

---

# Managing Fisheries for Biodiversity: Case Studies of Community Approaches to Fish Reserves among the Small Island States of the Pacific

Kenneth T. MacKay

Barton Lodge Consulting and Canada-South Pacific

Ocean Development Program, Field Program Coordinator, C-SPOD

South Pacific Forum Secretariat, Private Mailbag, Suva, Fiji

E-mail: [kennethm@forumsec.org.fj](mailto:kennethm@forumsec.org.fj) or [kmackay@islandnet.com](mailto:kmackay@islandnet.com)

 **GLOBAL ENVIRONMENT FACILITY**  
Biodiversity Planning Support Programme



## Table of Contents

Summary .....	5
Introduction .....	5
Biodiversity .....	6
Fishery Resource and Exploitation .....	8
Resource.....	8
Exploitation.....	9
Status of Fishery.....	10
Current Management .....	11
Case Study: The Establishment of Traditional Marine Protected Areas (Ra’ui) on Rarotonga, Cook Islands.....	13
Background.....	13
Physical environment.....	13
Legal and administrative.....	13
State of the marine resource .....	13
Management intervention.....	14
Description and process.....	14
Results .....	15
Target and non target species .....	15
Lessons learned.....	16
Modifications to system .....	17
New guidelines, policies and legislation.....	17
Case Study: Community Marine Protected Areas in Samoa.....	18
Background.....	18
Physical environment.....	18

Legal and administrative.....	18
State of the marine resource .....	19
Management intervention.....	20
Description and process.....	20
Results .....	21
Evaluating success .....	21
Target and non-target species .....	22
Lessons learned.....	23
Modification to system.....	24
New guidelines, policies and legislation.....	24
Case Study: The Uluikoro Marine Reserve and Conservation Area, Ono Island, Kadavu, Fiji.....	24
Background.....	24
Physical environment.....	24
Legal and administrative.....	25
State of the marine resource .....	25
Management intervention.....	26
Description and process.....	26
Results .....	28
Target species.....	28
Non-target species.....	28
Lessons learned.....	29
Modifications to system .....	30
New guidelines, policies and legislation.....	31
Discussion .....	31
Acknowledgements.....	32

References .....	33
Figures and Tables .....	37
Figure 1. Fishing Gear Owned by Households in Eastern Samoa.....	37
Figure 2. Location of Ra’ui on Rarotonga in 1998.....	37
Figure 3. Location of Ra’ui on Rarotonga in 2000.....	38
Figure 4. Map of Samoa.....	38
Figure 5. The community-based fisheries extension process in Samoan villages.....	39
Figure 6. Simplified example of a problem/solution tree as constructed by a village community. ....	40
Figure 7. Map of Ono, Kadavu and Viti Levu, Fiji .....	41
Table 1. Marine biodiversity of inshore areas in the Pacific Islands.....	42
Table 2. The fish composition of the small-scale inshore fishery in Samoa.....	43
Table 3. The invertebrate composition of the small-scale inshore fishery in Samoa. ....	44
Table 4. Change in numbers of selected invertebrates in the four ra’ui, Rarotonga, Cook Islands, after 22 months. ....	44
Table 5. Per cent of village undertakings various fisheries management measures in the Samoan Training and Extension Project. ....	45

## Summary

The small island states of the tropical Pacific Ocean have limited land area yet considerable ocean resources. The population relies on the inshore fisheries for food and income. This fishery is complex, multi-species, and multi-gear, pursued by large numbers of fishers. Data, relevant research and enforcement are severely limited. Anecdotal evidence suggests overfishing on a number of stocks and many of the most valuable and vulnerable species are already extinct.

Conventional fisheries management has not been effective. Elsewhere, ecosystem approaches involving closed areas such as fish reserves have assisted in sustaining fisheries and conserving biodiversity. In the Pacific this ecosystem approach has been combined with traditional systems. This paper describes the ra'ui system from Rarotonga, Cook Islands, a Marine Protected Area from Ono, Fiji and village reserves in Samoa.

The fish reserves have been effective in increasing biomass and biodiversity. Local communities have implemented them, decided the location, the rules and management. Traditional leaders have played critical roles, while NGOs and fisheries departments have facilitated. The reserves allow harvest flexibility to match socio-cultural concerns and are evolving from short-term food banks to longer term closed areas. The village reserves are small but the network of reserves is significant and increasing.

Compliance is high. Traditional sanctions appear to allow enforcement of compliance on community members but outside legitimisation is needed for compliance by outsiders. Village by-laws are used in Samoa, a simple legal instrument is being developed in Fiji while in the Cook Islands traditional respect is sufficient.

These cases are but a few of the systems in the Pacific that are combining traditional and scientific management. There is a need to continue to document and share these success stories.

## Introduction

There are twenty-one Pacific Island Countries (PICs) and territories in the tropical west and central Pacific Ocean. Fourteen of these are independent island states that are also classified as Small Island Developing States (SIDS). These countries vary from large high islands like Papua New Guinea (PNG) with a population of 4.2 million and considerable land area (462,000 km<sup>2</sup>) and resources, to isolated atolls like Tuvalu with 10,000 people on 26 km<sup>2</sup> of land less than 2 m above sea level.

All of the PICs rely heavily on their marine resources for food and income. The islands may be small, but the Exclusive Economic Zones (EEZs) are large. The total land area is only 550,000 km<sup>2</sup> compared to EEZs of 30.5 million km<sup>2</sup>. The tuna fishery in these EEZs is now the largest in the world carried out by over 1000 boats from 21 countries mainly distant water

fishing nations. This fishery captures over a million tons a year and is worth about \$70 million (US) to the PICs in license fees and direct value.

It is, however, the coastal marine resources and environments that are of utmost importance to the communities of the Pacific countries. Most of the islands have a barrier or fringing outer reef with an inner lagoon, often with seagrass beds and mangroves associated. It is primarily within this coral reef and lagoon environment that the inshore fishery is carried out.

The inshore fishery is often designated into three components.

- 1) Subsistence; the catch is for home consumption or given away to friends and relatives but not sold.
- 2) Artisanal; part of the catch is sold but some retained for home consumption.
- 3) Commercial; all of the catch is sold.

The annual inshore fishery production in the PICs is estimated at 108,000 tonnes, (Dalzell *et al.* 1996) with about 80 per cent of that accounted for by the subsistence fishery. Home fish consumption of marine products in the Pacific is among the highest in the world. Some of the small atoll nations consume up to 250 kg per head per annum (Wright 1993) while consumption in Fijian coastal villages was 32.5 to 41 kg per year (Rawlinson *et al.* 1994). In Samoa, the average annual consumption is estimated at 27 kg per capita and the artisanal fishery comprises about 34 percent of annual protein intake (Zann 1991).

## Biodiversity

The coral reef and lagoon habitats throughout the Pacific contain a large number of species of fish, invertebrates, and algae. A summary of the number of species of fish, corals, and algae is presented in Table 1. The number of species declines as one moves eastward from the Indo-west Pacific region (e.g. Indonesia and Philippines) the centre of origin for a large number of species (Meyers 1999). There are 3,700 inshore fish species known from the Indo-west Pacific, 1681 from Micronesia, about 1400 in Fiji, 900 in Samoa, and less than 500 in the Cook Islands. The pattern is similar for the invertebrates and algae, however, these groups have been much less studied than the fishes. Recent work on marine algae in Samoa has added 89 new records include some species new to science (Skelton *et al.* 2000). This stresses the need for biodiversity surveys of the lesser-known organisms particularly invertebrates and algae.

In the terrestrial environment of the Pacific Islands there are a large number of endemic species. In Samoa, 25 per cent of the land plants are endemic while 25 per cent of the 32 land birds are endemic (Annon. 2001). Similarly in Fiji, 44 per cent of the 59 species of native land birds are endemic (Watling ND). While in the Cook Islands, with a much smaller land area, there are fewer endemic species with 10 per cent of the land plants and four per cent of the ferns being endemic although a larger number of species are endemic to eastern Polynesia (Gerald McCormack, Cook Islands National Heritage Project, Rarotonga, personal

communications). There were only 12 native land birds, 6 are now extinct and half of the remaining are endemic to the Cook Islands, one is found only on Rarotonga.

In the coastal marine environment of the Pacific islands there are fewer endemic species than on land primarily because of the ability of larvae to drift for considerable distances. However, a recent study (Roberts *et al.* in press) shows that 10 per cent of coral reef fish species have very restricted habitat and 25 per cent have limited ranges. Thus, wide scale overfishing and habitat damage can cause species extinction.

In Micronesia, where the fishes have been the best studied, Myers (1999) considers 49 species or 3 per cent as true endemics. Fiji has only two endemic species of inshore fishes (Johnson Seeto, USP, Fiji, pers. comm.). The Cook Islands has a higher percentage of endemic (3%) but a number are deepwater fishes (Gerald McCormack, Cook Islands National Heritage Project, Rarotonga, pers. comm.). These include two species of angelfish known only from the coral reef drop off below 100m (Allen *et al.* 1998) although these may be found in other locations once the technology for exploring these habitats is improved. There are, however, groups of fish like the blennies (Blenniidae) and gobies (Gobiidae) which have been much less studied and there may be a number of endemic species in these groups yet to be discovered (J. Seeto pers. comm.).

Humans have had a large impact on the terrestrial biodiversity in the Pacific. For example, in Fiji a large number of plants and animals have been introduced. The introduction of mammalian predators such as cats, mongoose, and rats has contributed to the extinction of a number of native ground nesting birds while the introduction of livestock and deforestation has permanently change the habitat of many offshore islands.

In the marine environment there has not been the same dramatic changes. There has, however, been extinction in some countries or Islands of a number of high value and vulnerable species. These include the coconut crab (*Birgus latro*), giant clams (*Tridacna gigas* and *Hippopus hippopus*), *Trochus* (*Trochus niloticus*), green snail (*Turbo mamoratus*), the black-lipped pearl oyster (*Pinctata margaritifera*) and the gold-lip pearl oyster (*P. maxima*). In addition, a number of sea cucumber species used in the production of *bêche-de-mer* have been driven to commercial extinction due to overfishing (Wright and Hill 1993; Kelso 1996). The overfishing of these high value species is not a new phenomena as overfishing of *beche-de mer* occurred in the 1800's (Preston 1993).

There is also recent evidence that some of the large, slow-growing reef fishes such as the Humphead wrasse (*Cheilinus undulatus*) and the humphead parrotfish (*Bolbometopon muricatum*) are becoming locally extinct, even around isolated islands. This is likely due to their vulnerability to night spear fishermen (Myers 1999) and the live reef fish trade (Johannes *et al.* 1999). Marine turtles are considered endangered throughout the Pacific and are listed on the CITES appendix 1 list of endangered species.

Selective fishing of reef species may change the structure of the reef ecosystem and these changes may not be reversible (Jennings and Poulin 1996). However, the situation is probably more complex. As recent surveys on Fijian reefs experiencing different fishing pressures (Jennings and Poulin 1997) indicate, the biomass of piscivorous fish is significantly

different between sites and has been correlated to fishing pressure. There was, however, no correlation between biomass of piscivorous fish and biomass or diversity of their prey.

Similarly there is a considerable difference in fish biomass between fished and non-fished sites. A recent survey in Fiji showed tens times the numbers of fish in an isolated, seldom fished area compared to a fished and tourist area (Tuwai *et al.* 2000).

There is, however, clear evidence that severe fishing pressure combined with habitat destructive fishing methods (e.g. blast and cyanide fishing as occurs in South East Asia) has clear impacts on the diversity and structure of the reef ecosystem (Russ and Alcalá 1994).

## Fishery Resource and Exploitation

### Resource

A recent review of the coastal fisheries in the Pacific Islands (Dalzell *et al.* 1996) gives an excellent overview of the fishery. In general there are few reliable official statistics but there are a number of detailed studies based on household surveys and creel census (summarized in op cite) that yield considerable detail on the fishery and fishers.

The inshore fishery resource in the Pacific comprises a large number of species and families. There are 253 species representing fifteen families of fish in the catch in the Tigak Islands of northern PNG (Wright and Richards 1985); 396 species were taken by residents of Onotoa in Kiribati (in Wright 1993); 450 species are reported in the artisanal catch in Samoa (Zann 1991). In Fiji, routine surveys of the commercial markets have identified 93 species of fishes and Rawlinson *et al.* (1994) identified 99 species in the subsistence catch taken from fringing reefs. An example of the diversity of the catch is shown in Table 2 using data collected from 12 villages on the east coast of Upolu, Samoa during only one week by high school students and extension workers (Hosch 2000). Eight families of fishes accounted for 80 percent of the catch. There were however, at least 26 families of fishes and 9 families of invertebrates in the small-scale catch. A comparison with longer-term data taken from Apia and other fish markets shows considerable agreement (Table 2.).

