

## PACIFIC FREELY ASSOCIATED STATES

The Pacific Freely Associated States include the Republic of the Marshall Islands (the Marshalls), the Federated States of Micronesia (FSM), and the Republic of Palau (Palau). These islands are all independent countries that at one-time were governed by the U. S. as part of the Trust Territory of the Pacific Islands after World War II. Although these countries are independent, they still maintain close ties with the U.S. and are eligible to receive funds from U.S. Federal agencies, including NOAA, DOI, EPA, and the National Science Foundation.

The coral reef resources of these islands remain mostly unmapped.

### Republic of the Marshall Islands

The Marshall Islands encompasses approximately 1,225 individual islands and islets, with 29 atolls and 5 solitary low coral islands (Figure FAS-1). The Marshalls have a total dry land area of only about 181.3 km<sup>2</sup>. However, when the Exclusive Economic Zone (from the shoreline to 200 miles offshore) is considered, the Republic covers 1,942,000 km<sup>2</sup> of ocean within the larger Micronesia region. There are 11,670 km<sup>2</sup> of sea within the lagoons of the atolls. Land makes up less than 0.01% of the area of the Marshalls. Most of the country is the broad open ocean with a seafloor depth that reaches 4.6 km. Scattered throughout the Marshalls are nearly 100 isolated submerged volcanic seamounts; those with flattened tops are called guyots. The average elevation of the Marshalls is about 2 m above sea level. In extremely dry years, there may be no precipitation on some of the drier atolls.

