ISSN 1818-5614

Ecological assessment and community monitoring plan for marine protected areas in Yap State, FSM

By Palau International Coral Reef Center

IWP-Pacific Technical Report (International Waters Project) no. 42

Global Environment Facility

United Nations Development Programme

Pacific Regional Environment Programme

SPREP IRC Cataloguing-in-Publication Data

Ecological assessment and community monitoring plan for marine protected areas in Yap State, Federated States of Micronesia / by Palau International Coral Reef Center. – Apia, Samoa : SPREP, 2007.

iv, 34 p. ; 29 cm. - *(IWP-Pacific Technical report, ISSN 1818 - 5614 ; no.42).*

ISBN: 978-982-04-0365-9

1. Ecological risk assessment – Marine protected areas - Federated States of Micronesia, Yap State. 2.Ecological surveys – Federated States of Micronesia, Yap State. 3. Coastal ecology – Risk assessment – Federated States of Micronesia, Yap State. 4. Community participation – Planning – Policy – Federated States of Micronesia, Yap State. I. International Waters Project (IWP). II. Secretariat of the Pacific Regional Environment Programme (SPREP). III. Palau International Coral Reef Center. IV. Title. V. Series.

333.917 14

Originally written in 2005.

This report was produced by SPREP's International Waters Project, which is implementing the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States, with funding from the Global Environment Facility. The views expressed in this report are not necessarily those of the publisher.

Cover design by SPREP's Publication Unit
Editing and layout: Mark Smaalders, IWP editorial consultant

SPREP
PO Box 240, Apia
Samoa
E: sprep@sprep.org
T: +685 21 929
F: +685 20 231
Website: www.sprep.org

Contents

Acronyms

ABS	Area of Biodiversity Significance
DAWR	Division of Aquatic and Wildlife Resources (Guam)
FSM	Federated States of Micronesia
GEF	Global Environment Facility
IWP	International Waters Project
MPA	Marine Protected Area
MRD	Marine Resources Division (Yap)
NGO	non-governmental ogranization
PICRC	Palau International Coral Reef Center
TNC	The Nature Conservancy
UNDP	United Nations Development Programme

Executive summary

Yap State is one of the four constituent states of the Federated States of Micronesia (FSM). Yap consists of four closely associated high islands: Yap, Tamil-Gagil, Maap, and Rumung, which are collectively known as Wa'ab or "Yap proper". Yap proper is entirely surrounded by an extensive fringing reef. The reef encloses a lagoon that ranges in width from 3.5 km at the northern and southern tips of Yap, to about 200 m along the west coast. Recently, The Nature Conservancy partnered with the United States (US) Department of the Interior, the US Forest Service, and the United Nations Development Programme (UNDP) Global Environment Fund (GEF), to produce a blueprint for biodiversity conservation in FSM. Part of this project involved a threats analysis for each of the four states within FSM (The Nature Conservancy 2003). Overfishing/overhunting was identified as the "most urgent and critical threat across marine and terrestrial ABS [Areas of Biodiversity Significance] in all states" (The Nature Conservancy 2003: 33). For this reason, marine resource management plans for Yap should include tools for reducing fishing pressure and thereby conserving spawning stock biomass. One relatively simple and often effective way to reduce fishing pressure on depleted fish stocks is by implementing no-take area closures, generally referred to as marine protected areas (MPAs), or no-take marine reserves (NTMRs).

Although overfishing/overhunting was identified as an urgent and critical threat, and Yapese fishers claim a steady decline in size and abundance over the past decade, at present no scientific data are available to either prove or disprove these claims (see Foale 2007). Anecdotal evidence gathered through interviews with dive tour operators (who collectively have spend a great deal of time underwater) on Yap proper suggested that that no obvious changes in size or abundance of fish on the outer reef have occurred, but these observations do not extend to the lagoon, where significant subsistence fishing takes place (Foale 2007). Any reports that may have been available from the Marine Resources Department (MRD) were either destroyed or placed in storage following Typhoon Sudal in April 2004, and the authors were thus unable to access any archived fisheries data (e.g. CPUE data from creel surveys or other fisheries-dependent monitoring programs) that may have demonstrated stock declines. Good data on CPUE, length frequencies, and other standard fisheries management information are sorely lacking in Yap.

The objectives of this project are to prepare and conduct an ecological baseline survey of the nearshore reef fisheries at proposed MPA sites in each of four IWP communities in Yap, prepare a monitoring plan and support the involvement of the community in baseline assessment and monitoring work.

Results

Of all the sites surveyed, Gagil had the highest coral cover and was the most diverse in terms of coral species. It was the only site that included a channel through the reef; the three other sites surveyed were strictly reef flat areas. Maap had coral cover of 11%, the lowest when compared with all the other sites surveyed. The most dominant category at Maap was sand and rubble, which covered 72% of the area surveyed. Rumung was the only site surveyed with significant seagrass areas, with 22% of the site being covered by seagrass. Coral cover was at 27%, the second highest of all the areas surveyed. Coral covered 21% of the areas surveyed at Gilman. Inside the lagoon, only the southern tip of Gilman supported extensive patch reefs. The majority of the lagoon at Gilman was sandy, and several fishers and dive operators told us that "nobody fished down there".

Belt transect surveys have the advantage of yielding quantitative estimates of density or biomass per unit area. Our transects covered an area of 100 m^2, which is a convenient size for counting small and sedentary reef fishes, but too small to obtain accurate counts of larger, more mobile species. Mean density of target species (i.e. the average of the 4 transects per location) on transects varied from about 7 fishes per 100 m^2 at Maap and Rumung to 18 fishes per 100 m^2 at

Gilman and 24 fishes per 100 m^2 at Gagil. Mean biomass ranged from 1100 g wet weight per 100 m^2 at Maap and Rumung to 6100 g wet weight per 100 m^2 at Gagil. This figure is obviously an underestimate, caused by the disturbance of divers and resulting in all the larger fish moving to a distance greater than 2 m from the transect line.

Abundance and biomass of reef fishes from timed swim surveys showed a very different (almost opposite) pattern to that of the transects. The abundance and biomass of all target fishes was much lower at Gagil than at the other three sites. Data from the timed swims also indicated that lined bristletooth (*Ctenochaetus striatus*), convict tang (*Acanthurus triostegus*), and bullethead parrotfish (*Chlorurus sordidus*) accounted for most of the fish abundance and biomass at all sites. However, timed swims also indicated that several other, larger species, including the epaulette surgeonfish (*Acanthurus nigricauda*), the blacktail snapper (*Lutjanus fulvus*), and the filament-finned parrotfish (*Scarus altipinnis*), were found at all sites except Gagil.

Results of the monitoring program can be used by marine resources managers to evaluate the MPA's effectiveness in protecting marine biodiversity. From this information, the mangers can then determine what type of use can be sustainable for the resources through a management plan. The three major goals of the monitoring program are: 1) to evaluate the effectiveness of protected areas for (a) protecting and providing information on fish abundance and diversity, (b) enhancing non-consumptive activities, (c) promoting conservation, and (d) increasing fisheries knowledge; 2) to monitor trends in fisheries resource use and the condition of Yap's coral reefs; and 3) to measure biological changes inside and outside of the MPA. Goal 3 may not be accomplished unless there is a capacity for monitoring benthic life-forms.

The primary purpose of the monitoring in the first five years will be to test the hypothesis that the abundance of most exploited fish species will change significantly as a result of the protected areas. We propose a two-level monitoring plan, with a simplified protocol (based on Reef Check) for ease of community involvement, and a more advanced protocol that can be used if professional help from government, academic, or NGO personnel is available.

Community awareness and participation in the designation of marine protected areas is important to the successful management of these areas. One of the objectives of the trip was to provide an opportunity for Reef Check training to members of the community. This would provide simple techniques that they could use to monitor their own marine protected areas. A 2-day Reef Check training workshop was held in Colonia. Six people participated in the training, which consisted of a classroom session (where the methods were taught and the target species identified) and field session (where participants had the opportunity to apply what was learned). Because most of the participants were not SCUBA certified, surveys were conducted at only 3 m depth. After completion of the training, each participant was presented with a certificate of achievement from Reef Check.

Based on our surveys, we recommend that the following actions be taken:

1. No scientific evidence currently exists to support or refute claims that Yap's reefs are overfished, and that size and abundance of reef fish is declining. It is vital that Yap MRD develop a strong, fisheries–dependent monitoring program, probably based mainly on creel survey CPUE data. One idea might be to bring staff from Guam DAWR to train MRD staff in creel survey techniques, and to help establish a survey program in Yap.
2. Further baseline assessment is needed to obtain density and biomass estimates for reference sites, an important part of this exercise that we unfortunately could not finish due to time constraints. There may be a chance for PICRC researchers to complete these surveys in spring of 2005, as we will be in Yap conducting surveys for juvenile groupers and humphead wrasse.

3. We recommend the use of the Reef Check protocol for communities to monitor their own MPAs. The method is relatively simple, standardized, and widely used. The trainees that attended our workshop were able to understand and apply this protocol quickly, and they need little other than transect tapes and slates to conduct their monitoring program.
4. The MPA boundaries at Gilman should be adjusted to include only the southern and southwestern portions of the lagoon, where extensive coral growth occurs.
5. Up-to-date GIS-based maps of benthic habitat should be obtained from the US National Ocean Service as they become available.

Introduction

The International Waters Project (IWP) is funded by the Global Environment Facility and executed by the Secretariat of the Pacific Regional Environment Programme (SPREP) in partnership with 14 Pacific Island countries. The objective of the project is to help participating countries improve the management of their environment and coastal resources by supporting "pilot" projects in each participating country. These pilot projects will assist countries (communities and governments) to identify and address the "root causes" of environmental degradation and to design and implement possible solutions at the local and national level. Community based activities may include "low tech" solutions to addressing environmental degradation, while national level activities may involve activities that have a broader or more strategic focus.

The aim of IWP in the Federated States of Micronesia (FSM) is to address the root causes of non-sustainable coastal resource use on Yap. This is being addressed at two levels. The first focuses at the community level, to identify and address local level threats to sustainable coastal resource use. At the same time, the IWP works at the district and/or State level to address policy, institutional and legislative issues that may be contributing to root causes for non-sustainable coastal resource use on Yap.

Two principal threats to sustainable marine resource use at the four communities selected to host IWP activities on Yap (Rumung, Maap, Gagil and Gilmaan) have been identified. They are over-exploitation of fisheries and the degradation of near shore environments as a result of land-based activities. The communities have proposed marine protected areas as a tool they could manage to support sustainable coastal resource use.

One of the first steps in the process of establishing pilot activities for community-based coastal resource management at the four host communities is to conduct an ecological baseline assessment, in close cooperation with IWP national staff, the Yap State IWP Task Force, the Lead Agency, SPREP PCU and other stakeholders.

