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Group Coordinator and Bulletin Editor: Kenneth Ruddle, Matsugaoka-cho 11-20, Nishinomiya-shi, Hyogo-ken 662, Japan. [Tel. & fax: +81 798 71 4749; E-mail: ii3k-rddl@asahi-net.or.jp] **Production**: Information Section, Marine Resources Division, SPC, B.P. D5, 98848 Noumea Cedex, New Caledonia. [Fax: +687 263818; E-mail: cfpinfo@spc.org.nc]. The bulletin is available at: <http://www.spc.org.nc/coastfish> (click Newsletter in the menu). **Printed with financial assistance from France.**

Note from the coordinator

This issue gives me particular pleasure, for which I thank the authors. For the first time since launching this InfoBull all contributions were unsolicited! Better yet, we were able to pick and choose among manuscripts offered. So perhaps we are over one daunting hill that faces all new serials.

But, I will continue badgering those who have yet to contribute, especially you who have promised over the last few years, but have still to deliver! It might encourage those in academic institutions to know that all articles in this issue have been peer reviewed. This is another first. I intend to continue that, so your time and efforts will not be wasted.

However, it remains a constant problem to catch relevant items of new literature. So we would be grateful if you could bring to our attention books, articles and other documents that you think should be reviewed, or at least noted. Better yet, please arrange to have a copy sent to us.

Don't forget that this Information Bulletin as well as most other SPC fisheries-related publications can be found on SPC web site at: <http://www.spc.org.nc/coastfish> (click 'Newsletter' on the menu).

Kenneth Ruddle

Inside this issue

A network of small, community-owned Village Fish Reserves in Samoa

by Michael King & Ueta Fa'asili [1]

Summary

Under a community-based fisheries extension programme in Samoa, 44 coastal villages have developed their own Village Fisheries Management Plans. Each plan sets out the resource management and conservation undertakings of the community, and the servicing and technical support required from the government Fisheries Division. Community undertakings ranged from enforcing laws banning destructive fishing methods to protecting critical habitats such as mangrove areas. An unexpectedly large number of villages (38) chose to establish small Village Fish Reserves in part of their traditional fishing areas. Although by social necessity many of the community-owned reserves are small, their large number, often with small separating distances, forms a network of fish refuges. Such a network may maximise linking of larval sources and suitable settlement areas and provide the means by which adjacent fishing areas are eventually replenished with marine species through reproduction and migration. As the Fish Reserves are being managed by communities which have a direct interest in their continuation and success, prospects for continuing compliance and commitment appear high. Results confirm our belief that the responsible management of marine resources will be achieved only when fishing communities themselves accept it as their responsibility.

Introduction

In many countries in the tropics, inshore catches of fish and shellfish are declining. In Samoa, catches of seafood from lagoons and inshore reefs have been decreasing for over ten years (Horsman & Mulipola, 1995). Reasons for this decline include overexploitation, the use of destructive fishing methods (including explosives, chemicals and traditional plant-derived poisons) and environmental disturbances.

Despite concerns over declining fish stocks, government actions and national laws to protect fish stocks are rarely successful. This is due to many factors, including poor enforcement regimes and particularly the lack of community involvement. Fishing communities are often repositories of valuable traditional knowledge concerning fish stocks, and have a high level of awareness of the marine environment (Johannes, 1982). In addition, many subsistence fishers in tropical regions live in discrete communities that have some degree of control, either legal or traditional, over adjacent waters. Together, these factors provide an excellent basis to encourage and motivate communities to manage their own marine resources.

Methods

The community-based fisheries extension project began in 1995. After staff training, a culturally acceptable extension process was developed which recognised the village *fono* (council) as the prime instigator of change, while still allowing ample opportunities for the wider community to participate (Figure 1; also King and Fa'asili, 1999). Full field operations began in 1996.

Following an indication of interest, a village *fono* meeting was arranged to provide the community with information to allow either acceptance or refusal of the extension programme. If the *fono* accepted, it was then asked to arrange for meetings of several village groups, including women and untitled men *(aumaga)*.

Over a series of meetings, each group held separate meetings to discuss their marine environment and fish stocks, decide on key problems, determine causes, propose solutions, and plan remedial actions. Problem / solution trees were recorded on a portable white board by a trained facilitator. Finally, a village Fisheries Management Advisory Committee was formed, with three people nominated from each group, to prepare a draft Village Fisheries Management Plan (assisted by Extension Officers) for discussion and approval by the village *fono*. One third of all village group meetings were for women only, and approximately one third of members of the management committees were women. The proportions for untitled village men were similar.

Each Village Fisheries Management Plan listed the resource management and conservation undertak-

1. Fisheries Division, MAFFM, PO Box 244, Apia, Samoa.

ings of the community, and the servicing and technical support required from the Fisheries Division. If the plan was accepted, the *fono* then appointed a Fisheries Management Committee to oversee the working of the plan.

Results

Within almost two years of full operation, fisheries extension staff attempted to introduce the extension programme in 65 villages. The extension process was rejected by nine villages and discontinued in a further four villages when extension staff noted a lack of community commitment (King & Faasili, 1999). So far 44 of the remaining villages have produced Village Fisheries Management Plans. The time taken from initial contact to approval of the plan by each village community averaged 13.4 weeks.

In their plans, communities included undertakings to support and enforce Government laws banning the use of chemicals and explosives to kill fish. Traditional destructive fishing methods, such as the use of plant-derived fish poisons *(ava niukini)* and smashing of coral to catch sheltering fish (*fa'amo'a* and *tuiga*), were also banned. Most villages made their own rules to enforce national laws banning the capture of fish less than a minimum size, and some set their own (larger) minimum size limits. Some villages placed controls on the use of nets and on underwater torches for spearfishing at night. Community conservation measures included collecting crown-of-thorns starfish (*Acanthaster planci* [L]), and banning the removal of beach sand and dumping of rubbish in lagoon waters. An unexpectedly large number of villages (38) chose to establish their own small Village Fish Reserves, closed to all fishing, in part of their traditional fishing area (see Figure 2, next page). The size of reserves ranged from 5,000 to 175,000 m^2.

