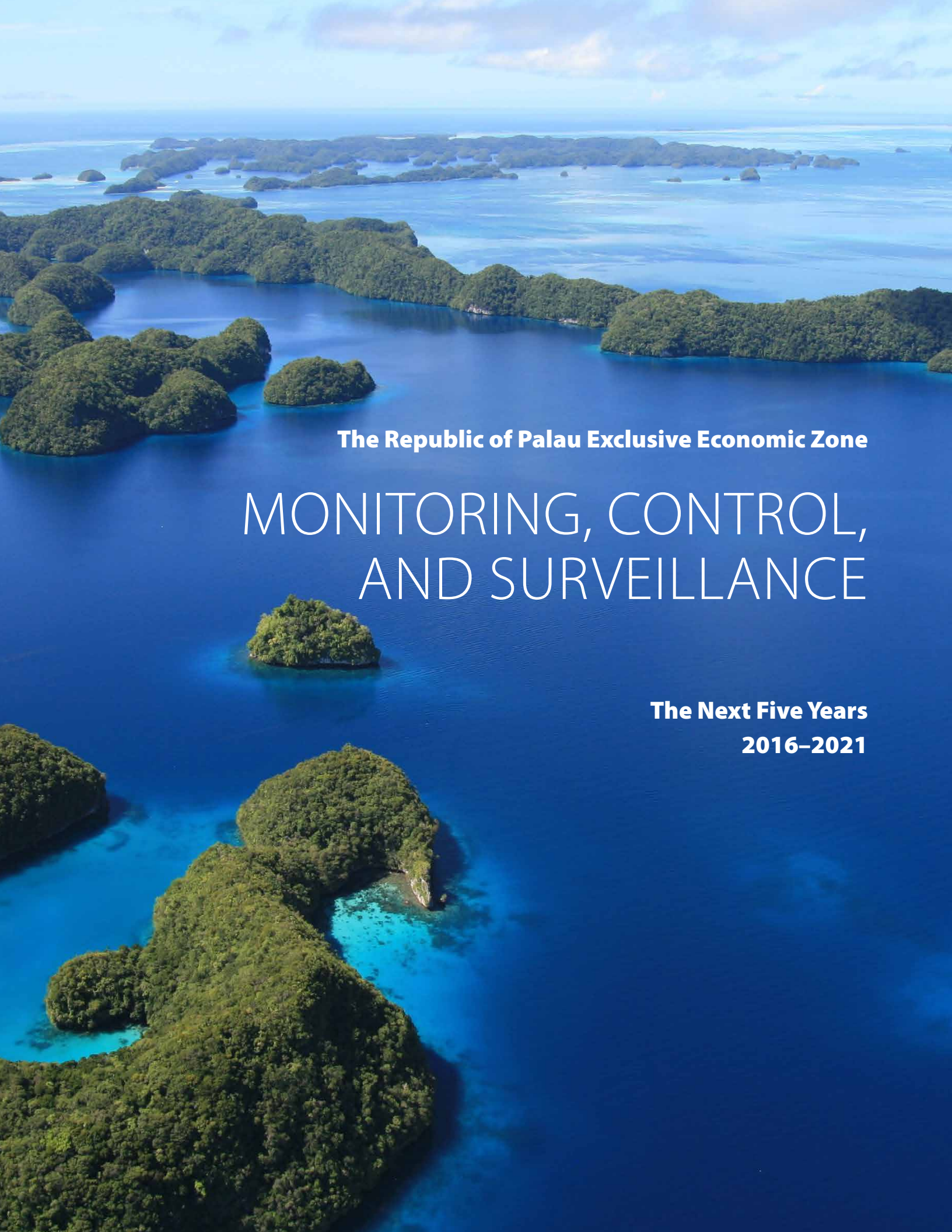

The Republic of Palau Exclusive Economic Zone

MONITORING, CONTROL, AND SURVEILLANCE

The Next Five Years
2016–2021

VISION

By December 2021, the Palau National Marine Sanctuary will be fully established, incorporating robust monitoring and control measures that have sufficient financial and legal support to protect Palauan marine resources from man-made pollution, exploitation, and/or illegal activity.

MISSION

Beginning in January 2020, Palau Marine Law Enforcement, in collaboration with local, state, national, partner nations, and nongovernmental and intergovernmental organizations, will conduct continuous monitoring and control operations to deter, detect, investigate, and/or interdict maritime violations of the Palau National Marine Sanctuary in order to protect Palauan natural resources from illegal fishing, criminal acts, or other activities that are detrimental to the natural environment of Palau and its international waters.

Richard Brooks for the Pew Charitable Trusts

The Republic of Palau Exclusive Economic Zone

MONITORING, CONTROL, AND SURVEILLANCE

The Next Five Years
2016–2021

Palau Monitoring, Control, and Surveillance Plan

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Richard Brooks for the Pew Charitable Trusts

Executive Summary

This plan provides recommendations to the Republic of Palau for improved monitoring, control, and surveillance (MCS) of Palau's Exclusive Economic Zone (EEZ). Improved MCS will aid in the deterrence, detection, interdiction, and prosecutions of illegal, unreported, and unregulated (IUU) fishing violations and illegal drug and human trafficking in Palau's EEZ. It will also improve search and rescue, oil spill and disaster response, pollution detection, weather forecasting, and resilience to a changing climate. The proposed actions will also serve to enhance Palau's national security as well as regional security.

The recommendations for improved MCS discussed in this report represent the outcome of the Monitoring, Control, and Surveillance Plan Workshop held from April 15–17, 2015, in Koror, Palau, organized by The Pew Charitable Trusts and Scripps Institution of Oceanography in partnership with the Republic of Palau. The workshop brought scientists, technology experts, and regional security partners from Australia, the United States, Japan, and Palau together with Palau National and State government officials and staff to pool their knowledge and experience in developing needed improvements to Palau's MCS execution. Vision and mission statements developed prior to the workshop by the Office of the President of Palau helped workshop participants focus their efforts:

Vision. By December 2021, the Palau National Marine Sanctuary will be fully established, incorporating robust monitoring and control measures that have sufficient financial and legal support to protect Palauan marine resources from man-made pollution, exploitation, and/or illegal activity.

Mission. Beginning in January 2020, Palau Marine Law Enforcement, in collaboration with local, state, national, partner nations, and nongovernmental and intergovernmental organizations, will conduct continuous monitoring and control operations to deter, detect, investigate, and/or interdict maritime violations of the Palau National Marine Sanctuary in order to protect Palauan natural resources from illegal fishing, criminal acts, or other activities that are detrimental to the natural environment of Palau and its international waters.

The outcome of the workshop was 25 detailed recommendations for improving MCS of Palau's EEZ through advancements in internal and external communications, establishing more precisely the roles and responsibilities of the organizations involved in enforcing marine protection laws, and building additional capacity into Palau's ocean monitoring and surveillance capabilities. Workshop participants recommended implementing a scalable and nested surveillance strategy to address Palau's MCS challenges that is sustainable and efficient. The approach would include: (1) broad surveillance of the EEZ using the Vessel Monitoring System (VMS) and Automatic Identification System (AIS) combined with commercially available Synthetic Aperture Radar imagery and environmental forecasts to identify regions of potential illegal activity as well as identify and track regions of high fishing pressure and high seas vessel traffic; (2) aircraft and offshore patrol vessels cued and deployed to confirm illegal activity, collect evidence, and make interdictions; (3) shore-based radar for detection of illegal activities closer to land that would be followed up by the cooperative efforts of National and State law enforcement. Workshop participants also recognized that a new processing and detention facility is required to handle increases in the number of foreign detainees.

Several workshop recommendations can be acted upon immediately, and include exploiting data from existing ocean monitoring efforts; implementing strategies for the Republic of Palau to strengthen ties with neighbor partner countries and intergovernmental and nongovernmental organizations to leverage MCS expertise; and continuing engagement in Pacific regional partnerships. Other recommendations include improvements in communication and information sharing among National government entities, and between National and State governments, to make better use of existing assets and personnel. Workshop participants recognized the need for capacity building in both capital equipment (e.g., aircraft, patrol vessels, radar) and human resources (personnel, training, maintenance), and for partnerships with external organizations to meet Palau's MCS requirements.

2016–2017 Action Plan

A sustainable financial structure must be implemented to ensure that the MCS initiatives have dependable and sufficient funds to be effective. A two-year action plan was identified to initiate Palau's MCS program as soon as the National Marine Sanctuary bill is signed into law.

- Establish the financial structure for supporting Palau's MCS plan.
- Recruit and train additional Palau Marine Law Enforcement (MLE) officers to meet existing demands, including interdictions based on existing Pacific Islands Forum Fisheries Agency (FFA) data, increased patrols, and the processing and securing of detainees.
- Stabilize the MLE fuel budget to allow for increased EEZ patrols by PSS *H.I. Remeliik*.
- Initiate an MCS human resources study, including development of detailed job descriptions and a chain-of-command reporting structure. The study should include contracting a human resources expert to identify improvements for staff recruiting, performance, education, and retention.
- Conduct engineering studies and begin construction of the Southwest Islands Support Facility.
- Establish a provisional Coordination Center at the DMLE facility to formalize interagency coordination; provide a physical location for display, fusion, analysis, and communication of surveillance data; provide an external focal point for growing Palau's MCS capacity; and centralize MCS responsibilities across Palau's agencies. Begin planning for the funding, construction, and establishment of a permanent Coordination Center.
- Establish robust communications from the provisional Coordination Center to State Rangers at the Southwest Islands and Kayangel and to the patrol boats.
- Establish weekly surveys using the PMA Islander aircraft. At a minimum, a five-hour sortie would be flown weekly, expanding as the MCS operations mature.
- Establish weekly satellite data overpasses from commercially available Synthetic Aperture Radar with no less than 12-hour data and target analysis latencies. Data will be used for cueing the patrol aircraft and the patrol boat, as well as scoping the statistics of total IUU/dark targets within Palau's EEZ. Overpasses of satellite imagery were estimated by workshop participants to be $500K per year if imagery was collected several times a week. Contracting for a large number of scenes on an annual basis will reduce the total cost.
- Establish shore-based radar stations in Kayangel and Hatohobei State, expanding to Sonsoral, Merir, Pulo Anna, Angaur, Peleliu, and Melekeok.
- Install and maintain a data fusion system at the MCS Coordination Center to ingest the data feeds provided by the surveillance assets, the FFA AIS and VMS data, and ocean and atmospheric forecasts of ocean temperatures, currents, winds, and sea state. The fusion system should permit archival analysis of collected data to establish locations of fishing hotspots and pattern recognition of IUU. Archiving of VMS data should begin as soon as possible.

Recommendations

MONITORING

2016 RECOMMENDATION M1. Establish and promote an independent and interagency hotline to receive reports of suspected illegal activity in the maritime domain from members of the public, local fishermen, and boat operators. Explore a financial reward system for tips leading to prosecutions.

2017 RECOMMENDATION M2. Expand the Shiprider program to other countries.

2017 RECOMMENDATION M3. Strengthen the Observer Program by purchasing 30 satellite phones for Palauan observers deployed to licensed fishing vessels, enabling a network of "eyes on the sea."

2016–2018 RECOMMENDATION M4. Create an MCS Interagency Coordination Center to centralize activities of all divisions and ministries related to monitoring, control, and surveillance of the Palau EEZ. Develop and implement a plan for the collection, management, and visualization of fisheries and ocean surveillance data.

CONTROL

2016 RECOMMENDATION C1. Establish an internal Palau MCS Working Group.

2016 RECOMMENDATION C2. Draft and execute MOUs between States and National departments.

2016 RECOMMENDATION C3. Write DMLE job descriptions and disseminate them to staff.

2016 RECOMMENDATION C4. Hire a human resources management consultant to examine and develop a plan to improve staff recruiting, performance, and retention.

2016 RECOMMENDATION C5. Initiate staffing study to identify appropriate MCS personnel allocations from existing National government billets.

2016 RECOMMENDATION C6. Strengthen the capacity and application of Port State Controls to expand the legal reach of enforcement.

2016 RECOMMENDATION C7. Issue warrants before vessels leave the Palau EEZ to facilitate prosecution.

2016 RECOMMENDATION C8. Implement suspension procedures under the FFA Vessel Register to document infractions and deter repeat offenders.

2017 RECOMMENDATION C9. Operationalize the Niue Treaty Subsidiary Agreement to assist regional enforcement.

2017 RECOMMENDATION C10. Develop and implement standard operating procedures for both legal and enforcement actions.

2017 RECOMMENDATION C11. Implement a sustainable financial structure to ensure MCS initiatives have a dependable and sufficient budget.

2018 RECOMMENDATION C12. Implement a comprehensive public relations/outreach program.

2018 RECOMMENDATION C13. Develop a detainee/quarantine program and facility that can accommodate foreigners.

SURVEILLANCE

Communications

2017 RECOMMENDATION S1. Upgrade secure communication hardware and procedures.

Patrol Boats

2016 RECOMMENDATION S2. Recruit and train a sufficient number of police officers to simultaneously operate offshore patrol vessels (OPVs) and inshore patrol vessels (IPVs).

2017 RECOMMENDATION S3. Add one 40-meter class OPV and one 15-meter class IPV, including vessel spares and equipment for crew.

2017 RECOMMENDATION S4. Construct a new wharf at the DMLE facility with the capacity to support two 40-meter class OPVs, three 15-meter class IPVs, and temporary berthing for holding a seized fishing vessel.

2017 RECOMMENDATION S5. Purchase weapons and ammunition for Palau Marine Law Enforcement operations. Construct a secure armory for weapons storage.

Radar Towers

2017–2021 RECOMMENDATION S6. Purchase and install nine radar towers equipped with camera systems for shore-based deployment at the outlying Palau islands.

Surveillance Aircraft

2016–2018 RECOMMENDATION S7. Develop and integrate an aviation surveillance platform and concept of operations for the Palau EEZ.

Southwest Islands

2016–2019 RECOMMENDATION S8. Construct a Southwest Islands Support Facility and develop plans for a refueling station and runway in Hatohobei State to ensure proper enforcement of the southwest region of Palau's EEZ.

Detailed descriptions of the recommendations are available beginning on page 36.

Summary of Costs

MONITORING	Investment	Additional Personnel
M1. Establish Independent Interagency Hotline (2016)	TBD	none?
M2. Expand Shiprider Program (2017)	stipend or salary for Shiprider	1–5
M3. Strengthen Observer Program (2017)	$400 per device	none
M4. Create an MCS Coordination Center (2016–2018)	$150K + add ons	1–3

CONTROL	Investment	Additional Personnel
C1. Establish Palau MCS Working Group (2016)	NC	none
C2. Draft/Execute National-State MOUs (2016)	NC	none
C3. Write/Disseminate DMLE Job Descriptions (2016)	NC	none
C4. Hire Human Resources Management Consultant (2016)	$5K–$10K or more	none
C5. Initiate Staffing Study (2016)	TBD	none
C6. Strengthen Port State Controls (2016)	TBD	1–3?
C7. Issue Warrants (2016)	NC	none
C8. Implement Suspension Procedures (2016)	NC	none
C9. Operationalize Niue Treaty Sub. Agreement (2017)	NC	none
C10. Implement Standard Operating Procedures (2017)	NC	none
C11. Implement Sustainable Financial Structure (2017)	TBD	none?
C12. Implement Public Relations/Outreach Program (2018)	$25,000	1–3
C13. Develop Detainee/Quarantine Program/Facility (2018)	TBD	4?

SURVEILLANCE	Investment	Additional Personnel
S1. Upgrade Secure Communication (2017)	$250–$3K each + monthly fee	none
S2. Recruit/Train Police Officers (2016)	TBD	8 + 22
S3. Add OPV and IPV (2017)	Nippon	none
S4. Construct New Wharf (2017)	Nippon	none
S5. Purchase Weapons/Ammo for MLE (2017)	$50,000	none
S6. Purchase/Install Nine Radar Towers (2017–2021)	$750,000 + $20K/yr per tower	none
S7. Aviation Surveillance Platform (2016–2018)	$360K–$2M + significant ongoing costs	0–9
S8. Southwest Islands (2016–2019)	TBD	none

NC = no cost

Background

PALAU'S GEOGRAPHY, CULTURE, AND ECONOMY

The Republic of Palau is a group of islands in the western Pacific Ocean, located approximately 800 km east of the Philippines and 800 km north of New Guinea (**Figure 1**). In addition to sharing maritime boundaries with Indonesia, the Philippines, and the Federated States of Micronesia (FSM), it has two high seas pockets (borders with no adjoining Exclusive Economic Zone [EEZ]). The country's location puts it in close proximity to major fishing nations and the markets of Japan and Taiwan.

Palau's population of approximately 21,000 citizens is spread among a dozen of its 300 islands, with the island of Koror being the most populous. The country's economic base is principally tourism, which is growing rapidly with an influx of wealthy Chinese vacationing abroad. Currently, about 160,000 tourists visit Palau each year, more than twice the number of a decade ago, many seeking to dive on the coral reefs that host abundant marine life: 1,300 species of fish, 700 species of coral, and 130 species of sharks and stingrays. The tourism industry provides for more than 50% of Palau's gross domestic product.

The waters around Palau are home to migratory tuna, among other commercially valuable species. Since 1979 when the EEZ was declared, Palau earns $3–4 million dollars annually from the sale of fishing licenses and access agreements. Overfishing and illegal fishing, however, have contributed to the steep decline in fish stocks over the last decade or more, leading to an initiative to close Palau's waters to most commercial fishing and develop a no-take National Marine Sanctuary (**Box 1**). The Marine Sanctuary, which was passed by the Palau National Congress—the Olbiil era Kelulau (OEK)—and signed into law by President Remengesau in October 2015, follows Palau's long tradition of conservation of their ocean resources, and hence livelihoods, known as "bul." The closure of the fisheries emphasizes the need for integrated monitoring, control, and surveillance (MCS) to protect Palau's vast maritime EEZ.

Figure 1. Map of the Republic of Palau.

