A Rapid Ecological Assessment of the Coral, Fish and Seagrasses of Pohnpei, Ahnd and Pakin, Federated States of Micronesia – Findings and Recommendations.

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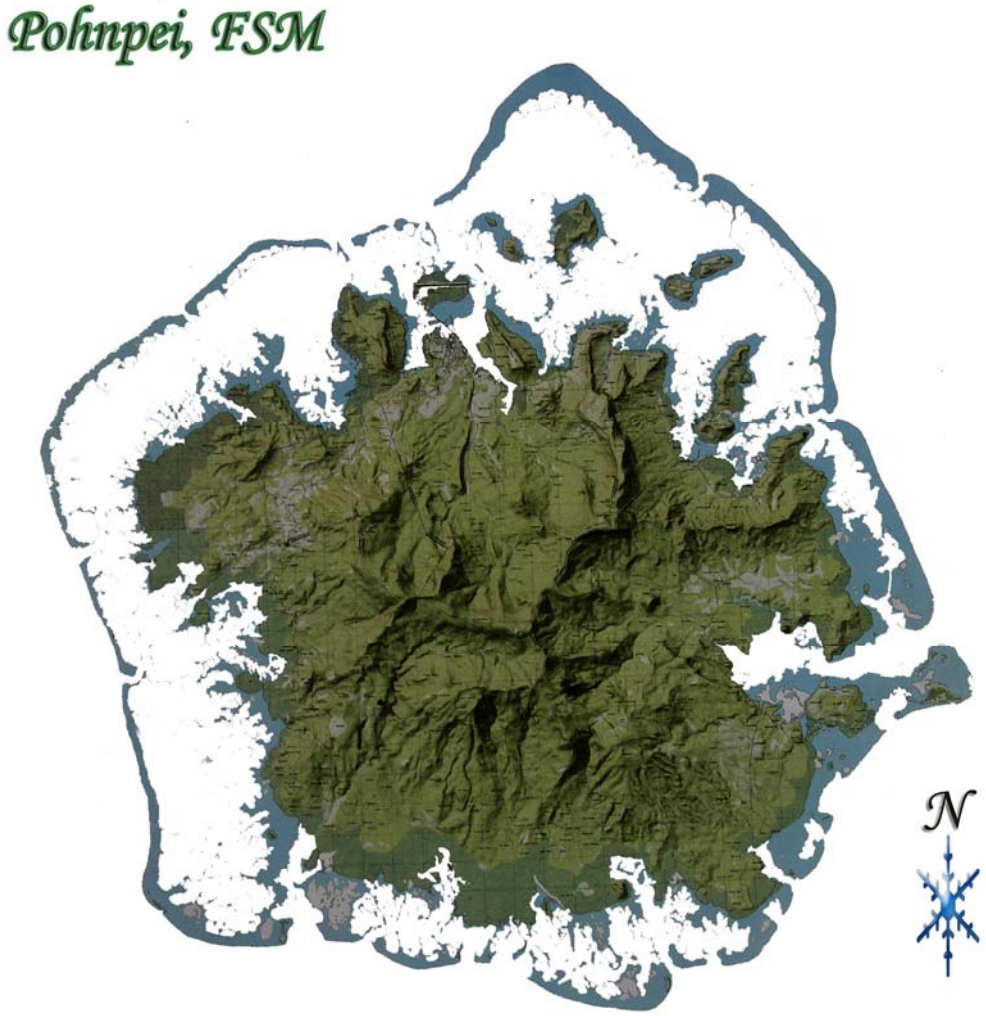
Prepared by the Conservation Society of Pohnpei



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1. Acknowledgements

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2. Acronyms and abbreviations

ABS – Area of Biodiversity Significance
CRC – CRC Reef Research Center Ltd.
CSP – Conservation Society of Pohnpei
COT – Crown of Thorns Starfish
DEA – Pohnpei State Department of Economic Affairs
DNLR – Pohnpei State Department of Land and Natural Resources
DOI-OIA – United States Department of the Interior- Office of Insular Affairs
MPA – Marine Protected Area
REA – Rapid Ecological Assessment
TNC – The Nature Conservancy
WFR – Watershed Forest Reserve

3. Introduction

During 2005, the Conservation Society of Pohnpei (CSP), in conjunction with Pohnpei State partners, Department of Lands and Natural Resources (DNLR) and Department of Economic Affairs (DEA) undertook a Rapid Ecological Assessment (REA) of Pohnpei island, and Ahnd and Pakin atolls in Pohnpei State, Federated States of Micronesia (FSM). The REA was undertaken with financial assistance from the United States Department of the Interior – Office of Insular Affairs (DOI-OIA) and the David and Lucille Packard Foundation. Outside technical assistance was provided by The Nature Conservancy (TNC) and the CRC Reef Research Center.

The decision to undertake the REA was based on a lack of adequate biological data to support the network of Marine Protected Areas (MPA's) in Pohnpei State. Despite the gains in conservation in Pohnpei, significant gaps in understanding of the biological adequacy of MPA network still exist. A recent publication titled "A Blueprint for Conserving the Biodiversity of the Federated States of Micronesia" pinpoints several key

areas of significant biodiversity around Pohnpei which include: marsh; mangrove; seagrass areas; and inshore and offshore reefs. However, the authors state that their efforts to define key marine ecological systems were "continually confounded by a lack of biological data for lagoons, coral reefs and sea grass beds". While MPA establishment has been based on best available data on fisheries and biodiversity, key questions remain unanswered. Where are the areas of highest biodiversity in Pohnpei? Are the current MPA's large enough to protect biodiversity and fisheries? Answers to these questions will have significant impacts on selection of new sanctuaries and also expansion of existing ones and will ultimately be essential to conserving biodiversity and fisheries in Pohnpei.

Objectives of the study were as follows:
1. Assess marine biodiversity and status of marine resources of three key habitats (coral reefs and seagrasses) in Pohnpei island and Ahnd and Pakin atolls.
2. Use survey results to identify areas of biodiversity significance (ABS) for protection.
3. Provide advice on developing a resilient network of MPAs to protect marine biodiversity in Pohnpei island and Ahnd and Pakin atolls. This will require reviewing the size and location of existing MPAs, and making recommendations for the future.

To conduct the assessment, 3 teams of experts were identified and contracted. During June and July 2005, coral experts Emre Turak and Dr. Lyndon Devantier undertook the coral assessment (Turak and DeVantier, 2005). During August and September 2005, Dr. Gerry Allen conducted the fish assessment (Allen, 2005) and during October and November 2005, Dr. Len McKenzie and Dr. Michael Rasheed conducted the seagrass assessment (McKenzie and Rasheed, 2006). Final and extensive reports for each of the components for the REA are available in PDF format from CSP.

This report contains a synopsis of key findings and recommendations from the three separate REA components which are presented to give the reader an overview of the status of Pohnpei's biodiversity and areas of biological significance. Recommendations for future actions are also addressed.

4. Unanimous Findings from the REA

From analyzing the reports of the coral, fish and seagrass report, two main issues were unanimous among the authors as follows:

1. Terrestrial-based human activities such as land clearing, dredging for roads and buildings, and human and animal waste are having a noticeable and significant ill-effect on Pohnpei's marine environment.

"Dredging and coral reef mining have also caused significant impacts to marine biota around Pohnpei. In the present study, dredge/coral reef mining impacts, combined with sediment run-off, were clear in Station 13, with low species diversity, particularly on the deep slope, and very high levels of silt reducing water clarity to only a few metres visibility." Turak and DeVantier, 2005

"The only significant and obvious biotic factor that seems to be having a detrimental effect on Pohnpei's reefs that I observed was an unusually large crown-of-thorns starfish (COTS) population in several areas. ……evidence from other areas in the Indo-Pacific provides for a strong correlation between COTS epidemics and coastal pollution, particularly excessive uncontrolled runoff from poorly managed terrestrial habitats that results in increased sediment and nutrient deposition." Allen, 2005

"Increased sedimentation, particularly to coastal and near shore marine communities was observed at several locations around Pohnpei. The greatest impacts appear from road construction without sufficient sediment-stabilisation mitigation, clearing for infrastructure and cash crops (eg., sakau), and dredging/coral mining near shore and in the lagoon for sand and fill" McKenzie and Rasheed, 2006

2. Ahnd atoll contains fish, coral and seagrass habitats that, if conserved, would make a significant contribution to biodiversity conservation for Pohnpei and the Eastern Caroline Islands.

"*The development of And and Pakin Atolls as MPAs will aid in conservation of many of the highest scoring locations in respect of key bioidversity attributes, including stations scoring highly in terms of rarity and replenishment potential,…….*" Turak and DeVantier, 2005

"Ant and Pakin atolls are certainly prime areas for future MPA establishment, and ones that I know are presently under consideration by CSP. These locations present a rare opportunity to combine genuine atoll MPAs with those already established at Pohnpei, to provide a network of high-island and atoll environments under a single "blanket" of conservation management. There are few, if any, existing MPA networks on the globe that offer protection and management opportunities of such diverse habitats in close proximity." Allen, 2005

"*The inclusion of Ahnd atoll into the states MPA program would aid in conservation*" McKenzie and Rasheed, 2006

5. Rapid Ecological Assessment of Reef Building Corals

5.1 Executive Summary

The report describes the results of surveys of biodiversity and status of coral communities of Pohnpei, Ahnd and Pakin Atolls in June - July 2005.

