher operational costs and infrastructure investments. **Several policy and investment priorities are important no matter which vessels and gear are used.** In particular, a central marketplace would facilitate sale and processing of pelagic fishes, and a cold chain—actions or equipment that maintain high product quality from harvest to consumption—would allow fishers both to preserve quality and to offer buyers a reliable year-round supply. Palau would also need to take proactive measures to build domestic demand for pelagic fish to sustain a growing sector. The Palau Conservation Society and The Nature Conservancy's "Choose Pelagics" program to build consumer interest through community outreach is showing promise. Surveys indicate that a local, sustainable brand of pelagic-fish meals appeals to tourists, offering higher returns to local fishers. Banning or limiting the sale of reef fish in restaurants is another measure that could promote a reliable demand for pelagic fish, as surveys have shown that reef and pelagic fish are close substitutes for tourists.

The creation of a domestic pole-and-line and/or longline fishery is not promising. Building such fisheries would require significant capital investments (e.g., infrastructure and gear), and operational costs will be high. The current domestic market offers low returns; even if export were allowed, it is unlikely that it would


Photo courtesy of Ian Shive

offer a compelling return on investment.

Scaling up the current small day-boat fleet offers more potential. A few Palauans currently operate small-scale recreational vessels using a variety of gear types to catch pelagics for sale in the domestic market. These operations are limited by infrastructure needs and gaps in the supply chain, as described earlier. Operational costs are high, and while returns are potentially higher than for reef fishing, they are also more uncertain. The Government could bolster the small day-boat pelagic fishing operations by including a carefully designed startup package that helps operations acquire safety gear and fishing gear, provides training for fishers, supports fish prices, and/or defrays operational costs; a benefits package that provides fishers with services similar to government employees (e.g., retirement, sick leave); and a functioning network of Fish Aggregating Devices (FADs) that helps fishers more easily find fish. Support to provide equipment and boats must be carefully controlled to ensure that these capital investments are not used to expand reef fishing. The Government could also improve potential economic returns by allowing local small-scale fishers to sell their product to the more lucrative international market (i.e., lift the export ban for local fishers) and providing technical assistance to help them develop the commercial capacity to export.

Palau could capture more value from the other components of its pelagic fishery sector instead of, or in addition to, developing a domestic pelagic fishery. If Palau sustains a pelagic fleet, foreign or domestic, a requirement that fish be processed prior to export could stimulate an onshore industry. Development of value-added products, such as fish loins, dried fish, and jerky, could create additional economic opportunities and food security benefits. Relaxation or repeal of the export ban for such locally-made products would allow access to international markets that offer higher returns without necessarily raising domestic prices.

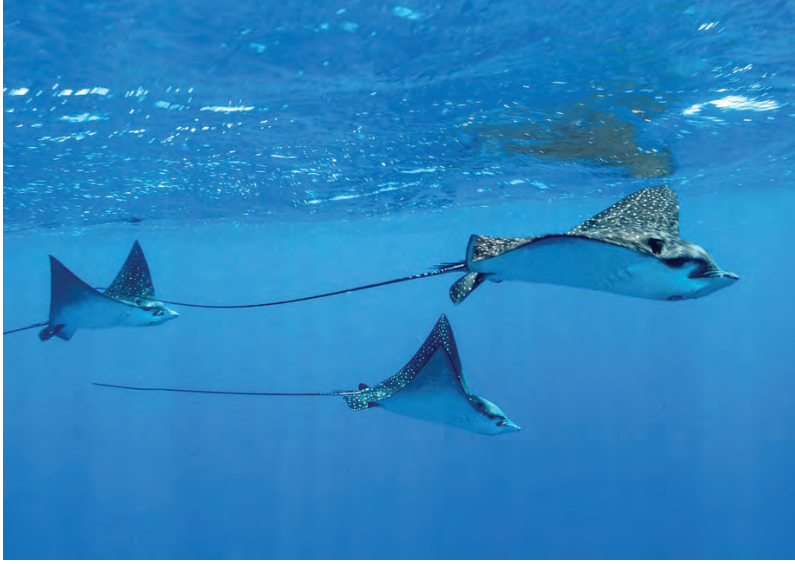
Finally, **there are critical analyses that were not possible with data available to the working group but that should be conducted before Palau determines how best to develop its domestic pelagic fishery sector.** Specifically, it will be essential to develop a more robust assessment of how the PNMS policies will impact the foreign fleets, fishing effort, and government-related revenues from these fleets; gain a better understanding of how climate change and associated stressors will affect fisheries productivity; assess the scope of a value-added industry and the economic viability of value-added products; and identify which measures are most appropriate for building and sustaining a domestic pelagic fishery sector.

Effective Implementation

Successful implementation of the PNMS legislation will depend on active engagement of the public and stakeholders to cultivate support, build human dimensions into decision making, and avoid or address conflicts. Effective engagement enables co-development of adaptive governance, monitoring, and management processes.

To promote active engagement, PICRC, the Ministries, and partner organizations should lead a participatory process to develop and execute a science, monitoring, and evaluation plan. An initial framework is provided in this report with the intention that a stakeholder advisory group in Palau could use this scaffolding to build a process that meets the needs of the PNMS legislation and the institutions and stakeholders involved.

A robust participatory process should start with open reflection on the process to date, acknowledging missteps and committing to accountability and transparency moving forward. It will then require a strong communication and engagement plan, and development of a stakeholder advisory group that can be an active partner in design and implementation.



In addition to tracking performance, informing future directions, and disseminating information, a participatory process can aid in building trust among management and stakeholder bodies and smoothing the path for successful implementation.

In the long term, there is exciting potential to build innovative partnerships. New partnerships should leverage domestic and international capacity for data collection to enable effective management of the Sanctuary and enforcement of its restrictions, and long-term monitoring of the most critical social, economic, and ecological indicators of the effects of the PNMS.

A Legacy for Palau, A Legacy for the World

The people of Palau have a rich cultural heritage, anchored in the ocean. The PNMS legislation affirms the enduring customary value of ocean stewardship while celebrating Palauan sovereignty over the vast seascape of its EEZ. Policies of the PNMS offer the opportunity to improve food security and public health, while supporting a domestic pelagic fishing sector that can decrease reliance on imported foods, offer new opportunities for sustainable economic development, and reduce pressure on coral reef ecosystems. With strategic marketing and careful planning, the PNMS can also help grow Palau's vital tourism industry.

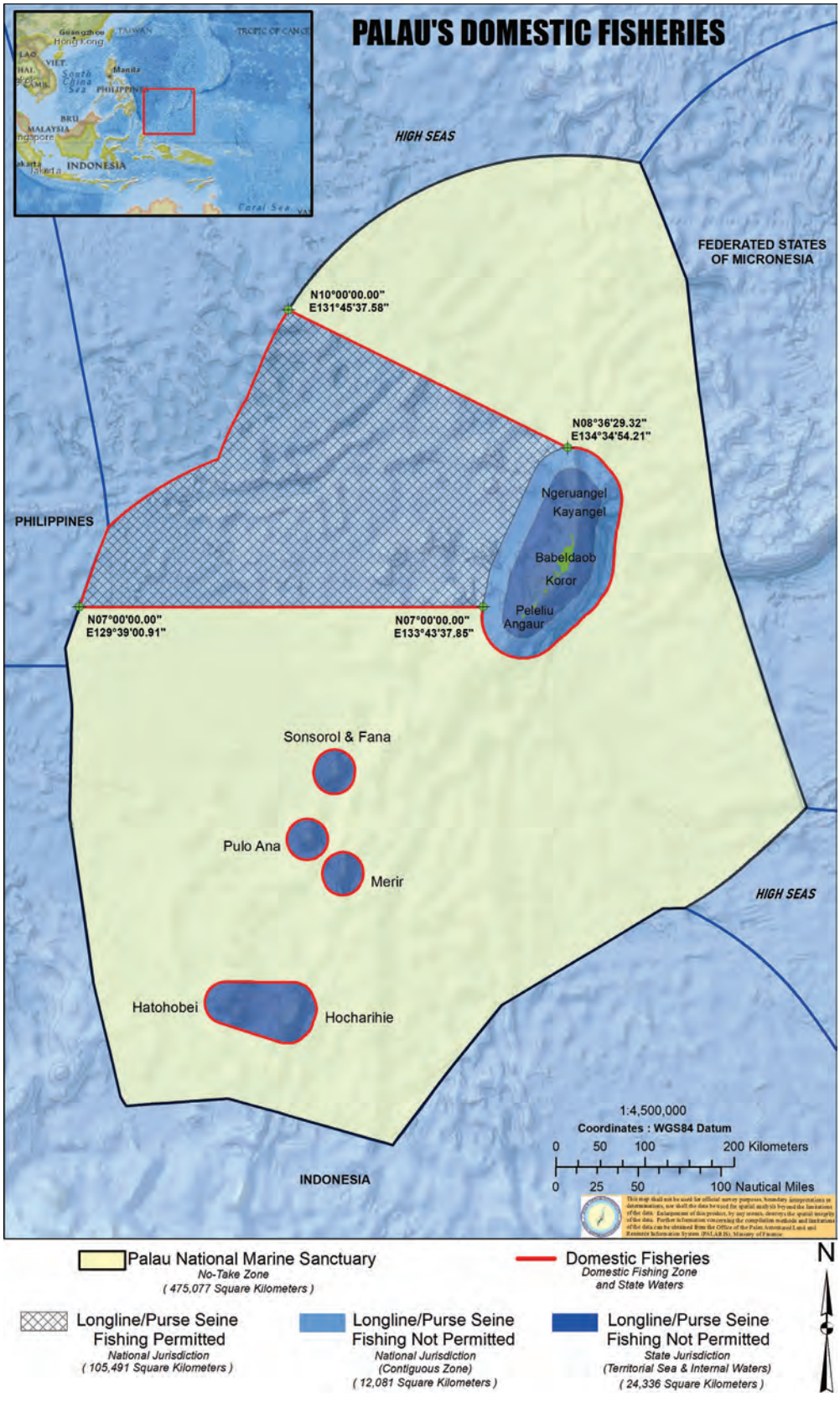
The PNMS can provide a strong example for the rest of the world, yielding long-term conservation benefits for the region and charting a course that others can follow. The PNMS is a strategic solution at a crucial moment to ever-increasing threats from global climate change and declining local and regional fisheries. As the world struggles to find pathways to sustainable development, the PNMS story offers a ray of hope—the potential for a small island or a large ocean state to shape its future. By engaging Palauans' ancestral ties to their open ocean, the PNMS offers the opportunity to strengthen cultural identity and add depth to a Pacific voice increasingly audible around the world.

Image courtesy of PICRC

Stakeholder engagement meeting organized by PICRC, May 2019

Figure 1.

The Palau National Marine Sanctuary comprises 80% of Palau's Exclusive Economic Zone (yellow) and Palau's Domestic Fishing Zone (DFZ) comprises the remaining 20% (bounded by the red line encircling the Northern Archipelago and excluding its territorial sea (dark blue)). The DFZ has two zones: the Contiguous Zone (pale blue; 12nm-24nm zone surrounding the Northern Archipelago) and the Fishing Permitted Area (FPA) (hashed) beyond the Contiguous Zone. Pole-and-line and personal and recreational fishing vessels are permitted in the entire DFZ. Purse seine and longline fishing are only permitted in the FPA (hashed) beyond the Contiguous Zone. State rights in the Territorial Sea and Internal Waters remain unaffected. Figure provided by PALARIS.



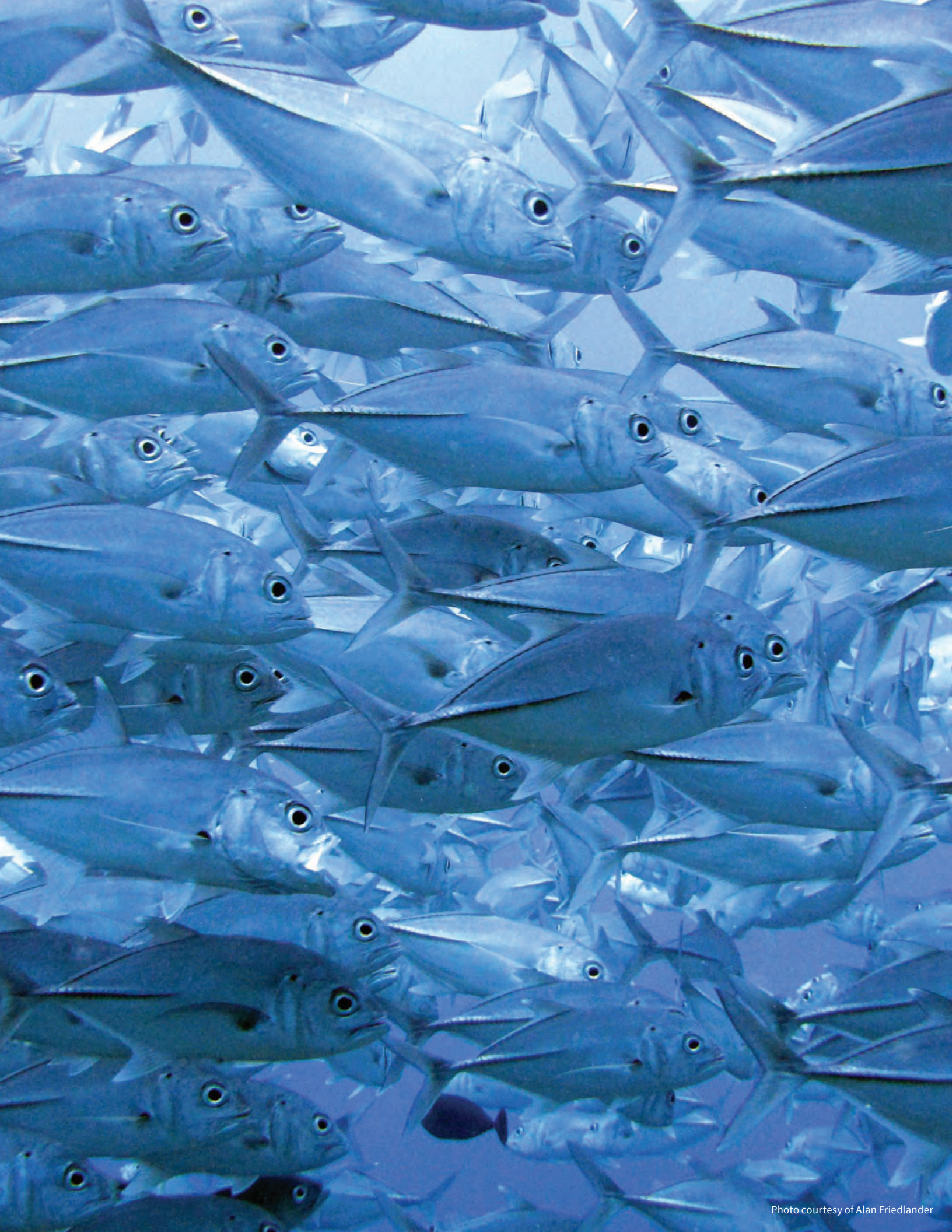


Photo courtesy of Alan Friedlander

I. Introduction

1. Working Group Charge and Composition

In December 2018, the national leaders of Palau asked the Palau International Coral Reef Center (PICRC) and the Stanford Center for Ocean Solutions (COS) to convene a group of Palauan and international experts to provide scientific advice to inform implementation of the PNMS legislation. With the support of the National Center for Ecological Analysis and Synthesis (NCEAS) and Future Earth, PICRC and COS convened a working group on "Managing Ocean Change and Food Security: Palau's National Marine Sanctuary" to address decision makers' needs by generating new insights and actionable knowledge. The first meeting took place in February 2019 in Koror, Palau, and (per the terms of the grant) the subsequent two meetings were held at NCEAS in Santa Barbara, California, in May and October of 2019.

In consultation with the President of Palau, the Minister of Natural Resources, Environment & Tourism, and other national-level officials, PICRC and COS identified three topics as most important to address in advance of full implementation in January 2020.

Implementation of the PNMS Legislation

- What processes, indicators, and systems will be important to successful implementation of the PNMS?

The No-Take Zone

- What are the likely social, ecological, and economic effects of protecting 80% of the exclusive economic zone (EEZ) as a no-take zone?

Fishing in Palau's Waters

- What are the likely social, ecological, and economic effects of the provisions for commercial fishing in the Domestic Fishing Zone (DFZ), and what options should the Government consider?
- What are the prospects and barriers to the development of a domestic pelagic fishery and what options should the Government consider?

Photo courtesy of Sadie Cwikiel

2. Working Group Process

In coordination with on-island partner organizations and other stakeholders, the Working Group undertook a combination of syntheses and analyses to address these questions. The Working Group completed an inventory of resources protected by the PNMS, a literature review of predicted redistribution of tuna species out to 2050 and 2100, a review of existing data on domestic consumption and demand of pelagic and reef fishes, and an assessment of effective management practices of large-scale marine protected areas (large-scale MPAs—MPAs greater than 150,000 km^2). We also conducted new analyses, including an assessment of historical as well as likely future fishing efforts within Palau's DFZ and policy options for maximizing Palau's domestic pelagic fishery sector. The Working Group also identified priorities and key indicators for monitoring efforts to track the outcomes of the PNMS and priority research areas to better understand the socioecological system components and linkages affected by the PNMS, and to address knowledge gaps that are most important for successful implementation.

3. Goals of the PNMS Legislation

The overarching purpose of the PNMS legislation is to conserve Palau's ocean heritage and increase the sustainable contribution of the ocean to livelihoods and human wellbeing. This purpose is elaborated in a series of goals articulated in the laws, the signing statement by President Remengesau, and the subsequent strategic plan written by a stakeholder group. Under this overarching purpose are three core goals, the achievement of which will require strong leadership, inclusive consultations, and transparency for robust implementation, coupled with monitoring and evaluation as well as new research.

1. **Healthy Ocean Populations and Ecosystems:** Sustaining pelagic biodiversity and marine resources that benefit Palauan livelihoods and culture and support the Palauan economy. This includes:
    - Rekindle Palauan societal connection to and appreciation for Palau's offshore environments and resources. Create the next generation of Palauan leadership to manage Palau's open ocean resources.
    - Protect pelagic populations and preserve marine biodiversity in Palau's waters.
    - Support sustainable fisheries by replenishing Palau's fishing zones and adjacent areas.
2. **Food Security:** Ensuring a sustained, safe, and nutritious supply of seafood. This includes:
    - Increase the availability of and access to domestic pelagic fish according to standard guidelines for health and nutrition for all Palauan residents.
    - Reduce fishing pressure on reef fish for the sustained cultural and socioeconomic benefit to Palauans.
3. **Sustainable Development:** Developing a sustainable domestic pelagic fishing industry and supporting ecotourism initiatives. This will entail:
    - Enhance the contribution of the DFZ to economic development, food security, and the conservation of the coral reef fish and invertebrate populations.
    - Support Palau's brand as a high-value ecotourism destination.
    - Support long-term health and wellbeing for Palauan residents.
    - Support long-term economic sustainability in Palau.

4. PNMS Legislation Overview

The PNMS Act established a new legal framework for managing resource extraction in Palau's maritime zones.

These changes fall within six major themes:

1. **Establishment of the Palau National Marine Sanctuary:**
    a. The PNMS comprises approximately 80% of the EEZ (Figure 1) and is a no-take zone with fishing and other exploitative actions expressly prohibited effective January 1, 2020.
2. **Definition of Fishing Parameters:**
    a. The DFZ comprises approximately 20% of the EEZ (Figure 1) and is adjacent to the PNMS. The DFZ includes a Fishing Permitted Area (~17.8% of Palau's EEZ) where longline and purse seine vessels are allowed, and the Contiguous Zone (between 12 nm and 24 nm of the baseline; 2.2% of the DFZ) around Ngeruangel, Kayangel, Babeldaob, Koror, Peleliu, and Angaur (hereinafter collectively referred to as the "Northern Archipelago"), which extends to the western boundary of the EEZ.
    b. Pole-and-line fishing permitted within 24 nm of the baseline of the Northern Archipelago.


Photo courtesy of Ian Shrive

c. Purse seining permitted in the DFZ beyond 24 nm from baseline.

d. Longline fishing permitted in the DFZ beyond 24 nm from the baseline.

3. **Exportation of Fish for Commercial Purposes:**

a. Only fish caught in Palau's DFZ through purse seining utilizing free school operations or through longline fishing can be exported for commercial purposes.

b. All fishing vessels must land in Palau before they export their catch, unless exempted.

4. **Taxation of Fish Export:**

a. The export tax for tuna and any species of billfish is $0.50/kg.

b. An export tax of $0.35/kg applies to all other fish whatsoever, including exported reef fish and bycatch.

5. **Expansion of MNRET, PICRC and MOJ Mandates**

a. MNRET has a broad mandate for the management and conservation of the PNMS Zone and the DFZ.

b. PICRC will coordinate research, education, and outreach activities relating to the Sanctuary and the DFZ. It will also develop and recommend to MNRET the appropriate conservation and management measures for the DFZ.

c. MOJ is mandated to protect the safety of persons and wildlife within the Republic of Palau's jurisdiction, including restrictions pertaining to the EEZ, the DFZ, and the PNMS.

6. **Establishment of the Pristine Paradise Environmental Fee (PPEF):**

a. The PPEF is established at $US100 and applicable to international travel into Palau. Contributions are broken down as follows: Fisheries Protection Trust Fund ($5), PICRC ($5), States ($12.50), Palau International Airport ($25), Green Fee ($30), and National Treasury ($22.50).

Photo courtesy of J. Tamelander

II. The Sanctuary (80% of Palau's EEZ)

Palau joins a small but growing number of nations around the world that have established large-scale marine protected areas (MPAs). Large-scale MPAs provide a suite of benefits, including protecting cultural resources, conserving marine populations and biodiversity, enhancing the resilience of marine resources in the face of climate change impacts, benefitting adjacent fisheries, and supporting nonextractive industries like tourism[1]. While there are many potential benefits to large-scale MPAs, there are also costs to implementation. The challenge to the success of the PNMS is how to leverage these benefits and fund initial and sustained costs moving forward.