Invertebrates are very important component in the catch in most countries. In American Samoa (summarized in Adams & Dalzell 1994) ten invertebrate species comprised 28 per cent of the landed weight while Hosch (2000) for Samoa shows nine species of invertebrates (Table 3) comprising 12-16 per cent of the catch. In Fiji 32 species of invertebrates, and three seaweed species are routinely found in the commercial markets with invertebrates comprising 72 per cent (by weight) (Rawlinson *et al.* 1994). The fresh water/estuarine clam, *Batissa violacea* make up two-thirds of the seafood in markets in the main island, Viti Levu. Of considerable interest is that there has been very little biological or management research directed to this fishery or other commonly consumed invertebrates.

Bellwood (1988) has suggested that an examination of families does not yield sufficient information for fisheries management but it is important to determine the tropic relationships. Russ (1991) has observed that many coral reef fisheries target fish lower on the food chain. In



the central Philippines, over 70 per cent of the catch is planktivorous fusiliers (Caesionidae) while in Palmerston Atoll in the Cook Islands, a targeted fishery, captures 15-20 tons of herbivorous parrotfish. Wright (1993) suggests that for the Tigak Islands of PNG there is close to an even split between the three major trophic groups: piscivores 30 per cent, omnivores 32 per cent, and herbivores 38 per cent. An analysis of the Samoan data in table 3 suggests that at least 50 per cent of the captured fish and invertebrates are herbivores, about 30 per cent are omnivores, and around 10 per cent are piscivorous.

In a number of countries there is a developing marine aquarium fishery which takes an additional number of reef species not normally taken by the food fishery. Fiji is currently exporting 100 fish species and 50 coral species (Esaroma Ledua, Forum Secretariat, Suva, Fiji, pers. comm.) while the Cook Island exports at least 37 fish species (Manarangi-Trott 2001).

## Exploitation

The inshore fishery in the Pacific is carried out by a large number of different types of gear and techniques. In general, simple inexpensive gears are used in the subsistence fishery. They include gleaning on the reef crest for shellfish and algae, hand-spears used both from canoes or free diving, simple traps or fences, and hand-lining and trolling from non-motorized canoes. When fish are captured for sale, more sophisticated techniques are used including, motorized canoes or other boats using longline, trolling, or gill nets; and air compressors (hooka) or scuba gear used to harvest commercially valuable species like sea cucumbers or giant clams.

In the Tigak Islands, PNG (Wright 1993) 20 per cent of the catch was taken by spears and 42 per cent by handlines. In Fiji (Rawlison *et al.* 1994) shows that handline fishing was more than twice as important as other methods such as push nets, spear fishing and collecting (gleaning). In the villages of eastern Samoa (Hosch 2000) shows that spears (underwater spears and throw spears) were the most common method (61 per cent) while line fishing (which included hand lines, trolling lines, fishing rods, and bottom lines) was next at 21 per cent. Net fishing, which included gill nets, seine nets and throw nets accounted for 12 per cent, while gleaning accounted for 6 per cent. Trap fishing which included fish fences, fish pots, and crab/lobster pots were identified but not used during the student survey. Figure 1 indicates the percentage of households owning different types of gear in Samoa.

The types of fish captured are clearly influenced by the type of fishing gear (Wright and Hall 1993). To further complicate any analysis of fishing effort, one fishing trip may use a number of fishing gears.

The subsistence fishery is carried out from every coastal village by many of the men, women, and children normally on a part time basis. The Fiji surveys (Rawlison *et al.* 1994) showed over 50 per cent of households reporting at least one member who went fishing, with Fijians much more active (87%) than Indo-Fijian (31 %) households. Of fishing households 68 per cent fished for subsistence, 31 per cent were artisanal, and less than 1 per cent were commercial.

There is often a gender difference in the harvesting. Men generally harvest the fish while women and children harvest the shellfish and seaweed. In Fiji, adult Fijian women were the dominant fishers while children under 16 undertook little fishing activity (op cite).

The fish are landed at the village and consumed by the fishing household, exchanged with family and clan members or other villagers, and surplus is transported to markets in more populated centres or processed (dried or smoked) for later transport to market. The commercial fishery normally will land fish at central ports or market centres.

Thus, it is clear that the inshore fishery is a complex multi-species, multi-gear fishery pursued by large numbers of coastal dwellers. The complex nature of the fishery makes it difficult to collect accurate data on the state of the fishery this is compounded by limited research on most of the species. Further, many countries have limited capacity to enforce the management measures that are in place.

## Status of Fishery

As has been indicated previously it is difficult to obtain accurate information on the state of the fisheries. There is evidence that a number of vulnerable and high value species particularly invertebrates, are now extinct or very rare in many locations (see section 2). In many places high yields appear to be sustainable. Dalzell *et al.* (1996) suggest that yields of reef fish of 5-20 t km<sup>2</sup> (reef area) per year are probably sustainable.

However, for the remainder of the fishery in the absence of hard evidence, it is necessary to examine perceptions of the coastal fishers. These studies suggest there is clear concern that the inshore resources are overfished.

The World Bank (1999) has recently carried out a study of coastal resources management in five pacific countries (Fiji, Palau, Samoa, Solomon Islands and Tonga). Respondents from 16 communities were asked to assess the changes in catch per unit effort over the past 10 years, 78 per cent indicated there had been a decline while only 10 per cent suggested there had been an increase. The reasons for the perceived declines were:

- Increased commercial fishing,
- destructive fishing,
- improvements in fishing technology (e.g. use of nets and night diving),
- cyclones,
- increased population,
- siltation,
- pollution, and

- coral and habitat destruction.

These conclusions are echoed by country reports presented at a Regional Marine Awareness Meeting (Tuquri and South 1997). At a similar marine awareness workshop on the Fijian Island of Kadavu (Annon. 1996) participants from the coastal communities stated:

- Loss of certain species has been observed.
- Fish are smaller.
- Commercialization (e.g. beche-de-mere) now very common.
- Loss of respect for traditional leadership and non-respect for taboo areas.

## Current Management

As indicated previously the coastal fishery in the Pacific islands is a very diverse mix of species taken by many gears and brought to shore at a multitude of landing points. The subsistence fishery is subject to very little formal regulation and where regulations are in place enforcement is very difficult.

Due to the absence of scientific data and the complexity of the fisheries, the single species management approach used in many temperate species are not appropriate. The management regulations, where they exist, tend to be passive, low-cost measures such as minimum size limits (Dalzell *et al.* 1996), total exclusions on endangered species, or bans on destructive fishing techniques such as blast and poison fishing. Other measures tend to be mesh size limits on gill nets, closed seasons, and bans on taking egg-bearing crustaceans. However, enforcement where possible is normally only applied to the commercial portion of the catch.

Thus, it safe to say that most inshore coastal fisheries in the Pacific are not under any formal management.

Johannes (1998) has argued for a new paradigm of fisheries management in these situations one of data-less management. He argues that this is a mechanism that gives importance to information of fishers and allows for traditional and community approaches to be integrated into the management of local resources.

Pacific island communities have practiced traditional management systems for centuries (Johannes 1981). Recently these systems have been suggested as possible solutions for modern management problems (Ruddle *et al.* 1992). In addition, in many Pacific islands there is still a concept of marine tenure that is sometimes enshrined in the legal system but normally informally recognised.

What appears to be a promising approach to the management of the inshore fisheries of the Pacific islands is an ecosystem approach. The best example of this is the use of marine reserves to protect a portion of the fishing area. The term marine reserve is used in this paper to describe the closing of an area to fishing either temporality or permanently. This is similar

to the more popular term Marine Protected Area (MPA), however, MPAs are often associated with marine parks and have a set definition usually involving a total exclusion of fishing and other uses. Marine reserves are a more flexible system that may allow some fishing for some species or are temporally opened.

Twenty five years of monitoring the coral reef fish at Sumilon Island and Apo Island, Philippines (Russ and Alcala 1994, 1996) the first modern marine reserves, has clearly shown that an unfished reserve area leads to the establishment of very high densities and biomass of fishes important to local fisheries. The rates of recovery of fish biomass is species specific, a couple of years for short-lived species like fusiliers but at least ten years for long-lived groupers. There is an enhancement of the fishery in adjacent areas. In addition to being an affective management tool the fisheries reserves allows protection of the coral reef habitat and offers a refuge for otherwise endangered biodiversity.

A recent global review of marine reserves (Roberts and Hawkins 2000) clearly indicates that fully protected marine reserves:

- Protect exploited populations and enhance the production of recruits, which can restock fishing grounds.
- Supplement fisheries through spillover of adults and juveniles into fishing grounds.
- Provide a refuge from fishing for vulnerable species.
- Maintain biodiversity of natural biological communities that are different from those in fishing grounds.
- Facilitate ecosystem recovery after major human or natural disturbances.

Thus, the implementation of fisheries reserves would appear to address the problem of managing the sustainable use and at the same time conserving biodiversity. Considerable interest is now being shown in the use of marine reserves or marine protected areas (MPAs) as a conservation tool. There are projects to implement reserves in many of the countries by non-governmental organizations (NGOs), communities, and governments.

There are a number of traditional practices in the Pacific that approach the marine reserve concept. The custom of taboo is common through the Pacific where areas (both terrestrial and aquatic) are declared no go and trespassers are subject to various traditional punishments (material, physical and spiritual). Normally taboo is temporary and the area is reopened for normal use. In Vanuatu, successful management of *Trochus* restocking areas have been initiated by temporary closures of the area by the community imposing a 2-5 year taboo on the area (Amos 1995; Jimmy 1995). A similar system, Sasi is in use in Eastern Indonesia and has recently been well documented (Novaczek in press).

There are number of examples now of the use of community marine reserves to manage fisheries in the Pacific. I will report on three of these examples. The three examples are the Ra'ui system in Rarotonga, Cook Islands, the village fisheries reserves in Samoa, and the Uluikoro Marine Reserve and Conservation Area, Ono Island, Kadavu, Fiji

Details on these case studies were assembled from published and unpublished sources, interviews with people directly involved, and visits to and marine surveys of some of the reserve areas by the author.

## Case Study: The Establishment of Traditional Marine Protected Areas (Ra'ui) on Rarotonga, Cook Islands

### Background

#### Physical environment

The Cook Islands comprises 15 small islands scattered over 1.8 million km<sup>2</sup> of ocean. Rarotonga is the largest island (67.2 km<sup>2</sup>) and the capital with a population of less than 8000. It is a high (max elevation 652 m) mountainous island surrounded by a fringing reef with a lagoon varying from 400-800 m on the south to 50-100m on the north.

#### Legal and administrative

The Cook Islands are a self-governing nation with control over its own affairs, in free association with New Zealand. The ownership and management control of inshore waters is vested in the crown (national government). However, the traditional system is still partially accepted (but not legally) in which all Rarotongans have customary rights to fish these resources but in most cases people who fish do so only in the areas of their traditional villages. The chiefs are the traditional custodians of the resource.

The situation in the outer islands appears to be somewhat different in that the local elected councils have been given increased powers to control their own affairs including the ability to pass local by-laws including fisheries management measures. Once the Prime Minister approves these by-laws they have the effect of law.

There is no formal marine protected area in Rarotonga despite numerous recommendations to establish one, although there is a terrestrial conservation area.

#### State of the marine resource

Inshore fishing around Rarotonga is mainly for subsistence. Fish are caught with gill nets including small mesh (down to 1/2 inch mesh), spearing, using both free diving and SCUBA, sometimes fishing at night with lights, and natural fish poisons are used. There is also heavy gleaning of the reef flats for invertebrates and some diving on the reef crest and drop off for invertebrates. There is no list of species caught or estimates of total catch available.

The inshore fishery is regarded as being considerably overfished with the fish becoming smaller and scarcer. There had been no fishing regulations applied or enforced.

There is an aquarium fishing operation collecting fish by diving on the reef crest and drop off (but not in the lagoon). They have exported about 20,000 fish annually since 1990. Five

species dominate the catch but a total of 37 species have been exported (Manarangi-Trott 2001). The catch of these species shows no trend in declining catches although they do fluctuate depending on markets and availability of skilled collectors. The one operator does enforce his own management measures and has been receptive to concerns and complaints from environmental and tourism groups.