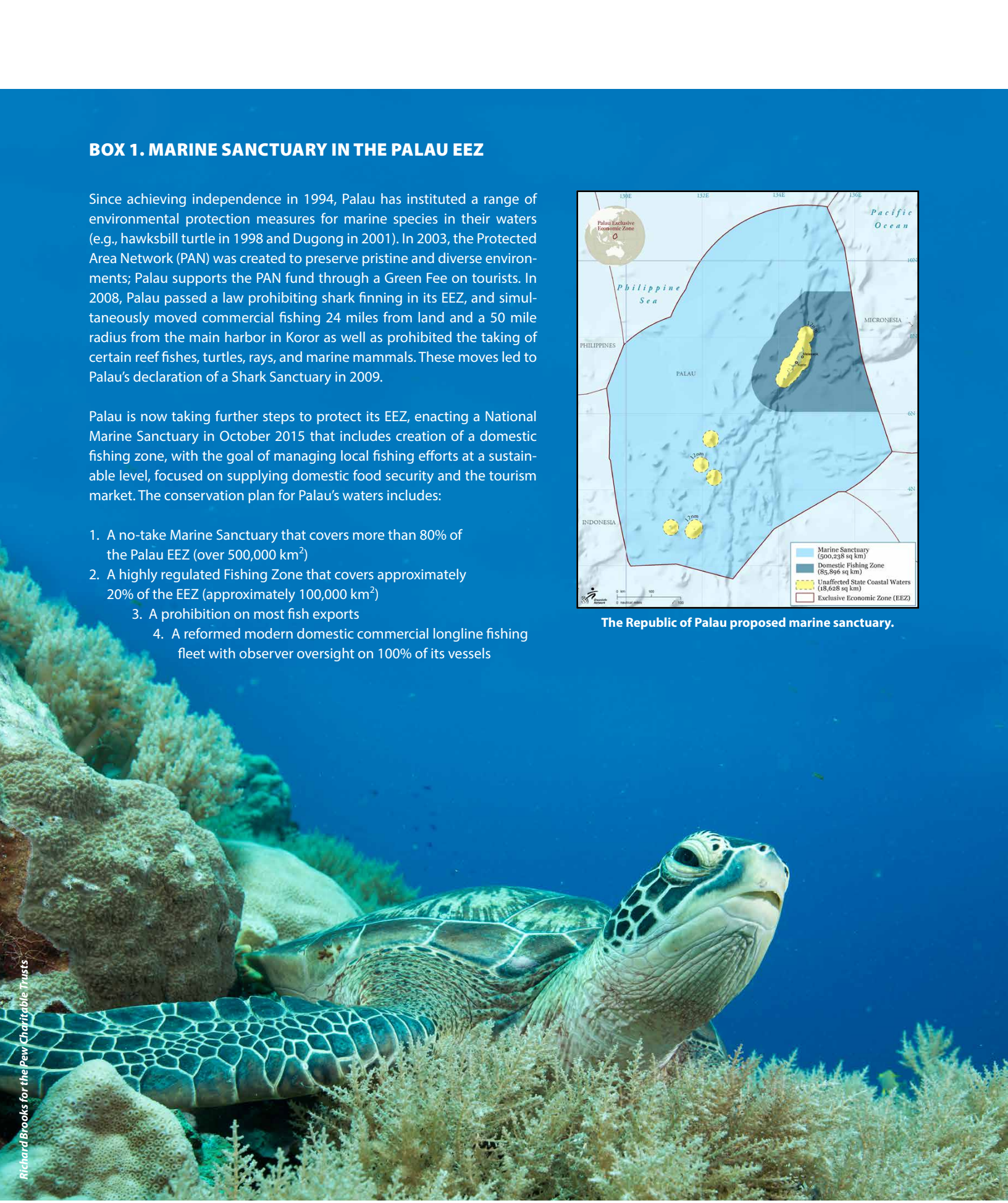
BOX 1. MARINE SANCTUARY IN THE PALAU EEZ

Since achieving independence in 1994, Palau has instituted a range of environmental protection measures for marine species in their waters (e.g., hawksbill turtle in 1998 and Dugong in 2001). In 2003, the Protected Area Network (PAN) was created to preserve pristine and diverse environments; Palau supports the PAN fund through a Green Fee on tourists. In 2008, Palau passed a law prohibiting shark finning in its EEZ, and simultaneously moved commercial fishing 24 miles from land and a 50 mile radius from the main harbor in Koror as well as prohibited the taking of certain reef fishes, turtles, rays, and marine mammals. These moves led to Palau's declaration of a Shark Sanctuary in 2009.

Palau is now taking further steps to protect its EEZ, enacting a National Marine Sanctuary in October 2015 that includes creation of a domestic fishing zone, with the goal of managing local fishing efforts at a sustainable level, focused on supplying domestic food security and the tourism market. The conservation plan for Palau's waters includes:

1. A no-take Marine Sanctuary that covers more than 80% of the Palau EEZ (over 500,000 km^2)
2. A highly regulated Fishing Zone that covers approximately 20% of the EEZ (approximately 100,000 km^2)
3. A prohibition on most fish exports
4. A reformed modern domestic commercial longline fishing fleet with observer oversight on 100% of its vessels

The Republic of Palau proposed marine sanctuary.



Richard Brooks for the Pew Charitable Trusts

DEVELOPMENT OF THE MCS STRATEGY

The Pew Charitable Trusts and Scripps Institution of Oceanography partnered with the Republic of Palau to organize a workshop in April 15–17, 2015, to develop a comprehensive maritime monitoring, control, and surveillance plan for Palau's EEZ. The Monitoring, Control, and Surveillance Plan Workshop, held in Koror, Palau, brought scientists, technology experts, and regional security partners from Australia, the United States, Japan, and Palau together with Palau's National and State government officials and staff to pool their knowledge and experience in developing recommendations for the best approaches to enforce Palau's laws; protect the natural resources; and deter, detect, interdict, and prosecute illegal activities in Palau's EEZ. The information and recommendations presented in this report represent the outcomes of April workshop discussions.

The workshop was kicked off by a presentation on Palau's EEZ and the efforts to designate it a National Marine Sanctuary, and was followed by presentations that assessed the threats to the EEZ, discussed Southwest Islands challenges, and reviewed legislation relevant to the EEZ. The next set of presentations provided information on current capabilities and responsibilities of Palau and its regional partners. A final set of presentations displayed technologies for monitoring and surveillance of Palau's EEZ and provided information on a Palau-US Maritime Domain Awareness demonstration conducted in 2014.

Breakout sessions used the information from the presentations and participants' knowledge and expertise to develop an MCS plan for the Palau EEZ. Participants used the vision and mission statements developed by Office of the President of Palau to focus MCS strategy development.

Vision. By December 2021, the Palau National Marine Sanctuary will be fully established, incorporating robust monitoring and control measures that have sufficient financial and legal support to protect Palauan marine resources from man-made pollution, exploitation, and/or illegal activity.

Mission. Beginning in January 2020, Palau Marine Law Enforcement, in collaboration with local, state, national, partner nations, and nongovernmental and intergovernmental organizations, will conduct continuous monitoring and control operations to deter, detect, investigate, and/or interdict maritime violations of the Palau National Marine Sanctuary in order to protect Palauan natural resources from illegal fishing, criminal acts, or other activities that are detrimental to the natural environment of Palau and its international waters.

A plenary session on the last day of the workshop consolidated the findings and recommendations of the two breakout groups, developed cost estimates associated with the recommendations, and identified partnership opportunities that would strengthen both Palau's national and regional security.

Monitoring, Control, and Surveillance

Monitoring is the continuous requirement for the measurement of activities occurring within an EEZ.

Control is the regulatory conditions, to include enforcement, under which activities within an EEZ may be conducted.

Surveillance is the degree and types of observations required to maintain compliance with the regulatory controls imposed on activities within an EEZ to include enforcement activity coordination.

The Need for Enhanced Monitoring, Control, and Surveillance of Palau's EEZ

More effective monitoring, control, and surveillance of Palau's EEZ will have multiple benefits. Principal among them is greatly improved deterrence, detection, interdiction, and prosecution of illegal activities, including illegal, unreported, and unregulated (IUU) fishing; transshipment of contraband; and human trafficking. An effective and complete MCS system will also improve search and rescue capacity, oil spill response and pollution detection and management, and weather forecasting and disaster preparation and response.

Palau's vast western Pacific EEZ of almost 604,000 km^2 creates a challenge for monitoring fluctuations in ocean conditions, which define the oceanic habitats of the pelagic fish, fish stocks, the fishing pressures on those stocks, and the oceanic ecosystem as a whole. Few data are collected and synthesized in a manner that allows for ecosystem-based management decisions of Palau's EEZ waters. Data collected through deployment of additional technologies that improve MCS could also be used to implement ecosystem-based management practices. Increased monitoring and surveillance of the EEZ will also allow Palau to assess environmental issues such as sea level rise, coastal erosion (e.g., Southwest Islands such as Helen Reef are at high risk), and coral reef bleaching, and take appropriate actions.

ILLEGAL, UNREPORTED, AND UNREGULATED (IUU) FISHING

Fishing in Palau's EEZ is currently regulated through license agreements with the National government and in cooperation with the Western and Central Pacific Fisheries Commission (WCPFC). The Pacific Islands Forum Fisheries Agency (FFA) serves as an advisory and capacity building body as well as a direct service provider to the Pacific Island countries. FFA manages the FFA Vessel Monitoring System (VMS), one of two primary VMS run in the region. FFA VMS is an automatic reporting system for registered fishing vessels that are licensed to operate and fish within FFA member waters. It is a satellite-transponder-based system that broadcasts a vessel's identity, position, and other information. The WCPFC also runs a VMS for fishing vessels that operate in the region, primarily on the high seas. The Automated Identification System (AIS) is an electronic transponder system required for all vessels over 300 gross tonnage as per Regulation 19 of SOLAS Chapter V (International Maritime Organization). AIS was originally designed to increase safety and prevent collisions at sea, but its commercial availability has resulted in it being used increasingly as a means to monitor and track vessels. AIS is not mandatory for fishing vessels unless a coastal state requires it for its own flagged ships or vessels licensed to fish while in waters under its jurisdiction, providing a somewhat limited view of the fishing traffic. Detailed monitoring of both licensed and unlicensed fishing boats through analysis of AIS and VMS data can reveal patterns consistent with illegal fishing activities in Palau's EEZ, and allow for future development of automated detection routines.

Forms of IUU fishing (**Box 2**) that have been documented in the Palau EEZ include shark finning, unauthorized placement of fish aggregation devices (FADs; **Figure 2**), unlicensed purse

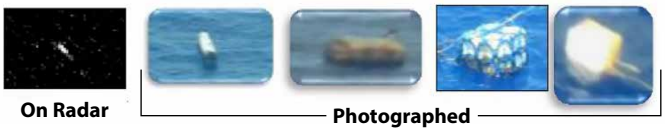


Figure 2. Examples of fish aggregation devices (FADs) detected by airborne radar or by aircraft operators during a five-week period of routine patrols in the Palau EEZ in summer 2014 as part of an Island Maritime Domain Awareness demonstration (see Box 3 for fuller discussion). Five of the FADs were determined to be illegally placed.

BOX 2. IUU FISHING DEFINITION

Illegal Fishing

Refers to fishing activities:

- Conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations
- Conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law
- In violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organization

Unreported Fishing

Refers to fishing activities:

- That have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations
- Undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization

Unregulated Fishing

Refers to fishing activities:

- In the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization
- In areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law

seiner and long-liners intermingling among the licensed fleet fishing for commercially regulated species, small coastal boats raiding reefs of their clam beds and sea cucumbers (**Figure 3**), poachers fishing the reefs and atolls of the Southwest Islands, and fishing of undersized or out-of-season species. While the smaller boats that approach and illegally fish the reefs have been known to originate from Vietnam, Indonesia, and Philippines, the larger illegal commercial fishing vessels typically originate from Asia and are of the same size and style as the licensed and regulated vessels (**Figure 4**). For example, in 2014, arrests of over 74 Vietnamese fishermen in six different vessels took place in three separate incidents in March, October, and November. Similar vessels from Vietnam have also been found in the Federated States of Micronesia (FSM). Vessels from Asia have also been known to deploy smaller vessels that illegally fish closer to shore. An example was the April 2012 incident that ultimately resulted in the sinking of the mothership, the death of a Chinese fishermen, and the loss of two Palau police officers and an American pilot after their plane was lost searching for additional fishing boats near Velasco Reef.

The use of FADs, large floating buoys designed to attract fish, is another common practice of illegal fishermen in the western Pacific (**Figure 2**). FADs significantly reduce the time required to catch fish by taking advantage of their natural response to aggregate near floating objects. Most FADs are placed far offshore in a drifting mode with a satellite buoy attached so they can be remotely monitored. Many FADs have sonar capability, allowing fishing companies to remotely determine how much fish they hold. In some areas, including high seas areas very close to Palau's EEZ, FADs are anchored to the seabed through a long mooring line.

Transshipment of fish taken illegally occurs on the high seas. In one example, a raft that moves between two vessels carries out the transfer. Photographic evidence shows the presence of sharks, an illegal fishing take in Palau EEZ waters (**Figure 4**).

Figure 3. Palau authorities burned four Vietnamese "Blue Boats" that were caught fishing illegally off of Kayangel Island. The unauthorized boats were discovered in a protected area with over 8 metric tons of sea cucumbers and reef fish on board. Since 2014, 15 Blue Boats from Vietnam have been captured stealing over 25 metric tons of Palau's marine species for the black market in Asia. This recent influx of Vietnamese fishing boats in the Palau and Federated States of Micronesia EEZs is thought to be a result of increased Chinese presence in the South China Sea. ***Photo credit: Matt Rand for The Pew Charitable Trusts***

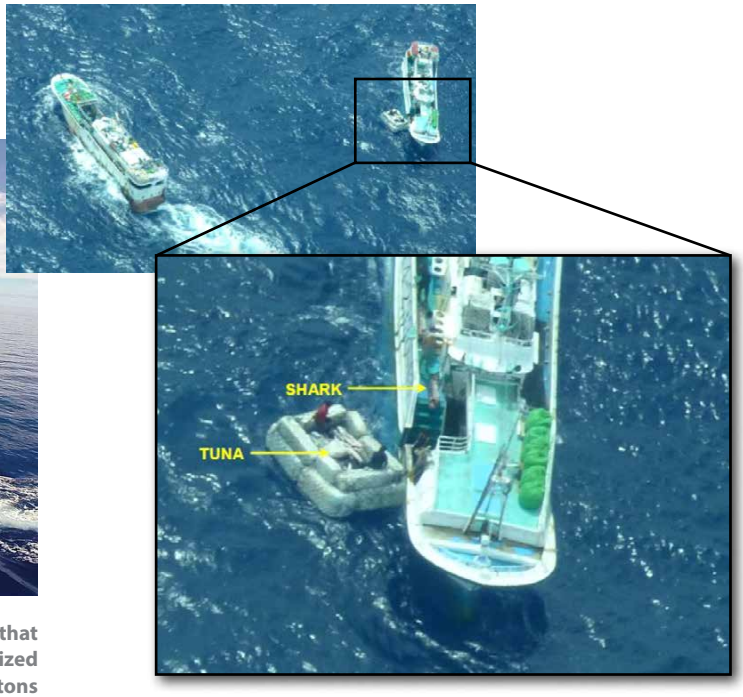


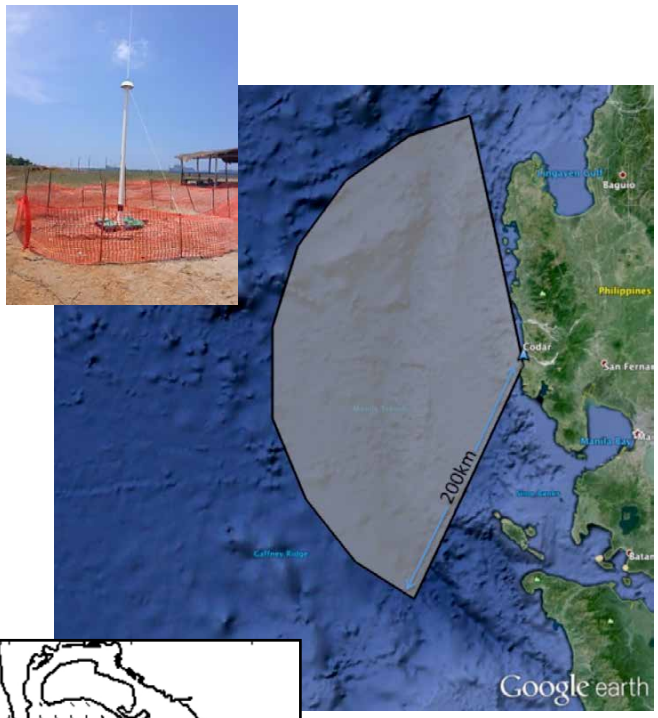
Figure 4. Example of IUU fishing activity between two vessels on the high seas. The raft is being used to transfer tuna and shark between one vessel and another. The image was captured during the 2014 Island Maritime Domain Awareness demonstration (see Box 3) using the small aircraft flown by Pacific Mission Aviation and a camera operated by TSC personnel that were also deployed to operate an airborne radar.

ILLEGAL TRAFFICKING

With the high seas unregulated, evidence exists for human trafficking and the drug trade, among other illegal activities. Human smuggling on the high seas is an increasing threat, and was the subject of a multinational meeting on March 16, 2015, between the FSM, the Republic of Palau, Australia, and US representatives from the Department of State, US Pacific Command, Joint Region Marianas, Department of Homeland Security, Federal Bureau of Investigation, US Coast Guard, and Scripps Institution of Oceanography. Compounding pressures from Australia tightening their EEZ to illegal immigration and China asserting their claims to fishing grounds in the South China Sea suggest that there will be an increase in the amount of human smuggling cases in the FSM and Palau EEZs. The vast majority of the small boats are originating from Indonesia, where an estimated 10,000 individuals are awaiting transport to other countries. On November 17, 2014, FSM captured a vessel near Yap with 53 individuals who had paid for transit to the United States, where traditionally their destination would have been Australia. The occupants were primarily from India and Nepal and, when questioned, they indicated that they did not want to return home. Increases in human smuggling pose a burden to the legal system; housing captured illegal immigrants is costly, and these people can potentially introduce infectious diseases.