1. The Goals of the Sanctuary: Healthy Ocean Populations and Ecosystems

The PNMS Act designates approximately 80% of Palau's EEZ, 475,077 km^2, as a no-take and no-resource-extraction zone. This Sanctuary serves conservation, economic, and cultural purposes. From a conservation perspective, the PNMS aims to protect pelagic populations and biodiversity in Palau's waters and surrounding areas. From an economic perspective, the Sanctuary offers the potential to reduce mortality of commercially important pelagic fishes; protect sites that are important for feeding and reproduction; and, for species to grow larger, produce many more offspring and thus help sustain stocks in the fishing zones in Palau and adjacent areas. The Sanctuary can burnish Palau's ecotourism brand and support the tourism economy. Importantly, the Sanctuary is an opportunity for Palauans to strengthen their connection to Palau's offshore environments and resources.

"Euotelel a klingil a debel Belau"

This phrase captures the meaning of the Palau National Marine Sanctuary in the Palauan language. Palau's customary marine strategies, such as *"bul,"* are effective tools for community-managed natural resources. Translating the PNMS into Palauan is a big step towards Palauans embracing the PNMS as another culturally-significant management strategy.

In October 2019, PICRC convened a panel of Palauan language, cultural, and conservation experts to judge a contest translating the Palau National Marine Sanctuary into Palauan. The winning entry submitted by a young Palauan, Tkerbai Junior, captured Palau's connection to life in the ocean and the PNMS's role in creating a sanctuary for future generations of Palauans.

The esteemed panel noted that *"Euotelel,"* derived from the word *"Euatel,"* meaning refuge or sanctuary, beautifully captures the essence of the PNMS. *"Klingil"* refers to all life, and *"debel"* signifies ocean with *"debel Belau"* referring to Palauan's ownership or claim to it.

2. Biological Resources of the Sanctuary

a) State of Knowledge of the Biodiversity within the PNMS

Extensive studies detail the biological richness in Palau's nearshore and coral reef environments, yet much less is known about the biology and ecology of the open ocean, deep sea, and seamount habitats now protected in the Sanctuary. Using global databases (Fishbase, IUCN Red List, World Register of Marine Species) and species descriptions in the peer-reviewed literature, we assembled a list of currently known

species found throughout the PNMS habitats.[1] A total of 794 vertebrate animal species have been reported for the PNMS, including 565 teleost fishes, 60 sharks and rays, 27 marine mammals, 20 seabirds, and 7 reptiles (Figure 2). We note that this list is inevitably an underestimate of total species richness, given the limited number of previous assessments, the bias toward vertebrate studies, and the limited knowledge of open ocean and deep sea ecosystems in general, including in this region. There are doubtless thousands more species, including plankton, benthic invertebrates, and the many undiscovered species that associate with mesopelagic and deep-sea ecosystems.

b) Protection of Biodiversity at Risk

The Sanctuary hosts nine species that have been identified as at conservation risk in the IUCN Red List[2], including critically endangered hawksbill turtles (*Eretmochelys imbricata*) and leatherback turtles (*Dermochelys coriacea*), and endangered sei whales (*Balaenoptera borealis*), blue whales (*Balaenoptera musculus)*, green turtles (*Chelonia mydas*), whale sharks (*Rhincodon typus*), shortfin mako sharks (*Isurus oxyrinchus*), longfin mako sharks (*Isurus paucus*), and great hammerhead sharks (*Sphyrna mokarran*). An additional 23 vulnerable species are reported within the PNMS, though many more likely exist here. The conservation status of species was overlaid on species distributions[3] to assess a biodiversity risk, which is defined as the mean conservation status of all species in a given area of the PNMS (Figure 3A). Note that the biodiversity risk in the PNMS is higher than on reefs, which is consistent with global patterns (Figure 3B) that indicate that, in general, species at high risk as assessed in the IUCN Red List, such as marine megafauna, are found in the open ocean. This highlights the potential benefits of the PNMS in protecting species that are facing conservation risk.

c) Protection of Home Ranges and Ecological Processes

Models suggest that marine reserves are expected to be most effective in conserving protected populations when the spatial extent of protection exceeds the home range of the species being protected[4], [5]. A potential benefit of large-scale MPAs is their ability to protect areas that are larger than the home range of individuals within a given species, thus fully protecting populations found within the MPA[6]–[8]. Data on home ranges for species found in the PNMS indicate that the PNMS is able to capture home ranges of many species of conservation concern (Figure 4A). For example, silvertip sharks (*Carcharhinus albimarginatus*), which demonstrate strong site fidelity for seamounts in the northern Line Islands [9], have home ranges that would fit within the PNMS size. Tracking of multiple pelagic species—blue marlin (*Makaira nigricans*), reef mantas (*Manta alfredi*), sailfish (*Istiophorus platypterus*), silky sharks (*Carcharhinus falciformis*), silvertip sharks, and yellowfin tuna (*Thunnus albacares*)—has also indicated that they are effectively protected by an MPA of comparable size to the PNMS, the British Indian Ocean Territory MPA [10]. Other species with home ranges likely to be effectively protected by the PNMS include red-footed boobies (*Sula sula*), blacktip reef shark (*Carcharhinus melanopterus*), gray reef shark (*Carcharhinus amblyrhynchos*), common bottlenose dolphin (*Tursiops truncatus*), Olive Ridley turtles (*Lepidochelys olivacea*), hawksbill turtles, green sea turtles, loggerhead turtles (*Caretta caretta*), and leatherback turtles (Figure 4A). Notably, as body size increases, home range size of an individual tends to also increase (Figure 4B), suggesting that smaller species are more likely to have home ranges fully protected by the Sanctuary than larger species.

1 Databases and peer-reviewed literature were searched for species with geographic extent overlapping with Palau's EEZ and whose habitat was noted as oceanic, pelagic, mesopelagic, deep sea, or seamount associated, or that otherwise could be identified as being in habitats within the PNMS.

Figure 2.

There are 794 species recorded in the PNMS from 10 different classes. The class of ray-finned fishes (Actinopterygii) has the largest number of identified families. Within each class, each color is a different family.

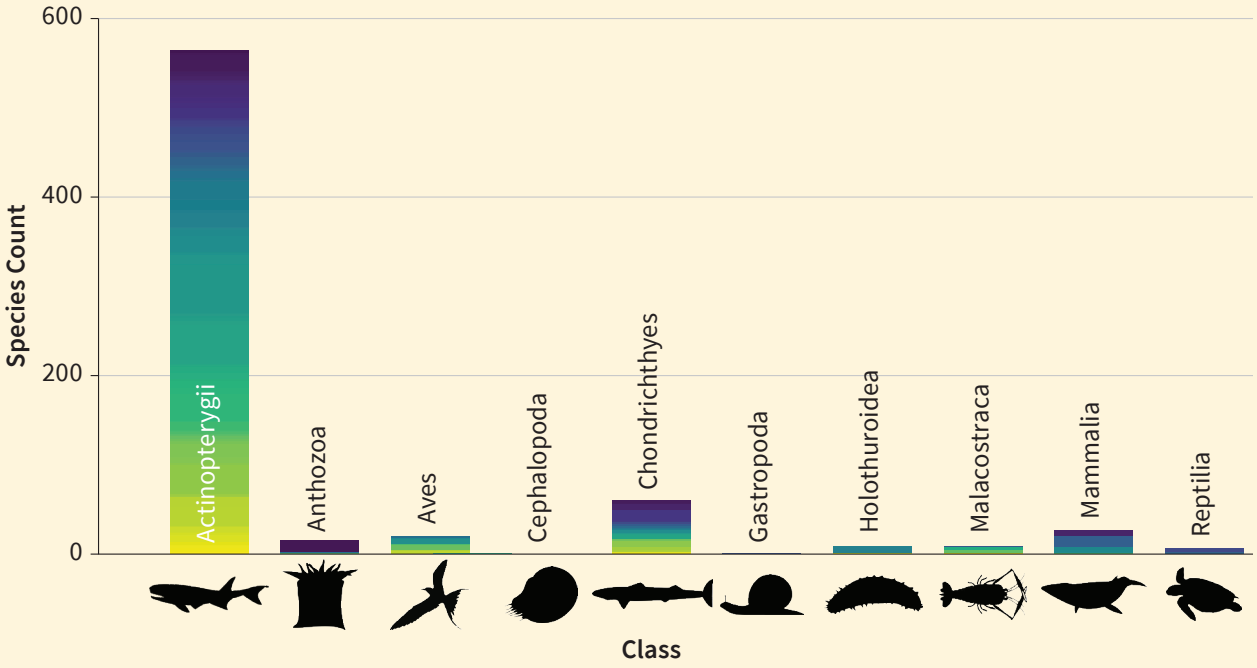


Figure 3.

Average IUCN Red List status (Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (EN), Extinct (EX)) of species (A) in Palau's EEZ compared to (B) the global oceans. The PNMS is outlined in red in (A) and is within the red box in (B). Figure (A) from Casey O'Hara and (B) modified from O'Hara et al. (2019).

(A) (B)

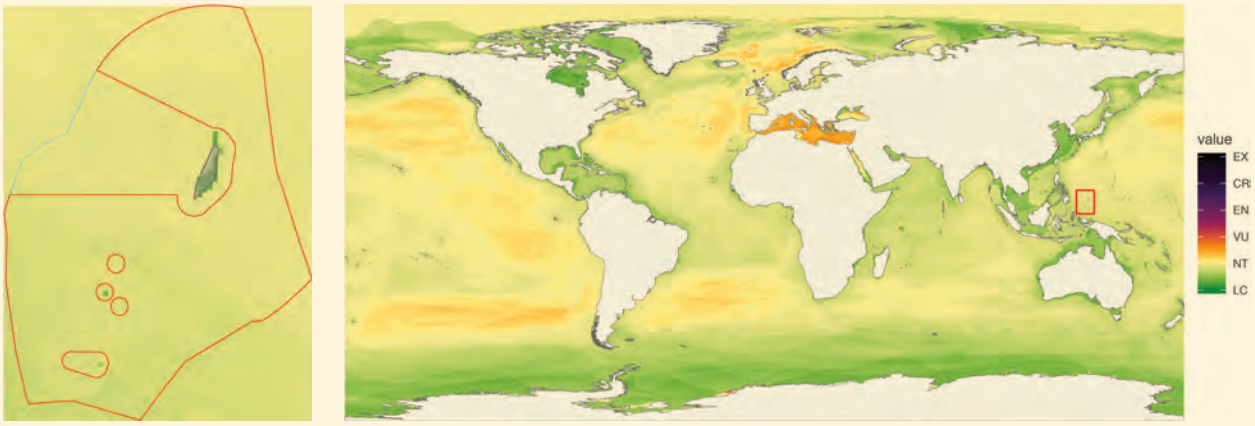
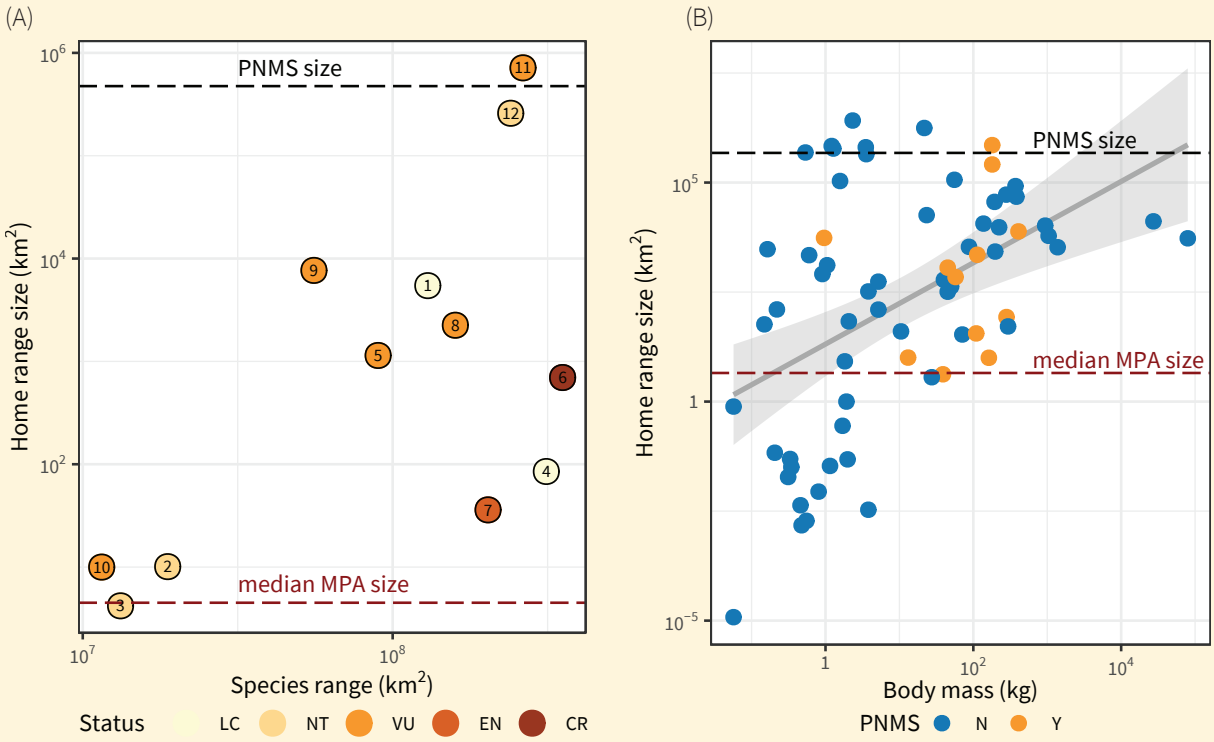


Figure 4.

(A) Home range sizes of marine fishes, marine mammals, seabirds, and marine reptiles found within the PNMS as compared to the overall species range, colored by IUCN Red List conservation status (Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), and Extinct (EX)). Species are: 1) *Sula sula*, 2) *Carcharhinus melanopterus*, 3) *Carcharhinus amblyrhynchos*, 4) *Tursiops truncatus*, 5) *Lepidochelys olivacea,* 6) *Eretmochelys imbricata*, 7) *Chelonia mydas*, 8) *Caretta caretta*, 9) *Dermochelys coriacea*, 10) *Carcharhinus albimarginatus*, 11) *Thunnus obesus*, and 12) *Thunnus albacares* (citation details in Supplementary Material document). (B) Home range sizes of marine fishes, marine mammals, seabirds, and marine reptiles as compared to body size for species found within the PNMS (orange) and species not found within the PNMS from other geographies or habitats (blue). Plot B uses data and is adapted from McCauley et al. 2015, with the addition of species 10-12 from (A) (details in Supplementary Material document). On both plots, the dotted red line represents the median MPA size globally while the black dotted line indicates the size of the PNMS.



Importantly, home ranges can be difficult to quantify when species have specific habitat needs for feeding or reproduction that may take them into very different areas, across considerable distances away from Palau. In addition, for those species that breed on land, like seabirds and turtles, or in nearshore coastal waters, like many species of sharks, key habitats such as breeding and nursery grounds may be found within Palau's waters (i.e., in the Territorial Sea) but not within the PNMS. Connectivity between nearshore and open ocean habitats requires further study, but conserving these critical habitats and locations will be important to sustaining the biodiversity of the Sanctuary.

Some of the pelagic fishes of commercial interest are highly migratory and move throughout EEZs of multiple nations adjacent to Palau, as well as international waters. In particular, the home ranges of tuna species exceed the PNMS in size (Figure 4A). However, there is growing evidence that open ocean large-scale MPAs have the potential to contribute significantly to the conservation and management of some species of tuna and other large pelagics by protecting critical areas necessary for reproduction and feeding[8], [11]. For example, it has been shown that

the Phoenix Islands Protected Area (PIPA) is effectively protecting spawning grounds for skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna, and bigeye tuna (*Thunnus obesus*)[12].

Although these species are able to move great distances, individuals within a population may spend significant portions of their time within the Sanctuary, where they will now be protected from fishing and bycatch mortality. Reduced mortality will likely increase the density of marine life, the size of individuals, and therefore the reproductive output inside the nation's EEZ, which in turn may benefit adjacent and local fisheries once animals cross over[12]–[14]. For example, tagging work within Palau's EEZ suggests that over a time frame of one to two months, yellowfin tuna and blue marlin individuals stay within EEZ waters. In 2018, Filous and colleagues tagged three blue marlins with MinPAT-348A satellite tags[15]. Individuals displayed fidelity to nearshore waters and never traveled outside Palau's EEZ over a mean 35 days of monitoring. Additionally, 30 sub-adult yellowfin tuna (50–79cm FL) were tagged with acoustic tags, and 27 of them were detected a total of 20,302 times at FADs with receivers, meaning that these individuals spent most of the time during this period within Palau's EEZ[15]. While the sample size was small and monitoring times were short, these initial tagging results provide preliminary insights into the movements of these species as well as the potential protection the PNMS may provide them.

With a combination of modeling and tagging data in the Western Pacific, researchers estimated the median distance skipjack tuna travel is approximately 760–870km, with even lower displacements for yellowfin tuna (625–705km)[16]. These distances are comparable to the maximum distance internal to the PNMS, approximately 940km (Figure 1). In another study, more than 91% of sub-adult yellowfin tuna collected from the nearshore waters of the Hawaiian Islands originated from the same area[17]. In addition, sub-adults collected in offshore locations within the Hawaiian Islands appear to originate from nearshore locations, highlighting the importance of local production and retention of yellowfin tuna to the standing stock and domestic fisheries of Hawaii[17].

Among the species reported within Palau's EEZ for which we have estimated home ranges, the Sanctuary is likely to provide vital protection for several of the species that use its waters (Figure 4A). Resident populations of a species are likely to benefit most from the Sanctuary[18].

Finally, large-scale MPAs offer benefits for biodiversity that are not obtainable at smaller scales. They offer the ability to protect whole ecosystems and interdependent habitats so that biologically connected ecosystems (nearshore/offshore and shallow/deep sea) can be included within the same management area[19]. In addition, connections between offshore and nearshore ecosystems, and therefore between the Sanctuary and the Protected Area Network (PAN) that protects Palau's nearshore waters, have also been highlighted in empirical studies conducted elsewhere[17], [20], [21], and should be further explored within the PNMS.

3. Climate Change Threats and Impacts

In the next century, climate change is expected to have profound impacts on the ocean, the atmosphere, and all life[22]. Many efforts are underway to model and predict what these impacts will look like on regional and global scales. One example is the Coupled Model Intercomparison Project, which is a global effort to synthesize models in a robust way. Its fifth synthesis (CMIP5) was recently released, and a CMIP6 synthesis is nearing completion. CMIP5 provides important insights into what lies ahead.

a) Climate Forecasts

The CMIP5 multi-model forecast for 2081–2100 suggests that, relative to 1986–2005, sea surface temperatures within Palau's waters will rise 1°C under Representative Concentration Pathway (RCP) 2.6, the most optimistc scenario. Temperatures are projected to rise as much as 3°C under RCP8.5 (the model pathway with the highest CO2 concentration). The current greenhouse gas emissions trajectory is closer to RCP8.5, and so it is likely that temperature increases will be at the higher end of that range[22]. We have learned from the CMIP project leaders that the sixth synthesis effort, underway in 2019/2020, is yielding similar results as CMIP5 for the tropical western Pacific.

A direct effect of increasing sea surface temperatures in the western Pacific tropics is an overall increase in the

number and intensity of tropical storms. At the same time the interannual variability in large tropical storms is expected to increase. For example, large tropical storms are expected to become 20–40% more frequent between 2070–2100 when considering future-climate El Niño states and 20–60% less frequent during future-climate La Niña states[23] relative to today. Increasing water temperatures will also lead to lower oxygen levels in the surface ocean layer, with concentrations expected to decrease between 15–30% by 2100.

As temperatures increase, we will also see an increase in extreme events, such as droughts, heavy rainfall, and marine heatwaves that will bring impacts of climate change earlier than expected under long-term mean change scenarios[24]. Marine heatwaves—in particular, periods of anomalously warm waters—have increased in intensity, duration, and frequency over the past century and are projected to increase in future[25].

b) Impacts from Projected Climate Change

The combination of all of these factors will have profound effects on marine life in Palau's exclusive economic zone[26]. Warmer water will lead to a redistribution of biodiversity as organisms move to areas within their temperature tolerance ranges. This will eventually lead to dominance by heat-tolerant species that can live in a warmer ocean, a trend already observed over the past decades in many regions of the world, including the Pacific Ocean[27]–[29]. Increased greenhouse gas emissions are leading to ocean acidification, with potential impacts on pelagic food webs by negatively affecting calcifying organisms that constitute the resource basis of these ecosystems, such as pteropods (pelagic sea snails) and some phytoplankton groups (e.g., diatoms and coccolitophores)[30].

Declining oxygen levels are also expected to lead to a redistribution of species and local habitat compression, as organisms with high oxygen requirements, such as tuna and billfish, lose foraging habitat and migrate to areas with higher oxygen concentrations[31]. Reduced oxygen levels will constrain the maximum size of fishes[32], with associated reductions in fecundity[32]. Recent work has also demonstrated that the expansion of low-oxygen areas leads to a reduction in biodiversity, as fewer species are able to survive under such conditions[33]. It is also likely that increased vertical density stratification within Palau's EEZ will reduce levels of planktonic primary production, with cascading impacts on the entire food chain[34]. Finally, with more frequent and more intense/prolonged marine heat waves, coral bleaching is likely to become more frequent, further stressing coastal and reef ecosystems and fisheries, which may result in acute temporary impacts on the distribution, reproduction, growth, and mortality of some pelagic species. Additional detail regarding impacts of climate change on tuna and fisheries follows in ***Section III: Fishing in Palau's Waters***.

4. Potential Benefits, Costs, and Effects of the Sanctuary

a) Conservation of Resources

In establishing the sixth largest large-scale MPA on Earth, Palau has clearly reaffirmed its commitment to conservation. No-take MPAs (marine reserves) have been demonstrated to increase biomass, density, size, and species richness[35], [36] and strengthen resilience to climate change[37]. As discussed in Section 2 the PNMS is likely to yield these benefits, particularly because home ranges of many species, including endangered or vulnerable species, lie fully within the no-take zone (Figures 3&4)[7]. The Sanctuary is also expected to protect populations of species that are exploited by fisheries in areas open to extraction[38]. While there is much research still to be done, with effective implementation and enforcement, the no-take zone—closed to all forms of extraction—is expected to protect a suite of pelagic species, as well as mesopelagic and benthic species and ecosystems that we still know little about, particularly in deep-sea habitats.

b) Spillover Effects

Spillover of resources from a marine reserve into areas in which extraction (e.g., fishing) is allowed is a major benefit of setting aside some seascapes as no-take zones. Research over the last several decades has demonstrated spillover from MPAs[38]–[40] and shown that the magnitude and extent of spillover varies, depending on the size of species' home ranges, species behaviors, water flow patterns, and other habitat features favoring

retention or dispersal. However, the spatial extent of spillover from a large-scale MPA has not yet been well quantified (but see[4]). The PNMS provides an opportunity to further address this important question.

