

## 14. STATUS OF CORAL REEF RESOURCES IN MICRONESIA AND AMERICAN SAMOA: 2008

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### ABSTRACT

- Coral reefs in Micronesia and American Samoa appear to be amongst the most resilient in the world, despite numerous on-going threats;
- There has been considerable recovery of reefs in western Micronesia (especially Palau) that were devastated during the massive coral bleaching in 1998;
- The more remote islands support thriving communities of large reef fishes due to limited fishing pressures and habitat degradation;
- Fish populations around major population centres show clear signs of over-fishing with few large fish observed because of fishing pressure, particularly spear-fishers using scuba;
- Management and monitoring efforts are on-going throughout the region and numerous effective initiatives are promoting recovery of damaged coral reefs as well as the conservation of healthy ones;
- Lack of enforcement continues to be one of the major hindrances to effective resource management outcomes and more support is necessary.

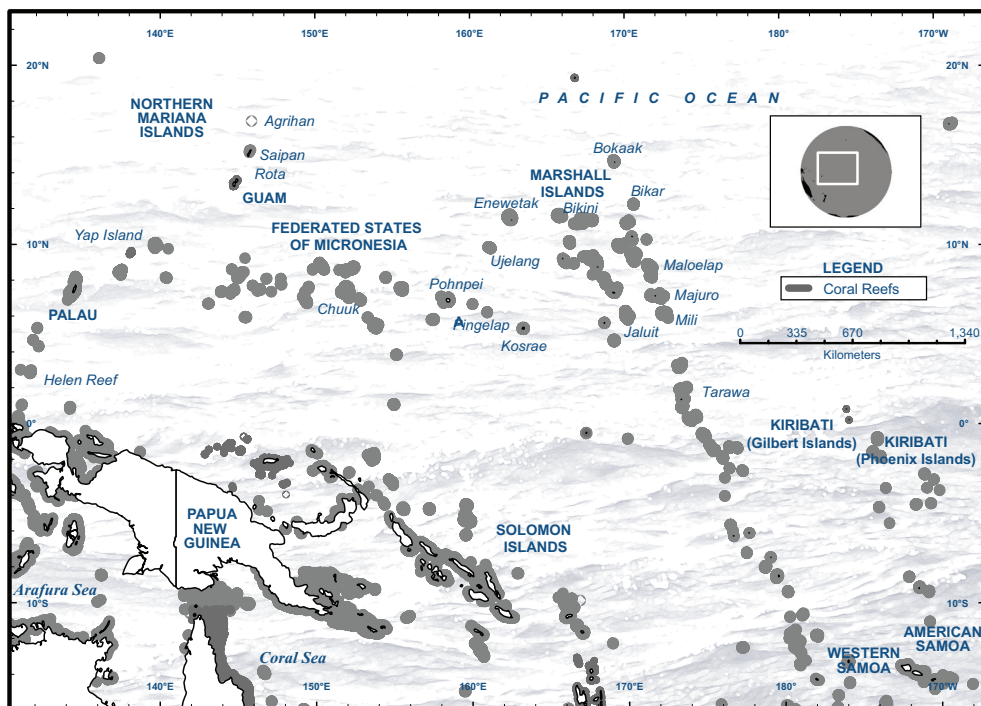
## INTRODUCTION

This chapter has been assembled by coral reef experts across Micronesia and in American Samoa and essentially summarizes more detailed information contained in: *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008*; the full text is available at: <http://ccma.nos.noaa.gov/stateofthereefs>.

**American Samoa:** The Territory of American Samoa consists of 5 volcanic islands and 2 atolls in the central South Pacific Ocean. The islands are small, ranging in size from the heavily populated main island of Tutuila (142 km<sup>2</sup>) to the uninhabited and remote Rose Atoll (less than 1 km<sup>2</sup> of land). The volcanic islands are surrounded by fringing reefs, while the atolls have steeply sloping sides, and Rose Atoll has a lagoon. More than 2,700 species of corals, fish, invertebrates, marine plants, turtles and marine mammals are known.

**Commonwealth of the Northern Mariana Islands:** The 14 islands that make up CNMI lie on a north-south axis in the western Pacific basin and stretch approximately 600 km with the Pacific Ocean to the east and the Philippine Sea to the west. The southern islands of the archipelago are uplifted limestone, whereas the northern islands are volcanic.

**Federated States of Micronesia:** The Federated States of Micronesia (FSM) is comprised of 607 islands found within the states of Chuuk, Kosrae, Pohnpei and Yap, covering 1.6 million km<sup>2</sup> of ocean. FSM has a total landmass of 702 km<sup>2</sup> comprised of high volcanic islands, low reef islands and atolls. Each island or group has its own language, customs, local government, and traditional system for managing marine resources. Islanders have a strong cultural and economic dependence on coral reefs resources.