## Management intervention

### Description and process

Ra'ui is a traditional Polynesian management measure involving temporary prohibition of access or prohibition on harvesting. As indicated earlier, it is very similar to the taboo system elsewhere in the Pacific and the sasi system of eastern Indonesia. In Rarotonga, the Ra'ui was traditionally used to ban harvesting of certain crops, fish or invertebrates and also applied to areas of land or the lagoon. It was often used to reserve fish or other crops when a group of visitors were expected from another island or in anticipation of a feast. It is normally declared by the chief of the clan who calls the people together to inform them of the prohibition and declares the boundaries. Elsewhere in the Cooks it has been used for similar purposes although in some areas the name is not known or associated with a ban on coconut harvesting, pearl oyster harvesting or long term closure of land areas for emergency food. (G. McCormac pers. com.). Ra'ui has no legal basis.

Until 1998 it had not been applied to the marine environment of Rarotonga for over 40 years. However, a survey of the marine resources of the Cook Islands in 1976 (Dahl 1980) indicated that the marine resources were heavily exploited and suggested that the resurrection of the ra'ui system could assist in conservation. Similarly, a 1997 report (King 1997) suggested the use of ra'ui for a number of park and conservation areas in Rarotonga in both the marine and terrestrial environments. As a result of public meetings associated with this Tourism Master Plan and long term concern for the state of the marine environment, the Koutu Nui (formal council of chiefs) of Rarotonga led by the president Te Tika Mataiapo Dorice Reid proposed to reintroduce ra'ui. The Koutu Nui discussed the issue and agreed, they then called meetings of local chiefs who agreed on the areas and then met with their clan, fishers, other community members and tourism operators to discuss the establishment of ra'ui. The New Zealand Overseas Development Assistance (NZ ODA) and the World Wide Fund for Nature (WWF) assisted them. Further description of the process is contained in Evans (2001) and Reid (2000).

The result was that in February 1998 five temporary protected areas covering 15 per cent of the lagoon area (Figure 2) were established. It was significant that the areas closed were determined by the chiefs on the basis of areas they felt could be enforced. These areas were different than those suggested by the 1997 tourism Master Plan. Four of the areas were protected for two years while the fifth Rutaki ra'ui was in place for ten months.

Just prior to the first introduction of the Ra'ui, all Rarotonga churches were asked to say prayers for the closing and mention it in the sermons. The closings were also accompanied by a large amount of media coverage and an education campaign. The education campaign

focused on school children and attempted to instill in them respect for the marine resources, traditional culture, and traditional leaders role in stewardship of these resources.

The government (Ministry of Marine Resources) was involved in marking the closed areas and monitoring. The systems were not legalised and as such are not officially protected areas. Those harvesting or encroaching on the closed areas were dealt with via community pressure, scolding or in some cases threats of supernatural retribution, but they were not brought to the formal justice system. Compliance in most areas was high.

Rutaki ra'ui followed more closely the traditional system and was closed for only ten months. When it was opened there was a "fishing frenzy," with about 100 community members proceeding to fish very intensely for both fish and invertebrates for a few weeks. Although the community felt very happy with the results the catches appeared to have declined to levels comparable to those before the Ra'ui was installed. This raised concerns among leaders who saw this as a conservation system rather than a temporary savings bank. The Ra'ui at Rutaki was then re-established but moved two kilometers west and again was in place for ten months. However when the system was opened there were instructions from the chief to fish more moderately and only for home food consumption. Subsequently a new ra'ui in a nearby area off the Rarotonga Hotel was declared 1 February 2000 and will be in place for two years.

The other four ra'ui experienced a variety of opening and re-closing strategies including:

- opening for only one day of fishing and then being closed,
- opening for two weeks and then being re-closed,
- opening for three weeks but a ban continued on gill net fishing, and
- opening but maintaining a small area of the original (which is an important spawning area) as a permanent protected areas (ra'ui mutukore—ra'ui forever) and closing a new area.

In addition, three new ra'ui were declared in early 2000 for a period of nine months to five years. The situation in early 2000 was that nine ra'ui were in place including one permanently protected area and over 30 per cent of the lagoon was closed (Figure 3).

## Results

### Target and non target species

There was limited assessment of the ra'ui for target species and no records of catches during the openings. Anecdotal evidence suggests that in all areas fishing was intense when the lifting occurred and people perceived considerable increase in the fish and invertebrates. An interview with spearfishermen who fished one of the Ra'ui shortly after opening, suggested that their catch was at least double the normal situation, and the fish were larger and easier to spear (less wary). In some cases fish caught was sold but much was for home consumption and in one case the opening was accompanied by the harvest of particular species for a

community feast (BBQ). The community harvested the shellfish, Trochus with the money from the sale used for community projects.

There were detailed surveys of the marine invertebrates at four of the ra'ui just after established in February 1998 and prior to opening in November 1999 (Raumea *et al.* 2000). A selection of the results shown in Table 4 indicates that the species number of invertebrates increased 30 per cent and numbers of invertebrates increased at three of the sites but not at the fourth. At these three sites the increase was 70 per cent, 150 per cent, and 260 per cent. Fish dominated the fourth site Tikioki, and fish predation may have resulted in a decrease in the invertebrates.

Fish surveys were taken at Tikioki, comparing densities within and without the closed area. The fish densities of the indicator species the topsail drummer (*Kyphosus cinerascens*) increased 20 times between February 1998 and November 1999. The density of fish inside the Ra'ui was 250 times greater than outside, however this is a highly aggregated species so fish surveys may overestimate abundance. The number of fish species inside was 60 per cent higher than outside.

I carried out a snorkel survey of the Tikioki/Akopuao Ra'ui and sanctuary 21 April 2001. I did not do a qualitative survey but clearly the area has a much greater density of fish than normally seen on dives or snorkels elsewhere in the Pacific. There was a considerable number of large fish (e.g. parrot fish) suggesting that the reserve also attracted fish. There were also a number of fish not normally seen that are vulnerable to spearing e.g. flounder and coral trout. The other significant feature was that the fish were very approachable and comments from tourists were "there are so many fish". While small fish were plentiful just outside the closed area there were fewer large ones seen and they were much more wary.

The ra'ui experience after three years gives strong indication that it does increase fisheries management and leads to increased biodiversity conservation. There is now in place a considerable number of closed areas and an attitude of respect leading to compliance. This offers a positive sign for the future that the pressure of overfishing is being managed. Other challenges remain as pollution of the lagoon and land-based run-off are not yet controlled and thus continue to threaten biodiversity.

#### Lessons learned

- An approach based on a traditional system has been successful where government management efforts were not.
- Success depends on the strong support of the traditional leaders and strong community involvement and community enforcement.
- The ra'ui system may not be applicable in areas where the community and/or outside fishers do not respect traditional leaders.
- Community or traditional leaders may select management area using different criteria than those used by managers and conservationists.



- Traditional approaches need to be modified to incorporate long term conservation.
- Fisheries Management and conservation can occur in the absence of legal backup. The ra'ui approach is "Respect rather than fear of legal action".
- Care needs to be taken when opening a temporarily closed area to prevent serious overfishing.
- Education and public awareness are very important.
- Need for further biological monitoring of conservation effects and contribution to catch.
- Ra'ui can not control external pollution such as land based run-off

### Modifications to system

The major modification has been to change a traditional system that dealt with preserving resources for short-term future needs to a system that is offering long-term protection. The ra'ui have evolved from 10 months to two years in Rutaki, and from two years to five years and a permanent closure in Tikioki. The system is continuing to evolve based on community feedback and the closed areas may change in future. The next steps are to address some of the other management systems including the use of gill nets and land based pollution.

The second major modification was to change the way the Ra'ui was opened. The initial opening in Rutaki was a free for all leading to overfishing, subsequent opening were more controlled and in some other sites gill nets were banned and opening restricted in time.

### New guidelines, policies and legislation

In the Cook Islands there is a now a much greater awareness of marine conservation and the role that ra'ui can play. As an example, the village council in an outer island, Aitutaki, in conjunction with Ministry of Marine Resources has recently developed a management plan which relies on the implementation of ra'ui in four critical biological areas.

A new fishery act is being developed and while not specifically aimed at legalising ra'ui it will legally recognise management plans. These plans can include ra'ui as part of the plan.

The national biodiversity plan is currently being developed. It is being developed as a bottom-up process with community consultation in problem and solution identification. Ra'ui is being identified as a potential tool for solving some conservation problems.

### Background

#### Physical environment

Samoa (previously known as Western Samoa) is an oceanic volcanic archipelago in the southwest Pacific. There are two main islands, Upolu and Savaii, seven smaller islands (two of which are inhabited), and several islets and rock outcrops (Figure 4). Samoa has a land area of 2839 km<sup>2</sup> and an Exclusive Economic Zone (EEZ) of 120,000 km<sup>2</sup>, one of the smallest in the Pacific area. Volcanic activity is persistent and frequent earth tremors are experienced. Upolu and Savaii have coastal plains, rising to central mountains. The climate is tropical. The average annual temperature is 26.5 ° and the average annual rainfall is 3000 mm with 75% of the precipitation occurring during the distinct wet season from November to April. The population was 161,298 in 1991 with 34,126 individuals living in the national capital, Apia.

The islands are more or less surrounded by fringing coral reefs with an inner lagoon. The north side has reefs that extend offshore up to 3 km with shallow (2m deep) and murky lagoons. On the south side the reefs are closer to shore and the lagoons are deeper and clearer (Skelton *et al.* 2000). The coral reefs were severely damaged in two devastating cyclones in 1990 and 1991. There has been considerable recovery of the fast growing *Acropora* corals, however, there is currently (March 2001) a severe coral bleaching event related to above average sea temperatures that may result in a considerable loss of coral cover.

#### Legal and administrative

Samoa is a self-governing nation with control over its own affairs. There is a Head of State to be elected by the Legislative Assembly for a term of five years but the present Head of State, however, holds the office for life. The Legislative Assembly is composed of 49 members, all of whom are elected by universal suffrage. There is, however, still considerable power held by traditional leaders as 47 members are elected from among the holders of *matai* (Chief) titles and two from non-Samoan candidates. Members hold office for five years.

The ownership and management control of inshore waters is theoretically with the national state authorities. The Land Survey and Environment Act 1989 designates as public land all land lying below the line of high water mark and all people have the right to navigate over the foreshore and fish within the limits of the territorial waters of the state.

Traditionally, the Samoans had elaborate customs of ownership and control of fishing rights. The right to fish in reef, lagoon and mangrove areas was owned by adjacent villages, families or chiefs. These customs have largely disappeared as far as reefs and lagoons are concerned but there is still a strong traditional feeling that access and use of the waters rests with the village and requires permission of the local clan leaders/chiefs (*matai*). This superimposition of a western legal concept over top of a traditional system has created confusion in management and along with the introduction of new fishing technologies and population increase has led to unsustainable fisheries practices.

In recognition of the conflict between state and traditional systems, the government passed the Fono Act. This gives village council (Fono) the power to make local by-laws. Thus through the village by-laws the village can protect and conserve the marine resources of that village.

The Fisheries Act of 1988 has the flexibility to allow the formulation of by-laws to incorporate local village marine resource and conservation undertakings. Thus, specific undertakings in the village fisheries management plan can be made into by-laws, which are recognized and enforced by the government. This in essence allows the village Fono to make rules that can have national recognition and be enforceable by the national authorities thus ensuring that both villagers and outsiders must comply with village rules.

Once the village agrees to rules becoming by-laws, they are forwarded to the Fisheries Division for deliberation, before being passed onto the Attorney General's Office, for processing. On approval, the by-laws are signed by the Director of the Ministry of Agriculture, Fisheries, Forestry and Meteorology and then passed onto to the Legislative Assembly for advertisement in the Government Gazette. By-laws are also published in local newspapers. They become effective seven days after publishing in the Government Gazette. In the past, local offenders have been fined by the village Fono (tinned fish, pigs and/or money) and recently, legal prosecution processes have been instigated against outside offenders for transgressing village by-laws. It is the role of the Fisheries Division Extension Officers to assist village communities to prepare cases against transgressors of by-laws. Special training in evidence collecting has been provided for Fisheries Division staff. Further details are found in Fa'asili (1999).