Spillover effects are fundamentally important to the goals of the PNMS Act: to support a domestic pelagic fishery, safely increase pelagic fish consumption by Palauans, benefit sportfishing and thus the tourism industry in Palau, reduce reef fish extraction, and contribute to sustainable ocean livelihoods[41]. Review and synthesis of available information (see Section 2c) suggests that full implementation of the PNMS policies is likely to play an important role in sustaining healthy populations of highly mobile organisms within the Sanctuary, such as tuna, that could increase densities in the domestic fishing zones as well. Thus, understanding the abundance, population structure, distribution, and use of space of these fish now and through time is essential for understanding the success of the PNMS, for Palau and the region, and for its downstream socioecological effects. Stock assessments currently undertaken at a regional level will provide important data to this end, but given that many of these highly migratory fish populations are regularly assessed for the entire western and central Pacific Ocean, there are gaps in our understanding of how the PNMS will influence some economically important species within Palau's EEZ in particular.

c) Costs of Implementation

Implementation of the PNMS will require long-term economic investments to enable the enforcement, monitoring, and research needed to achieve its objectives and to track its social, economic, and ecological outcomes. Enforcing the new restrictions within Palau's maritime jurisdictions established by PNMS legislation will require sustained funding for Ministry of Justice (MOJ) and Ministry of Natural Resources Environment & Tourism (MNRET) (e.g., the costs to support the increase in observer coverage on longline vessels from 5% to 100%, and the costs of satellite surveillance and interception of illegal vessels in the Sanctuary), the costs of which have been estimated in the Monitoring, Control, and Surveillance Report to be an initial investment of at least $US1.5 million plus additional personnel and annual costs[42].

The Fisheries Protection Trust Fund, which receives $US5 out of the Pristine Paradise Environment Fee (PPEF) of $US100 visitors currently pay, will provide some funding to MOJ and MNRET, but PPEF revenues have varied in recent years, as tourist numbers have fluctuated. From fiscal year 2014 through fiscal year 2019, the 5% share would have provided between $US580,000 to $US840,000 each year to the Fisheries Protection Trust Fund. The Fund is thus not likely to fully cover the PNMS-related costs for MOJ and MNRET. Partnerships with outside organizations, as well as funding streams from philanthropic and international governments, are opportunities to supplement Palau's resources for enforcing and monitoring the Sanctuary and fishing zones. Long-term planning is needed to assess the full current and future costs of enforcing and monitoring the PNMS and to determine how revenue streams (e.g., PPEF) can be allocated along with additional appropriations from government revenues (e.g., revenue from raised export tax) to ensure Palau's agencies have the capacity and infrastructure to enforce the PNMS.

PICRC has new authority, defined by the PNMS legislation, to administer communication, outreach, and education, along with overseeing the research and monitoring of the PNMS and the DFZ. The PPEF allocates $US5 per visitor to support PICRC in meeting these responsibilities (this would be the same magnitude as above, which generated between $US580,000 to $US840,000 each year in the past). Research and monitoring costs alone are expected to add up to at least ~$US0.5million per year, including research vessel time (~$US14,000–$US30,000 per day), salaries for field technicians and analysts, scientific equipment costs and maintenance, and satellite imagery and data, among other costs. Close partnerships with research institutions and government agencies abroad, along with regional support from the Secretariat of the Pacific Community (SPC) and the Pacific Islands Forum Fisheries Agency (FFA), would further support scientific research in Palau's EEZ that is critical to monitoring and informing management of PNMS and the DFZ. Additional funds above the estimate for research and monitoring will be needed for assessment and evaluation of the PNMS goals and process, as well as PICRC's role in communication, outreach, and education.

d) Palau's Brand as a Premier Ecotourism Destination

The PNMS protects approximately 38 km^2 of ocean per Palauan, making it the largest no-take, no-extraction area in the world, per capita, that surrounds a whole nation.

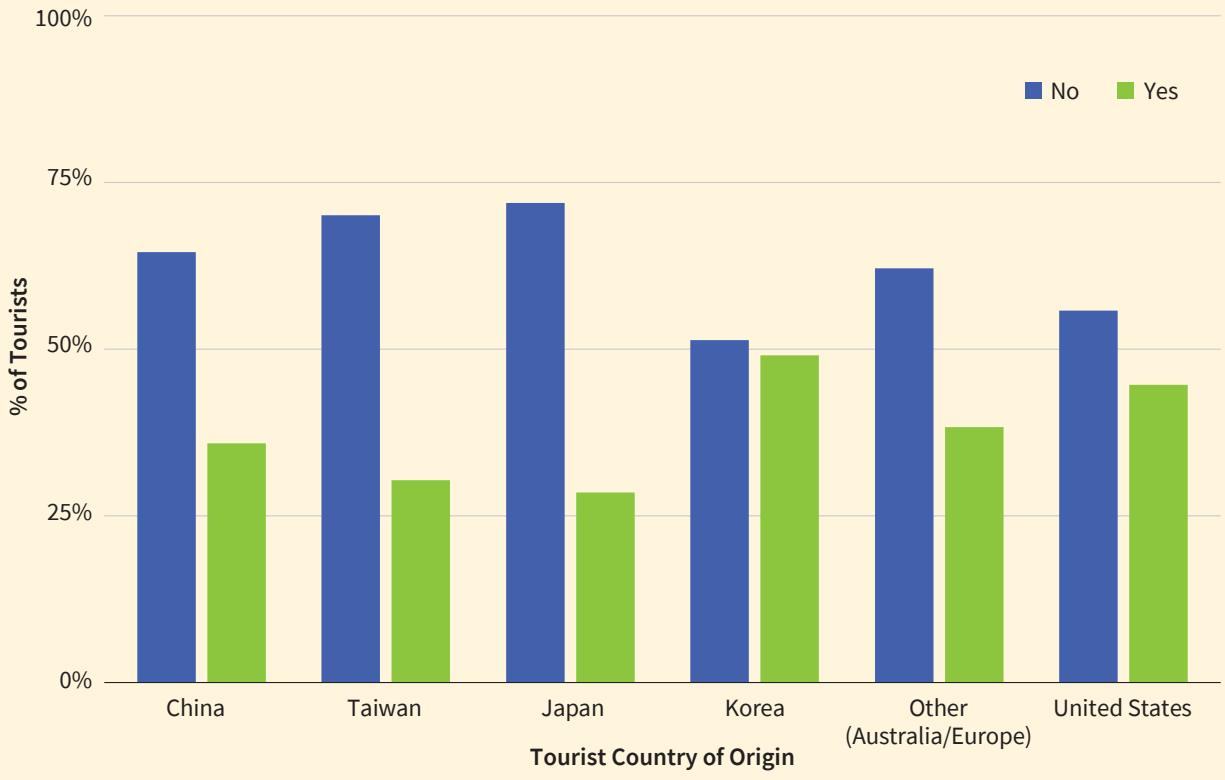
"*The Palau National Marine Sanctuary is a mindful choice to act on behalf of Palauans today so that we have a secure future; to act on behalf of Palauans who are yet to be born so they are assured of a bountiful sea; and to act on behalf of the world's ocean to ensure that this global heritage that we have in common is safeguarded now and into the future.*"
– Tommy Remengesau, President, Republic of Palau (from the strategic plan, 2017)

One of the primary goals of the PNMS legislation is to strengthen Palau's position as a premier high-value ecotourism destination. Tourism, particularly dive-based tourism, has been among the top sectors of Palau's economy for decades[43]. Through diving, snorkeling, and boating, the majority of tourists (80%) visit Palau's corals reefs, with most visiting its Rock Islands Southern Lagoon, a UNESCO World Heritage site[44]. From fiscal year 2013 to fiscal year 2018, the tourism industry contributed between 21.2% and 27.3% of Palau's GDP (between $US51.6 million and $US76.9 million per year). It is also an important source of jobs—employing 10% of Palauan workers[45], [46]. Yet Palau faces similar issues to other small island developing nations: how to grow its tourism industry while conserving the natural resources upon which that industry depends.

Palau's shift from reliance on foreign fishing toward growing value from its high-value ecotourism industry

Figure 5.

Percentage of tourists aware of the PNMS prior to their visit to Palau. Data from Oleson et al. (2019).



is expected to bolster Palau's economic independence and support livelihoods. Early evidence suggests that visitors will increasingly be attracted by Palau's "Pristine Paradise" campaign. Baseline surveys in 2017[47] asked tourists whether the PNMS was influential in making their decision to choose Palau (Figure 5). Overall, 22% of all respondents said the PNMS was important to their decision to travel to Palau. This demonstrates that even before its full implementation, the PNMS legislation was already attracting tourists interested in Palau's legacy to protect the ocean. Careful planning around sustainably harnessing that interest has the potential to improve livelihood opportunities for Palauans.

Palau aims to be a high-value ecotourism destination for the future. Achieving this goal and minimizing potential negative outcomes depends on effective management and consideration of matters such as equitable distribution of benefits, sustainable development practices, and assessments of the socioeconomic, wellbeing, and ecological costs of tourism. To ensure that the tourism industry in Palau distinguishes itself as a premium destination with positive impacts on Palauans, it will be important to support policies that incentivize businesses to maintain environmental and labor standards. Recent efforts, including those lead by the Bureau of Tourism, have focused on responsible tourism growth by establishing a Repsonsible Tourism Framework[48], among other initatives.

5. Further Analysis and Research Needs

Here, we review and synthesize available information, yet there are clearly important knowledge gaps and opportunities for additional analyses and future research. A key need is to expand the characterization and discovery of the biodiversity, ecosystems, and habitat features within the Sanctuary—particularly for the relatively understudied planktonic and benthic invertebrate communities and the deep and mesopelagic environments. Additional research and monitoring to track how much time individuals of different endangered and economically and culturally important species spend in the Sanctuary, how they utilize the Sanctuary (for migration, feeding, spawning/reproduction), and how populations respond to protection will also be crucially important to assess the function of the Sanctuary in protecting species at risk and fisheries targets. More research is needed to develop a fuller understanding of the use of the Sanctuary by fishes and other organisms and, in particular, to identify the areas that are important for reproduction and feeding. In particular, studies across multiple life stages for a given species are needed to best understand home range needs of populations[10]. Crucially important connections between offshore and nearshore ecosystems should be further explored, and long-term monitoring and research are needed to track and understand climate change impacts on key populations. A critically important area for further research is also the assessment of potential spillover of economically important species from the no-take into the DFZ and nearshore waters. Finally, it will also be important to track—and adaptively adjust policies and management accordingly—new or existing indicators, such as tourists' expenditures, spending preferences, and perceptions; contribution of tourism to GDP, including distribution of tourism-related benefits through Palau's economy; diversity and sustainability of ecotourism-branded activities; and indicators of overtourism, including environmental impacts.

Photo courtesy of Elsei Tellei

III. Fishing in Palau's Waters

The PNMS policies set out to foster a stronger domestic pelagic fishery sector—to support food security, livelihoods and economic development in Palau. The policies create significant new restrictions on existing foreign fleets and new opportunities for local fishers and others. These reforms present important issues for the Government to consider as it moves into full implementation.

1. Goals of the PNMS Policies: Food Security and Economy

Proponents of the PNMS legislation saw potential to bolster food security by expanding the pelagic harvest by domestic fishers, as well as create economic development and job opportunities. Food security is often evaluated in terms of three pillars: the quantity of food supplied through domestic production and trade (availability); the physical, economic, and social factors that allow people to receive and consume food (access); and the health of individuals that allows them to make the most of nutrients (utilization)[49]. The stability of each of these dimensions over time is also critical, as even temporary food insecurity can lead to adverse health outcomes.

Policies of the PNMS have potential to improve multiple dimensions of Palau's food security. The impacts will depend on how the domestic pelagic fishery sector develops and how consumer preferences evolve. Ideally, the pelagic fishery will maintain or even increase seafood availability while shifting pressure off of the reefs and reducing the consumption of processed foods. In this scenario, public education would be necessary to ensure that people, especially sensitive populations (i.e., children and pregnant and lactating women), do not overconsume species with high mercury levels.[2] If consumed within healthy levels, however, and especially if associated with a shift away from processed foods, pelagic fish will improve nutrition outcomes[50], [51].

Given the overexploited status of coastal resources and the projected impacts of climate change on reef fish populations, a reliable supply of pelagic fish could help support the continued consumption of fish by Palauans, while at the same time potentially reducing demand for reef fish. Preliminary unpublished analyses indicate that micronutrient concentrations are comparable between the main consumed pelagic and reef species[52]. Target pelagic species were actually found to have higher concentrations of protein, iron, fat, and omega-3 fatty acids, which are critical to infant development, human health, and disease prevention[52]. Further, reduced pressure on reefs, diversification of domestic food sources, and reduced reliance on imports can also improve the short- and long-term stability of the seafood supply in the face of environmental, political, and economic shocks[53]. PNMS policies thus can be leveraged as important elements in building a food-secure future for all Palauans. Ultimately, the impact of these measures will depend on Palau's decisions regarding broader food and trade policy (e.g., imported foods from international markets).

2 Local studies will be necessary to determine the level of mercury in consumed pelagic species in order to establish safe and healthy guidelines by population group. As a starting point, synthesis of available information on mercury levels in pelagic fish species will provide useful initial guidelines.

The future of pelagic fisheries is also important to Palau's economy. From 2014 to 2017, Palau generated an average $US13.8 million per year in government revenues from foreign commercial fishing through export taxes, fishing rights fees, fishing licensing fees, and a purse-seine vessel day scheme. This revenue accounted for approximately 12% of total government revenues during the same period and 5% of GDP.

Commercial, foreign-owned fishing vessels are the main suppliers of pelagic fish in Palau's market. Achieving food security and economic benefit through a robust pelagic fishery will thus depend on how the foreign fleet currently fishing Palau's waters evolves (Section 3), and on how domestic fishers respond to the opportunities the PNMS legislation envisions (Section 4). These possibilities will be shaped by climate change and its impact on fish stocks.

2. Implications of Climate Change

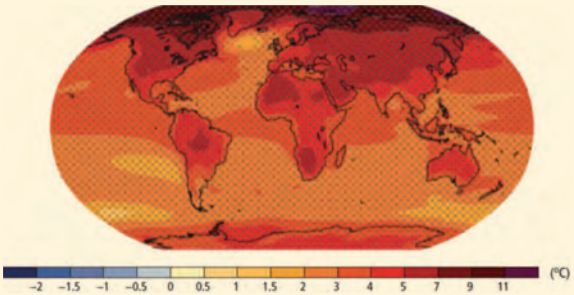
Leading global models project that climate change will decrease the productivity of ocean ecosystems in many regions of the world, including the western tropical Pacific. The ~3°C increase in sea surface temperature projected by RCP8.5 (the trajectory we are currently on) (Figure 6A), associated decreases in dissolved oxygen of up to 15–30% by 2100, and increased frequency of extreme events will lead to significant changes in abundance and redistribution of fish species and associated fisheries. Recent analyses project that total catch from fisheries in the region around Palau will decrease by up to 25% by 2050 and 30–50% by 2100[54] (from a baseline year of 2005).

Climate change will have significant effects on tuna stocks, which since the 1980s have represented more than 80% of the total catch by weight in Palau[55]. Declines will be caused primarily by changing ocean currents in the central Pacific that will cause an eastward expansion of the warm pool of water in the Pacific Ocean, shifting tuna feeding grounds and thus driving tuna populations eastward[27], [56], [57].[3]

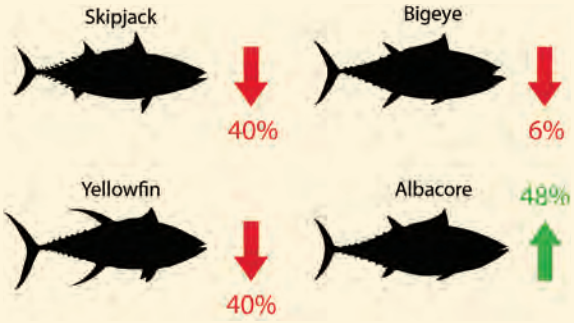
Figure 6.

(A) Expected global changes in Sea Surface Temperature up to 2100 using the modelling assemblage CMIP5 under the climate change scenario RCP8.5. (B) Expected changes in tuna populations (skipjack, bigeye, yellowfin and albacore) biomass within the PNMS up to 2100 under climate change scenario RCP8.5. Figure (A) from IPCC (2014) and data for (B) from Senina et al. (2018).

(A)



(B)



Commercial fishers target four species of tuna in Palau's waters: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), and albacore (*Thunnus alalunga)*. Skipjack and yellowfin represent the two most important species—fishers caught 1.6 million metric tons of skipjack in the western and central Pacific region in 2017, accounting for 64% of the total tuna catch[58], and 0.7 million metric tons of yellowfin, which was 27% of the total[58]. Both species

3 All projections assume that fishing effort and power are kept relatively constant throughout the whole time period, which might lead to underestimates on the negative impacts of climate change on tuna populations if fish populations that decline due to climate change are then fished at levels that grossly exceed maximum sustainable yield.

are expected to experience significant declines in abundance within Palau's EEZ, especially in the second half of the century. For skipjack, Spatial Ecosystem And Population Dynamics Model (SEAPODYM) projections indicate an increase in biomass of around 7% by 2050, but then a decline of as much as 33% by 2100, from a baseline year of 2010. For yellowfin, the model projects a 3% loss by 2050 and a 22% loss by 2100 (Figure 6B)[57].

Projections for bigeye and albacore show a more positive outlook. Increasing temperatures have a lesser effect on spawning habitats for bigeye (0.1 million metric tons[58]). Projections of bigeye abundance show an increase of 4% in Palau's waters by 2050 and a decrease of 6% by by 2100 (from a baseline year of 2010[57]). Albacore (0.1 million metric tons[58]) is expected to increase in Palau's waters by at least 58% by 2050 and 48% by 2100 (from a baseline year of 2010), though oxygen projections strongly influence these expected increases[27], [56], [57]. But bigeye and albacore currently represent less than 10% of the total tuna catch[50].

The low abundance of albacore in the region means that even with projected future increases, it is unlikely that albacore could replace current catches of skipjack and yellowfin tuna. At the same time, there are other species, such as amberjack (*Seriola rivoliana*) and mahi mahi (dolphin fish) (*Coryphaena hippurus*), that also may increase in abundance[29]. It will be important that the Government of Palau develop flexible fisheries management policies to allow shifting of fishing effort to these and other abundant species as climate change impacts Palau's waters. Continual monitoring of fish species abundance will be essential to enable adaptive management.

3. The Foreign Fleet: Potential Consequences of PNMS Policies

Pelagic fishing in Palau's EEZ is currently conducted by foreign-owned fleets, principally from Japan and Taiwan. The PNMS policies make significant changes in the terms upon which these fleets are allowed to operate.

a) Current Composition and Fishing Activity

Purse seine vessels, primarily operating out of Japan, fish in Palau's waters approximately 200 vessel days a year (see section b for an explanation of the PNA vessel day allocation scheme for purse seine vessels). From 2014 to 2017, their annual catch ranged from 799 to 4,928 metric tons (mt); 80% of the catch was skipjack[59]. Catch is exported without landing in Palau[59].

Longline fishing levels have varied widely, ranging from ~2,500 to 10,000 vessel days (Figure 7A). A longline vessel day scheme through the PNA has not been formally established. Instead, longline vessel days are set annually by MNRET. Japanese longliner vessels operate out of Japan and do not land catch in Palau. The Taiwanese longliner vessels operate out of Palau and land catch in Palau, but then export 90% of their catch to international markets.

Most of the offshore fish in Palau's market are leftovers from locally operated vessels owned by two Taiwanese companies[47], [60], [61]. These companies provide 84–94% of all pelagic fish in the market[47], [60]. As large operations with access to the lucrative international markets for their higher-value fish, these foreign companies are able to take fish that is uneconomical to export and sell it in the Palau market at a low price. This low price, the foreign boats' economies of scale, and their dominance of the market make it difficult for small-scale fishers in Palau to sell their catch at a price that would cover their higher operational costs and provide compelling returns.

Figure 7.

Longline vessels activity can be tracked via Automatic Identification Systems (*globalfishingwatch.org/map*). The fishing effort within the boundaries of the PNMS can be estimated as the total number of vessel days, which represent the number of days that in total vessels spent navigating or fishing. Total number of vessel days spent by the (A) longline and (B) purse seine fleets within the waters of Palau from 2016 to 2018. Average monthly (2012-2019) vessel days (i.e. fishing and transiting) spent by each vessel class on every 0.05° X 0.05° cell for (C) longliners and (D) purse seiners. Yellow colors indicate more time spent by vessels in those areas but note that vessel days are counted regardless of whether ships were actively fishing or just navigating through a region. Colors are presented in a logarithmic scale. Data for 2019 include January to June. (E) Proportion of fishing activity that was spent by longline and purse-seine vessels within the Domestic Fishing Zone within Palau's EEZ between 2012-2018.