**Guam:** This U.S. territory is the most southern, largest and most populated island in the Mariana Archipelago and in all of Micronesia with 173,500 people living on 560 km<sup>2</sup>. Guam has more than 5,100 marine species, including 1,000 nearshore fish species and 300 species of hard coral. The primary threats to Guam's coral reefs include runoff from land, storm activity and over-fishing, as well as other threats including crown-of-thorns starfish (COTS) outbreaks, coral diseases, dredging, boat groundings, marine debris, coral bleaching, and recreational misuse and overuse. The plans to expand the military presence on Guam pose significant threats to coral reef resources due to a projected population increase of up to 60,000 people and numerous associated construction projects.

**Palau:** Palau is the most western archipelago in Oceania, has the most diverse coral reef fauna of Micronesia and is home to the highest density of tropical marine biota of any comparable geographic area in the world. An estimated 425 coral species and 1,700 fish species are found in Palau and the culture and economy have historically gained sustainable food supplies from the reefs. Dynamic multi-species fisheries involve individual fishers feeding their families, providing food for traditional customs and selling to commercial markets, restaurants and to selective buyers for export. Tourism has been the major component of economic growth in Palau and visitor numbers are increasing annually; the majority of which are sport divers.

**Republic of the Marshall Islands:** The Marshall Islands are comprised of 29 atolls and 5 low reef islands grouped into two north-south oriented chains. There are nearly 300 coral and more than 800 fish species, and most reefs are virtually pristine with very high coral cover (50-90%) and relatively high algal cover. The country has been relatively unaffected by over-fishing, destructive fishing, coral bleaching, sedimentation, coral disease, and COTS outbreaks, although remote atolls are targeted for shark finning. The highly populated atoll of Majuro has suffered rapid, profound degradation and high fishing pressure leading to reductions in fish communities and declines in coral diversity. The RMI has one of the few remaining healthy populations of humphead wrasse (p. 52) and predominantly healthy shark populations. Some outer atolls are considered very healthy and pristine with abundant megafauna despite no take zones being only recently initiated. Ailinginae Atoll and Bikini Atoll will be nominated for World Heritage status in early 2009.

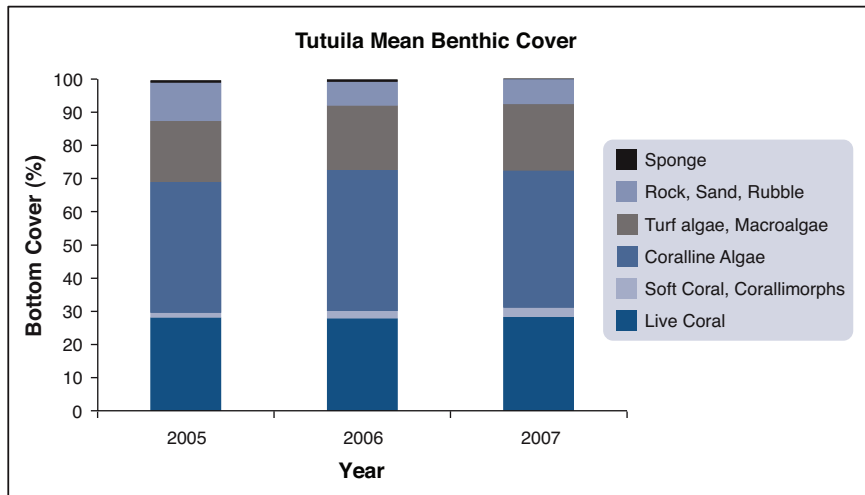
### **STATUS OF CORAL REEF BENTHOS: 2008**

**American Samoa:** Coral communities in American Samoa have been exposed to an extensive series of major disturbances including: a COTS outbreak in 1978 which killed many corals except on the reef crest; major hurricanes in 1987, 1990, 1991, 2004 and 2005; mass coral bleaching events in 1994, 2002 and 2003; and extreme low tides in 1998, 2005 and 2006. Before the 1978 COTS event, reefs were dominated by table and branching *Acropora*, and coral cover at selected sites was estimated at 63%. Subsequently, reefs have been dominated by coralline algae and encrusting corals, although some areas are now dominated by *Acropora* and thus appear to have recovered. The reefs in American Samoa appear to be in good condition and are resilient to repeated disturbances.

There are at least 5 different monitoring programs, and all report about 28% coral cover around Tutuila, high coralline algae cover on the south side of Tutuila and more turf algae on the north side. The Territorial Monitoring Program has found no significant changes in bottom cover since 2005. There are very few dead corals on reef slopes (less than 5% of all coral) and

virtually none have been recently killed. Outer reef flats currently have about 21% coral cover and inner flats have 10%.

In 2007 the U.S. Fish and Wildlife Service successfully removed all debris from a Taiwanese long-liner that ran aground on Rose Atoll National Wildlife Refuge in 1993. The cleanup removed more than 200 tons of debris and corals are now showing recovery from the 1993 shipwreck, 1994 bleaching event and 2005 hurricane. However, giant clam populations and reef fish populations have declined during recent years; unauthorized fishing is the likely reason.