Fisheries Division actions to support community undertakings included the provision of assistance with the farming of tilapia *(Oreochromis niloticus)* in freshwater (in 16% of villages), facilitating the purchase of medium-sized boats to allow community members to fish outside the lagoons (39%), and restocking giant clams *(Tridacna derasa)* in Village Fish Reserves (82%).

Giant clams have been heavily depleted in Samoa and ongoing attempts to breed from native species *(Tridacna squamosa* and *T. maxima)* have been hampered by the difficulty of finding enough large

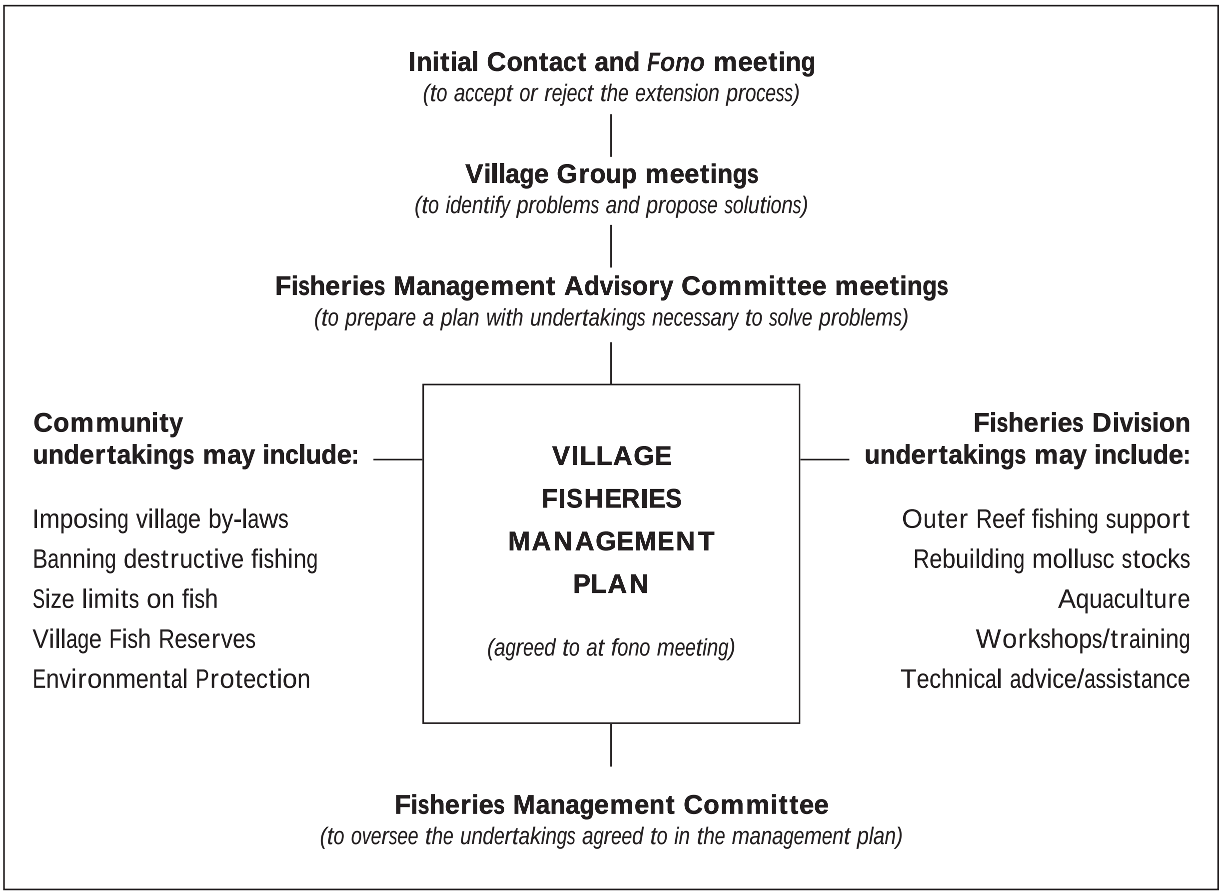

Figure 1: **The community-based fisheries extension process in Samoan villages**

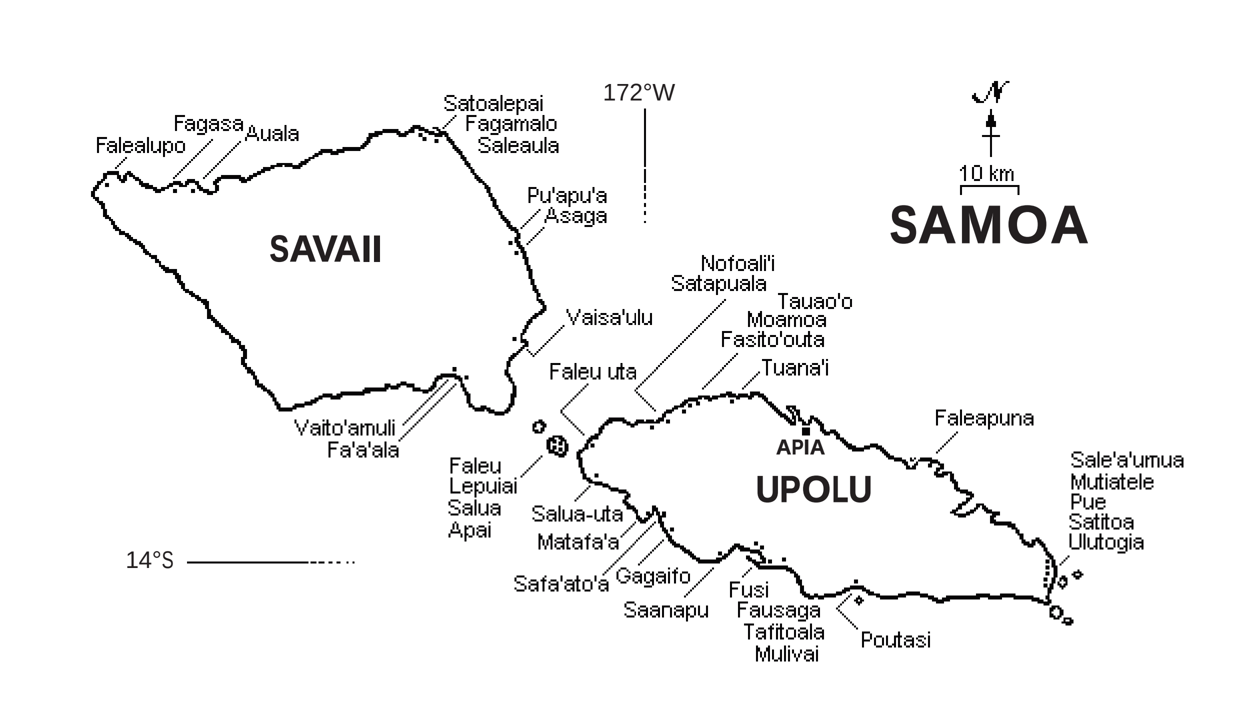

Figure 2. **Villages with community-owned Village Fish Reserves in Samoa.**

animals in the wild. Large numbers of a related species *(T. derasa)* were imported from American Samoa to fill the vacant ecological niche (for a photosynthesising filter-feeder). After a quarantine period, these were placed in village reserves to be monitored and cared for by communities. These translocations were regarded as low risk, involving hatchery-raised clams from an adjacent island, which is geographically, if not politically, the same country.

A quantitative assessment of villages with Fisheries Management Plans in place for over six months revealed that all but eight were still actively pursuing undertakings and enforcing conservation rules included in their plans. Villages received low scores for various reasons, including holding few village Fisheries Management Committee meetings, not enforcing village rules, failing to care for restocked clams and poorly maintaining their reserve signs and markers.

Discussion

Community-owned Fish Reserves may be discussed in terms of expected benefits to both villages and government. The community expectation is that, by banning fishing in part of its traditional fishing area, fish catches in adjacent areas will eventually improve. Although government authorities may share this expectation, there are additional public benefits relating to management, compliance and sustainability.

Because the Samoan Village Fish Reserves are being managed by communities with a direct interest in their success, compliance with bans on fishing is high and there are not the enforcement costs associated with national reserves. Most villages with reserves have actively enforced their own rules, and applied often severe penalties, including traditional fines of pigs or canned goods, for infringements. Some villages have made their village rules into fisheries by-laws, so they can be applied to people from other villages (Faasili, 1997). Community enthusiasm and commitment suggests that the prospects for continuity of the reserves are high.