Background

Geography

Yap State is one of the four constituent states of FSM. Yap consists of four closely associated high islands: Yap, Tamil-Gagil, Maap, and Rumung, which are collectively known as Wa'ab or "Yap proper", along with 134 low coralline islands and atolls, 22 of which are populated (Yap State Environmental Stewardship Consortium, 2004). These smaller islands and atolls are referred to as the outer or neighbouring islands (Remethau). Wa'ab's land area of 38.7 square miles (95 km^2) comprises roughly 78% of the Yap State's total land area of 49.7 square miles. In contrast, only 3% of the coral reef area of Yap State is found in Wa'ab (Smith and Dalzell 1993). The great majority of Yap State's estimated population of approximately 12,000 live in Wa'ab, resulting in a disproportionate impact on Wa'ab's coral reefs, as compared to the reefs of Remethau.

The complex of four islands that constitutes Yap proper is entirely surrounded by an extensive fringing reef. The reef encloses a lagoon that ranges in width from 3.5 km at the northern and southern tips of Yap, to about 200 m along the west coast. The lagoon is generally shallow, except for a series of enclosed "holes" or deep areas dispersed haphazardly throughout the lagoon. These holes range in diameter from 10 m to 1.5 km and in depth from 3 m to 22 m. According to Smith (1990: 2), these holes are mostly likely "the remnants of a lagoon and barrier reef system that has been filled in by sediments and closed by active reef growth". Wa'ab has one of the longest shorelines in the FSM, due to its complex shape. A large portion of that coastline is fringed by mangrove forests, which comprise 1171 ha or 12% of the total land area of Wa'ab (Smith 1990).

Yap lies south of the typhoon belt and usually experiences a major typhoon only once every 20 years. However, four typhoons affected Yap State between November 2003 and April 2004, including Typhoon Sudal, which struck Wa'ab on 9 April 2004, causing widespread damage (Yap State Environmental Stewardship Consortium 2004). Typhoon Sudal caused extensive and obvious damage to Yap's mangrove forests, but the effects on Yap's coral reefs are unknown at present.

Yap's position at the western end of the Caroline Islands, near Palau and the Philippines, places it near a geographic center of high biodiversity. Yap proper has the highest biodiversity within FSM, but the number of endemic species is higher in the more remote eastern islands. Four of the seven existing species of sea turtle are found in Yap, including the largest green turtle (*Chelonia mydas*) rookery in the insular Pacific region (The Nature Conservancy 2003). The Nature Conservancy identified 6 marine and 21 coastal marine Areas of Biodiversity Significance (ABS) in Yap State. Marine areas (mostly lagoons and coral reefs) covered a total of 49,471 ha or 191 square miles. Coastal marine sites covered a total of 24,007 ha or 92.7 square miles.

Resource issues

Recently, The Nature Conservancy partnered with the US Department of the Interior, the US Forest Service, and the United Nations Development Programme (Global Environment Fund) to produce a blueprint for biodiversity conservation in the FSM. Part of this project involved a threats analysis for each of the four states within the FSM (The Nature Conservancy 2003). This analysis revealed 8 major threats to biodiversity and the environment in general, listed from most to least severe:

1. overfishing/overhunting
2. coastal erosion and sea-level rise
3. water pollution
4. dredging
5. erosion/sedimentation from land-based activities
6. destructive harvesting
7. invasive species
8. incompatible commercial development

Overfishing/overhunting was identified as the "most urgent and critical threat across marine and terrestrial ABS in all states" (The Nature Conservancy 2003: 33). For this reason, marine resource management plans for Yap should include tools for reducing fishing pressure and thereby conserving spawning stock biomass. One relatively simple and often effective way to reduce fishing pressure on depleted fish stocks is by implementing no-take area closures, generally referred to as Marine Protected Areas (MPAs), or no-take marine reserves (NTMRs).

Although overfishing/overhunting was identified as an urgent and critical threat, and Yapese fishers claim a steady decline in size and abundance over the past decade, at present no scientific data are available to either prove or disprove these claims (see Foale 2007). Anecdotal evidence gathered through interviews with dive tour operators (who collectively have spend a great deal of time underwater) on Yap proper suggested that that no obvious changes in size or abundance of fish on the outer reef have occurred, but these observations do not extend to the lagoon, where significant subsistence fishing takes place (Foale 2007). Any reports that may have been available from the Marine Resources Department (MRD) were either destroyed or placed in storage following Typhoon Sudal in April 2004, and the authors were thus unable to access any archived fisheries data (e.g. CPUE data from creel surveys or other fisheries-dependent monitoring programs) that may have demonstrated stock declines. Good data on CPUE, length frequencies, and other standard fisheries management information are sorely lacking in Yap.

Within Micronesia, Guam has the best data on inshore reef fish catches due to an extensive creel survey program that has continued for the past 17 years (B. Tibbets, Guam Division of Aquatic and Wildlife Resources, pers. comm.). Data from Guam clearly indicate a 70% decrease in CPUE over the past 13 years. However, Yap State does not possess the resources needed to conduct extensive fisheries surveys. Thus, critical information on stock status is unavailable. Unfortunately, due to Typhoon Sudal's extensive damage to the MRD building, what little information does exist was not available to us. Interestingly, available information tends to focus on sea turtles, sea birds, mangroves forests, giant clams, and trochus, with little or no attention given to finfish (e.g. Goldman 1994). Despite this, Yap fishers identified reef fish as their most important catch during our conversations with them.

We were unable to examine any local coastal resource or vegetation maps during our visit, as existing maps had been placed in storage following extensive damage to government office buildings caused by Typhoon Sudal. As mentioned previously, mangrove forests cover about 12% of the land mass of Yap proper. These forests are concentrated along the seaward edge of the coastal plain and the perimeters of estuaries. Seaward of the mangroves, lagoon areas support a band of seagrass, in addition to macroalgal plains. The existing maps of these often ephemeral seagrass and macroalgae habitats are outdated, and new maps should be created based on recent satellite imagery (IKONOS) available from the US National Ocean Service.

Background on MPAs

In recent years, the establishment of marine protected areas closed to fishing has been promoted as a cost-effective means to protect exploited species from overfishing (Russ and Alcala 1996; Murray et al. 1999, Roberts et al. 2001). The potential ecological advantages of marine reserves are thought to be the maintenance of a critical spawning-stock biomass to ensure recruitment supply to fished areas, and the possible enhancement of yields in areas adjacent to the reserve via emigration of adult fish (Johnson et al. 1999; Roberts et al. 2001; Tupper and Rudd 2002). MPA proponents have argued that they are simple and inexpensive to monitor and enforce, thereby having cost advantages over more traditional effort- or catch-oriented fisheries management alternatives (Bohnsack 1993; Roberts and Polunin 1993).

Whether or not MPAs achieve their ecological and economic potential depends on the behaviour of local fishers. If compliance is poor, MPA benefits may prove difficult to achieve because of unsustainable fishing pressure and/or escalating enforcement costs (Rudd et al. 2003). Compliance with closures increases in common pool resource systems when local users, who bear most of the costs of an area closure, derive direct benefits from that closure (Ostrom 1990). If MPAs are to be viable in areas with limited opportunities for economic diversification, it will be critical that fishers benefit from improved fishing opportunities arising from the emigration or "spillover" of commercially important fish species from the MPAs. While numerous studies have shown that marine reserves contain a higher abundance and/or mean size of fish than adjacent fished reefs (Russ and Alcala 1989, 1996; Polunin and Roberts 1993; Wantiez et al. 1997; Johnson et al. 1999; Tupper and Juanes 1999; McClanahan and Mangi 2000; Roberts et al. 2001), fewer studies have shown an increase in catch-per-unit-effort (CPUE) in fishing grounds adjacent to marine reserves (Alcala and Russ 1990; Bennett and Attwood 1991; McClanahan and Kaunda-Arara 1996; McClanahan and Mangi 2000; Roberts et al. 2001).

The degree of emigration or spillover from MPAs, which should increase fishery landings and/or reduce CPUE in adjacent fishing grounds, depends on the rate of fish migration across MPA boundaries (DeMartini 1993). Reef fish are generally considered sedentary, although the scale of movement varies among species (Chapman and Kramer 1999, 2000; Meyer et al. 2000). Some studies have shown that many species of fish migrate considerable distances to forage (Hobson 1973; Bryant et al., 1989; Helfman 1993; Burke 1995) or reproduce (Shapiro 1987; Bolden 2000). In contrast, however, other research has found no emigration from reserves (Buxton and Allen 1989) or indicated that the difference in fish density between fished and protected reefs was not related to species mobility (Chapman and Kramer 1999). Whether MPAs are a preferred policy tool will depend on species- and site-specific factors. Establishment of MPAs for species or areas with insignificant spillover effects (despite size and/or abundance increases within the MPA) would serve as an incentive for fishers to disregard reserve regulations. At best such MPAs would be inefficient, incurring high monitoring and enforcement costs; at worst, these would be ineffective for either fisheries management or conservation purposes. In such cases, it is conceivable that policy tools other than MPAs would provide higher fisheries benefits, and receive greater support from fishers, thus increasing the likelihood of their being successfully implemented.

MPAs in Yap

In an effort to conserve coastal fisheries resources in Yap State, Yap Government and the people of Yap through their International Waters Program (IWP) are putting their efforts together to establish Marine Protected Areas (MPAs). To date one reef area has been designated as MPA. Three other areas have been proposed as MPA's (Figure 1).

The Palau International Coral Reef Center (PICRC) was contracted to conduct baseline ecological assessments of these four sites, and to develop a monitoring plan that could be undertaken by local communities managing the MPAs. The objective of community-based monitoring is to allow the MPA stakeholders to determine first-hand whether or not the MPAs are reaching their objectives of protecting and enhancing valuable reef resources.