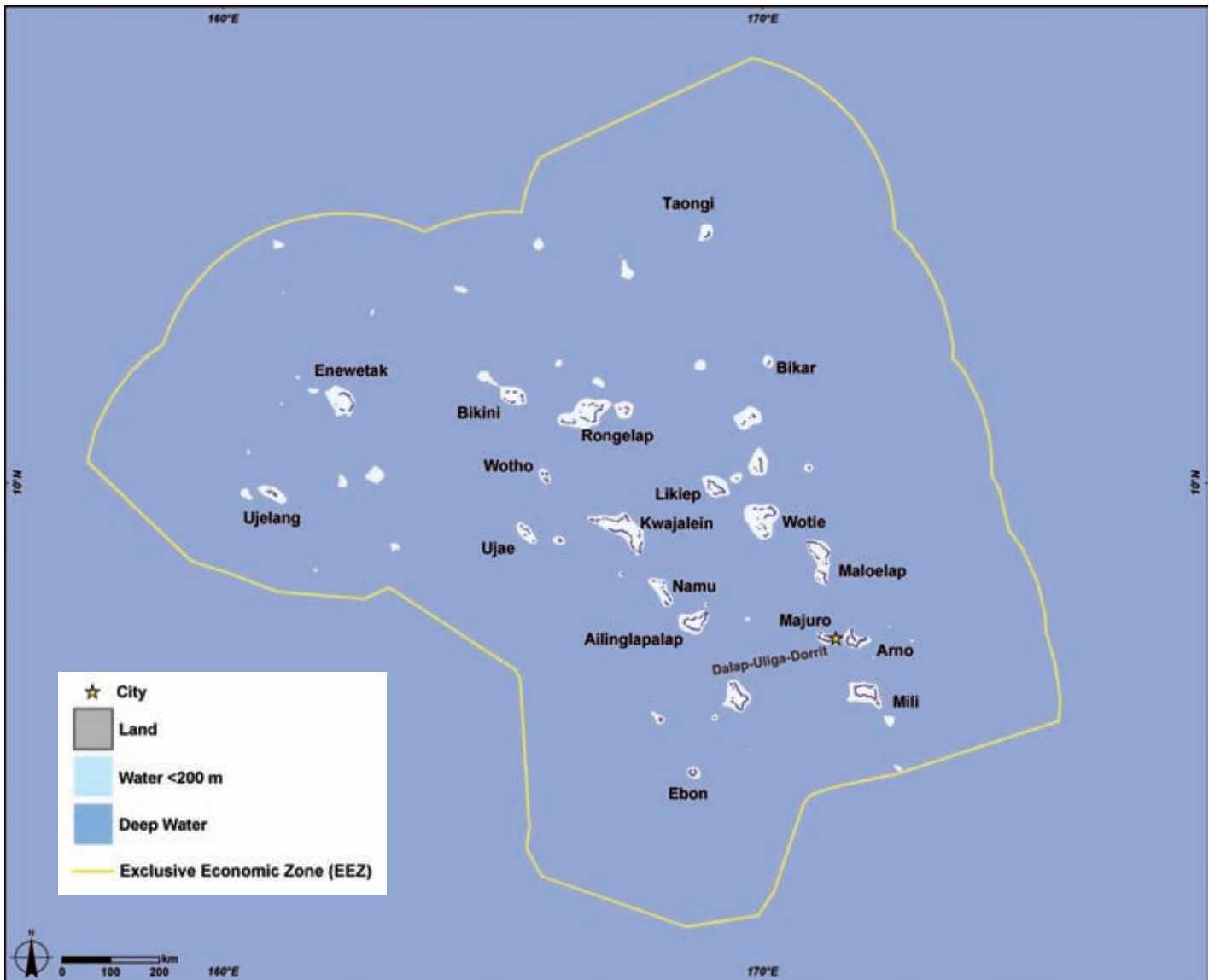


Figure FAS-1. Locator map for the Marshall Islands. (See Figure 5 for geographical context.) Map: A. Shapiro. Source: Pinca et al. (2005).

Tropical storms (typhoons) are relatively rare, but can be devastating. Lagoons within the atolls typically have at least one deep-pass access; however, some, such as Namdrik, have no natural passes.

In general, the reefs of the Marshalls are in good condition and have experienced minimal damage from bleaching, destructive fishing techniques, and sedimentation. Even those in the former nuclear test sites show remarkable recovery, although many of the larger bomb craters may not fill in for years, if at all. However, there is some evidence of unsustainable resource exploitation – the largest giant clams have been harvested and the current take of grouper, reef shark, and Napoleon wrasse may not be sustainable. The reefs near the urban areas of Majuro are stressed, but still have an abundance of fish and invertebrates. Localized outbreaks of crown-of-thorns starfish, *Acanthaster planci*, and coral disease were observed around Majuro in 2005. Recent information on the status of coral reefs of the Marshalls can be found in Maragos and Holthus (1999), Price and Maragos (2000), NBTRMI (2000), and Pinca et al. (2005).

The need to protect Marshallese marine resources stems from both a precautionary effort to conserve pristine reefs and a direct demand from local fishers who report a decline in target species for both commercial and local use. Lower abundance of clams, fish, lobsters, and cowry shells have been reported by local populations from the outer atolls. Marine reserves and other management measures are still in their infancy, but several atolls (Jaluit, Arno, Likiep, Mili, and Rongelap) are spearheading this effort. In 2000, the National Biodiversity Strategy and Action Plan (NBSAP) and the National Biodiversity Report were approved by the Cabinet. Both address the need for conservation and management of natural resources. The NBSAP recommends strengthening the concept of 'mo', a traditional system of taboo identifying certain areas as 'pantries' that could be harvested only periodically. The NBSAP also addressed the need for sustainable fishing practices and retention of local knowledge.<sup>19</sup>