Samoa was the first Pacific nation to establish a national marine reserve. The Palolo Deep National Marine Reserve in the capital Apia, was established in 1974. The area has become an attractive tourist attraction and compliance is high. There appears to be considerable increase in biomass and diversity partly associated with the protection but also as part of a natural recovery from the severe cyclones in the 1990s. Although high water temperatures in early 2001 have threatened the coral here and elsewhere in Samoa with coral bleaching.

#### State of the marine resource

Inshore fishing in Samoa is primarily for subsistence. There is a recently developed near-shore fishery for tunas that has been highly successful and is worth about \$10 million (US). It, however, is harvesting very different species than the inshore fishery. The inshore fishery has been estimated at 4,600 tonnes per annum (Zann 1991). The fishery is multi-species (as discussed in Section 3) taking over 450 species of fish, invertebrates, and algae. Table 2 and 3 give the common families of fish and invertebrates harvested.

Spears are the most common gears with line fishing and then nets, but gleaning from the reef flats is also important. Figure 1 indicates the common gear owned by families. There is also some use of destructive fishing techniques including explosives and poisons.

The inshore fishery has declined. In the mid 1980's this decline was recognized as being very serious (Fa'asili 1999). The two devastating cyclones of 1990 and 1991 had severe effects on

coral and the marine resources as well as destroyed Samoa's agriculture. Previous applications of national fishing regulations have been unsuccessful.

Skelton *et al.* (2000) summarising previous studies indicated there has been a reduction in the size and biomass of fishes in shallower, heavily fished areas. They also indicate that the giant clam *Hippopus hippopusm* is extinct while trochus *Tridacna squamosa* is functionally extinct. The mullet (*Mugil cephalus*), milkfish (*Chanos chanos*), the mollusk, *Charonia tritonis* and the mangrove crab (*Scylla serrata*) have declined seriously due to overfishing.

Aquarium fish exports have occurred sporadically. There are currently two exporters, one exporting only live rock and the other licensed to export both fish and other organisms. Annual exports ranged from 30,000 to 66,000 fish during 1993 –1995. Current exports include fish, live coral, a range of invertebrates and live rock (op cite).

## Management intervention

### Description and process

Recognising that the decline in inshore resources was a serious threat to the Samoan lifestyle and economy, the Samoa Fisheries Division requested aid assistance. In response, Australian AusAID provided funding, initially for a three year Fisheries Training and Extension Project with advisory support continuing via a second phase until 2001. Details on the project and the approach are found in Kaillie *et al.* 2000, King and Fa'asili (1998a, 1998b and 1999) and King and Lambeth (2000).

The project has focused on an approach directed at mobilising communities to manage and protect their own resources. The outline of the project is shown in Figure 5. The project strategy was based on four principles:

- 1) Maximum community participation.
- 2) Motivation not education.
- 3) A demand-based extension system.
- 4) Development of alternate sources of seafood.

At the project commencement in 1995, 15 new recruits (men and women) were appointed to the Fisheries Division in a newly created Extension Division. These new officers were specifically chosen and trained to facilitate a "bottom-up" approach.

The extension process outlined in Figure 5, engages the village community through an outreach program that begins with a meeting with the village council or Fono. The initial meeting is attended by the key decision-makers, the matai's (chiefs) and the pulenuu (village mayor). Fisheries extension officers introduce the program, generating discussion of the critical issues relating to sustainable management of marine resources and the environment. Ideas and viewpoints are exchanged and if agreement is reached, arrangements are made to continue the extension process.

Over the next several weeks, a series of separate group meetings are held with the village community involving three groups the matai's, the aumaga (untitled young men) and the komiti o tina (women committee). At group meetings, extension officers, skilled in facilitation, encourage group discussion of the perceived causes and effects of the lack of marine resources within the village. Then, a number of potential solutions to problems are generated by the villagers within the different groups (an example is indicated in Figure 6).

The derived solutions are consolidated into village-specific marine resource and conservation management undertakings before approval for them is sought from the village Fono. Once obtained, a committee representing all groups is elected to work with Fisheries Division staff, to draw up a Fisheries Management Plan for the village. The plan describes the marine environment, lists the advisory and management committee members, and documents the management undertakings, which the village has agreed to follow. Thus, each village fisheries management plan embodies the specific rules that villagers themselves have suggested during group meetings.

Once the plan is accepted by the Fono, a committee the Village Fisheries Management Committee (FMC) is selected. It consists of selected representatives from matai, aumaga and aualuma groups. The members take on the responsibility for monitoring inshore waters and enforcing village by-laws. They also liaise with the Fisheries Division staff. As part of the ongoing extension service, *at least* monthly visits are made to the village to discuss progress and problems, arrange training workshops, monitor the fish reserve, measure clam growth and mortality, and collect records for outer reef slope fishing. The Fisheries Division assesses their management capacity at six-monthly intervals and provides feedback to the committee.

Table 5 summarises the specific undertakings, which are adopted in individual village management plans. The majority of villages also declare their undertakings as by-laws so the percentages in the table are also an indication of numbers of by-laws per village. This has been a very important component of the success of the project.

As of now, 72 villages are in the program, 65 have completed management plans, and an unexpected 57 have fish reserves.

## Results

### Evaluating success

Village management capability is assessed every six months using a quantitative assessment method described in Kallie *et al.* (1999). The assessment instrument uses a robust scoring system that differentiates *poor performance*, *average performance* and *good/competent performance*. This type of system is very important when decisions to withdraw services from some village communities have to be made and defended.

The Assessment is similar for each village and has three components; involving interviews with the management committee and with village people and then input from research staff, so that aquaculture and outer reef fishing outcomes can be appraised. This procedure involves a prearranged meeting between, fisheries extension officers, the Village Mayor and

the other Management Committee members. One extension officer then asks a standardised set of questions, while the others note responses. The assessment takes approximately two hours and is followed by a walk around the village to enable a random selection of 5 villagers for interview. Their individual responses to a further set of questions are also recorded. The response form is then completed and scored in the Division, after input from research staff, regarding aquaculture and outer reef fishing undertakings. A database which tracks the management progress is updated to facilitate scheduling and content of discussion during monthly visits and subsequent reviews.

Commitment to undertakings and management competence amongst participants is variable. A few communities have been unable to sustain their management objectives. During the period 1999 to 2001, six villages elected to withdraw from the program because of unresolved inter-village dispute and/or changed village priorities.

Currently, 21 villages meet the Extension staff's imposed criteria for autonomy of self-management: achievement of management scores greater than 85 per cent on three consecutive assessments and involvement in the program for more than two years.

Conversely, four villages are noted as having consistently unsatisfactory performance (management scores less than 55% on three consecutive assessments)

Reasons for poor performance vary but include: Management Committee failure to hold meetings, non-enforcement of village rules, lack of care for restocked clams, failure to maintain shorelines, reserve signs and/or marking of fish reserve areas.

#### Target and non-target species

Informal reports from villagers suggest that an increase in abundance and diversity of fish and non-fish species occur within many fish reserves in a relatively short time. Villagers report that some species of fish, shellfish and corals, formerly found in the area but later destroyed by excessive exploitation, destructive fishing methods, previous cyclones, and run-off from land activities are again beginning to flourish within reserve areas. A few villagers also comment on the arrival of new species. For example, evidence of sea hare eggs and schools of mullet, where none had occurred previously. Villagers also observed that fish were closer to shore in reserve areas than in other areas.

Community based monitoring of the reserves has been established with fisheries staff trained in monitoring techniques and they in turn trained 46 villagers from 6 villages. Results to date are not adequate to assess the effect of the reserves.

A recent detailed survey (Kaille *et al.* 2000) of village perceptions of change as a result of fish reserves, verified the following anecdotal reports.

Fish reserves were seen to replenish inshore resources. Notable increases included butterfly fish, parrotfish and goatfish, table, massive and branching corals. Less striking changes were noted for surgeon and emperor fish.

Perceptions of changes to shellfish species were minimal. However, all respondents in the study were male and traditionally shellfish are collected by females, so the respondents may not have direct knowledge of differences. Increased numbers of mudcrabs, razor clams, eels and seahares were noted in half the villages in the study. Very few villages perceived increases in giant clam numbers, although a few villages reported the appearance of some important bivalve species.

Reserves were thus clearly seen to restore the marine biodiversity with most respondents claiming that catches outside or adjacent to the reserve were also improving. Most respondents believed that fish reserves and increases in catches were related events, fish spilling-out from the reserve accounting for the increase in adjacent areas. Others believed that fish “learned” that the reserve was a safe haven but that numbers within the reserve had not reached large enough proportions for a spill-out effect to be noticed.

An extensive survey of households in 20 per cent of all Samoan villages conducted by the Fisheries Division at the end of 2000 showed that in villages with management plans fishermen caught 1.4kg/person/hour compared to 0.9kg/person/hour in other coastal villages. The higher catch rate in villages with management plans strongly suggests that the Extension program is successful. However, it may also indicate that villages who decide to enter the program are simply more skilled in fishing techniques. The study was unable to partition which part of the catch rate was due to community-owned fish reserves and which to other community-based undertakings such as limiting mesh size, preventing destructive fishing etc (M. King, Samoa AusAid Fisheries Project, Apia, Samoa, pers. com.)

#### Lessons learned

- The biological approach of reserves as absolute *no take zones* for maximum recruitment of fish stocks does not match with the social and cultural obligations of village life. Thus restricted and controlled opening of reserves is a wiser management practice than no reserves and continued indiscriminant and uncontrolled plundering of fish stocks.
- Communities support for the idea of conservation and preservation of their marine environment takes a relatively long time (3-5 years).
- Fish reserves have been much more popular than previously anticipated and some communities who initially did not include marine reserves have asked to change there management plans to incorporate the reserves. The success of the small fish reserves is linked to also establishing good management practices.
- Some communities continue to be more concerned about harvesting rather than conservation. Management committee members are often under continual pressure to open fish reserves.
- Community perceptions of the effect of the management approaches and fish reserves is very positive but the formal community level monitoring has not produced adequate data.

- Village by-laws and management plans are an essential part of the process and facilitate management committees to uphold conservation and resource protection undertakings. Advertising the village by-laws is expensive.
- Such a program requires a long-term commitment by the Fisheries Division and communities alike, as there are few immediate advantages and the sacrifices and attitude changes required by whole communities are significant. The challenge for any Government is how to maintain a complete and professional service to all villages accepted into the program.
- Incentives for sustaining interest in conservation and resource management are necessary at least in the short- term.
- Giant clams introduced into community-owned fish reserves have met with limited success. Clams have been lost largely because of lack of care and through theft.

### Modification to system

This has been a very interactive project so that many of the lessons learned have been incorporated into the work in new villages.

### New guidelines, policies and legislation

Many other Pacific island countries are interested in examining the Samoan approach. American Samoa for example has recently implement a community approach to fisheries management and the establishment of community reserves based on their Samoan neighbours experience.

The national biodiversity plan recognizes ecosystem management and the use of reserve areas as an essential ingredient in the plan.

A Samoa-Marine Biodiversity Protection and Management project with support from International Union for the Conservation of Nature (IUCN) with the Division of Environment and Conservation of Samoa is building on the lessons from this project and assisting communities to establish district level MPAs.

## Case Study: The Uluikoro Marine Reserve and Conservation Area, Ono Island, Kadavu, Fiji

### Background

#### Physical environment

Fiji is made up of 300 Islands, one-third of which are populated. The population of 700,000 is concentrated mainly around the coast of the two large islands Viti Levu and Vanua Levu, as well as a number of other island groups. The province of Kadavu is made up of a group of



islands about 70-km south of Suva (on Viti Levu), the capital of Fiji. Ono is the second largest island of Kadavu and is administratively a district of Kadavu province. It is a high volcanic island. The inhabitants live in 7 villages around the coast. Waisomo village is the focus for this case.

Ono is almost surrounded by an isolated barrier reef, the Great Astrolabe Reef. This reef is identified in the National Environment Strategy as requiring protective management and has a high biodiversity. There are also fringing reefs closer to the island.

#### Legal and administrative

The Fiji islands are a self-governing nation with control over its own affairs. Currently, ownership and management control of inshore waters in Fiji is under the dual control of both national government and traditional land holding units. The traditional owners retain their inshore exclusive fishing rights, but the actual ownership of all of the territory waters is held by the national government. Fong (1994) and Ruddle (1994) give further details on the historic background. This system lead Ruddle to say:

“ The result is that fisheries legislation in Fiji remains chaotic. ---- The legal question of fisheries rights and resource ownership is one of the most highly charged and potentially divisive issues confronting present-day Fiji.”