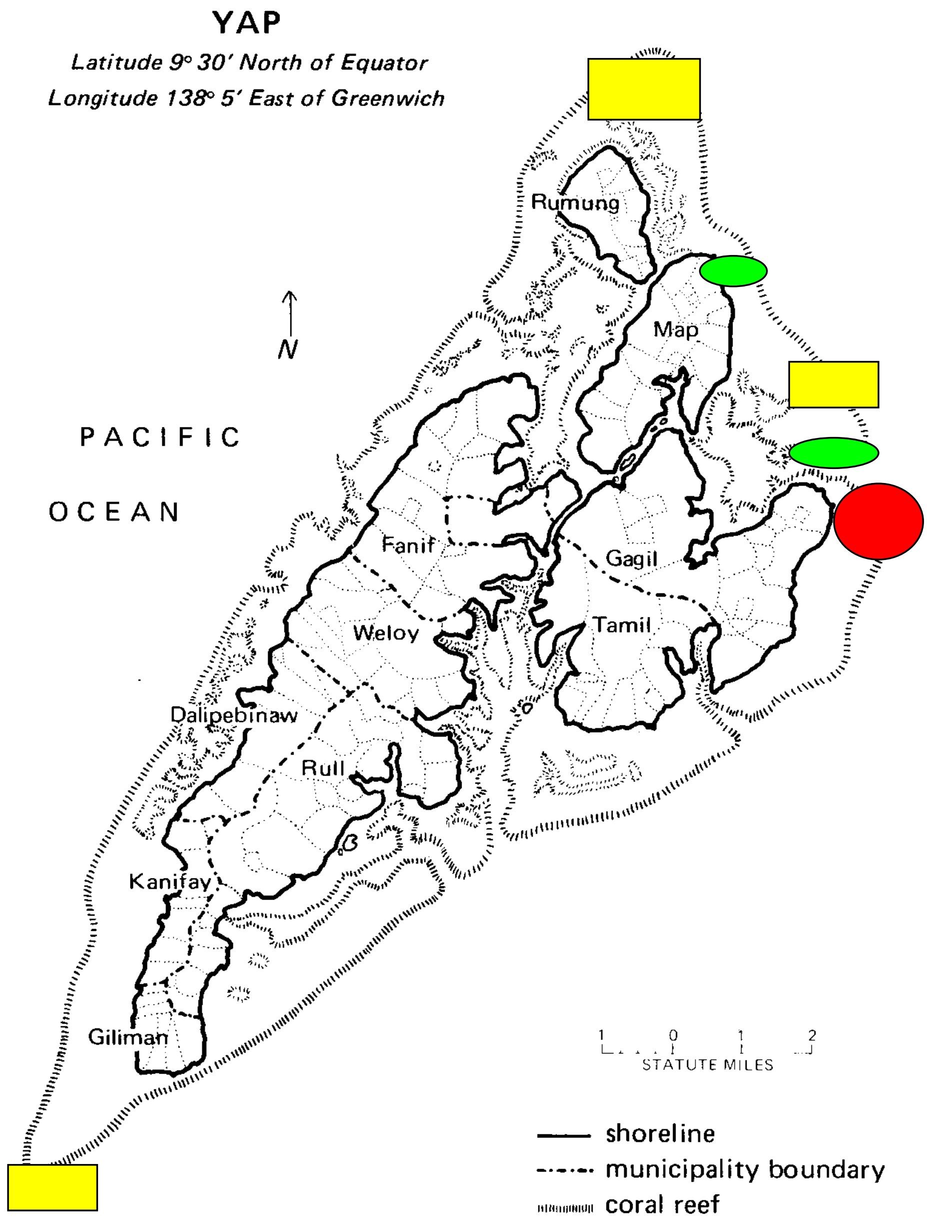
Ecological assessment

A. Habitat characterization of study sites

At each site, four 25 m transects were laid haphazardly following the depth contour. Once the transects were laid, an observer swam slowly over the transect and recorded the lifeforms that encountered under the tape. Corals and other benthic organisms were identified to the lowest taxonomic level possible. Benthic habitats were classified as carbonate or sand and rubble.

Gagil

Gagil had the highest coral cover of the sites surveyed, (Fig. 2) and was the most diverse in terms of coral species. It was the only site including a through-reef channel; the three other sites surveyed were only reef flat areas. In the channel, coral cover was 56%, sand and rubble was 34% and carbonate was 10% (Fig. 3). On the reef flat, coral also had the highest coverage at 41%, sand and rubble was second at 33%, carbonate was third at 25% and algae was under 1% (Fig. 4). Only 3 transects were laid at Gagil due to time constraints and heavy currents.



Map 1

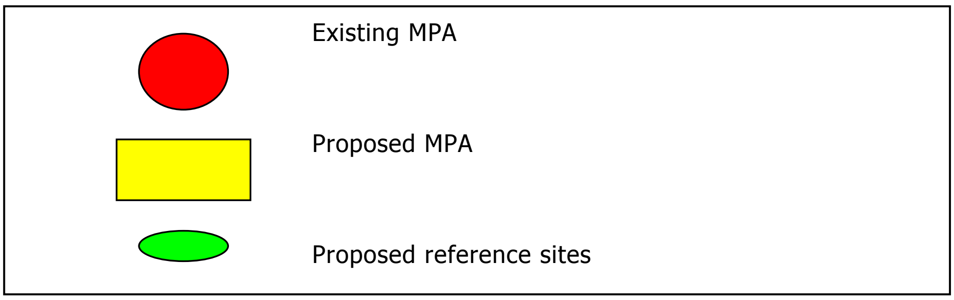


Figure 1. Map of Yap showing existing MPA site, proposed MPAs, and proposed reference sites for monitoring.

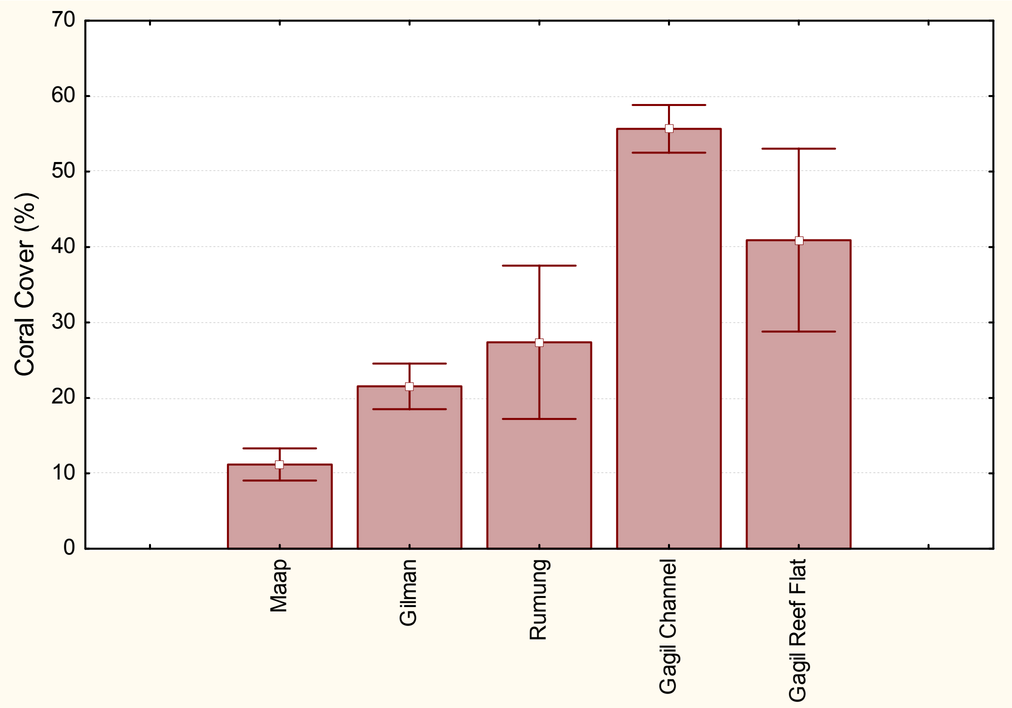


Figure 2. Percent coral cover at each of 4 proposed MPA locations in Yap, FSM.

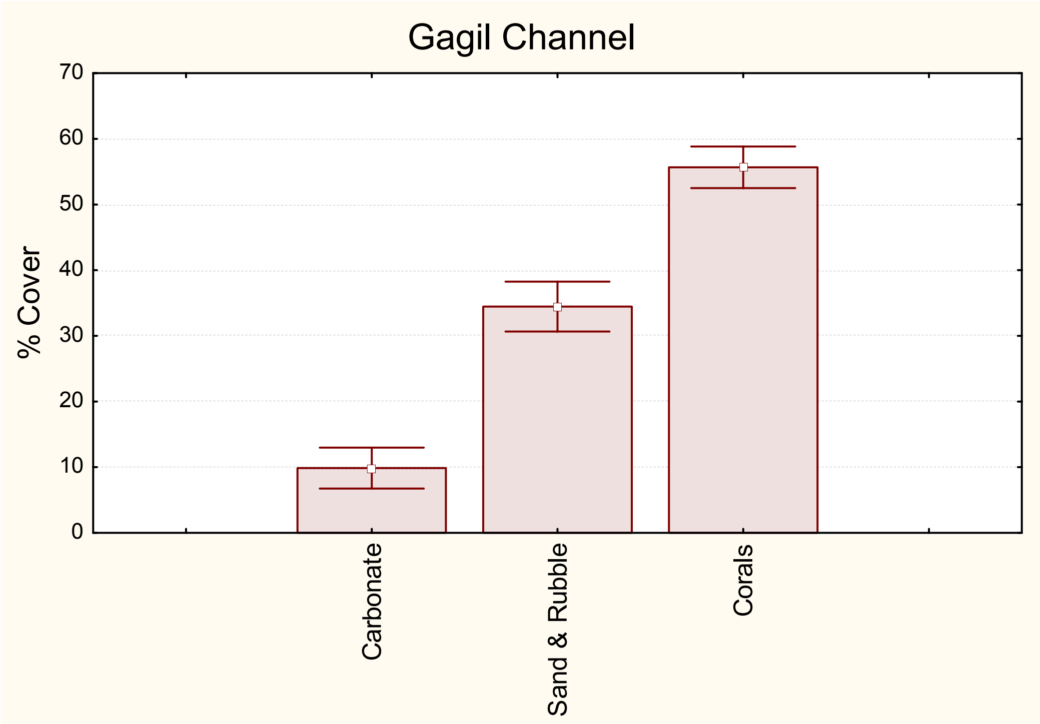


Figure 3. Percent benthic cover at the Gagil channel site.

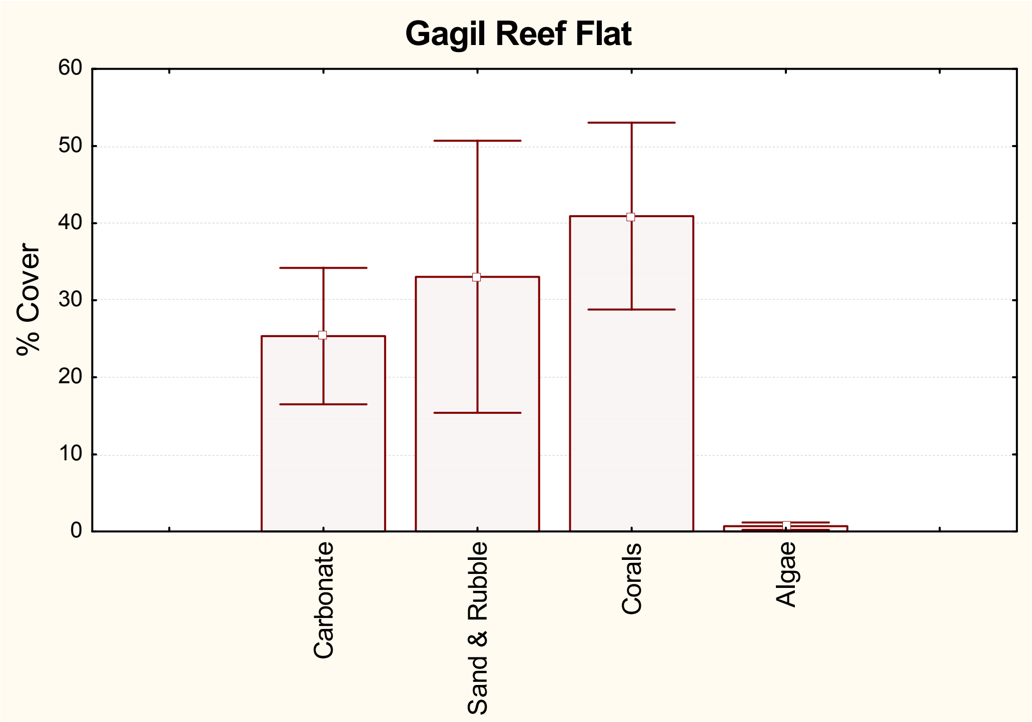


Figure 4. Percent benthic cover at the Gagil reef flat site.