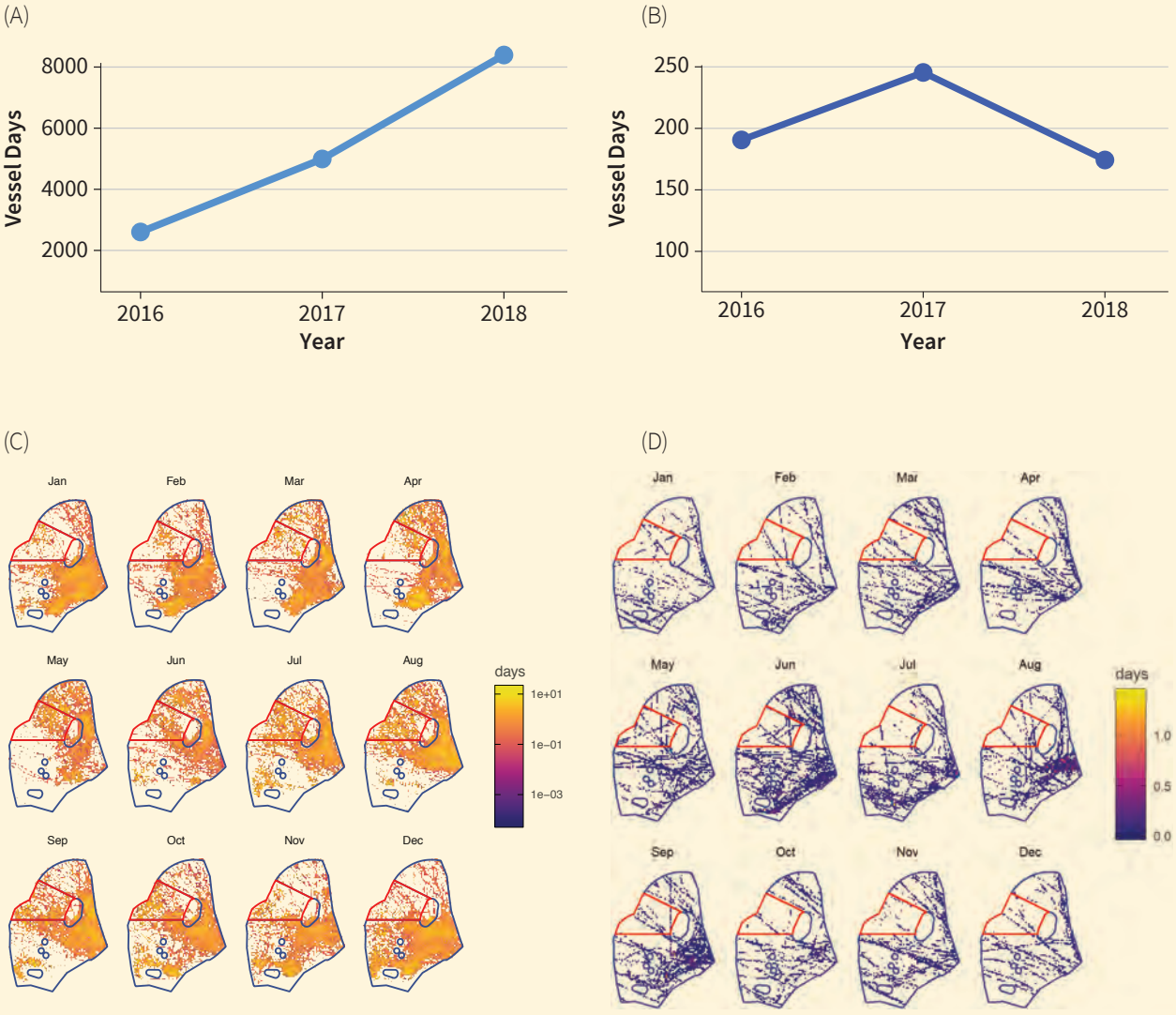
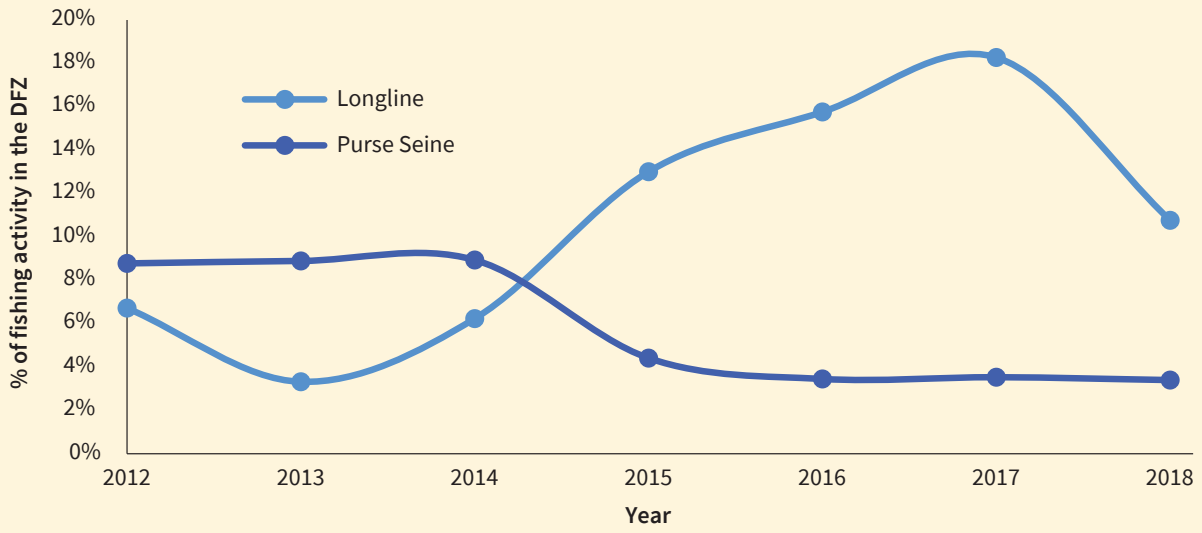


Figure 7, continued

(E)



The Japanese and Taiwanese longline fleets in Palau target primarily bigeye and yellowfin tuna. An analysis of their spatial distribution from 2011 to 2016 [62] shows that the Japanese fleet operates primarily on the western side of Palau's EEZ, moving from south to north from winter to summer. In contrast, the Taiwanese fleet operates primarily to the southeast of Palau. The Taiwanese-owned, locally operated fleet is based in Malakal, Koror, and its spatial range is limited to approximately 100–500 km from their homeport to save on fuel expenses. In contrast, Japanese vessels are equipped to routinely stay at sea for long periods of time, giving them more freedom to switch their fishing grounds as needed and the potential to better adapt after the full implementation of the PNMS.

b) PNMS Policies and Implications for Industrial Fishing

The PNMS policies change the opportunities and costs for industrial fishing operations in Palau. How the existing fleets respond to these changes will have implications for government revenues and, at least in the near term, for the supply of pelagic fish in the domestic market.

Changes to Fishing Provisions: Starting January 1, 2020, fishing in the EEZ will be allowed only in the DFZ, which constitutes 20% of the EEZ (Figure 1). Within the DFZ, the PNMS legislation designates a "Contiguous Zone," which is the waters between 12 and 24 nautical miles from Palau's baseline, comprising 2.2% of Palau's EEZ. The Contiguous Zone is open only to fishing vessels using pole-and-line fishing gear and to small-scale recreational vessels (Figure 1). Longline and purse-seine fishing are restricted to a Fishing Permitted Area (FPA),[4] which covers 17.8% of Palau's EEZ. It begins 24 nautical miles from Palau's EEZ baseline and extends to the western edge of the EEZ (Figure 1).

The PNMS legislation provides that only longline and free-school purse seine vessels may export their catch. They must land all catch before exporting, unless exempted by the MNRET. Pole-and-line and local small-scale fishers are prohibited from exporting their catch.

4 The Fishing Permitted Area (FPA) is a term coined by the Working Group for the purpose of this report to provide clarity about what activities are allowed in this area. In previous itierations of the PNMS map provided in the PNMS legislation, this area was labeled as Commerical Fishing Zone, but commercial fishing activities (i.e., pole-and-line and day boats selling catch commercially) can occur in all of the DFZ.

The legislation increases the export tax from $US0.35/kilogram (kg) to $US0.50/kg and expands its coverage. The tax now applies to all fish,[5] including tuna and billfish species, caught in Palau's waters and exported for commercial purposes, whether they are landed first in Palau or, under an exemption, taken directly to international markets.[6,7]

Quantification of Effort Displacement: It will be important to understand how effort within Palau's EEZ will be redistributed after the full implementation of the PNMS policies and the closing of 80% of the EEZ as a no-take zone. To address this question, we developed an analysis of fishing activity within Palau's EEZ, using publicly accessible data on the *Global Fishing Watch* platform that track the location of fishing vessels with Automatic Identification System (AIS) transponders[63]. These analyses focus on activities from 2012–2018 of two fleets of interest: longline and purse seine. Results highlight that the intensity and location of fishing effort varies significantly over the course of a year and from one year to the next, likely reflecting seasonal distributions of the resources, weather conditions, and distance from the shore or ports. Our analyses reveal, for example, that the areas most used by both longline and purse seine vessels are located to the east of Koror, the location of the country's port, and that these areas shift north and south throughout the year, probably following tuna distribution. Previous analyses, however, reveal that the Japanese fleet fished primarily to the west side of Koror, which is the closest to their home port in Japan[62].

The PNMS Act mandated that from December 2015 to December 2019 there would be a steady reduction in fishing activity inside the area to be included in the Sanctuary, preparatory to full closure in January 2020.[8] AIS data analyses show that longline fishing effort within Palau's EEZ increased from ~2,500 to 10,000 vessel days from 2016 to 2018 (Figure 7A). Purse seine vessels' effort varied, increasing to 240 AIS-estimated vessel days in 2017 and dropping to 160 AIS-estimated vessel days in 2018 (Figure 7B). Variations in effort revealed by these analyses may reflect a regional shift of tuna populations with the 2013/16 warm temperature anomaly[56]. It could also be a manifestation of "the blue paradox" described by McDermott et al.[64], who documented a spike in fishing effort just before the closure of the Phoenix Island Protected Area.

Analyses of the proportion of the total effort by longline and purse seine vessels in Palau's EEZ between January 2012 and December 2018 (Figures 7C, D, and E) indicate that the area now designated as the FPA has not been a primary target for fishing. Distribution of mean monthly vessel days between 2012–2018 by longliners (Figure 7C) indicates that only 10.6% of the longline effort was located inside the FPA (Figure 7E), although the FPA is 17.8% of the EEZ. Purse seine vessels were also more likely to fish in other parts of the EEZ (Figure 7D), with only 5.9% of effort, on average, in the FPA (Figure 7E).[9]

Given these historic patterns, we expect that both purse seine and longline fleets will reduce their total effort in Palau's waters after full implementation of the PNMS policies. Effort displacement might differ across different fleets. For example, Japanese longline vessels have historically spent some time fishing in the area soon to be the FPA (Figure 8), and therefore it may be easier for these vessels to relocate more of their effort there. In contrast, the Taiwanese fleet, based in Koror,

5 40 Palau National Code §1406 (amended by RPPL 10-35).

6 Note that the Minister is authorized to exempt some vessels landing all or some portion of their catch. It is unclear how the tax will be collected on catch directly taken to international markets. Verifying catch volumes through enhanced port surveillance will be important to prevent the underreporting of catch to avoid taxation.

7 Limiting fishing efforts in Palau's EEZ will likely lead to some losses in the government fishing-related revenues (e.g., reduced revenues from licensing fees, export taxation, and vessel day allocations through the PNA). To counter these losses, the PNMS legislation changed two policies: 1) the tourist departure fee, which increased from $US50 to $US100 and was renamed as the Pristine Paradise Environmental Fee (PPEF), $US10 of which goes directly to PNMS operations ($5 to PICRC for science, communications, and outreach and $5 to the Protection Trust Fund); and 2) the fish export tax, which was increased from $US0.35/kg to $US0.50/kg. Tracking revenues along with the cost of implementing, monitoring, and enforcing the PNMS policies will help reveal the effect of PNMS policies on government revenue.

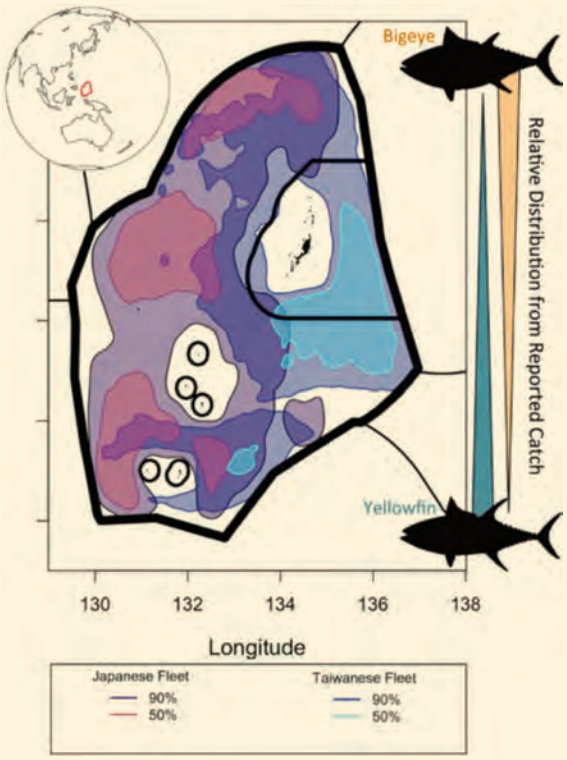
8 27 Palau National Code §161 (amended by RPPL 9-49)

9 Vessel data in Figure 7 includes only vessels that are more than 5 nm from shore or port. Vessel days include transiting and fishing time, as the PNA charge for both of these activities. Thus, some of the activity identified in Figure 7 may include transit, but given that vessels are charged for it, it is representative of the usage of Palau's EEZ and thus of potential usage after the implementation of the PNMS.

spent less time in the FPA (Figure 8), which indicates a preference for other portions of Palau's EEZ[62]. Thus, it is less likely they will relocate some or all of their effort to this new area. Instead, these vessels may spend more time in the high seas or fishing in Yap, which has recently opened its waters to longline fishing and as of yet does not impose an export tax. Following the PNMS full implementation in 2020, accurate assessments of effort displacement will require tracking boats that once operated in Palau to determine whether they fish in the FPA, in the high seas, or in other countries' EEZs (e.g., following the approach developed in[65]).

Figure 8.

The Palau Exclusive Economic Zone and regions fished by the Taiwanese and Japanese tuna longline fleets, with catch being mostly bigeye in the north and yellowfin in the south. The 90% and 50% contours represent the range and core of fishing location by fleet. The black polygon that surrounds Koror and extends to the east of the EEZ represents the original DFZ established by PNMS Act RPPL 09-49. The position of DFZ was amended to be on the west side of Koror by RPPL 10-35 in 2019 (see Figure 1). From Cimino et al. (2019).



Potential Consequences for Revenue from the Parties to the Nauru Agreement (PNA) Vessel Day Scheme: The PNA Vessel Day Scheme (VDS) allocation to Palau for purse seine vessels is the largest source of fisheries revenue for the government, generating $US5.9 million in 2015. So, a key question is how closing 80% of Palau's EEZ to fishing would affect Palau's Party Allowable Effort (PAE) for purse seine fishing.

Under the VDS, a country's allocation of days (i.e., PAE) is determined every year through a flexible formula—40% of a country's allocation is based on the proportion of regional tuna biomass that is found in its waters over the previous seven years; 60% is based on total fishing effort in its waters in that period. Under this formula, Palau has received an allocation of 547 vessel days per year (average between 2010–2012), representing 1.8% of the total allowable catch for the PNA[66]. Most of this allocation comes from biomass distribution (1.6%), while the rest (0.2%) comes from the relatively low effort in Palau's waters. Thus, although purse seine fishing effort is likely to decrease with implementation of the PNMS policies, as discussed eariler (see *Quantification of Effort Displacement*), even if fishing effort were to decrease by 80% in proportion to the closing of the Sanctuary as a no-take zone, the PNA allocation would decline by less than 10% under the current formula. This would mean the PNA allocation would change from 1.8% to 1.6% over 7 years, representing a total loss of $US0.54 million per year relative to the $US5.9 million generated in 2015. Overall, the loss of $US0.54 million per year would be a minimal reduction in government-related fisheries revenues.

Potential Consequences for Food Security: The locally operated Taiwanese fleet currently supplies most of the pelagic products available in the domestic market. Once the PNMS policies are fully implemented, it may no longer be economical for those vessels to operate at the same level or to provide the same volume of fish for the local market[66]. For example, if, in response to the PNMS policies, the vessels spend more time on the high seas, they are likely to take fewer trips per month, reducing their overall catch, which could lead to less catch entering Palau's domestic market. However, there are no publicly available data that could form the basis of an economic assessment to predict how the Taiwanese fleet will respond.

Any reduction in the supply or increase in price of pelagic fish in Palau's market could shift consumers to eating more reef fish and/or more processed foods. Therefore, at least until there is a reliable supply from the domestic pelagic fishery, it will be important to develop strategies to ensure a constant supply of pelagic fish.

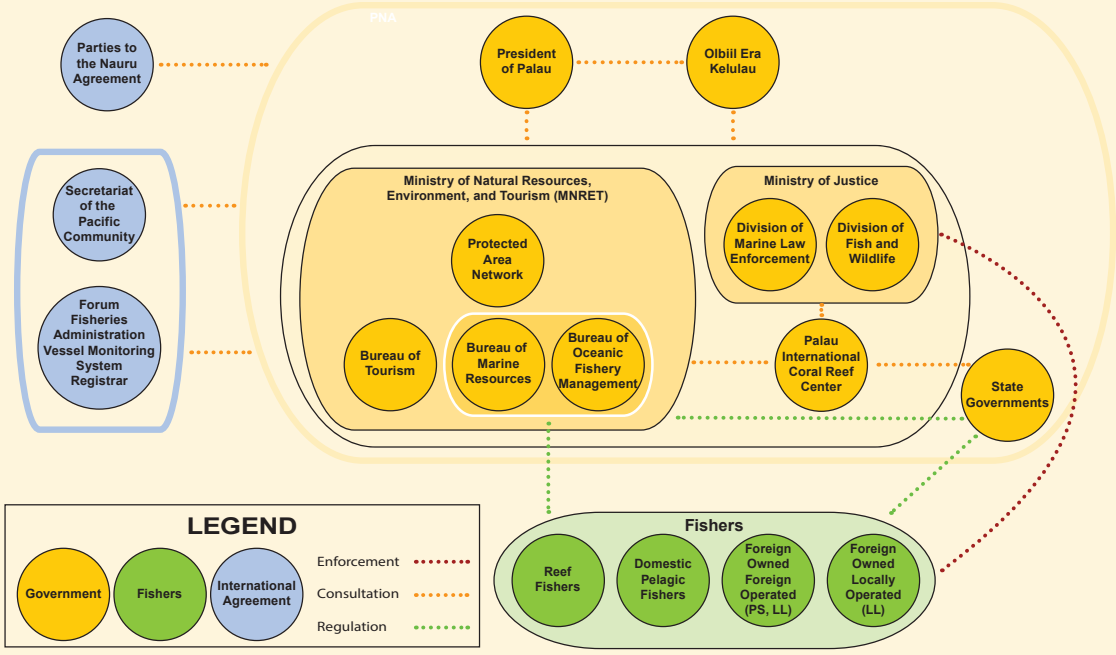
The Government could take a range of policy measures to maintain the supply of pelagic fish in the short term, while also pursuing a long-term strategy for its its domestic pelagic fishery sector. One option to maintain pelagic supply would be to require that a minimum portion of catch from the foreign fleets, based on assessment of local needs, be retained in Palau for the domestic market. The Government could also consider a temporary reduction of the export tax, which will increase by 40% (to $US0.50/kg) in 2020, for vessels that land their catch in Palau. If pelagic supply from foreign fleets is still uncertain, Palau should consider importing pelagic fish from other countries within the region. These options could be simultaneously implemented with policies that support domestic, small-scale fishers targeting pelagic species in the near term, such as guaranteed purchasing of catch and the development of a temporary retail marketplace, while longer-term initiatives for the domestic pelagic fishery develop.

4. Demand and Supply in the Current Domestic Pelagic Fishery

A major goal of the PNMS policies is to support the development of a robust domestic pelagic fishery sector to secure a consistent supply of pelagic fish in Palau's market while supporting Palauan livelihoods. Currently there are many government, nonprofit, and private sector entities working together to promote Palau's domestic pelagic fishery sector (Figure 9). They face many challenges, however. Domestic demand for pelagic fish is modest. There are only a few pelagic

Figure 9.

Major entities and organizations for fisheries governance in Palau.



fishers, and they face many obstacles to developing pelagic fishing as a full-time business. Here we detail current levels of demand, describe the existing domestic pelagic fishing sector, and evaluate some challenges for developing a domestic pelagic fishery.

a) Current Status of Domestic Market for Pelagic Fish

Palau's current domestic demand for pelagic fish ranges from 170–231 metric ton(mt)/year[26] [47], which is equivalent to the annual catch of approximately 1–4 standard longline vessels. Restaurants buy most of the pelagic fish on the market, purchasing 107mt/year of tuna and 10mt/year of other pelagic fish (mahi mahi, wahoo, marlins, and swordfish)[47]. Other major buyers of pelagic fish include grocers, caterers, and prepared food stores. Of the approximately 45mt of pelagics caught by small-scale fishers per year, approximately 43% (19mt) is sold to restaurants, a fishing cooperative, and the fish market[26]. The remaining 26mt of local fishers' pelagic catch is consumed for subsistence or shared informally.

Tourists consume about two-thirds of all the pelagic fish sold commercially, 109–118mt/year, while residents consume around 54mt/year of commercially available pelagic fish, from restaurants, prepared food stores, caterers, and supermarkets[47].