The project had five main objectives:

1) Conduct a survey of species diversity by identifying hard and soft corals and other benthic marine organisms and by compiling a detailed list of species for each site and for the survey region in general;

2) Assess coral community types, their current status and health, and the extent of impacts on these reefs from disturbances such as coral bleaching, Crown-of-thorns starfish outbreaks, destructive fishing practices, and terrestrial runoff;
3) Collect samples of hard corals and other benthic organisms which are difficult to identify in the field for further identification;
4) Analyze and interpret the data in relation to the broad and specific aims of the marine assessment, as defined in the proposal "Rapid Ecological Assessment of Pohnpei Lagoon and Ahnd Atoll";
5) Map and rank the coral reefs visited for biodiversity conservation value

These objectives were achieved during field surveys conducted using SCUBA at 36 stations around Pohnpei, Ahnd and Pakin Atolls, selected to provide a broad range of reef habitat types, as developed in relation to different environmental conditions (e.g. distance from shore, water clarity, wave energy and exposure, slope angle, depth). At most stations (survey areas of ca. 1 ha), deep and shallow sites were surveyed concurrently, representing the deeper reef slope (usually > 10 m depth) and the shallow slope, reef crest and flat (< 10 m depth) respectively. Two types of information were recorded during the ca. one and a half hour SCUBA survey swims at each station:
1) an inventory of species, genera and families of sessile benthic taxa; and
2) an assessment of the percent cover of the substrate by the major benthic groups and status of various ecological - environmental parameters.

Coral Diversity: In total, some 330 species of reef-building (hermatypic) corals in 61 genera from 14 scleractinian families were recorded, several of which, in the genera *Montipora*, *Acropora* and *Alveopora*, may be undescribed. A large number of the collected specimens require further taxonomic work, and it is likely that the overall species tally from the present survey for reef-building corals will approach 350 species or higher. Several species of hydrozoan 'fire-corals' *Millepora* were also present. Soft coral diversity of c. 20-24 genera was significantly less than other areas in the central Indo-Pacific and Southwest Pacific. Soft coral overall abundance was also low. Overall diversity was higher than the Banda Islands (Maluku, Indonesia) or the N. Great Barrier Reef (Australia). Diversity was lower than Palau (with c. 400 species), Kimbe Bay and Solomon Sea, showing a degree of attenuation at both species and generic level from most areas of the Indo-Pacific centre of diversity (Coral Triangle), with c. 500 species and 82 genera. Stations with highest local diversity (> 100 species) were widespread around Pohnpei, Ahnd and Pakin Atolls, but restricted to mid-lagoon and outer reef areas. Most near shore stations of Pohnpei were relatively low in biodiversity, likely caused by impacts over the past several decades (see later).

Distribution range extensions: Most of Pohnpei's corals are widespread species with distribution ranges across much of the Indo-west Pacific. Others have more restricted distributions in the north-central Pacific. Some 42 species were not previously known to occur in the FSM, many of which show major range extensions, most from the Coral Triangle to the west and / or Papua New Guinea to the south; others from more further a field, being known previously only from the western Indian Ocean.

Coral abundances and local distributions: Many of the coral species present were locally widespread and have reproductively-viable local populations, many of regional importance. By contrast, some corals had locally restricted distributions, and were also locally uncommon or rare, and are thus less likely to form locally viable populations. Rather, their presence may result from dispersal of larvae from further a field. For some of these species, larger populations exist in functioning and/or proposed MPA's elsewhere, although others are likely to be poorly represented at present. Management attention may be focused on such species as the region's MPA network is developed, and comprehensive species – abundance data becomes available from other areas of the FSM. Of particular note in such regional conservation planning are species with restricted global distribution ranges and generally low abundance. Pohnpei hosts populations of some 20 such species, and a further set of species that may be undescribed, providing a high degree of global importance to the area and conferring international conservation value to these reefs.

Coral communities: Pohnpei's corals form seven major community types, broadly distributed in relation to distance from the coast, depth (influencing both illumination and wave exposure), slope angle and other environmental factors. The seven communities were widespread around Pohnpei, Ahnd and Pakin Atolls. The communities are represented to greater or lesser degree in Pohnpei's developing MPA system, which excludes extractive activities, and thus should receive adequate protection, assuming MPA regulations are adhered to. At present, several locations hosting some of the most diverse coral communities with high replenishment potential (e.g. on Pohnpei's W coast, Ahnd and Pakin Atolls), are not well represented, and it is highly recommended that these be further conserved in developing future MPA's. Detailed mapping of the distribution of the coral communities in relation to the zoning scheme is warranted, to attain a high level of representativeness and foster replenishment.

Coral cover and status: Living cover of reef-building corals ranged from ~ 10 % to > 75 %, and was high (> 50 %) in stations of all exposure regimes and distances from the mainland, formed from large mono-specific and multi-specific coral stands, particularly poritids near shore and acroporids on the shallow outer reef slopes. On average, hard coral cover was c. 33 %, with a strong overall positive ratio of living:recently dead coral cover of some 16:1. Coral growth, particularly in most shallower sites (< 10 m depth) appeared vigorous, although continuing episodic and chronic disturbances, including sedimentation/re-suspension and predation, continue to reduce cover in some stations. High live coral cover (> 50 %) occurred at locations widely distributed around Pohnpei, Ahnd and Pakin Atolls.

Status and impacts: Some reefs have been adversely affected by sediment runoff, dredging and predation. Sediment run-off and dredging have caused a major loss of coral cover and diversity at worst-affected sites, which have a high cover of fine silt and very low water clarity, hindering recovery (e.g. areas of Pohnpei's East coast). Crown-of-thorns starfish (COT's) were widely distributed, being present in low – moderate abundances at c. one-third of stations, and in high abundances (approaching outbreak density) at several sites. Continuing predation by COT's is shifting the structure of the

coral communities. There was little to no evidence of destructive fishing, impact from boat anchoring and diver damage. Abundances of target species of reef-fishes, particularly in families Lethrinidae, Lutjanidae and Serranidae, appeared to be low in many areas, possibly indicating local over-fishing. The lack of fish predators, in association with likely nutrient enrichment of lagoonal areas in run-off, may also be contributing to the prevalence of the COT's.

The three major forms of disturbance, sedimentation from run-off, dredging (coral reef mining) and predation, together have affected species composition and the structure of the coral communities.

Replenishment of fishes in MPA waters over the next decade through 'no take' zones and other measures, combined with reduced run-off through improved land-use practices, may contribute to reducing COT's numbers in the medium - long term. In the short term, consideration may be given to the conduction of 'control programs' to limit the present impact and future reproductive potential of COT's, particularly in areas of high abundance. Early warning of further recruitment of COT's may be gained through monitoring, as is presently being coordinated and conducted by CSP.

Areas of Biodiversity Significance and Priority Action: The REA. stations were assessed in terms of several key conservation attributes, including coral cover and status, diversity, and representativeness. Areas of Biodiversity Significance were widespread, including stations around Pohnpei, Ahnd and Pakin Atolls, all scoring highly as conservation targets. Although some of these areas, and their representative coral community types are represented, to greater or lesser degree, in the present system of MPAs, many are not yet included. Ahnd and Pakin atolls hosted many of the highest scoring locations in respect of key biodiversity attributes. These ranked as Priority Action Areas in terms of their coral communities, and development of MPAs there is clearly warranted.

Around Pohnpei, four areas are of particular importance:

1. the southern mid-lagoonal reefs in and adjacent to the Nahtik MPA (Stations 28, 24 and 21; Figure 1);
2. the central western reefs (Stations 7, 8 and 25; Figure 1) from the coast to inside the outer barrier;
3. the northern mid-lagoonal and outer-barrier reefs (Stations 1, 2 and 14; Figure 1); and
4. the eastern outer barrier reefs (Stations 12 and 17; Figure 1).

The mid-lagoonal patch reefs around Nahtik host particularly diverse coral assemblages of uncommon community composition, with high abundance and diversity of otherwise locally-rare corals, notably of bottlebrush and fine-branching *Acropora spp*. Located mid-way across the lagoon, the area is less affected by run-off than more near-shore locations (e.g. Stations 19 and 16 further east) and has to date been unaffected by major predation by COT's. Consideration may be given to expansion of the present Nahtik MPA and/or creation of a larger MPA by expansion and merging with the Enipien MPA.

The central – northern area of Pohnpei's west coast is also of high conservation value, with some of the better remaining near shore coral assemblages, despite impacts from run-off. A large MPA from the mainland across the lagoon to the outer reefs here is worth consideration.