Maap

Maap had coral cover of 11%, the lowest when compared with all the other sites surveyed (Fig. 1). The most dominant category at Maap was sand and rubble, which covered 72% of the area surveyed (Fig. 5).

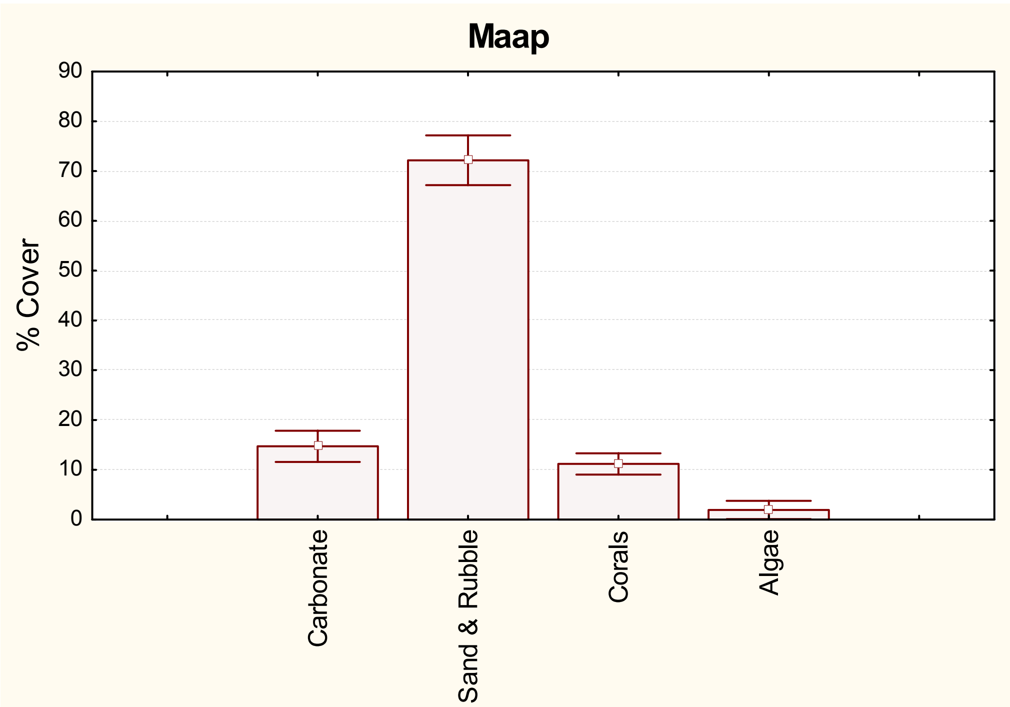


Figure 5. Percent benthic cover at the Maap site.

Rumung

This was the only site surveyed with significant seagrass areas, with 22% of the site being covered by seagrass (Fig. 6). Coral cover was at 27%, the second highest of all the areas surveyed (Fig. 2). Carbonate was the highest category found at Rumung as it covered 38% of the area surveyed (Fig. 6).

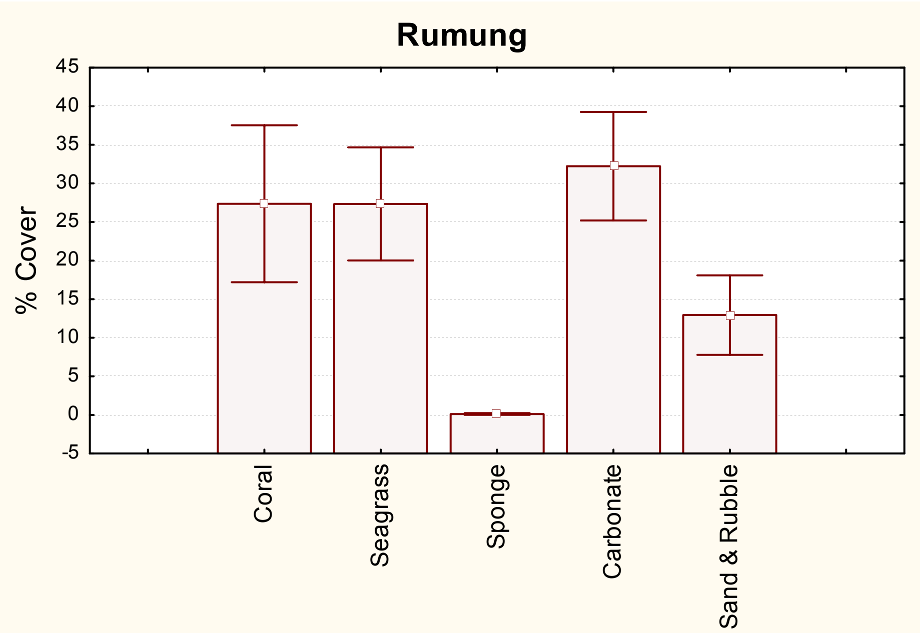


Figure 6. Percent benthic cover at the Rumung site.

Gilman

Coral covered 21% of the areas surveyed at Gilman (Figs. 2 and 7). Sand and rubble and carbonate structures dominated the area at 40% and 39% respectively (Fig. 7). Inside the lagoon, only the southern tip of Gilman supported extensive patch reefs.

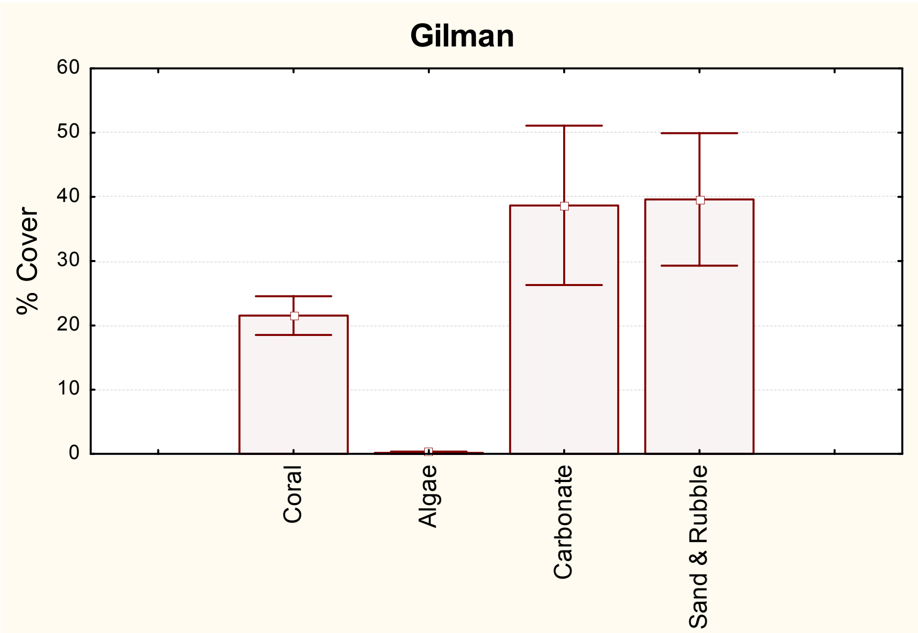


Figure 7. Percent benthic cover at the Gilman site.

The majority of the Gilman lagoon was sandy, and several fishers and dive operators told us that "nobody fished down there". Thus, it might be simpler to include only the southern and southwestern areas of Gilman in an MPA, as declaring a no-take zone over sandy bottom in an unfished area seems

B. Fish surveys

Methods

In addition to the 11 species selected for the community monitoring plan (see Section 3 below), we added three of the most common edible reef fishes in Yap. These were the convict tang (*Acanthurus triostegus*), the lined bristletooth (*Ctaenochaetus striatus*), and the bullethead parrotfish (*Chlorurus sordidus*). These 3 species are commonly caught by artisanal fishers throughout Micronesia. One species of the 11 on the community monitoring list, the lined sweetlips (*Plectorhinchus lineatus*), was not observed during any of our surveys.

Two methods were used to survey reef fishes at the Yap MPA sites. Small and sedentary species were surveyed using 25 × 4 m belt transects. Four replicate transects were laid in representative habitats at each site. In order to minimize the effects of deploying transects on fish activity, the observer waited a period of 20 seconds before starting the counts. The observer swam slowly along transects, counting all target species within 2 m on either side of the transect tape. Larger and more mobile species were counted using 10 min timed swims. The observer counted all target species within a 5 m radius. Speed of the timed swim was regulated to the extent possible by swimming at a rate of 1 fin kick per second. By taking GPS readings at the start/stop points of each swim, we calculated that the average timed swim covered approximately 400 m^2.

For both methods, total length of all target fishes was estimated to the nearest cm. Length estimates for each species were entered into length-weight regressions. Regressions were obtained primarily from FishBase (www.fishbase.org). A number of datasets were available from samples taken at Woleai Atoll in Yap State; these were used whenever possible. If length-weight regressions were not available for Yap, we used datasets either from the nearest geographic area or with the largest sample size. Once weight estimates were obtained for all fish counted, weights were added to compute biomass for each species on each transect/timed swim.

Results

Transect surveys

Belt transect surveys have the advantage of yielding quantitative estimates of density or biomass per unit area. Our transects covered an area of 100 m^2, which is a convenient size for counting small and sedentary reef fishes, but too small to obtain accurate counts of larger, more mobile species. Mean density of target species (i.e. the average of the 4 transects per location) on transects varied from about 7 fish per 100 m^2 at Maap and Rumung to 18 fish per 100 m^2 at Gilman and 24 fishes per 100 m^2 at Gagil. (Fig. 8a). Mean biomass ranged from 1100 g wet weight per 100 m^2 at Maap and Rumung to 6100 g wet weight per 100 m^2 at Gagil (Fig. 8b). This figure is obviously an underestimate, caused by the disturbance of divers which resulted in all the larger fish moving to a distance greater than 2 m from the transect line.

