

The State of Coral Reef Ecosystems of the Federated States of Micronesia

Mike Hasurmai¹, Eugene Joseph², Steve Palik³, Kerat Rikim⁴

INTRODUCTION AND SETTING

From east to west, the Freely Associated States include the Republic of the Marshall Islands (RMI), the Federated States of Micronesia (FSM), and the Republic of Palau. The FSM and Palau are known as the Caroline Islands, which span 2,500 km and are among the longest island chains in the world. All of these Micronesian islands were formerly a part of the Trust Territory of the Pacific Islands administered by the United States after World War II (WWII). All three countries achieved independence within the past 25 years but retain close economic and strategic ties to the U.S. (Hezel, 1995). Although the process was initiated as early as 1979, the Compact of Free Association between the U.S. and the RMI and FSM did not go into effect until 1986; the Compact of Free Association between the U.S. and the Republic of Guam was effective in 1995.

The FSM is comprised of four states, from east to west; Kosrae, Pohnpei, Chuuk, and Yap (Figure 14.1). Each island or group has its own language, customs, local government, and traditional system for managing marine resources. The FSM has both high islands and atolls, and islanders have a strong dependence on coral reefs and marine resources, both economically and culturally. The islands support three basic reef formations: fringing reefs, barrier reefs, and atolls, which correspond to the stage of reef development at each island.

Kosrae is a single volcanic island with a land mass of 109 km² and a maximum elevation of 629 m. It is among the least developed of the U.S. Territories and Freely Associated States, with approximately 7,700 people residing there. Kosrae is surrounded by a fringing reef and has a single harbor. In areas where the reef flat is wide, there are a number of large solution holes, some of which support extensive coral development. The reef is narrow along the east and south coasts, but wide enough along the west and north coasts to nearly be considered a barrier reef. The island is surrounded by coastal mangrove forest and extensive fringing reefs. Kosrae's reefs and mangroves are considered some of the healthiest in Micronesia and support a small but growing diving and ecotourism industry (currently about 1000 visitors per year). However, recent coastal development and land use patterns have resulted in coastal erosion and degradation of the coastal mangrove ecosystem, placing the health of Kosrae's reefs at risk.

The volcanic island of Pohnpei, the site of the FSM capital, is the largest island in the FSM (345 km²) and along with eight smaller island and atolls, makes up the state of Pohnpei. Pohnpei Island has a well-developed barrier reef and associated lagoon.

Chuuk State (formerly known as Truk) is made up of 15 inhabited islands and atolls, and is famous for the Japanese wrecks that were sunk in the lagoon during WWII. Chuuk Lagoon is the largest atoll in the FSM and serves as the population and political center of Chuuk State.

Yap State has a main island with a land area of approximately 100 km², and includes an additional 15 islands and atolls. The lifestyle of Yap islanders is among the most traditional in the FSM, with a highly sophisticated marine tenure and marine resource management system.

1 Yap Marine Resource Management Division

2 Conservation Society of Pohnpei

3 Kosrae Fisheries Department

4 Chuuk Department of Marine Resources

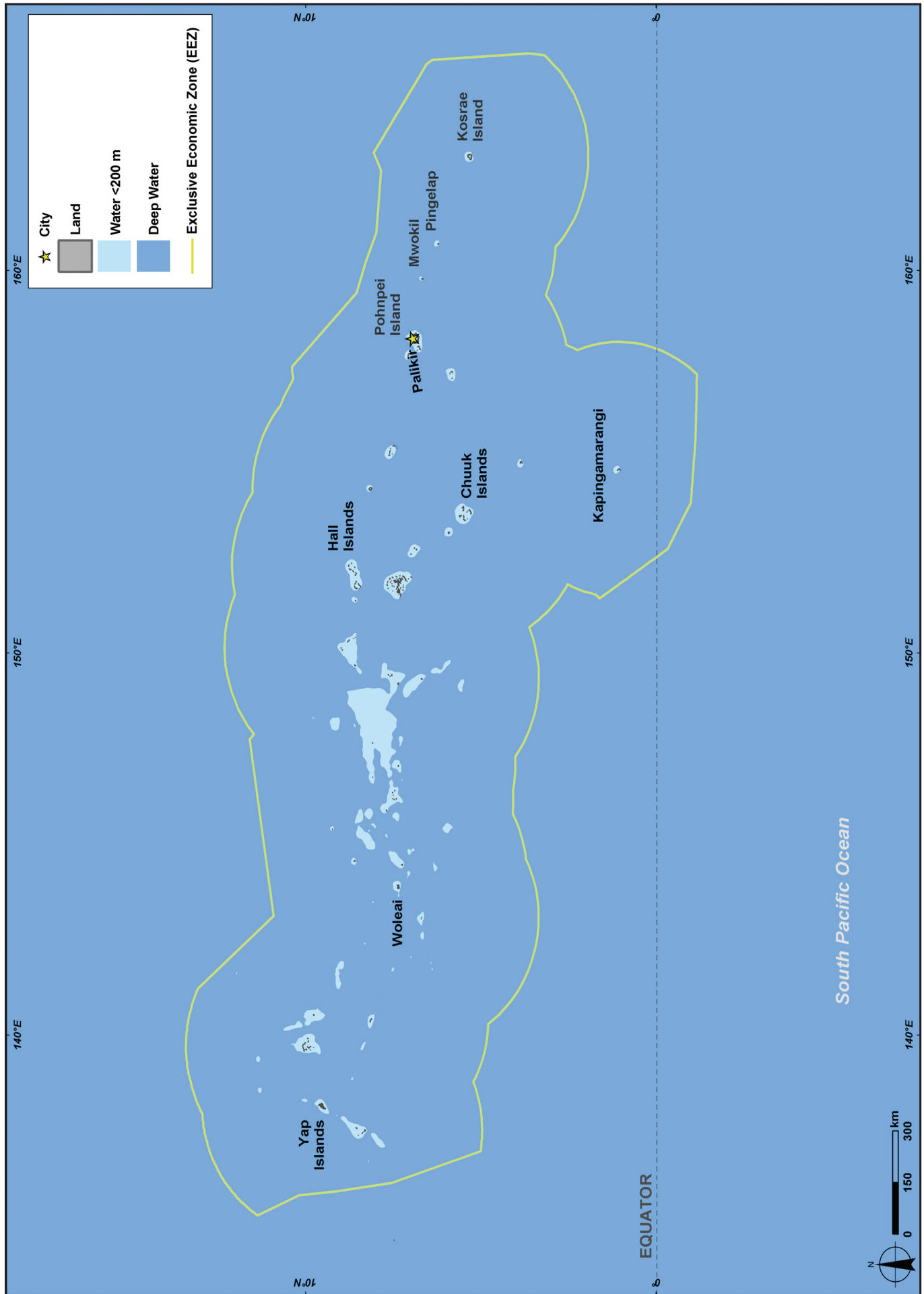


Figure 14.1. Locator map for the Federated States of Micronesia. Map: A. Shapiro.