Two of the key northern stations (1 and 2) are already included in MPAs at Sapwitik and Dekehos. Further to the south-east, Stations 12 and 17 are close to the recently delineated MPAs of Namwen Na and Namwen Nahnningi. The area is also close to the Nan Madol historical site, and development/expansion of MPAs there is worth consideration.

Conservation management: The recent development of a series of marine protected areas and the consideration being given by the government authorities to establishing more MPA's, with support from CSP and the local village communities, will contribute to the future viability of the coral communities and their associated species. This will in turn contribute to sustainability of fisheries.

Pohnpei's outer reefs appear well connected oceanographically, lying in the path of ocean currents facilitating larval dispersal. These coral communities are thus likely to act as both a source and a sink for larvae, enhancing connectivity locally and among other coral populations in the region. Reefs in the Pohnpei lagoon may be less well connected and may require a more concerted conservation effort.

On a broader geographic scale, similarities and differences in species composition and community structure with other areas of the FSM are unknown at present, and are crucial for detailed regional-level planning for representativeness and complementarity.

5.2 Priority Recommendations for Protecting the Coral Biodiversity of Pohnpei, Ahnd and Pakin

1. Focus on preserving the areas of Ahnd atoll already identified during a recent survey for inclusion of the atoll as a UNESCO Biosphere Reserve. (Figure 2).
2. Consider extending the Namwhen Nahninngi MPA out to the reef edge to protect some of the outer reef of the South slope off Nan Madol. Hold community meetings to determine feasibility.
3. Consider expanding Nahtik MPA to encompass some of the key identified reef areas or make independent MPA's. Hold community meetings to determine feasibility.
4. Consider an MPA to protect some of the key areas in the central northern area of Pohnpei's West coast. This could be combined with protecting Dawahk channel. Hold community meetings to determine feasibility.
5. Do not pursue Pakin at present due to the distance from Pohnpei and low human impact.
6. Continue education programs based around reducing organic and sediment run-off into Pohnpei lagoon.
7. Continue with efforts to demarcate the WFR and enforce legislation and encourage community compliance.

8. Work with government partners to reduce activities that needlessly cause organic pollution and sedimentation in Pohnpei lagoon.

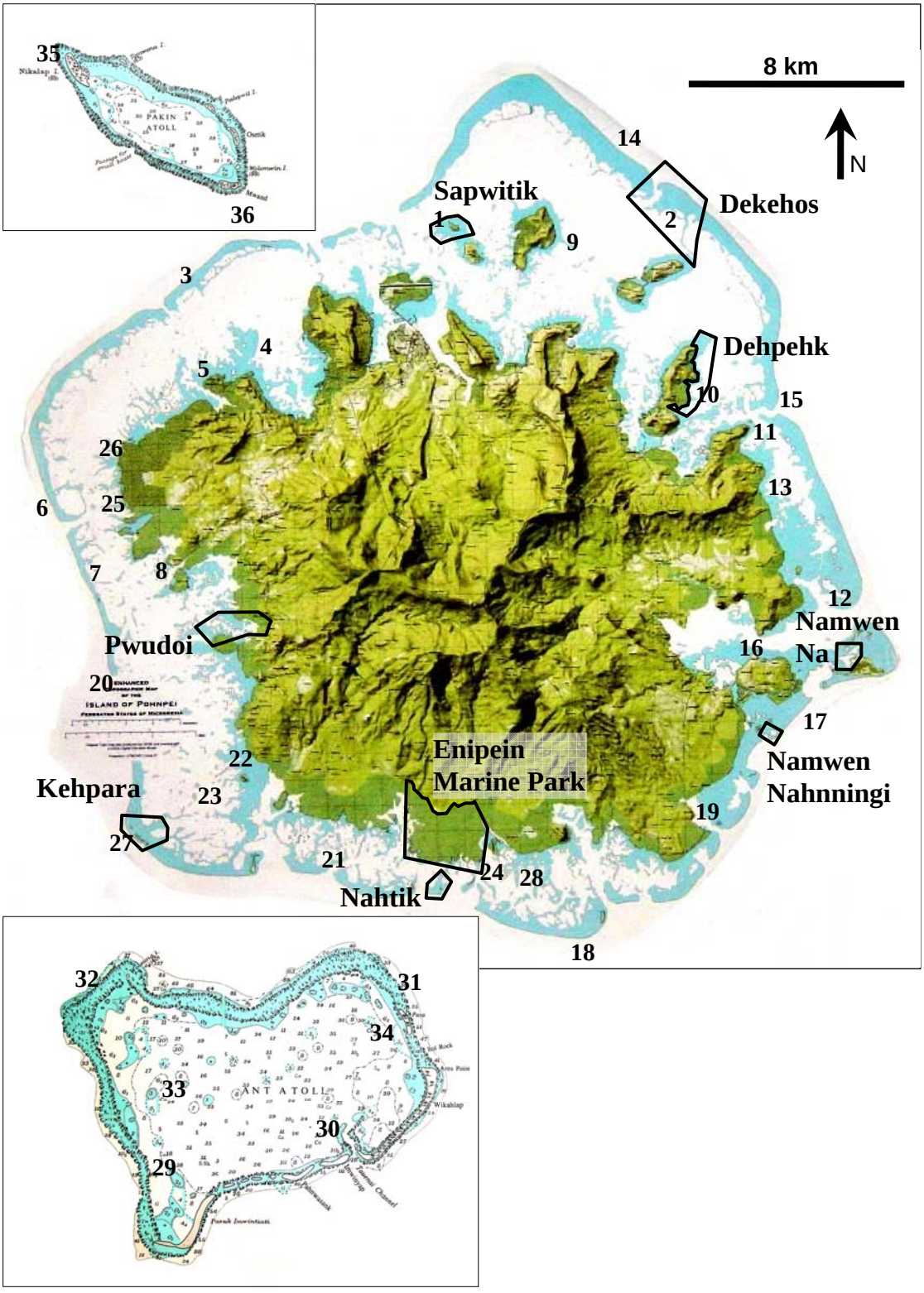


Figure 1. Maps of Pohnpei island, Ahnd and Pakin atolls showing the 36 sites surveyed during the coral REA.

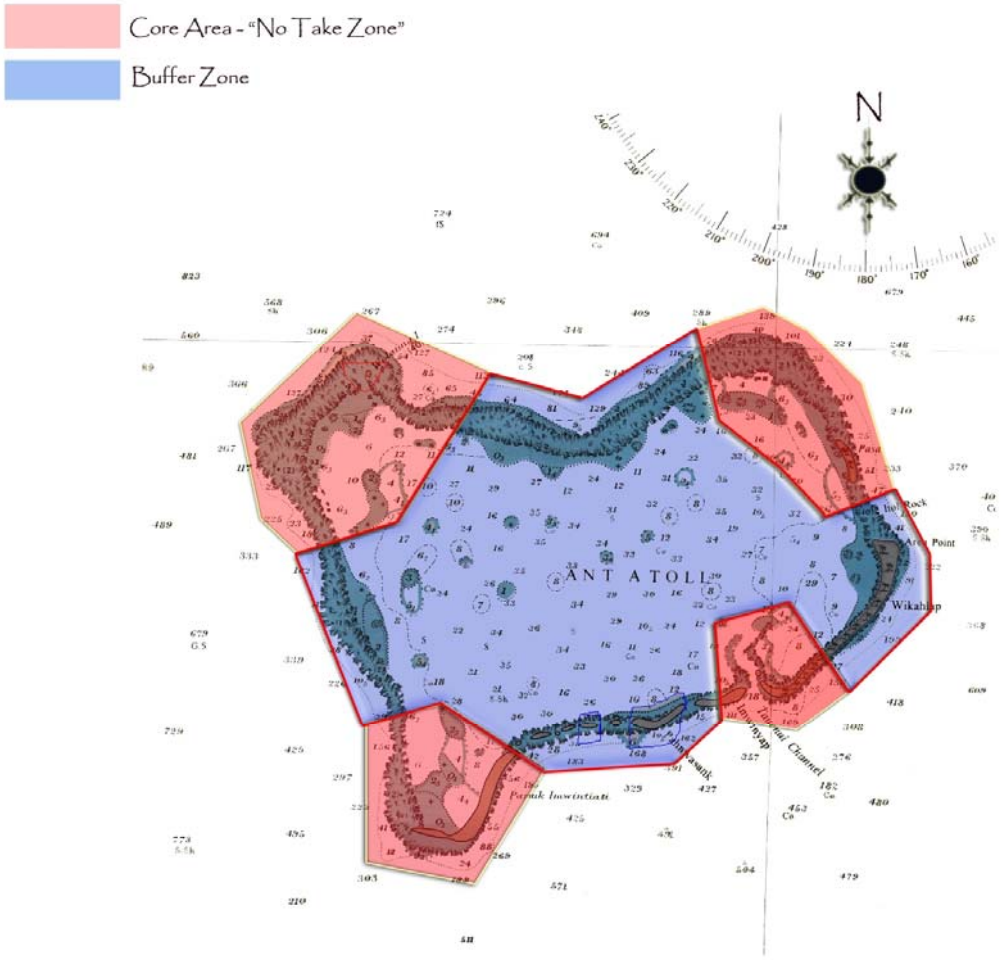


Figure 2. Map of Ahnd atoll showing no-take areas (red) and buffer areas (blue) as submitted to UNESCO during the application for the atoll to become a Biosphere Reserve. Plans are to incorporate no-take areas into the MPA network under the Pohnpei Marine Sanctuaries Act.