***Coral communities around American Samoa have been relatively consistent in benthic composition since 2005, with total hard and soft coral cover at monitoring sites around 30%.***

The NOAA Pacific Island Fisheries Science Center, Coral Reef Ecosystem Division (PIFSC-CRED) research cruise found coral cover to be similar at Ofu-Olosega and Tutuila, but higher at Swains and lower on Rose Atoll. A very large bloom of the encrusting colonial ascidian, *Diplosoma simile*, is overgrowing corals at Swains Island and patches of a corallimorph, *Rhodactis howesii*, are expanding to cover significant areas around Tutuila. Coral and coralline algal diseases are present, yet are generally uncommon. Sediment runoff is significant during heavy rain events and has damaged several local reefs. Nutrient runoff from piggery wastes, high phosphate detergents, septic systems, and non-point sources are also a problem on nearby reefs.

Coral reefs in Pago Pago harbor were severely damaged by massive human impacts from the 1950s to 1990s including dredging, infilling, sediment runoff, and the discharge of tuna cannery wastes. A transect started in 1917 on the reef flat at Aua is one of the oldest coral reef monitoring projects in the Pacific and showed steady declines in coral cover and predominant cover of dead rubble. Small areas of reef flat communities near the mouth of the harbor have high cover of healthy corals along the reef crest. Introduced species, ship groundings, tourism, marine debris, and collection for trade are all minor threats. All future human threats will be exacerbated by rapid and unsustainable population growth, which has grown from fewer than

10,000 residents in 1910 to an estimated present population of 69,000; projections are that this population will double within 40 years. As the entire territory is a coastal zone with limited habitable space, these population pressures will undoubtedly increase in the years ahead and are currently being addressed by a multi-agency local action strategy.

**Commonwealth of the Northern Mariana Islands:** Coral diversity and colony surface area are significantly lower on the northern islands than the southern (62 species per site and 206 cm<sup>2</sup> versus 82 species and 312 cm<sup>2</sup>). NOAA's Marianas Research and Monitoring Program (MARAMP) surveys revealed highly variable levels of coral and algal cover between islands: the highest overall coral cover was found at Pathfinder (25%) and Maug (22%). A standardized method for naming coral diseases has recently become available, but it is difficult to compare coral diseases on Saipan to elsewhere in the Pacific. Non-point source pollution remains one of the primary localized threats to coral reefs as decreases in species richness and recruit abundance, coupled with an increased dominance by a few coral species, is becoming apparent at sites influenced by watershed pollution; no such trend exists at other sites.

**Federated States of Micronesia:** The coral reefs of the FSM are in good health; coral bleaching and disease are rare and impacts from tourism, cyanide fishing, live coral/fish trade and storms are minimal. People in the FSM depend heavily on coral reefs for food and revenue from fish sales and tourism. Over-fishing, impacts from land-based activities, climate change, and an erosion of traditional management systems have led to a general decline in coral reef resources, especially near population centers. Recent coastal infrastructure development has led to increased sedimentation and the degradation of near-shore coral reefs. Residential and business developments on the coast also contribute significant sediment loads and inadequate waste management results in solid waste accumulation along the shore.

Each state has two government agencies which manage coral reefs (Marine Resources Departments/Divisions and Environmental Protection Agencies) with the support of local and regional organizations such as the Yap Community Action Program (Yap CAP), Chuuk Conservation Society, Conservation Society of Pohnpei, Kosrae Conservation and Safety Organization, the Secretariat of the Pacific Region Environmental Programme (SPREP), and the Nature Conservancy. Monitoring has been on-going in each state since 1994. On-going coordination efforts between the Palau International Coral Reef Center and NOAA will continue to support the first regionally-coordinated monitoring program within Micronesia.

Chuuk State has identified 30 Areas of Biodiversity Significance covering 97,773 ha as the basis for establishing a long-term monitoring program. A rapid ecological assessment was recently completed and a biodiversity gap assessment is planned for late 2008. Kosrae coral reefs are in good to excellent condition with hard coral cover ranging from 40% to 60%; however more effort is needed to reduce the impacts of coastal development, soil erosion and sediment flows. Pohnpei's reefs contain nearly 350 coral species but they have been damaged by sediment runoff, dredging and COTS which have reduced species composition and the structure of the coral communities while hindering recovery. There is little to no evidence of destructive fishing, impacts from boat anchors or sport diver damage. The existing coral monitoring programs were refined in 2004 to support decision making to improve the health of Pohnpei's coral reefs. Coral reefs on Yap are in relatively good condition and have the highest diversity in the FSM with 215 coral species. These reefs have historically thrived under traditional management practices yet recent larger scale resource uses and other uncontrollable factors, such as coral bleaching,

COTS, destructive fishing, coastal development and ship groundings, are undermining these practices. Marine ecosystem degradation occurs around development areas and coral reefs are becoming sources of major economic benefit but via contrasting roles in construction, export, and tourism. Yap CAP, in collaboration with the Yap State Environmental Protection Agency and Marine Resources Management Division, started annual monitoring at 6 sites in 2006.