The fisheries management benefits of marine protected areas are usually stated in terms of providing refuges in which invertebrate and fish stocks can grow and reproduce without interference. There is evidence that fish biomass increases, rapidly for some species, in areas where fishing is excluded (e.g. Roberts, 1995), and some evidence that this increase will result in higher catches in adjacent fishing areas (Roberts & Polunin, 1991; Alcala & Russ, 1990). Fish larvae, previously thought of as passive drifters, may be able to detect the presence of, and to swim towards, reefs several kilometres away (Wolanski *et al.*, 1997). This suggests that refuge-derived larvae may actively move to and repopulate nearby reefs. Alternatively, if larvae settle in the same area in which they were spawned, juvenile or adult fish may eventually move out of refuges in response to increased crowding and competition. Tagging studies in South Africa suggest that excess stocks of fish in reserves move to adjacent exploited areas (Attwood & Bennett, 1994).

Ideally, a reserve should be located in such a position, and be of sufficient size, to encourage a significant increase in the numbers of sedentary species (including corals) and fish stocks. However, in the case of village-ownership there are often constraints on both position and size.

In Samoa, when a village had proposed a reserve in an unsuitable position (e.g. an area of bare sand or coral rubble), additional scientific information was provided to encourage the community to select a more appropriate site. Some villages initially elected to have very large reserves, and a few wanted to ban fishing in their entire lagoon area. In such cases, extension staff were obliged to curb over-enthusiasm, and ask the community to balance the perceived fish production advantages of a large reserve against the sociological disadvantages of banning fishing in a large proportion of the village's fishing area. In the latter case, although young men would still be able to go fishing beyond the reef, women (who traditionally collect echinoderms and molluscs in subtidal areas) and the elderly would be particularly disadvantaged in losing access to shallow-water fishing areas. A large reserve may also force people to fish in the waters of neighbouring villages, thereby increasing the potential for inter-village conflict.

In terms of total fisheries production, a small reserve is unlikely to be as effective as a large one. Larger reserves are more likely to provide suitable breeding areas for small inshore pelagic fish, such as mullets and scads, but studies in South Africa (Buxton 1996) suggest that even small reserves are beneficial for non-migratory species. Indeed, it could be argued that for non-migratory species the combined larval production from many small reserves is likely to be greater than that from a smaller number of large ones. However, as the interconnections between larval sources and settlement areas are poorly understood, this remains a hypothesis, which is not easy to test.

There is currently a proposal to subsume several existing small, single-village Village Fish Reserves within two larger MPAs which would be managed by districts rather than single villages (Kelleher, pers. com). If these larger MPAs contain some no-fishing areas, as is proposed, it is possible that two large reserves connected via a broken chain of smaller Village Fish Reserves may confer the dual benefits of linking larval sources with settlement areas and providing larger breeding areas for inshore migratory species.