SEARCH AND RESCUE

A large percentage of Palau's tourism industry depends on water activities, including diving, boat tours, and sport fishing. Many of the same tourist activities are also local recreational activities, such as canoe paddling and traditional voyaging. Improved understanding and forecasting of ocean state (**Figure 5**), including currents, wind, and waves, will provide safer boating conditions and support search and rescue missions when needed. Ocean current forecasts are especially needed, as divers can be swept away in regions of high currents such as those in the Peleliu and Anguar dive sites.



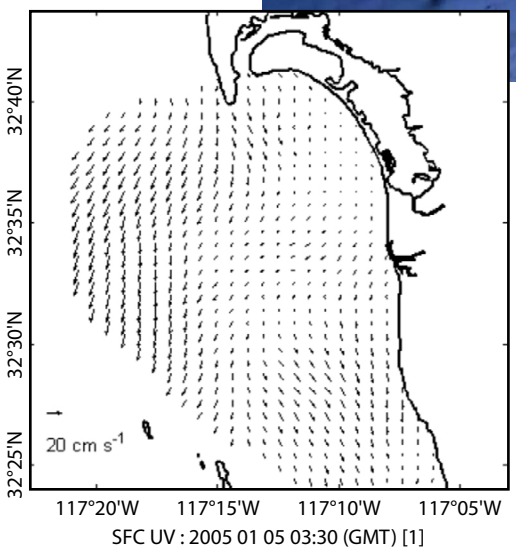


Figure 5. High-frequency radar can be used for monitoring ocean conditions as well as surveillance.

OIL SPILL RESPONSE AND OCEAN POLLUTION

At present, Palau imports all petroleum products. While the safety record is excellent, improved ocean current, wind, and wave data would support oil spill response efforts should a spill ever occur. In addition, currently there are no means for detecting or tracking offshore/illegal discharges (**Figure 6**). A system that improves ocean forecasting will also assist the country in managing future petrocarbon exploration and development, such as the exploratory drilling planned for Velasco Reef. In a similar manner, understanding the impacts to coastal habitats and ecosystems requires forecasting of the fate and transport of ocean pollution and discharges. In light of recent typhoon activity impacting the main island group, the risk of accidental land discharges during a disaster increases.

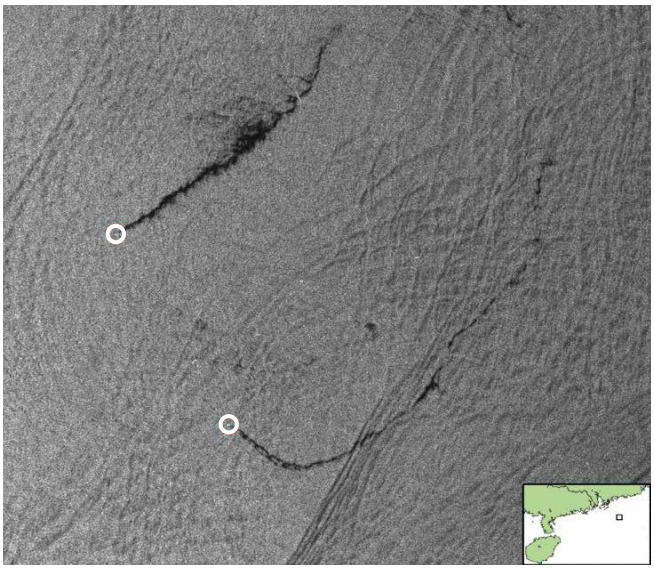


Figure 6. An ERS-2 Synthetic Aperture Radar image from May 25, 2007, at 14:44 GMT, showing illegal discharge from two vessels (circled) in the South China Sea. This type of oil spill is characterized by a thin trail following the path of the ship. ***From Caruso et al., 2013, http://dx.doi.org/10.5670/oceanog.2013.34***

WEATHER FORECASTING AND DISASTER RESPONSE

While Palau is traditionally not considered to be in the alley of typical western Pacific typhoon tracks, two super typhoons have recently impacted the island (Bopha in 2012 and Haiyan in 2013; **Figure 7**), damaging infrastructure including buildings, toppling trees, disrupting communications, flooding wastewater facilities, and inundating freshwater supplies with seawater. In addition, coral reefs on the eastern side of the islands were significantly damaged, and many of the beaches were subject to erosion. Accurate weather forecasting capabilities embedded within a Maritime Domain Awareness system will help not only promote safe maritime operations, but support emergency planning in the approach of storms.

Figure 7. (bottom) Damage at Kayangel Island as a result of Super Typhoon Haiyan. ***Credit: Office of the President, Republic of Palau.*** **(top) Satellite image of Super Typhoon Haiyan.** ***Credit: NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response.*** **Automatic reporting weather stations on Velasco Reef, Oningyang Island, and Helen Reef Island provide data to the Joint Typhoon Warning Center (Honolulu) and the NOAA National Weather Service Office in Guam. These stations are operated by Scripps Institution of Oceanography, and data can be fused into a Maritime Domain Awareness system.**

CLIMATE CHANGE ADAPTATION

The economics and stability of island nations depend on ocean conditions. Sea level rise, a warming ocean, and changes to local ecology and fisheries can rapidly affect the nutrition and economies of these countries. Understanding island response to secular changes in ocean state will help maintain geopolitical stability of island nations. While much discourse remains in predicting long-term changes to sea level, short-term fluctuations due to changes in ocean state (the El Niño-Southern Oscillation and the Pacific Decadal Oscillation), and variability of ocean currents hold promise for developing forecast skill. For example, Pacific-basin-scale wind changes are already attributed to increases in sea level that have been observed since the 1990s (**Figure 8**).

Sea level fluctuation particularly affects low-lying islands (annual variability can be 20 cm), and when coupled with large storm impacts, the islands could become completely denuded. An example of these conditions and the resulting geopolitical implications is found at Helen Reef, an outlying Palauan island located 360 nm south of the main island chain that sits at the boundary between Philippine, Indonesian, and Palauan EEZ waters (**Figures 9 and 10**). Occupied by approximately six rangers, the small, low-lying (600 m × 70 m) sand island is sensitive to storm erosion and fluctuations in sea level. If the island were to disappear, the Palauan Ministries predict that Indonesia's claim to EEZ waters would expand by 140,000 km^2. Clearly, Palau's Southwest Islands play a critical role in monitoring and surveillance of Palau's EEZ.

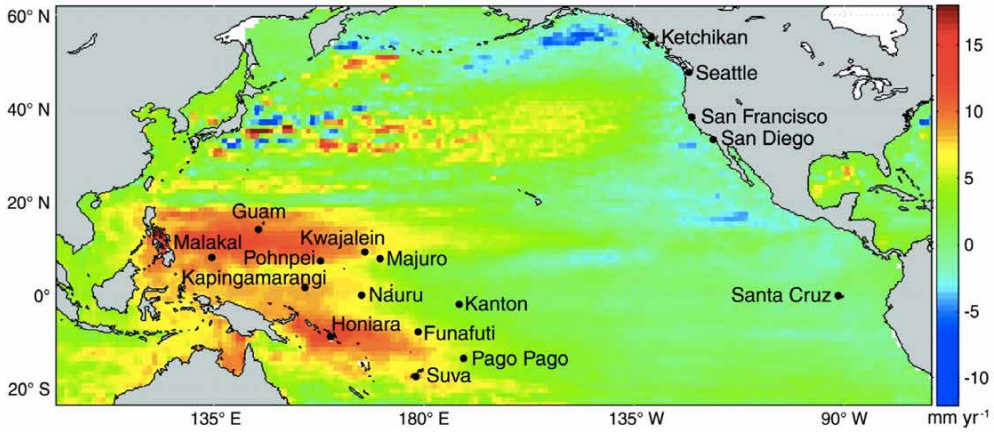


Figure 8. Pacific sea level rise rates (mm/year) averaged over the last 20 years. The map illustrates how sea level rise has been greater in the western Pacific.

Figure 9. (left) General location of Helen Reef in the western Pacific. (left middle) The Helen Reef atoll system. (right middle) Helen Reef Island, approximately 600 m × 70 m. (far right) Photos of Helen Reef Island and wildlife. The panel of pictures illustrates the vulnerability that the outer islands have to changing environmental conditions. Tracking these conditions is a form of environmental surveillance, which is included in a comprehensive MCS strategy.

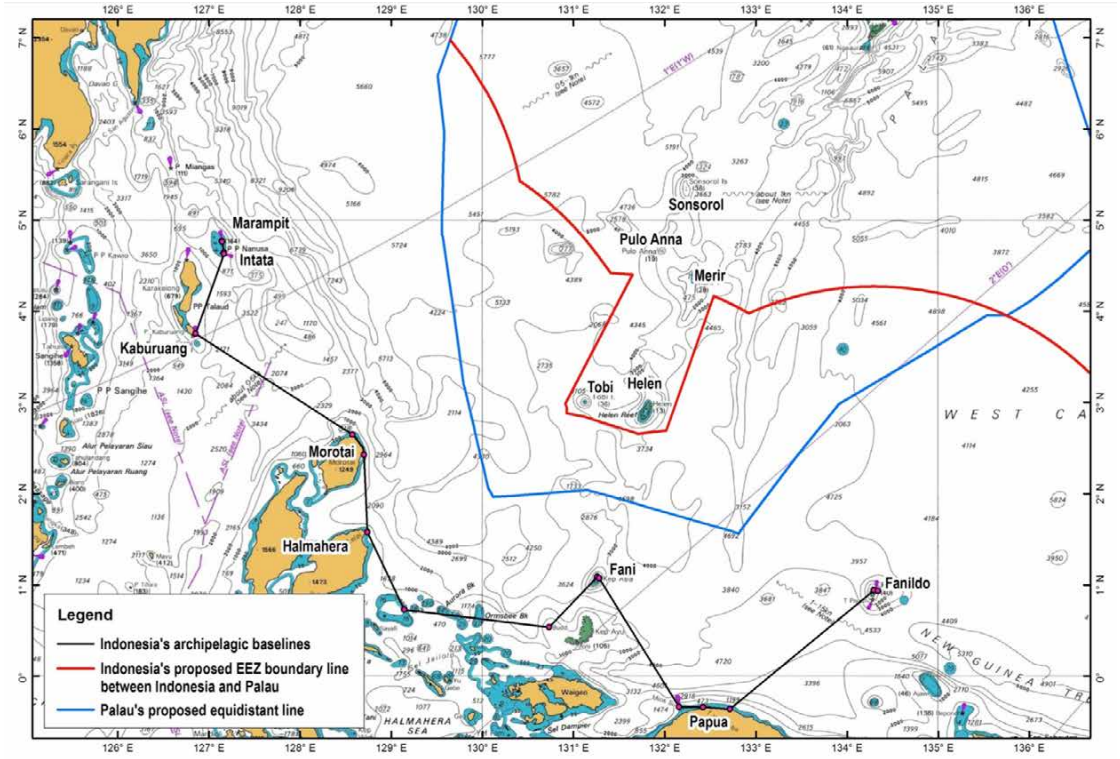


Figure 10. Boundary dispute lines between Indonesia and Palau that center upon the existence of Helen Reef Island. MCS surveillance of vessel traffic in this portion of the EEZ is critical to Palau's sovereignty. ***Figure provided by Republic of Palau Ministry of Public Infrastructure, Industries, and Commerce***

Current Capabilities and Responsibilities

NATIONAL GOVERNMENT

Many Ministries and Divisions are responsible for enforcing laws related to illegal fishing, drug trafficking, stewardship of ocean ecosystems and resources, pollution, and search and rescue, among other issues. To be able to formulate recommendations for an MCS system, it is essential to identify and assess Palau's current capacity related to marine law enforcement, the roles and responsibilities of different departments regarding MCS, the chain of command for decision making, interagency partnerships and information sharing, and clear definition of the law and legal precedence of enforcement. Regional partners, including Australia, The Nippon Foundation, the Pacific Islands Forum Fisheries Agency, and the United States, provide an array of support to Palau, from vessels, to surveillance data, to training, to direct funding of consumables such as fuel for patrol boats.

The Bureau of Marine Resources, Ministry of Natural Resources, Environment, and Tourism

The Bureau of Marine Resources of the Ministry of Natural Resources, Environment, and Tourism implements national-level fisheries management measures. The 16 State governments control all resources from the shoreline up to 12 nm offshore (except for the tuna resources). The Ministry has the duties, functions, and authority to: (a) adopt regulations for the conservation, management, and exploitation of all living resources in the contiguous zone and EEZ of the Republic of Palau; (b) negotiate and conclude foreign fishing agreements; (c) issue foreign fishing permits; and (d) perform such other duties and functions as may be necessary. The Bureau of Marine Resources determines the annual total allowable level of foreign fishing permitted with respect to specific fisheries. The regulations establish the total allowable level of foreign fishing, catch limits, and allocation so as to ensure the long-term sustainability and health of fish stocks, populations of living resources and reef fish, and submerged reef within the territorial sea, internal waters, contiguous zone, and Palau's EEZ.

The Bureau generates fisheries data through a robust data collection and verification system. These data come from required information submitted for licensing, fishing conditions, catch and landing data, and the Observer Program in the form of logsheets, port sampling forms, unloading forms, port visit logs, telex reports, and observers reports. Data collection enables Palau to meet its reporting obligations to national and regional fisheries management organizations.

Division of Marine Law Enforcement (DMLE)

The Division of Marine Law Enforcement (DMLE) is part of the Bureau of Public Safety, which in turn is part of the Ministry of Justice. It is responsible for marine surveillance of the Republic of Palau's territorial waters and its 200 nm EEZ, and the enforcement of laws and regulations, including, but not limited to, those related to fishing, environmental protection, and narcotics trafficking. The DMLE also conducts water safety inspections on boats for hire and dockside inspections, and responds to distress calls and assists in search and rescue. In addition, DMLE personnel are used to manage detainees who are currently accommodated at a temporary shelter outside of the DMLE building.

DMLE responds to tasking from the Director of the Bureau of Public Safety, who in turn reports to the Minister of Justice. State authorities channel requests for assistance through the Ministry or Bureau—there is little direct contact other than in the case of a search and rescue or a medical evacuation. There is little interaction between DMLE and State Rangers other than those from Helen Reef and Tobi, who occasionally contact DMLE either directly or via their main office to report suspected illegal vessels in the southern EEZ.

Figure 11. (top) Offshore patrol vessel PSS *H.I. Remeliik*. (bottom) Inshore patrol vessel *Kabekel M'tal*.

To carry out their duties, the DMLE uses the 30-meter offshore patrol vessel (OPV) PSS *H.I. Remeliik*, which was donated in 1996 by Australia as part of the Pacific Patrol Boat Program (**Figure 11**). The vessel is owned and crewed by DMLE. This boat is the primary asset for fisheries surveillance in Palau's EEZ. *Remeliik*'s endurance enables law enforcement to make arrests anywhere inside the EEZ; however, the vessel's limited size and speed means that it takes a significant amount of time to patrol a sizable area. *Remeliik* is also limited to conducting boarding operations in sea state 3 and below. With an EEZ that is approximately 600 nm × 450 nm, one patrol boat cannot provide adequate EEZ surveillance.

DMLE also has two small 15-meter inshore patrol vessels (IPVs), *Kabekel M'Tal* and *Bul*, donated by The Nippon Foundation (**Figure 11**). DMLE uses these smaller boats for the surveillance of inshore and territorial waters. They are not suitable for operating outside the 12 nm territorial sea boundary in anything other than benign conditions. The vessels can cover inshore areas quickly, but have a very limited endurance and are not ideal for boarding operations; their hulls are constructed of fiberglass and can easily be damaged if rafted up alongside another vessel without adequate fendering.

In addition, DMLE owns and operates two small craft: a search and rescue Rigid Hulled Inflatable Boat (RHIB) and a twin 85 HP boat. They are used only for inshore operations (search and rescue and police tasking).

Currently, DMLE has 25 Government of Palau funded positions (although some are currently vacant). This staffing level enables operation of the headquarters and *Remeliik*. The positions include:

- 18 *Remeliik* crew (police officers)
- 7 base staff:
  - Chief of DMLE (police officer)
  - OIC Surveillance (police officer)
  - VMS Officer (police officer)
  - Base Technical Officer (police officer)
  - OIC Workshop (police officer)
  - Water Safety Officer (police officer)
  - Administrative Assistant (civil servant)

The Sasakawa Peace Foundation funds a living allowance for a further five positions on one-year contracts. These people are often referred to as OJTs (On the Job Training), and they support the DMLE staff. OJTs are not police officers. Their training program is prepared by the DMLE, but some support from Japan or other partner government with experience in marine law enforcement is anticipated as the MLE's tempo of operations increases.

Palau, as a member of the FFA, is provided with a complete picture of the known fishing vessel activity within the Palauan EEZ by the Regional Fisheries Surveillance Center (RFSC) in Honiara (see a more detailed description of the Regional Surveillance Picture on page 26). DMLE responds to suspected illegal activity in different ways depending on the circumstances. Direct interdiction is the most immediate response, but that is not always possible because there is neither sufficient fuel nor qualified personnel to have *Remeliik* permanently on standby. Pacific countries have a long history of cooperating with each other on suspect activities, either informally or through specific instruments such as the Niue Treaty Subsidiary Agreement. These mechanisms open up avenues such as monitoring suspect vessels until they enter the port of another country and seeking assistance from that country to board and inspect the vessel. There are also formal procedures for working with flag States. Where specific cases are identified, FFA is able to provide assistance in the preparation of evidence briefs and throughout any prosecution/negotiation.

Office of the Attorney General

The Attorney General's office currently assists MCS by acting closely with Marine Law Enforcement to promptly resolve prosecution of cases when violators have been detained. MLE notifies the Attorney General as soon as a vessel is seized and, if necessary, provides legal advice and direction pertaining to the specific circumstances of the seizure. When a vessel is brought back to Palau for disposition, the Attorney General works with local and international agencies to secure translation services if needed (e.g., the recent Vietnamese fishing boat seizures required a translator from the US Coast Guard). The Republic of Palau has historically seized the boats through civil forfeiture proceedings; however, the current practice focuses also on criminal charges against the boat captains. The Attorney General contacts boat owners in their home country and notifies them of the intent to seize and prosecute crew members. The Assistant Attorney General assigned to the case determines which law to use to prosecute the boat captains, as fishing, labor, and immigration laws were violated. The Attorney General also monitors the conditions of detained boat crew members to ensure that their civil rights are respected. The Assistant Attorney General is also responsible for courtroom prosecution, and this office also worked with MLE and the Environmental Protection Board in arranging the permits and approval for destruction of the seized vessels.