### **Federated States of Micronesia**

The FSM is comprised of four states – from east to west, Kosrae, Pohnpei, Chuuk, and Yap. Along with Palau, these comprise the Caroline Islands (Figure FAS-2). Each island or group has its own language, customs, local government, and reef tenure system. FSM has high islands and low

atolls, and a strong dependence on coral reefs and marine resources, both economically and culturally. Each state supports population centers on high volcanic islands surrounded by barrier reefs (Pohnpei, Chuuk) or very broad fringing reefs that are nearly barrier reefs (Kosrae, Yap). All states except Kosrae also include remote clusters of atolls and low coral islands (Maragos and Holthus 1999). Spalding et al. (2001) estimated total shallow water coral reef area off the FSM to be 5,440 km<sup>2</sup>. Kosrae is a single volcanic island with a landmass of 109 km<sup>2</sup> and an elevation of 629 m. It is surrounded by a fringing reef and has a single harbor. The volcanic island of Pohnpei is the largest island in the FSM and is the FSM capitol. It has an area of 345 km<sup>2</sup> with a well-developed barrier reef surrounding a narrow lagoon. It and the eight nearby coral islands and atolls make up the State of Pohnpei. Chuuk State (formerly known as Truk) has 15 inhabited volcanic and coral islands and atolls. Chuuk Lagoon is the largest atoll in the FSM and serves as the population and political center of Chuuk State. It is famous for the Japanese ships that were sunk in the lagoon during World War II. Yap State has a main volcanic island approximately 100 km<sup>2</sup>, along with 15 coral islands and atolls. The peoples inhabiting the offshore atolls and coral islands in Chuuk, Yap, and Pohnpei states are among the most traditional, with a highly sophisticated marine tenure and associated marine resource management system.