6. Rapid Ecological Assessment of Reef Fishes

6.1 Executive Summary

The report describes the results of surveys of biodiversity and status of fish communities of Pohnpei, Ahnd and Pakin Atolls in August and September 2005. The primary goal of the fish survey was to provide a comprehensive inventory of reef fishes inhabiting Pohnpei and nearby Ant and Pakin atolls. This segment of the fauna includes fishes living on or near coral reefs down to the limit of safe sport diving or approximately 55 m depth. It therefore excludes most deepwater and offshore pelagic species such as flying fishes, tunas, and billfishes.

Fish Diversity: A total of 41 sites were surveyed over the project period. Some of these sites were the same as those of the coral survey and some were different. A total of 470 species were recorded during the present expedition, including 161 new distribution records and one new species. Therefore, the total known reef fish fauna of the Pohnpei region now stands at 642 species in 261 genera and 80 families. The majority of the fish fauna of the Pohnpei region consists of relatively wide-ranging species associated with coral reefs and intermingled habitats including sand, rubble, and seagrass beds. The most abundant families in terms of number of species (in descending order, are: gobies (Gobiidae); wrasses (Labridae); damselfishes (Pomacentridae); groupers (Serranidae); butterflyfishes (Chaetodontidae); surgeonfishes (Acanthuridae); parrotfishes (Scaridae); moray eels (Muraenidae); blennies (Blenniidae); squirrelfishes (Holocentridae); and cardinalfishes (Apogonidae). These families collectively account for approximately 60 percent of the total reef fish fauna.

Fish community structure and habitat variability: Outer reefs and passages were the richest areas for fish diversity with 142.3 species per site compared to 119.3 for lagoon reefs. Values for average number of species per site according to major habitat types (lagoon and outer reefs/passages) are compared for Pohnpei Island, Ahnd Atoll, and Pakin Atoll in Table 1.

Table 1. Average number of species per site for various habitats and locations.

Habitat type	Location	Avg. spp. per site
Outer reef and passages	Pohnpei	145.7
Outer reef and passages	Pakin	145.2
Outer reef and passages	Ahnd	132.6
Lagoon	Ahnd	121.8
Lagoon	Pohnpei	118.7

The 11 richest sites for fishes are indicated in Table 2. The total species at a particular site is ultimately dependent on the availability of food and shelter and the diversity of

substrata. Significantly, the most species (171 and 166) for a single dive was recorded in channels connecting lagoon and outer reef habitats at Kehpara MPA on Pohnpei and Ahnd Atoll. Both sites incorporate diverse elements of the two major habitat systems (lagoon and outer reef) as well as the intermediate transition zone. Periodic strong currents provide a wealth of current-borne zooplankton, which supports an inordinate number of plankton-feeding fishes. These sites also incorporate an impressive drop-off, extensive rubble bottom, reasonable coral growth, and an extensive shallow reef top.

Table 3. Eleven richest fish sites.

Site No.	Location	Total fish spp.
47	Kehpara pass and outer reef	171
30	Ant Atoll: main channel	166
14	Mwand Pass (north of)	163
15	Aru Channel (N side)	158
36	Pakin Atoll: Mwam I..	154
38	N of Nahpali Pass (outer)	153
2	S of Mwand Pass	150
46	Nahlap	150
17	Nan Madol (outer S slope)	159
3	Palikir (outer reef)	146
51	about 300 m E of North Pt.	146

Coral Fish Diversity Index (CFDI): Dr. Allen used a convenient method for assessing and comparing overall reef fish diversity called CFDI. The technique essentially involves an inventory of six key families: Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae. The number of species in these families is totaled to obtain the Coral Fish Diversity Index (CFDI) for a single dive site, relatively restricted geographic areas (eg. Pohnpei and nearby atolls) or countries and large regions (eg. western Pacific Ocean).

CFDI values can be used to make a reasonably accurate estimate of the total coral reef fish fauna of a particular locality by means of regression formulas. The latter were obtained after analysis of 35 Indo-Pacific locations for which reliable, comprehensive species lists exist. CFDI is useful for short term surveys such as the present one because it is capable of accurately predicting the overall faunal total. The main premise of the CFDI method is that short term surveys of only 2-4 weeks duration are sufficient to record nearly all members of the six indicator families due to their conspicuous nature. The CFDI for Pohnpei is 202, composed of the following elements: Chaetodontidae (31), Pomacanthidae (12), Pomacentridae (46), Labridae (60), Scaridae (26), and Acanthuridae (27). The resultant predicted faunal total is 664 species. Comparison of this total with the actual number of species (642) currently recorded from the area indicates that the fauna has now been comprehensively documented, and only 16 additional species of shallow reef fishes can be expected from the area.

Notable elements of the Pohnpei reef fish fauna

Endemism

Considering the broad dispersal capabilities via the pelagic larval stage of most reef fishes it is unlikely that any reef fish species are restricted to Pohnpei waters. Only one species presently enjoys this distinction, *Parioglossus verticalis*, described by Rennis and Hoese (1985). It is known from a single male specimen (21.4 mm standard length) that was collected from shallow coastal waters by V.G. Springer in September 1980.

The undescribed damselfish (*Pomacentrus* sp.) is currently known only from this area, future collecting or observations will probably expand the known range to at least Chuuk and Kosrae, based on larval-stage duration of similar species. The new species is very similar to *Pomacentrus philippinus*, which ranges from the Maldives in the central Indian Ocean eastward to Palau, southern Japan, and Australia. During the present survey it was encountered at depths between about 4 and 35 m in a variety of lagoonal and outer reef habitats, but was most abundant in the inner (lagoon) portion of passages to the outer reef. The extensive, main deepwater channel at Ahnd Atoll is one of the best locations for viewing this species, but it is also common around the main island of Pohnpei.

Although Pohnpei endemics are scarce, several species that are entirely or mainly restricted to central Pacific waters are relatively common around the island and offshore atolls. These include the damselfishes *Chrysiptera traceyi* and *Pomacentrus bipunctatus*, and the wrasse *Cirrhilabrus luteovittatus*. Other restricted range species include the central Pacific moray eel *Gymnothorax marshallensis* and the wrasse *Cirrhilabrus katherinae*, which was previously known only from Japan and the Mariana Islands.

Range boundary species

Another interesting element of the Pohnpei fauna is a group of wide-ranging species that appear to have the eastern limit of distribution in Pohnpei waters. Common examples of this phenomenon include such species as *Serranocirrhitus latus, Sphaeramia nematoptera, S. orbicularis, Plectorhynchus lineatus,* and *Amphiprion clarkii*. At least in some cases, the reason for the abrupt termination of distributional range is the fact that Pohnpei and Kosrae represent isolated high island environments the huge distances to similar habitats farther east are much too vast to be bridged by the pelagic larval stage despite prevailing easterly currents.

Rare species

The most notable find in this category is the attractive banded pipefish, *Dunckerocampus naia*. The species was previously known from less than 10 specimens collected or observed at southern Japan, Guam, Solomon Islands, Fiji, Kalimantan, and the Raja Ampat Islands of Indonesia. A pair was observed in 20 m depth in a deep crevice at site 43.

New distribution records

A total of 161 species that were observed during the current survey represent new distribution records for the Pohnpei area.

Areas of Biodiversity Significance and Priority Action: The present fish survey indicates that passages or channels that connect the outer reef and lagoonal environments harbor particularly rich fish communities, simply due to the "loading" factor that results from this transitional habitat. Over just a few hundred meters there is a dramatic transition between outer reef and lagoon faunal assemblages. An excellent example is provided by the narrow channel running between two small islands at Kehpara MPA (site 47), which coincidentally was the richest site for fishes for the entire survey with 171 species.

Ahnd and Pakin atolls are prime areas for future MPA establishment. These locations present a rare opportunity to combine genuine atoll MPA's with those already established at Pohnpei, to provide a network of high-island and atoll environments under a single "blanket" of conservation management. There are few, if any, existing MPA networks on the globe that offer protection and management opportunities of such diverse habitats in close proximity. Of particular conservation value, at least in terms of fish diversity are the outer reefs of Pakin, where a number of species not seen elsewhere were observed, or that were rare around Pohnpei and Ahnd, but were common. Likewise, the main channel leading into the lagoon at Ahnd Atoll is deserving of MPA status. Due to regular strong tidal flushing the narrow entrance supports a very dynamic and diverse reef community that extends for a considerable distance into the lagoon.