STATE GOVERNMENTS

Individual States are responsible for the fishing and protection of territorial waters (0–12 nm), however, individual States do not have their own police and law enforcement agencies. Each State has its own State Rangers who vary widely in ability, training, numbers, and organization. States with the best resources and organization are those whose jurisdictions include tourist areas where access fees can be levied via permits (e.g., Koror State), and the State Rangers are responsible for administering/enforcing permits. State Rangers cannot arrest anyone because, in general, they are not law enforcement. The exception is the Southwest Islands, where eight State Rangers have been deputized by the Director of the Bureau of Public Safety following some police training.

States are responsible for administering State waters, but the national authorities (DMLE and Division of Fish and Wildlife Protection) remain responsible for law enforcement in State waters, just as the National police enforce and investigate illegal activities on shore throughout Palau.

REGIONAL PARTNERS

Australia

Provision of Assets. Under the Defense Cooperation and Pacific Patrol Boat Programs, Australia provides a wide variety of assistance to Palau and other Pacific Island Countries to help them protect their EEZs and promote regional security. Specifically, Australia provided Palau with PSS *H.I. Remeliik* in 1996. Australia also constructed the current DMLE headquarters in 2001 and constructed the patrol boat wharf in 2002. Australia provides two full-time advisors to Palau: a Maritime Surveillance Advisor (MSA) and a Technical Advisor. They provide advice to the Chief of DMLE and the Director of the Bureau of Public Safety on the maintenance, operation, and employment of *Remeliik*, administer Australian support to DMLE, and advise the Chief of DMLE on the conduct of surveillance operations. Australia also provides ongoing support, including: (1) annual fuel funding for all FFA operations and some national operations; (2) funding for approved projects requested by DMLE in support of *Remeliik*, for example, additional kit/equipment, warehouse construction, building renovations, and US Coast Guard MLE training; (3) training of DMLE personnel at the Australian Maritime College via a continuum of progressive courses specific to Pacific class patrol boats on subjects such as mechanical engineering, electrical engineering, seamanship, cooking and hygiene, navigation, bridge watch-keeping, general management, and fisheries boardings; and (4) availability of broader courses provided by defense.

The Pacific Patrol Boat Program will be superseded by the Pacific Maritime Security Program (PMSP) commencing in 2018. Under the PMSP, Australia will provide Palau with a new patrol boat to replace *Remeliik*; the replacement vessel will be substantially larger (up to 40 m in length), which will increase the vessel's endurance and enable the conduct of boarding operations in sea state 4. It is also likely that the replacement vessel will be fitted with satellite communications systems, allowing secure and effective communication between the vessel and the shore. The PMSP will also incorporate the provision of aerial surveillance to participating nations to complement the operations of the new Australian patrol boat.

The Nippon Foundation Group

Working with the Republic of Palau, The Nippon Foundation and The Sasakawa Peace Foundation have contributed to improving Palau's coast guard capability by providing assets such as the 15-meter patrol crafts *Kabekel M'Tal* and *Bul*, the 7-meter high-speed Police Search and Rescue Unit, and radio communications facilities (HF antennas and transmitters, VHF repeater systems for northern and southern areas, and satellite communications equipment). The Nippon Foundation also provides operational assistance such as fuel for IPVs and the vessel participating in FFA-led multinational law enforcement operations, annual maintenance of IPVs, and satellite communication fees. The Sasakawa Peace Foundation funds five OJT personnel. The Nippon Foundation has been planning to further assist Palau by providing a 40-meter OPV, an additional IPV, and berthing facilities for OPVs and IPVs and other vessels.

Pacific Islands Forum Fisheries Agency

Training and Capacity Building. FFA provides a range of opportunities to its members, including an MCS Officer Foundations and regional prosecutors awareness courses, training in dockside boarding and inspection and VMS, and training for shipboard observers.

Surveillance Data. FFA provides each member, which includes Palau, with a live feed of a risk analyzed Regional Surveillance Picture of all fishing vessels that operate in or near their EEZs (see p. 26 for details).

Regional Exercises. Palau participates in three out of the four major regional MCS operations organized each year by the FFA Regional Fisheries Surveillance Center. These operations, which bring together surface forces (e.g., Palau's PSS *H.I. Remeliik*) from throughout the region with aerial and surface assets from the Quadrilateral Defense Coordinating Group ("Quads"—Australia, New Zealand, United States, and France), are aimed at the detection and deterrence of illegal fishing vessels. While the FFA provides the Regional Surveillance Picture and analysis of all visible fishing vessels in the region year-round, this effort is particularly focused and effective when conducted in conjunction with the air and surface support provided by the Quads. Palau receives approximately six to 10 air surveillance days per year from the Quads assets.

United States

Shiprider Program. In support of regional maritime security efforts, through a bilateral agreement, the Republic of Palau may embark Palauan law enforcement officers on board select US Coast Guard law enforcement vessels or aircraft. The embarked officer exercises authority to grant the US Coast Guard vessel or aircraft, on behalf of the Government of the Republic of Palau, authority to enter Palau's territorial seas and (1) assist the embarked officer to stop, board, and search vessels suspected of violating Palau's laws or regulations; (2) assist in arrest of persons on board and seizure of contraband; (3) assist the embarked officer in performing fisheries surveillance and law enforcement activities in the Palau EEZ, including the stopping, inspecting, detaining, directing to port, and seizing fishing vessels in accordance with the national laws and regulations of Palau; (4) stop, board, and search vessels located seaward of any State's territorial seas and claiming registry of nationality on the Republic of Palau to assist the embarked officer in the enforcement of applicable laws and regulations of Palau; and (5) employ reasonable force to stop noncompliant vessels subject to the jurisdiction of the embarked officers.

Search and Rescue Exercises. Annually, the US Coast Guard and Palau jointly hold a search and rescue exercise. The aim of the 2014 exercise was to jointly develop guidelines for cooperation and evaluate Palau's use of PSS *H.I. Remeliik* in support of search and rescue. The Coast Guard Cutter *Washington* and *Remeliik* were on scene during the exercise, coordinating rescue efforts. Coast Guard Shipriders aboard *Remeliik* taught Palauan officials how to plot assets and conduct a standardized expanding square search. This annual exercise serves to improve cooperation and processes between the US Coast Guard and Palau.

Maritime Domain Awareness Working Group. US Pacific Command organizes the Maritime Domain Awareness Working Group. MDA is defined as the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of a given country or region. It is an essential element to ensure maritime security, especially in a region subject to transnational maritime criminal activity and IUU fishing such as Oceania. MDA requires a means for collecting information, fusing this information to provide a detailed picture of what is occurring in the maritime domain, and a means to segregate and disseminate the information to those organizations that can act on it. The Working Group acts as a facilitator of sharing concepts, ideas, and new technologies among partner countries and organizations, including FSM, Palau, the US Pacific Command (PACOM), US Coast Guard, US Pacific Fleet (PACFLT), US Office of Naval Research, University of Hawaii, and Scripps Institution of Oceanography.

Office of Naval Research. The US Office of Naval Research, in partnership with other US federal agencies, sponsors and organizes surveillance demonstrations to identify appropriate technologies and tactics for IUU vessel detection.

Survey of Technology Options and Enhancements

This section summarizes several candidate tools to support MCS suggested by workshop participants based upon the diversity and depth of their experiences in developing and using surveillance systems. An informal down selection processes occurred during the workshop to put forward tools that are mature enough to support the required EEZ monitoring. In addition to facilities, a common requirement voiced by workshop participants was the need to make data compatible with data fusion tools to allow rapid situational awareness of both ocean conditions and the fishing traffic across the entire EEZ. The MCS system should include the capability to conduct historical data analysis using output from the surveillance system for purposes of identifying patterns and trends, incorporate statistical heat maps of where pressures are highest, correlate fishing behaviors with environmental pressures, and provide evidence in the prosecution of active cases.

FFA REGIONAL SURVEILLANCE PICTURE

The FFA Regional Fisheries Surveillance Center integrates the ongoing flow of FFA VMS, WCPFC VMS, and AIS data into a fused, coherent display that is assessed against each member nation's fishing license list, the WCPFC IUU and vessel of interest lists, individual fishing vessel log entries, flag-state catch and effort reports, and member nation boarding reports to generate the Regional Surveillance Picture (RSP). A series of manually generated risk assessments are then overlaid, and a specific compliance index is assigned to each vessel. At the broadest level, the risk assessment is based on whether a vessel is licensed for the area where it is currently located. Following that, actual vessel movements are interrogated to distinguish between activities that are likely to be fishing and innocent passage/steaming. Each member of the FFA, which includes Palau, has the right to access RSP information pertaining to their respective EEZ and the high seas.

Vessels are color coded (green, amber, red) to allow national VMS officers to easily identify high risk vessels and to prioritize responses (**Figure 12**). The system allows users to further investigate vessels, including accessing information on owners and operators, compliance history, boarding and inspection reports, and vessel details.

The RSP includes capabilities such as a transshipment detection tool. The system also has the ability to translate the RSP into "OTG Gold" reporting in a way that it can be integrated in the targeting systems of military assets that are used in regional exercises.

The RSP is under continual development. Current focus is on:

- Automating some of the risk analysis processes that are currently undertaken manually
- Linking additional data sets, such as real-time reporting from observers and electronic reporting of catch and effort information
- Investigating the MCS benefits of incorporating satellite tracking of FADs
- Investigating the usefulness and cost efficiency of incorporating Synthetic Aperture Radar imagery

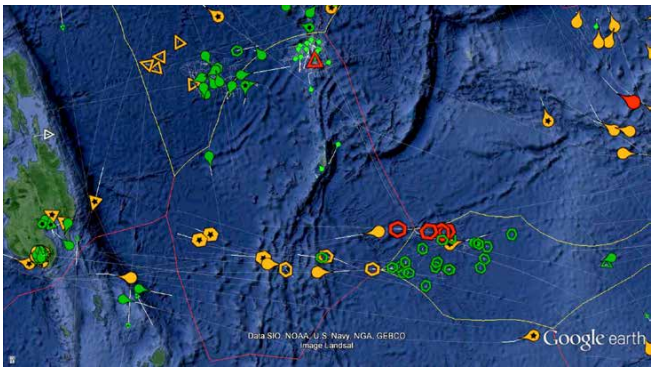


Figure 12. VMS and AIS information provided to DMLE enables staff to create a map of ships in the Republic of Palau EEZ. Triangles = AIS contacts. Teardrops = FFA VMS contacts. Color coding (red/amber/green) indicates an assessment of risk to commit an act of IUU fishing.

RSP highlights:

- Provides data with proven success in courts
- Provides national VMS officers the ability to rapidly prioritize vessels of interest
- Links to wider databases, providing essential information to determine appropriate response
- Uses a low bandwidth platform designed around the IT capacity of Pacific fisheries and law enforcement agencies
- Integrates with systems used by surveillance providers
- Fully cost recovered from the fishing industry and provided free of charge to members
- Fully supported through seven-days-per-week operations room (the FFA Regional Fisheries Surveillance Center)
- Fully supported through national training
- Capitalizes on data sharing agreements between members
- System, products, and data are all owned by member countries

TOPSIDE

The US Navy's TOPSIDE data fusion system provides a comprehensive common operating picture of the maritime environment to support real-time decision making and situational awareness. System development was guided by the US Office of Naval Research and was implemented during the Palau-US Island Maritime Domain Awareness demonstration (**Box 3**). An evolving set of tools allows the same interface to be used to examine historical data to identify patterns and trends and to conduct statistical analyses. TOPSIDE integrates complex maritime system details and displays them in an intuitive way to greatly simplify the users' understanding of the operational environment (**Figures 13 and 14**). To assist decision makers, TOPSIDE information is displayed on a time axis that shows a record of all previous system actions. Some of the information provided by TOPSIDE includes global AIS, VMS, and weather data, including ocean model forecasts (Navy Coastal Ocean Model) with ocean currents. Thus, in addition to being used for identifying and tracking potential illegal activities, TOPSIDE information is useful for search and rescue operations. TOPSIDE can integrate and fuse commercially available satellite imagery.

The data fusion component is designed to allow operators to sift through disparate data sets to find correlations that, in this case, could lead to prosecution of illegal fishing or transshipping activities. The correlated package of information is then exportable to the appropriate parties for continued analysis. With the use of automation, an operator is alerted to the presence of vessels within restricted areas as the information is received. The overall response time is dictated by the latency of the data.

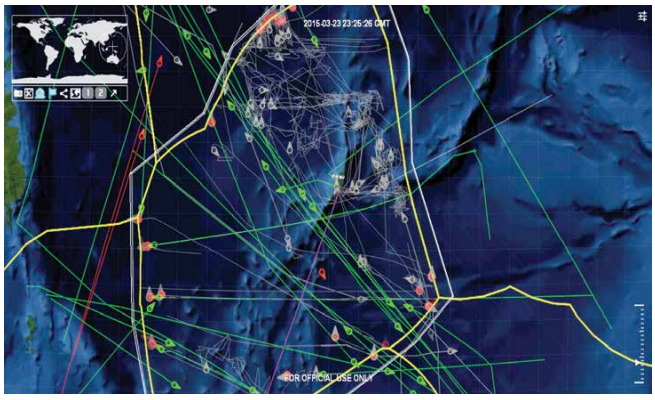


Figure 13. This figure from the TOPSIDE data fusion system shows one full week of reporting vessel traffic for both AIS and VMS. The colored tracks are AIS vessels, and the gray tracks are from VMS. The color-coding scheme is used to differentiate AIS vessel types. The green tracks are cargo ships; the red vessel south of middle is a tanker. The gray ships with a red dot behind them indicates a VMS vessel that is either not licensed in the Palau EEZ or not in FFA good standing, and might therefore warrant further attention.

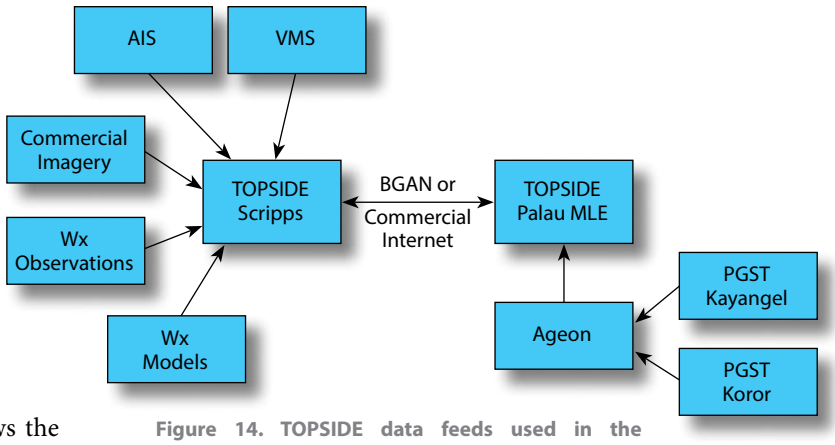


Figure 14. TOPSIDE data feeds used in the Maritime Domain Awareness demonstration (see Box 3). AIS = Automated Identification System. VMS = Vessel Monitoring System. PGST = Persistent Ground Surveillance Tower.

The scalable platform has an interface that mimics the gaming and smartphone industry, which significantly eases the training period. It is also designed with the use of easily modifiable plugins to scale to the diverse needs of divisions across the US Navy and other armed and government services that use the system. To solve problems that presented when testing the hardware and software framework in far flung, resource-limited locations, the team developed a secure command and control center that can be rapidly deployed via sea, land, or air, in both shipping container and truck versions. For even faster deployment, the team developed a compact expeditionary system that can be transported on commercial flights.