In addition to the availability of people-motivating skills, the success or otherwise of community-based fisheries management depends on the availability of professional technical support for the communities involved. Scientific input is required to assist communities with alternative sources of seafood and to advise on and monitor community actions.

Whether community-based or not, most fisheries conservation measures, including the prevention of destructive fishing and the imposition of fish size limits, will cause a short-term decrease in catches. The same is so for Village Fish Reserves, as they reduce the area available for fishing. As most subsistence fishers require seafood for their families on a daily basis, it is unreasonable to expect fishing communities to adopt conservation measures which will initially reduce present catches of seafood even further without offering alternatives. Accordingly, the Samoan extension programme included the promotion and development of alternative sources of seafood to those resulting from the present heavy and destructive exploitation of near-shore reefs and lagoons. These alternatives included the introduction of medium-sized, low-cost boats (to divert fishing pressure to areas immediately beyond the reefs), the promotion of village-level aquaculture and the restocking of depleted species of molluscs in village areas. It is doubtful that community-based fisheries management would continue on a sustainable basis without such ongoing support.

Scientific input is also required to advise on, and monitor the effects of, village actions. For the community-owned Village Fish Reserves, this included providing advice on the placement of reserves, monitoring biological changes within the reserves, and collecting data on fish catches in adjacent areas. An additional benefit of fisheries staff working closely with communities is that the collection of scientific data on subsistence fisheries is greatly facilitated by community involvement. A large amount of information, and even estimates of sustainable yield by area, may be gained from such extensive surveys on subsistence fisheries. Where data are collected from different areas with similar ecological characteristics it may be possible to apply a surplus yield model (over area rather than time) to estimate not only the average sustainable catch, but also indicate villages where resources are presently under pressure (King, 1995).

The Samoan model appears applicable to other countries in which fishing communities have either traditional, *de facto* or legal control over their adjacent waters. In countries where this is not the case, it may be necessary to grant such rights (Territorial Use Rights in Fisheries, or

TURFs) as proposed in the Philippines (Agbayani and Siar, 1994) to facilitate community management and the establishment of Village Fish Reserves. Indeed, results in Samoa have confirmed our belief that, regardless of legislation or enforcement, the responsible management of marine resources will be achieved only when fishing communities themselves see it as their responsibility. If community actions include the declaration of even small Fish Reserves, this may contribute to fisheries and biodiversity conservation.

Finally, it should be noted that the small, community-owned, Village Fish Reserves in Samoa are not easy to classify under existing IUCN categories for MPAs. Category IV (Habitat / Species Management Area) appears to provide the best fit, although the category guidelines refer to national rather than community ownership. Given the increasing trend towards community-based management, the popularity of reserves as a fisheries conservation tool and the necessarily small size of village MPAs, there may be a need for another IUCN category for "networks of small, highly protected, community-owned MPAs".

Acknowledgments

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The use of village by-laws in marine conservation and fisheries management

by Ueta Fa'asili & Iuliaa Kelekolo [1]

Background

Thirty years ago, most of the waters surrounding the islands of Samoa were untouched, and the beauty of the underwater world was seen as a major attraction. Corals of different forms provided a naturally arranged beauty of different structures. Reef fish of many types added colour to this beauty. Reefs and lagoons were rich in food resources and able to sustain the demand of coastal dwellers.

As years passed, and as the population expanded, the demand for fishery resources similarly increased. People were attracted to use the most effective but often destructive ways of catching fish. These include breaking corals, poisoning fish, using explosives and many others. It is now realised that many of these methods are very destructive to the marine environment. The Division of Fisheries through its extension programme has introduced a community-based approach in order to assist village communities to manage and conserve their inshore fishery resources. Through this approach, by-laws become an important tool for the management of subsistence fisheries.

Inception of village fisheries by-laws

In the mid-1980s, it was realised that the inshore fisheries of almost all villages along the coast of Samoa were experiencing serious declines in catches. The identified causes include overexploitation, the use of destructive fishing methods, and environmental disturbance. The situation has caused concern not only to the Government, but also to a large number of the village communities. As a result, village communities through their village *fono* (council) began to use local media to advertise village rules to prevent further decline of their inshore fishery resources. Advertisements reiterated the ban on the use of explosives, chemicals and other destructive fishing techniques and expressly prohibited nearby villages fishing in their respective lagoon areas. They also indicated penalties to be paid to the *fono* for any breach of their village rules by their own residents. For breach by outside villages, advertisements included threats of legal action. While the enforcement of village rules within individual communities was relatively easy, problems were experienced with enforcement on outside communities.

The Fisheries Division recognised that such actions by the *fono* provided an excellent avenue to introduce effective management regimes for the inshore fisheries. However, some village rules to manage and conserve fishery resources contradicted existing Government laws. This has resulted in several *fono* not being able to pursue court action against breaches by neighboring villages. For this reason, the Fisheries Division felt that the village *fono* should be given assistance; village rules that facilitated the conservation and management of their subsistence fisheries should be legalised. Therefore, when the Fisheries Act was formulated in 1988, the Fisheries Division made sure that the rules set by the village *fono* were given legal recognition. To this end, the Fisheries Act was specifically designed to include provisions dealing with procedures wherby a village *fono* could declare its own rules as by-laws. These in essence are village rules that have legal recognition; hence the inception of village fisheries by-laws.

What are village by-laws?

Village Fisheries By-laws are village rules that have been prepared in accordance with relevant provisions of national Fisheries Legislation and are accorded legal recognition in the courts of law.