ENVIRONMENTAL AND ANTHROPOGENIC STRESSORS

Climate Change and Coral Bleaching

There have been a few cases of localized bleaching in some areas around Pohnpei's lagoon but these have been associated with unusually heavy rain events.

Diseases

No information on this threat is available.

Tropical Storms

Tropical storms frequently pass through or near the FSM (Figure 14.2). In 1990, a destructive typhoon passed over remote reefs in Pohnpei State (Holthus et al., 1993). Large waves at Minto Reef caused massive coral heads to be transported from the lagoon to the reef flat, killing a variety of associated wildlife. In early 2004, another large destructive typhoon passed by Chuuk and Yap, causing structural damage to reef areas.

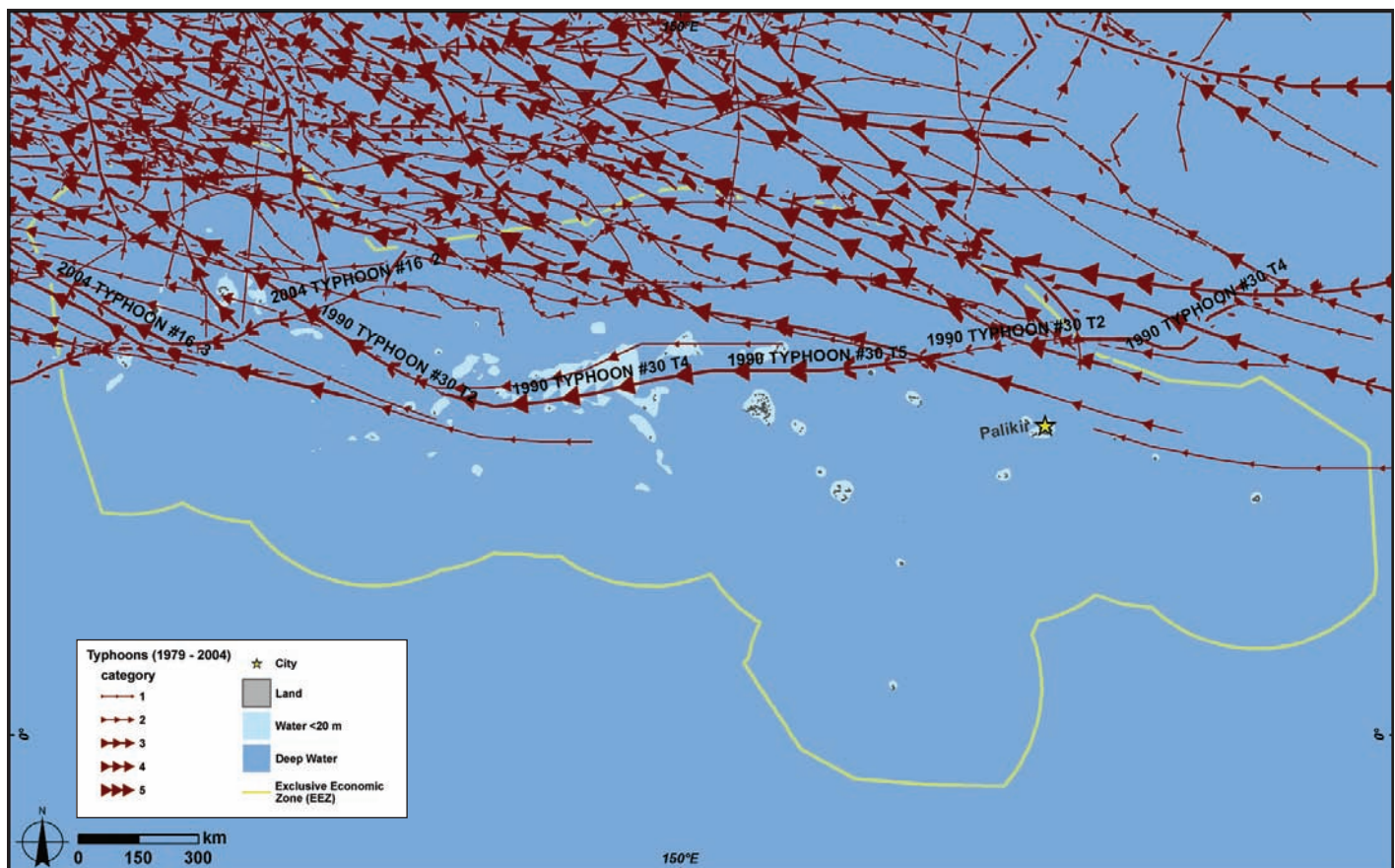


Figure 14.2. The path and intensity of typhoons passing near the FSM from 1979-2004. Many Pacific typhoons are not named or the names are not recorded in the typhoon database. Map: A Shapiro. Data: Unisys, <http://weather.unisys.com/hurricane>.

The population of the FSM has increased in the past several decades (Figure 14.3), with 50% of the population residing in Chuuk State (FSM Division of Statistics, 2002). By 2000, the average population density reached 395 persons per mi² in 2000 (FSM Division of Statistics, 2002). However, since the signing of the Compact of Free Association with the U.S. in 1986, the effect of the population increase has been mitigated by emigration of Micronesians to pursue education and employment opportunities in U.S. states and territories. Guam, Hawaii, and the Commonwealth of the Northern Mariana Islands (CNMI), and are the primary destinations for Micronesians who leave to live and work abroad.