**Guam:** Coral reefs in the north and south at sufficient distances from rivers are relatively healthy, while large areas of reef in the south, particularly near river mouths, are in fair to poor condition. Chronic COTS outbreaks have stripped many reefs around the island, including some reefs with previously high coral cover and diversity. Average coral cover on the fore reef slopes was 50% in the 1960s but by the 1990s it had dwindled to less than 25% with only a few sites having more than 50% cover. Degradation of water quality, chronic COTS outbreaks, low abundance of major herbivore fish species and other persistent stressors are lowering reef resilience and recovery potential. A particularly distressing indicator is the marked decrease in coral recruitment rates during the last few decades.

A comprehensive coral reef monitoring program was recently initiated, although island-wide rapid assessments conducted by NOAA in 2003, 2005, and 2007 contribute substantially to the understanding of coral reef status and trends. Coral cover in 2005 ranged from 11.8% on the southwest coast to 38.2% on the west side of the island, with an average cover of 26%. Coral cover is similar in the west/northwest, east/northeast, and east/southeast regions of the island (25%, 26%, and 26%, respectively), while coral cover was lowest in the west/southwest region (12%).

Coral disease prevalence is high and potentially problematic as determined by University of Guam Marine Lab (UOGML) at 10 sites in 2006. Coral cover ranged from less than 10% at Pago Bay site to greater than 80% at one site in Apra Harbor. Extremely high sedimentation rates continue to devastate reefs near river mouths: a 2005 National Park Service study found that sedimentation rates in Asan Bay were among the highest in the literature, ranging from 0.045 to over 2.0 g/cm<sup>2</sup>/day. The extremely elevated rate of sedimentation and drastically reduced rates of coral recruitment raises serious concerns about the long term health and survival of Guam's coral reefs. A 2004 UOGML study in Fouha Bay, in southwestern Guam, showed that sediment from runoff during heavy rain damaged corals and resulted in a steep decline in coral species richness over a 25-yr period; more than 100 species were reported in 1978, fewer than 50 in 2003. Macro-invertebrate surveys indicate relatively low abundance of the more conspicuous invertebrates, except for high urchin and COTS densities at some sites.

**Palau:** Palau has the highest coral species diversity in Micronesia, yet human and natural threats to coral reef health such as over-fishing, sewage outflow, sedimentation, and a rapidly growing tourism industry are increasing.

Although coral mortality was as high as 90% in some areas after the 1998 bleaching event, recovery has been tremendous. The Palau International Coral Reef Center has monitored 22 sites since 2001 and found that coral cover has increased at an annual rate of 2.9% from 2001 to 2004. The average coral cover across all monitoring sites in 2004 was 31%. Surveys from 2006-2007 show continuing recovery and increased coral cover at all sites. In addition to the Protected Areas Network Act of 2003, which supports local communities in setting up MPAs, the *Micronesia Challenge* is a specific initiative originally proposed by the President of the Republic of Palau that has attracted wide support (p. 48).

**Republic of the Marshall Islands:** Coral reefs on outer islands and atolls with relatively small populations have not changed significantly since 2004 and no major mortality or degradation has been reported. RMI has suffered little coral mortality from bleaching, although Majuro typically experiences inter-tidal, annual reef flat bleaching. Majuro's reefs have experienced significant changes since 2004 due to major increases in coral diseases, such as white syndrome and CLOD, as well as COTS outbreaks. Less than 1% of Majuro reefs have been lost to dredging yet 30-50% of corals in the lagoon have recently been devastated by a COTS outbreak, with at least 20% having a persistent algae-dominated condition as a result. Further, 30% of Majuro oceanic reefs have suffered high disease mortality of table corals. The Micronesia Challenge, with its pledge to effectively conserve 30% of marine resources, signed in 2007 by former President Note, has increased both local and international efforts to protect reef ecosystems.

### STATUS OF MANGROVES AND SEAGRASSES: 2008

**American Samoa:** American Samoa lies towards the eastern periphery of mangrove distribution so their presence within the territory is limited. The major mangrove stands in Pala Lagoon on the south coast of Tutuila continue to dwindle due to coastal development and land based sources of pollution. Little is known of the status of the remaining small mangrove stands in the Territory although the majority is found on Tutuila, Aunu'u and Ta'u. The only seagrass bed present is very small and incapable of serving as fish habitat.

**Guam:** Mangrove growth on Guam is limited to 70 ha on the eastern shore. Mangroves are protected against un-licensed removal and reclamation; however this protection is inadequate to address multiple other threats such as filling, road construction and oil spills which have caused mangrove declines. Some mangroves in Apra Harbor will probably be affected during the upcoming military expansion. No recent studies have been conducted on Guam's mangroves since the island-wide inventory in the mid 1970s. Island-wide benthic habitat mapping by the UOGML showed seagrass beds occupied 3.1 km<sup>2</sup>, or approximately 2.8% of Guam's nearshore waters (< 40 m water depth).

**Palau:** Palau has about 45 km<sup>2</sup> of mangrove and swamp forest area around the east and west coast, including the remote islands of Meriil and Pulo Anna. A mangrove survey in 2006-2007 added two new mangrove species records to the Palau Mangrove Management Plan, *Xylocarpus moluccensis* and *Sonneratia caseolaris*. Seagrass areas have always been an important subsistence fishing habitat for local communities in Palau. Prior to Palau becoming a member of the Global Seagrass Monitoring Network in 2001, few seagrass studies were done in Palau, e.g. a 1980 study identified 10 seagrass species in Palau.