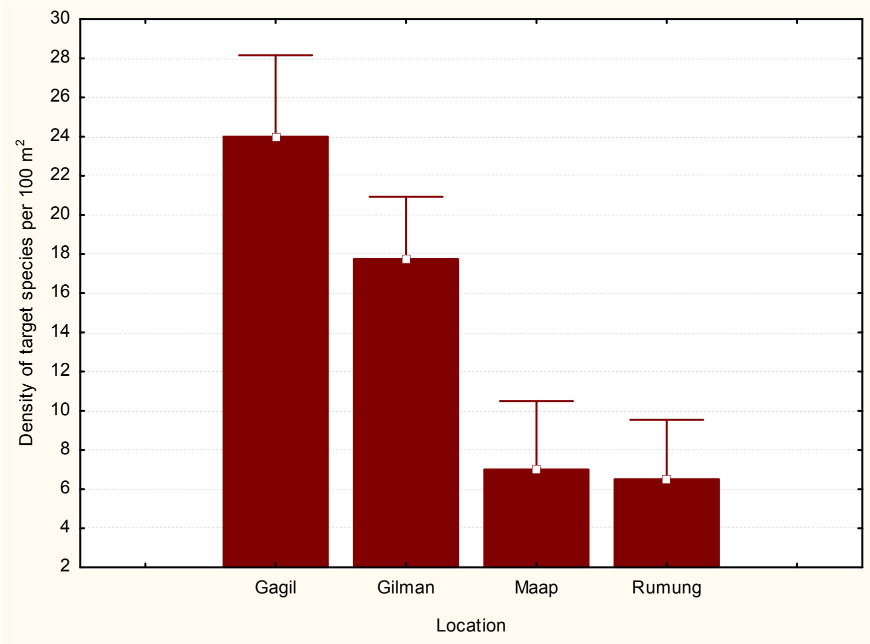


Figure 8a. Total density of commercial reef fishes at 4 proposed MPA sites in Yap, FSM.

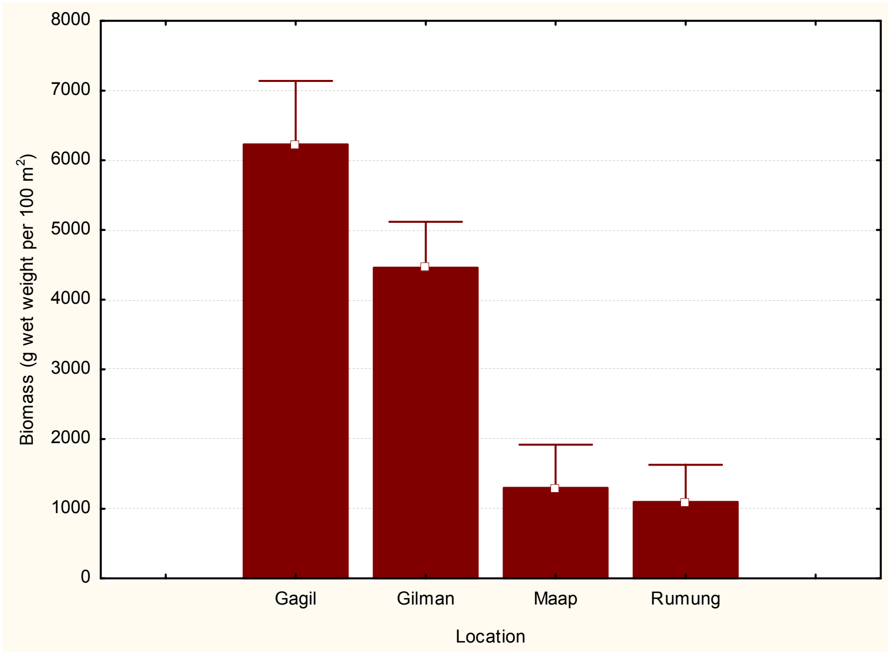


Figure 8b. Total biomass of commercial reef fishes at 4 proposed MPA sites in Yap, FSM.

Looking at species separately, the most common species in terms of both density (Fig. 9) and abundance (Fig. 10) were bullethead parrotfish, lined bristletooth, convict tang, and filament-finned parrotfish. In Gagil, the abundance of shallow live coral and rubble habitats, particularly on the shallow reef flat (Figure 4), afforded excellent juvenile habitat for several commercial species, most notably the lined bristletooth and bullethead parrotfish. Very few fish were counted on the transects in Maap and Rumung. In the case of Maap, this may be due to a lack of complex bottom structures to provide shelter for fish (Figure 5). It is evident from our results that using multiple 25 m transects (such as used in the Reef Check method) may yield useful information on juvenile abundance and recruitment patterns, but transects to count larger fishes should be increased in size to 50 × 5 m.

Figure 9: Population density of commercial reef fishes from transects at 4 proposed MPA sites in Yap, FSM.

Figure 10: Population biomass of commercial reef fishes from transects at 4 proposed MPA sites in Yap, FSM.

Timed swim surveys

Abundance and biomass of reef fishes from timed swim surveys showed a very different (almost opposite) pattern to that of transects. The abundance and biomass of all target fishes was much lower at Gagil than at the other three sites (Fig. 11a,b). Data from the timed swims also indicated that lined bristletooth, convict tang, and bullethead parrotfish accounted for most of the fish abundance (Figure 12) and biomass (Figure 13) at all sites. However, timed swims also indicated that several other, larger species, including the epaulette surgeonfish (*Acanthurus nigricauda*), the blacktail snapper (*Lutjanus fulvus*), and the filament-finned parrotfish (*Scarus altipinnis*), were found at all sites except Gagil.

These data demonstrate the extreme differences in results possible when different fish census methods are used. The transect data indicated that the Gagil site supported the highest density and biomass, but the timed swim data indicate the opposite. This is simply because Gagil contained primarily rubble habitats more suitable for small juvenile fishes. These fish typically take cover in the reef and remain motionless when approached by an observer, whereas, older and larger fish tend to swim more than 2 m away from the transect and are thus not counted. Consequently, the transect data at Gagil indicated high abundance of small fishes, while the timed swims indicated that Gagil supported low abundance and biomass of larger, more mobile fishes.

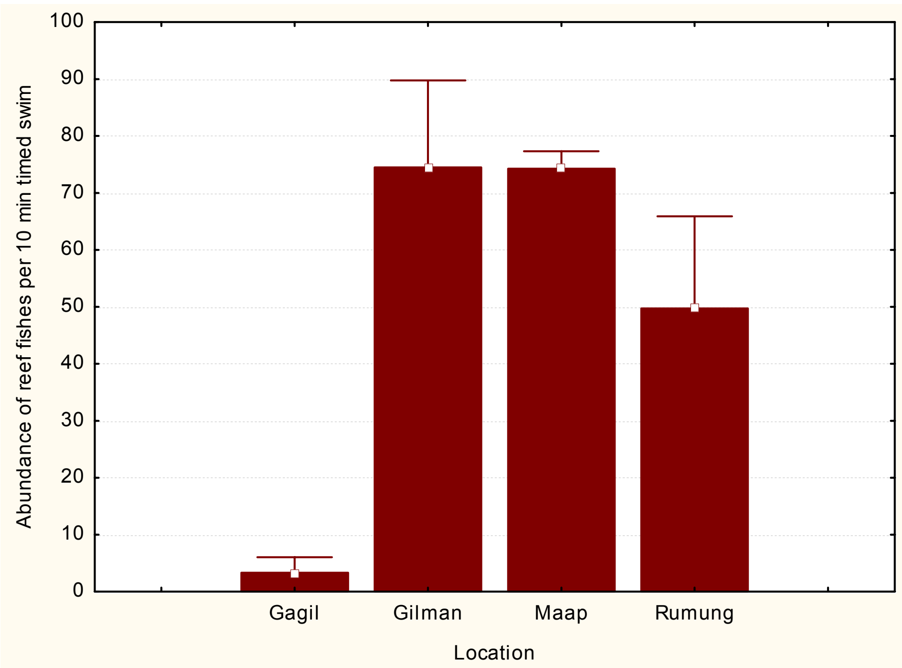


Figure 11a: Total abundance of commercial reef fishes from timed swim surveys of 4 proposed MPA sites in Yap, FSM.

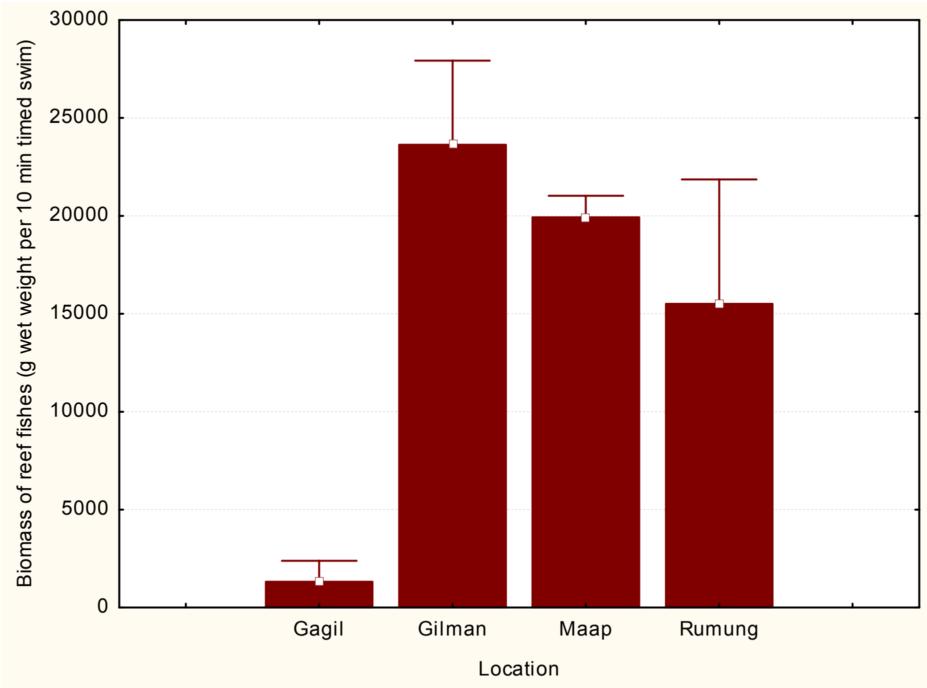


Figure 11b. Total biomass of commercial reef fishes from timed swim surveys of 4 proposed MPA sites in Yap, FSM.

Figure 12: Population abundance of commercial reef fishes from timed swims at 4 proposed MPA sites in Yap, FSM.

Figure 13: Population biomass of commercial reef fishes from timed swims at 4 proposed MPA sites in Yap, FSM.

Community reef fish monitoring plan

Why monitor the MPAs?

The effectiveness of the planned MPAs best be determined through a comprehensive program that monitors species abundance and diversity in the protected areas. The MPAs also offer an opportunity to examine human impacts on coral reef ecosystem.

Because of lack of capacity in Yap to monitor both fish and benthic communities, this monitoring plan is tailored for monitoring of fish in the MPAs. If the capacity to conduct benthic community surveys is developed in the future, however, then it is strongly recommended that this component be included in the monitoring program.

Results of the monitoring program can be used by marine resources managers to evaluate the effectiveness of the MPA(s) in protecting marine biodiversity, and can inform preparation of a management plan that regulates resource use at sustainable levels.