Reefs in Kosrae have been impacted by coastal development, and one of the most noteworthy projects was the construction of the airport on the reef flat at Okat. Sedimentation, caused by dredging and road construction projects, has resulted in the destruction of reefs in Okat and Lelu (M. Tupper, pers. comm.). A new road is being constructed to connect the villages of Utwe and Walung on the south coast, and this will likely lead to increased soil erosion and sedimentation in the Utwe-Walung Marine Park. A large solution hole in Lelu, named “the Blue Hole”, is a popular snorkel and dive site, but has been impacted by the construction of a causeway across the lagoon to Lelu village. The Blue Hole now suffers from high turbidity and macroalgal overgrowth (M. Tupper, pers. comm.).

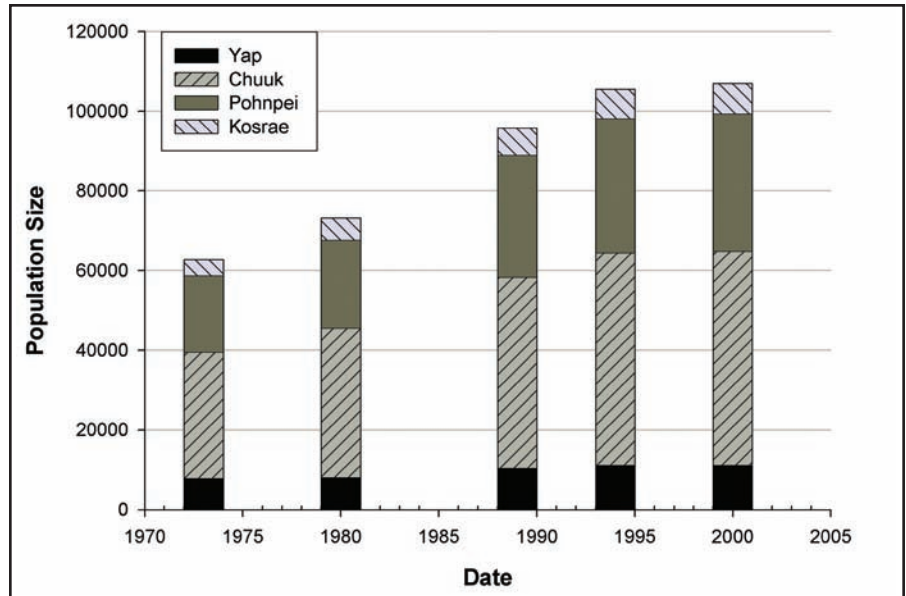


Figure 14.3. Human population growth in the FSM, 1973-2000. Slightly more than half of the population resides in the islands of Chuuk State. Source: FSM Division of Statistics, 2004.

Coastal Pollution

Increased population is a concern for the future of some islands as they come to terms with the need for associated infrastructure, including sewage treatment plants and waste disposal facilities.

Tourism and Recreation

Tourism and recreation have increased in the FSM, with a peak in visitor arrivals of 20,501 in 2000 (FSM Division of Statistics, 2004). According to the FSM Division of Statistics, total international visitors to FSM in 2003 was 18,168 people. Approximately 72% of visitors were citizens of the U.S. (41%) or Japan (31%).

The FSM Visitors Board maintains an informative and attractive website (FSM Visitors Board, <http://www.visit-fsm.org>, Accessed 1/31/05) to help guide potential visitors to the country and has established Visitors Bureau offices in each state. Overseas tourism offices are co-located with Embassy or Consul offices in Guam, Honolulu, Tokyo, Fiji, and Washington, D.C.

Each of the four states in the FSM have deep draft harbors and modern jet airfields served by Continental Airlines, a major U.S. carrier. A range of accommodations, from simple traditional huts to fancy hotels and luxury resorts, can be found in each state with online booking often available. In addition, three live aboard dive vessels are offering cruises in Chuuk in 2005. Diving is one of the most popular activities for visitors who are drawn to the abundant marine life in the FSM and the numerous planes and ships that were sunk, especially in Chuuk Lagoon, during WWII.

Fishing

Commercial fishing in the FSM is focused primarily on the offshore tuna and billfish stocks, which contribute \$14-24 million to the national government annually from the sale of fishing rights to foreign vessels (FSM Division of Statistics, 2004). In addition, the value of exports of marine products in 2002 was over \$9 million, which represents a decrease of about 25% over the export value in the previous two years. Only a fraction of this total value is represented by reef fish (1.2% or less) and other inshore species (Figure 14.4); the majority of reef-associated products exported for sale originate in Chuuk (Figure 14.5). The commercial fishing industry employed between 280 and 340 people per year between 1999 and 2002 (FSM Division of Statistics, 2004).

Reef fish species are primarily exploited for subsistence purposes, but little information exists to characterize subsistence or artisanal catch by species or method of capture. The FSM Division of Statistics reports that of total GDP, approximately one-third can be attributed to subsistence activities such as fishing, agriculture, and copra production (FSM Division of Statistics, 2004), so it is likely that the harvest of reef-associated organisms is substantial. There have been numerous anecdotal reports of destructive fishing practices in the past, but little published information is available.