Dr. Allen recommended blanket protection of two of the largest reef fish species, the Napoleon Wrasse and Bumphead Parrotfish. The Napoleon Wrasse, in particular, is increasingly threatened across the Indo-Pacific, as a consequence of its high value in the live-fish trade associated with the restaurant industry in South-east Asia. Stocks of this fish are severely depleted over much of its range, especially in the Philippines and Indonesia, where it is seldom seen or is present in very small numbers. The Pohnpei area has great potential to form a sanctuary for this species. Relatively high numbers were observed (68% of dives) during the survey compared to most other locations, although mainly immature individuals were seen.

6.2 Priority Recommendations for Protecting the Fish Biodiversity of Pohnpei, Ahnd and Pakin

1. Focus on preserving the areas of Ahnd atoll already identified during a recent survey for inclusion of the atoll as a UNESCO Biosphere Reserve. (Figure 2).
2. Consider placing one or two more channels in Pohnpei under protection. Conduct stakeholder and community meetings to determine which ones.
3. Consider extending the Namwhen Nahninngi MPA out to the reef edge to protect some of the outer reef of the South slope off Nan Madol. Hold community meetings to determine feasibility.
4. Introduce fishery legislation to prohibit catching Napoleon wrasse and Bumphead parrotfish. Work with AG office to determine feasibility of this.
5. Do not pursue Pakin at present due to the distance from Pohnpei and low human impact.
6. Continue with efforts to demarcate the WFR and enforce legislation and encourage community compliance.

7. Work with government partners to reduce activities that needlessly cause organic pollution and sedimentation in Pohnpei lagoon.

7. Rapid Ecological Assessment of Seagrasses

7.1 Executive Summary

Introduction: Seagrass meadows are a significant coastal habitat of Pohnpei. Seagrasses are a functional grouping of vascular flowering plants, which grow fully submerged and rooted in soft bottom estuarine and marine environments. Seagrass are among the few plants that have migrated back to the seas roughly 100 million years ago. Seagrasses can survive in a range of conditions encompassing fresh water, estuarine, marine, or hypersaline. There are relatively few species globally (about 60) and these are grouped into just 13 genera and five families. The greatest diversity of seagrasses occurs in the Indo-Pacific region.

Seagrasses rank as one of the major marine ecosystems on world terms. In the last few decades, seagrass meadows have received greater attention with the recognition of their importance in stabilizing coastal sediments, providing food and shelter for diverse organisms, as a nursery ground for fish and invertebrates of commercial and artisanal fisheries importance. Seagrass are rated the third most valuable ecosystem globally (on a per hectare basis). This value would be significantly greater if the habitat/refugia and food production services of seagrasses were included.

Tropical seagrasses are also important in their interactions with mangroves and coral reefs. All these systems exert a stabilizing effect on the environment, resulting in important physical and biological support for the other communities. Seagrasses slow water movement, causing suspended sediment to fall out, and thereby benefiting corals by reducing sediment loads in the water. Worldwide there is a concern that seagrass meadows are being lost from coastal areas due to both natural and anthropogenic disturbances.
It is generally accepted that there are three species of seagrass (*Cymodocea rotundata*, *Enhalus acoroides* and *Thalassia hemprichii*) in the waters surrounding Pohnpei and two species (*Cymodocea rotundata* and *Thalassia hemprichii*) from Ahnd atoll.

Methodology: The survey focused on the main island of Pohnpei State, and included Ahnd atoll. The survey was conducted from 26 October to 3 November 2005, and primarily focused on providing detailed information (distribution & abundance) on intertidal and shallow subtidal seagrass ecosystems in the region.
Intertidal and shallow sub-tidal areas were surveyed using boats and free-diving. Benthos was examined at points which extended from the upper intertidal to depths beyond the outer edge of seagrass meadows (usually 5-6m). Some locations were surveyed at a lower intensity, with points >1 km apart, but sufficient to map and describe the major seagrass habitats.

Findings: This survey was the first detailed assessment of seagrasses in the waters surrounding Pohnpei Island and Ahnd atoll. Most of Pohnpei's seagrasses are found in water less than 3m deep and meadows were mono-specific or consisted of multi-species

communities, with up to three species present at a single location. The number of seagrass species identified is within the range expected and the species are all typical of coral reef flat communities in the western Pacific.

Pohnpei's seagrass habitats can be generally categorised into six habitats: estuaries, sheltered fringing reef, exposed fringing reef, patch reef, barrier reef and atoll. Seagrass meadows in the region as a whole are in relatively healthy condition compared to many other regions globally. Coastal fringing mangrove communities appear to be generally intact, with only localised impacts. High sedimentation/turbidity in coastal waters, primarily the result of watershed runoff and marine extraction activity was identified as a major threat at some locations. Other impacts were similarly localised, and included soil erosion related to coastal agriculture (sakau plantations), sewage discharge (human and agriculture), industrial pollution, port/village infrastructure/dwellings and overfishing. Most of these impacts can be managed with appropriate environmental guidelines.

Seagrass was present at 88% of ground truth points examined. 4,403.6 ±324.3 hectares (ha) of seagrass was mapped in the intertidal and shallow subtidal waters surrounding Pohnpei Island and Ahnd atoll. 260 individual meadows were identified and mapped from 508 ground-truthed points.

Extensive intertidal and shallow subtidal meadows were present around the entire island of Pohnpei. 21 seagrass meadow communities were identified, based on the relative composition of species present. Meadows were located predominately on fringing reef platforms (83% of area) and mostly continuous in landscape structure (62% of all meadow area). Dense stands of mangroves (*Rhizophora*) bordered the mainland side of fringing reefs, particularly on the south western side of the main island. Inside the reef crest of fringing reefs, *Thalassia* and *Cymodocea* meadows dominate (<1 m depth) on coarse sand, shell, reef substrate associated with *Halimedia/Padina* and turf algae. Aggregated patches of *Enhalus acorodies* dominated the landward edge of the fringing reefs, bordering the mangroves.

Seagrass meadows dominated by *Thalassia hemprichii* were the most common, comprising approximately 69% of area of all meadows encountered. The most dominant single seagrass community (36%) was *Thalassia hemprichii* dominated meadows with patches of *Enhalus acoroides*. Meadows of the greatest cover were generally dominated by *Cymodocea rotundata*, however the meadow with the highest cover (mean = 88.3%) was a relatively small *Enhalus acoroides*/*Thalassia hemprichii* meadow on the western side of Ros Island (Kiti).

Along the parts of the coastline, which are protected by the outer barrier reef, the waters are generally more turbid and the size of the meadows dependent on the size of the fringing or patch reef. Much of the coast in these sheltered waters is fringed by dense mangroves and rivers which drain steep watersheds into the lagoon. The turbidity of the coastal waters may be a consequence of deforestation (eg. sakau planting) activities. Although the seagrass meadows may be continuous and extend over entire platform, the general pattern seaward from the mangroves was *Enhalus acoroides* dominated, to *Cymodocea rotundata* dominated and then to *Thalassia hemprichii* dominate before the reef crest.

Associated Fauna: Branching and massive hard coral varieties were associated with all seagrass meadows around Pohnpei. Although no soft corals were observed within meadows, they did occur on large fringing reef platforms between Nan Madol and Rohi.
Holothuria atra (lollyfish) were found in high densities in inshore shallow waters, particularly on large sand flats. The presence of *H. atr* was significantly higher when seagrass was present (Two sample T-Test, T=-8.72, d.f.=305.9, p<<0.01), however there does not appear to be a relationship between the abundance of *H. atr*a and the abundance of seagrass. The commercial holothurian *Holothuria scabra* (sandfish) was observed only in four meadow, all in the north west of Pohnpei – they included the *E. acorodies* dominated meadow adjacent to Parem Island, on the large fringing reef of Nantuhtu, on the fringing reef of Pohndauauk adjacent to the causeway and on the large fringing reef adjacent to Kitialap. Apart from the fact that seagrass cover was not high at these meadows (generally <30%), there did not appear to be any preference in the seagrass species composition for *H. scara*.