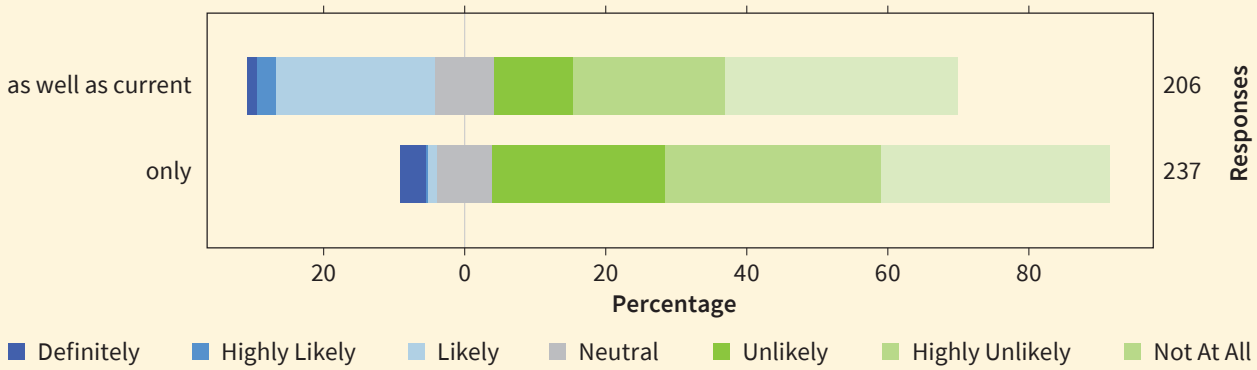
An examination of tourists' preferences via a choice experiment[47] found that pelagic and reef fish are close substitutes and that if pelagic fish is unavailable or more expensive tourists will consume more reef fish. However, tourists are also willing to pay a considerable price premium (on average $US10 more per meal, corresponding to a 67% increase to the average pelagic fish meal price of $US15) for pelagic fish sourced locally and fished in a sustainable manner. This willingness to pay could be leveraged to shift demand toward local, sustainable pelagics and support the development of Palau's domestic offshore fishery sector.

b) Palau's Small-Scale Pelagic Fishers: Capacity and Barriers

There are very few fishers in Palau who currently fish offshore. There are no Palauan-owned industrial boats—either longline or pole-and-line. Only a handful of small day boats fish beyond the nearshore waters. MNRET is currently assessing the number of fishers targeting pelagic fishes. Unpublished data[67] provide a boat inventory for the two most populous states (Airai and Koror)—an insight into the current boat infrastructure for Palau's domestic pelagic fishery. In Airai, 28 boats were registered in 2017, with an average boat length of 26 feet (ft) and 145 horsepower (hp) engine; six of the boats had twin engines. In Koror, 451 boats were registered in 2017, with an average length of 29ft and 170hp engine; 271 boats had twin engines. Overall, Palau's available boat inventory consists of small boats that are not ideally designed for industrial or pole-and-line fishing.

Figure 10.

Fisher responses to their willingness to fish for tuna and pelagic fish as well as their current targeted catch (reef fish) or only tuna and pelagic fish. Data from James and Ueda (2018).



Most fishers in Palau are reluctant to shift to pelagic fishing. In a survey of 388 fishing households (sponsored by The Nature Conservancy and SPC)[68], only 5% said they were willing to target pelagic fish exclusively. Twenty-five percent of respondents said they were willing to fish for tuna or pelagic fish as well as reef fish. Most respondents were not willing to fish for tuna or pelagic fish as well as reef fish; 30% said they would not fish for pelagic species under any circumstances (Figure 10).

A survey of fishers participating in a sport fishing derby[67] found that the biggest barriers that keep fishers from entering the pelagic fishery in Palau were: 1) the lack of a reliable place to sell their offshore catch (57%); and 2) the cost of fuel (66%).[10] When asked how much the price of fish and gas need to be for respondents to double the frequency of their fishing trips, the average price for fish would need to be $US25/kg (as compared to the current average $US8.82/kg), and the average price of gas would need to be $US2.75/gallon (as compared to $US5/gallon).

Average trip data and operational costs for the 38 offshore fisher respondents were collected[68], [49] and compared to the reef fisher respondents' costs. The average hours per fishing trip (8) and trips per week (2) spent fishing were the same for reef and offshore fishing, but the average operational cost per trip was 35% higher for offshore fishing ($US133 per trip versus $US86 per trip), largely due to higher fuel costs. Generally, pelagic fish are sold for higher, though more varied, prices (from $US4.41–$US11.00/kg) than reef fish (an average of $US6.61/kg), and pelagic fishers catch a higher average weight of fish than reef fishers (80.74kg vs. 47.17kg). Thus, pelagic fishers have a higher profit per trip ($US66–$US198 per median trip) than reef fishers ($US52–$US79 per trip), suggesting offshore fishing could generate higher revenue.

Although on average offshore fishing yields higher returns, the costs are also high, and fishers, especially from poor households, may therefore be more reluctant to take the risk of bad fishing days. Of the surveyed households[49], 25% were living near the poverty level, with higher levels in rural communities (e.g., 45% in west Babeldoab). Thus, many fishers are vulnerable, and their ability to adapt to change could be low.

Finally, it is important to recognize that fishers' decisions are not purely market-based decisions. As noted above, small-scale fishers sell less than half of what they catch, consuming or informally sharing the rest[47].

5. Prospects and Challenges for a Domestic Pelagic Fishery

Developing a domestic pelagic fishery (DPF) is difficult. There are significant challenges in each of the possible models: industrial longline or pole-and-line, and small-scale day boats. Here we first consider the steps that will be important to building a market for pelagic fish, and then the specific challenges in each approach.

a) Building a More Robust Domestic Market

Not matter what approach is taken, if Palau is to build a stronger domestic pelagic fishery sector, it will need to take measures to create infrastructure to support that fishery, to build the demand for pelagic fish, and to increase the potential economic returns.

Infrastructure that enables fishers to sell their fish was identified as a major obstacle[47]. To build a domestic pelagic fishery, Palau needs a physical, central marketplace that brings domestic fishers and buyers together. A comprehensive cold chain—actions or equipment that maintain high product quality from harvest to consumption—is also essential. Buyers are currently unwilling to buy large quantities of offshore fish because they do not have adequate cooling facilities to keep the fish fresh. As a result, restaurants are often reluctant to list offshore fish on their menus because supply is unreliable. Thus, a complete cold chain—on boats and onshore—allows reliable, year-round supply. It also allows fishers to preserve the quality of their fish and therefore to get higher prices, domestically and perhaps eventually in international markets[67]. A cold chain must include refrigeration onshore. It should also include cold storage on boats, so that fish do not spoil before they return to port. It will thus be important to address the costs of storing fish on ice at sea in small vessels and to provide training to fishers on handling

10 Fishers were not asked if low market price was a barrier in this survey, although follow-up interviews revealed low market price as a barrier.

fish onboard to preserve quality. Many residents, local business owners, and even fishers noted that they were not confident they could recognize high-quality tuna, suggesting there is also a need for training and raising awareness across the value chain[47].

Domestic demand for pelagic fish is modest and may not offer the economies of scale needed to make pelagic fishing a financially viable endeavor. Increasing demand could help this calculus and also yield public health benefits. Several recent efforts in Palau have focused on increasing demand for pelagic fish and decreasing demand for reef fish. Public campaigns to encourage pelagic fish consumption may be able to shift behavior by educating consumers on the environmental and health benefits of pelagic fish consumption, presenting pelagic fish as a tasty and healthy option, and providing information about preparation techniques and inspiration for recipes. Campaigns will also need to provide guidance on safe consumption levels of pelagic fish for vulnerable groups, such as women of childbearing age, pregnant women, and children. For adults already consuming healthy levels of fish, pelagic fish should replace some proportion of reef fish consumption. For Palauans currently not consuming fish, pelagics must compete with substitute foods in terms of availability and price. Value-added processing, discussed in section *Thinking More Broadly*, can also help make pelagic fish products more convenient, easing use and increasing shelf life.

As noted in the *Current Status of Domestic Market for Pelagic Fish* section, tourists consume a majority of the commercially-available pelagic fish. A full or partial ban on sale of reef fish in restaurants would help expand that part of the market. Also noted in the same section, tourists also value pelagic fish caught locally and in a sustainable manner, so another option to improve the financial returns to pelagic fishing would be to create a label for a local, sustainable brand of pelagic fish and to educate tourists about the fish they are buying to capture their willingness to pay. An added benefit of this approach is that it may help persuade tourists to choose pelagic meals even if meal prices rise. Furthermore, if these returns are funneled to local pelagic fishers, the local, sustainable brand could provide much-needed funds to stimulate the domestic pelagic fishery.

Development of a domestic pelagic fishery is also constrained by the limited economic returns. One key option the Government should consider is whether to allow domestic fishers to access international markets. The PNMS legislation bans the export of fish caught in Palau's waters, except for catch from free-school purse seine or longline vessels. That means that local fishers who own smaller vessels will not be able to export and get top prices for high-quality fish sold in Japan and other markets. Even though exporting is not profitable for local fishers at this time, if the local fishery is to expand and be sustained, lifting or relaxing the export ban and providing necessary capacity building would eventually help local fishers further develop their businesses.

b) Prospects and Challenges for Industrial Fishing

Many island nations in the western Central Pacific have tried to create a domestic industrial pelagic fishery[63], [64].[11] The PNMS legislation makes special provisions for pole-and-line fishing, establishing the Contiguous Zone of its Northern Archipelago as an area where other forms of industrial fishing are not allowed. While Palau had pole-and-line operations until the 1980s, none exist today[69], [70]. A 2019 rapid assessment outlined the options for revitalizing pole-and-line fishing operations in Palau, and this included purchasing/renovating a pole-and-line vessel, training fishers, and acquiring gear[69]. Gillett described Hawaii and Palau's pole-and-line operations as "the unprofitable last remnants of fishing fleets in a classic decline," arguing that emotional attachment to the vessels rather than profitability was the main reason why the pole-and-line fishing had continued[71]. Pole-and-line fishing requires eight to nine times more labor than purse seining

11 To derive more benefits from such resources for their people, several Pacific Island Countries and Territories (PICTs) began domesticating industrial fishing in the 1990s by investing in onshore port and processing facilities and their own fleets[88], [89]. Most countries have also encouraged foreign companies to base themselves locally for employment and tax benefits[90]. Attempted in at least eight geographies and in various forms of public and private, national, and international investment, development of domestic tuna enterprises has resulted in more failure than success[88], [90], with the most relevant examples for Palau being from Cook Islands[90], Fiji[89], [91], Solomon Islands[92], and Marshall Islands[90].

and thus could be seen as a job generator. However, high labor costs, the costs (and ecological impacts) of catching bait, and high fuel use make it very difficult to see a profitable path. Therefore, fisheries management and government investment efforts should be directed, at least in the near term, toward supporting the existing small-scale, day boat fishers and ensuring they have access to the training, safety gear, and infrastructure to sustain and grow their businesses.

c) Prospects and Challenges for Small-Scale Fishing

Developing a small-scale domestic pelagic fishery may have more potential in Palau than developing a domestic industrial pelagic fishery. As outlined in the *Palau's Small-Scale Pelagic Fishers: Capacity and Barriers* section, there are significant challenges—many Palauan fishers are simply not interested in fishing beyond the 12 nautical mile limit, and the economic case is currently not compelling. Success will require the measures to build a more robust domestic market, as previously described, and additional measures to meet the specific challenge of small-scale fishers.

Reflecting on the past 40 years of small-scale tuna development in the Pacific Islands regions, a recent SPC/Food and Agriculture Organization of the United Nations (FAO) consultation identified important lessons for sustaining a small-scale tuna fishery[72]. Given the interplay of different sociocultural, economic, logistical, and environmental drivers, the success or failure of small-scale tuna fishery development is highly dependent on the local context[72]. For that reason, government interventions should be piloted for thorough practical and economic analyses, including seeking advice from other countries. In particular, subsidies should be instituted only after cost-and-benefit analysis and then reviewed periodically. In addition, little chance of success exists for government interventions that introduce new vessel designs and/or engines, as these would require substantial investments in long-term technical assistance programs and wide support from fishers. Venturing offshore comes with significant safety risks, so governments should develop and maintain safety programs. FADs can be an important tool for development of small-scale pelagic fisheries; a FAD network should be well funded and maintained by a national program. Governments should also recognize that most benefits from small-scale tuna fisheries go to men, while the contributions of women to the fisheries are substantial. Governments should therefore develop mechanisms to engage women in the fisheries at individual, family, business, and policy levels. Finally, government agencies should establish and improve methodologies for collecting and tracking catch and socioeconomic data from small-scale tuna fishers to more effectively manage the fishery.

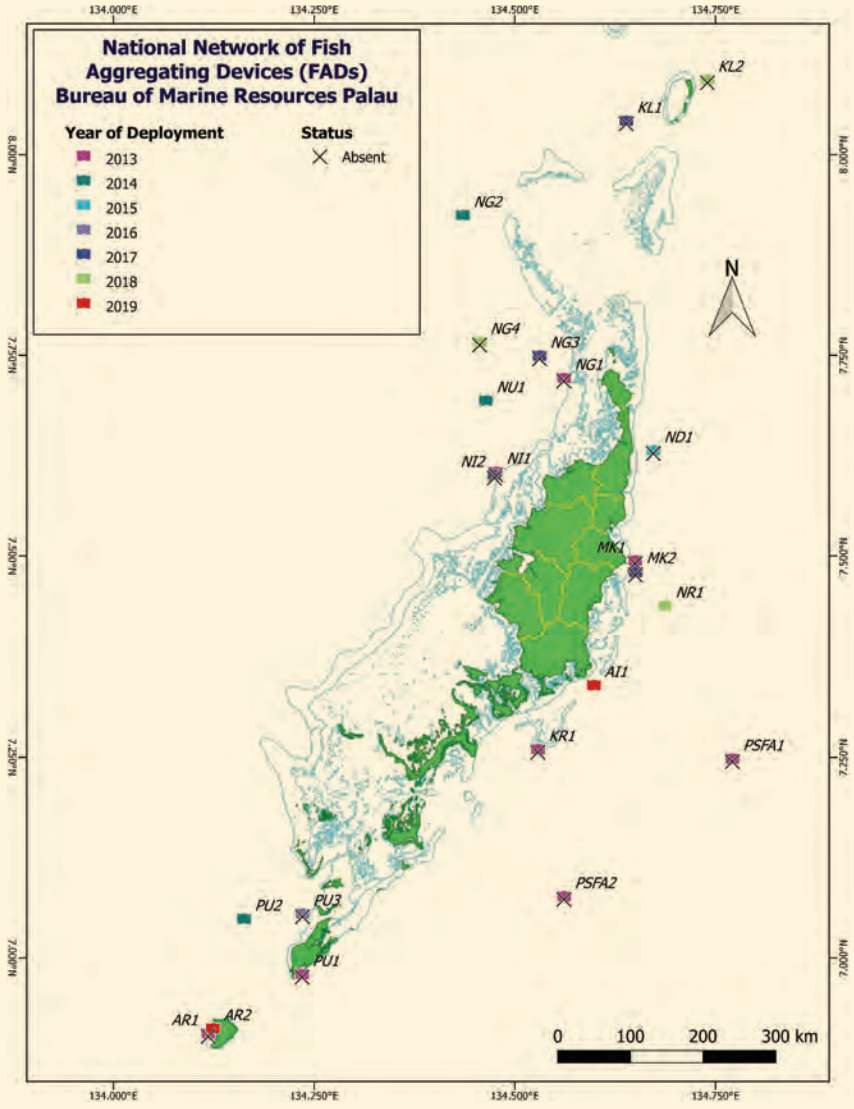
To address the specific challenges faced by small-scale fishers, the Government will need to take action to help them move into pelagic fishing. These measures could include a carefully designed startup package that helps them acquire safety gear and fishing gear, provides training for fishers, supports prices, and/or defrays operational costs, as well as a benefits package that provides fishers with services similar to government employees (e.g., retirement, sick leave). Support to provide equipment and boats must be carefully controlled to ensure that these capital investments are not used to expand reef fishing.

Despite the inherent risk of traveling farther offshore, fishers often do not make the costly investments for safety equipment. Thus, government programs should prioritize providing fishers with safety equipment and training them to use the equipment properly. Otherwise, offshore accidents, avoidable with proper safety equipment, would deter fishers from offshore activities. Next, as described in the earlier section *Palau's Small-Scale Pelagic Fishers: Capacity and Barriers*, offshore fishing has higher operational costs than reef fishing, and the selling price has higher varability than for reef fish. Policies that would support stable prices and help fishers with the high operational costs would likely incentivize fishers to spend more time fishing offshore. Finally, fisher reluctance to fish full time is further exacerbated by the lack of long-term benefits (e.g., retirement) many Palauans enjoy from government jobs. Thus, government policies that would provide fishers with these types of benefits could be motivation for part-time fishers to transition over to full-time effort.

In addition, as highlighted in the lessons from other countries, a functioning network of FADs can help fishers more easily find fish. Beginning in 2013, Bureau of Marine Resources (BMR) has installed 20 FADs (Figure 11) to

Figure 11.

Map of Palau's deployed FADs. Note that FAD status is as of September 2019 but a significant number of FADs have since been reported missing. Map from Palau Bureau of Marine Resources (2019).



support artisanal fishers in capturing large pelagic fish. Unfortunately, in 2019 a survey revealed that some of the FADs have been lost, indicating that maintaining a FAD network will require sustained effort in monitoring, maintenance, and timely replacement. Still, it has been demonstrated by other countries that FADs have the potential to increase fish production and reduce costs for fishers[73]. Therefore, if Palau can design a strategy to place, monitor, and maintain the FADs, there is an opportunity to use them to develop a domestic pelagic fishery.

Development of a sustainable small-scale pelagic fishery will also require collaboration among government entities, nonprofit organizations, and stakeholder groups to nurture a fleet. Some promising efforts are underway in Palau, including Palau Conservation Society and The Nature Conservancy's "Choose Pelagics" program. Some of the partners in this initiative include BMR, the Ministry of Education, the Ministry of Health, the Ministry of Community and Cultural Affairs, Palau Community College, Palau Visitors Authority, and Palau Sports Fishing Association. The objectives of this program include:

1. Collecting data on current pelagic fishing practices and landings by Palauan fishers
2. Supporting the national-level commitment to choose pelagics over reef fish to be served in any government function and food service systems
3. Creating a supply chain and market strategy that will help local fishers to sell their pelagic catch without competing with industrial fishing companies
4. Jump-starting long-lasting shifts of society's demand for reef fish toward tuna and other pelagic fish by:
   a. Recruiting and training young and interested fishers
   b. Shifting consumers' preference to tuna and other pelagic fish
   c. Building awareness about the environmental benefits of eating pelagic species

6. Thinking More Broadly

It is important to note that Palau could capture more value from its fisheries without developing a new domestic pelagic fishing fleet. Opportunities exist across the entire value chain—including fish processing and value-added products—to increase the benefits of the existing domestic pelagic fishery for economic development, livelihoods, and food security. For example, if Palau required that a proportion of fish caught in its waters be landed and processed prior to export, it could stimulate an onshore industry.

There may be potential in development of value-added products, such as fish loins, dried fish, and jerky, which could create opportunities for employment and sales, without trying to establish a major canning operation.[12] Such products would have nutritional benefits to Palauan residents in addition to potential for tourist and export sales. Emerging efforts have demonstrated an interest by the tourist-focused retail sector for the opportunity to develop a local, sustainable brand and marketing of such products in addition to fresh products with this branding (see Section 5 on *The Prospects and Challenges of Creating a Domestic Pelagic Fishery*). Thus, policies should support economic opportunities across this sector. A market analysis could guide possible development in this arena, building on numerous market demand studies[47], [60], [68]. These value-added opportunities are only viable, of course, if Palau can sustain a supply of fish, whether from the existing industrial fleet or from an expanded domestic fishery.

7. Further Analysis

There are robust data on Palau's fisheries that were not available to this Working Group. Palau's national authorities have access to data from the FFA Trackwell and the Regional Surveillance Picture, which give both historical and near-real-time information on vessel activities. These data come in the forms of the FFA Vessel Monitoring System (VMS) data, AIS data, and the Western and Central Pacfic Fisheries Commission (WCPFC) VMS data. It will be important to work with these data: (1) to develop a better understanding of the economics of the current foreign fleets, how they are likely to respond to the PNMS reforms, and what policy measures are needed; and (2) to assess the options for development of the domestic pelagic fishery sector.

The Working Group recommends that a formal collaboration is established between MNRET and the Ministry of Finance (MOF), and that the existing collaboration with FFA and SPC continue in order to facilitate analyses predicting and tracking impacts of the PNMS. These collaborations are vital opportunities to assess how the PNMS policies will affect commercial fisheries costs and vessels' profitability. It will also be important to access other data sets, such as data on airline cargo revenues, to better understand export flows and trends.

12 Many coastal nations have pursued tuna canning for export—more than 40 tuna canning facilities exist in 10 different nations in the Western and Central Pacific[93]. In Papua New Guinea, these facilities have created upwards of 7,000 jobs[94]. However, these facilities have high capital costs and operational costs, including labor and electricity. Additionally, limited total production capacity and a potential for surplus processing capacities in the region that could lead to competition[93] potentially decrease the benefit of this value-add. Finally, in some places with tuna canning facilities, local people have increased their canned tuna consumption[94], which is somewhat contrary to the benefit of the PNMS in delivering fresh fish to Palauan residents.

IV. Effective Implementation

Experience from designing and implementing large-scale MPAs from around the world demonstrates that successful implementation depends upon a robust and deeply participatory process, supported by strong monitoring and ongoing research. The early development of a strategic plan for the PNMS, initial follow-up actions, and stakeholder engagement activities are key building blocks. Going forward, there are key opportunities to better incorporating human dimensions into decision making for the PNMS, building stakeholder buy-in, and tracking the management process.

The first key opportunity is to incorporate science, monitoring, and evaluation into the PNMS governance, implemented by the Ministries involved, PICRC, and other stakeholder organizations. In addition to tracking performance, informing future directions, and disseminating information, this process can aid in building trust among management and stakeholder bodies and smoothing the path for successful implementation. Another key element for success and sustainability in the long term is coordinating present and future research and montioring efforts of local, regional, and international scientific, nonprofit, and government organizations. Ultimately this coordination can lead to complementary research and monitoring efforts, as well as provide effective means to inform the evaluation of the PNMS management processes and outcomes and identify knowledge gaps.

1. PNMS Design and Planning Process as of 2015

In 2015, Palau's Olbiil Era Kelulau (OEK) passed Republic of Palau Public Law (RPPL) 09-49 and established Palau's National Marine Sanctuary to be fully implemented in 2020. The Act provides that *"The Palau National Marine Sanctuary is managed in a collaborative, inclusive and responsive process enabling the delivery of all of its benefits."* The PNMS strategic plan, developed in 2015 by a stakeholder group, articulates clear goals and objectives, which provide a critical benchmark for assessing effectiveness[74]. This plan recognizes stakeholder engagement as integral for success, as demonstrated by the fundamental stakeholder engagement principles and actions woven throughout the plan.

Under the strategic plan, a communication and outreach plan is being executed by PICRC staff (1.1.1b), a cornerstone for effective large-scale MPA management[1], and is being applied via activities such as town hall meetings and social media coverage (1.1.3a). In May 2019, PICRC hosted a PNMS stakeholder workshop, with 38 people representing 20 agencies and organizations. A second, larger event entitled "Allow the Ocean to Sustain Us" was hosted in August 2019 by the National Environmental Protection Council. This stakeholders' dialogue brought together 165 attendees to learn and exchange information about Palau's ocean conservation efforts, including clarifying policy, research, and management questions about planning and implementation of the PNMS policies to date and ideas for next steps. These participatory events are a solid foundation upon which to build.