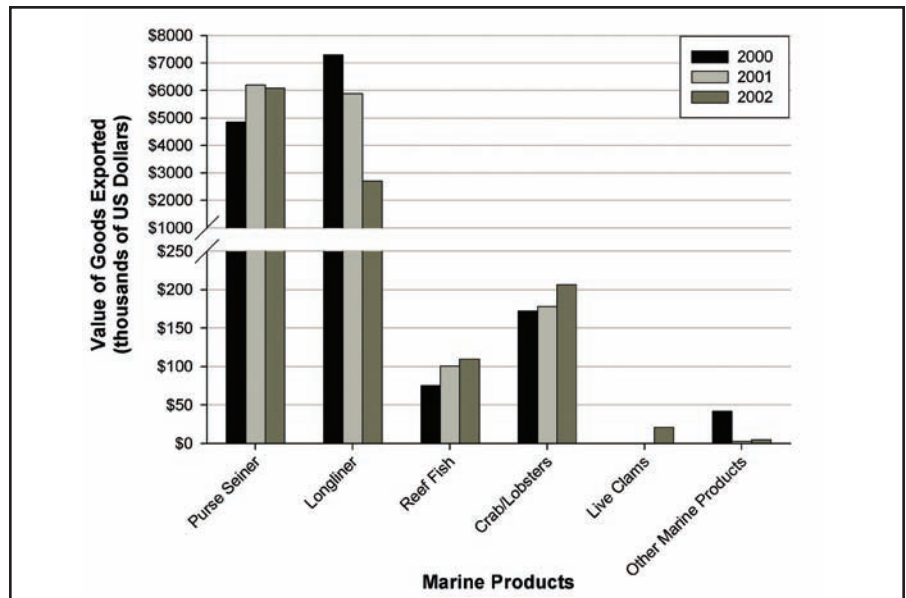


Figure 14.4. Fisheries resources contribute significantly to FSM exports, though only a small fraction are from reef fish. Source: FSM Division of Statistics, 2004.

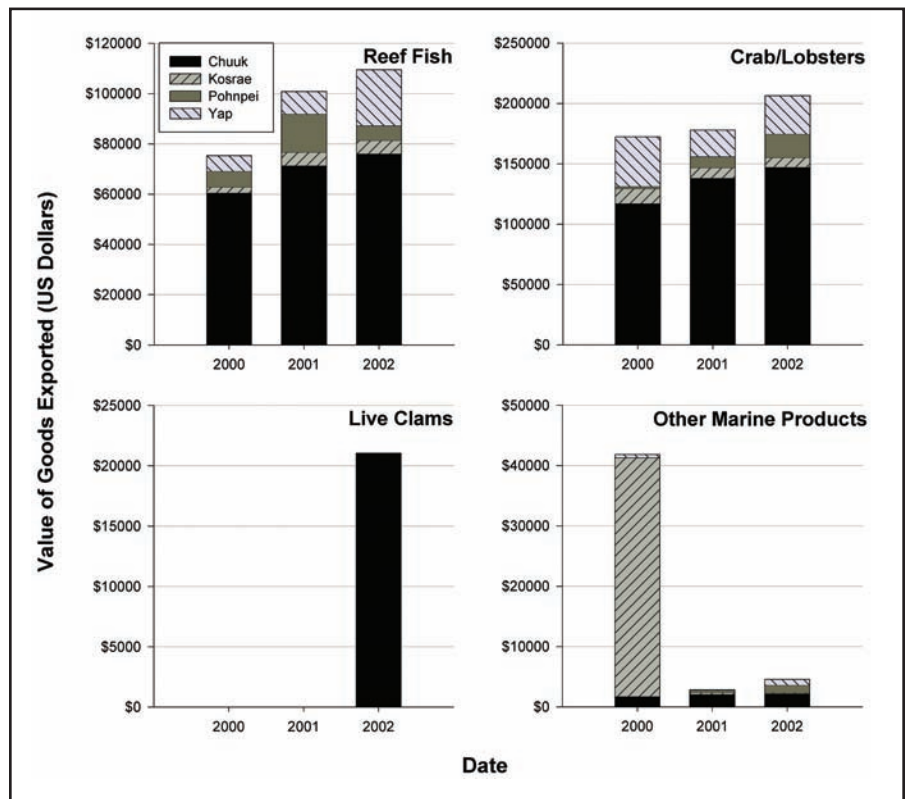


Figure 14.5. The majority of exports of reef fish and other reef-associated species originates in Chuuk. Source: FSM Division of Statistics, 2004.

Trade in Coral and Live Reef Species

No information on this threat is available.

Ships, Boats, and Groundings

Ship groundings have been a problem for both the high islands and atolls in the FSM. Foreign long-line vessels have been abandoned on numerous FSM reefs, and virtually no funds are available to clean up associated oil spills or remove the ships. Large shipping vessels have also run aground, most recently in Satawal, Yap and on the island of Pohnpei. Maragos and Fagolimul (1996) reported extensive direct (13,000 m²) and indirect (300,000 m²) impacts of the 1994 grounding and subsequent removal of a large freighter from a reef

at Satawal Island, Yap. Sediments generated by the erosion at the reef site migrated to other reef areas more than a kilometer away, smothering corals, burying reef flats, creating new beaches on the island, and damaging reef life in a fish reserve. The people of Satawal reached an out-of-court settlement with the ship owners for more than \$2 million (J.E. Maragos, pers. comm.).

Marine Debris

No information on this threat is available.

Aquatic Invasive Species

No information on this threat is available.

Security Training Activities

No information on this threat is available.

Offshore Oil and Gas Exploration

No information on this threat is available.

CORAL REEF ECOSYSTEMS—DATA GATHERING ACTIVITIES AND RESOURCE CONDITION

The Government of the FSM has two regulatory agencies that manage coral reef ecosystems. Each state has a Marine Resources Management office and an Environmental Protection Agency (EPA) office. Cooperation among regional institutions, formalized under the Marine Resources Pacific Consortium and funded by the U.S. Department of the Interior, is intended to increase the local and regional capacity for assessment and monitoring. In addition, the College of Micronesia-FSM has faculty and staff trained in marine resource assessment and monitoring. Non-governmental organizations (NGOs) active in the FSM, such as The Nature Conservancy, offer technical and financial assistance for reef-related programs. The Conservation Society of Pohnpei (CSP) is playing a large role in spearheading the development of a statewide coral reef monitoring program and promoting public awareness programs. CSP also assists local communities in designating and monitoring local marine protected areas. The Peace Corps has a presence in the FSM, and some of its volunteers have been involved in monitoring programs.

WATER QUALITY

Kosrae is a steep volcanic island with high annual rainfall. Erosion and sedimentation are problems wherever land clearing and road construction activities occur. Turbidity is quite high in Okat, Utwe Bay, and Lelu Harbor, particularly in the vicinity of streams and river mouths. Dredging in Okat also periodically increases turbidity in the area. However, pollutants such as pesticides and fertilizers do not appear to have a large impact.