By-laws can cover any measure that assists the management and conservation of the fishery resources. These may include the restriction of the sizes of fish and shellfish (providing they are not smaller than those set out in the Fisheries Regulations 1996), bans on certain types of fishing gear and methods, allocation of fish quotas, restriction of mesh sizes for nets and fish traps (again providing they are not smaller than those set out in the Regulations) and closure of fishing seasons or areas to allow fish to reproduce. Importantly, they must apply to all citizens equally (not just people from outside the sponsoring village). Table 1 lists some of the common fisheries regulations now being taken over by communities as their own by-laws.

1. This paper was presented at the first SPC Head Of Fisheries Meeting, Noumea, New Caledonia, 9–13 August 1999.
2. Fisheries Division, Ministry of Agriculture, Forests, Fisheries and Meteorology, Apia, Western Samoa

The by-law process

Step 1: By-law formulation

In all Samoan village communities, the highest village authority is referred to as a *fono* (council of chiefs). It is the authority that determines village rules, sets village policies and imposes traditional punishments on village residents when they do not abide with village rules and polices. So if a village *fono* decides to promulgate village by-laws, the chiefs will consult among themselves first on the rules they would like to introduce, bearing in mind that the rules must be related to the conservation and management of the fishery resources.

Step 2: Consultation process

Once the chiefs have agreed upon the rules, they then send their representatives to the Fisheries Division and consult as to the appropriateness of their proposed rules. This process is essential because the village *fono* may decide on rules that contradict some existing Government legislation. Sometimes the *fono* may wish to introduce rules that apply to outside villages but exempt their own residents. So this process allows the *fono* to have a better understanding of the limitations of by-laws and why they should be applied equally to all Samoan citizens. Through this process, the Fisheries Division may suggest improvements, alterations, and in extreme cases, recommend complete deletion of the proposed by-law. Also through this process, the Fisheries Division undertakes redrafting of the by-laws to reflect the wish of the *fono*.

Step 3: Final checking and clearance by the Office of the Attorney General

When the changes made in the consultation process have been agreed upon, they are then submitted to the Office of the Attorney General for final checking and clearance. In this step, the by-laws are also written into their legal and proper forms.

Step 4: Signing

When all by-laws have been checked and finalised, they are returned to the Fisheries Division for the signature of the Director of the Ministry of Agriculture, Forests, Fisheries and Meteorology.

Step 5: Gazetting, publishing and distribution process

After the by-laws are signed, they are then passed to the Legislative Assembly to be gazetted. At the same time they are published by the Fisheries Division in the local newspaper and copies are distributed to *pulenu* (nominated Government representatives) of neighbouring villages. The distribution of the by-laws to neighbouring villages is necessary because they are the people most likely to breach the by-laws if they are not duly informed. The by-laws will then come into force on a fixed date stipulated in the by-laws. The by-laws do not come into effect until 14 clear days after the date of publication in the Government Gazette. Until this time the village communities are not able to enforce them. The by-laws may be altered or revoked as required from time to time by the village *fono*.

Table 1: Community Actions and Regulations in villages in Samoa (Figures in the right-hand column indicate the percentage of all villages using the particular action or Fisheries regulation as their own by-laws).

Action/Regulation	Percentage
Banning the use of chemicals and dynamite to kill fish.	100%
Banning the use of traditional plant-derived fish poisons.	100%
Establishing small protected areas in which fishing is banned.	86%
Banning other traditional destructive fishing methods (e.g. smashing coral).	80%
Organising collections of crown-of-thorns starfish.	80%
Enforcing (national) mesh size limits on nets.	75%
Banning the dumping of rubbish in lagoon waters.	71%
Banning the commercial collection of sea cucumbers (Holothuroidea).	41%
Banning the capture of fish less than a minimum size.	41%
Banning removal of mangroves (in villages with mangroves).	27%
Restricting the use of underwater torches for spear fishing at night.	21%
Banning the removal of beach sand.	14%
Placing controls or limits on the number of fish fences or traps.	<10%
Prohibiting the collection of live corals for the overseas aquarium trade.	<10%
Banning the coral-damaging collection of edible anemones (Actinaria).	<10%

Step 6: Monitoring and enforcement

The last and most important process is the monitoring and enforcement of the by-laws by village communities. The communities normally put signboards along roadsides and beaches to inform the public of the areas to which their respective by-laws apply. Communities variously build watch houses; and use patrol canoes and regular watchmen to monitor illegal activities in their coastal zones and marine protected areas.

Once the by-laws come into effect, breaches by individuals from the village sponsoring the by-laws can be dealt with by the village *fono* using traditional fines such as provision of pigs, taro and others. Breaches by outside village communities are handled through the court of law. Anyone found breaching a by-law is liable to a fine not exceeding $ 100 (Samoan Tala) and not more than $ 20 for each day if the breach continues. The village *fono* is the enforcement body and any breach of the by-laws should be reported to the police. If the offence involves an existing Government law or Fisheries legislation, applicable fines under those laws will apply.

Advantages of village by-laws over village rules and government laws

While most of the rules set by the *fono* to govern the management and conservation of their fishery resources receive full support from Fisheries, these rules are only applicable to members of that community. In cases where people from outside a village come into local waters, the community may be powerless to insist that visitors obey local rules. Village rules are not legally recognised and therefore cannot be used to take court action. An example of this would be the banning of outside villagers from fishing another village's Marine Protected Area. Under the Lands, Survey and Environment Act 1989, all land lying below the line of high water mark shall be public land. This gives the authority to any person outside the village that owns the rules to fish in the area designated as Marine Protected Area. As for Government, much legislation has been passed to prohibit harmful fishing practices, and Fisheries Regulations have been put in place to restrict the harvest of small fish. Such Government legislation has not proven effective in ensuring the proper management and conservation of Samoa's fishery resources. The basic reason is that Samoa, in common with many other island countries, does not have adequate resources (either funds or manpower) to monitor and enforce legislation.