The traditional system was codified into national law and the boundaries arbitrarily frozen based on the situation in 1874. These traditional use areas, *gologoli* are registered in the Registry of Native Customary Fishing Rights. In addition, there is a subset of the *gologoli*, the *kanakana* which, has been allocated by the district chief to a group of users. The *gologoli* for Waisomo is shared with five other villages in Ono. The *kanakana* of Ono is traditionally accepted but the boundaries are not clearly delineated and are subject to dispute with neighbouring villages.

There is no formal marine protected area legislation in Fiji. There is one island, Makogai where the Fiji fisheries division has negotiated with the local landowners of the adjacent *gologoli* to declare it a protected area. There is a shellfish hatchery here and this area is being used to stock giant clam, trochus, and pearl oyster. The area is policed by the fisheries division but even still there is often poaching sometimes by members from the *gologoli* group.

#### State of the marine resource

In general, Fiji's inshore fishing resources are considered to be under threat. Fish species are overfished and there are many reports of fish size decreasing and fish declining. Two species of giant clam *Tridacna gigas* and *Hippopus hippopus* are extinct in most areas.

At a marine awareness workshop in Kadavu (Annon, 1996) the participants from the coastal communities stated:

- Loss of certain species has been observed.

- Fish are smaller.
- Commercialisation (e.g. beche-de-mere) now very common.
- Loss of respect for traditional leadership and non-respect for taboo areas.

The Ono villages have identified (Mangubhai & Rupeni 2001) the following as the major threats:

- Over-harvesting of marine resources for subsistence purposes.
- Use of destructive harvesting, reef damage by tourists.
- Increased presence of crown-of-thorns starfish, coral bleaching.
- Increased conflict among resource owners due to unclear boundaries of customary fishing areas.

## Management intervention

### Description and process

Concern by a few members of the Waisomo community over the decline in fisheries resources resulted in an approach to the World Wide Fund for Nature (WWF) in 1997 for assistance. WWF had been developing and refining an approach to community conservation the “Community Resources Conservation and Development” (CRCD). This approach was based on 8 years of field experience in the Pacific particularly in Papua New Guinea and Solomon Islands. Through this approach they saw their role as a facilitator of community efforts rather, than driving the process. They initially entered into the process as a scoping mission. WWF’s involvement has expanded considerably since then and funding has often been on an ad hoc basis as there was no dedicated budget. A summary of the approach is found in Mangubhai and Rupeni, (2001). Many of the activities have focused around community workshops of which seven have been held. WWF have assisted the community identify problems, initiate solutions, lobby governments, carry out village education and awareness workshops, and facilitate and assist in scientific monitoring. In addition, WWF have assisted in a broad media campaign to promote the ideas of marine reserves and facilitate village participation in relevant meetings elsewhere in Fiji.

The interest from Waisomo actually started in 1996 when the University of the South Pacific in conjunction with the Fiji Dive Association sponsored a number of marine awareness workshops throughout Fiji, including one in Kadavu (Annon. 1996). The aim of these workshops was to increase awareness of the vulnerability of resources to unsustainable fishing practices and pollution, and the long-term benefits of conserving resources. Mika Vunituraga, the headman of Waisomo village attended and became very interested. He returned to the village and convinced a number of others of the idea and then approached the University of the South Pacific Marine Studies Programme to assist in the preparation of a project document. USP advised Mika to contact WWF and Fisheries Division. In mid 1997, he contacted WWF seeking assistance for MPA development and for assistance in

implementing sustainable fishing practices. Unfortunately he died in 1998 but his brother Iokimi Naqeleuvuki, has replaced him as headman and has carried on as the driving force behind the idea.

The nature of rights ownership to fish in customary fishing areas is such that the villagers of the 6 villages on Ono Island collectively share the right to use the *gologoli*. Though the tendency is for members of each village to fish in waters immediately outside each village they can fish in any area around Ono. The issue of commercial license to fish in customary fishing area gives the licence holder the right to fish all over the customary fishing area. During the course of facilitating activities in Waisomo, it became evident that the support and active participation of all villagers is necessary to the success of the venture. This led to the realisation by Waisomo villagers of the need to negotiate with the other five villages that shared the *gologoli* to obtain their consent to the establishment of the protected area in writing. This was not easy, but the persistence of the Waisomo headman resulted in consent being obtained. WWF assisted in informing the provincial government of the process for establishing community-based protected areas and obtained their support.

After a WWF awareness and problem analysis workshop, the community developed a preliminary action plan that includes:

- Prohibition of the use of traditional poisons (duva- derived from the derris root) for fishing.
- Clearing land by burning was prohibited in Waisomo and two adjacent villages.
- Banning of the use of SCUBA for collecting beche-de mer.
- Minimum gill net mesh size (3”).
- Prohibition on the taking of turtles and eggs.

Subsequently the community declared a one km<sup>2</sup> area as the Uluikoro Marine Reserve and placed a ban on all fishing and harvesting in the area. WWF assisted in the facilitation of conflict resolution between the villages that shared the *gologoli*.

In 1998 and 1999, WWF facilitated community workshops to generate information and ideas from the community, building on earlier information obtained, as building blocks to develop a preliminary coastal resources management plan for Waisomo. In 1999 they facilitated a baseline survey carried out by the University of the South Pacific. The survey obtained socio-economic and biological data; and assessed issues and conflicts and initiated a community biodiversity survey.

Subsequently, WWF has worked with the village to establish a community management body. The Fiji fisheries division provided assistance by carrying out the training of village fisheries wardens in monitoring and enforcement.

Due to the dual nature of the fisheries ownership and use rights in Fiji, although the community had agreement from the other five villages to abide by the rules, they had more

difficulty in preventing outsiders from poaching in the protected area. The poachers reportedly came from the larger Kadavu Island and from Suva (two hours away, by boat). In addition, there is no MPA legislation that would allow national protection.

WWF assisted the villages with a novel approach. A lawyer assisted them in preparing a document for the cabinet eventually to be signed by the Minister responsible for fisheries. This would allow the formal declaration of a marine reserve (the Uluikoro Marine Reserve) and a conservation area (the entire kankana of Waisomo). The reserve will be a no take area while the conservation area will have restrictions on types of gear and activities. In addition, the village fish wardens will have policing power in the marine reserve. Thus, existing sections in the fisheries act can be incorporated to allow the exclusion of outsiders.

A small community protected area is now in place along with a larger conservation area. There is considerable compliance both by villagers and outsiders. There is now a legal mechanism being pursued through government channels to legalise and legitimise the village reserve and conservation area. This will also that will allow other communities to more easily repeat the process.

## Results

### Target species

During the baseline survey in October 1999, the community indicated that they had observed an increase in number of fish in the reserve in the two years that fishing had been restricted. The fish survey (IOI 1999) indicated that medium schools of snappers (Lutjanidae), emperors (Lethrinidae) and parrotfish (Scaridae) were present. Although, only a very few small groupers (Serranidae) were found. In addition, the fish were much more wary than is typical in protected areas. The suggestion was that there was still some undetected fishing by divers using spears and spear guns.

A major biological survey is currently (May 2001) being carried out inside and outside the protected area. Preliminary findings (Etika Rupeni, WWF, Suva, pers. comm.) are that there are an increased number of fishes in the reserve with larger schools and larger fish. Target species of snappers and emperors are present in schools of 40–50 and the fish are much less wary than in 1999, suggesting that there is little fishing activity in the reserve now. The villagers also indicate that there are now more fish outside the reserve

### Non-target species

The 1999 survey indicated that the biodiversity of coral and coral reef fishes was high, although harvestable invertebrates were scarce. During January-March 2000 there was a major coral bleaching event throughout Fiji, associated with high ocean temperatures. Satellite data showed the hot spot just south of Kadavu. In many areas of Fiji, the fast growing *Acropora* corals suffered close to 100% mortality. Around Ono there has been a similar massive reduction in coral cover on the reef in and outside the protected area.

## Lessons learned

### 1) Strong leadership essential

The success of the Waisomo project has been because of the strong driving force of the village headmen. Mika initiated the idea and convinced the village to approach WWF. His brother Iokimi has follow up. He has assisted in village facilitation to convince people of the need for conservation, he has been fundamental in the negotiations with other villages and he has been able to get considerable additional resources for the project, including a new village hall, a boat and motor. Strong leadership is especially important in remote areas like Ono where outside advisers are not close at hand.

### 2) Community consensus building and decision making

In order to ensure compliance it was important that all community members were part of the process and supported and understood the plans. The participation of women was essential, as they are responsible for considerable fishing and gleaning activities. The community involvement takes considerable time and patience.

No additional administrative framework has been established but WWF has been working to strengthen the existing decision making structures and processes. This has, however, required a focus on conflict resolution.

### 3) Sensitivity of tenure issues

The issue of land and marine tenure has a long history in Fiji and as quoted earlier is highly charged and potential divisive. That lesson has been borne out. Attempting to draw boundaries around fishing areas has been very contentious both within communities and between communities. The issue has to be approached very cautiously as it can lead to conflict between neighbouring communities and can lead to a competition to harvest the resources before others take them.

In addition it is important to avoid conflict between neighbouring villages and resolve conflict that arises. WWF assisted in facilitating conflict resolution and the village leaders spent considerable time and effort in negotiating with and getting agreement with the nearby villages. Establishing mechanisms to hear grievances was also important.

### 4) Establish co-management systems

In the absence of a legal or strong traditional mechanism to enforce the village agreements on outsiders it is essential to involve Government agencies to assist. The approval by Cabinet of the declaration of the marine reserve and conservation area will be an important precedent for other communities. Considerable effort has also gone into involving the Fisheries Division from the start in the project.

### 5) Monitoring and baseline surveys

The early monitoring was weak. This has been partly due to the nature of the development of the project. There was no dedicated funding and the project evolved rather than was planned.

Biological data was collected after the reserve had been established and was insufficient to evaluate the effectiveness of the reserve. A detailed biological survey is currently under way and while after the fact it will establish the current baseline and allow comparison between protected and non-protected areas.

Community monitoring has been planned and while the community has been trained in various monitoring techniques there has been little systematic monitoring. However, community perception of the success has been important, particularly that the reserve is contributing fish to areas outside the reserve.

#### 6) Sustainability

There are a number of points related to the long-term viability of the project.

- Financial - The cost of policing the marine reserve is high as it is at a distance from the village. WWF is working with the Village to develop income generating activities like boat hiring to cover the costs of fuel and enforcement operations.
- Supportive Network - A technical advisory group is being developed to provide access to information and technical advice so that communities can respond to new issues as they arise.

### Modifications to system

The process has been going for four years and there are a number of areas that need strengthening in future in Waisomo or new villages. WWF is now receiving requests from communities on the adjacent Island of Kadavu to assist in establishing their protected areas. The lessons learned will be readily transferred to the new communities.

#### 1) Education

The conservation ethic requires a change in thinking. In the future, more effort will be spent on conservation education of children in the school system.

#### 2) Community monitoring

Baselines should be done prior to or at establishment of protected areas. Biological surveys have just been carried out. They will assist in establish baselines and identify areas for long term monitoring. There will need to be continuing biological surveys.

Community monitoring needs to be strengthened. Future efforts will have to go into strengthening the ability of communities to monitor their own resources, select appropriate indicators, analyze the data and incorporate this into community decision making. Communities need to be able to monitor the state of their own resources and the success of management interventions.

### 3) Sharing lessons learned

Both successes and failures need to be documented and shared with other organisations and communities. There is an evolving network in Fiji and the Pacific that is starting to do this in order to avoid painful mistakes.

#### New guidelines, policies and legislation

The early success of this project is arousing interest in various communities who also want to initiate protect areas. Of interest is that the communities most interested are not part of the project villages in Ono but nearby villages on Kadavu.

The legal documents when approved by Cabinet will make it much easier for other villages to establish protected and conservation areas.

There are currently suggestions that the ownership of the marine areas will be devolved from the National Government to the landowners. In this case these precedents set in this project may assist other villages.

## Discussion

In the cases presented from three Pacific Islands local communities have implemented their own fish reserves, decide on the location, established their own rules and management approaches. In all cases the process takes time.

In Fiji and Cook Island the traditional leaders where the driving force behind the reserves with an NGO (WWF) assisting and facilitating and government fisheries staff backstopping. In Samoa the reserves were implemented by the Fisheries Division with outside donor funding. However, staff had been special trained in facilitation to assisted communities to develop their own plans.