A number of economically important fish were observed inhabiting or transienting the seagrass meadows (particularly near the mangroves); these included groupers (e.g., *Lutjanus argentimaculatus, Lutjanus fulvus*), emperor (e.g., thumb-print emperor *Lethrinus harak*), mullets (e.g., *Liza vaigiensis, Valamugil seheli*), rabbitfish (*Siganus* spp.) and goatfish (e.g., *Parupeneus barberinus*). More fish were associated with seagrass meadows in the southern region of Pohnpei between Rohi and Black Coral Island. Highest abundances were observed in the Rohi (inlet) area. Large schools of rabbit fish were also observed feeding amongst the isolated *Enhalus acoroides* patches along the mangrove edge near Pohnrakied (Kolonia)

Mangroves: Well developed mangrove forests were observed around Pohnpei and in some areas extended more than two kilometers from shore. The forests were characterised by channels bordered by large trees with a canopy height of up to 30 metres. Away from the channels, canopy height decreases markedly. Along the channels and toward the leeward edge of the mangrove forest, *Rhizophora stylosa* and *Sonneratia alba* tended to dominate. Other common tree species are *R. apiculata, Xylocarpus granatum, Lumnitzera littorea* and occasionally *Bruguiera gymnorrhiza*.
Turbid waters were observed at a number of locations spread around Pohnpei Island, mostly at the mouths of creeks and bordering the mangrove fringe. The highest turbidities were observed adjacent to all dredging/extraction sites and at other nearshore locations including: within the sheltered harbour in Madolenihmw, Maramosok (Uh), the waters surrounding Kolonia, Sokehs Harbour, Dauen Irendodi (west of Sokehs Harbour), along the south western coast of Kitti and adjacent to Enipein Marine Park (on dark sediment). Generally the highest turbidities were observed in the southern region of Sokehs (in the vicinity of Palikir), within the sheltered harbour in Madolenihmw and Maramosok (Uh).

Ahnd atoll. 21.3 ±11.8 hectares (ha) of seagrass was mapped in 8 meadows on the sandy nearshore edge of And Atoll on the 28 October 2005 (Map 10). *C. rotundata* and *T. hemprichii* were the only seagrass species present. Seagrass meadows were generally long, narrow (25-50m) and only present adjacent to vegetated islands. The monospecific *C. rotundata* meadow adjacent to Pasa Island was continuous in structure and near

homogeneous in cover (~30%). The widest and densest meadow (~50% cover) on the atoll was on the eastern side of Tauenai Passage. This *C. rotundata* with *T. hemprichii* meadow was in a well sheltered region, which was evident on the structure of the plants as the leaves were very long. The meadows were also associated with Porites colonies on coarse sand/shell.

MPA's: There are nine Marine Protected Areas (MPAs) located around Pohnpei which are conserved under the Pohnpei State Marine Sanctuary and Wildlife System, pursuant to State Lax No. 4L-115-99. These are present in all municipalities with the exception of Sokehs.
Less than 5% of the total seagrass area surrounding Pohnpei is located within MPAs . 12 of the 21 meadow types identified for Pohnpei and Ahnd atoll occur within MPAs. Seagrass communities not represented within an MPA include:

1. *C. rotundata* – these are monospecific meadows which are only found at Ahnd Atoll.
2. *C. rotundata* with *E. acoroides/T. hemprichii* – this meadow is located on the large intertidal bank in front of Sokehs rock, opposite Sokehs Passage and the loading wharves.
3. *C. rotundata/E. acoroides* – this is a small meadow adjacent to the large Thalassia meadows at Pahn Nihkehke.
4. *C. rotundata/T. hemprichii* with *E. acoroides* - these meadows occur on the fringing reef platform adjacent to Lohd Pa and north of Nan Madol.
5. *C. rotundata/T. hemprichii/E. acoroides* - these meadows occur on the patch reefs at Dauko, adjacent to Enipein marine park.
6. *E. acoroides* with *T. hemprichii & C. rotundata* – this is a large meadow on the fringing reef platform of Nankaoros in Kitti.
7. *T. hemprichii* with *C. rotundata* – these occur: as a large meadow on the shallow sandy lagoon fringing the eastern shores of Ahnd atoll; on the barrier reef on southern mouth of Kepidauen Dawahk (channel; on the northern fringing reef flat adjacent to the airport; on the patch reef between Mwahnd Peidi (island) and Dekehn Awak (mainland); as a dense continuous meadow on the south end Nahlap (southern Kitti), protected by shingle, up to mangrove.
8. *T. hemprichii* with *E. acoroides*/*C. rotundata* - these are a large meadow scattered across the reef flat at Nantuhtu, south of Net Point (Kitti) and seaward edge of the meadow on the fringing reef flat along the northern shores of Dehpehk (Uh)
9. *T. hemprichii/C. rotundata/E. acoroides* – these are four meadows located on patch reefs in Rohi (Madolenihmw).

Threats: Reef and marine degradation in the Federated States of Micronesia (FSM) region is attributed to various natural and anthropogenic disturbances, including: storm and wave action (particularly those resulting from typhoons), increased seawater temperature (El-Nino Southern Oscillation), freshwater runoff, soil erosion related to inappropriate / unregulated land clearing (e.g., sakau crops, logging), development activities (e.g., road construction, port/village infrastructure/dwellings), boat anchoring, marine quarrying / dredging, sewage discharge (human and agriculture), industrial pollution and over fishing. Apart from climate change, these impacts are mostly localized and would have occurred post World War Two.

Increased sedimentation, particularly to coastal and near shore marine communities was observed at several locations around Pohnpei. The greatest impacts appear from road construction without sufficient sediment-stabilization mitigation, clearing for infrastructure and cash crops (e.g., sakau), and dredging/coral mining near shore and in the lagoon for sand and fill. Coral reefs on the southern coast are silting as a result of sediment discharged from Enipein watershed after heavy rain events. This high sedimentation rate is attributed to poor farming and land-use practices in the upland areas.

The presence of particulates in the near shore waters (from terrigenous soils in run-off and sediments in dredge spoils) and re-suspension from climatic events, results in reduced photosynthetic capability of seagrass, a consequence of reduced water clarity and nutrient enrichment. Although seagrass meadows trap and store both sediments and nutrients, seagrasses have a high minimum light requirement, which results in susceptibility to altered water clarity.

Elevated nutrients can lead to a loss in seagrass by limiting light. Chronic increases in dissolved nutrients can lead to proliferation of algae reducing the amount of light reaching the seagrass (e.g. phytoplankton, macroalgae or algal epiphytes on seagrass leaves and stems) or chronic and pulsed increases in suspended sediments and particles leading to increased turbidity. Eutrophication of shallow estuaries and lagoons can also lead to the proliferation of bloom-forming "ephemeral" macroalgae shading seagrass populations and eventually in displacing seagrasses as the dominant benthic autotrophs. High epiphyte and macro-algal abundance was observed at several locations around Phonpei, most adjacent to villages and towns, but also in estuaries.

Dredging and coral mining have caused significant impacts on near shore habitats around Pohnpei. On land quarrying would be a suitable and viable alternate.

O*ver fishing and destructive fishing* practices can threaten seagrasses. Most of the marine fish species recorded for the FSM are reef-associated (873 of 1,125). There are few catch and export data, but some market information suggests that the fisheries may be substantial. The gross value output of FSM fisheries was estimated at US$86.4 million in 1998, and while commercial export has the greatest impact on FSM fisheries, over fishing by foreign vessels has also been documented. Destructive fishing practices, including the use of explosives taken from the wrecks, have caused local damage, but better assessments of fisheries resources within the FSM are needed.

Most of these localized impacts can be managed with appropriate environmental guidelines, however climate change and associated increase in storm activity, water temperature and/or sea level rise has the potential to damage seagrasses in the region or to influence their distribution. Sea level rise and increased storm activity could lead to large seagrasses losses.

7.2 Priority Recommendations for Protecting the Seagrass Biodiversity of Pohnpei and Ahnd atolls

1. Promote seagrass and mangrove conservation in the Pacific Islands as they have had a low priority in conservation programs in the region.

2. The inclusion of And Atoll into the states MPA program would aid in conservation.
3. Additional Seagrass-Watch monitoring sites established to serve as an early warning of decline and scientific reference;
4. More protected areas to be established, to ensure that examples of seagrass ecosystem remain in the FSM for use by future generations
5. Seagrass conservation values need to be enhanced by development of education resource materials, to be used in schools and community groups
6. A Pacific Island monitoring program of seagrass ecosystem health needs to be established. This could be linked to existing region/global monitoring programs (e.g., Seagrass-Watch, www.seagrasswatch.org) for monitoring climate change/sea level rise impact.
7. Studies on importance, ecology, and population dynamics of subsistence fisheries which seagrass ecosystems support

8. References

Allen GR. 2005. Reef fishes of Pohnpei, Federated States of Micronesia. Report prepared for the Conservation Society of Pohnpei. 13pp.

McKenzie, L.J. and Rasheed, M.J. (2006). Seagrasses: Pohnpei Island and And Atoll Marine Assessment: Technical report of survey conducted 26 October – 3 November 2005. (Seagrass-Watch HQ, DPI&F, Cairns). 62pp.

Turak E and L DeVantier. 2005. Reef-building corals and coral communities of Pohnpei, Federated States of Micronesia: Rapid ecological assessment of biodiversity and status. Final report for the Conservation Society of Pohnpei, September 2005, 103 p.