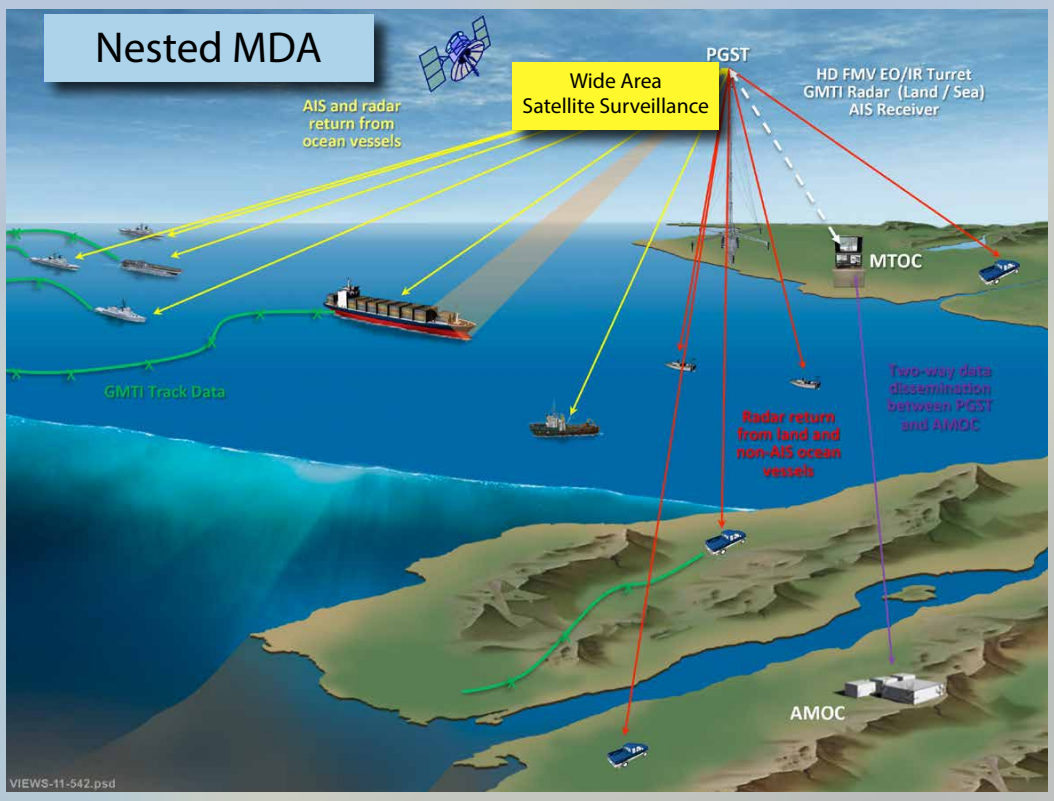
TOPSIDE highlights:

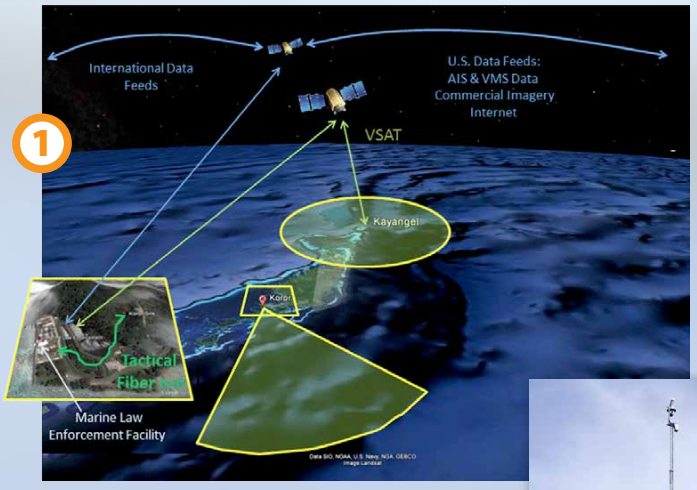
- Spatial and temporal situational awareness
- Enhanced vessel tracking with AIS and VMS
- Environmental model forecasts
- Historical and updated bathymetry data
- Meteorological and oceanographic data; atmospheric conditions at remote locations
- Sea surface and subsurface conditions
- Commercial satellite imagery
- Dual-use HF over-the-horizon-radar (follow-on capability) to provide ocean currents and ship tracking
- Cross-domain operation at multiple levels (i.e., open versus law enforcement sensitive data)
- Exportable platform for host-country partnering; network capabilities back to United States
- Database interface allows tool to be used in non-real-time mode to identify patterns of behavior

BOX 3. 2014 PALAU-UNITED STATES MARITIME DOMAIN AWARENESS DEMONSTRATION

Palau State and National government representatives, in conjunction with Palau Marine Law Enforcement and the US Pacific Command (PACOM), the Office of Naval Research, and Scripps Institution of Oceanography, conducted a Maritime Domain Awareness (MDA) demonstration of how the nested use of surveillance technologies can assist Palau Marine Law Enforcement in the detection of illegal fishing activities in Palau waters as well as search and rescue, pollution monitoring, and hazard warning. The demonstration was held June to September 2014 and had several components: (1) installation of two portable Persistent Ground Surveillance Towers (PGST) with radar and visible and night-sensing cameras that provided continuous monitoring of boats out to distances of approximately 25 nm; (2) acquisition and streaming of global AIS and Terra SAR Ocean Model satellite imagery; (3) fusion of global AIS, a near-real- time connection of VMS data from FFA to Scripps Institution of Oceanography for fusion with other ship data, satellite imagery, ocean model forecasts, and select shots from the PGST data feed; and (4) the Sea Dragon aircraft system with radar and cameras to detect and document illegal fishing taking place offshore. Routine imagery from commercial satellites was available for the demonstration. US Office of Naval Research TOPSIDE data fusion software merged all of the data along with reported vessel positions and environmental information. Outcomes from the demonstration effort include:

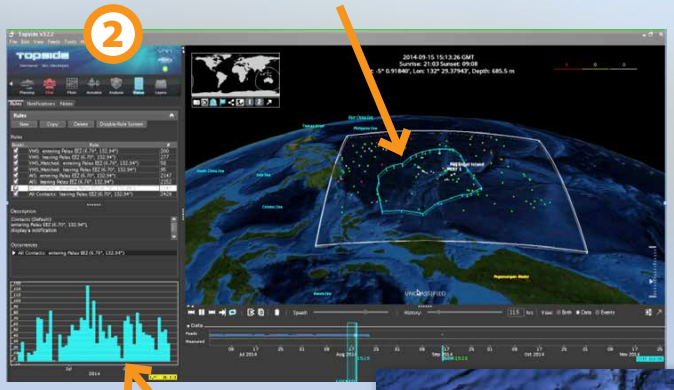
- Demonstrated the value of US–Palau cooperation in establishing an IUU surveillance system, the trade-offs of various technologies, the value of integrating environmental data and forecasts with marine intelligence data, and the need for long-term technical support by trusted organizations.
- Mapped vessel and fishing traffic by country, resulting in increased awareness and threat to the Palau EEZ from IUU, poaching, transshipment, and human and narcotics trafficking.
- Identified IUU fishing patterns that were confirmed with aircraft surveillance and with marine patrol craft—and showed that they can be used to cue Palau's patrol vessels. The Attorney General's office is evaluating evidence for upcoming prosecutions.
- Assessed potential for these technologies as part of a sustainable surveillance program and in support of Palau's National Marine Sanctuary bill.



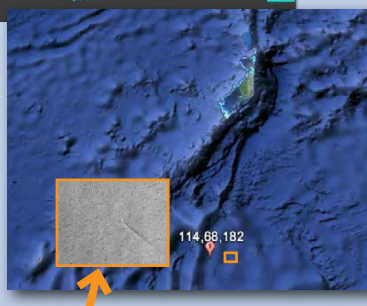


(above) Nested concept of operations showing data flow. Two PGST towers were employed during the MDA demonstration, one on Koror (due to topography, full 360° coverage was not available), and one on Kayangel (top middle full yellow circle). (right) Shore-based tower on Kayangel with radar, sensors, and satellite communications systems.

Tripwire set around Palau EEZ for AIS and VMS



Daily count of vessels crossing Tripwire into EEZ (June–August 2014 shown)



Vessel target in imagery identified with known time and position

(top) Data fusion of AIS and legal fishing boat tracks overlaid with ocean circulation forecasts and commercial Synthetic Aperture Radar (SAR) image. (inset) Zoomed region of SAR image, AIS tracks, and identified "dark" targets potentially engaged in IUU.

The Sea Dragon aircraft system with radar and cameras to detect and document illegal fishing taking place offshore

PROJECT EYES ON THE SEAS

The Pew Charitable Trusts, in partnership with the Satellite Applications Catapult, developed Project Eyes on the Seas, a technology platform that combines satellite monitoring and imagery data with other information, such as fishing vessel databases and oceanographic data, to help authorities detect suspicious fishing activity (**Figure 15**). The system can synthesize and analyze multiple layers of data in near-real time to monitor and identify suspicious vessels, then it alerts authorities so they can investigate and take action.

The Virtual Watch Room application is designed to hold and cross reference vast amounts of data so that when fused, the results can help identify suspicious vessel activity in an efficient and cost-effective way. The information includes multiple sources of satellite data, vessel and other specialist databases, international fishing and marine reserve boundaries, and oceanic data such as depth and temperature. The system can activate the most appropriate surveillance method to see vessels that are not transmitting their positions. Automatic alerts are triggered when the computer, using specially designed algorithms, detects: (1) patterns of vessel movements or speeds typical of fishing; (2) when a vessel has stopped signaling its position; (3) when two vessels are in close proximity, a possible sign of transshipment of fish or other goods; and (4) when a vessel crosses a virtual geo-fence to enter a marine reserve or other area of restricted use. Trained analysts investigate the alerts and then notify relevant government enforcement of highly suspicious activity and transfer a data package of supporting evidence. Governments then proceed with enforcement action or other appropriate response. As the system develops into the next phase, new data sources will be integrated into the system to add emerging technologies and respond to evolving needs. Among the potential sources are additional satellite imagery, types of optical imagery, imagery from unmanned aerial vehicles, crowd-sourced photographs and sightings, electronic signals such as radar on ships, and possibly radio broadcasts.

Project Eyes on the Seas highlights:

- Vessel tracking. The system uses AIS data and also has the capability to incorporate, where appropriate, VMS data.

- Satellite imagery. When AIS or VMS transponder data are inconsistent or unavailable, Synthetic Aperture Radar images help track vessel activity. The system is also capable of incorporating optical satellite imagery, which provides higher-resolution images for smaller, targeted areas of ocean.

- Vessel databases. Pew and its partners have begun to develop a credible and comprehensive global database of fishing vessels that combines international, regional, and national vessel registries with verified data sets. This repository contains records on a vessel's country of registration, aliases, and known history of illegal or unreported fishing. In addition, the database includes information on vessel owners and operators and any links they may have to other vessels, fleets, or owners that have been flagged as bad actors. Combined with details on a vessel's current and historical movement and activity, databases provide in-depth, up-to-date dossiers on vessels and their owners. Other databases can be incorporated based on the user's needs.

- Automated analysis. Computer algorithms detect vessels' movements and can spot patterns that indicate when boats are fishing or engaged in suspicious activity. The system can then alert authorities in a fraction of the time it would take a person to do the same analysis.

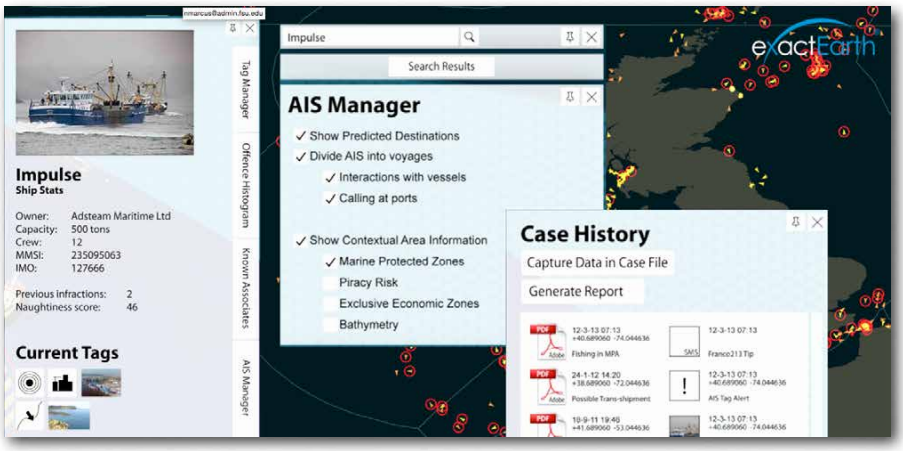


Figure 15. Example Eyes on the Seas screen.

SEA DRAGON

The Sea Dragon system was developed by the US Air Force Research Laboratory (AFRL) to combat illegal fishing in the western Pacific Ocean and provide MDA and search and rescue assistance to coalition nations (**Figure 16**). The aerial surveillance system performs wide area searches (over 35,000 km^2/hr) for fishing vessels using an AFRL-owned Synthetic Aperture Radar payload that is belly mounted to a Cessna 337 "Skymaster" manned aircraft. The real-time ingest and display of VMS and AIS data provide Sea Dragon operators with information to support the identification of illegal activities. A stabilized full motion video (FMV) electro-optic and infrared gimbal and other high-resolution camera technologies collect geo-registered images to identify the target and capture illegal activity for use as evidence supporting court prosecutions. Sea Dragon can stream real-time video to a line of sight hand-held display for coordinated law enforcement vessel engagements.

Sea Dragon highlights:

- Wide-area, day/night aerial surveillance
- Detects and geo-locates illegal activity
- Produces digital evidence for prosecution
- Low-cost platform and small operations team
- Self-sustaining through illegal fishing fines
- Easily integrates into modest marine law enforcement operations

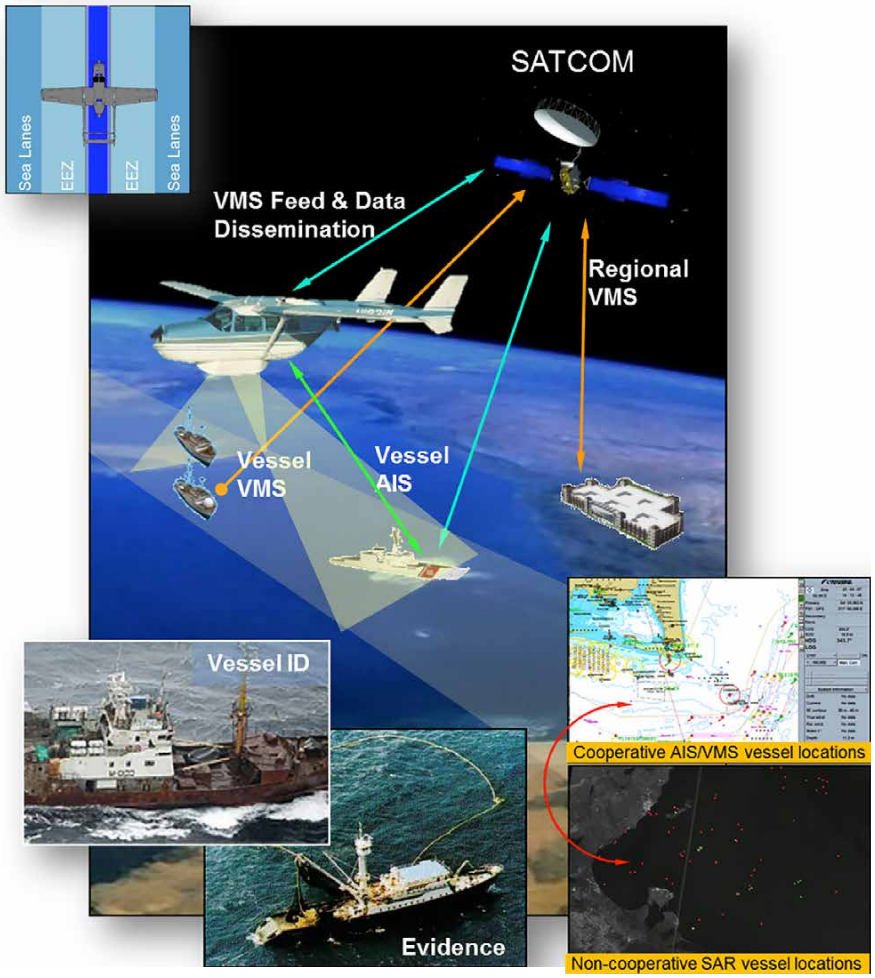


Figure 16. Sea Dragon conceptual overview.

SYNTHETIC APERTURE RADAR

Synthetic Aperture Radar (SAR) imagery provides day/night and all weather coverage with image resolutions as good as one meter (**Figures 17** and **18**). SAR can "see" through clouds, and it can also can be used for oil slick detection as well as pinpointing vessels that illegally discharge oil and/or pollutants (**Figure 6**). Radar backscatter is also sensitive to changes in wind speed and direction and, therefore, SAR images can provide high-resolution windfield maps that would be useful, especially during typhoons. Currently, numerous SAR satellites are in space, and when combined with electro-optical sensors, could provide a constellation with nearly persistent coverage. However, purchasing images is expensive and longer-term commitments and/or bulk purchases make the cost more attractive. A skilled person is also required to read and analyze the images correctly. Combining ship AIS and SAR imagery is a powerful way to detect illegal ships and dark targets—identify those ships that are not emitting AIS or VMS signals.

Synthetic Aperture Radar highlights:

- Commercial satellites provide unclassified, sharable data
- All weather and day/night imaging
- Medium to high spatial resolution and polarization sensors
- Readily available satellites: TerraSAR-X/TanDEM-X, Cosmo-SkyMed, RADARSAT-2, KompSat-5, PALSAR-2, and others
- Minimal conflict for tasking over the ocean
- Long visibility of wake signature provides course heading and changes
- Numerous tests show utility for MDA

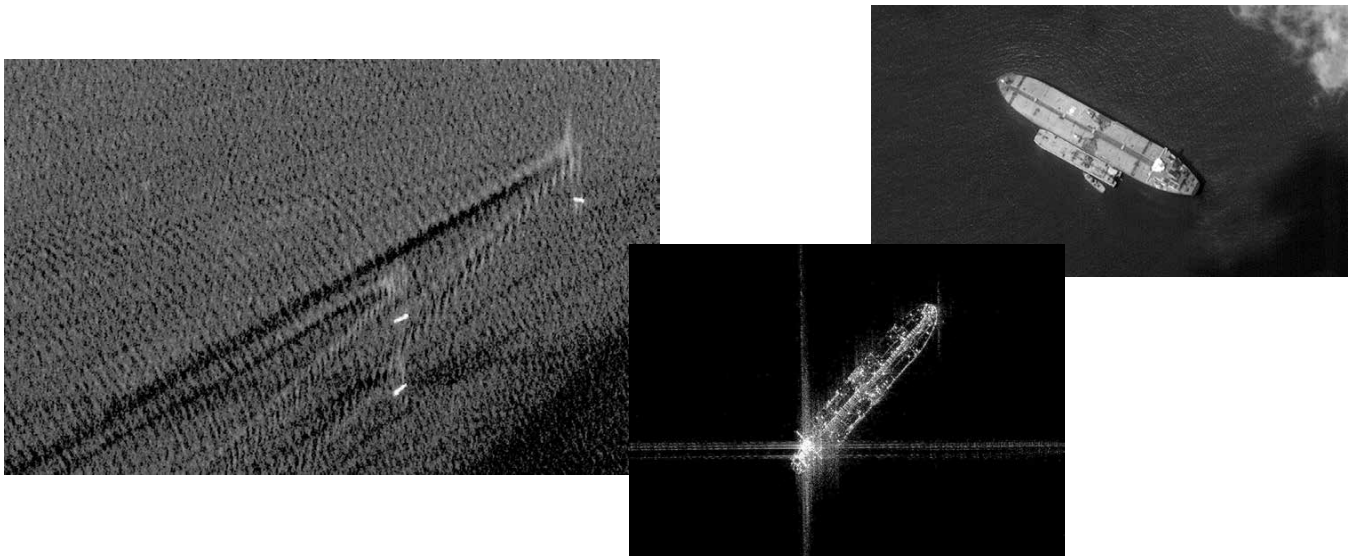


Figure 17. (left) TerraSAR-X StripMap image of several ships and their wakes. Note that the ships (white shapes) are Doppler-shifted from the wake due to their motion. *© 2007 Astrium Services/Infoterra GmbH.* (center) A Cosmo-SkyMed spotlight mode radar image of a tanker showing the central pipeline structure, the pilot house (very bright reflector), and pump locations to pump oil into storage tanks. *© COSMO- (FigureSkyMed™ Product - ASI 2010 processed under license from ASI – Agenzia Spaziale Italiana. All rights reserved. Distributed by e-GEOS.* (right) EROS-B panchromatic image (~ 70 cm resolution) of large ship and support vessels, showing many detailed features of the tanker vessel. Note clouds in upper right corner. *©2013 ImageSat International N.V., Licensed by ImageSat International N.V.*

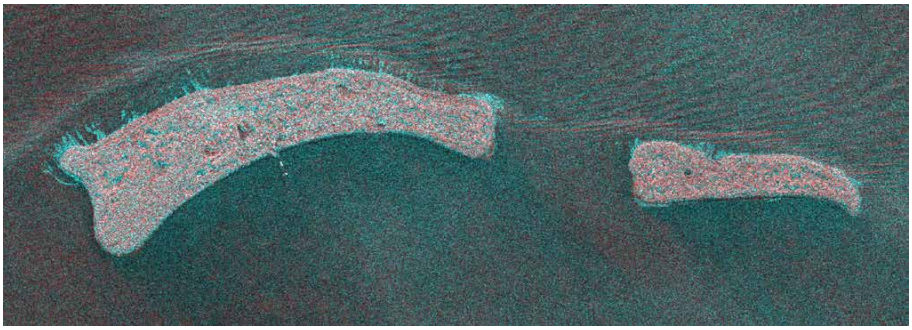


Figure 18. (top) Synthetic Aperture Radar change detection image of Kayangel that is composed of an image before and after Typhoon Haiyan. If there were no changes, the image would be gray. The red pixels indicate that something changed—trees were knocked down. (bottom) Aerial photo mosaic of Kayangel Island after Typhoon Haiyan, November 8, 2013, visually showing the damage, and verifying the radar image interpretation. Synthetic Aperture Radar images of the Palau EEZ would be useful for many different purposes.