Students from Xavier High School in Chuuk, in conjunction with the Chuuk State EPA, surveyed the water quality of Chuuk Lagoon from 1998-2000. Water quality testing included measurements of water clarity, temperature, turbidity, salinity, pH, dissolved oxygen, and coliform bacteria counts. Although the water quality data collected in Chuuk Lagoon was not available for inclusion in this reporting effort, more information about the students' monitoring efforts can be found at: <http://www.xaviermicronesia.org> (Accessed 02/02/05).

BENTHIC HABITATS

Coral reef biodiversity and complexity is high within the reefs of the FSM and this diversity decreases in scale from west to east away from the center of marine diversity in Southeast Asia. It is estimated that the FSM has more than 300 species of corals (200 in Yap, 300 in Chuuk, 200 in Pohnpei, and 150 in Kosrae). A total of 143 species of algae were reported from Yap. In Pohnpei, the most recent report documented 74 species of algae. FSM has 14 documented species of mangroves.

Marine Resource Monitoring in Kosrae

In Kosrae, the status of the reefs is monitored annually by the Kosrae Conservation and Safety Organization (KCSO), a local NGO, to detect changes in benthic cover and fish abundance.

Methods

Reef Check methods and protocols are used by the government agencies in Kosrae to carry out monitoring. Details on the Reef Check methods can be found at: <http://www.reefcheck.org>.

Results and Discussion

Kosrae's coral reefs are generally in good to excellent condition, but some reefs have been impacted by coastal development. Unregulated mangrove clearing over the past two decades has resulted in shoreline erosion all along the coast and has caused sedimentation to occur on the adjacent reef flats and seagrass beds. Data has been collected annually from five permanent monitoring sites around the island for the past three years (Figure 14.6). Surveys conducted within and adjacent to the Utwe-Walung Marine Park indicated healthy coral cover, ranging from 80% at Hiroshi Point to 50% at the mouth of Utwe Bay. In contrast, live coral cover around the airport at Okat was less than 10% (M. Tupper, pers. comm.).

Data on hard coral cover were collected at five monitoring sites around Kosrae by University of Guam scientist, Laurie Raymundo, and are presented in Figure 4.7. From left to right, the bars correspond to sites near Malem Reef Shelf, Hiroshi

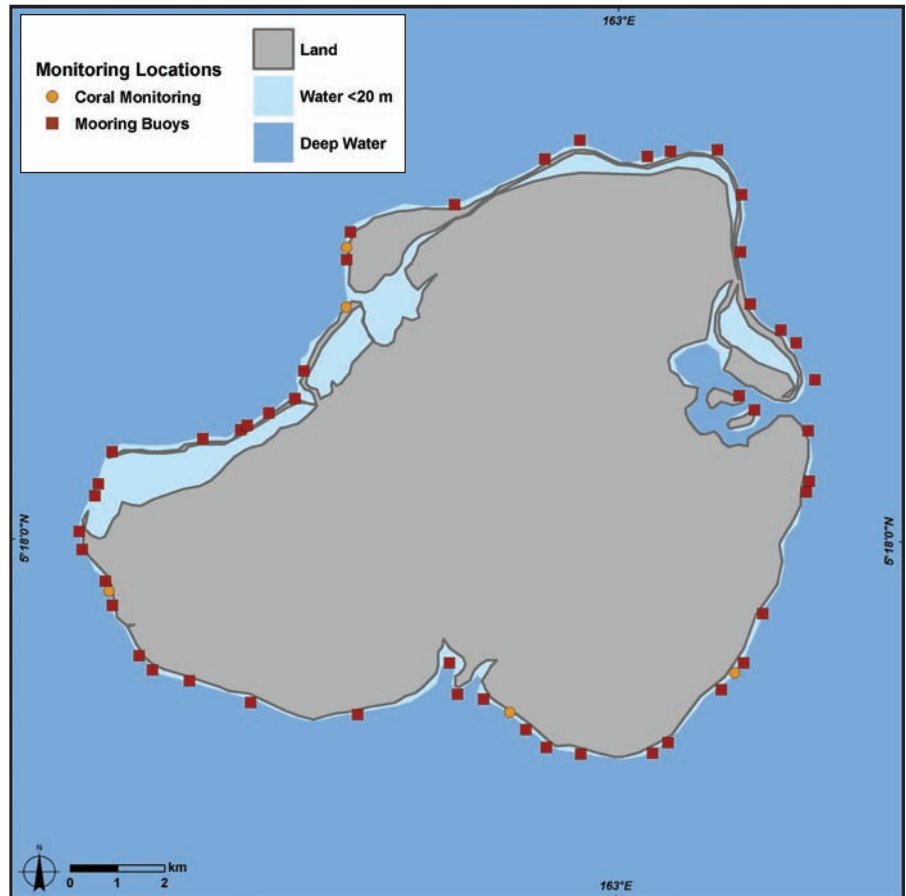


Figure 14.6. Locator map of monitoring sites and mooring buoys around Kosrae. Map: A. Shapiro. Data: Palau International Coral Reef Center, unpublished data.