The condition of FSM coral reef ecosystems is generally good to excellent. Most of the reefs in the low islands are in excellent condition. The primary human impacts come from fishing, ship groundings, and coastal development (including dredging and filling). Sedimentation from dredging and road construction projects has resulted in localized reef destruction, including much of Okat. Construction of an airport on top of a broad reef at Okat has further damaged the reefs. On the island of Pohnpei, expansion of sakau cultivation (called kava in other cultures) has reduced rainforest cover by two-thirds, resulting in increased sedimentation on coastal reefs.

In the FSM, traditional leaders (chiefs or their equivalent) and community groups are active in traditional governance as well as western-style, democratically elected officials. This dual system provides opportunities and challenges to reef and marine resource protection. Over the past several years, Kosrae has begun to develop a MPA program that involves co-management of coastal resources between local communities and state resource

<sup>19</sup> Introductory material was taken, with slight modifications, from Pinca et al. (2005).

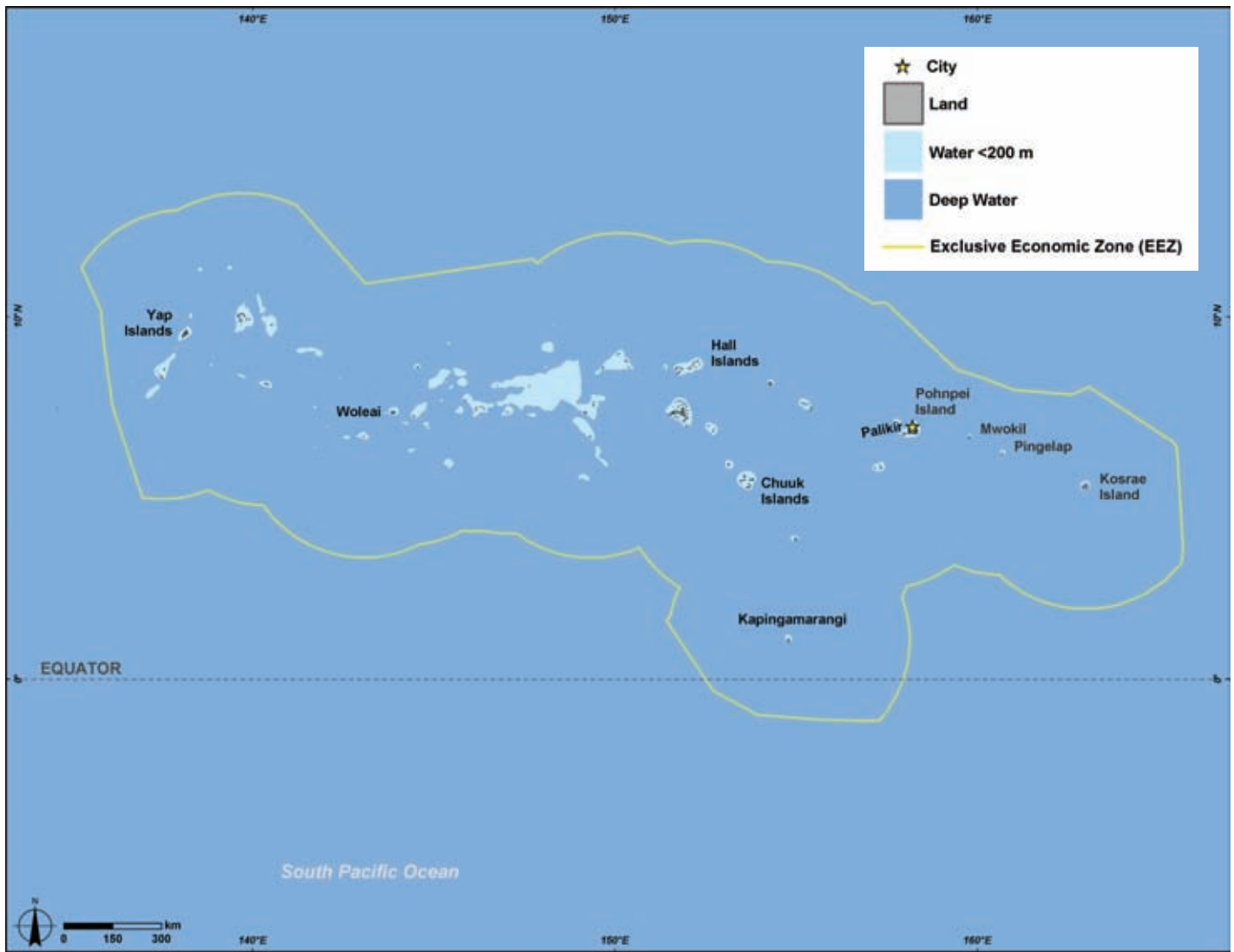


Figure FAS-2. Locator map for the Federated States of Micronesia. (See Figure 5 for geographical context.) Map: A. Shapiro. Source: Hasurmai et al. (2005).

management agencies. Currently, Kosrae has four MPAs that are managed by government agencies and/or local communities. These are the Utwe-Walung Marine Park and three Areas of Special Concern: the Tukasungai (*Trochus niloticus*) Sanctuary (commonly referred to as the "Trochus Sanctuary"), the Giant Clam (*Tridacna* spp.) Sanctuary, and the Okat-Yela Mangrove Reserve. Chiefs and other traditional leaders usually control protection of specific areas. In Yap, the villages own the reefs and have authority over resource use. A number of the islands have areas set aside for reef protection and limited resource extraction, but currently the FSM lacks the enforcement capacity to protect the MPAs (A. Edward, pers. comm.).<sup>20</sup>

### Republic of Palau

Palau, part of the Caroline Islands group, is the westernmost archipelago in Oceania, located 741 km east of Mindanao in the southern Philippines and about 1,300 km southwest of Guam (Figure FAS-3). Palau is composed of inhabited islands and 700+ islets, stretching 700 km from Ngeruangel Atoll in the Kayangel Islands in the north to Helen Reef in the south. The archipelago consists of a clustered island group (including Babeldaob, Koror, Peleiu, Angaur, Kayangel, Ngeruangel, and the Rock Islands) and six isolated islands (Helen Reef, Tobi, Merir, Pulo Anna, Sonsorol, and Fana) that lie approximately 339 to 599 km to the southwest (Figure FAS-4). Babeldaob, the second largest island in Micronesia after Guam, is the biggest island in the Palauan chain; however, the country's capital and greatest population is located on Koror. The volcanic island of Babeldaob and its reefs are separated from Koror and the southern islands of the group by a deep (30 to 40 m), east-west pass called Toachel El Mid.

<sup>20</sup> Introductory material was taken, with slight modifications, from Hasurmai et al. (2005).