**Republic of the Marshall Islands:** Mangroves are limited in the atolls of the Marshall Islands and are mostly confined to the southern, wettest atolls. The depressed centres of some of the larger atoll islands support stands of mangroves, and a few stands of red mangroves *Rhizophora* were noted in the lagoon of Arno Atoll during 1988 coral reef surveys. Undoubtedly, additional mangroves will be reported once a country-wide inventory is accomplished.

### STATUS OF CORAL REEF FISHERIES

**American Samoa:** Coral reef fish assemblages around Tutuila are dominated by herbivores and detritivores such as surgeonfish, small parrotfish, and damselfish. Reef fish populations of small

to medium size fish are relatively good, but all of the larger reef fish species are uncommon to rare. The standing stock and size structure of fishes is lower on Tutuila compared with the Manu'a Islands, Rose Atoll and Swains Island, where human habitation and visitation are low. Overall biomass levels of reef fish are similar to literature values for other fished reefs in the mid-Pacific region, but remain one third the biomass values found at unfished reefs. Large fishes such as sharks, snappers, jacks, and groupers are rare, especially around Tutuila. Reef fish catches and effort have declined over the last 50 years as the population shifted from subsistence food sources to a cash-based economy. Generally, active-selective gear like spearfishing and gleaning resulted in a decrease in CPUE, while passive-non-selective gear like throw nets and hook and line remained constant or had increasing CPUE.

**Commonwealth of the Northern Mariana Islands:** PIFSC-CRED found that fish assemblages have remained relatively consistent during the past 3 years. There is a greater biomass of larger fish in the northernmost islands (0.25 ton per ha) compared to the middle section of the island chain (0.13 ton per ha) and the heavily populated southern islands (0.05 ton per ha). Sharks are scarce throughout the archipelago and the ban on the use of scuba spearfishing on Saipan has improved the abundance of food fish groups. Monthly catch data is sent to PIFSC's WPacFin program which maintains fisheries data across the Pacific at: <http://www.pifsc.noaa.gov/wpacfin/cnmi/Pages/>.

**Federated States of Micronesia:** Over-fishing is the most urgent and critical threat to marine resources in the FSM and the breakdown of traditional management systems has contributed to this problem. In Chuuk, over-harvesting and dynamite fishing are the greatest concerns for coral reef ecosystem health, especially near population centers. Approximately 610 species of reef fish have been recorded, although approximately 750 species are predicted to exist.

In Kosrae, destructive fishing methods are commonly used by fishers and certainly damage fish populations. Some fish genera were missing during 2006 rapid ecological assessment in Kosrae compared to a 1986 survey. A few humphead wrasse (*Cheilinus undulatus*) were recorded but no humphead parrotfish (*Bolbometopon muricatum*) were seen, most likely due to over-fishing. About 200 species are considered as common food fish and Kosrae has recently limited the export of reef organisms except for personal and family use (p. 52).

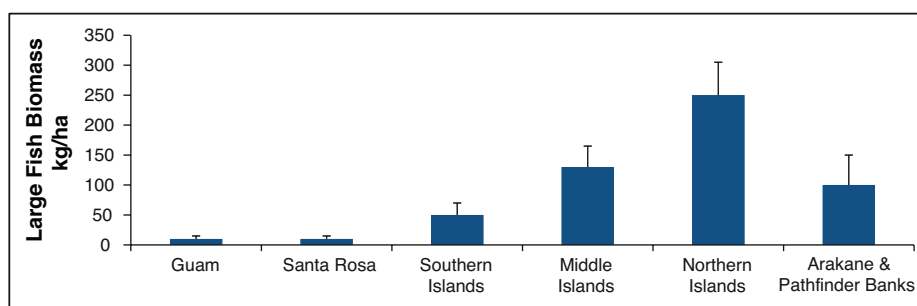
Local fisheries in Pohnpei are being unsustainably over-fished and 70% of fish sold at markets are immature or found with eggs. Night-time spearfishing is the most popular type of fishing and this overly efficient method is contributing to the overall decline in reef fisheries. Without an overarching policy that combines habitat protection and fishery management, Pohnpei's marine environment will continue to decline dramatically. Over 660 species of reef fish are expected to occur in the waters of Pohnpei state, with 470 species recorded in 2005. The abundance of target species of reef fishes, particularly emperors, snappers, and groupers, appear to be low in many areas, possibly indicating local over-fishing.

Yap has more than 780 fish species in 76 families, although up to 900 total species may be present. The highly threatened humphead wrasse (*Cheilinus undulatus*) is relatively abundant (observed at 50% of survey sites) and the estimated average total length of individuals is only 48 cm. Few sharks were seen at Ngulu Atoll indicating probable shark finning.