SHORE-BASED RADAR

Shore-based radar systems provide an opportunity to provide a 24/7 continuous surveillance capability over focused regions. For example, small-scale Marine Protected Areas can be monitored using an off-grid radar installed on a tower, which allows for coverage to extend out to approximately 25 nm. These data can be accessed and used by local rangers, as well as fed back to a central location using network connections. For remote island locations, off-grid solutions exist that permit the radar and communications infrastructure to be supported by solar power. The size of the vessel, and the range out to which it can be detected, is influenced by the radar hardware (power output, frequency, elevation of antenna from water) as well as the environment; rough seas introduce clutter, which decreases the range at which small vessels can be detected. As an example, a commercially available marine X-band can detect small fishing boats out to 20 nm or so, while a HF radar can detect vessels that are hundreds of feet long out to distances of 100+ nm, but with uncertainties approaching a nautical mile.

As part of a pilot program initiated during the Island MDA demonstration, Hatohobei State Government received a small marine X-band radar (4G Simrad) from the Scripps Institution of Oceanography. The 32 nm range Scripps-donated radar continues to operate using solar power, and the data are routinely used by the rangers. One shortcoming identified during the pilot is the need to maximize the elevation of the tower above sea level. Current thinking is that a tower at 12 m elevation above mean sea level or more would provide adequate height to maximize the range of the commercial radars and allow for surveillance across the entire atoll. The radar provided under the pilot program continues to be operated and used by the Hatohobei State Rangers as part of a long-term evaluation effort.

Jeff Barabe for The Pew Charitable Trusts

Palau MCS
The Next Five Years

This section provides guidance to the Republic of Palau on ways to enhance monitoring, control, and surveillance of the Palau EEZ. It recommends several actions that the National government can take to more efficiently use current monitoring and enforcement assets. Participants in the April 2015 workshop shared their knowledge of ocean monitoring efforts external to Palau that can be exploited at little to no cost as well as ways in which the Palau government can strengthen ties with outside governments and intergovernmental and nongovernmental organizations to take advantage of MCS expertise and programs in the Pacific region. Workshop participants identified communication gaps among National government entities, and between National and State governments, that hamper monitoring and enforcement efforts and recommended courses of action to improve information sharing. Ideally, the Republic of Palau would deploy a nested surveillance system for the EEZ. While purchase of additional surveillance technologies would considerably improve identification of illegal activities in the Palau EEZ, there is significant initial cost to some items, and the commitment to using these technologies will likely occur with external partnerships. Means to reduce long-term outlays for personnel, training, upgrades, and maintenance should be pursued.

Monitoring

2016

RECOMMENDATION M1. Establish and promote an independent and interagency hotline to receive reports of suspected illegal activity in the maritime domain from members of the public, local fishermen, and boat operators. Explore a financial reward system for tips leading to prosecutions.

The hotline operator ideally will be situated in the MCS Interagency Coordination Center (see **Recommendation M4**), and hotline operators will be capable of verifying and assessing received information before passing it on to the appropriate agency (e.g., State Rangers, Division of Fish and Wildlife Protection, or DMLE) for action. In order to encourage members of the public to participate in scheme, a financial reward should be provided for all information leading to successful prosecution/enforcement actions. In order to minimize false reporting, the hotline would be launched along with an educational campaign to inform members of the public about what is legal and what is illegal in the maritime domain.

2017

RECOMMENDATION M2. Expand the Shiprider program to other countries.

The Shiprider program, officially known as the Cooperative Shiprider Agreement, permits Palau Marine Law Enforcement officials to embark law enforcement platforms of the US Coast Guard (both surface and air). Once embarked, the US Coast Guard can assist the Palau Marine Law Enforcement official in enforcing the laws and regulations of the Republic of Palau. This assistance includes the authority to stop, board, and arrest on behalf of the Republic of Palau and is consistent with international law (the United States has executed Shiprider programs with other nations as well). The Palau Shiprider program is currently limited to one patrol a year on a US Coast Guard vessel. Similar agreements between Palau and other regional partner nations that transit through the Palau EEZ should be enacted to broaden this cost-effective law enforcement activity.

RECOMMENDATION M3. Strengthen the Observer Program by purchasing 30 satellite phones for Palauan observers deployed to licensed fishing vessels, enabling a network of "eyes on the sea."

The presence of observers on fishing vessels is a valuable and cost-effective additional source of surveillance. Observers record information about the fishing vessel they are on, and this information can be used for compliance purposes. They can also provide information on the sighting of other vessels in the vicinity. However, for this sighting information to be useful, the observer requires real-time communication ability. FFA is rolling out the use of DeLorme handheld satellite communication devices. These cheap but robust and reliable devices are similar to satellite phones, but instead use text-based messaging. Over time, these devices can be integrated with a ruggedized tablet, allowing the observer to provide real-time catch and effort reports as well. FFA will work with the Bureau of Marine Resources to assist in rollout of devices, including the ability to receive and manage the reports through the "Observer Program Management" module in the Regional Information Management Facility.

Cost Estimate. ~$400 per device. Training and data fusion TBD.

2016–2018

RECOMMENDATION M4. Create an MCS Interagency Coordination Center to centralize activities of all divisions and ministries related to monitoring, control, and surveillance of the Palau EEZ. Develop and implement a plan for the collection, management, and visualization of fisheries and ocean surveillance data.

A Coordination Center is needed to ensure that each division responsible for some aspect of MCS (see list under MCS Working Group, **Recommendation C1**) is adequately represented in efforts to undertake continual operations. Direct and formal cooperation through a specific center provides the most certain prospects for whole government involvement and agreement. Such cross-agency MCS centers in many other countries have proved extremely valuable in minimizing duplication of effort, maximizing cooperation, and enabling rapid decision making. Organizationally, the cross-cutting MCS Coordination Center would be under the Office of the President and operationally managed by the Chief, Division of Marine Law Enforcement.

The MCS Interagency Coordination Center should be staffed 24/7 as it will serve not only to coordinate daytime illegal fishing response, but it will also be in place for search and rescue operations in support of the nighttime fishing common to the indigenous population and support broader situational awareness of the Palau EEZ's weather and ocean conditions.

The Coordination Center's final structure and staffing would be informed by the MCS staffing study (see **Recommendation C5**), but initial suggestions are:

- *Center manager (DMLE).* The manager would be responsible for the day-to-day operations of the MCS Interagency Coordination Center and would be the conduit for communication across government and externally. This position is likely to be new and so would require funding.

- *A rotating roster of analysts/watchkeepers.* The roster needs to include about eight officers potentially implemented through a "Panama" schedule.[1] These positions could be filled by existing officers in agencies such as the DMLE (e.g., VMS Officer and OIC Surveillance Officer) or the Bureau of Marine Resources. A detailed assessment of skills required for the analyst position needs to be conducted before a decision is made if the required skill sets are consistent with those presently defined in existing billets.

- *In-house IT capacity.* During initial setup and system development, there is likely to be a need for in-house IT capacity. Training and external partnerships should be pursued to establish a capability that can reside in Palau.

- *Legal specialists.* For the MCS Coordination Center to be most effective, policy and legal experts need to be involved. These positions do not necessarily need to be based at the Center, as they would also be carrying multiple other duties, but they need to be "on call" and would benefit from some form of regular visits to the Center.

The greatest cost associated with the MCS Interagency Coordination Center is likely to be setup. The physical building and IT infrastructure required to access, process, analyze, and disseminate large amounts of data in a secure environment are significant. Assuming a suitable building is available, setup costs are likely to be approximately $150K. The communication infrastructure is also a substantial undertaking. FFA has offered to provide and install a VSAT communication system if this is helpful. FFA already contributes to bandwidth costs in Palau. Startup training, provided by outside organizations, is also likely to be a substantial cost.

2016

Evaluate and select a data fusion/analysis/cueing system.

Workshop participants discussed three options for monitoring of Palau's EEZ. Fuller analysis of the costs and benefits of the three monitoring systems are required. In addition, over the next five years, a detailed study is required to begin to identify temporal and spatial patterns of legal and illegal fishing using collected AIS, VMS, and other surveillance data. This information will guide the future operations of the surveillance system. An overview of these three options are presented on pages 26–30.

[1] This is a slow, rotating shift pattern that uses four teams and two 12-hour shifts to provide 24/7 coverage. The working and non-working days follow a pattern of two days on, two days off, three days on, two days off, two days on, three days off.

1. *Regional Surveillance Picture.* FFA's RSP is free of cost to Palau, is fully supported at the regional level, and is fully supported through existing training programs (the cost of which is borne by FFA). Both the DMLE and the Division of Oceanic Fishery Management currently receive these data.

2. *Eyes on the Seas.* Leasing the Virtual Watch Room system will initially be cost-free. Future cost would be determined by which capabilities Palau requires, the amount of analysis needed, and level of satellite imagery that is acquired.

3. *TOPSIDE.* This data fusion software would be a government-to-government transfer and hence would be provided to the Republic of Palau by the United States at no cost. However, there would be costs associated with development of new modules, if needed, once the evaluation of Palau's needs have been carried out. Similar to all data fusion systems, there would be a training phase that would incur costs.

Cost Estimate. Based on the outcome of the evaluation, it would cost $0–$500K per year to run the data fusion systems. This estimate does not include the cost of any equipment required or personnel to run the system. Development of national partnerships may offset some costs.

Evaluate the need to request that FFA provide, on a continual basis, all available AIS information pertaining to all vessels operating within the Palau EEZ.

The RSP provided to FFA members such as Palau includes fishing vessel AIS data. FFA also purchases non-fishing vessel (e.g., bulk carriers, cruise ships, personal yachts) AIS data across the entire region, but they are filtered out of the RSP in order to reduce the workload over already strained regional Internet links. It is technologically and contractually feasible for the non-fishing vessel information to be relayed to Palau to further inform EEZ situational awareness should Palau request it. Because MCS of the Palau EEZ would cover issues beyond IUU fishing, there might be benefits to accessing the complete data set. However, these are raw data, not processed as part of the RSP, so they may not be useful.

Cost Estimate. There is no additional cost to obtain these AIS data, but their transmission would slow down the overall RSP data transfer unless ways to compress data or upgrade the Internet connection are implemented.

2017

Upgrade automated cueing algorithm and machine learning.

Depending on the chosen data fusion, analysis, and cueing system, the automated cueing algorithm may need to be upgraded to meet Palau's needs. During the MDA demonstration (see **Box 3**), the automated cueing built into TOPSIDE was tested to determine the presence of fishing vessels in defined locations, but with the additional communication packages, sensor suites, and increased manning, there is an opportunity to further hone the algorithms to provide a more collaborative alert system.

Cost Estimate. ($150K)

2018

Evaluate the costs and benefits of purchasing Synthetic Aperture Radar (SAR) images for surveillance.

Workshop participants agreed that additional analysis of the costs and benefits of incorporating SAR images into analysis of IUU fishing should be carried out. While there are benefits to having SAR images available for monitoring the EEZ, they are costly to purchase and image analysis to identify and track "dark targets" is time consuming and requires a fair level of training. As with collection of other surveillance information, to make use of it, Palau would need a response capability to pursue the possible illegal activity.

Input into this analysis can be obtained from FFA. The FFA is currently in the process of identifying funding for two separate tests to determine whether or not SAR efficiently contributes to the effectiveness of the current RSP. As a member of the FFA, Palau would be in a position to benefit from a commensurate portion of the surveillance data this trial could produce. The Center for Southeastern Tropical Advanced Remote Sensing (CSTARS) at the University of Miami has downlink capabilities to the constellation of commercial satellites, and is in a position to provide both raw and analyzed data in bulk.

Cost Estimate. $500K per year for one image per day covering 81,000 km^2. $3K per scene or $3M for the entire EEZ for one year.

Control

2016

RECOMMENDATION C1. Establish an internal Palau MCS Working Group.

MCS is a cross-ministry issue that requires adequate coordination and cooperation among numerous agencies. For example, in terms of fisheries MCS, it is essential that measures and procedures for MCS systems are based on the fisheries management rules that are in place. It is equally important that the fisheries management rules are designed with a firm understanding of the MCS capabilities available to enforce them. The MCS Working Group would convene quarterly to discuss resources, share information, and review completed interdiction efforts. It would also initiate annual assessments of the MCS system to ensure that the system is meeting the challenges of changing environment, including addressing emerging threats, and that it is incorporating advances in technology. The MCS Working Group would evaluate the outcomes of each recommendation from this MCS plan and suggest course corrections. These assessments should be conducted by an unbiased third party who would report directly to the chairperson of the MCS Working Group. The Working Group would also be responsible for writing standard operating procedures related to Palau's maritime security (see **Recommendation C10**).

Working Group membership would consist of: the Attorney General (Chair); Ministry of State; Ministry of Natural Resources, Environment, and Tourism, including a representative from the Division of Oceanic Fishery Management; Ministry of Justice, including a representative from the Division of Marine Law Enforcement; Ministry of Public Infrastructure, Industries, and Commerce; Ministry of Finance, including a representative from the Bureau of Revenue, Customs, and Taxation; and the Royal Australian Navy Maritime Surveillance Advisor. The MCS Working Group Chair would report directly to and advise the President.

RECOMMENDATION C2. Draft and execute MOUs between States and National departments.

Currently, there are no formal procedures for State governments to work with National government representatives in incidents that involve ship groundings, intrusion of fishing vessels into state jurisdictions, emergency response, and the introduction of pollution. As one example, there needs to be a coordinated State and National response to deter and stop the small illegal fishing boats before they enter the 12 nm coastal zone. The MOUs would specify how State and National departments would work together and share information to improve communications, better monitor and enforce IUU fishing, coordinate search and rescue operations, and detect marine pollution. The MOUs will clearly articulate the decision-making process to task both surveillance and response assets and specifically identify the relevant decision makers. Financial and technical issues and responsibilities would be clarified by this process.

RECOMMENDATION C3. Write DMLE job descriptions and disseminate them to staff.

Marine Law Enforcement officers need to be properly assigned to their positions with a full understanding of their duties. Detailed job descriptions must be written for each position that include: (1) a job title that accurately reflects the duties being performed, rank associated with the position, pay grade or range, reporting relationships (by position, not individual), hours or shifts, and the likelihood of overtime; (2) job duties and responsibilities—identify tasks that comprise nearly all of their work and list the tasks in order of importance and roughly how much time might be associated with each task; (3) qualifications (e.g., education, experience, training, and technical skills necessary for the job); and (4) special demands (e.g., heavy lifting, prolonged standing, exposure to extreme weather). The Australian Maritime Surveillance Adviser is available to advise and assist the person executing this task.

RECOMMENDATION C4. Hire a human resources management consultant to examine and develop a plan to improve staff recruiting, performance, and retention.

Human resource (HR) management is concerned with employee recruitment, training and development, performance appraisal, and rewarding (e.g., managing pay and benefit systems). Most institutions, government and private, have written policies in place to ensure a well-trained, incentivized workforce. Workshop participants identified several HR deficiencies that negatively impact DMLE performance, in particular, that urgently need to be addressed. For example, Palau's increasing retirement age and the limited numbers of management positions within DMLE mean that promotion opportunities for Marine Law Enforcement officers are few and far between. Police officers complete training at the Australian Maritime College in Australia; however, in most cases, the full potential of this training is not realized as officers do not move "up the ladder" due to a stagnating management structure. Despite training for advancement, officers become disillusioned and the DMLE runs the risk of losing these officers to other employment unless this matter is addressed. To compound this problem, DMLE pay is subject to years of service in the rank (e.g., Police Sergeant, Lieutenant) rather than to the officer's actual qualifications.

An experienced, independent HR consultant should be hired to assist the Republic of Palau in developing and implementing policies that:

- Reward staff for increasing their skill sets
- Establish performance incentives
- Establish paths for career advancement
- Include annual performance appraisals

Although the initial target for developing and implementing human resources best practices would be DMLE, the policies should be consistently enacted for all government staff.

Cost Estimate. $5K–$10K or more depending on the services contracted plus travel.

RECOMMENDATION C5. Initiate staffing study to identify appropriate MCS personnel allocations from existing National government billets.