Monitoring goals

The three major goals of the monitoring program are to: 1) evaluate the effectiveness of protected areas for protecting and understanding fish abundance and diversity, enhancing non-consumptive activities, promoting conservation, and increasing fisheries knowledge; 2) monitor trends in the condition and use of Yap's coral reef associated fishery resources; and 3) measure biological changes inside and outside the MPA(s). Goal three may not be accomplished unless there is a capacity for monitoring benthic life-forms.

The primary purpose of the monitoring in the first five years will be to test the following hypothesis: The abundance of most exploited fish species will change significantly as a result of the protected areas.

How will the MPA be monitored?

The monitoring will begin in 2005 and continue through 2010. The purpose of the first year of monitoring will be to establish baseline and reference conditions inside and outside the protected areas. Because of lack of capacity for benthic monitoring the following monitoring approach will be used to maximize the available capacity. The approach consists of the following two levels:

Level 1

MPA sites have been pre-selected but no reference (control) sites have yet been selected. The monitoring program proposes reference sites in the reef areas shown in Fig. 1.

Objectives

To determine the effect of the MPAs on the abundance of fish.

Implementation

Fish monitoring will be conducted by selected members of communities to which the MPAs belong. The following 11 species of fish were chosen in consultation with fishermen (Table 1 and

Figure 14). Because the community members who will be tasked with monitoring have no experience in fish monitoring, it was decided that they begin the monitoring with as few fish as possible, until such time that they are comfortable with this method to be able to collect accurate data.

Table 1: List of fish species to be monitored inside and outside of MPA.

Yapese name	English name	Scientific name
Ngol	Bluefin trevalley	*Carnax melampygus*
Gadgad	Yellow stripe emperor	*Lethrinus obsoletus*
Blaw	Epaulette surgeonfish	*Acanthurus nigricauda*
Sabakuw	Honeycomb grouper	*Epinephelus merra*
Gadaw	Yellow goatfish	*Parupeneus cyclostomus*
Numen	Humphead wrasse	*Cheilinus undulatus*
Glanglung	Bluechin parrotfish	*Scarus atropectoralis*
Nguywee	Yellowtail parrotfish	*Hipposcarus longiceps*
Buywood	Forktail rabbitfish	*Siganus argenteus*
Gumiy	Highfin rudderfish	*Kyphosus cinarescens*
Laf	Lined sweetlips	*Plectorhinchus lineatus*

Monitoring method

Fish monitoring will be conducted both inside the MPA and in a reference site on a 25 m × 4 m belt transect. The transects will be laid randomly in each area and then the observer will swim along the transect and record on the datasheet (Fig.15) the number of fish species within the prescribed area. The observer will only count those fish that are within 2 m to each side (left and right) of the transect (Fig. 16). Four replicate transect will be laid in each area. Because the selected MPAs are on a reef flat, it is not necessary to replicate the depths for this monitoring.

It is recommended at this stage that monitoring be conducted at least twice a year, one during the wet season and one during the dry season. All sites have to be monitored during the same period.

Level 2

IWP should seek additional training for the community representatives to be trained in appropriate benthic monitoring protocols. If and when this happens then it is recommended that benthic monitoring be implemented to enhance the information available for effective management of the protected areas.

Objective

To determine if the MPAs have an effect on the abundance and diversity of benthic organisms and fish.

Implementation

Interagency teams, composed of appropriate state agencies and community representatives, are to conduct this level of monitoring. Level 1 monitoring activities should continue with addition of a few more fish species. Fish species should be added to the list in consultation with fishermen to determine the most frequently targeted species among those not already on the list. Size estimation is also recommended for this level of monitoring.

Monitoring should also be expanded to include the following benthic categories: corals, coral recruits, sponges, algae, and invertebrates.

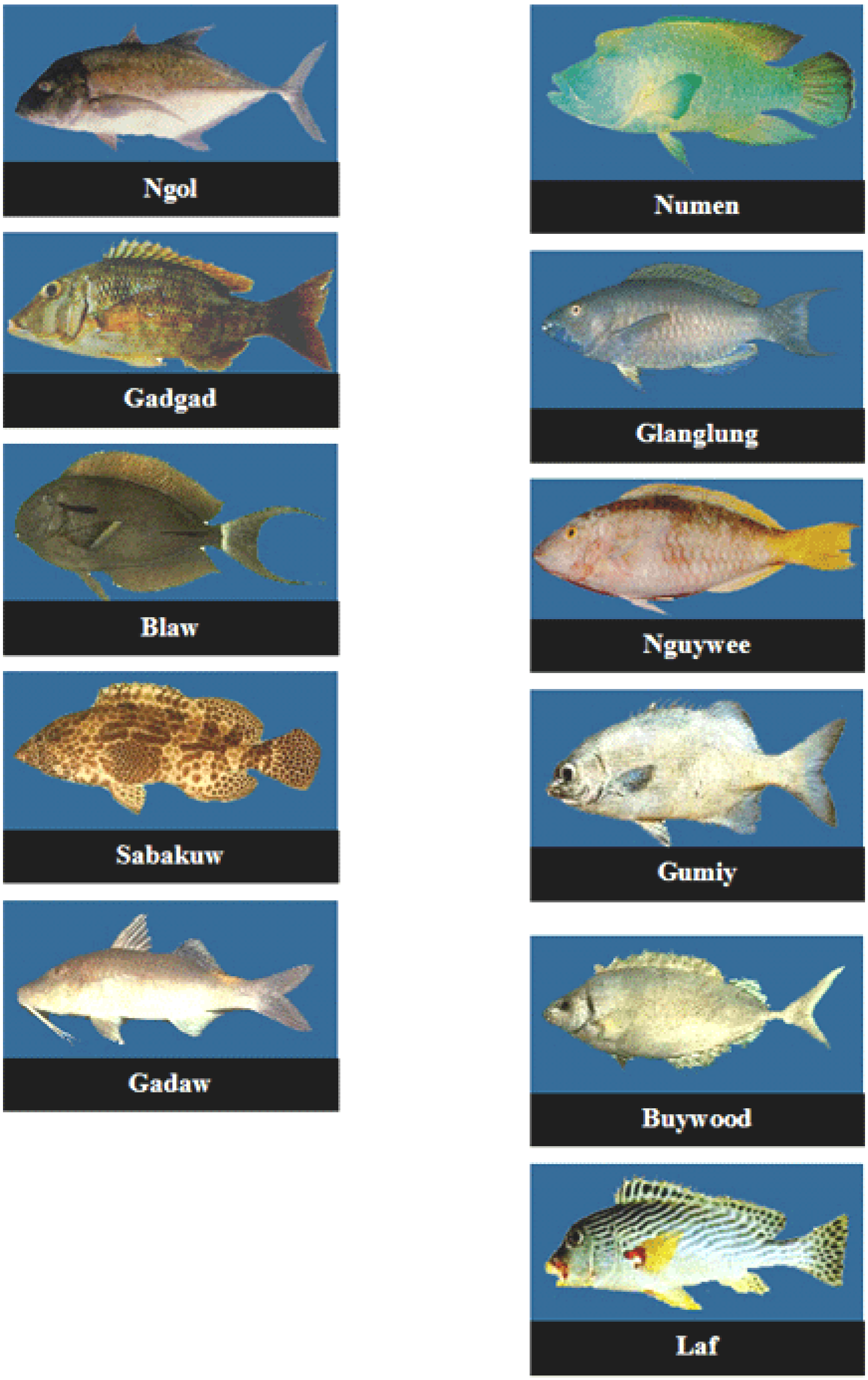


Figure 14: Fish to be monitored in- and outside of MPAs.

Yap MPA Fish Monitoring Sheet		
Site Name:		Date/Time:
GPS: Lat Long		
Name of observer:		
Transect Number:		
Weather: __Rainy __Cloudy __Sunny		
Sea state: ___Calm ___Moderate ___Rough		
Moon phase:		
Tide:		

Yapese	Common names	Observed Number
Ngol	Bluefin trevally	
Gadgad	Yellowstripe emperor	
Blaw	Epaulette surgeonfish	
Sabakuw	Honeycomb grouper	
Gadaw	Yellow goatfish	
Numen	Humphead wrasse	
Scaridae	**Parrotfishes**	
Ganglung	Bluechin parrotfish	
Nguywee	Yellowtail parrotfish	
Buywod	Forktail rabbitfish	
Gumiy	Highfin rudderfish	
Laf	Lined sweetlips	
Comments:		

Figure 15: MPA Fish Monitoring Sheet

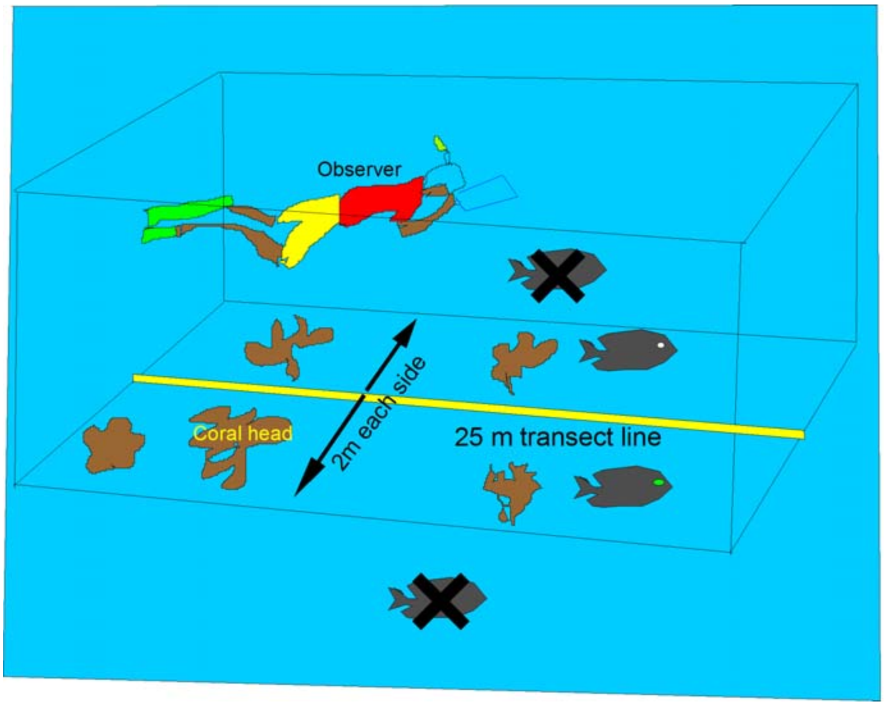


Figure 16. Schematic diagram showing layout of transect and fish observer.

Monitoring methods

The method that will be chosen for Level 2 monitoring will depend on available capacity and equipment. Possible methods include the Line Intercept Transect (LIT) and Reef Check methods.

Recommended method

Four person team with the following equipment: dive gear, transect tapes (5), underwater paper, underwater video camera with housing, underwater digital camera with housing, VCR, and TV.