**Guam:** Fish longer than 25 cm are uncommon to rare on Guam, and although their numbers are slightly higher on northern reefs, medium and large fish abundance is still very low compared to other islands in the Mariana Archipelago. Despite improvements in gear and technology, fishery catches on Guam have declined during recent decades. Small-scale fishery catches have declined by up to 86% since 1950 and data from DAWR creel surveys indicate that fisheries have not recovered from a sharp decline in the 1980s. Additionally, catches have continued to decline for hook and line and cast net methods, despite increasing effort. Large reef fish are noticeably absent from many reefs. The recent NOAA MARAMP towed diver surveys reports that the biomass of large reef fish (> 50 cm) is 5 times greater around remote islands in the southern Marianas, than around Guam and Santa Rosa Bank and 25 times greater in the more remote northern islands.

The use of scuba and artificial lights for spear fishing and the continued use of monofilament gill nets are particular concerns. These methods have been banned or heavily restricted in most Pacific countries but remain legal on Guam. Local fisheries biologists suggest these methods have contributed to a boom and bust harvest of large humphead wrasse, the depletion of large groupers, a shift from preferred species (large slow-growing fish) to smaller, faster growing species, and a decrease in the number of other large wrasse, parrotfish, snapper, and grouper caught by other methods. The government of Guam has created 5 Marine Preserves as a counter-measure, and fish biomass has increased significantly inside the preserves since enforcement began in 2001.



*Mean large fish (TL >50 cm) biomass (kg/ha) measured during towed-diver surveys in the Mariana Islands, Guam and the southern islands of the Northern Marianas, including Rota, Tinian, and Saipan. There are more large fish on the remote, and virtually unpopulated reefs than on the more heavily populated islands of Guam, Santa Rosa and to a lesser extent on the Southern islands (source Burdick et al., 2008).*

**Republic of the Marshall Islands:** Fisheries data is very limited and exploitation is unregulated, except that humphead wrasses are not permitted in atoll-to-atoll commerce. All non-destructive fishing techniques other than gillnetting (including night spearing with scuba) are currently allowed. No catch data or fish population statistics are collected and thus the extent of fish population status is unknown. Anecdotal observations suggest fish populations have declined on Majuro, Arno and other heavily populated atolls. The aquarium live fish trade is avidly pursued by 3 businesses which annually export tens of thousands of live fish, especially the prized flame angelfish, to Japan and America. Some fish populations are declining as there is no

geographic or numerical limit to the aquarium fish catch, although some businesses support the designation of no-take reserves to protect breeding stocks. Unfortunately, the Government regulatory process has stalled.

The illegal trade in shark fins still persists to supply Asian markets. An American operator is working to commercialize beche-de-mer fishing on Arno and elsewhere although they are not exploited on Majuro, where there are healthy populations. Tridacnid clams are widely harvested and *T. gigas* has become extremely rare. Some outer atolls still boast good *T. gigas* populations yet these remain vulnerable to illegal fishing. There are very few tridacnids near populated areas of Majuro, possibly due to heavy metal pollution interfering with recruitment. Green turtles are still harvested for subsistence purposes although it is illegal to sell any turtles or to take females that have come ashore. However, violations of these laws routinely occur and populations are likely dwindling.

### **CORAL REEF AND COASTAL RESOURCE MANAGEMENT**

**American Samoa:** The Department of Marine & Wildlife Resources (DMWR) has an on-going Community-Based Fisheries Management Program (CFMP) in 10 participating village MPAs, each with its own management plan. DMWR is also developing a network of no-take MPAs with a target to include 20% of the territory's coral reef ecosystems. The program is using biological criteria to identify unique and diverse coral reef habitats and areas found to have higher densities of recruits and spawning fish. DMWR is currently enforcing size limits on giant clams and lobsters as well as limits on mesh size for throw and barrier nets. Removing or damaging all coral is illegal, as are destructive fishing methods, and night time scuba spearfishing was banned in 2001. DMWR is currently adopting new regulations that will ban the taking of all large, rare reef fish species throughout the territory for all types of fishing gear (Box p. 209). The only permanent no-take area is Rose Atoll, a remote atoll that is a National Wildlife Refuge.

The National Park of American Samoa contracts with land owners, who agree to certain restrictions in return for monetary support; subsistence fishing, however, is allowed throughout the park areas and enforcement is lacking. The American Samoa EPA Piggery Compliance Team has recently reduced nutrient loads to nearby waters by more than 5000 kg of nitrogen and 1800 kg of phosphorous. One watershed saw a reduction in bacterial contamination by more than 90%. In collaboration with the Sanctuary's Advisory Council, local government partners and villagers, the Fagatele Bay National Marine Sanctuary (FBNMS) is reviewing the management plan to evaluate existing programs, identify emerging issues, and to address, enhance and strengthen future management. FBNMS is also exploring a site expansion of existing boundaries to promote greater recognition and protection. The leaders of Samoa and American Samoa have initiated the 'Two Samoas Initiative' to bring together local and regional environmental agencies and organizations to promote efficient management for addressing shared marine and terrestrial environmental concerns.