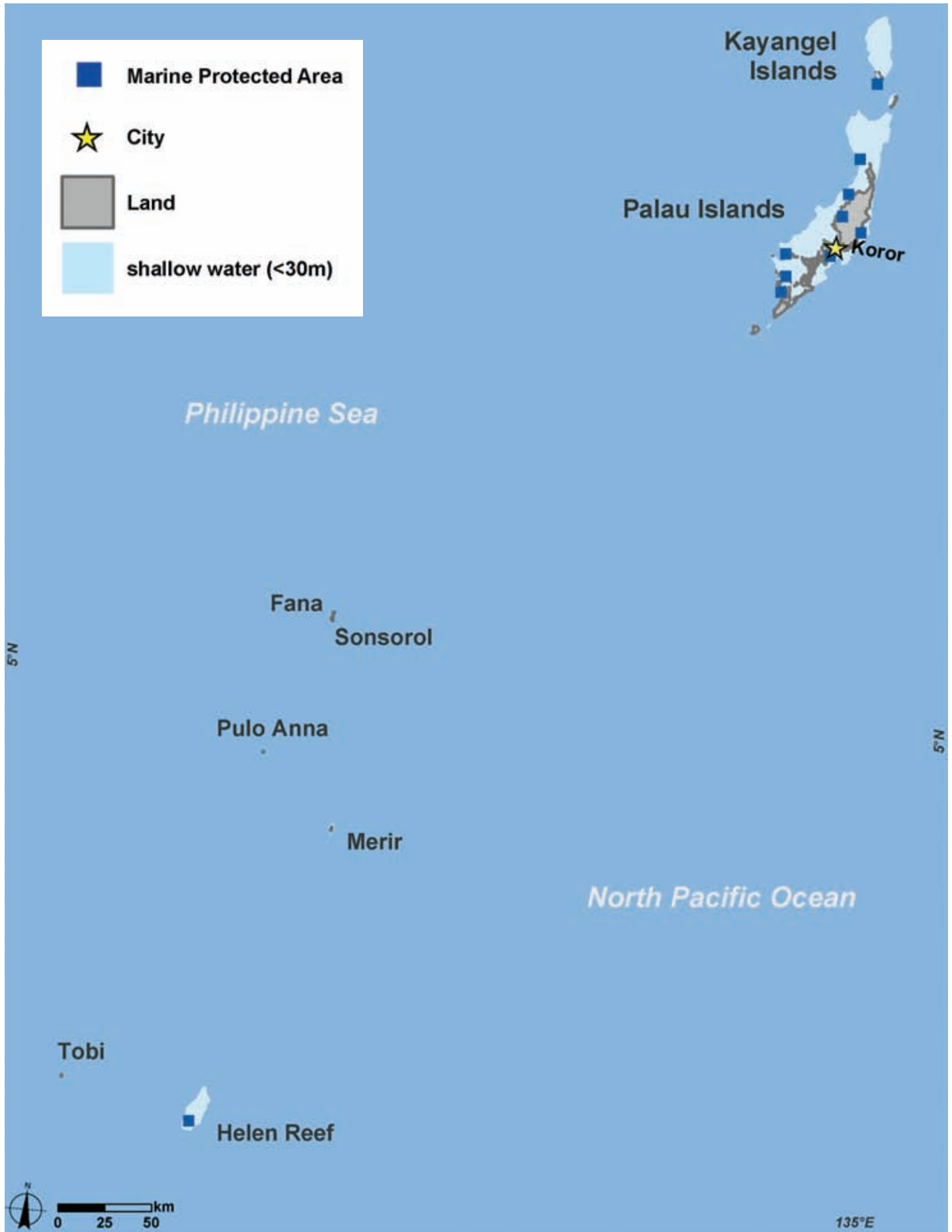


Figure FAS-3. The nation of Palau is an archipelago in the Caroline Islands. Most Palauans reside in the cluster of the northern islands (see Figure FAS-4 for detail of main island group). (See Figure 5 for geographical context.) Map: A. Shapiro. Source: Golbuu et al. (2005).

Palau has numerous island and reef types, including volcanic islands, atolls, raised limestone islands, and low coral islands. A barrier reef surrounds much of the main island cluster, from the northern tip of Babeldaob down to the southern lagoon, merging into the fringing reef with Peleliu in the south. Palau has the most diverse coral fauna of Micronesia and the highest density of tropical marine habitats of comparable geographic areas around the world.

Palau has already done a great deal toward limiting the impacts of tourists on reef resources. Mooring buoys, laws preventing the collection of corals, and diving tour operator education help conserve the culturally and economically important reef resources. The largest direct impact on some reef sites is now the volume of divers with varying levels of training. Increased sedimentation is another major threat to coral reef ecosystems worldwide (McCook et al. 2001; Wolanski and Spagnol 2000; Wolanski et al. 2003), and Palau is no exception. Sedimentation associated with runoff from coastal development poses a serious threat to reefs around Babeldaob. Foreign-based fishing activities are also a problem; poachers from Indonesia and the Philippines are frequently encountered on Helen's Reef. Ship groundings have also been occurring off the main islands, as well as those in the south.

The Palau Ministry of Resources and Development has overlapping jurisdiction with each of Palau's 16 state governments for all marine areas within 12 nm of the high tide watermark. National and state agencies, in coordination with locally based nongovernmental organizations, have put a variety of management tools in place to address issues such as fishing, recreational use, and land-based sources of pollution to protect the marine resources of Palau. Several MPAs have been established throughout Palau to provide measures of protection for marine resources tailored to the management goals and intended purpose of the individual MPAs. Most of Palau's MPAs have been designated by the states and management of these areas falls under the authority of the local governments. In addition, there are MPAs designated by the national government for the purpose of protecting biodiversity and significant habitats. The designation of a MPA by the local governments is initiated by the implementation of a traditional moratorium, or 'bul', on the area, prohibiting all use for a restricted time period (usually one to three years). The majority of these MPAs were designated to address local concerns of decreased

commercial reef fish populations. Palau recently passed the Protected Areas Network Act of 2003 which provides a framework for the establishment of a MPA network in Palau. Much of the design, criteria, and regulations are still under development, and expertise and technical assistance are needed to assist in implementation.<sup>21</sup>

<sup>21</sup> Introductory material was taken, with slight modifications, from Birkeland et al. (2002) and Golbuu et al. (2005).