If there is enough capacity and equipment, it is recommended that 50 m × 5 m belt transects be used for benthic and fish monitoring. Five replicate transects are recommended for each site. The method employed will require at least four divers (or snorkelers in the case of shallow areas). One person should swim along a straight line and count the fish in a pre-selected size range. It is important that the fish observer count only those fish present in a 50 m × 5 m belt transect; the length of the transect by a second person, who swims behind the first one (at a sufficient distance so as not to disturb the fish), and lays a 50 m x 5 m belt transect. The second person signals the fish observer to stop when the 50 m transect has been laid. The fish observer then begins counting fish in a second transect. This process is repeated until five transects have been completed. A third person swims behind the second one with an underwater video camera, and video tapes the transect from 70 cm above the transect line. It should take about five minutes to complete video taping of one transect. It is important to keep the distance from the reef constant throughout the videotaping. The fourth person swims behind the video person and counts coral recruits (<5cm in size) in a 10 m × 5 m transect. The fourth surveyor counts recruits in only the first three of the five transects. The method requires coordination between the four participants and should be practiced prior to beginning the actual transects.

After the field surveys, the video will should be projected and the benthic category be counted at 5 randomly picked points on the screen. At the beginning of each transect, it is run for every seven seconds and then stopped. Whatever falls behind each randomly selected point will be recorded. This will be repeated every seven seconds, throughout the whole length of the transect. At the end of each transect 40 video frames with 5 points in each frame should have been recorded to yield a total of 200 points of data for each transect. This method requires practice in order to accurately identify what is being projected on the TV.

Yap Reef Check Training

Community awareness and participation in the designation of marine protected areas is important to the successful management of these areas. One of the objectives of the trip was to provide an opportunity for Reef Check training to members of the community. This would provide simple techniques which they could use to monitor their own marine protected areas.

A two-day Reef Check training workshop was held in Colonia. Six people participated in the training, consisting of a classroom session in which methods were taught and target species identified, and a field session in which participants had the opportunity to apply what was learned. Because most of the participants were not SCUBA certified, surveys were conducted at only 3 m depth. After completion of the training, each participant was presented a certificate of achievement from Reef Check.

Reef Check Methodology

Reef Check teams collect four types of data:

1. A description of each reef site based on over 30 measures of environmental conditions and ratings of human impacts;
2. A measure of the percentage of the seabed covered by different substrate types, including live and dead coral, along four 20 m sections of a 100 m shallow reef transect;
3. Invertebrate counts over four, 20 m x 5 m areas along the transect; and
4. Fish counts, up to 5 m above the same areas.

Monitoring of the indicators is made along two depth contours. Manta tows are also recommended as a site selection technique in areas with sufficiently clear water. Indicator lists come from a standardized Reef Check index for Indo-Pacific species.

The goal is to survey two depth contours, 3 m and 10 m below chart datum (lowest low tide). However, on many reefs, the highest coral cover will not be found at these exact depths. Therefore, choose the depth contour with the highest coral cover within the following ranges: Shallow (2 - 6 m depth) and Midreef (>6 - 12 m depth). Note that particularly for the shallow transect, the tide should be taken into account (2 – 6 m below lowest low tide). Along each depth contour, four 20 m long segments are surveyed to make up one transect. The segments should follow the designated depth contour one after the other, however, segment start and end points MUST be separated by a minimum of a 5 m gap. The distance between the start of the first segment and end of the last segment will be 20 + 5 + 20 + 5 + 20 + 5 + 20 = 95 m. The 5 m gaps are necessary to ensure independence between samples, which is important for statistical analyses. We recommend use of a single 100 m or two 50 m fiberglass measuring tapes available from hardware and survey equipment supply stores. The depth contours were chosen for practical reasons of time and safety. Reefs in many areas are not suitable for a survey at both depths. In this case, just survey one depth contour. At some reefs, it may be necessary to deploy the transects perpendicular to the reef edge or crest, i.e. following spurs or ridges. In such areas, teams may prefer to survey individual 20 m transect segments located within the specified depth contours. A strictly random design is not practical and wastes resources. Since fiberglass tapes can break, it may be useful to have a second tape available as a back up.

Source: Reef Check manual

Conclusions and Recommendations

A number of important issues for the management of Yap's reef fisheries arose from this investigation.

1. No scientific evidence currently exists to support or refute claims that Yap's reefs are overfished, and that size and abundance of reef fish is declining. It is vital that Yap MRD develop a strong fisheries–dependent monitoring program, probably based mainly on creel survey CPUE data. It might be possible to bring staff from Guam DAWR to train MRD staff in creel survey techniques, and to help establish a survey program in Yap. It is beyond the scope of this rapid assessment to obtain CPUE data. Yap requires good estimates of CPUE that will be useful for management purposes, but these simply cannot be generated from a few days of fishing. To document declines in fish stocks with any level of confidence requires intensive effort, several times per year (e.g. on a seasonal basis) for several years.
2. Further baseline assessment is needed to obtain density and biomass estimates for reference sites, an important part of this exercise that we unfortunately could not finish due to time constraints. There may be a chance for PICRC researchers to complete these surveys in spring of 2005, as we will be in Yap conducting surveys for juvenile groupers and humphead wrasse.
3. We recommend the use of the Reef Check protocol for communities to monitor their own MPAs. The method is relatively simple, standardized, and is widely used. The trainees that attended our workshop were able to understand and apply this protocol quickly, and they need little other than transect tapes and slates to conduct their monitoring program. Staff from MRD could also participate in the Reef Check monitoring, but their assistance would not be required.
4. The MPA boundaries at Gilman should be adjusted to include only the southern and southwestern portions of the lagoon, where extensive coral growth occurs. It serves no purpose to close and patrol a large sandy area where fishing does not occur.
5. GIS-based maps of benthic habitat should be obtained from the US National Ocean Service as they become available. Both PICRC and the University of Guam are licensed to obtain and use these map products, so analysis of these maps with respect to nearshore fisheries could be conducted by the PICRC team in the future.

References

Alcala, A.C. and Russ, G.R. 1990. A direct test of the effects of protective marine management on abundance and yield of tropical marine resources. Journal du Conseil Permanent International pour L'exploration de la Mer 46: 40-47.

Bennett, B.A. and Attwood, C.G. 1991. Evidence for recovery of a surf-zone fish assemblage following the establishment of a marine reserve on the south coast of South Africa. Marine Ecology Progress Series 75: 173-181.

Bolden, S.K. 2000. Long-distance movement of a Nassau grouper (*Epinephelus striatus*) to a spawning aggregation in the central Bahamas. Fisheries Bulletin 98: 642-645.

Bohnsack, J.A. 1993. Marine reserves: they enhance fisheries, reduce conflicts, and protect resources. Oceanus 36: 63-71.

Bryant, H.E., Dewey, M.R., Funicelli, N.A., Ludwig, G.M., Meineke, D.A. and Mengel, J. 1989. Movement of five selected species of fish in Everglades National Park [abstract]. Bulletin of Marine Science 44: 515.

Burke, N. 1995. Nocturnal foraging habits of French and bluestriped grunts, *Haemulon flavolineatum* and *H. sciurus*, at Tobacco Caye, Belize. Environmental Biology of Fishes 42: 365-374.

Buxton, C.D. and Allen, J.L. 1989. Mark and recapture studies of two reef sparids in Tsitsikamma Coastal National Park. Koedoe 32: 39-45.

Chapman, M. R. and Kramer, D.L. 1999 Gradients in coral reef fish density and size across the Barbados Marine Reserve boundary: effects of reserve protection and habitat characteristics. Marine Ecology Progress Series 181: 81-96.

Chapman, M. R. and Kramer, D.L. 2000. Movements of fishes within and among fringing coral reefs in Barbados. Environmental Biology of Fishes 57: 11-24.

DeMartini, E.E. 1993. Modeling the potential of fishery reserves for managing Pacific coral reef fishes. Fishery Bulletin 91: 414-427.

Foale, S. 2007. Social and economic context of marine resource depletion in Gagil and Maap, Yap State, FSM. IWP-Pacific Technical Report no. 41. Apia, Samoa: Secretariat of the Pacific Regional Environment Pprogramme.

Helfman, G.S. 1993. Fish behaviour by day, night, and twilight. In: The Behaviour of Teleost Fishes, 2nd ed., ed. T.J. Pitcher, pp. 479-512. London: Chapman and Hall.

Hobson, E.S. 1973. Diel feeding migrations in tropical reef fishes. Helgoland Wiss Meeresunter 24: 671-680.

Johnson, D.R., Funacelli, N.A. and Bohnsack, J.A. 1999. Effectiveness of an existing estuarine no-take fish sanctuary within the Kennedy Space Center, Florida. North American Journal of Fisheries Management 19: 436-453.

Kramer, D.L. and Chapman, M.R. 1999. Implications of fish home range size and relocation for marine reserve function. Environmental Biology of Fishes 55: 65-79.

McClanahan, T.R. and Kaunda-Arara, B. 1996. Fishery recovery in a coral-reef marine park and its effect on the adjacent fishery. Conservation Biology 10: 1187-1189.

McClanahan, T.R. and Mangi, S. 2000. Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery. Ecological Applications 10: 1792-1805.

Meyer, C.G., Holland, K.N. Wetherbee, B.M. and Lowe, C.G. 2000. Movement patterns, habitat utilization, home range size and site fidelity of whitesaddle goatfish, *Parupeneus porphyreus*, in a marine reserve. Environmental Biology of Fishes 59: 235-242.

Murray, S.N., Ambrose, R.F., Bohnsack, J.A., Botsford, L.W., Carr, M.H., Davis, G.E., Dayton, P.K., Gotshall, D., Gunderson, D.R., Hixon, M.A., Lubchenco, J., Mangel, M., MacCall, A., McArdle, D.A., Ogden, J.C., Roughgarden, J., Starr, R.M., Tegner, M.J. and Yoklavich, M.M. 1999. No-take reserve networks: sustaining fishery populations and marine ecosystems. *Fisheries* 24(11): 11-25.

Ostrom, E. 1990. Governing the Commons: The Evolution of Collective Action. Cambridge University Press. 280 pp.

Polunin, N.V.C. and Roberts, C.M. 1993. Greater biomass and value of target coral-reef fishes in two small Caribbean marine reserves. Marine Ecology Progress Series 100: 167-176.

Roberts, C.M., Bohnsack, J.A., Gell, F., Hawkins, J.P. and Goodridge, R. 2001. Effects of marine reserves on adjacent fisheries. Science 294: 1920-1923.

Roberts, C.R. and Polunin, N.V.C. 1993. Marine reserves: simple solutions to managing complex fisheries? Ambio 22: 363-368.

Rudd, M.A., Tupper, M.H., Folmer, H. and van Kooten, G.C. 2003. Policy analysis for tropical marine reserves: challenges and directions. Fish and Fisheries 3: 1-21.

Russ, G.R. and Alcala, A.C. 1996. Do marine reserves export adult fish biomass? Evidence from Apo Island, central Philippines. Marine Ecology Progress Series 132: 1-9.