Workshop participants recommend that the President's Office initiate a staffing study to identify:

- How to deploy MCS personnel more efficiently and effectively
- Gaps in knowledge that need to be filled to optimize use of current and future assets
- Training needed to improve staff skills for MCS implementation
- Where new staff is needed to better support MCS requirements

Table 1 provides a broad outline of some of the anticipated MCS roles and responsibilities of the Palau National Ministries and Departments. This table could be used as initial input to guide the staffing study, realizing that some duties (e.g., staffing to implement a public relations program, see **Recommendation C12**) are missing. It is expected that the study would lay out agency MCS roles and responsibilities in more detail and then determine the appropriate staffing levels and write detailed job descriptions for each position. Structure and staffing levels of the new MCS Interagency Coordination Center would be included (see **Recommendation M4** for initial staffing suggestions). Required DMLE staffing levels for IPVs and OPVs are detailed in **Recommendation S2**, but other DMLE positions are not included in that recommendation, including staffing a detainee program (see **Recommendation C13**). The study should also consider **Recommendation C6** on the staff required to strengthen Port State Controls. In addition, **Table 1** omits detailed workshop participant suggestions, such as hiring a second administrative assistant (civil servant) in DMLE so that when the current administrative assistant goes on leave or takes courses, that person's duties are covered.

The decision-making process and coordination among departments should be considered during the staffing study (see **Recommendation C10** on standard operating procedures).

Table 1. National MCS roles and responsibilities framework.

Ministry / Department	Role	MCS Responsibilities
The Bureau of Marine Resources of the Ministry of Natural Resources, Environment, and Tourism	Devise and implement Palau fisheries management framework Focal point with industry (the main source and driver of voluntary compliance)	**Monitoring** – Support VMS, Observer and Logbook Programs, maintain Fishing Licensing Registers. Analyze data holdings. **Control** – Support Attorney General's office in drafting of subordinate regulations and management plans on an as needed basis. **Surveillance** – Provide data to other agencies (e.g. DMLE and Office of Attorney General) for analysis baselines on an as needed basis in addition to normal reporting.
Division of Marine Law Enforcement	Provision of surface asset and coordination of regional surface and aerial asset support	**Monitoring** – Implement VMS, AIS, FFA RSP, plus Catapult or TOPSIDE. **Control –** Draft instructions for powers of officers. Execute seizure/evidence collection enforcement operations. **Surveillance** – Provide intelligence analysis, planning and deployment of assets. Prioritize assets and initiatives when they are multitasked. Identify and undertake risk assessments of persons, vessels, areas, and activities of interest. Detect and investigate fisheries offenses and enforce the laws of the Republic.
Ministry of State	Oversight of bilateral and multi-lateral international relations and negotiations	**Monitoring** – Maintain awareness of international impacts of interest to MCS agencies. **Control** – Ensure MCS initiatives are compatible with national laws and procedures with international obligations. **Surveillance** – Provide real-time support of translation services and attempts to coordinate identification of suspicious activity with the identified nations of possible offenders.
Office of the Attorney General	Violation prosecution	**Monitoring** – Provide support to DMLE MCS efforts on an as needed basis in addition to regular support. **Control** – Develop and publish subordinate regulations procedures for enforcement/ evidence collection activities. **Surveillance** – Assist DMLE with guidance and evidence collection/seizure operations for prosecution and administrative actions.
Bureau of Revenue, Customs, and Taxation	Export and import control	**Monitoring** – Collect fisheries import and export attributes. **Control** – Provide legislative drafting support instructions for export and import legislation. **Surveillance** – Provide data to other agencies for analysis baselines on an as needed basis in addition to normal reporting.

RECOMMENDATION C6. Strengthen the capacity and application of Port State Controls to expand the legal reach of enforcement.

Port State Control Officers from the Ministry of Natural Resources, Environment, and Tourism, Division of Oceanic Fishery Management inspect foreign vessels coming into port in Palau to ensure that the vessels comply with the requirements of international conventions and that they are staffed and operated in compliance with applicable international law. Currently, there is insufficient manpower both in terms of the port personnel and observers on vessels to support a more aggressive stance on monitoring and enforcement. The staffing study (see **Recommendations C5**) should address these personnel issues. The US Coast Guard can assist in capacity building with respect to technical proficiency of the Port State Control officers.

RECOMMENDATION C7. Issue warrants before vessels leave the Palau EEZ to facilitate prosecution.

The Attorney General should seek to issue warrants for all vessels that have violated the laws of the Republic of Palau, even if they have left the EEZ. By doing so, the Republic will be able to intercept the vessel should they re-enter the EEZ. Additionally, the information used to seek the warrant can assist the Republic in establishing a case for suspension either through FFA or WCPFC, even if the vessel does not return to Palauan waters.

RECOMMENDATION C8. Implement suspension procedures under the FFA Vessel Register to document infractions and deter repeat offenders.

Pursuant to FFA membership agreements, any member may request suspension of good standing of a vessel on the FFA Vessel Register if there are reasonable grounds to believe there has been a violation of terms and conditions of access (see Harmonized Minimum Terms and Conditions for Access by Fishing Vessels – As amended by FFC90 § 5.2 & 7). In an effort to fortify enforcement efforts, the Attorney General of Palau should develop policies and procedures to make use of these suspension procedures when appropriate. If granted, the suspension of good standing shall remain valid until the required corrective action is taken, giving added incentive for compliance and/or cooperation by offending vessels.

2017

RECOMMENDATION C9. Operationalize the Niue Treaty Subsidiary Agreement to assist regional enforcement.

The Niue Treaty on Cooperation in Fisheries Surveillance and Law Enforcement in the South Pacific Region is a multilateral treaty of FFA members. The Niue Treaty Subsidiary Agreement (NTSA) strengthens the ability of participants to enforce their maritime legislation through increased direct cooperation and collaboration, including in areas such as data sharing, cross vesting of assets, and cross authorization of officers. Palau is among six nations that have ratified the NTSA, and it is now in force. There remains considerable implementation work to make it operational. Annexes C(1) (Operational Requirement Notification) and C(2) (National Authority Notification) need to be formally completed and subsequently submitted to the NTSA Administrator (i.e., FFA). Completion will require the efforts of a broad range of government departments, including the Ministry of State, Bureau of Agriculture, and Bureau of Immigration, and will also require the identification of a national authority empowered to make decisions on behalf of the nation; submission is the equivalent of accession to a formal treaty, which requires specific intervention of the Ministry of State. To then operationalize the NTSA—activate some aspect of the mutual rights and obligations within the Agreement—Annex C(3) (Activity Notification) would need to be submitted to another ratifying nation (or another ratifying nation would have to submit their own Annex C(3) to Palau) for consideration and concurrence.

RECOMMENDATION C10. Develop and implement standard operating procedures for both legal and enforcement actions.

Currently, there appears to be some disagreement between key agencies within the Republic of Palau national government over who has responsibility for Palau's maritime security. Standard operating procedures (SOPs) will identify the person charged with making specific decisions, and the other agencies that will need to cooperate. If deviations from the decision are allowed, the conditions for these deviations must be documented in the SOPs, including who can give permission and exactly what the complete procedure will be. Establishing a chain of command and SOPs will streamline the decision-making process so that actions can be taken in a reasonable amount of time and be effective. Development of a decision-making matrix is important. The SOPs will need to address all of the foreseeable circumstances associated with the MCS effort, while still providing sufficient flexibility to respond to unforeseen circumstances.

RECOMMENDATION C11. Implement a sustainable financial structure to ensure MCS initiatives have a dependable and sufficient budget.

To effectively implement many of the recommendations to improve MCS of Palau's EEZ requires a reliable base of funding. The Palau National Marine Sanctuary legislation included a new Environmental Impact Fee of $50 per tourist and will be deposited into the Marine Sanctuary Fund, within the National Treasury. A portion of this revenue is mandated to fund government surveillance and enforcement efforts as well as necessary training. In addition to funds from the Environmental Impact Fee, the Marine Sanctuary Fund will also receive illegal fishing fines and civil penalties as well as the proceeds of sales from forfeitures mandated by these same titles. Ultimately, the fund is intended to serve as a match and leverage to funding from other outside sources. The Minister of Finance will administer this fund within the Palau National Treasury.

2018

RECOMMENDATION C12. Implement a comprehensive public relations/outreach program.

The goal of the program is to provide a strong deterrent capability and achieve optimal levels of voluntary compliance.

Cost Estimate. $25K

RECOMMENDATION C13. Develop a detainee/quarantine program and facility that can accommodate foreigners.

Over the course of two months in spring 2015, MLE seized five vessels that were conducting illegal fishing operations in the EEZ. Three were caught in early April, and two more were caught a couple of weeks later. The first three vessels were brought to the MLE station, and crew members were detained on board the vessels and they fed themselves from their own food storage. The crews were interviewed and two of the three boat captains were placed under arrest and taken to the Koror Jail. MLE was then unable to go out on extended patrol operations because officers were placed on 24-hour supervision of the boat crews at anchor. Officers from other law enforcement divisions were approved to cover the night shift monitoring of the seized crew members/vessels. When two more boats were seized using short-range watercraft, MLE officers were faced with over 50 crew members that could only be detained on their own vessels. During interviews, some of the crew members reported conditions that raised concerns of human trafficking (being on board to pay back debts to the boat owners), however, it was impossible to address those issues with the limited manpower available. No health screening was carried out, though each crew member's name was taken and they were photographed for future reference. If the Republic wishes to prosecute and process the entire boat crew in the future, separate holding facilities need to be arranged to do so. The two boat captains who were taken to Koror Jail spoke no English or Palauan, and they later reported feeling threatened and having their food stolen by other inmates while they were incarcerated. The concerns about placing foreign crew members into the jail are many, but the current facilities prohibit any thought of mass prosecution as there is simply no room to keep them.

A new detainee/quarantine program and facility need to be implemented that: (1) provides initial health checks to ensure the safety of the Republic of Palau and to establish a baseline for those persons detained by the Republic; (2) catalogs and identifies detainees, including taking photographs and fingerprints, which may be used with other national or international databases to identify human and/or drug traffickers and serial violators of international fishing laws; (3) provides shelter and sleeping facilities for up to 50 detainees, ensuring the continued health, safety, and welfare of the detained persons; and (4) provides dining services for up to 50 detainees.

The staffing study (see **Recommendations C5**) must address the issue of having police officers available to cover duties at the detention facility while at the same time there is sufficient crew to conduct law enforcement operations on *Remeliik* and the IPVs. The MCS Working Group will establish standard operating procedures for this program (see **Recommendations C1**).

Communications

2017

RECOMMENDATION S1. Upgrade secure communication hardware and procedures.

Currently, all communications between the shore and DMLE patrol vessels are via HF and VHF radios that are not secure. Thus, fishing vessels with HF and VHF receivers can listen in on DMLE conversations. If the communication is about a vessel of interest, the information can be compromised. To counter this problem, DMLE employs a simple substitution cipher to pass along key information; however, this way of communicating is very inefficient. Only short messages can be passed in this manner and errors are not uncommon due to interference and human error. Ensuring secure communications between DMLE and shore is a basic requirement. There are several options to consider (**Table 2**).

OPTIONS

Low Cost — Secure Voice

Add "scramble boxes" to the entire current HF radio system to enable secure voice communications between all parties. A voice modulator can be added to each marine band radio to scramble analog signals. Decoding by eavesdroppers would require effort. (~$250 each)

Higher End — Secure Digital Voice

Upgrade all radio systems to secure digital marine band radios. The range needs to be researched. Decoding by eavesdroppers would require significant effort. (~$3,000 each)

Aircraft/Inshore Boat(s) — Data Only

- Low-bandwidth Iridium Modem Short Burst Data (SBD) digital communications enables secure text-based chat, automated cueing reports, overlays, and in-range along surface contacts (AIS/VMS).
- Iridium modem and antenna per mobile node. Existing Internet can be used for land-based operations, for example, Iridium GO. ($1,000–$1,500 each + monthly usage fee)

Offshore Boat(s)/High-End Airplane — Voice and Data Options

- Iridium Pilot satellite Internet system enables secure text-based chat, automated cueing reports, overlays, FULL surface contacts (AIS/VMS), and photography. (~$8,000 + monthly fee)
- Inmarsat satellite communications for mobile assets and leverage existing Internet for land-based operations. There would be enough bandwidth to have a complete picture of EEZ activity and collaboration from all nodes. Data Services: secure text/voice chat, automated cueing reports, overlays, FULL surface contacts (AIS/VMS), photography, and SAR satellite imagery. (~$15,000 each + monthly fee)

Table 2. Communications upgrade options.

Service	Iridium SBD	Iridium Internet	Inmarsat Internet	SB0 Internet
Secure Text Chat	X	X	X	X
Secure Voice Chat			X	X
Overlays/Points/ Planning	X	X	X	X
Automated Cueing Reports	X	X	X	X
Limited AIS/VMS/Radar Tracks	X			
Full AIS/VMS/ Radar Tracks		X	X	X
Environmental Models/ Data			X	X
Digital Photography		X	X	X
SAR Satellite Imagery			X	X

Patrol Boats

2016

RECOMMENDATION S2. Recruit and train a sufficient number of police officers to simultaneously operate offshore patrol vessels (OPVs) and inshore patrol vessels (IPVs).

MCS requires 26 qualified police officers to operate existing maritime assets (18 officers for PSS *Remeliik* and eight officers for two 15-meter IPVs) and another 22 qualified officers to operate additional vessels to be provided by The Nippon Foundation (one OPV and one IPV). At the current staff level of 18 qualified police officers to crew the DMLE boats, if *Remeliik* is on patrol, the IPVs must remain idle. Conversely, if the IPVs are in use, *Remeliik* cannot patrol the EEZ. Thus, in order to operate the existing two 15-meter IPVs concurrently with *Remeliik*, an additional eight police officers need to be hired and trained now. A crew of four police officers per IPV allows for a two-man boat crew and a two-man boarding/enforcement team.

In order to ensure that the incoming OPV capability donated by The Nippon Foundation can be operated effectively upon receipt, it is important that recruiting commence as soon as possible. Early hiring would ensure that the newly qualified police officers gain as much maritime training and experience as possible prior to receipt of the new patrol boat. Teams of officers need to be well trained on how to properly board a suspected illegal vessel and conduct enforcement operations. Workshop participants assessed the training burden to operate the new OPV to be high.

Recruitment of IPV officers should be done separately from OPV officers as the skill sets required to operate an OPV for long patrols in the EEZ in support of boarding and operations are quite different to those required when working inshore with the public/tourists.

2017

RECOMMENDATION S3. Add one 40-meter class OPV and one 15-meter class IPV, including vessel spares and equipment for crew.

One *Remeliik*-class patrol boat is not sufficient to cover the Palau EEZ. The Nippon Foundation has agreed to provide one 40-meter class OPV and one 15-meter IPV to the Republic of Palau in the next few years. The additional boats would provide Palau with a five-vessel fleet: two OPVs and three IPVs. Prior to the handover of those additional patrol vessels, construction work of the new berthing facilities should be completed and the crew of police officers should be recruited and well trained for the safe and effective navigation/operation of the new vessels (see **Recommendations S2** and **S4**).

The Nippon Foundation has offered to continue to provide assistance for maintenance and operation of the patrol boats, including fuel and OJT personnel. It is essential that there is a regular and reliable source of fuel for the vessels and consumables to cover maintenance needs to ensure their readiness to support MCS operations.

Operations: Offshore Patrol Vessel

The Australia- and Japan-supplied OPVs will be crewed and employed to maximize response availability using a two-week operational cycle imposed upon each vessel's annual maintenance cycle. Specifically, when not in maintenance, each vessel will be scheduled to be available for deployment for two weeks out of every four. The primary role of the OPVs is monitoring, control, and surveillance of Palau's EEZ outside of the 12 nm territorial border. These vessels will also be available to conduct offshore search and rescue, casualty evacuation, pollution control, and other tasking as approved by the director of the Bureau of Public Safety.

During each two-week availability period, the vessels will conduct a one-week (seven-day) underway patrol in the Palau EEZ. During periods of non-availability, each vessel will undergo routine maintenance and the crew will be involved in both maintenance and individual/team training (**Table 3**).

When one OPV is undergoing deep-level maintenance, the other will continue on a similar patrol cycle, but the patrol duration will be extended to 10 days and the frequency adjusted to 10 days in 20, followed by a routine maintenance and training period (**Table 4**).

Aerial surveillance will fill in the gaps when there is no patrol vessel at sea and also will provide information immediately prior to a planned patrol, making the planned patrols more effective (see **Recommendation S7**).

Operations: Inshore Patrol Vessel

The IPVs will be crewed and employed to maximize response availability utilizing a six-week operational cycle. Specifically, each craft will be scheduled to be available for deployment for four weeks out of every six. These patrols will be primarily aimed at enforcement of safety and environmental regulations. These craft will also be available to conduct inshore search and rescue, casualty evacuation, and pollution control, and to assist State authorities as appropriate.

During each four-week availability period, the craft will be tasked to conduct regular patrols and inspections within the Palauan Territorial Sea and Internal Waters. When out of its availability period, each craft will undergo routine maintenance and the crew will be involved in both maintenance and individual/team training (**Table 5**).

Table 3.

	Week 1	Week 2	Week 3	Week 4
OPV 1	Standby	Patrol	Routine Maintenance and Training	Routine Maintenance and Training
OPV 2	Routine Maintenance and Training	Routine Maintenance and Training	Standby	Patrol

Table 4.

	Day 1-10	Day 10-20	Day 20-30
OPV 1	Standby	Patrol	Routine Maintenance and Training
OPV 2	Deep-level Maintenance	Deep-level Maintenance	Deep-level Maintenance

Table 5.

	Week 1/2	Week 3/4	Week 5/6
IPV 1	Patrol and Inspections	Patrol and Inspections	Maintenance and Training
IPV 2	Maintenance and Training	Patrol and Inspections	Patrol and Inspections
IPV 3	Patrol and Inspections	Maintenance and Training	Patrol and Inspections

RECOMMENDATION S4. Construct a new wharf at the DMLE facility with the capacity to support two 40-meter class OPVs, three 15-meter class IPVs, and temporary berthing for holding a seized fishing vessel.

Cost Estimate. The Nippon Foundation has agreed to fund this requirement. Temporary berthing for impounded vessels needs to be addressed.

RECOMMENDATION S5. Purchase weapons and ammunition for Palau Marine Law Enforcement operations. Construct a secure armory for weapons storage.