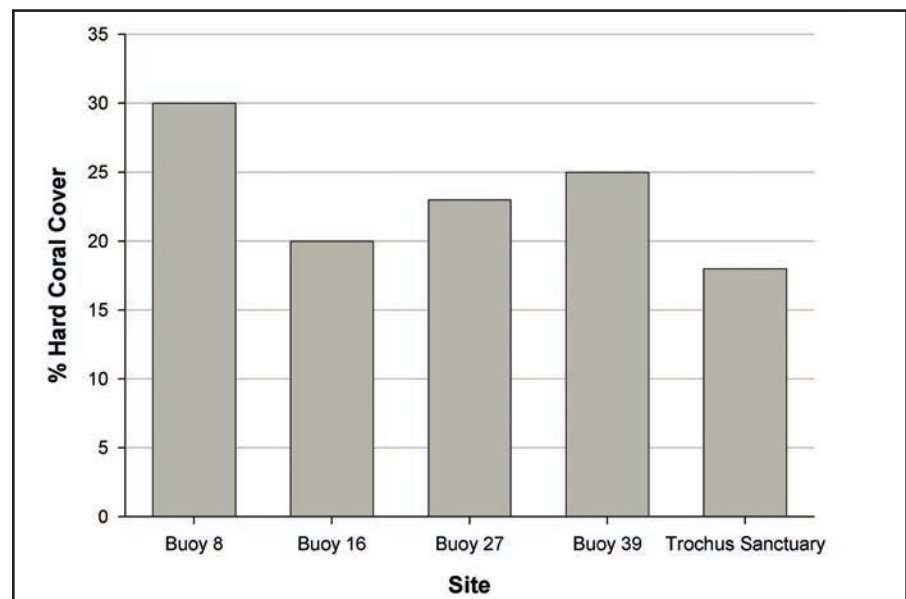


Figure 14.7. Percent cover of hard coral at Kosrae monitoring sites in 2002 at 10 m depth. Source: L. Raymundo, unpublished data.

Point, Walung Drop-off, Shark Island, and the Trochus Sanctuary, which is located near the airport on the north-west coast.

Conservation Society of Pohnpei (CSP) Marine Resource Monitoring

The CSP has been conducting monitoring activities in Pohnpei since 2001. This program monitors has several ecosystem components: 1) grouper spawning aggregations; 2) MPA effectiveness; and 3) changes in benthic communities over time.

Methods

The Australian Institute of Marine Science (AIMS) line-intercept method was used to record benthic communities at monitoring sites. At four of the MPA sites (Figure 14.8), 50 m belt-transects were used to assess fish and invertebrate abundance. The monitoring of the large grouper aggregations occurs during the peak spawning seasons during the first half of the year. They are monitored from 10 m to 30 m depths over several days each month in the spawning season.

Results and Discussion

The reefs around the island of Pohnpei vary in condition. Surveys performed adjacent to Sokehs Channel after a ship grounding found the average coral cover above 20%, and limited surveys around the main island show coral cover ranging from 10% to more than 80% at selected monitoring sites (Figure 14.9). Due to high annual rainfall and steep volcanic topography, erosion and sedimentation rates can be high. Upland clearing of forested areas to grow sakau (kava) has resulted in landslides and other impacts to coastal villages and resources.

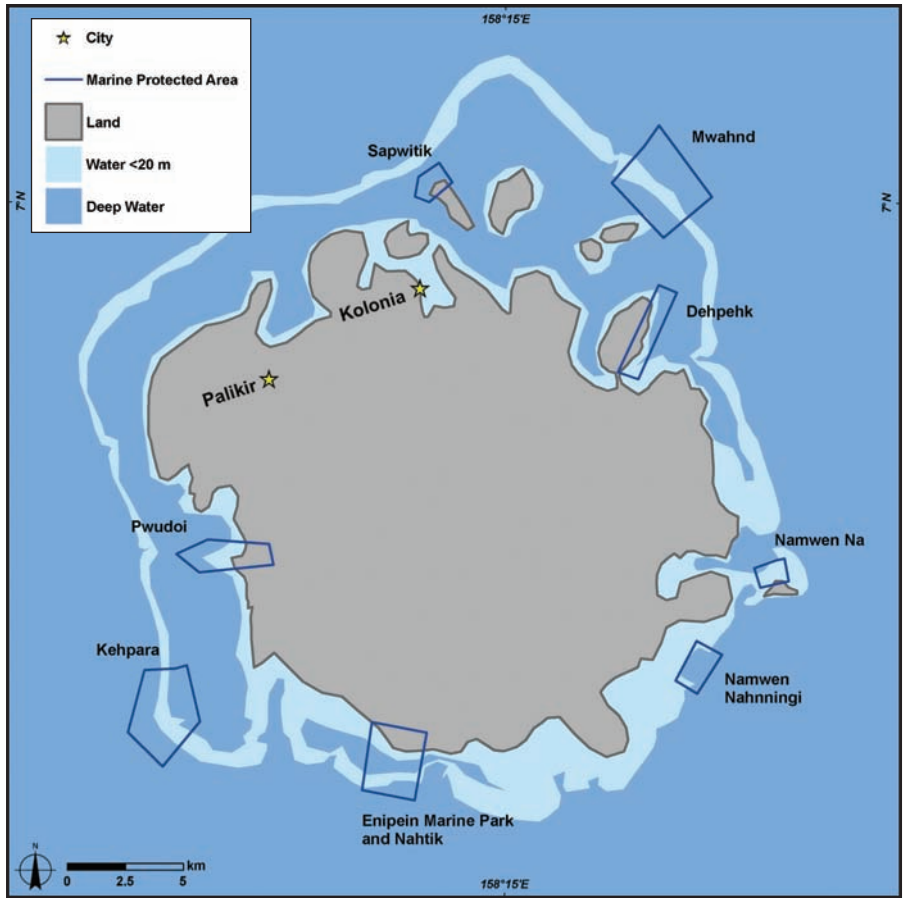


Figure 14.8. Several MPAs have been established in coastal areas of Pohnpei. Map: A. Shapiro. Source: Conservation Society of Pohnpei, unpublished map.