The PNMS strategic plan envisions additional measures to ensure an inclusive process. Objective 2.1 states that the "The PNMS has a strong culture of informed decision making based on scientific and social findings," then lists several tasks for reaching that aim. In particular, Objective 3.4, that "PNMS management performance is reviewed and evaluated and routinely shared with all stakeholders" specifies an opportunity for stakeholders to co-design monitoring frameworks and to assess ongoing effectiveness and inclusivity of implementation processes. Further, the PNMS amendments have established PICRC as the new authority for executing communications and outreach, MNRET as the overall authority establishing new rules, and MOJ as enforcing those rules, all of which will require engagement across stakeholder groups to prevent confusion and facilitate buy-in.

2. Best Management Practices for Implementation of the PNMS Policies

A significant challenge for large-scale MPAs designated for far offshore waters, such as the PNMS, is that socioeconomic benefits common to nearshore MPAs are more tenuous[75]. For example, livelihoods of current coastal fishermen would not be directly influenced by the PNMS, at least in the short term. Similarly, tourism-related economic improvements are anticipated but uncertain. Thus, this Working Group identified a need to provide a distillation of the most pertinent best practices of existing large-scale MPAs and guiding management considerations in advance of full implementation of the PNMS policies.

Integrating human dimensions into conservation management generally, and for large-scale MPAs in particular, is central for positive ecological, economic, and social outcomes[76]. Large-scale MPAs with greater stakeholder involvement (e.g., Great Barrier Reef Marine Park), tend to have more successful management outcomes[77], [78]. Further, failure to incorporate social, economic, and cultural considerations into large-scale MPAs can undermine success and lead to significant conflict and resistance[78]. Unresolved conflicts are in fact a significant contributor to failure of MPAs[1]. In practice, however, accounting for the human dimensions of large-scale MPAs through participatory decision making is often delayed or replaced by top-down processes[75].

Based on a series of discussions and input from in-country experts and stakeholders, the following narrative focuses on the four most relevant management practices of large-scale MPAs as they apply to the purpose, status, needs, and cultural context of the PNMS policies.

1. **Effective public and stakeholder engagement:** Effectively addressing stakeholder rights, including those of indigenous and local communities, is cited as a top challenge of large-scale MPAs[1] in large part because of the logistical complexities of adequately engaging constituents of massive seascapes for decision-making needs.
2. **Institutional transparency:** Openness in policy and decision making throughout large-scale MPA planning, implementation, management, and evaluation lends credibility to management authorities and can reduce the potential for misinformation.
3. **Conflict management and resolution:** Due to the sheer size and scope of the socio-ecological dimensions of large-scale MPAs, potential for discord among management, economic, user group, and sociocultural sectors is high[79].
4. **Maintenance of livelihoods and wellbeing:** Large-scale MPA management authorities can achieve more effective outcomes by striving to understand and connect the importance and existence value of the large-scale MPA to the daily lives and social wellbeing of stakeholders and the public[76]. Identifying and maximizing tangible social benefits can be the deciding factor in public support for MPAs[80], [81].

The most salient components of each theme gleaned from large-scale MPA literature are considered in the Appendices, with a more in-depth assessment of stakeholder engagement, as it is inextricably linked to the other three to achieve effective management. For the above practices to be impactful, each of these themes will need to be tailored to Palau's specific context.

Given the impending implementation timeline of January 2020 and that the planning phase and effective stakeholder processes take time and resources, the following actions should be considered as soon as feasibly possible. These actions are categorized by the four themes discussed above. If undertaken as implementation takes shape, it is possible for meaningful engagement to occur, conflicts to be avoided or resolved, and stakeholder support to be cultivated.

a) Effective Public and Stakeholder Engagement

- **Establish a stakeholder advisory group and process for meaningful participation in adaptive management of the PNMS policies.** Identify key stakeholder groups (e.g., fishers, government resource managers, traditional and state government leaders, community members, Non-governmental organization (NGO) entities) and allow each group to nominate a representative to directly participate as

a means to advance outreach, communications, and evaluation activities of the PNMS implementation.

- **Design a robust communication and engagement plan** to establish transparency and mechanisms for conflict resolution, and to disseminate measured outcomes for evaluation. PICRC, as the new PNMS management authority, needs an adaptive communication and engagement plan designed for its particular stakeholders, to be modified as needed over time. Regularly share monitoring data in an appropriate format with stakeholders to ensure transparency.
- **Develop a platform (e.g., via a designated, inclusive advisory group) for meaningful participation in adaptive management of the PNMS.** Opportunities for review and adaptation as implementation occurs are key for ensuring long-term sustainability and buy-in. Social and ecological monitoring should be participatory, and monitoring results should be available for stakeholder review and interpretation.

b) Institutional Transparency

- **Reflect on the process to date, acknowledge missteps, and commit to improvements.** A first important step would be a brief, honest recognition and message about a course correction.
- **Develop and execute a science coordination plan to capture and track the various research and monitoring activities underway** by local, regional, and international scientific, nonprofit, and government organizations.
- **Develop institutional frameworks for the various implementing government entities** and their coordination (i.e., MNRET, PICRC, MOJ, MOF) that outline mechanisms for across- and within-agency coordination and ways to incorporate results from science, monitoring, and evaluation efforts.
- **Communicate measured outcomes.** Development of clear key messages about process and outcomes is essential, through consultation with the diverse, targeted group of public and stakeholder representatives, including users (tourism and seafood business leaders, fishers, etc.), elected officials, cultural leaders, educators, and youth. Include feedback mechanisms as part of the process to allow for stakeholder input.

c) Conflict Management and Resolution

- **Design a conflict resolution plan.** A process that identifies likely conflicts and allows for timely, objective, and context-appropriate mediation/resolution should be developed and applied when needed. Essential elements include training and leadership development for staff involved in executing the PNMS policies, and participation of a third-party facilitator at critical junctions.

d) Maintenance of Livelihoods and Wellbeing

- **Create a stakeholder engagement process to define how the PNMS policies align with stakeholders' livelihood- and wellbeing-related values and objectives.** Opportunities should be provided for stakeholders to express their interests and expectations around health and welfare benefits to be derived from Palau's oceanic resources. Management authorities should respectfully acknowledge and respond to such statements.
- **Co-design monitoring frameworks to assess progress toward livelihood and wellbeing objectives in comparison to local values.** Actions under Objective 3.4 of the strategic plan mandate this approach, but the outcomes will ultimately be determined by the nature of the co-design process (i.e., in terms of whether it is truly participatory).
- **Integrate traditional and local knowledge and local experience to assess the effects of the PNMS policies on livelihood and wellbeing.** The goal of such activities will not be to convince the Palauan citizenry of the merits of the PNMS legislation, but rather will serve as listening sessions with real impacts on future PNMS policies and monitoring activities.
- **Develop and execute a monitoring and evaluation plan that includes tracking of livelihood and wellbeing effects of the PNMS legislation.** Assessing impacts requires tracking key, culturally relevant process and outcome indicators regularly (such as those identified in the science, monitoring, and evaluation plans). Notably, such social and economic assessment should be conducted in parallel with ecological monitoring.

3. Science, Monitoring, and Evaluation

a) Purpose for the PNMS

Science, monitoring, and evaluation will be essential to supporting the implementation and operationalization of the PNMS policies. Scientific research into the social, economic, and ecological impacts will be essential for understanding how the legislation shapes Palau in the future. The goal of monitoring and evaluation (M & E) is to take the "pulse" of programs, policies, and projects and to determine whether desired impacts are being achieved. Ultimately about improving management effectiveness and increasing the probability of success, M & E uses multiple context-appropriate participatory and nonparticipatory methods and collects both quantitative and qualitative information. Further, it is about fostering self-reflection within governance and management institutions and staff, and creating opportunities for dialogue between the PNMS staff and stakeholder groups. Ideally, such a plan includes both process and outcome indicators, undergirded by scientific research. And while M & E focuses on collecting information, it is ultimately about bringing people together to assess implementation, to learn, and to adapt management accordingly.

b) State of the Art for Conservation Planning

M & E is a fundamental component of effective project management, key to the effective delivery of overall goals. A range of monitoring and evaluation approaches have been developed and applied in conservation management, international development, and other fields, leading to many practical examples and a range of approaches[82]. For example, status assessment, management reviews, and performance measurements are well established processes in many projects and programs. These tend to focus on the assessment of management measures as input variables (i.e., financing), activity variables (i.e., meetings), and output variables (i.e., reports).

While this has some value and is relatively easy to monitor and measure, impact and outcome evaluation is more effective for informing management and ensuring that implementation is on track. This shifts the focus to whether a program is effective in meeting its overall goals and provides a results-based lens through which management authorities can enhance positive and minimize negative effects. An impact and outcome process can be deeply sensitive to cultural norms and values when the M & E process is co-designed by local stakeholders with the tacit and indigenous knowledge required to evolve culturally and institutionally appropriate process indicators. In fact, a recent *Pacific Monitoring, Evaluation and Learning Convening* took place in Fiji, as a starting point for a collective commitment to an M & E approach for sustainable development.

The implementation of the PNMS will influence, and be influenced by, intended and unintended effects of a broad array of conservation and development measures, making it important to design an M & E approach that extends beyond biological indicators of change in the marine environment. A systems approach[83] with an emphasis on monitoring the interdependencies within the socio-ecological system could include a qualitative approach to understanding management impacts on human dimensions criteria, such as Palauans' perceptions of the PNMS. This involves decision making based on value-laden inputs, incomplete information, and high degrees of uncertainty[84]. Key to M & E best practice is adherence to the principle of adaptive management[85], [86]. This ensures that insights and lessons are systematically used to steer management actions toward improvement. This can include resetting targets and/or indicators in light of new data and information, or evolving organizational capacity to address new or emerging issues.

In Appendix D, we present considerations for a draft science, monitoring, and evaluation framework for the PNMS. The opportunity exists for the co-design of a locally and culturally specific plan from the outset. Technical training in the field of evaluation can facilitate the core competencies required to maximize value from the M & E process, bearing in mind the complex nature of maintaining an iterative, systematic monitoring and evaluation process.

V. PNMS 2020 and Beyond


Photo courtesy of Staci Lewis

"The PNMS is a representation of Palau's culture of caring for the environment."

– NGO representative

Successful implementation of the policies of the PNMS legislation will require long-term commitments of human, financial, and institutional resources to enable the enforcement, research, monitoring, and evaluation programs needed to achieve the PNMS objectives and to track its social, economic, and ecological outcomes. Intrinsic to such commitments is the prioritization of capacity development. We highlight two complementary options. The Palau Community College can play a key role in training future leaders in fields such as marine technology, fisheries science, data management, and ecotourism business to build the necessary local workforce. At the same time, partnerships among local and regional government agencies, NGOs, other PICTs, and additional stakeholder groups can be leveraged to conduct essential research, monitoring, and evaluation work.

On a day-to-day level, the entities responsible for management, administration, and enforcement of the PNMS will need to fully transition to new responsibilities and develop practices around communication and coordination. For example, a leadership team of representatives from PICRC, MNRET, and MOJ with an external review board could ensure that the operationalization timeline and approach are on track. The review board could be composed of individuals from stakeholder groups and other agencies in Palau as well as international experts. In its role supporting the leadership team and implementation of PNMS policies, the external review board would also serve an advisory role to guide decision makers on topics such as:

- Optimizing human, financial, and institutional resources
- Monitoring and evaluating the most impactful, feasible, and culturally relevant indicators for assessing implementation
- Utilizing adaptive management strategies
- Overcoming barriers limiting the uptake of best large-scale MPA practices

Working Group members are committed to continuing to support the social, ecological, and economic success of the PNMS legislation and regional efforts to strengthen conservation-based sustainable development initiatives of PICTs. We hope to support information and analytical needs in Palau and the broader region by advancing understanding of fisheries, food security, and sustainability under climate change. There is great potential for the PNMS to inspire action in the broader region and globally, yet prospects hinge on strong and sustained institutional and public support.

To take one example, members of the Working Group are committed to working with PICRC and the Government to mobilize international cooperation in a "Voyage of Discovery" program. Conceptualized as a multiplatform, two-year series of research cruises to assess and better understand Palau's vast biophysical resources, this initiative proposes to contribute to three fundamental purposes: resource evaluation and monitoring, basic science, and Palauan ownership. The Voyage is designed for Palauan students, scientists,

and community members to be central to the discovery process and creation of new knowledge about their oceanic waters. An important part of this proposed program is assessing, tracking, and better understanding ecological linkages among marine living resources, which would include commercial fish, sharks, marine mammals, and other components of the offshore ecosystem that contribute to biodiversity. With unparalleled opportunities to weave science, education, and discovery into cultural identity and effective conservation practices, a Palauan Voyage of Discovery would be an extraordinary means for addressing fundamental questions and providing critical baseline data.

Another example would be the co-design and implementation of an ambitious human dimensions research program involving Palauan and international researchers and ocean sustainability practitioners. Such a program would feed much-needed information directly into management systems and could form the basis of and complement a context-appropriate the PNMS monitoring and evaluation system, create a baseline against which the PNMS impacts could be measured, and improve the likelihood of success in reaching social goals of the PNMS that underlie and shape the attainment of ecological goals. Intial thematic priorities may be context-appropriate participatory governance opportunities, current or intended social and economic reliance on and cultural relations to offshore areas, public relations and opportunities for public engagement with the PNMS implementation organizations, lessons learned from other Palauan marine and MPA management systems, opportunities for institutional and human resource development, current and anticipated levels of stakeholder influence over ocean governance, and perceived socioeconomic impacts of the PNMS. The scope and priorities of such human dimensions research would need to be co-designed with Palauan leaders, researchers, and the PNMS implementation agencies.

Photo courtesy of Manu San Felix

VI. A Legacy for Palau, a Legacy for the World

The PNMS legislation is ultimately for and about the people of Palau, who have a rich cultural heritage anchored in the ocean. Exemplifying Palau's connection to its natural resources and the traditional commitment to managing those resources for the security of future generations, the PNMS affirms the enduring traditional value of ocean stewardship and associated cultural identity. By adapting the traditional bul process involving traditional chiefs, governors, businesses, fishermen, and other constituents, Palau's national policymakers honored a time-tested approach to pass along enduring benefits to current and future Palauans. The PNMS policies establish a vision to safeguard cultural and socioeconomic benefits, while also formalizing and celebrating Palauan sovereignty over the vast seascape of its EEZ. The immense no-take area will allow for Palauans to rekindle and expand historical relationships with an oceanic realm uninterrupted by extractive activities, including deep-sea mining as well as fisheries.

> *"PNMS a klungiolir a rechad er Belau"* – The PNMS is for the benefit of the Palauan people
>
> — NGO representative

The anticipated effects directly of interest to Palauans span two additional themes. First, there is potential for the PNMS policies to improve food security and public health. A strategically supported, locally operated domestic pelagic fishery could ensure a reliable, high-quality supply for much of the growing local demand for pelagic seafood, encourage a value-added industry, decrease reliance on imported foods, and reduce pressure on the coastal reef resources. Second, the PNMS policies expands possibilities for livelihoods and income for Palauan fishers. With

Photo courtesy of Staci Lewis

effective marketing and careful planning, policies can also boost job opportunities and revenue from tourism. Such diversification increases economic resilience. In aggregate, many varied, positive outcomes for Palauans are likely to emerge over time from implementing this sweeping initiative.

Further, the PNMS policies present a unique opportunity for education, cultural expression, and inspiration for current and future generations of Palauans and potentially provide a blueprint for other Pacific islanders. A strong connection to the nearshore environment is a principal value in Palau as in many island cultures, yet there is much to be gained from supporting that connection to deeper seas. An opportunity to revive ancestral ties to the open ocean also supports a shared identity throughout the Pacific. In fact, this bold step taken by Palau adds depth to a Pacific voice increasingly audible around the world.

The PNMS legislation is a bold initiative that can yield important lessons for communities facing similar issues. If effectively implemented, it will generate long-term conservation benefits for the region and beyond. By protecting 80% of their EEZ, Palauans are charting a course that others can follow. In recent decades Palauan leadership on major initiatives has activated other PICTs—for example, Palau's leading role in inspiring the initial convening of the Micronesia Challenge in 2006. While many traditions and values are common throughout the region, the Pacific Islands also face similar challenges, including declines in ocean ecosystems, economic opportunity, and public health. By protecting 80% of its EEZ, Palau is acting to ensure sovereignty over its resources and help secure a sustainable ocean economy that serves its goals, needs, and priorities and supports its resilience to climate change.

The PNMS legislation is a strategic solution at a crucial moment to increasing threats from climate change and declining local and regional coastal fisheries. National attention has focused on protecting Palau's expansive marine resources in recent years, and regional interest is growing as 2020 approaches. Stewardship of the ocean has long been considered an ancestral gift to be bestowed on future generations. If Palau can deliver the envisioned benefits of this bold initiative, it will inspire other island and coastal nations to follow its example.

As the world struggles to find pathways to sustainable development, the PNMS story offers a ray of hope—the potential for a large ocean state to shape its future. If, through the PNMS, Palau can inspire other PICTs to take collective control of their ocean resources for the wellbeing of all, it will have made a vital contribution to the future of the Pacific Ocean and the people who depend on it.

Photo courtesy of Staci Lewis

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Appendix A.
Palau's Maritime Governance Overview

In 2015, Palau enacted the *Palau National Marine Sanctuary Act* ("PNMS Act") which created two distinct zones in the exclusive economic zone (EEZ): the Palau National Marine Sanctuary ("PNMS") that covers approximately 80% of its EEZ; and the Domestic Fishing Zone, which comprises approximately 20% of the EEZ. The PNMS officially enters into force on January 1, 2020. Below is an overview of Palau's maritime zones as established by Title 27 of the Palau National Code and its subsequent amendments, followed by an outline of relevant government authorities and their respective mandates as they relate to the PNMS.

Palau's Maritime Zones

Internal Waters

Waters landward of Palau's baseline,[1] including lagoons of atolls or islands, are called Internal Waters.[2] Palau, in line with the United Nations Convention on Law of the Sea, has jurisdiction and sovereignty over its Internal Waters.[3] In the Constitution, Palau confers on its states *"exclusive ownership of all living and non-living resources, except highly migratory fish"* in the Internal Waters.[4] However, traditional fishing rights and practices shall not be prejudiced. Additional protections for fishing rights are built into Title 27 of the Palau National Code, noting that traditionally recognized fishing rights in submerged reef areas, wherever located in fishing zones, are preserved and respected.[5]

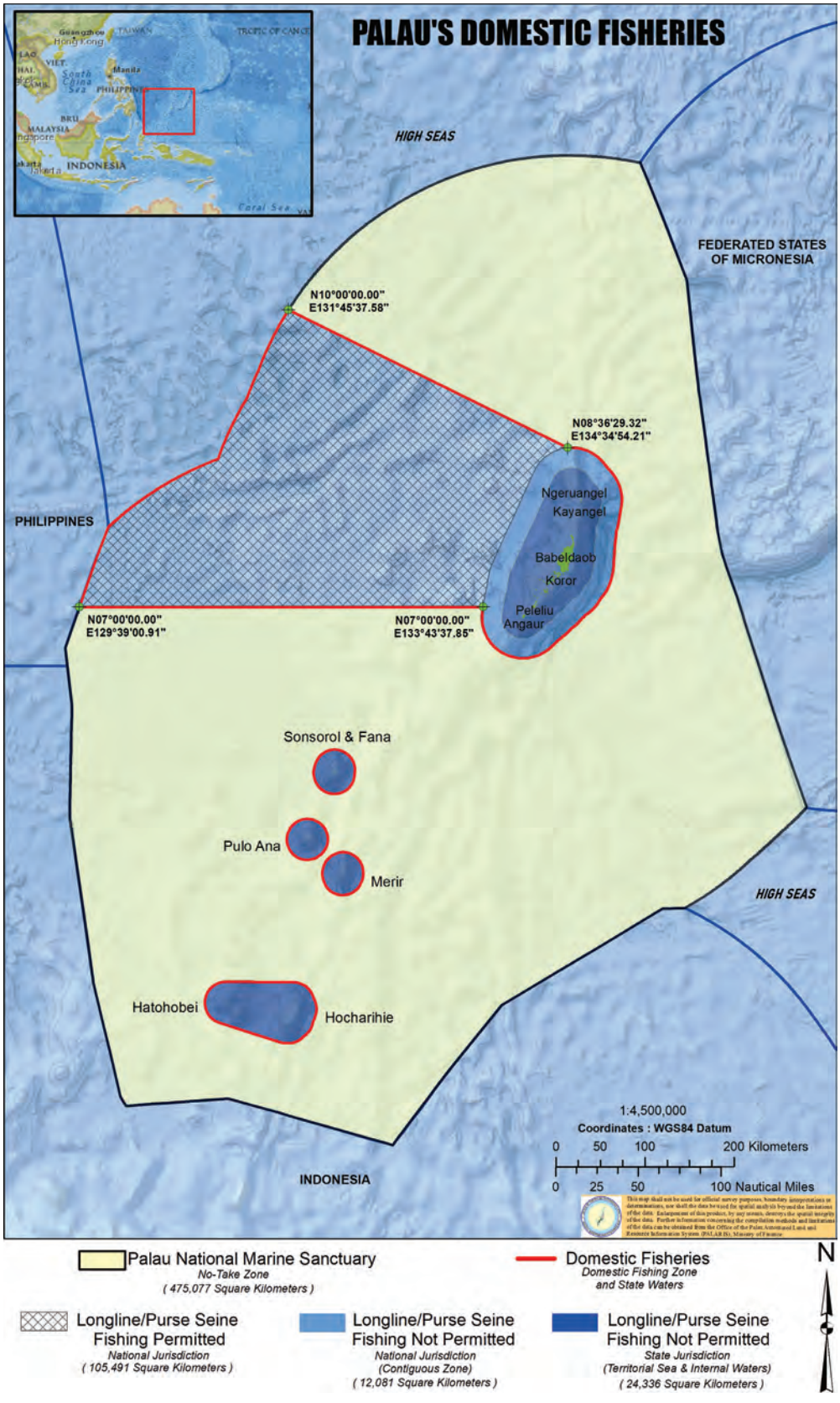
Territorial Sea

The Territorial Sea starts at Palau's baseline and extends seaward 12 nm.[6] Palau has jurisdiction and sovereignty over the Territorial Sea.[7] In the Constitution, Palau confers the same exclusive ownership of resources to its states and traditionally recognized fishing rights in the Territorial Sea as in Internal Waters. RPPL 10-35 has also added a restriction that only fishing

1 In the context of maritime zones, baselines are used as fixed coordinates from which to measure maritime zones. Given Palau's reef system, its baseline is *a line following the contour of the seaward edge of the reef system, which line connects those outermost elevations of the reef which are above water at low tide.*
2 27 P.N.C. §142(b).
3 PALAU CONST. art. 1, §1.
4 PALAU CONST. art. 1. §2.
5 27 P.N.C. §146.
6 27 P.N.C. §142(a).
7 PALAU CONST. art. 1, §1; and 27 P.N.C. §142(b).