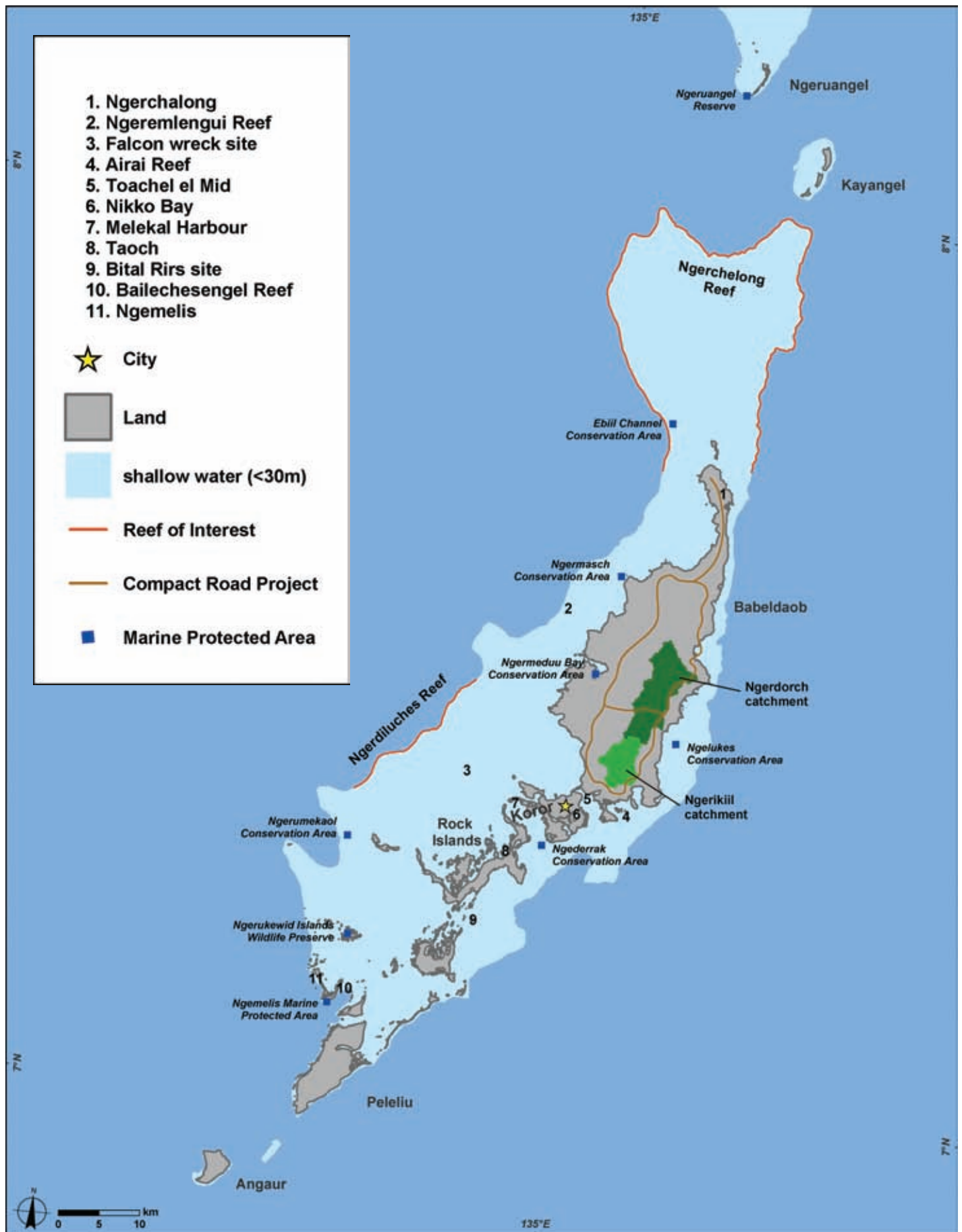


Figure FAS-4. A detailed map of Palau's main island cluster. Map: A. Shapiro. Source: Golbuu et al. (2005).