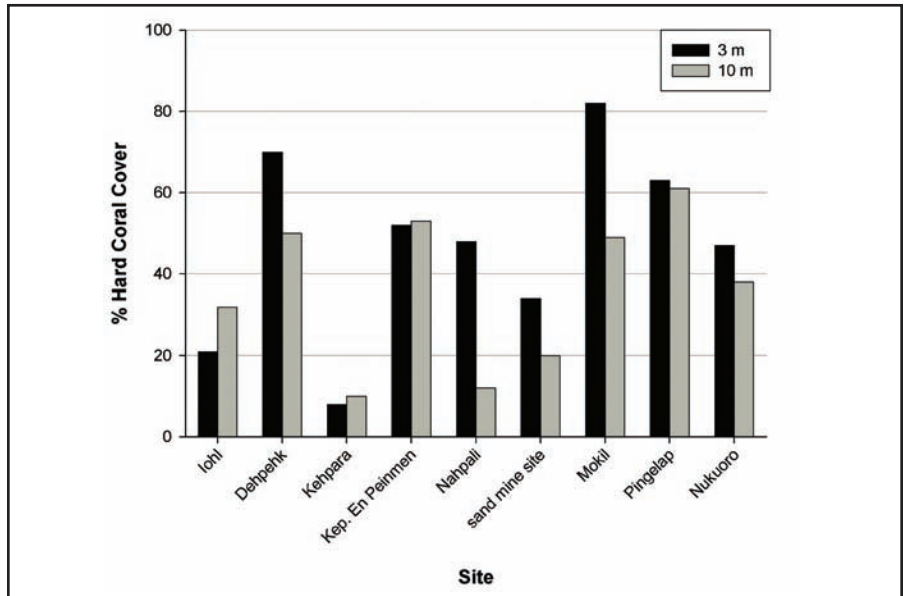


Figure 14.9. Limited surveys conducted at 3 m and 10 m sites around Pohnpei found hard coral cover percentages ranging from about 10% to 80%. Source: Conservation Society of Pohnpei, unpublished data.

Chuuk

The coral cover in Chuuk is indicative of generally high water quality, although overfishing has been observed as a result of foreign commercial activities. Destructive fishing practices, including the use of explosives taken from the wrecks, have caused localized damage in certain areas. Surveys conducted in 1998 at two sites showed that hard coral cover averaged around 25% on inshore reefs. Typhoon events in 2002 and 2003 caused structural damage to large sections of coral reefs, particularly in the lagoons.

Yap

Surveys of 18 sites around the island of Yap conducted in 1995 and repeated 16 months later found mean coral cover at 28.8% and 28.7% respectively (Richmond, 1997), even though a typhoon hit the island between surveys. Crustose coralline algae was also abundant on the reefs. Typhoon Sudal hit Yap in April 2004 causing widespread damage on the island as well as on the adjacent reefs. The potential damage to coral reefs in Yap has not yet been quantified.

FSM is increasing coral reef ecosystem monitoring efforts, focusing on coral cover, commercially important fish abundance, and the occurrence of reef fish spawning aggregations. The capacity to monitor coral reefs has improved since the 2002 status report (Turgeon et al., 2002). Since that time, all state marine resource agencies have received training in monitoring reef fish spawning aggregations and efforts are currently underway to identify and monitor any existing large aggregations of commercially important reef fish species. Kosrae State is continuing its annual coral reef monitoring program examining benthic cover and fish populations. In Pohnpei State, governmental and private environmental organizations have collaborated to develop a statewide coral reef monitoring program focusing on four permanent sites.

ASSOCIATED BIOLOGICAL COMMUNITIES

Recent surveys were undertaken by the Kosrae Fisheries Department to assess stocks of bumphead parrotfish, humphead wrasse, and groupers. Bumphead parrotfish, in particular, were once very important to Kosraean fisheries, but have since declined. The results of this survey were very disturbing. Not one commercially valuable grouper of any species was seen in 75 dives (M. Tupper, pers. comm.). This includes the squaretail coral grouper (*Plectropomus areolatus*) and camouflage grouper (*Epinephelus polyphkadion*). These species are known to form spawning aggregations at Kosrae, but much deeper than elsewhere in Micronesia (i.e., 100-120 m as opposed to 40 m in Pohnpei or 10-15 m in Palau). However, no catches of these species were recorded in the Kosrae reef fishery this year. The survey also recorded only three bumphead parrotfish and seven humphead wrasse in 75 dives. When interviewed, fishers suggested that Taiwanese and Hong Kong long-liners have been fishing the shelf edge illegally at night and have removed most of the groupers, humphead wrasse, and bumphead parrotfish. Unfortunately, fisheries officers could not confirm or deny this. Healthy spawning aggregations of snappers, surgeonfishes, and rabbitfishes are still known to occur at Kosrae.

Over 1,000 species of fish and over 1,200 species of mollusks are thought to be found in the FSM. 873 of the 1,125 marine fish species recorded for the FSM are reef-associated (FishBase, 2002). Overall catch and export data are limited, but some market information suggests the scale of the fisheries operation may be substantial. While commercial export has the greatest impact on FSM fisheries, overfishing by foreign vessels has also been documented. Yap and Kosrae have recently limited the export of reef organisms except for personal and family use, such as shipping coolers of fish to relatives on Guam and in the CNMI. Chuuk had the largest commercial export. Commercial export of fish and crab from Pohnpei occurred until a recent cholera outbreak caused it to shut down. Destructive fishing practices, including the use of explosives taken from the wrecks, have caused localized damage. Better quantitative assessments of fisheries resources within the FSM are needed.

CURRENT CONSERVATION MANAGEMENT ACTIVITIES

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 management agencies. Non-governmental organizations active in Kosrae include the Peace Corps and KCSO.

Kosrae has an extensive system of 54 mooring buoys around the island (Figure 14.6) designed to minimize anchor damage to corals at popular dive sites. 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. The Utwe-Walung Marine Park was created in 1996 to protect extensive mangrove and coral reef ecosystems along the undeveloped southern shore of Kosrae. The Marine Park is a community-based project managed by a Board of Directors that includes the park manager, private landowners, and directors and senior technical staff of several resource management agencies including the Kosrae Island Resource Management Program and Department of Land, Agriculture, and Fisheries-Division of Marine Resources. The Board is responsible for developing and revising the marine park management strategy, and plans to use the results of the community-based project to revise and improve the strategy. The stated objectives of the Marine Park are: to maintain and manage an area with ecologically valuable, undisturbed, and highly scenic features; to provide a variety of benefits, from the protection of natural habitat to enhancing the tourism and recreational appeal of Kosrae; and to provide opportunities for public education and scientific research.

Limited traditional and subsistence harvesting activities are permitted within the Marine Park. The Trochus and Giant Clam Sanctuaries are legislated under Kosrae State Code and managed by government agencies. The objective of the sanctuaries is to protect species of *Trochus* and *Tridacna* from overfishing, in addition to preventing logging and coastal development along the sanctuary shorelines. Unfortunately, Kosrae’s MPAs are not strictly enforced, and surveys of reef fish and invertebrate biomass within and adjacent to protected areas show no difference in biomass of commercial species (Figure 14.10).