Figure 1.

The Palau National Marine Sanctuary comprises 80% of Palau's Exclusive Economic Zone (yellow) and Palau's Domestic Fishing Zone (DFZ) comprises the remaining 20% (bounded by the red line encircling the Northern Archipelago and excluding its territorial sea (dark blue)). The DFZ has two zones: the Contiguous Zone (pale blue; 12nm-24nm zone surrounding the Northern Archipelago) and the Fishing Permitted Area (FPA) (hashed) beyond the Contiguous Zone. Pole-and-line and personal and recreational fishing vessels are permitted in the entire DFZ. Purse seine and longline fishing are only permitted in the FPA (hashed) beyond the Contiguous Zone. State rights in the Territorial Sea and Internal Waters remain unaffected. Figure provided by PALARIS.



vessels using pole and line are allowed to fish within 24nm surrounding the baseline of Ngeruangel, Kayangel, Babeldaob, Koror, Peleliu, and Angaur (hereinafter collectively referred to as the "Northern Archipelago").[8]

Contiguous Zone

The law designates a Contiguous Zone surrounding the Northern Archipelago. The Contiguous Zone is adjacent to the seaward extent of the Territorial Sea and extends out 12 nm. Its outer boundary being every point 24 nm from the baseline.[9] In the Contiguous Zone, fishing is restricted to fishing vessels[10] using pole-and-line fishing[11] and in possession of a valid fishing permit allowed to fish in this zone.[12] The definition of fishing vessels does not include "personal vessels used primarily for recreation or sports" and this is generally understood as a provision for local subsistence fishermen.

Exclusive Economic Zone ("EEZ")

Palau's EEZ begins at the seaward extent of the Territorial Sea with its outer boundary being every point 200 nm seaward of the nearest baseline point.[13] Within the EEZ, Palau has sovereign rights[14] for the *"exclusive management, conservation, and regulatory authority over all living resources within the exclusive economic zone to the full extent recognized by international law."*[15] It is within this zone that both the Palau National Marine Sanctuary and the Domestic Fishing Zone exist.

Palau National Marine Sanctuary (PNMS)

The PNMS Act establishes the PNMS as all Palau's waters with the exception of the Domestic Fishing Zone and the Territorial Sea.[16] The PNMS comprises approximately 80% of the EEZ. The PNMS is a no-take zone, with fishing and other extractive activities expressly prohibited effective January 1, 2020.[17]

Domestic Fishing Zone (DFZ)

The DFZ is that demarcated area where fishing is permitted.[18] It comprises approximately 20% of the EEZ and is adjacent to the PNMS. The DFZ includes the Contiguous Zone around the Northern Archipelago and extends to the western boundary of the EEZ.

Fishing vessels may only fish in the DFZ with a valid permit.[19] Applications for fishing permits may be made to the Division of Oceanic Fishery Management at the Bureau of Marine Resources specifying, *inter alia*, vessel identification names and number, details of the vessel including fishing gear, target catch, fishing area and season of fishing.

Only fish caught in the DFZ using purse-seine free-school operations or long-line fishing may be exported for commercial purposes.[20] All fish caught in the DFZ for commercial export must be landed in Palau before it is exported,[21] unless exempted.[22] All other fish caught in the DFZ shall only be available for domestic sale.

Authorities and Mandates

Ministry of Natural Resources, Environment and Tourism

The Ministry of Natural Resources, Environment and Tourism ("MNRET") is established under the Executive branch of the national government of Palau under the

8 27 P.N.C. §165, amended by RPPL 10-35 (2019).
9 27 P.N.C. §143(a).
10 27 P.N.C.§202(d), amended by RPPL 9-49 (2015). "***Fishing vessels*** means any vessel, boat, ship or other craft which is used for, equipped to be used for, or of a type normally used for: (1) fishing, but does not include personal vessels used primarily for recreation or sports..."
11 27 P.N.C.§102(x), amended by RPPL 9-49 (2015). "***Pole-and-line fishing*** means the method of fishing that involves using a barbless hook attached to a fixed length of line to catch one fish at a time
12 27 P.N.C.§165, amended by RPPL 10-35 (2019).
13 27 P.N.C.§144(a), amended by RPPL 6-36 (2001).
14 UNCLOS art. 56(1)(a).
15 27 P.N.C.§144(b), amended by RPPL 6-36 (2001).
16 27 P.N.C.§147, amended by RPPL 9-49 (2015).
17 27 P.N.C.§149, amended by RPPL 9-49 (2015).
18 27 P.N.C.§§148 and 164, amended by RPPL 10-35 (2019).
19 27 P.N.C.§170, amended by RPPL 9-49 (2015).
20 27 P.N.C.§164(c), amended by RPPL 10-35 (2019).
21 27 P.N.C. §164(d), amended by RPPL 10-35 (2019).
22 27 P.N.C. §164(d), amended by RPPL 10-35 (2019).

Palau National Code.[23] MNRET has broad powers under its mandate as the Executive branch agency responsible for the management of natural resources, including fisheries, agriculture, aquaculture, forests, mineral and other land-based and ocean-based resources; the promotion and development of tourism, and the protection and management of the environment; labor; and other related matters.[24]

The PNMS Act assigns MNRET central roles in the management and conservation of the PNMS Zone and the DFZ. The PNMS Act mandates MNRET:[25]

- to adopt regulations for the conservation, management, and exploitation of all living resources in the Palau National Marine Sanctuary and the Domestic Fishing Zone…;
- to negotiate and conclude foreign fishing agreements…;
- to issue foreign fishing permits in accordance with the law and regulations promulgated…;
- to monitor fish stocks and set allowable catch limits within the Domestic Fishing Zone;
- to monitor all fish caught within the Domestic Fishing Zone;
- to coordinate with the Ministry of Justice for the enforcement of all laws, rules and regulations in relation to domestic fishing, transit by foreign and domestic vessels through Palau's waters, and illegal or unreported or unregulated fishing or illegal activities within the Palau National Marine Sanctuary or Domestic Fishing Zone;
- to adopt regulations for the placement of Palau observers aboard all foreign and domestic fishing vessels engaged in fishing within Palau's waters or for Palau's continental shelf resources;
- to coordinate Palau's compliance with all international fishery agreement or foreign fishing agreements, with a focus on maximizing the returns to Palau under any such agreements and negotiate with parties to such international fishery agreements, such as the Nauru agreement; and
- to perform such other duties and functions as may be necessary to carry out the purposes of this chapter

The Minister of MNRET has additional authority and responsibilities under the PNMS Act that includes:

- drafting regulations to *"manage, conserve, and regulate the harvesting of fish throughout their habitat, both within the reef areas of islands and atolls, and in other areas within the jurisdictional competence…"*[26]
- granting exemptions from the requirement to land fish caught in the DFZ for commercial export purposes in Palau.[27]
- promulgate regulations and inspection procedures necessary to collect any tax on fish.[28]
- developing the Minister's Report that annually reports all activities within Palau's waters, including the PNMS and the DFZ. This shall contain, inter alia, detailed expenditure of funds by MNRET, all fishing permits, revenues, types and amounts of fish harvested, sustainability of fish stocks, and monitoring and enforcements efforts.[29]

The Bureau of Marine Resources ("BMR"), under MNRET, has discretion to make regulations to provide for the issuance of permits on reasonable grounds to foreign vessels or parties for research, recreational, or other noncommercial fishing within the PNMS and DFZ.[30] BMR may also grant special bait fishing permits for catching bait fish subject to terms and conditions

23 2 P.N.C. §102(a)(8).
24 2 P.N.C. §121(a).
25 27 P.N.C. §123, amended by RPPL 9-49 (2015).
26 27 P.N.C.§101; and §122, amended by RPPL 9-49 (2015). MNRET is developing PNMS Fishing Regulations ("Regulations") that is likely to go into force on January 1, 2020 coinciding with full implementation of the PNMS Act. The purpose of the Regulations will be to give effect to and implement the PNMS Act. For the purpose of this report, details pertaining to the Regulations are not included as it has yet to be finalized as of the time of publication of this report. However, it should be noted that Regulations will be able to provide additional detail and clarity on many aspects of the PNMS and DFZ.
27 27 P.N.C.§164(d), amended by RPPL 10-35 (2019).
28 40 P.N.C. P.N.C.§1406.
29 27 P.N.C. §124, amended by RPPL 9-49 (2015).
30 27 P.N.C. §174, amended by RPPL 9-49 (2015).

that maintain the sustainability of the bait fish stock and the ecosystem.[31] The Director of BMR is responsible for exploring, surveying, developing, managing and conserving all near shore marine resources.[32]

Ministry of Justice

The Ministry of Justice ("MOJ") is also established under the Executive branch of the national government of Palau.[33] The MOJ is responsible for providing legal services to the national government and its agencies and political subdivisions, promoting and protecting the safety and peace of the public, maintaining order, enforcing all laws, and related matters.[34]

The PNMS Act authorized MNRET to coordinate with the MOJ for the enforcement of all laws, rules and regulations in relation to Palau's waters, and with regard to illegal, unreported, and unregulated ("IUU") fishing or other illegal activities within the PNMS or DFZ.

In 2019 through an amendment to the PNMS Act, the functions of the Ministry of Justice were expanded to include:

- …take all necessary lawful actions to defend the integrity of the Republic's jurisdiction and to promote the safety of persons and wildlife therein.[35]
- …be responsible for surveillance of the Republic's maritime jurisdiction, and for monitoring and enforcing the restrictions pertaining to the Exclusive Economic Zone, the Domestic Fishing Zone, and the Palau National Marine Sanctuary.[36]

The MOJ has broad enforcement powers under its primary role as well as that specifically listed under the PNMS Act amendment. Interestingly, the newest expansion of its roles extends to surveillance and monitoring of the maritime zones.

Palau International Coral Reef Center (PICRC)

The Palau International Coral Reef Center is established as a non-profit public corporation[37] that is an autonomous entity wholly owned by the National Government under the Code and exists in perpetuity.[38] The Code notes that PICRC is strictly limited to scientific, research and educational purposes. It also notes activities that PICRC may not engage in and these include: carrying on propaganda or attempting to influence legislation.[39]

PICRC's primary objectives, *inter alia*, include:

- Provide information, expertise, assistance and other relevant support to any local government or private agency or non-government organization whose mission requires operating in the marine environment;[40]
- Provide educational resources and assistance for development of marine environment studies programs for the entire Palau education system;[41] and
- Provide information and technical support to Palau's traditional chiefs in their role of managing the reefs and implementing traditional conservation practices.[42]

In 2019, through an amendment to the PNMS Act, the primary objectives of PICRC were expanded. These new objectives include:

- Administer the Palau National Marine Sanctuary by coordinating research, education, and outreach activities relating to the Sanctuary and Domestic Fishing Zone established under Title 27 of the Palau National Code;[43] and
- Develop and recommend to MNRET, appropriate conservation management measures for the Domestic

31 27 P.N.C. §175, amended by RPPL 9-49 (2015).
32 2 P.N.C. §121(c).
33 2 P.N.C. §102(a)(2).
34 2 P.N.C. §105.
35 2 P.N.C. §105, amended by RPPL 10-35 (2019).
36 2 P.N.C. §105, amended by RPPL 10-35 (2019).
37 24 P.N.C. §3301(f) and (h).
38 24 P.N.C. §3301(a) and (c).
39 24 P.N.C. §3301(a) and (c).
40 24 P.N.C. §3303(f).
41 24 P.N.C. §3303(i).
42 24 P.N.C. §3303(j).
43 24 P.N.C. §3303(k), amended by RPPL 10-35 (2019).

Photo courtesy of Eric Hartge

Fishing Zone.[44]

These objectives appear to be complementary and supporting the work of MNRET. MNRET's regulatory powers enable it to make regulations in the future to enhance the role of PICRC.

Taxes and Fees

Fish Export Tax

In the 2019 amendment to the PNMS Act, fish export taxes were amended to include two classes, tuna or billfish, and all other fish. All types of tuna or billfish in any form are subject to an export tax of 50 cents per kilogram, while all other fish receive a tax of 35 cents per kilogram.[45] Fish export taxes only apply when fish is exported for commercial purposes. The Minister of Finance and MNRET are responsible for creating regulations and procedures for collecting this tax[46] with the National Treasury being the entity into which these taxes are deposited.[47]

Pristine Paradise Environmental Fee

The Pristine Paradise Environmental Fee ("PPEF") was established by an amendment to the Palau National Code in RPPL 10-02 and replaced the Environmental Impact Fee established by the PNMS Act.[48] The PPEF of $100 is applicable for international travel into Palau with refunds available to Palau citizens, their spouses and other identified classes. In the 2019 amendment to the PNMS Act, PICRC was allocated $5 from the PPEF for its administration of the Palau National Marine Sanctuary.[49] The current allocations of the PPEF are: Fisheries Protection Trust Fund ($5),[50] PICRC ($5),[51] States ($12.50),[52] Palau International Airport ($25),[53] Green Fee ($30)[54] and National Treasury ($22.50).[55]

44 24 P.N.C. §3303(i), amended by RPPL 10-35 (2019).
45 40 P.N.C. §1406, amended by RPPL 10-35 (2019).
46 40 P.N.C. §1406, amended by RPPL 10-35 (2019).
47 40 P.N.C. §101.
48 40 P.N.C. §2701, amended by RPPL 10-02 (2017); and RPPL 10-02 §2 (2017) repeals §§ 5,7 and 8 of RPPL 9-49.
49 40 P.N.C. §2706(b), amended by RPPL 10-35 (2019).
50 40 P.N.C. §2706(a), amended by RPPL 10-35 (2019).
51 40 P.N.C. §2706(b), amended by RPPL 10-35 (2019).
52 40 P.N.C. §2706(b), amended by RPPL 10-02 (2017); 70% divided amongst states in equal shares and the remaining 30% apportioned according to population.
53 40 P.N.C. §2706(b), amended by RPPL 10-02 (2017); earmarked and appropriated to relevant agencies for purposes related to the security, operation, maintenance, and improvement of the Palau International Airport; provided that all funds from local revenue or other sources that otherwise would have been appropriated for these purposes shall be appropriated to the Civil Service Pension Fund.
54 40 P.N.C. §2706(d), amended by RPPL 10-02 (2017); 24 P.N.C. §3413 provides that the Green Fee shall be used for the operation of PAN.
55 40 P.N.C. §2706(e), amended by RPPL 10-02 (2017).

Appendix B.
Towards Strengthening Palau's Domestic Fishery Sector

Palau's pelagic fishery sector is currently dominated by foreign-owned businesses

Locally based, foreign-owned longline fleets provide 84–94% of pelagic fish in Palau's market, which is often low-quality fish. Conversely, a few Palauans currently operate small-scale, recreational vessels (i.e. day boats) using a variety of gear types (e.g., trolling, vertical longlines, jigging, live-bait handlining, and deep drop-stone (Ika-shibi)), and contribute the remaining 6–16% of pelagic fish in the market. Moreover, studies show there is a high unwillingness from Palauans to enter the fishery given its high operational costs and low returns.

Achieving a viable day-boat fleet could be more immediate and sustainable than a domestic industrial fleet

Revival of a pole-and-line fishery, which was once a small operation in Palau, or a domestic industrial longline fleet have low likelihoods of economic success based on previous experiences in the region. Moreover, current domestic demand and market prices will result in low returns while fleets accrue high operational costs and require significant capital investments (e.g., infrastructure and gear). Thus, ***the viability of these industrial fishery fleets is highly uncertain.***

Scaling up the current small day-boat fleet would similarly require capital investments, albeit smaller than supporting a domestic industrial fleet. However, at their current effort, the existing day-boat vessels do not fully meet Palau's pelagic demand and are limited by infrastructure needs, gaps in the supply chain (e.g., market access), and high operational costs versus low returns. However, ***these obstacles to a viable day-boat fleet could be overcome more immediately and efficiently*** than investments and training needs for industrial fleet.

Several policy and investment priorities are important to Palau's domestic pelagic fishery

If Palau wants to build and sustain a domestic pelagic fishery, several policy and investment priorities are clearly important no matter which fishery sector structure (longline; pole-and-line; day-boat; or some hybrid) is pursued. First, ***infrastructure improvements*** would be needed to connect the pelagic supply to potential consumers. Palau would need a central marketplace for sale and processing of pelagic fishes. It also would need a cold chain that allows fishers to preserve quality, and allows buyers to have a reliable year-round supply of pelagics. Second, proactive measures are needed to ***build domestic demand for pelagic fish***—within recommended and safe health limits—to sustain a growing industry. These measures

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could include:

1. A ban or limit on the sale of reef fish in restaurants and tourist operations
2. Development of a local, sustainable brand of pelagics, primarily aimed for sale to tourists
3. Support value-added products (eg: loins, dried, jerky) and seafood processing opportunities
4. Support for the "Choose Pelagics" program

Third, Palau should consider measures to ***improve the economic returns for pelagic fishers***. Policies that would bolster the small day-boat fleet include ***a "start-up" package*** which offsets gear and operational costs, provides safety equipment and a benefits packages where fishers receive services similar to government employees (e.g., retirement, sick leave), and ***a functioning and maintained FAD network***. These policies, which should be transparent and accountable, could help defray the costs of capital investments or operations, excluding fuel subsidies and capacity enhancing which have proven to be detrimental in most cases. Incentives need to be carefully controlled so that these capital investments are not used for reef fishing and monitoring should support appropriate use of fishing gear.

A viable domestic pelagic fishery sector will face challenges.

Previous efforts around the region and the world prove that ***building a local industrial pelagic fishery is costly***, and it has typically been difficult to create an industry that is profitable and can be sustained. ***Climate change is expected to have impacts on fisheries in Palau's EEZ***, primarily by changing the distribution, size, and availability of fishes. Model projections indicate that total fisheries catch potential within the western pacific region will likely decrease by 30–50% by 2100. Conversely, a recent study found that other species, such as mahi mahi and amberjack, might increase their populations, presenting new opportunities for fisheries.

Options exist to strengthen Palau's pelagic fishery sector beyond strengthening its fleet.

Palau does not have to focus on developing a domestic pelagic fishing fleet to capture more value from its fisheries. Instead, opportunities exist across the whole sector—from fisher to consumer, including fishing, fish processing, and value-added products—to increase the value of the domestic pelagic fishery for economic development, livelihoods, and food security. For example, ***if fish processing of some form were required prior to export***, it could stimulate an on-shore industry. Next, ***development of value-added products***, such as fish loins, dried fish, and jerky, could create opportunities for employment and sales, and emerging efforts have demonstrated an interest by the tourist-focused retail sector for marketing such products. Thus, policies should support economic opportunities across this sector. Finally, the ***relaxation or repeal of the export ban for domestic fishers and value-added products*** would allow them to access international markets that offer higher returns without (necessarily) raising the domestic price.

Appendix C.
Science, Monitoring, and Evaluation: Operationalizing the PNMS Policies

The Palau National Marine Sanctuary (PNMS) legislation establishes 80% of Palau's exclusive economic zone to be a no-take area, new fishing zones, and new export rules and taxes; expands the mandates of the Ministry of Natural Resources, Environment & Tourism, the Palau International Coral Reef Center, and the Ministry of Justice; and establishes the Pristine Paradise Palau Fee. On January 1, 2020, the PNMS will fully enter into force with closure of the 80%. Science, Monitoring, and Evaluation will be essential to supporting the implementation and operationalization of the PNMS. The goal of Monitoring and Evaluation (M & E) is to take the 'pulse' of programs, policies, and projects and to determine whether desired impacts are being achieved. Further development and application of the scientific research and monitoring framework presented below, will enable tracking of the social, economic, and ecological effects of the PNMS.

M & E is key to delivering the overall goals of the PNMS. M & E uses multiple, context appropriate, participatory and non-participatory methods and collects both quantitative and qualitative information. Further, it is about fostering self-reflection within governance and management institutions and staff and creating opportunities for dialogue between PICRC and MNRET staff and stakeholder groups. While M & E focuses on collecting information, it is ultimately about bringing people together to assess implementation, learn, and adapt management accordingly.

A range of M & E approaches have been developed and applied in conservation management, international development and other fields, leading to many practical examples and a range of approaches[1]. For example, status assessment, management reviews, and performance measurements are well established processes in many projects and programs. These tend to focus on the assessment of management measures as input variables (i.e. financing), activity variables (i.e. meetings), and output variables (i.e. reports). While this has value and is relatively easy to track, impact and outcome evaluation is more effective for informing management and ensuring that implementation is on track. Assessing results of near-term implementation effects (impact) is the interim step to understanding the longer-term effects (outcome). Focusing on whether a program is effective in meeting its overall goals, this approach allows management authorities to enhance positive and minimize negative effects. Importantly, an impact and outcome process can be sensitive to cultural norms and values when the M & E plan is co-designed by local stakeholders, as indigenous knowledge is instrumental for selection of culturally and institutionally appropriate process indicators.

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Key to M & E best practice is adherence to the principle of adaptive management,[2], [3]. This ensures that insights and lessons are systematically used to steer management actions towards improvement. This can include resetting targets and/or indicators in light of new data and information, or evolving organizational capacity to address new or emerging issues.