Executive Summary:

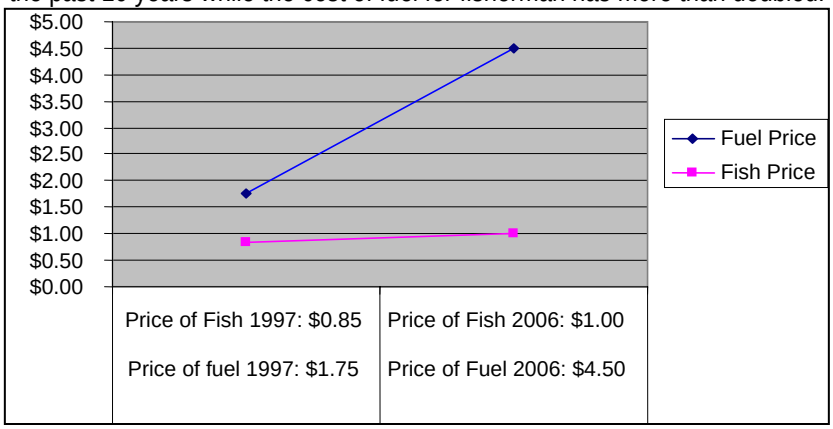
Two scientific studies completed in 2006 looked at the current state of Pohnpei's reef fisheries. The Rapid Ecological Assessment (REA) conducted by Dr. Gerald Allen, Dr. Lyndon DeVantier, Emre Turak and the Market Survey conducted by Dr. Kevin Rhodes both concluded that presently the fisheries in Pohnpei are over-fished and subsequently, unsustainable. Without an overarching policy that combines habitat protection and fishery management practices, Pohnpei's marine environment will continue to decline dramatically.

Market survey results indicate that at a minimum, 2,500 lbs of reef fish are being sold at the markets daily (1,000,000 lbs a year). These amounts do not include subsistence use, what is sold to schools and hospitals, funerals or amounts of exported fish. If these sources are taken into account, it is likely that the amount of reef fish taken from Pohnpei's reefs exceed 4,000 lbs daily (1,500,000 lbs annually). An example of the immature fishery problem can be highlighted with the highly threatened Napoleon Wrasse. The REA observed 63 Napoleon Wrasse in Pohnpei of which, the majority observed were immature, indicating that the mature fish were highly exploited (see table 5). The REA found stronger habitat protection (MPAs) are needed in areas of high biodiversity, (see map). Therefore the establishment of additional MPAs in species-rich passages between outer reef and lagoon habitats is critical for protection of the reef fisheries in Pohnpei.

In addition to MPAs, Pohnpei needs to establish fishery management policies. Currently, there is no policy on size limits, or sales limits. Moreover, an artificially low market price of fish ($1.00 per pound) is another significant factor contributing to the over-fishing problem. Market survey results indicate that at least 70 percent of all the fish sold at markets are immature fish. Furthermore, the fish that are caught with eggs and sold on the market are a wasted resource since they would otherwise replenish the reef with more fish.

As stated briefly above, an important issue for the fishermen is the current price of fish. The price of fish has remained unchanged for the past 10 years while the price of fuel has increased dramatically, (see figure 1). The low price of fish coupled with rising fuel costs causes fishers to increase their catch in order to cover fuel costs, and earn a living, while nothing is being returned to the reef. The fishing practice is growing so intense that we are degrading the future ability to catch fish while simultaneously destroying the coral reefs regenerative capacity. Therefore, designating a network of MPAs will aid in the pressure created by rising fuel costs. Further, designating these areas as part of the national marine protected area network will help meet the goals of the Micronesian Challenge.

Fig. 1: Exacerbating the over-fishing problem is that, the price of fish has remained relatively the same for the past 10 years while the cost of fuel for fisherman has more than doubled.



Immediate legislative action is needed to:
1) Reduce the consumption of fish captured.
2) Reduce the sale of undersized, immature fish.
3) Enact a ban on spawning aggregation fishing.
4) Expand Nahtik and Namwen Nahningi to include outer reef. Establish Pelieniak, Ant, and Pakin atolls as no take MPAs.
5) Designate the channels of Dawahk, Palikir, Nahpali, Nahlap and Areu as MPAs.

In order to meet these challenges, the following management techniques are suggested:
1) Size and sales limits on reef fish and crustaceans.
2) Complete ban on Bumphead Parrotfish and Napoleon Wrasse.
3) An export ban on all reef fish.

In addition, in order to improve enforcement, state licensing of fish markets is recommended to require data submission for statistics on reef fish as well as provide a means to control market behavior by providing a stringent avenue for compliance.

Over-fishing affects the reef eco-system in three ways. First, there is little to no return or replenishment to the reef. Second, over-fishing undersized fish leads to a reduction in overall population. Finally, small fish have little value economically causing an increase in fishing pressure. A failure to legislate fishery management practices will promote; (1) a continued decline in reef fish populations; (2) increase in poverty among fishing communities; (3) a reduction in revenue to fish markets and state agencies, and; (4) a compromised ability of the state to develop a robust marine-based tourist industry (e.g. dive and snorkel tourism).

Background:
The purpose of the fish market survey and the REA provided several things for Pohnpei state; 1) to supply Pohnpei state baseline statistics for future comparison of fish data, 2) measure current level of fish consumption versus productivity of reef fisheries, 3) to identify the most significant fish families for Pohnpeians and how much pressure is being placed on them, where, and by whom and 4) to determine the health of the reef eco-system. The signs of a healthy reef include habitat variability and subsequent variability of food and shelter. The Pohnpei area provides and excellent range of marine habitats from mangrove forests to near pristine atolls. The rational behind both of these studies was to identify potential changes to the market, fishing practices, and changes to legislation that will benefit the Pohnpeian community as a whole for future generations.

Market questionnaire results indicate that night time spear fishing is the most popular type of fishing, giving an unfair advantage to the fishermen and contributing to the overall decline in reef fisheries. The fishermen predominantly target 4 families of reef fish; unicorn, grouper, parrotfish and jack. When seasonal bans occur for the groupers, higher levels of parrotfish are recorded in the markets. Fishing pressure is dominated by the village of the Kitty municipality, followed by Parem.

Table 2: Price of fish and fuel needed to cover costs for fishermen from 1997 to 2006

	Price of fuel	Price for fish	Total fish weight needed to cover fuel costs
1997	$1.75 / gallon (6 g.=$10.50)	$0.85 per pound	12.5 pounds of fish
2006	$4.50 / gallon (6 g. = $27.00	$1.00 per pound	27 pounds of fish

Data from the REA illustrate that the total number of species at a particular dive site depends on the availability of food, shelter and variety of habitats. The highest levels of biodiversity in Pohnpei were the channels connecting the lagoons and outer reef habitats. Most sites have at least two major habitat systems (lagoon and outer reef). These areas have strong currents which bring in nutrient rich food which support large numbers of plankton feeding fishes. These sites also incorporate an impressive drop-off, extensive rubble bottom, reasonable coral growth, and an extensive shallow reef top. These habitats must be protected in order to regain high numbers of mature sizes of fish. The 11 richest sites for reef fish in Pohnpei are indicated in Table 3.

Table 3. Eleven richest fish sites.

Location	Total fish spp.
Kehpara pass and outer reef	171
Ant Atoll: main channel	166
Mwand Pass (north of)	163
Areu Channel (N side)	158
Pakin Atoll: Mwam I..	154
N of Nahpali Pass (outer)	153
S of Mwand Pass	150
Nahlap	150
Nan Madol (outer S slope)	159
Palikir (outer reef)	146
about 300 m E of North Pt.	146

Ant and Pakin atolls are a rare opportunity to combine habitat protection and fishery conservation in one broad stroke. Of all the sites studied, the outer reefs at Pakin and Ant were both had significant levels of bio-diversity. A number of species were seen at Pakin and Ant that were not observed anywhere else in Pohnpei. Further, Ant and Pakin atolls appear to have escaped recent coral-bleaching episodes that have destroyed living corals in numerous areas of the Indo-Pacific region. For this reason, every effort should be made to set aside at least a portion of these atolls as a conservation reserve. In addition, the main channel leading into the lagoon at Ant Atoll is deserving of MPA status. Due to regular strong tidal flushing the narrow entrance supports a very dynamic and diverse reef community that extends for a considerable distance into the lagoon.

Shark populations are becoming increasingly threatened throughout the tropical Pacific due to the unrestrained South-east Asian-based shark fin fishery. Special consideration should be given to protecting local reef shark populations (including Black-tip, White-tip, Grey Reef, and Silvertip sharks) considering the critical role they play in the marine ecosystem. The global shark fin trade kills approximately 100,000 million sharks per year. Intense fishing over a relatively short period of time can cause considerable harm due to the territoriality of reef sharks, their slow growth rate, and low birth rates. Low populations of sharks have significant negative impacts to the coral reef community and offset the entire balance of the ecosystem.

Additionally, designating Ant as a state protected area along with the development of an eco-tourism site could lead to a substantial increase of sustainable jobs and income generation for Pohnpei state agencies, hotels, and supporting industries; (snorkel and dive tourism, restaurants, local shops etc).

Moreover, if the current policy is left in place, the end result is a decrease in fish population, a higher loss of jobs to fishermen and increase in poverty levels among the fish dependent communities.