Shapiro, D.Y. 1987. Reproduction in groupers. In: Tropical Snappers and Groupers: Biology and Fisheries Management, eds. J.J. Polovina and S. Ralston, pp. 295-327. Boulder, Colorado: Westview Press.

Smith, A. 1990. Tradition and the development of the marine resources coastal management plan for Yap State, Federated States of Micronesia. Resource Management and Optimization 18(3-4): 155-165.

Smith, A. and Dalzell, P. 1993. Fisheries resources and management investigations in Woleai Atoll, Yap State, Federated States of Micronesia. Inshore Fisheries Research Project Technical Document 4. South Pacific Commission, Noumea, New Caledonia. 64 pp.

The Nature Conservancy. 2003. A blueprint for conserving the biodiversity of the Federated States of Micronesia. The Nature Conservancy Micronesia Program Office, Kolonia, Pohnpei, FSM. 102 pp.

Tupper, M. and Juanes, F. 1999. Effects of a marine reserve on recruitment of grunts (Pisces: Haemulidae) at Barbados, West Indies. Environmental Biology of Fishes 55: 53-63.

Tupper, M. and Rudd, M. 2002. Species-specific impacts of a small marine reserve on reef fish production and fishing productivity in the Turks & Caicos Islands. Environmental Conservation 29(4): 484-492.

Wantiez, L., Thoolot, P. and Kulbicki, M. 1997. Effects of marine reserves on coral reef fish communities from five islands in New Caledonia. Coral Reefs 16: 215-224.

Yap State Environmental Stewardship Consortium. 2004. Chothowliy yu Waab (Yap State biodiversity strategy and action plan). Colonia, Yap State, FSM, September 2004.

Appendix 1: Communities and sites involved in the Yap IWP Project

Site	Municipality	Location of proposed MPA	Approximate area of no take zone (ha)	Villages involved	Population (2000 census)
1	Gagil	Gofnuw channel reef and blue holes, high biodiversity, culturally important site	a. 52 b. 14 c. 43	Riken	34
				Wanyan	196
2	Rumung	Ma'aw MPA, pristine sand, coral and seagrass meadows, abundance of clams	142	Riy	23
				Gaanaun	26
3	Maap	Reef system off eastern Maap, pristine waters, coral, sand and sea grass meadows, possible spawning aggregation site	a.12 b. 148	Waned	72
				Bechiyal	26
				Toruw	36
				Wacholab	39
4	Gilman	Southern Yap Buguw MPA, linked communities from mangrove to seagrass meadows to coral, sand reef, reef slope and coral cave with nutrient rich waters and concentrations of fish, culturally important site	312	Anoth	40
				Towoway	19
All		All proposed areas are within high priority "Areas of Biological Significance (ABS) " designated in TNC workshops	723	10 villages in 4 Municipalities	511

(Source: Original Project Proposal).

Appendix 2: Benthic habitat surveys

Site		**Gagil Reef Flat**		
GPS Coordinates		**9⁰33.818N**	**138⁰12.109E**	
	Transect 1	**Transect 2**	**Transect 3**	**Mean**
A. palifera	5.76	32.92	10.96	16.55
Acropora	1.72	2	8.52	4.08
Algae	1.68	0	0.4	0.69
Carbonate	9.92	24.04	42.08	25.35
Favia	1.12	0	0	0.37
Favites	0	1.4	0.2	0.53
Goniastrea	0	2	0.2	0.73
Heliopora	0.92	6.44	11.44	6.27
Millepora	0	7	0.48	2.49
Montipora	1.24	1.48	0	0.91
Pavona	0	0	0.64	0.21
P. damicornis	0.4	1.48	0	0.63
P. meandrina	1.56	0	0	0.52
Pocillopora sp.	0.12	2.52	3.08	1.91
Porites	3.76	0	6.68	3.48
Sand & Rubble	70.2	13.6	15.32	33.04
Stylophora	1.6	5.12	0	2.24
Total	100	100	100	100

Site		**Gagil Channel**		
GPS Coordinates		**9⁰34.070N**	**138⁰12.124E**	
	Transect 1	**Transect 2**	**Transect 3**	**Mean**
Acropora	28	13.64	0.96	14.20
Carbonate	11.44	3.56	10.6	8.53
Favia	0	0.2	0	0.07
Faviidae	0	0	0.12	0.04
Favites	1.2	0	0	0.40
Goniastrea	0.2	0.4	0.88	0.49
Goniopora	0	9.2	0	3.07
Hydrophora	1.2	0	0	0.40
Lobophyllia	0	0.6	0	0.20
Millepora	0	13	0	4.33
Montipora	14.64	6.64	16.56	12.61
Oxypora	0	0	0.4	0.13
P. cylindrica	3	6.8	6.48	5.43
Pectinia	0	2.28	2.08	1.45
Platygyra	0	1	2.6	1.20
Porites	0.16	5.4	0.96	2.17
P. rus	0	0	24.96	8.32
Pachyseris	0	0	6.84	2.28
Sand & Rubble	39.56	37.28	26.56	34.47
Soft Coral	0.6	0	0	0.20
Total	100	100	100	100

Site		Maap			
GPS Coordinates		**9^{0}35.066N**	**138^{0}11.779E**		
	Transect 1	**Transect 2**	**Transect 3**	**Transect 4**	**Mean**
Acropora	9.84	9	1.08	3.12	5.76
Algae	0	0	7.76	0	1.94
Carbonate	15.6	21.12	16.32	5.44	14.62
Favites	0	0	0	0.12	0.03
Fungia	0	0.16	1.32	0.48	0.49
Goniastrea	0.28	0	0.8	0	0.27
Hydrophora	0	0	0	0.4	0.1
P. damicornis	0	0	0.52	0	0.13
Porites	0.6	6.2	0.84	0.16	1.95
Sand & Rubble	71.24	62.08	68.52	86.84	72.17
Seriatopora	0.4	1.08	0	0	0.37
Stylophora	2.04	0.36	2.84	3.44	2.17
Total	100	100	100	100	100

Site		Rumung			
GPS Coordinates		**9^{0}36.617N**	**138^{0}02.524E**		
	Transect 1	**Transect 2**	**Transect 3**	**Transect 4**	**Mean**
A. palifera	0	0	0.8	0.12	0.23
Acropora	27.44	4.68	2.28	0.68	8.77
Carbonate	37.36	24.12	17.68	50.64	32.45
Favites	0	0	0.6	0	0.15
Fungia	0	0	5.12	2.04	1.79
Millepora	0	0.28	0	0	0.07
Montipora	1.88	2.2	0.12	0	1.05
P. damicornis	0.48	0	0	0.72	0.3
Pavona	0	0	1.56	0.16	0.43
Porites	4.56	38.32	3.68	0	11.64
Psammocora	0	0	0	0.64	0.16
Sand & Rubble	5.64	16.32	27.52	3.8	13.32
Seagrass	22.16	6.28	39.92	39.48	26.96
Seriatopora	0	0	0.72	1.72	0.61
Soft Coral	0	7.8	0	0	1.95
Sponge	0.48	0	0	0	0.12
Total	100	100	100	100	100

Site		**Gilman**		
GPS Coordinates		**$9^0$26.116N**	**$138^0$02.524E**	
	Transect 1	**Transect 2**	**Transect 3**	**Mean**
A. palifera	11.24	6.72	1.84	6.60
Acropora sp.	2.08	2.4	3.44	2.64
Algae	0	0.56	0	0.19
Carbonate	32.16	63.44	19.2	38.27
Favites	0	0.56	1.56	0.71
Goniastrea	1.2	1.28	4.16	2.21
Leptrastrea	0.2	0	0	0.07
Millepora	1.36	0	0	0.45
P. cylindrica	0	0	3.44	1.15
P.damicornis	0.84	0	0	0.28
Pavona	0	0.52	1.48	0.67
Platygyra	0	0.16	0	0.05
Porites	7.2	2.2	6.68	5.36
Sand & Rubble	40.28	20.48	58.04	39.60
Seriatopora	1.96	0.8	0.16	0.97
Stylophora	1.48	0.88	0	0.79
Total	100	100	100	100

Appendix 3: Objectives and terms of reference

Objectives

The objectives of this project are to prepare and conduct an ecological baseline survey of the fisheries at the four IWP communities, prepare a monitoring plan and support the involvement of the community in baseline assessment and monitoring work.

Scope of work

Working in tandem with the National Coordinator Yap-IWP, staff from the lead agency in Yap (Division of Marine Resources), the PCU and Dr Simon Foale, socioeconomic consultant for Yap-IWP, the consultants are contracted to:

- assess the ecological status of fisheries at Rumung, Maap, Gagil and Gilmaan in Yap, FSM;
- assess and recommend areas, objectives and strategies for establishing one or more marine protected area within the authority of each community;
- design a Monitoring Plan for key indicator species and/or habitats at each of the four communities;
- produce a Marine Ecological Baseline Report that will include a Coastal Monitoring Program for each of the four communities. The Coastal Monitoring Program will be low cost and focused on community implementation with possible support from MRD.

Tasks to be performed

The consultants will:

- review relevant existing information on the status of the fisheries including vegetation and coastal resource maps;
- in consultation with the IWP National Coordinator, IWP/PCU and Dr Foale, plan for local stakeholder participation in the assessment of the fisheries (who, why, when, how stakeholders will be involved);
- brief and train local stakeholders, including staff of the Division of Marine Resources, as necessary to participate in the ecological assessment work;
- in consultation with the IWP National Coordinator, IWP/PCU and Dr Foale, coordinate ecological baseline assessment work;
- coordinate and undertake the interpretation of the assessment and the write up of results;
- in light of assessment, recommend areas, objectives and strategies for establishing one or more marine protected area within the authority of each community as appropriate;
- in consultation with the IWP National Coordinator, IWP/PCU and Dr Foale, design a Monitoring Plan for key indicator species and/or habitats at each of the four communities. The monitoring plan will focus on the coastal ecology with identification of key species, proportional coverage and indicator species/habitats that could serve as the basis for future monitoring. The monitoring plan will be low cost and focused on community implementation with possible support from MRD. It will include a plan for gradual phase out of any external support required to establish it;
- identify training needs for local stakeholders to undertake the monitoring work and provide training as necessary; and
- document work and findings in a Marine Ecological Baseline Report.

Reports required

The consultants are required to produce a Marine Ecological Baseline Report that clearly describes the activities undertaken and outcomes of the consultancy. The report will be written in plain English and be submitted in electronic format. It will at least include the following sections:

- review of current coastal ecological information for Yap;
- consultations conducted with government and community stakeholders
- description of ecological assessment methodologies and activities employed including citations for useful reference material;
- findings including:
  - ecological profile for the fisheries at the four communities;
  - any constraints or issues encountered;
  - any lessons learned for the IWP;
  - any other relevant recommendations
- description of current resource/habitat use considerations and issues (related as appropriate to the socioeconomic work undertaken by Dr Simon Foale);
- identification of appropriate indicator species and/or habitats for future monitoring; and
- community-based coastal monitoring program. (This may appear as an annex to the report if appropriate.)