In Cook Islands and Samoa the reserves are not classic no-take MPAs but allow some flexibility to match the socio-cultural concerns. They may open for short times or allow harvesting during certain seasons or for certain species. In Fiji the community has accepted a small no-take permanent closed area and a larger management area. The systems have and are evolving, in the case of the Cook Islands they are moving from a short-term community food bank to a longer term closed areas including permanent closures on biologically important areas.

Compliance is much higher than is normal for government imposed Marine Protected Areas. In most case the communities are able to enforce compliance on community members by using traditional sanctions but there is a need for outside legitimation of the area to enforce compliance on outsider. In Samoa existing village by-laws are being used to allow fisheries officers and police to enforce the rules, In Fiji a simple legal instrument is currently being present to the Cabinet. In the Cook Islands the respect for the traditional system and traditional leaders appears to enforce compliance even on non-community members.

The individual reserves are small but in the case of Cook Islands and Samoa the network of village reserves adds up to a significant area. In Fiji it is anticipated the area will increase as adjacent areas implement their own reserves. In all cases the reserves are perceived to be increasing the biomass of harvestable fish and invertebrates and biodiversity. In all cases there is increased interest from other communities and areas are expanding.

In most cases formally biological baseline surveys were lacking or not complete. Community monitoring has been attempted in Samoa and Fiji but is as yet not fully implemented. All cases have plans to improve the biological and community monitoring. Information from communities on their perceptions of the changes was available from all cases but only in Samoa was there a rigorous approach to collecting the data. There is, however, a need for a more rigorous and routine approach to monitoring across all projects.

Education particularly of school children and media awareness have been important components of all the projects.

The cases presented here are but a few of the systems in the Pacific that are combining traditional management measures with fisheries management and biodiversity conservation. There is clearly a need to continue to document and share these success stories.

## Acknowledgements

A number of people assisted with the preparation of this paper. WWF South Pacific Program was extremely helpful, answering questions, supplying unpublished reports, maps and pictures, and reviewing drafts. They also were very good at reminding me that it is the community who we are also responsible to. Particular thanks to Etica Rupeni and Kesa Tabunakawai, WWF Suva and Jacqueline Evans, WWF, Cook Islands. The preparation of the Samoan case was only possible with the assistance of Jenny Kallie who prepared the first draft and Mike King for his continued information on the project. In the Cook Islands, Ian Bertram, Ministry of Marine Resources and Gerald McCormack, Cook Islands National Heritage Project both supplied useful information and unpublished data. Johnson Seeto and Esaroma Ledua both supplied additional reports and information. Naomi Johnson assisted in editing.

A special thanks to Te Tika Mataiapo Dorice Reid who first described the Ra'ui and its cultural and spiritual values to me. A similar special thanks to Iokimi Nagelevuki and the Waisomo villagers who first allowed me to be immersed in their blue holes.



## References

- Adams, T. H and P. T. Dalzell. 1994. Artisanal fishing. Unpublished draft for Pacific Science Association Coastal Zone Biodiversity Workshop. 19 p.
- Allen, G. R., R. Steene, and M. Allen. 1998. A guide to the angelfishes and butterflyfishes. Odyssey Publishing/Tropical Reef Research. 249 p.
- Amos, M. 1995. Combination of fisheries management regulation, traditional based management and wild stock enhancement using hatchery reared trochus juveniles as a precautionary management principle for *Trochus niloticus* resources in Vanuatu. Pages 169-181, *in* P. Dalzell and T. J. H. Adams (Eds.). South Pacific Commission and Forum Fisheries Agency Workshop on the Management of South Pacific Inshore Fisheries; Manuscript collection of country statements and background papers. Volume II.
- Annon. 2001. Samoa's biodiversity strategy and action plans. Unpublished report, Division of Environment and Conservation, Department of Lands, Surveys and Environment. Apia, Samoa. 91 p.
- Annon. 1996. Report on the Marine Awareness Workshops for Taveuni, Kadavu and Lautoka. IOI-South Pacific, Suva, Fiji. 66 p.
- Bellwood, D. R. 1988. Seasonal changes in the size and composition of the fish yields from the reefs around Apo Island, central Philippines, with notes on methods of yield estimation. *J. Fish Biol.* 32:881-893.
- Dahl, A. 1980. Report on 1976 marine survey Rarotonga, Cook Islands. SPC Report.
- Dalzell, P. T, T. H. Adams, and N. V. C. Poulin. 1996. Coastal fisheries in the Pacific Islands. *Oceanography and Marine Biology: An Annual Review* 34:395-531
- Evans, Jacqueline. 2001. The role of community initiative and traditional leadership in the establishment of Marine Protected Areas (Ra'ui), on Rarotonga, Cook Islands. World Wide Fund for Nature, Suva.
- Fa'asili, U. 1999. The use of village by-laws in marine conservation and fisheries management. Paper presented at the 1<sup>st</sup> SPC Heads of Fisheries Meeting, 9-13 August, 1999. Noumea, New Caledonia. 7 p.
- Fong, G. M. 1994. Case study of a traditional marine management system: Sasa village, Macuata Province, Fiji. *FAO Field Report. RAS/92/T05. No 94/1. FAO, Rome.* 85 p.
- Hosch, G. 2000. The use of students in surveying subsistence fisheries-A Pacific Island case study. *FAO Fisheries Circular No. 962. Food and Agriculture Organization, Rome.* 104 p.
- IOI. 1999. Report of biological survey of the proposed Marine Protected Area, Ono, Kadavu and village workshop, 5-9 October, 1999. Waisomo, Ono. Unpublished Report. International Ocean Institute (IOI)-Pacific. 29 p.
- Jennings, S., and N. V. C. Polunin. 1996. Impacts of fishing on tropical reef ecosystems. *Ambio* 25(1):44-49.
- Jennings, S., and N. V. C. Polunin. 1997. Impacts of predator depletion by fishing on the biomass and diversity of non-target reef fish communities. *Coral Reef* 16:71-82

- Jimmy, R. 1995. Case study: The application of traditional management on trochus fishery in Vanuatu. Pages 221-224, *in* P. Dalzell and T. J. H. Adams (Eds.). South Pacific Commission and Forum Fisheries Agency Workshop on the Management of South Pacific Inshore Fisheries; Manuscript collection of country statements and background papers. Volume II.
- Johannes, R. E. 1981. Words of the lagoon: fishing and marine lore in the Palau district of Micronesia. University of California Press. Berkeley. 245 p.
- Johannes, R. E. 1998. The case for data-less marine resource management examples from tropical nearshore finfisheries. *Trends in Ecology and Evolution* 13:243-246.
- Johannes, R. E., L. Squire, Y. Sadovy, and H. Renguul. 1999. Spawning aggregations of Groupers (Serranidae) in Palau. *Marine Conservation Research Series Publ. # 1*, The Nature Conservancy: 144 p.
- Kallie, J. Y., A. Taua, and U. Faasili. 1999. An assessment of community-based subsistence fisheries in Samoa. Paper prepared for Marine Resources Assessment Group, Coastal Fisheries Management Conference.
- Kallie, J. Y., M. Lober, U. Tiitii, and A. Trevor. 2000. Community-owned protected areas. Paper presented at the National Environment Conference, Department of Conservation, Apia, Samoa.
- Kelso, B. J. 1996. Warning signs unheeded in South Pacific invertebrate trade. *Naga* 19(1):9-12.
- King, M. G., and U. Faasili. 1998a. Village fisheries management and community-owned Marine Protected Areas. *Naga* 21(2).
- King, M. G., and U. Faasili. 1998b. A network of small, community-owned fish reserves in Samoa. *PARKS* 8:11-16.
- King, M. G., and U. Faasili. 1999. Community-based management of subsistence fisheries in Samoa. *Fisheries Management and Ecology*, UK 6:133-144.
- King, M. G., and L. Lambeth. 2000. Fisheries management by communities. A manual on promoting the management of subsistence fisheries by Pacific Island communities. Secretariat of the Pacific Community. New Caledonia.
- King, W. T. 1997. Parks, reserves and Ra'ui on Rarotonga: A proposal for establishment of protected areas in a partnership between landowners, the community and government. Unpublished Report, Cook Islands Tourism Master Plan, April 1997.
- Mangubhai, S., and E. Rupeni. 2001. Establishing community-based marine reserves in the Fiji Islands- Lessons from the field, Unpublished Manuscript. April 2001. 7 p.
- Manarangi-Trott, L. 2001. Status report for Cook Islands aquarium fishes. Presented at the Sustainable Management of the Marine Aquarium Trade Workshop, 4-7 February, 2001. Nadi, Fiji. 6 p.
- Meyers, R. E. 1999. Micronesian reef fishes: A comprehensive guide to the coral reef fishes of Micronesia. 3rd edition. Coral Graphics, Guam. 330 p.
- Moosa, M. K., R. Dahuri, M. Hutomo, I. S. Suwelo, and S. Salim. 1996. Indonesian country study on integrated coastal and marine biodiversity management. Ministry of State for Environment, Republic of Indonesia. 189 p.

- Novaczek, I., I. Harkes, J. Sopacua, and M. Tatuhey, (in press). An institutional analysis of Sasi Laut in Maluku. ICLARM, Philippines.
- Preston, G. L. 1993. Beche-de-Mer. Pages 371-408, *in* A. Wright, and L. Hill (Eds.). Nearshore marine resources of the South Pacific. Information for fisheries development and management. Institute of Pacific Studies, Suva, Fiji and Forum Fisheries Agency, Honiara, Solomon Islands.
- Skelton, P. A., L. J. Bell, A. Mulipola, and A. Trevor. 2000. The status of the coral reefs and marine resources of Samoa. Paper presented at the International Coral Reef Initiative- Regional Symposium, 22-24 May, 2000. Noumea, New Caledonia. 66 p.
- South, G. R. 1993. Seaweeds. Pages 683-710, *in* A. Wright, and L. Hill (Eds.). Nearshore marine resources of the South Pacific. Information for fisheries development and management. Institute of Pacific Studies, Suva, Fiji, and Forum Fisheries Agency, Honiara, Solomon Islands.
- Raumea, K., T. Turua, N. Makikiriti, T. Rongo, N. Roi, and B. Ponia. 2000. 2<sup>nd</sup> monitoring survey of Rarotonga Ra'ui. Misc Report 2000/01 Ministry of Marine Resources. Rarotonga, Cook Islands. 27 p.
- Rawlinson, N. J. F., D. A. Milton, S. J. M. Blaber, A. Sesewa, and S. P. Sharma. 1994. A survey of the subsistence and artisanal fisheries in rural areas of Viti Levu, Fiji. ACIAR Monograph No. 35. 138 p.
- Reid, Te Tika Mataiapo D. 2000. Traditionally respecting the environment. Tok Blong Pasifik. March 2000. 7-8 p.
- Roberts, C. M., and J. R. Hawkins. 2000. Fully protected marine reserves: a guide. WWF Endangered Seas Campaign. Washington, D.C. and Environment Department, University of York, York, UK. 131 p.
- Roberts C. M., J. R. Hawkins, D. E. McAllister, and F. W. Schueler. In press. Hotspots, endemism and the conservation of coral reef fish biodiversity. Coral Reefs.
- Ruddle, K. 1995. Traditional community-based marine resources management systems in the Asia-Pacific region: Status and potential. Chapman Hall, London.
- Ruddle, K., E. Hviding, and R. E. Johannes. 1992. Marine resources management in the context of customary marine tenure. *Marine Resource Economics* 7:249-273.
- Russ, G. 1991. Coral reef fisheries: Effects and yields. Pages 601-635, *in* P. F. Sale (Ed.). The ecology of fishes on coral reefs. Academic Press.
- Russ, G. R., and A. C. Alcala. 1994. Sumilon Island Reserve 20 years of hopes and frustrations. *Naga* 17(3):8-12.
- Russ, G. R., and A. C. Alcala. 1996. Marine reserves: rates and patterns of recovery and decline of large predatory fish. *Ecological Applications* 6:947-961.
- Tuqiri, S., and R. S. South. 1997. Report on the Regional Marine Awareness Workshop, 12-15 August, 1997. Marine Studies Programme, Suva, Fiji. International Ocean Institute-South Pacific, Suva, Fiji. 91 p.
- Tuwai, I., A. Sesewa, and J. Korovulavula. 2000. Nagelelevu fisheries resource survey. Unpublished Report, Fisheries Divisions, Suva, Fiji. 38 p.
- Watling, D. N. D. Pocket poster guide of the birds of Fiji: Landbirds. Suva, Fiji.