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.).

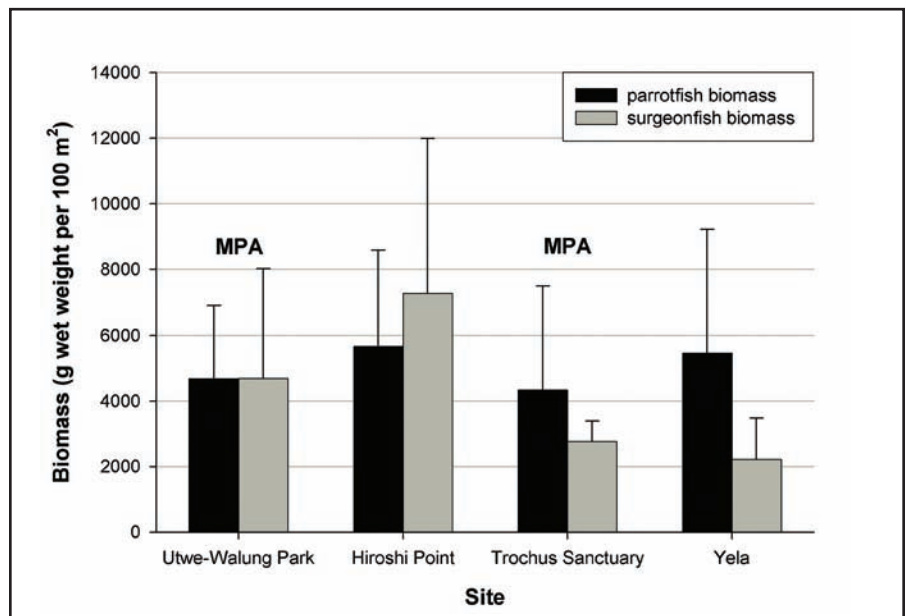


Figure 14.10. Biomass of commercially valuable parrotfish and surgeonfish in MPAs and adjacent fished areas in Kosrae, FSM. Source: M. Tupper, unpublished data.

OVERALL CONCLUSIONS AND RECOMMENDATIONS

A number of conservation programs are in place for Kosrae's reefs. Mapping of coastal reefs and reef resources is ongoing. Unfortunately, the Kosraean government does not possess extensive finances, manpower, or technical expertise. Thus, it is important that both institutional and community capacity be strengthened and integrated to ensure sound management of Kosrae's coastal resources.

The coral reefs of Kosrae are in relatively good condition, but the effects of land use practices and reef fishing are cause for concern. The greatest need for Kosrae is an integrated watershed management program that will address both terrestrial (pollution and habitat destruction) and marine (overfishing) issues. In order to meet this need, more funding and support for resource management agencies are necessary.

Reef fisheries on some islands have been overexploited. Damaging blast fishery practices have been documented in Chuuk Lagoon as late as 1994 (J.E. Maragos, pers. comm.).

Improved coordination of management activities among the states is recommended. Educational programs involving the community need to be expanded. Ship groundings need to be addressed at the state and national level, possibly requiring vessels to post bonds to cover any damage to the reefs. Additional support for the resource agencies is necessary if they are to meet their mandates.

REFERENCES

- Edward, A. College of Micronesia. Pohnpei, Federated States of Micronesia. Personal communication.
- FishBase. 2002. on-line FishBase: A Global Information System on Fishes. Available from the internet URL: <http://www.fishbase.org>.
- FSM (Federated States of Micronesia), Division of Statistics, Department of Economic Affairs. 2002. The FSM 2000 Census of Population and Housing, National Census Report. FSM National Government. Palikir, Pohnpei.
- FSM (Federated States of Micronesia), Division of Statistics, Department of Economic Affairs. 2004. Key Statistics for the FSM. Microsoft Excel workbook. Available from the internet URL: <http://www.spc.int/prism/country/fm/stats/index.htm>
- Hezel, F.X. 1995. Strangers in Their Own Land. University of Hawaii Press, Honolulu. 81 pp.
- Holthus, P.F., J.E. Maragos, J. Naughton, C. Dahl, D. David, A. Edward, M. Gawel and S. Liphei. 1993. Oroluk Atoll and Minto Reef Resource Survey. East West Center Program on the Environment. East West Center, Honolulu. 94 pp.
- Maragos, J.E. U.S. Fish and Wildlife Service, Honolulu. Personal communication.
- Maragos, J.E. and J.O. Fagolimul. 1996. Impact of the grounding and removal of the bulk carrier M/V *Oceanus* on the coastal resources of Satawal Island (Yap State, Federated States of Micronesia). Prepared for Paul, Johnson, Park, and Niles on behalf of the People of Satawal. East-West Center, Honolulu and the Environmental Protection Authority, Yap. 23 pp.
- Richmond, R.H. 1997. Reproduction and recruitment in corals: critical links in the persistence of reefs. pp. 175 - 197. In: C.E. Birkeland (ed.) Life and Death of Coral Reefs. Chapman and Hall Publishers, New York.
- Tupper, M. Palau International Coral Reef Center. Koror, Palau. Personal communication.
- Turgeon, D.D., R.G. Asch, B.D. Causey, R.E. Dodge, W. Jaap, K. Banks, J. Delaney, B.D. Keller, R. Speiler, C.A. Matos, J.R. Garcia, E. Diaz, D. Catanzaro, C.S. Rogers, Z. Hillis-Starr, R. Nemeth, M. Taylor, G.P. Schmahl, M.W. Miller, D.A. Gulko, J.E. Maragos, A.M. Friedlander, C.L. Hunter, R.S. Brainard, P. Craig, R.H. Richmond, G. Davis, J. Starmer, M. Trianni, P. Houk, C.E. Birkeland, A. Edward, Y. Golbuu, J. Gutierrez, N. Idechong, G. Paulay, A. Tafleichig and N. Vander Velde. 2002. The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2002. National Oceanic and Atmospheric Administration/National Ocean Service/National Centers for Coastal Ocean Science, Silver Spring, MD. 265 pp.