On the other hand, village Fisheries by-laws are village rules that can be monitored and enforced by the village *fono*. Quite often village *fonos* take existing Fisheries regulations to form major parts of their by-laws. Customary fines are imposed on residents of villages that own the by-laws. For outsiders, the village *fono* can take legal action against any breach through the court of law. One very important aspect that has been noticed is, that the communities, guided by the village *fono*, are more active and committed when the rules belong to them. By-laws form an important part of the village community management plan**. The main advantage of the by-laws over the regular laws concerning fisheries is that by-laws are monitored more effectively than those of regular fisheries laws.** Given the limitation of resources and personnel, many laws set by Government are hard to police and so can not be effectively monitored. By-laws on the other hand are created by people with real interest in the management and conservation of fishery resources in question. In cases of by-laws set by the *fono*, the *fono* itself is inclined to ensure that the by-laws are properly monitored. Within the three-and-a-half-year period since Fisheries first introduced the community-based programme to manage the inshore fishery resources of Samoa, 52 villages have established their own by-laws.

Problems

While the by-laws are seen to work very effectively, there have been problems identified within both the village communities and Government agencies themselves.

In some village communities, village *fonos* are subject to disruption due to internal differences amongst the chiefs themselves. When this happens, the *fono* can no longer function properly and enforcement is not effective. Two such cases have been reported to the Fisheries Division since the inception of the village by-laws.

From the Government side, the process involving other Government agencies is not prompt enough to meet the expectation of village communities. When there is a delay in the process, the village *fono* will often go ahead and enforce its by-laws before the legal procedure is completed. While the by-laws can be enforced amongst the residents of the village that owns them, enforcement against the nearby villages is difficult and quite often involves the use of physical force. So there is a potential for inter-village battles as a result of delays in the process.

One problem Fisheries Division has realised is the cost involved in advertisement of the by-laws. If Fisheries is targeting 17 village communities for its annual work program, costs exceed $ 5,100

(Samoan Tala). This is quite a large amount for one-line item in a Divisional budget. However, it is not expensive relative to the expected long-term beneficial impact on the marine environment.

Conclusion

The success of village by-laws is related to community ownership. Regardless of legislation or enforcement, the responsible management of marine resources will only be achieved when fishing communities themselves see it as their responsibility. Communities of villages which set their own by-laws are more likely to respect and abide by these rules than those set by a government authority. Village by-laws, therefore, represent a fisheries management tool, which has great potential for solving many problems involving the conservation of the inshore marine environment. This tool has not been taken advantage of by authorities in most Pacific Islands. Village by-laws have become a key part of village Fisheries Management Plans created under the community based Fisheries Extension program operated in Samoa (King & Fa'asili, 1997).

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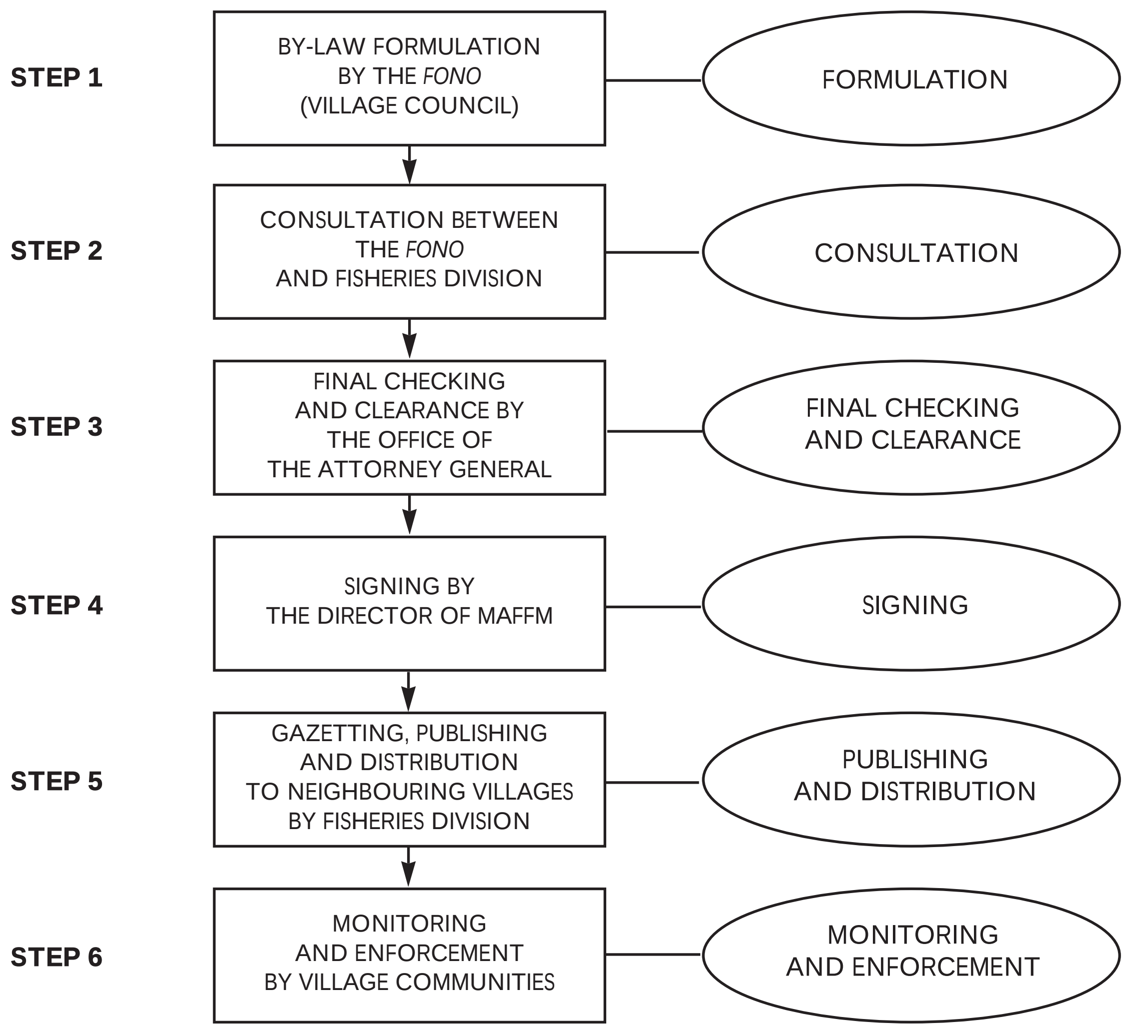
Annex 1: By-law formulation process