**Research Needs**

<p><b>PACIFIC FREELY ASSOCIATED STATES</b></p>	<p><b>FISHING</b></p>	<p>All</p>	<p>Republic of the Marshall Islands</p>	<p>Federated States of Micronesia</p>	<p>Republic of Palau</p>
<p><b>Management Objective</b></p>	<p><b>Research Need</b></p>				
<p>Conserve and manage fisheries to prevent overfishing of stocks, rebuild overfished stocks, and minimize destructive fishing.</p> <p><i>See Jurisdiction-Wide Section for additional research needs.</i></p>	<p>Create benthic habitat maps that include fish-habitat associations to provide spatial framework for research and management activities.</p>	√			
	<p>Quantify the impacts of subsistence fishing on populations of fished species.</p>	√			
	<p>Document traditional knowledge and evaluate its application to modern fisheries management.</p>	√			
	<p>Determine sustainable harvest levels and fishing limits for the various fisheries.</p>				√
	<p>Examine how physical factors and biological components control the transport of fish and coral larvae around Palau.</p>				√
	<p>Evaluate implications of recent fishery regulations including bans on spearfishing, gill, and drag nets; and seasonal and spatial closures on key reef species and on fishermen.</p>	√			
	<p>Evaluate and characterize marine ornamental fisheries and the role of aquaculture efforts in reducing impacts associated with the aquarium trade</p>		√		
	<p>Characterize live reef food fish fisheries (for Asian markets), including locations and species harvested, extent of cyanide use and illegal fishing, and impacts on target populations</p>				
	<p>Characterize the threat to coral reef ecosystems from commercial fishing and fishing gear.</p>		√	√	
<p>Protect, conserve, and enhance the recovery of protected, threatened, and other key species.</p>	<p>Assess the abundance of harvested species, including clams, fish, lobsters, and cowry shells, in outer atolls to provide early warning of population declines and unsustainable harvest levels.</p>		√		
<p>Evaluate and improve the effectiveness of MPAs as a fisheries management tool.</p> <p><i>See Jurisdiction-Wide Section for additional research needs.</i></p>	<p>Evaluate the effectiveness of the Trochus and Giant Clam Sanctuaries in protecting these species from overfishing and in preventing logging and coastal development along sanctuary shorelines.</p>			√	

PACIFIC FREELY ASSOCIATED STATES	POLLUTION	All	Republic of the Marshall Islands	Federated States of Micronesia	Republic of Palau
<b>Management Objective</b>	<b>Research Need</b>				
Reduce the impacts of pollutants on coral reef ecosystems by improving the understanding of their effects.  <i>See Jurisdiction-Wide Section for additional research needs.</i>	Quantify the impacts of the Majuro sewage outfall on adjacent coral reef resources, including coral recruitment rates, coral condition, and benthic cover.		√		
	Characterize the extent of nutrient and chemical leakage from septic tanks on Babeldaob Island.				√
	Evaluate impacts of coastal construction (including ports, docks, airfields, causeways, and roads) on coral reef ecosystems, especially those that are proximate to human population centers (e.g., Majuro and Likiep).		√		
	Determine the water quality around the dump area and sewage outfall.				√
	Determine the water quality in primary watersheds with current and future development plans.				√
	Quantify nutrient loads in key watersheds on Babeldaob Island.				√
Improve water quality by reducing land-based pollutant inputs and impacts on coral reef ecosystems.  <i>See Jurisdiction-Wide Section for additional research needs.</i>	Evaluate the effectiveness of various management strategies to protect forested land on Babeldaob Island.				√
	Manage land use in priority watersheds to significantly reduce land-based pollutants, particularly the clearing of upland rain forest areas for sakau farming.			√	
	Determine the water quality in primary watersheds with current and future development plans, and identify alternative management measures to reduce impacts; and determine their effectiveness.				√
	Develop national and state land use plans covering terrestrial and marine systems in Palau.				√
	Assess coral reef ecosystem condition adjacent to and offshore from areas of coastal development to assist in prioritization of sites to receive new sewage treatment plants and waste disposal facilities.			√	

PACIFIC FREELY ASSOCIATED STATES	COASTAL USES	All	Republic of the Marshall Islands	Federated States of Micronesia	Republic of Palau
<b>Management Objective</b>	<b>Research Need</b>				
Reduce the impacts from recreational use, industry, coastal development, and maritime vessels on coral reef ecosystems.  <i>See Jurisdiction-Wide Section for additional research needs.</i>	Quantify the impact of development on marine resources and assess the transport of pollutants from these areas into the Rock Islands.				√
	Evaluate BMPs for minimizing sedimentation associated with coastal development and changes in land use practices.			√	
	Assess impacts of motorboat fuel and antifouling paints on marine animal survivorship, including investigating gamete and larvae susceptibility.				√
	Forecast the impacts of proposed development projects on nearshore water quality and circulation patterns.			√	
	Document sedimentation associated with dredging and road construction projects and its impacts on coral reef ecosystems.			√	