Each OPV (two) will require:

- Six 5.56 mm rifles (M-16/Austeyr/AR-15) for boarding party protection and FAD destruction
- Nine 9 mm pistols for use by boarding party
- Two shotguns for use by boarding party
- Two 12.7 mm machine guns (.50 cal) for FAD and fishing vessel destruction

Each IPV (three) will require:

- One 5.56 mm rifles for boarding party protection and FAD destruction
- One shotgun for use by boarding party
- Four 9 mm pistols for use by boarding party

The total weapon procurement requirement is:

- Fifteen 5.56 mm rifles
- Thirty 9 mm pistols
- Seven shotguns
- Four 12.7 mm (.50 cal) machine guns

In addition, each weapon requires the appropriate ammunition, slings, holsters, and mounts. Procurement of these items should also include an allowance for operator training so that all police officers operating and maintaining these weapons are appropriately qualified. In order to store weapons and ammunition safely and securely when vessels are not in use, it is essential to construct an armory and magazine at DMLE.

Cost Estimate. $50,000

Radar Towers

2017–2021

RECOMMENDATION S6. Purchase and install nine radar towers equipped with camera systems for shore-based deployment at the outlying Palau islands.

Illegal fishing in the Republic of Palau predominantly takes two forms: (1) industrial fishing and (2) poaching from reefs. The latter occurs both within established Marine Protected Areas, which are off limits to all fishing, and by small foreign fishing vessels coming from afar to raid clam beds, sea cucumbers, and reef fish (**Figure 3**). It has been challenging to provide surveillance of the coastal resources of the outer islands (Southwest Islands, Kayangel) because of their remoteness. More recently, the number of illegal vessels, usually seen in groups of three to five boats, approaching the main island group has been increasing. Illegal fishing activities also occur at night, and industrialized "mother ships" have been known to support the small boats from some distance offshore (**Figure 4**). Beyond the biological damage that these vessels cause, they also pose risks for human trafficking and spreading infectious diseases, and are potential pathways for narcotics or weapons trafficking. The Southwest Islands pose a particular challenge due to their remoteness, but are equally critical as these small inhabited land masses define a large fraction of the total Palau EEZ.

The use of coastal surveillance towers equipped with radar and cameras in view of areas of special biological significance would serve as the inner component of a nested wide-area approach to MCS. Land-based surveillance systems composed of radar and electro-optical and infrared cameras permit unattended sensing of coastal waters, both for real-time enforcement needs and for characterizing trends in EEZ usage. In Hatohobei State, the southernmost location of Palau's EEZ, the towers would provide an efficient means for detecting traffic moving north.

Cost Estimate. It will cost approximately $150K per tower for equipment procurement and installation, with annual costs of approximately $20K for consumables ($5K radar parts) and ($15K) amortization of capital equipment over a 10-year period to allow for replacement. While the recommendation is to spread the purchase over five years, price reductions may be found if a large number of towers are installed at one time. It is assumed local State Rangers would be stakeholders in the operation and maintenance of these systems and would be local users of the data output.

Site Locations. Site locations for full deployment are Kayangel, Melekeok, Peleliu, Anguar, Merir, Sonsoral, Pulo Anna, Tobi, and Helen Reef.

Surveillance Aircraft

2016–2018

RECOMMENDATION S7. Develop and integrate an aviation surveillance platform and concept of operations for the Palau EEZ.

Aerial surveillance greatly multiplies the effectiveness of the MLE boat patrolling the EEZ. It greatly increases the scanned area, acts as a cue, and can provide prosecutable evidence (by support from observers taking pictures) for the Attorney General's office. In the surveillance role, the aircraft will conduct regular patrols in the EEZ, in direct support of the deployed offshore patrol vessel. When deployed during periods when no patrol boat is available due to maintenance, the aircraft could be tasked for independent surveillance aimed at providing cueing for the standby patrol boat (if available). In the response role, the aircraft will conduct evidence gathering aimed at providing support for legal action against alleged violators of the EEZ. Aircraft could also serve as a deterrent for illegal activities. A small visual-search-only aircraft operating from Koror could cover as much as 10,000 nm^2 per mission and reach up to 90% of the entire EEZ.

Palau has tested the use of unmanned aerial vehicles (UAVs), also known as drones or remotely piloted aircraft, to patrol its waters. They have the potential to greatly increase the efficiency of maritime surveillance to combat illegal fishing, and could significantly decrease its cost. UAVs can also assist in search and rescue operations and map and observe marine wildlife. However, the technical expertise required to operate a UAV is significant. Consequently, purchase and operation of UAVs were not recommended as a viable aircraft option at this time by workshop participants.

2016

Support monthly PMA Islander / PSS H.I. Remeliik *test for one year.*

Pacific Mission Aviation, a long time nongovernmental organization active throughout Micronesia and an approved Air Operator by US and Palau Aviation authorities, would work with DMLE for one year to coordinate surveillance and evidence-gathering activities. A year-long trial would inform national authorities on the challenges and resource needs of an ongoing air surveillance program. It would also provide a vital learning opportunity for both tasking and supported agencies.

Cost Estimate. Thirty (30) hours per month (total one year cost: $360K); PMA charter for five days each month for coordinated and/or independent operations.

2017

The one-year Islander/*Remeliik* test would provide Palau with significant input on aircraft needs and options. Assuming Palau moves forward with a program of more continuous aircraft surveillance, hangar facilities that can withstand a typhoon must be built for airplane and operating support equipment. Currently, Palau has no hangar facilities. There are two options for obtaining hangar facilities.

Option 1. Fund construction of a typhoon-proof airplane hangar.

The cost to build a suitable hangar in Palau is ~ $1 million.

Option 2. Grant PMA requested lease for hangar space.

PMA has funds available to construct the hangar, provided the requested lease for hangar space is granted to PMA by the Republic of Palau.

2018

Once the hangar is built, there are two options for long-term aircraft surveillance.

Option 1. Acquire and maintain an aircraft surveillance platform.

Assuming a hangar facility for an aircraft has been built, the range of types of aircraft and on-board equipment varies according to capability and budget. The two purchasing options listed below provide the lower and upper limits for an airplane (cheapest and most expensive/versatile) for surveillance. The most economical option can only be used in fair weather conditions during daytime hours; visual contact is a requirement. The more expensive equipment option allows detection in less than ideal conditions (e.g., "see" through extensive cloud cover, night vision). An option is to start with a simply equipped platform and then plan for upgrades and improved equipment as experience is gained.

- *Cessna 337.* $250K one-time acquisition cost of aircraft plus $25K one-time cost for equipment (e.g., binoculars and cameras). Operating costs are $3.6K/mission.

- *King Air.* $1M one-time acquisition cost for the aircraft plus $100K one-time cost for radar equipment. Operating costs are $8.4K/mission.

Associated with acquiring and maintaining an airplane, there are ongoing personnel costs, including training and support for two pilots, two mechanics, four observers, and one administrative assistant.

Option 2. Put in place an MOU between the Republic of Palau and PMA for regular aircraft surveillance support.

Southwest Islands

2016–2019

RECOMMENDATION S8. Construct a Southwest Islands Support Facility and develop plans for a refueling station and runway in Hatohobei State to ensure proper enforcement of the southwest region of Palau's EEZ.

Hatohobei State is comprised of Helen Reef Atoll and Hatohobei Island, extending Palau's EEZ 300 nm southwest of the main island of Babeldaob. Hatohobei State defines Palau's EEZ borders with the Indonesian and Philippines EEZs. The islands are key to defining Palau's southern border, yet present logistical challenges for patrol boats based out of the main island group. Currently, no berthing, refueling, or defined anchorages exist. Establishment of a facility would provide a means for Palau to more effectively enforce IUU infractions over a large area of its EEZ. A comprehensive refueling, ship berthing, and airstrip facility at Helen Reef would be strategic for Palau's ability to monitor its EEZ and maintain sovereignty over its waters.

Helen Reef is a Protected Areas Network (PAN) site registered with the Ministry of Natural Resources, Environment, and Tourism and since 2000 has been managed by the Helen Reef Resource Management Program (HRRMP) under the Hatohobei State Government (HSG). HRRMP enforces the HSG Marine Protected Area and currently employs eight State Rangers.

2016

Communication Facility

The HSG Koror Office communicates daily with the Helen Reef Ranger Station using single side band (SSB) radio powered by a backup battery and small gas generator. Helen Reef Rangers have secured a donation of a satellite phone for emergency use. However, the Helen Reef station is urgently in need relocation, as island drift threatens its present site.

HSG has secured a $20,000 grant for a temporary ranger station that will be used as communication facility while they will be working to secure a larger grant for a permanent ranger station.

2017–2019

Southwest Islands Support Facility: Patrol Boat Berthing, Fuel Depot, and Runway

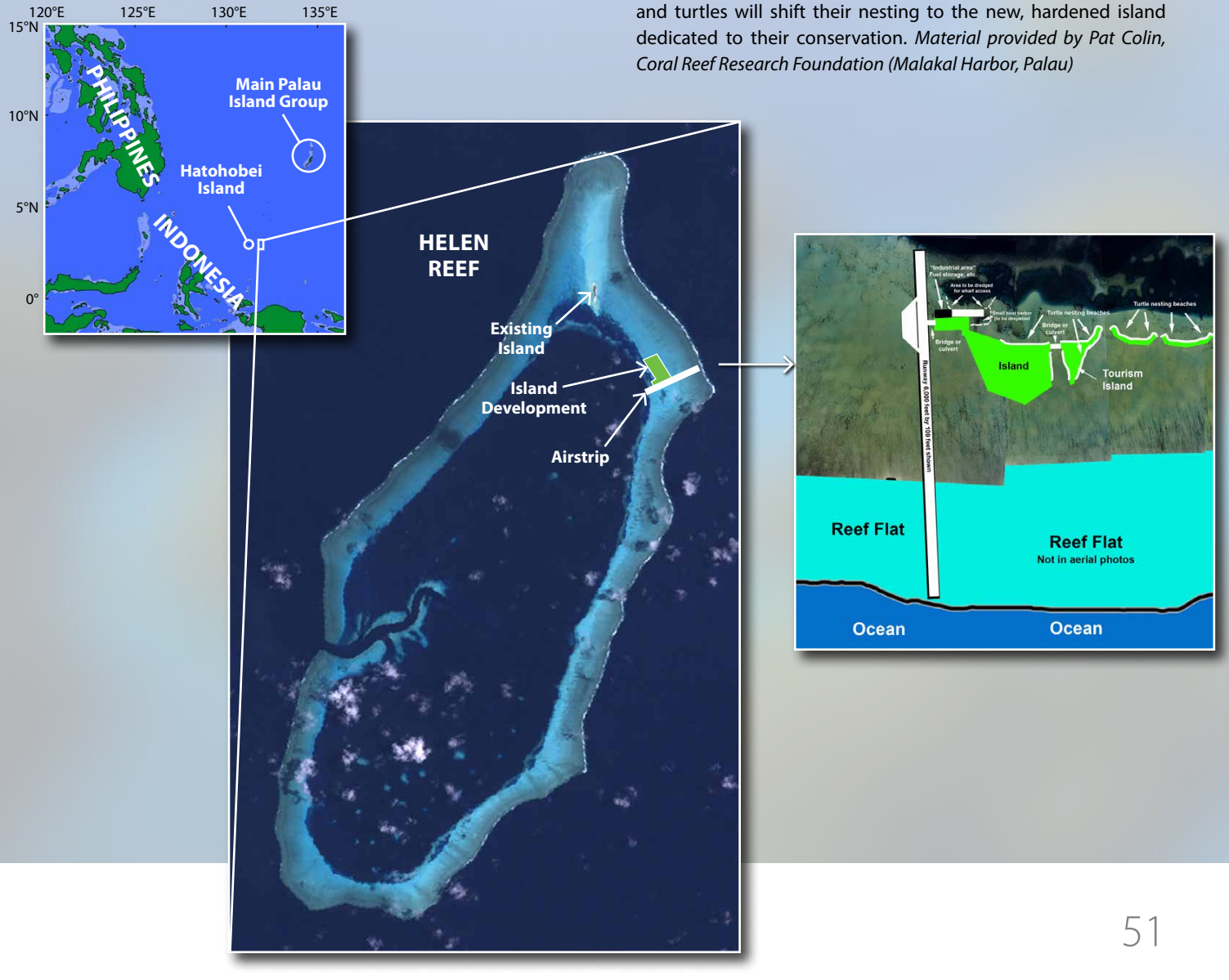
The Office of the President, HSG, and other outside organizations and experts will work together to develop plans to implement an outpost that consists of vessel berthing, a fuel depot, and an airstrip in Hatohobei State, most likely at Helen Reef Island. Planning for this facility requires an engineering study to determine the best means to reclaim land to establish the airstrip within the protected waters of the atoll. The patrol boat berthing and fuel depot could be accomplished through mooring a barge facility within the lagoon waters.

Runway

Concept planning has begun for an airstrip to be built on Helen Reef in Hatohobei State (see **Box 4**). Once the plans are reviewed and completed, coordination will need to occur with HSG and with the Office of the President to secure funding to implement this project.

BOX 4. SOUTHWEST ISLANDS SUPPORT FACILITY

A Southwest Islands Support Facility has been identified as a priority to provide MCS in the southwest region of Palau's EEZ. This region of Palau's EEZ/Marine Sanctuary is largely uncontrolled and represents a significant fraction of the total protected area. Both reef fisheries of the Southwest Islands, and the high-seas pelagic (tuna) fisheries require protection from foreign vessels. A Southwest Islands Support Facility would provide a base and refueling depot for patrol boats, an air base for maritime surveillance aircraft, and a location for transport of stores, and it would enable Palau to fly out foreigners apprehended in the no-fishing zone for processing at the main island group facility. Helen Reef atoll provides an ideal geographic and physical location for basing such a facility. The 14 x 6 mile atoll has a lagoon of about 80 square miles, and contains one extremely small island that is now feeling the pressures of sea level rise and denudation of its flora, and will soon not be able to provide the sensitive habitat it now provides to nesting turtles and seabirds. An artificial island at Helen Reef could have various components that support both surveillance and conservation needs. Island areas with nesting beaches and habitat for bird rookeries could be developed in parallel with fabrication of an airstrip, a wharf where ocean-going vessels could tie up and load/unload, and a small fuel farm. Potential expansion could include tourism development, with a small fishing/diving resort operated as a means of providing support revenue. One potential location for the projected island is where there is already a small sand spit that is emergent at very low tides and adjacent to inshore basins large enough for a *Remeliik*-class patrol vessel. These basins, coupled with the protected waters of the atoll (accessible by an existing navigable channel), provide an ideal location for housing a vessel. The existing concept plan would cover less than 1% of Helen Atoll's reef flat, and the extremely healthy marine environment of Helen Reef would recover quickly from construction impacts. Similar man-made islands have been created in the Indo-Pacific with demonstrated success. As the existing island at Helen Reef continues to succumb to climate-induced changes, it is expected that birds and turtles will shift their nesting to the new, hardened island dedicated to their conservation. *Material provided by Pat Colin, Coral Reef Research Foundation (Malakal Harbor, Palau)*



Summary

Participants at the MCS Workshop held in Koror, Palau, in April 2015 thought that significant progress in monitoring, control, and surveillance of the Palau EEZ could be made in 2016–2017 as soon as the National Marine Sanctuary bill is signed into law. Participants agreed that conducting a detailed trade-off and cost-benefit study for the final surveillance system to meet the 2021 MCS vision was beyond the scope of the workshop, due in part to uncertainties of funding and funding sources, ambiguity of the scope and scale of the IUU problem, and unknowns in the technical and human resource elements within Palau. However, there was consensus that an immediate MCS action plan for 2016–2017 would allow Palau to begin identifying the best practices for interagency coordination, formalizing legal processes, and establishing a technical base that would expand in time. This "test-bed" approach sets the stage for Palau to have immediate measurable successes, and will provide hard data for identifying the recurring costs for a built out MCS plan in 2021 and beyond.

2016–2017 Action Plan

- Establish the financial structure for supporting Palau's MCS plan.

- Recruit and train additional Palau Marine Law Enforcement (MLE) officers to meet existing demands, including interdictions based on existing FFA data, increased patrols, and the processing and securing of detainees.

- Stabilize the MLE fuel budget to allow for increased EEZ patrols by PSS *H.I. Remeliik*.

- Initiate an MCS human resources study, including development of detailed job descriptions and a chain-of-command reporting structure. The study should include contracting a human resources expert to identify improvements for staff recruiting, performance, education, and retention.

- Conduct engineering studies and begin construction of the Southwest Islands Support Facility.

- Establish a provisional Coordination Center at the DMLE facility to formalize interagency coordination; provide a physical location for display, fusion, analysis, and communication of surveillance data; provide an external focal point for growing Palau's MCS capacity; and centralize MCS responsibilities across Palau's agencies. Begin planning for the funding, construction, and establishment of a permanent Coordination Center.

- Establish robust communications from the provisional Coordination Center to State Rangers at the Southwest Islands and Kayangel and to the patrol boats.

- Establish weekly surveys using the PMA Islander aircraft At a minimum, a five-hour sortie would be flown weekly, expanding as the MCS operations mature.

- Establish weekly satellite data overpasses from commercially available Synthetic Aperture Radar with no less than 12-hour data and target analysis latencies. Data will be used for cueing the patrol aircraft and the patrol boat, as well as scoping the statistics of total IUU/dark targets within Palau's EEZ. Overpasses of satellite imagery were estimated by workshop participants to be $500K per year if imagery was collected several times a week. Contracting for a large number of scenes on an annual basis will reduce the total cost.

- Establish shore-based radar stations in Kayangel and Hatohobei State, expanding to Sonsoral, Merir, Pulo Anna, Angaur, Peleliu, and Melekeok.

- Install and maintain a data fusion system at the MCS Coordination Center to ingest the data feeds provided by the surveillance assets, the FFA AIS and VMS data, and ocean and atmospheric forecasts of ocean temperatures, currents, winds, and sea state. The fusion system should permit archival analysis of collected data to establish locations of fishing hotspots and pattern recognition of IUU. Archiving of VMS data should begin as soon as possible.

Richard Brooks for the Pew Charitable Trusts

DECEMBER 2015