Octopus fishing by women of Fakaofo Atoll, Tokelau Islands

by Anna Tiraa-Passfield[1]

Feke tu ake auta ia pusi ma mango o ka kati ki te pito.	Squid, stand up because the eel and the shark will bite at your head

A song formerly sung by Tokelauan women to entice the feke from the hole (Macgregor, 1937).

Tuolo mai feke te pilipili kavei valu e tuolo, *Mai tuolo mai.* *Ko nohonoho i lo kaoa* *Fakalongona ake pule kua, hoa, hoa, hoa.*	Crawl out, little squid, with eight legs, Crawl out, crawl out. You stay in your hole When you hear the sound, hoa, hoa, hoa, of the crab, crawling.

A song formerly sung by Tokelauan men to entice the feke from the hole (Macgregor, 1937).

Geography

Tokelau comprises the three low-lying atolls of Fakaofo, Nukunonu and Atafu, which stretch in a northwesterly direction from 9°23'S and 171°14'W, for a distance of 170 km to 8°30'S and 172°30'W. The southernmost atoll, Fakaofo, is 65 km from Nukunono, with a further 105 km to Atafu, the northernmost atoll.

Women's fishing

Several people on Fakaofo have commented that women's fishing is not as common today as it once was. A household questionnaire conducted in 1998, revealed that women fished on average two hours per week (Passfield, 1998). Gleaning for octopus (*feke*) is one of the few types of fishing activities practised by women. Others include clam and rod fishing in the lagoon area. Octopus fishing is a favoured and skilled activity undertaken particularly by women of Fakaofo, although men and children also do it.

Octopus fishing

There are several traditional methods of catching *feke* in Tokelau. One, formerly commonly practised by men, was described to me by an elderly man. This method uses an octopus lure (*puletakifeke*) made from cowry shells of genera *Cyparea* and *Ovulum*. The shells are arranged in the shape of a rat. (This stems from the famous Polynesian legend about the rat and the octopus.) The lure is towed from a canoe along the reef in the lagoon. Small pebbles are placed in the shell which rattles to attract the attention of the *feke*.

The method more commonly used today was described to me by Sofima Niusila, an elderly woman who used to actively hunt *feke*. I also participated in a *feke* fishing excursion with Eleni Pereira, Sofima's daughter.

This method is conducted mainly during the day, at low tide on the reef. A *gagie* (*Pemphis acidula*) stick or a metal rod about one metre long is pushed into a likely *kaoa* (coral hole occupied by octopus).

The stick normally works by drawing out the animal, as its tentacles, one by one, wrap around the stick. Once the head appears, the gatherer works quickly, seizing it around the head with her hand. Within seconds, the *feke* is killed by biting between the eyes or turning its head inside out (see Picture on next page).

If the stick or metal rod is unsuccessful in drawing the *feke* from its hole, the body wall of the sea cucumber, locally called *loli* (*Holothuria atra*), is rubbed around the mouth of the *kaoa*. The bitterness of the *loli* draws the animal out.

The hand is never used to move pebbles from the hole, for fear of being bitten by a moray eel. The collected *feke* are strung on a metal wire or *kalava* (the outer skin of the top surface of the leaf stalk of a coconut frond), which is poked between the two holes located on either side of the head.

Sofima stated that the greater catches of *feke* are taken on *fakaiva ote mahina*—the ninth phase of the moon (nine days after new moon)—though they are caught throughout the year.

1. Managing Director, Fisheries and Environmental Resource Consultants Ltd. Rarotonga, Cook Islands

Identifying *feke* holes

The *feke* blocks the entrance to its *kaoa* by using its tentacles to gather a collection of coral pebbles. An experienced hunter can identify potential *feke* holes by the arrangement and recently disturbed appearance of the pebbles blocking the entrance. The arrangement of the pebbles is also seen as an indicator of the direction the *feke* has taken if it has vacated a hole. For example, if the pebbles lie to the left of the hole, the *feke* moved in the right direction and vice versa. When a *feke* is removed from its hole, the hole is often reoccupied by another. Experienced hunters will memorise the location of the hole for subsequent visits to inspect for reoccupation by another *feke*.

If the water is disturbed by turbulence, coconut meat is chewed and spat out onto the water surface. The coconut oil smooths the water surface, enabling the woman to view clearly beneath the shallow waters for potential *kaoa*.

Uses

Feke are caught for subsistence purposes and as bait for catching certain fin fish. Preparation for consumption is done by baking in the *umu* (traditional oven), boiling by mixing with other ingredients for additional flavour (e.g. curry, coconut cream, onions, herbs) or boiling and then sun-drying. Before cooking, the meat is tenderised by beating with the *gagie* wood or a stone.

Another method for tenderising the meat is wrapping it in *pawpaw* (papaya) leaves, and adding it to boiling water.