**Commonwealth of the Northern Mariana Islands:** The Commonwealth Utility Corporation is upgrading sewage treatment; chronic lagoon side sewer line overflows in San Antonio, Saipan have been eliminated. A repair project at Agingan Point Sewage Treatment Plant on Saipan will relocate an outfall, which presently empties directly into the sea at the waterline. Recent enforcements of bans on gill, drag and surround nets appears to be effective in conserving

fisheries resources within the Saipan Lagoon. Cast nets (talaya) are still legal with a permit and exemptions are issued for annual celebrations honouring village patron saints. Large nets are no longer used in CNMI, and conversations with local fishermen indicate an increased abundance and size of food fishes in the lagoon. CNMI is participating in the Micronesia Challenge and is focusing on marine resource status and pollution issues, along with consideration of local management efforts.

### AMERICAN SAMOA PROTECTS LARGE RARE REEF FISHES

American Samoa is moving to protect all of its large and rare reef fish from fishing, including humphead wrasses, bumphead parrotfish, giant grouper, giant trevally, and all shark species. These fishes will be protected throughout the territory, at all times, and for all sizes. The basis for protection is their rarity and possible local extinction if they continue to be exploited. The only information required for protection is that they are rare and exploited; thus it is much easier to establish the required protection rather than having to define over-fishing. Rare fish are rarely caught, so protection incurs little cost to fishers, thus opposition may be minimized. Some large fish have large ranges and cannot be protected adequately by small MPAs, so a ban throughout American Samoa will be more likely to be effective (Douglas Fenner, DMWR, douglasfenner@yahoo.com).

**Federated States of Micronesia:** The FSM completed a National Biodiversity Strategy and Action Plan in 2003 with a blueprint for conserving biodiversity and sustainably managing a full representation of the country's ecosystems. This identified 130 areas of biodiversity significance, including 86 coastal and marine sites comprising 260,948 ha. The FSM National Government and a number of local partners signed a National Implementation Support Partnership Agreement in 2004 pledging to collaborate and support the implementation of protected areas. Each State is developing protected area networks and Pohnpei has established 11 marine sanctuaries. Kosrae has begun developing an MPA program that involves co-management of coastal resources between local communities and state resource management agencies and 5 areas are actively managed by government agencies and/or local communities. Chuuk communities commenced conservation work in several areas, including the Parem Totiw Marine Area, the Wichap-Epinup-Peidiu-Nukanap Mangrove and Marine area, and the Polle Piannu Pass Grouper spawning area. In Yap, there is currently one Locally Managed Marine Area set up on Wa'ab by the Riken community. In addition, Yap CAP is assisting communities on Qokaaw and Kadaay on the Nimpal Channel and Maaq and Lebinaw on the Peelaek Channel.

**Guam:** Although there are no long-term coral monitoring data, various independent studies and assessments indicate significant declines in coral cover, coral diversity, coral recruitment, and reef fish stocks on Guam during the last few decades. With the exception of increased reef fish abundance within MPAs, low reef fish abundance around the island and poor nearshore water quality suggest that coral reef health on Guam is unlikely to improve in the next few years unless major management measures are implemented at local and global scales. The planned

military expansion and associated coastal development, combined with probable increases in coral bleaching, and the effects of ocean acidification increase the likelihood that coral reef health will continue to decline on Guam.

The Guam Coral Reef Initiative Coordinating Committee, along with numerous partners, is implementing projects to reduce the threats to Guam's coral reefs including outreach campaigns, MPA enforcement, and the development of a comprehensive monitoring strategy. Major public works, including the extension of sewage outfalls and the closing of Ordot dump, will also reduce reef stresses. Indications of increasing public awareness are evident in greater participation in cleanups and erosion control and more outreach and education activities. However, financial and human resources remain limited compared to the disproportionate value of goods and services generated by coral reefs. Present conservation capacity will be further stretched by the planned military expansion, and predicted increases in impacts from global climate change.

The total economic value of coral reef resources on Guam in 2005-2006 was between \$85-164 million per year, with a core value of US\$127 million/yr. Tourism revenue accounted for nearly 75% of this, while other non-consumptive uses, such as coastal protection, diving/snorkeling, and amenity value, each accounted for approximately 7%. The contribution of extractive uses like reef fisheries was almost negligible (3.1%) compared to non-extractive use values. Guam is also participating in the Micronesia Challenge.

**Republic of the Marshall Islands:** Pollution, subsistence and commercial fishing, and climate related stress continue to increase in the RMI. The high cost of transportation and continued increases in population numbers will cause increases in subsistence fishing. A new large-scale fish farm rearing humpback grouper and cobia will increase lagoonal nutrient loading. The abundance and diversity of corals on Majuro will continue to decline, as coral recruitment is suppressed by pollution and eutrophication. Reefs on outer atolls will continue to be pollution-free, however they remain a tempting target for the Asian live fish and shark-finning industries and are vulnerable to climate change impacts. The RMI lacks the capacity and budget to properly police and protect its outer atolls.