- World Bank. 1999. Voices from the village: a comparative study of coastal resource management in the Pacific Island. Draft Report, World Bank, Washington. 58 p.
- Wright, A. 1993. Shallow water reef-associated finfish. Pages 203-284, *in* A. Wright A., L. Hill (Eds.). Nearshore marine resources of the South Pacific. Information for fisheries development and management. Institute of Pacific Studies, Suva, Fiji and Forum Fisheries Agency, Honiara, Solomon Islands.
- Wright, A., and L. Hill (Eds.). 1993. Nearshore marine resources of the South Pacific. Information for fisheries development and management. Institute of Pacific Studies, Suva, Fiji and Forum Fisheries Agency, Honiara, Solomon Islands. 710 p.
- Wright, A., and A. H. Richards. 1985. A multispecies fishery associated with coral reefs in the Tigak Islands, Papua New Guinea. *Asian Mar. Biol.* 2:69-84.
- Zann, L. 1991. The inshore resources of Upolu, Western Samoa: Coastal inventory and fisheries database. Unpubl report 5. FAO/UNDP Project SAM/89/002. Apia, Samoa, FAO.

## Figures and Tables

Figure 1. Fishing Gear Owned by Households in Eastern Samoa.

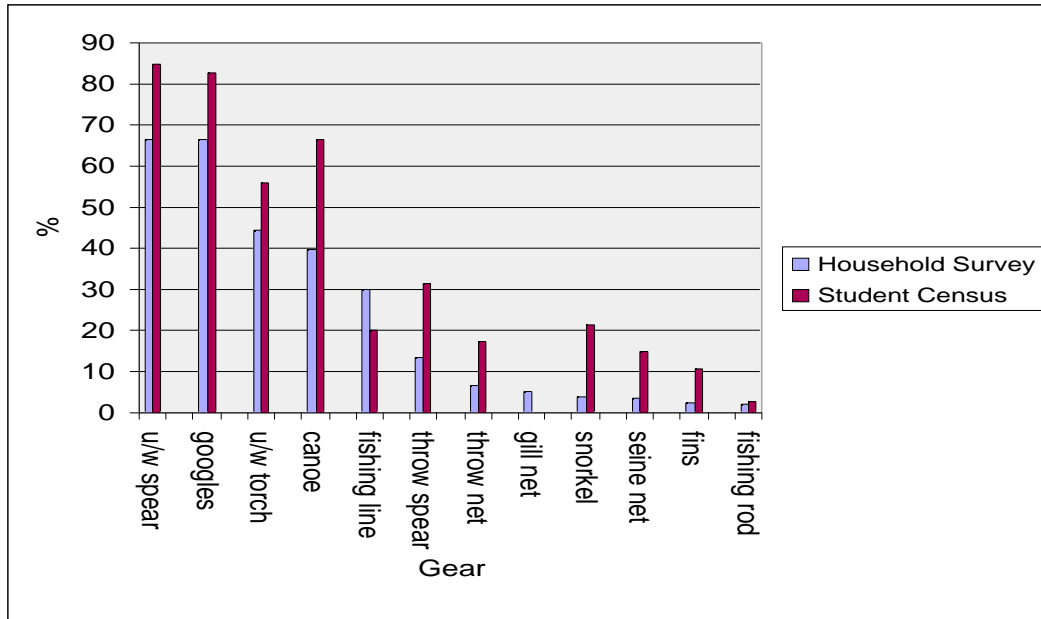
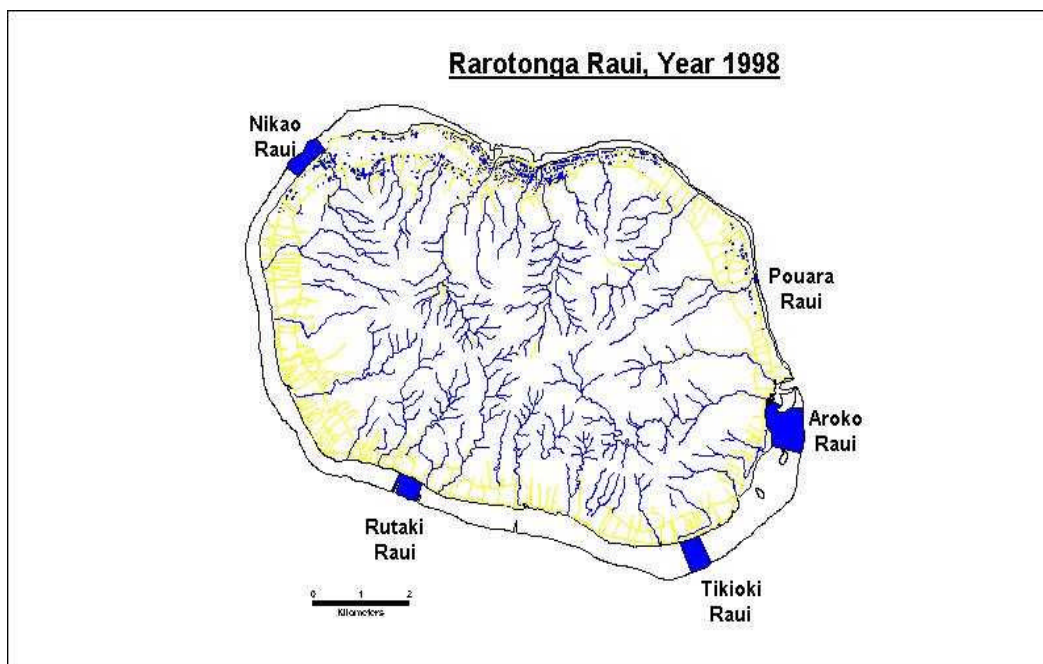


Figure 2. Location of Ra'ui on Rarotonga in 1998.<sup>1</sup>



<sup>1</sup> Source: Evans 2001.

Figure 3. Location of Ra'ui on Rarotonga in 2000.<sup>2</sup>

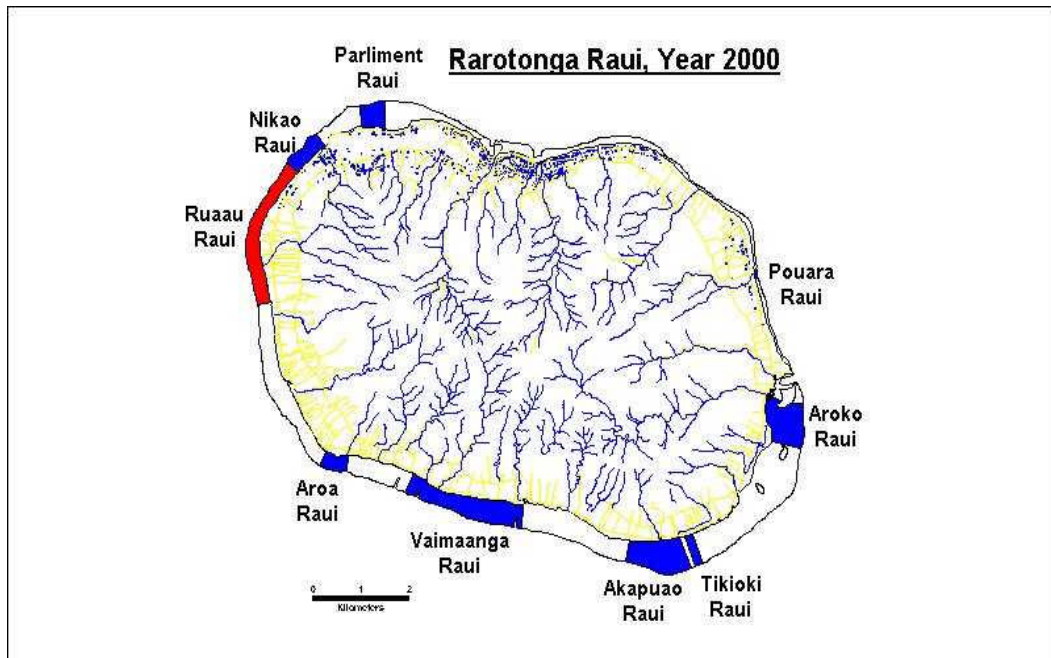
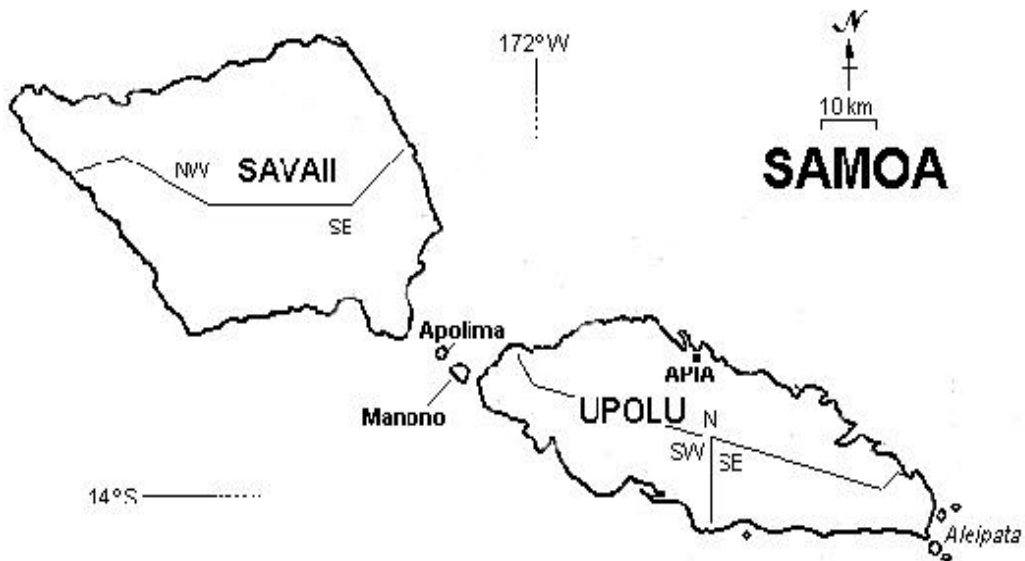


Figure 4. Map of Samoa.



<sup>2</sup> Source: Evans 2001.

Figure 5. The community-based fisheries extension process in Samoan villages.