Getting Started

Advancing M & E from principle to practice and enabling the PNMS implementation to be tracked necessitates initial groundwork. The following five steps, which may overlap in sequence, represent a roadmap for initiating a plan:

1. Review existing institutional capacity for M & E in Palau, identify the coordinating organization, and engage in evaluation training as required
2. Link M & E directly to the PNMS Science Plan as a source of data and information, (bearing in mind that some data may need to be generated, for example, through expert solicitation)
3. Identify the participants and facilitate a process in line with principles of good environmental governance (reference the heading for process indicators below)
4. Take an iterative approach to updating the PNMS strategic plan and application of theory of change
5. Identify core and peripheral process and outcome indicators (see the examples below)

There is existing capacity in the Office of Project Management in the Ministry of Finance and the Palau Conservation Society that can be leveraged to facilitate the development of an M & E System for the PNMS.

Considerations for Indicator Selection

An indicator is a unit of information measured over time that documents changes in a specific condition. A given goal, objective, or additional information needs can have multiple indicators. A good indicator meets the following criteria:

- **Measurable:** able to be recorded and analyzed in quantitative or qualitative terms
- **Precise:** defined the same way by all people
- **Consistent:** not changing over time so that it always measures the same thing
- **Sensitive:** changing proportionately in response to actual changes in the condition or item being measured

Indicator selection should follow from a clearly developed theory of change and results framework and include both process and outcomes indicators. The theory of change and results framework should be co-developed with stakeholders and allow for meaningful participation and input from a broad representation of the public and private sector. Outcome indicators will measure how well PNMS implementation is tracking against core long-term goals, while process indicators will determine whether adequate enabling conditions are in place to achieve those goals.

Indicators may encompass a mix of quantitative metrics that allow for comparison within sites (and potentially across sites as needed), as well as qualitative information that allows for deeper understanding of what is happening and why, and in particular unveiling the feedbacks between human actions, environmental health, and human health. There is too often a focus on monetary economy-based indicators (e.g., GDP) for evaluating success, principally because these are often easier to measure. However, this approach ignores important dimensions of wellbeing (e.g., connections to place, preservation of local knowledge and language) and does not necessarily include coupled measures about whether the growth is sustainable and equitable.

Careful consideration should be given to the development of culturally appropriate indicators, based on inputs from a range of knowledge and diversity of sources. Such an approach should begin with a locally grounded understanding of priorities and needs that

inform public interactions with, and management of, natural resources. It should also account for the availability of existing data and/or feasibility to collect new data. Using participatory methods, such as community-led visioning, co-design of workshops, or other locally/culturally informed engagement methods, ensures that the metrics are culturally relevant, are monitored in a respectful way, and target local decision-making needs. High levels of non-compliance with rules are routinely documented where people do not feel like their interests and values are represented. Furthermore, selecting locally appropriate indicators, including from civil society, can support local empowerment, cross-scale planning and evidence-based sustainability initiatives and avoid unintended negative impacts.[4] Engaging local stakeholders throughout M & E is essential for local buy-in and ultimately, improved environmental and social outcomes.

Resources for Example Indicators:

A suite of resources that may help inform indicator development for the PNMS M & E plan are presented below. While these resources provide example indicators that may be of interest for monitoring process and outcomes of the PNMS, it is still recommended that a Palauan-led participatory process be undertaken to review existing indicators and identify other indicators relevant to local circumstances.

- Measures of success: designing, managing, and monitoring conservation and development projects. Island Press. Salafsky, N. and Margoluis, R.A., 1998.
- *How is your MPA Doing? A Guidebook of Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness*
- *Vanuatu National Sustainable Development Plan Monitoring and Evaluation Framework*
- *Toolkit for the Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes*
- *Indicators Relevant for Indigenous Peoples: A Resource Book*
- *Large-scale Marine Protected Areas: Guidelines for Design and Management*
- *Monitoring and Evaluation Framework: Improving food security and reducing poverty through intra-regional fish trade in Sub-Saharan Africa*

Extracted from the literature and expert opinion, the following list of process and outcome indicators represents a potential starting point which a Palauan-led group could draw upon to best meet local needs and values. A guiding principle is balancing comprehensiveness with feasibility in defining the final list of indicators.

Process Indicators

Process indicators evaluate the circumstances and practices underlying the development of outcomes. Assessing governance, administrative, and management processes can shed light on challenges limiting progress, mechanisms for proactively resolving them, and the system's capacity for resilience. More specifically, examining transparency in decision making, constituency engagement, and consultative processes facilitates positive outcomes. Because such conditions are highly specific to local cultural and political dimensions, the sample process indicators listed below are **only suggestions**, and not built into a draft plan by the Working Group. Development and prioritization of the most relevant process indicators and the methods to measure them should be an in-country, facilitated process, undertaken as part of broader stakeholder engagement and outreach plans.

Box 1. Sample Process Indicators

Participatory Engagement

- Proportion of different sectors and stakeholder groups actively participating
- Management objectives reflect local concerns and issues
- Evidence of inclusion of input from various stakeholders and sectors, to ensure diverse representation from multiple sectors of society (e.g., including diversity in gender, race, religion), of contributions to management processes/ decisions
- Evidence of inclusion of traditional leaders in Sanctuary management decisions

Equity and Fairness

- Perceptions of equity in distribution of management costs and benefits (e.g., across demographic groups, inter-generations)
- Fairness in access to distribution of resource benefits
- Fairness in access to participatory processes (i.e. a meaningful seat at the table)

Appropriate Sanctions

- Frequency and effectiveness of monitoring, control, and surveillance
- Proportion of offenses that are adequately punished

Conflict Resolution

- Existence of forum or means to settle disputes
- Perception that conflict resolution is handled fairly and in a culturally appropriate way

Adaptive Management

- Monitoring information is regularly and effectively communicated to decision makers
- Decision makers use relevant information to adapt management measures
- Adaptations to rules consider present and future uncertainty regarding threats and processes

Inclusion of Different Knowledge Systems

- Evidence of inclusion of diverse knowledge systems (social and natural science and traditional and indigenous knowledge) in informing management decisions

Institutions and Institutional Capacity

- Clear institutional roles and mandates
- Complementary and nested institutional roles
- Management actions and monitoring is carried out by individuals who report to a coordinating body
- Consistency in goals and motivations across government institutions and economic sectors in achieving management outcomes
- Consistency of mandate through changes in political leadership
- Clear links between government decision-making process, civil society, and traditional institutions

Transparency

- Transparency in the decision-making process
- A documented and publicly available process

Outcome Indicators

Outcome indicators measure the effects of management activities on biophysical and socioeconomic dimensions. Unlike process indicators, they are more standard and broadly applicable to a diversity of contexts. The sample outcome indicators provided (Box 2) are likely to be refined by the PNMS strategic planning process, and accelerated by the forthcoming UNDP GEF 7 initiative. The next step in developing outcome indicators will involve inputs from multiple sectors (e.g. fisheries, tourism, food, health). A coordinating in-country body to facilitate the inputs will be an important aspect of capacity building. Core and optional indicators may be identified and prioritized, according to capacity, and may be expanded as institutional capacity grows over time.

A draft PNMS Science Plan (*oceansolutions.stanford.edu/pnms-report*) aligned with the following natural and social science subgoals has been prepared by this Working Group as a foundation for monitoring and evaluating outcomes of PNMS implementation. The draft plan is a compilation of questions, associated methodological information and connections to Sustainable Development Goals (SDGs),[1] addressing the most pressing PNMS research questions put forth by PNMS decision makers and stakeholders. The draft Science Plan will need to be reviewed by stakeholders in Palau to ensure research questions are appropriate for the needs and capacity of those conducting the monitoring. Recommendations for coordination amongst agencies and entities in Palau, the region, and internationally are included but not exhaustive. These initial suggestions are likely to change and be adapted through the GEF process and internal stakeholder and decision maker processes.

1. Healthy Ocean Populations and Ecosystems for Palau: Sustaining pelagic marine resources that benefit Palauan livelihoods and drive the Palauan economy
    - **Subgoal 1:** Foster Palauan societal connection to and appreciation for Palau's offshore environments and resources; create the next generation of Palauan leadership to manage Palau's open ocean resources
    - **Subgoal 2:** Protect pelagic populations and preserve marine biodiversity in Palau's waters
    - **Subgoal 3:** Support sustainable fisheries
2. Food Security for Palau: Ensuring sustained and nutritious supply of food for Palauan residents
    - **Subgoal 1:** Increase the availability of and access to domestic pelagic fish according to standard guidelines for health and nutrition for all Palauan residents
    - **Subgoal 2:** Reduce fishing pressure on reef fish for the sustained cultural benefit to Palauans
3. Sustainable Development for Palau: Developing a domestic pelagic fishing industry and supporting existing sustainable tourism initiatives
    - **Subgoal 1:** Develop a domestic pelagic fishery
    - **Subgoal 2:** Support Palau's brand as an ecotourism destination
    - **Subgoal 3:** Support long-term health and well-being for Palauan residents
    - **Subgoal 4:** Support long-term economic sustainability in Palau

1 In addition to Palau's national goals for the PNMS, the PNMS exemplifies global progress towards the United Nations Sustainable Development Goals (SDGs). The PNMS is inherently a contribution to conserving marine areas (SDG 14.5) as well as other ocean targets. However, it also contributes to many of the other 16 SDGs, including food security (SDG 2), human health (SDG 4), decent work (SDG 8), industry and innovation (SDG 9), sustainable communities (SDG 11), sustainable consumption (SDG 12), climate action (SDG 13), and strong institutions (SDG 16). Palau is thus a leader not only in SDG 14, but also in how to leverage its policies to achieve goals across sectors.

Box 2. Sample Outcome Indicators[2]

Ecological – sustainability of the marine ecosystem

- Healthy pelagic fish stocks
- Healthy reefs and reef fish stocks

Economic – conversion and diversification of economic activities

- Percent economic gain in tourism, evidence that (eco)tourists visit because of the PNMS
- Percent economic loss in fisheries
- Income by community
- Total fishery landings
- Provision of employment and training opportunities for Palauans in the 20%
- Ratio of fishery exports to imports
- Number of vessels in the domestic pelagic fleet

Food Security – Ensuring sustained nutritious and safe supply of food for Palauan residents

- Availability of and access to domestic pelagic fish according to standard and safe guidelines for health and nutrition for all Palauans
- Per capita domestic pelagic fish consumption, distribution of pelagic fish consumption (by geographic, socioeconomic status, and age/gender demographics), pelagic fish supply and demand dynamics, fish consumption and preferences for key groups (tourists, residents, children)
- Human health indicators (obesity and non–communicable disease in Palau)
- Reliance on imported and/or processed foods
- Domestic agriculture production, supply and demand

Geographic – changes in land use or sea patterns

- Mapping of tourism dollars
- Mapping of fishery landings
- Ratio of offshore / nearshore fishery landings

Political – impacts on power relations, perceptions of the state

- Survey results on the success of the political system supporting to PNMS
- Changes in power dynamics

Institutional / Legal – impacts on tenure, legal rights

- New legislation enabling wellbeing, economic opportunity
- New legislation inhibiting wellbeing, economic opportunity
- Fishery compliance & observer coverage within Palau's waters

Community – social division, tension, hostility

- Social network analysis within and among communities (e.g. more connectivity due to PNMS or less)
- Evidence of management efforts changing the attitudes and behaviors of area users and the full range of diverse stakeholders

2 These examples are high-level indicators – a Palauan M & E development process will need to locally define how to collect information (e.g., what does "fair" look like, what constitutes "inclusion", etc., as well as design a process to collect and analyze the information).

Conclusion

A major challenge of developing and operationalizing an M & E framework for science, monitoring, and evaluation of the PNMS is that it must be systematic and rigorous enough to effectively assess the complexity of differing activities and practices. At the same time, it must be simple enough to be easily understood with succinctly communicated results based on real evidence via scientific research of natural and social systems. The methodology also must be repeatable to form a trackable baseline. Designing such a plan is a significant undertaking. Yet a practical, culturally meaningful M & E Plan will allow Palau to tell the grounded story of the measures taken to achieve positive outcomes of the PNMS for current and future generations.

Resources

[1] Stem, R. Margoluis, N. Salafsky, and M. Brown, "Monitoring and evaluation in conservation: a Review of trends and approaches," *Conserv. Biol.*, vol. 19, no. 2, pp. 295–309, Apr. 2005.

[2] C. Folke, "Social-ecological systems and adaptive governance of the commons," *Ecol. Res.*, vol. 22, no. 1, pp. 14–15, 2007.

[3] Preiser, R. Biggs, A. De Vos, and C. Folke, "Social-ecological systems as complex adaptive systems: organizing principles for advancing research methods and approaches," *Ecol. Soc.*, vol. 23, no. 4, p. art46, 2018.

[4] E. J. Sterling et al., "Biocultural approaches to well-being and sustainability indicators across scales," *Nat. Ecol. Evol.*, vol. 1, no. 12, pp. 1798–1806, Dec. 2017.

Photo courtesy of J. Tamelander

Photo courtesy of Lilian Pang

Appendix D.
PNMS Science Plan Summary

The draft Palau National Marine Sanctuary (PNMS) Science Plan has been prepared by this Working Group as a foundation for assessing ecological, social, and economic outcomes of PNMS implementation. An overview of research and monitoring questions from the detailed Science Plan is below, aligning with the goals and subgoals of the PNMS legislation and addressing the most pressing knowledge gaps put forth by PNMS decision makers and stakeholders.

The full draft Science Plan can be downloaded at the link below and is a compilation of these research questions, associated methodological information, potential partners or collaborators already collecting data, and connections to the United Nations Sustainable Development Goals (SDGs). Advancing this preliminary draft to an actionable Science Plan will require local stakeholder review and ownership to ensure the content and granularity are appropriate for the needs and capacity of those conducting the monitoring. Recommendations for coordination amongst Palauan, regional, and international agencies and entities are included yet not exhaustive. Furthermore, these initial suggestions are likely to be adapted through national marine governance dialogues that include local stakeholders and decision-making processes.

Photo courtesy of Manu San Felix

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1. Healthy Ocean Populations and Ecosystems for Palau: Sustaining pelagic marine resources that benefit Palauan livelihoods and drive the Palauan economy

Subgoal 1: Rekindle Palauan societal connection to and appreciation for Palau's offshore environments and resources. Create the next generation of Palauan leadership to manage Palau's open ocean resources.	
First Priority	What are the historical and current attitudes, perceptions, and connections of Palauans toward the pelagic environment and how do they change through time?
	What is the level of support for PNMS legislation among stakeholder groups and the public?
	What capacity do the institutions involved in managing the no-take and domestic fishing zones have and how is it likely to evolve?
	How are stakeholders engaged in dissemination of PNMS-related information and decision making?
Second Priority	What curricula exist at secondary and tertiary education levels to educate Palauans about the pelagic environment and the PNMS legislation? How can curricula be modified to include, and foster interest in, the pelagic environment?
	How does citizen science participation impact the attitudes and behaviors of the public?
	How is conflict about the management of, or access to, the no-take and domestic fishing zones addressed?
Data necessary for establishing a baseline:	
First Priority	Who are the key stakeholders?
	What are the public's perceptions of current and future diversity of uses, interests, and values associated with Palau's pelagic waters?

Subgoal 2: Protect pelagic populations and preserve marine biodiversity in Palau's waters.	
First Priority	How does primary production change through time (including species composition)?
	What is the current biodiversity within Palau's open ocean and how does it change through time?
	How does bycatch amount and composition change through time?
	Determine distribution and abundance of different life states of mammals, reptiles, seabirds, and invertebrates within habitats over time to gain insight into how marine ecosystems function and the importance of different habitats and seasons for key species across their life cycles.
	Monitor sea temperature, salinity, and water quality.
Second Priority	How do connectivity patterns change through time as well as home ranges for reef and open ocean species?
	What is the distribution, abundance, life stage, fertility state, and size and weight of pelagic fish through time?
	What does population connectivity look like for species of interest?
	What are the statuses of culturally important species? What are the perceptions of species' population health by stakeholders and the public? What are the levels of stakeholder knowledge of natural history in Palau's pelagic waters?
	What are compliance levels with no-take and domestic fishing zone regulations?
	How do pelagic fishes that are caught on FADs and those caught in the open ocean use reef food sources? Are there differences?
Data necessary for establishing a baseline:	
First Priority	What are the baseline patterns of energy and trophic flows within the pelagic environment?
	What is the current size structure of target pelagic fish stocks?
Second Priority	Map benthic environment and 3-D water column structure (e.g., eddies, currents, upwelling regions)?
	Where are the pelagic nursery habitats for species of interest (i.e.: calving grounds or spawning aggregations) within Palau's EEZ?
	What are the connectivity patterns and oceanographic mechanisms for connectivity between reefs and the open ocean environment?

Subgoal 3: Support sustainable fisheries by replenishing Palau's fishing zones and adjacent areas.	
First Priority	What are the demographics of pelagic fish populations of commercial interest?
	How do catch volumes, rates, and composition change through time?
	How do imports and exports of seafood, including fish not landed in Palau, change through time?
	What proportion of fishing trips for both the purse seine and longline fleets have observers on board?
	How is fishing effort for all sectors changing through time?
	How have spatial and temporal fishing patterns changed in Palau's waters? For example, have exemptions been granted and to whom? How does this affect catch, revenue, and fish stocks?
	How are FADs being used over time? What are the factors affecting use?
Second Priority	How is the PNMS legislation affecting bilateral and multilateral agreements?
	What is the ratio of catch from each fishing zone through time?

Photo courtesy of Bill Abbott

2. Food Security for Palau: Ensuring sustained, nutritious, and safe supply of food for Palauan residents

Subgoal 1: Increase the availability of and access to domestic pelagic fish according to standard guidelines for health and nutrition for all Palauan residents.	
First Priority	What are the nutrient levels of reef and pelagic fish?
	Availability: What volume and species composition are residents consuming now and how does this change through time? What are the geographic and demographic profiles of residential consumers?
	Access: How does catch, price, and source of fish at markets change through time? What is the source of fish (e.g., pelagic offshore, pelagic nearshore, reef)?
	What is the mercury level of pelagic fishes available in local markets?
	What is the amount of (both pelagic and reef) fish leaving Palau as part of the (informal) cooler trade now? How does this change through time?
Second Priority	How does agricultural production change through time, particularly with regard to climate change? Are there shifts in agriculture production that correspond with changes in fish landings?

Subgoal 2: Reduce fishing pressure on reef fish for the sustained cultural and socioeconomic benefit to Palauans.	
First Priority	How do reef fish populations change through time?
	What are the size of coolers exported and the species, number, and size composition of seafood inside each cooler?
	What is reef fish catch per unit effort (CPUE) and how does it change through time?
	What is the volume and species composition of reef fishes consumed at restaurants? What is the volume and species composition of pelagic fishes consumed at restaurants?
	What are the historical and current cultural uses of reef fishes, and to what extent would individuals be willing or consider it culturally appropriate, to substitute these for pelagic fishes?
Second Priority	What is the abundance, size, and number of fishes caught for cultural use? How do these factors impact those species' long-term sustainability?

3. Sustainable Development for Palau: Developing a domestic pelagic fishing industry and supporting existing sustainable tourism initiatives

Subgoal 1: Enhance the contribution of the Domestic Fishing Zone to economic development, food security and the conservation of the coral reef fish and invertebrate populations.	
First Priority	How effective are Fish Aggregating Devices (FADs) at increasing fishing efficiency?
	What type of FADs are currently in place, what is their condition, and are other FAD materials or configurations likely to be more effective?
	Who funds the FADs? Who deploys and maintains them? Where are they located?
	How many fishers use the FADs? How frequently are FADs visited?
	What is the cost of operating on a FAD (e.g., fuel cost) versus benefit of operating on a FAD (e.g., efficiency of catch compared to non-FADs, price of catch).
	How many fishers are engaged in the DPF?
	How does income change through time for pole and line fishers? What are their operating costs and how much do they sell their catch for?
	What are the most viable business plans for developing a DPF? What infrastructure investments (e.g., fleet, processing, marketplace) for pelagic fisheries development are being considered?
	What training opportunities are being provided to fishers for engaging in the DPF? What is the investment in safety training and equipment for those fishers?
Second Priority	Where does pelagic catch enter the marketplace and how is it distributed?
	What is the proportion of fisheries products imported from overseas (e.g., canned tuna), compared to locally sourced seafood?
Subgoal 2: Support Palau's brand as a high-value ecotourism destination.	
First Priority	How is the PPEF distributed throughout the economy?
	How does the "Pristine Paradise" branding influence Palau's appeal to tourists with regard to the open ocean environment? What proportion of tourists said that they visited Palau as a result of the establishment of the PNMS?
	Where do tourists spend money?
Second Priority	How is the PNMS messaging being used to promote tourism?

Subgoal 3: Support long-term health and well-being for Palauan residents.	
First Priority	What does wellbeing mean to Palauan residents?
	What are the cultural effects of PNMS implementation on Palauans?
Second Priority	What is the proportion of Palauan residents that present non-communicable diseases and how does it change through time?
	What are the community effects of the no-take and domestic fishing zones on Palauan residents?

Subgoal 4: Support long-term economic sustainability in Palau.	
First Priority	How do jobs and employment distribution (e.g., gender, age) in ecotourism change through time?
	How do jobs and employment distribution (e.g., gender, age) in fisheries and fishing-related operations change through time?
	How does the PNMS legislation support Palauans beyond fishing and tourism (e.g., new jobs in monitoring, research, administration, etc.)?

Appendix E.
Acronyms

AIS	Automatic Identification System
BMR	Bureau of Marine Resources
DFZ	Domestic Fishing Zone
DPF	Domestic Pelagic Fishery
EEZ	Exclusive Economic Zone
FAD	Fish Aggregating Device
IUU	Illegal, unreported and unregulated fishing
IUCN	International Union for Conservation of Nature
MPA	marine protected area
MOF	Ministry of Finance
MOJ	Ministry of Justice
MNRET	Ministry of Natural Resources, Environment and Tourism
OEK	Olbiil Era Kelulau
PICRC	Palau International Coral Reef Center
PNMS	Palau National Marine Sanctuary
PNA	Parties to the Nauru Agreement
PAE	Party Allowable Effort
PPEF	Pristine Paradise Environmental Fee
SPC	Secretariat of the Pacific Community
VDS	Vessel Day Scheme
VMS	Vessel Monitoring System
WCPFC	Western Central Pacific Fisheries Commission

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For more information visit:
picrc.org/picrcpage/palau-national-marine-sanctuary

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