Coral dredging continues in the lagoon, representing the only commercial source of sand and aggregate, and small scale sand-mining continues on many beaches. Coastal erosion is ongoing and much of the southern lagoon shore of Majuro Atoll is composed of exposed bedrock where sandy beaches had previously occurred. The use of drag-line dredging was banned by RMI EPA in October 2008, to be replaced by suction dredging of deeper lagoon sediments.

A World Heritage workshop convened in Majuro in 2005 placed 9 atolls and one low reef island (Jemo) from the uninhabited northern Marshall Islands on a Tentative List. The nominations will be submitted to UNESCO in early 2009 to begin a formal evaluation by IUCN, ICOMOS and the World Heritage Commission within a two-year period. The national government also completed an action plan in early 2008 for the systematic protection of marine areas within the Republic.

## CONCLUSIONS AND RECOMMENDATIONS

**American Samoa:** Major disturbances have been produced by mass coral bleaching events, hurricanes, COTS and extreme low tide events, but the Territory's reefs appear to be amongst

the more resilient in the region. Piggeries, land development, and the lack of proper sewage treatment is an issue in certain areas. Coral reef fish populations, particularly around Tutuila, have low biomass and few large fish. Fishing effort and catch have declined over the past 30 years although there is likely a large unreported catch, particularly from night fishing activities. Fish populations on the outer banks and in deeper waters are in need of more extensive survey. An evaluation of the efficacy of the existing community-based fisheries management program is needed and a no-take MPA network needs to be implemented. Very little information is available on the impacts of habitat degradation on fish populations and fisheries. The issues of climate change and population pressure must be more effectively targeted with collaborative solutions. Enforcement and education/outreach continue to be two issues where more support is needed. Enhanced inclusion of cultural aspects and community participation in coral reef management will ensure increased compliance and effectiveness.

**Commonwealth of the Northern Mariana Islands:** CNMI's capacity to manage its coral reef resources effectively has grown substantially over the past 7 years as the ability to assess, monitor, educate and enforce coral reef management policy has grown through an increase in both personnel and the development of locally applicable management tools.

**Federated States of Micronesia:** Establishing new community-based marine protected areas for critical reef habitat will strengthen management and protection of coastal marine resources. Additionally, completing a gap assessment for areas of biodiversity significance, completing a capacity needs assessment for the protected area network, and determining baselines and developing indicators for measuring management effectiveness toward achieving the goals of the Micronesia Challenge will assist on-going management efforts.

**Guam:** Policy interventions must be prioritized in an economically sound manner to allocate the limited resources to effectively reduce coral reef degradation. Site-based approaches involving strong community participation and a coordinated network of multiple organizations will strengthen management to counter specific threats. Effective resource management will require more financial and staff capacity to reduce local coral reef threats and mitigate reef damage from stresses associated with climate change. The specific priority projects recommended for immediate implementation include: stop-gap measures to reduce soil erosion in southern Guam; large-scale restoration of southern watersheds; and an island-wide ban on monofilament gillnets and scuba spearfishing. A rapid, large-scale reduction in the pollution and over-fishing threats will enhance resilience to climate change impacts.

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#### LONG-TERM MONITORING IN AMERICAN SAMOA: THE AUA TRANSECT

Alfred Mayor of the Carnegie Institute in Washington DC established a transect in 1917 to study corals from the shore to the reef crest in the protected waters of Pago Pago harbor, near the village of Aua. The transect was covered by branching corals, with *Porites cylindrica* dominant from 15 m from shore to 160 m, and *Acropora* species dominant on the outer 100 m (30–75% cover). Substantial urban development began in Pago Pago after World War II and two tuna canneries were constructed in the 1950s, along with other developments. The inner 90 m of the 'Aua' transect was dredged for road construction which created a sediment plume over the transect for several years. The canneries poured out large volumes of wastewater which lowered water quality for 40 years (phosphorus concentration decreased by 80%, nitrogen by 75% and chlorophyll by more than 90% between 1990 and 1992). The Aua transect was resurveyed in 1973 by Art Dahl and Austin Lamberts who reported that the branching corals on the reef flat had converted into a blanket of loose rubble. In 1992 the canneries extended their outflows beyond the Aua transect where water flows were stronger. By 2000 coral cover was 2–10%, in 2004 it had increased to a mean of 31%. This was due to successful recruitment and growth on the solid bottom of the outer transect: live coral cover and species richness all increased to levels similar to those recorded by Mayor but with more, smaller coral colonies than in 1917. Coral cover today remains low on the inner reef flat where rubble predominates but the few colonies of *Acropora muricata* (= *A. formosa*), *Montipora*, *Millepora*, *Porites* and *Stylaraea* species appear healthy; cover on the outer flat ranges between 18% and 53%. The coral reefs of American Samoa are generally resilient and will recover readily from acute disturbances such as hurricanes, bleaching events and predation by COTS. The 90 year old Aua transect shows that chronic disturbances such as pollution can prevent coral growth for decades but the corals will bounce back if the disturbance stops; however, loose rubble will slow recovery until the bottom is stabilized (from Charles Birkeland, University of Hawai'i, [charlesb@Hawaii.edu](mailto:charlesb@Hawaii.edu)).