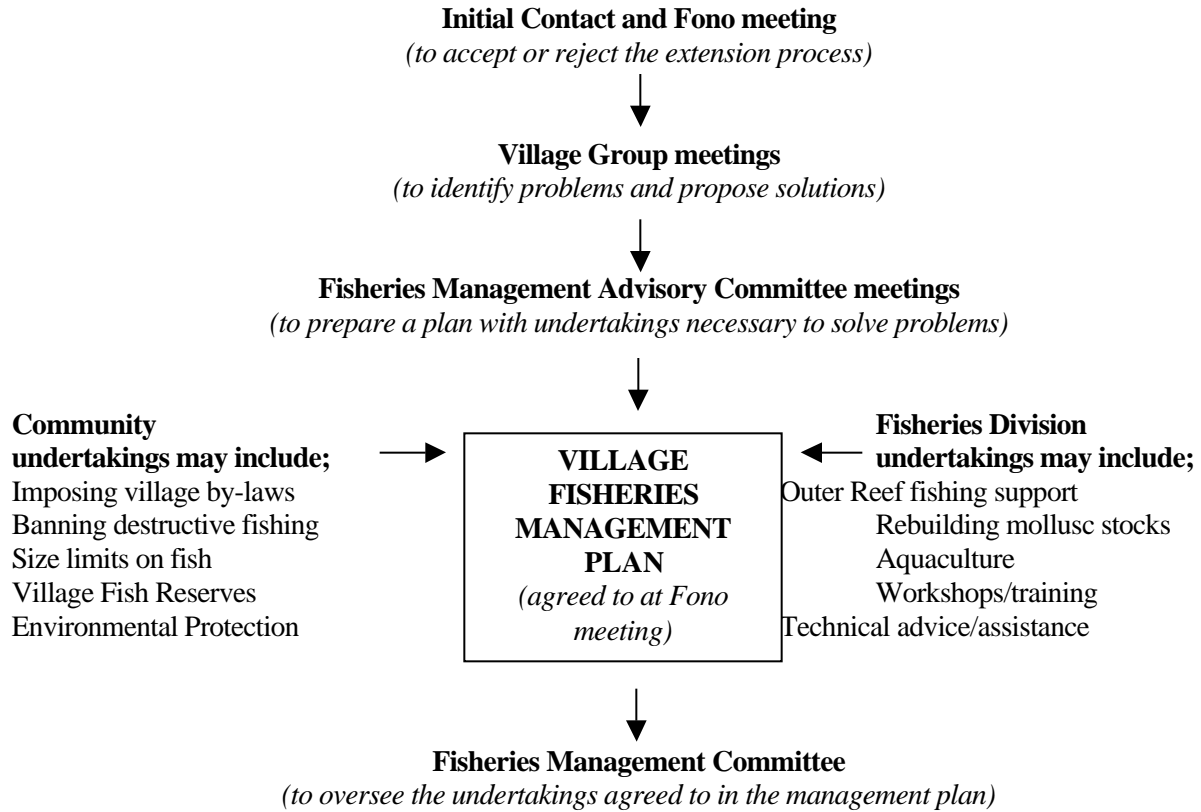
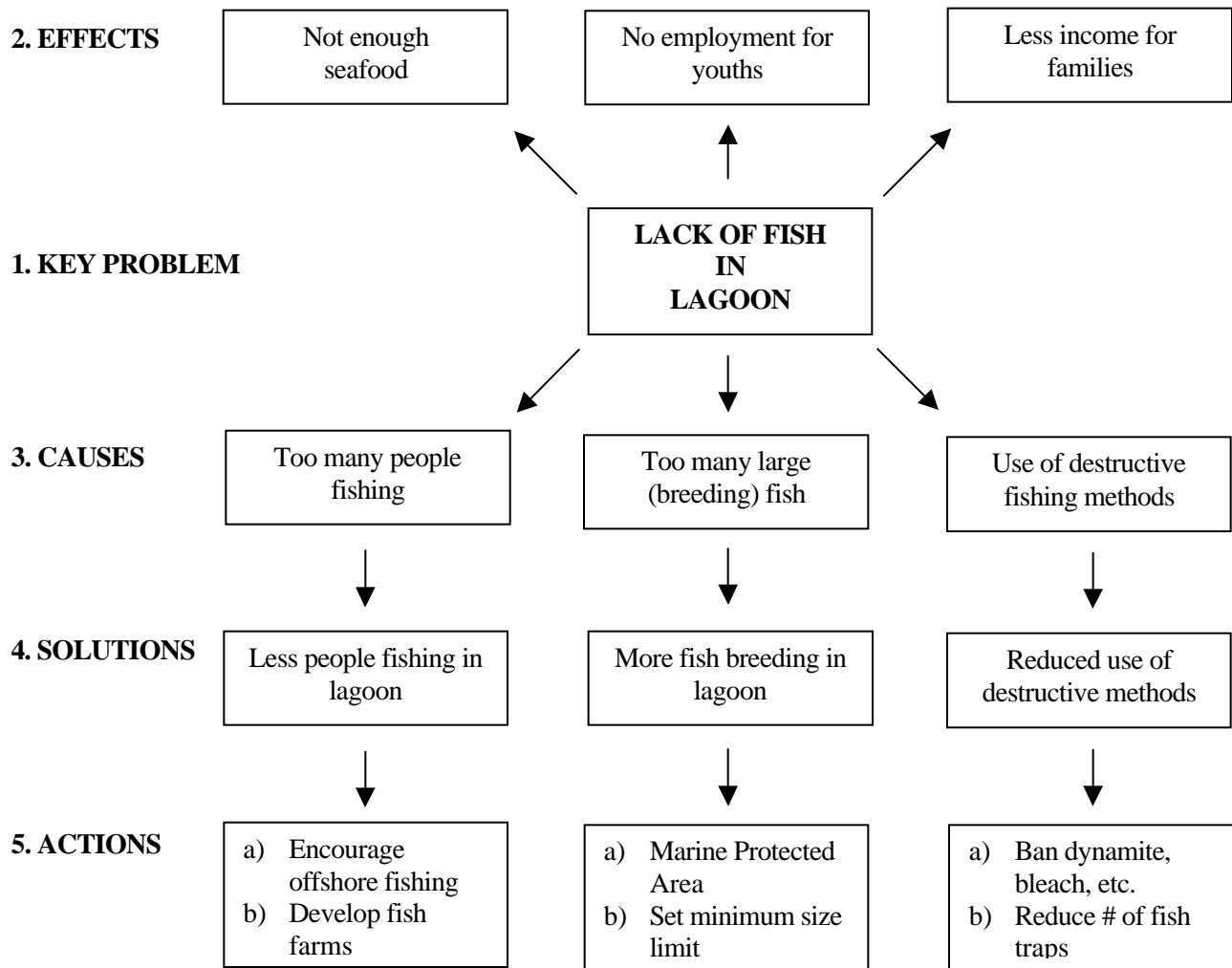


Figure 6. Simplified example of a problem/solution tree as constructed by a village community.<sup>3</sup>



<sup>3</sup> NOTE: The process begins with step 1 (Key Problem) before proceeding in the numerical order shown. All information is provided by the community, with a facilitator acting as a recorder.



Figure 7. Map of Ono, Kadavu and Viti Levu, Fiji

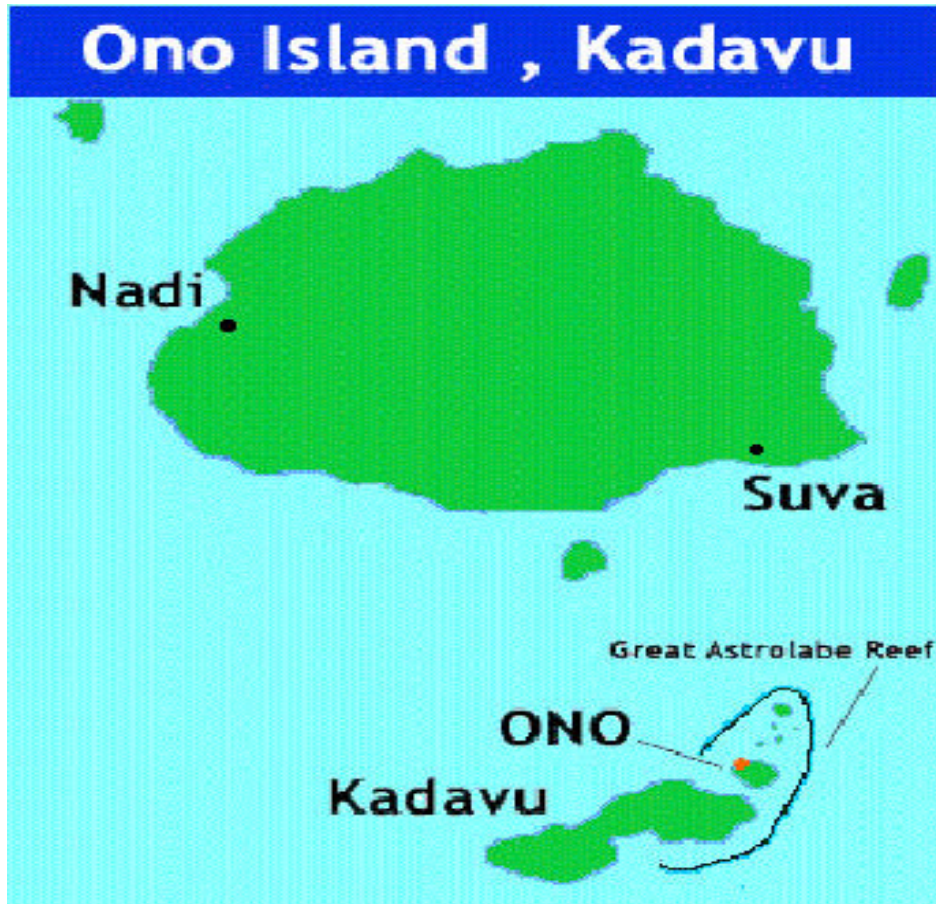


Table 1. Marine biodiversity of inshore areas in the Pacific Islands.<sup>4</sup>

Area/ Country	Inshore Fish		Hard Coral		Marine Algae	
	Species	Ref	Species	Ref	Species	Ref
Eastern Indonesia	2700	1	350	2		
Papua New Guinea	2146	1				
Micronesia	1681	1			550	3
Fiji	1400	4	160	4	310	3
Samoa	890	5	50	5	287	5
Cook Islands	492	6	58	7		

<sup>4</sup> References: 1. Meyers, 1999, 2. Moosa *et al.*, 1996, 3. South, 1993, 4. Johnson Seeto, USP, Fiji personal communication, 5. Skelton *et al.* 2000, 6. Gerald McCormack, Cook Islands National Heritage Project, Rarotonga, personal communications. 7. SPREP 1993.

Table 2. The fish composition of the small-scale inshore fishery in Samoa.<sup>5</sup>

Family/Group	Common name	% distribution in catch or creel census		
		Student census	Creel census	Apia market
Acanthuridae	Surgeonfishes & Unicornfishes	22.7	22.2	29.0
Aluteridae (Monacanthidae)	Filefishes	1.9	1.5	
Balistidae	Triggerfishes			
Belonidae	Needlefishes	-	0.2	
Canthigasteridae	Puffer fishes	-	0.2	
Carangidae	Jacks & Trevallys	3.3	1.0	3.9
Chaetodontidae	Butterfly fishes	2.4	2.0	
Diodontidae	Porcupine fishes	0.3	0.3	
Fistularidae	Coronetfishes	0.1	0.4	
Gerreidae	Mojarras	0.2	-	0.2
Haemulidae	Sweetlips	-	-	
Hemirhamphidae	Garfishes	0.2	-	
Holocentridae	Squirrelfishes & Soldierfishes	7.9	10.2	3.3
Kyphosidae	Rudderfishes	0.2	0.4	0.7
Labridae	Wrasses	3.3	6.2	1.2
Lethrinidae	Emperors	11.3	11.6	11.8
Lutjanidae	Snappers	0.5	3.2	1.4
Mullidae	Goatfishes	3.2	2.4	2.9
Mugilidae	Mulletts	1.5		10.9
Muraenidae	Moray eels	0.4	1.1	4.0
Plueronectidae	Righteye flounders	0.2	-	
Priacanthidae	Bigeyes	0.9	0.1	
Scaridae	Parrotfishes	9.1	12.4	24.8
Serranidae	Groupers	10.2	4.1	3.8
Sphyrnidae	Hammerhead shark	-	-	
Siganidae	Rabbitfishes	3.6	7.5	1.0
Scombridae	Tunas & mackerels	-	0.2	
Theraponidae	Grunters	0.7	0.4	
Other				1.3

<sup>5</sup> Source: Student census and creel census data from Hosch 2000, Apia Market data from Skelton *et al.* 2000.

Table 3. The invertebrate composition of the small-scale inshore fishery in Samoa.<sup>6</sup>

Family/Group	Common name	% distribution in catch or creel census	
		Student Census	Creel Census
Anaspidea	Sea hares	0.2	-
Cassidae	Helmut shells	-	0.1
Echinoidea	Sea urchins	8.1	6.6
Holothuroidea	Sea Cucumbers	2.2	0.5
Octopoda	Octopus	1.3	0.9
Portunidae	Mud crabs	0.2	0.3
Tridacnidae	Giant Clams	0.9	0.1
Trochidae	Trochus	2.3	3.5
Turbinidae	Turban Shells	0.6	-
<b>Total Invertebrates</b>		<b>15.8</b>	<b>12.2</b>

Table 4. Change in numbers of selected invertebrates in the four ra'ui, Rarotonga, Cook Islands, after 22 months.<sup>7</sup>

Location	Nikao	Matevera	Aroko	Tikoki	All
Species	% Increase from February 1998 to November 1999				
Kina ( <i>Echinometra mathaei</i> )	79	48	107	-26	50
Trochus ( <i>Trochus nioloticus</i> )	242	105	7050	-25	228
Paua ( <i>Tridacana maxima</i> )	544	126	31	-50	124
Number of Species	38	36	18	27	30

<sup>6</sup> Source: Hosch 2000.

<sup>7</sup> Source: Raumea *et al.* 2000.

Table 5. Per cent of village undertakings various fisheries management measures in the Samoan Training and Extension Project.

<b>Undertaking</b>	<b>Per Cent of villages</b>
ban on dynamite and bleach	100
ban on fish poisons	96
fish reserve declared	92
ban on smashing coral	82
remove crown of thorns	79
ban dumping of rubbish	75
mesh size limits	73
set fish size limits	39
ban export coral	39
ban clearing mangroves	30
ban underwater torches	16
ban taking sand	13
control fish fences	7