PACIFIC FREELY ASSOCIATED STATES	COASTAL USES	All	Republic of the Marshall Islands	Federated States of Micronesia	Republic of Palau
<b>Management Objective</b>	<b>Research Need</b>				
Reduce impacts from and restore habitat damaged by vessel anchoring and groundings.	Document vessel anchoring and groundings and determine their impact on coral reef ecosystems.		√		
	Document the impacts of grounded foreign long-line vessels on surrounding reefs and prioritize mitigation efforts.			√	
Restore injured and degraded coral reef habitat.	<i>See Jurisdiction-Wide Section for research needs.</i>	√			
Evaluate and improve the effectiveness of MPAs as a management tool.  <i>See Jurisdiction-Wide Section for additional research needs.</i>	Determine which areas and resources might benefit the most from additional protection.	√			
	Undertake marine eco-regional assessments to identify habitats and conservation targets, threats to these resources, and high priority areas for conservation including areas resistant and resilient to threats and spawning aggregation sites.	√			
	Develop criteria for designing networks of MPAs that include oceanographic parameters and ecological design principles.	√			
	Evaluate the effectiveness of the marine resource certification program in building local capacity for coral reef ecosystem stewardship.		√		

PACIFIC FREELY ASSOCIATED STATES	INVASIVE SPECIES	All	Republic of the Marshall Islands	Federated States of Micronesia	Republic of Palau
<b>Management Objective</b>	<b>Research Need</b>				
Minimize the introduction and spread of alien species.  <i>See Jurisdiction-Wide Section for additional research needs.</i>	Document the presence of marine alien invertebrates in Palau, including the hydroid <i>Eudendrium cameum</i> which has the potential for becoming a 'pest' organism in Palau.				√
Control or eradicate invasive species that have the potential to cause damage to coral reef ecosystems.	<i>See Jurisdiction-Wide Section for research needs.</i>	√			

PACIFIC FREELY ASSOCIATED STATES	CLIMATE CHANGE	All	Republic of the Marshall Islands	Federated States of Micronesia	Republic of Palau
<b>Management Objective</b>	<b>Research Need</b>				
Minimize the effects of climate change on coral reef ecosystems.	Predict the impact of increased intensity and frequency of storm events on low-lying islands and the reefs' ability to attenuate wave energy.		√		
<i>See Jurisdiction-Wide Section for additional research needs.</i>	Examine the relationship between localized coral bleaching and heavy rain events.			√	
Mitigate the impacts from climate change on coral reef ecosystems.	Document coral recovery from the 1997-1998 bleaching event, and identify factors that contributed to its recovery.				√
	Develop hydrodynamic models of currents to predict patterns of hot and cool water during a bleaching event.	√			
Improve the capacity to forecast and respond to bleaching events.	Model circulation patterns, depth, and temperature profiles to determine which lagoons are mostly likely to bleach.		√		

PACIFIC FREELY ASSOCIATED STATES	EXTREME EVENTS	All	Republic of the Marshall Islands	Federated States of Micronesia	Republic of Palau
<b>Management Objective</b>	<b>Research Need</b>				
Identify causes and consequences of diseases in coral reef ecosystems and mitigate their impacts.	Document the types and extent of coral disease within and among major habitat and community types.	√			
<i>See Jurisdiction-Wide Section for additional research needs.</i>	Examine the relationship between white syndrome on <i>Acropora spp.</i> and untreated sewage outfalls on the leeward shore of Majuro.		√		
	Investigate the mechanism of white syndrome transmission between acroporid colonies, and evaluate potential approaches to reduce its spread and mitigate the impacts.		√		
Reduce impacts to and promote restoration of coral reef organisms affected by extreme events.	Assess the impacts of <i>Acanthaster planci</i> including affected species, mortality rates, and locations.		√		
	Identify measures to mitigate <i>Acanthaster planci</i> outbreaks.		√		
	Develop and evaluate methods to reattach massive coral heads displaced by typhoons.			√	