Recommendations:

In order to decrease the overall amount of fish coming off the reef, a number of recommendations are proposed. Size limits, sales limits, fishing management regulations and habitat protection must be adopted in order to preserve Pohnpei's reef systems for the future. Critical for success of these recommendations is actual enforcement of the laws created. Further, the Crown of Thorns outbreak is due to an increase in sediment loads coming from pig and human waste. This runoff directly results in an overall population decrease for Emperors and Napoleon (Humphead) Wrasse. Every effort should be made to minimize the impact from this type of pollution.

Habitat Protection recommendations:

- Certain areas of Ant atoll designated as a state MPA. (CF)[1]
- Certain areas of Pakin atoll designated as a state MPA. (CF)
- Expand Nahtik MPA to include Pahnsedlap (C)[2]
- Consider additional Channel MPAs: Dauwahk, Palikir, Areu, Nahpali, and Nahlap. (F)[3]
- Pelieniak set aside as MPA (C)
- Total ban on filling and dredging in mangroves.
- Delineate and enforce a boundary of the watershed forest reserve to reduce sediment runoff to our coral reefs.
- Extend Namwen Nahningi to include the outer reef. (C)

Specific fish legislation recommendations on size limits:

- 2 lb/ 15 in. minimum for grouper, parrotfish, rudderfish and snapper.
- 1 lb/12 in. minimum for goatfish
- 3 lb./15 in. minimum for Naso Unicornis (Pwulak)
- 120 mm minimum carapace width size for Mangrove crabs.
- Extend ban of exported crabs to include reef fish. (Title 26: §6-153. Export of mangrove crabs, coconut crabs, and lobsters, prohibited).

Infractions to these rules can be enforced through a fish market license which can be repealed in the event of failure to sell only properly sized fish and fined for each undersized fish found. This might mean a state license on top of the municipal license. (We need to think about this and come up with something that does not double the expenses to the market owners or we risk losing their support altogether).

Sales and catch limits on specific species of fish that are threatened:

- Groupers: extend moratorium through January–May.
- Parrotfish: enact a moratorium through April–May.
- Unicornfish: enact a moratorium April-May.
- Reef Sharks: (Grey reef, black tip, white tip and silver tip) – actual enforcement of ban on shark finning and moratorium January-May.
- Lobsters and Mangrove crabs: seasonal ban January-May. Ban on possession or sale of lobsters and crabs with eggs. (Title 26: §6-152. Taking mangrove crab with eggs, prohibited).
- No catch possession, export or sale of Napoleon Wrasse to be included along with law on the Bumphead Parrotfish. (Title 26: §6-142. Taking bumphead parrotfish for sale, prohibited).
- Sales license required for all fish markets, which can be revoked if markets are found not to be in compliance with the law.

[1] CF designates high levels of coral and fish biodiversity
[2] C designates high levels of coral biodiversity
[3] F designates high levels of fish biodiversity

Infractions including sales and possession on undersized fish punishable by laws enforced with fines and/ or incarceration.

Management options regulating fishing practices:

- Ban on nighttime spear-fishing either year-round or seasonally.
- No sale or possession of Hawaiian slings or any variation thereof on the entire island.
- Cages for mangrove crabs required to have escape hatches for small crabs.

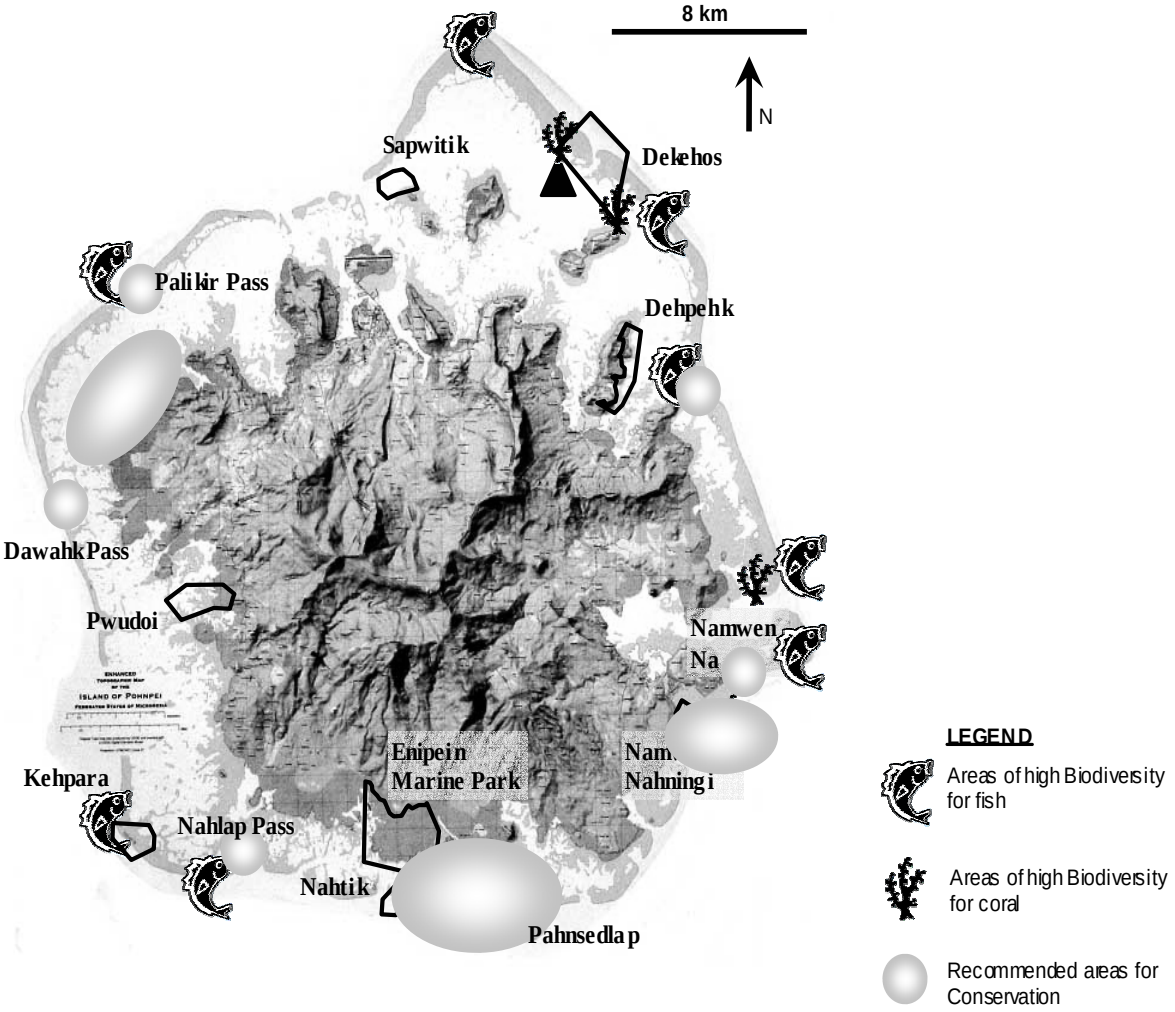
The price of fish must be raised; however this price increase must be done with the involvement of the fishing community. Marine resources should facilitate a fishermen's cooperative to set a correct price to curb consumption and cover fuel costs. An effect of the price increase should be a decline in the amount of fish coming off the reef while maintaining profits for the fishermen and reducing consumption.

Table 4. Raising the Price of fish:

	Price of fuel	Price for fish	Total fish weight needed to cover fuel costs
1997	$1.75 / gallon (6 g.=$10.50)	$0.85 per pound	12.5 pounds of fish
2006	$4.50 / gallon (6 g. = $27.00)	$1.00 per pound	27 pounds of fish
2007 (with price change)	$4.50 (6 g. = $27.00)	$2.00 per pound	13.5 pounds of fish
2007 (with price change)	$4.50 (6 g. = $27.00)	$2.50 per pound	10.8 pounds of fish

Table 5. Frequency of Napoleon Wrasse for various locations in the Indo-Pacific previously surveyed by G. Allen.

Location	No. sites where seen	% of total sites	Approx. no. seen
Phoenix Islands 2002	47	83.92	412
Milne Bay, PNG – 2000	28	49.12	90
Milne Bay, PNG – 1997	28	52.83	85
Pohnpei – 2005	28	68.29	63
Raja Ampat Islands – 2001	7	15.55	7
Togean/Banggai Islands – 1998	6	12.76	8
Weh Island, Sumatra – 1999	0	0.00	0
Calamianes Is., Philippines – 1998	3	7.89	5


8 km
N
Sapwitik
Dekehos
Palikir Pass
Dehpehk
DawahkPass
Pwudoi
Namwen
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Enipein
Marine Park
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Nahningi
Kehpara
Nahlap Pass
Nahtik
Pahnsedlap
LEGEND
Areas of high Biodiversity for fish
Areas of high Biodiversity for coral
Recommended areas for Conservation