Acknowledgments

I am sincerely grateful to Sofima Niusila for her time and patience, in particular, sitting through the translating part of the interviews. The male informant is Sofima's husband, whose name I did not record—my apologies. Thank you Eleni Pereira for allowing me to accompanying you to catch *feke*. To my old school mate, Petali (Tas) Sale it was good seeing you again after all these years. Suia and Mose Pelasio, thank you for hosting me and my family. I especially would like to thank Peta Kearney, one of Sofima's daughters, for all her help in arranging interviews and field excursions and translating questions and answers into English and Tokelauan. *Fakafetai!*

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The *feke* is killed by biting between the eyes

Indigenous ecological knowledge and its role in fisheries research design: A case study from Roviana Lagoon, Western Province, Solomon Islands

by Richard Hamilton[1] and Richard Walter[2]

Introduction

Over the last two decades the island states of Melanesia have experienced a rapid increase in coastal development activities. These include the large commercial tuna pole-and-line fisheries, eco-tourism, aquaculture, coastal logging and, in recent years, the live reef fish trade. These activities make significant contributions to local and central economies but concerns have been raised about their impact on local ecosystems, and their long-term environmental sustainability (Chadwick, 1999; Mathews *et al.*, 1998; Veitayaki, 1997). In response to these concerns increasing pressure has been put on government agencies to develop coastal management plans and on developers to utilise these plans in the design of sustainable management practices (Olsen *et al.*, 1997). Unfortunately the implementation and success of such policies has been limited. In part this stems from the difficulties and cost of acquiring the high quality scientific data that most management plans and monitoring programmes rely on. As Johannes *et al.* (1993:1) point out for coastal fisheries, 'The cost and complexities of effectively monitoring and managing small, multi-species, multi-method reef and lagoon fisheries along conventional lines have generally proven prohibitive'. Nevertheless, in many cases extensive ecological information on the relevant coastal environments already exists within the knowledge base of the local communities. Further, these same communities are often operating management and monitoring programmes of sorts, within the context of customary marine tenure (CMT) systems (Foale, 1998a; Foster & Poggie, 1993; Hviding, 1991; Johannes, 1981).

This cultural information, often referred to as traditional ecological knowledge (TEK), is widely recognised as potentially useful to fisheries researchers and managers, especially when used in conjunction with conventional scientific data, 'Local knowledge combined with specialised knowledge of the outside researcher is considered by advocates of the PAR [participatory action-research] to be more potent than either knowledge alone in understanding reality' (Christie & White, 1997:172). However, indigenous cultural information is useful in coastal management for more than its role in providing the baseline ecological data required for planning purposes. Frequently, development projects are set up within the territories of indigenous communities and those communities are directly and indirectly involved on a number of different levels (Alcala, 1998; Ruddle *et al.*, 1992). In these cases the successful operation of development projects depends on a proper understanding of local political and subsistence economies, ideology and social structures. In fact, the failure of development projects in the Pacific is probably more commonly the result of a failure to understand local cultural systems than of inadequacies in ecological, technological or market research.

Unfortunately, indigenous knowledge is usually either ignored or used inadequately by fisheries researchers. There are two fundamental problems. The first is that TEK and other types of indigenous knowledge exist as inseparable parts of complex cultural systems, and it requires anthropological methods to describe and interpret this information in a meaningful manner. These skills, however, are usually difficult, time consuming and well beyond the professional training of most fisheries scientists, resource planners and project managers working in island Melanesia (Christie & White, 1997; Clark & Murdoch, 1997). The second closely related problem, is that frequently, when scientists have attempted to incorporate indigenous knowledge into their baseline research, the result has been a naive reporting of interview data or observations taken out of their cultural and historical context. The results are often misleading and misrepresentative. 'The romantic and uncritical espousal of traditional environmental knowledge and management is an extreme almost as unfortunate as that of dismissing it' (Ruddle *et al.*, 1992:263). A particularly good example of this is the common practice of interpreting CMT systems as conservation strategies. Although CMT systems can have conservation outcomes, it has recently been demonstrated that in most cases this is a side effect of systems designed primarily for 'gain, not

1. Department of Marine Science, University of Otago, New Zealand
2. Department of Anthropology, University of Otago, New Zealand

restrain' (Ruttan, 1998; Aswani, 1998; Polunin, 1984). An integrated approach to coastal resource planning is required, in which the specific skills of anthropologists and fisheries scientists are properly utilised. In particular, cultural information needs to be gathered systematically and treated with the same critical scrutiny that is applied by scientists to any other data set.

In this article we take three premises as our starting point:

1. TEK contains complex ecological information obtained through generations of observation and experience;

2. TEK is culturally structured and if it is to be taken out of its original context and used in an empirical western scientific framework, its appropriateness to this framework should be established through systematic testing; and

3. One of the most powerful ways in which TEK can be used in fisheries or other types of ecological research is in the establishment of research designs.

We present below a case study in the development of a model for testing TEK, and in establishing the parameters within which it can be used in a scientific research design. The work is situated in Roviana Lagoon, on the island of New Georgia, Western Province, Solomon Islands. Roviana marine ecologies and local communities have already felt the impact of development activity in the form of forestry, and of the Solomon Taiyo tuna and baitfish industry (Nichols & Rawlinson, 1990). Several other small-scale coastal ventures have been set up over the last few years, and more are planned for the near future. In this study, we examine local knowledge of aggregating behaviours of the Carangidae fishes in a confined part of the lagoon ecosystem. Carangids, or trevally, are a diverse family of reef and lagoon fish which are important in the local subsistence and artisanal fishery. In this study, detailed ethnographic data on Carangidae behavior were collected from local informants using traditional anthropological techniques of interview and participant observation. This information served as a basis for designing hypotheses on the tidal movements and aggregating behaviours of Carangidae within Roviana Lagoon, which were then tested using scientific field observations. The purpose was not to test the accuracy of local ecological knowledge, but to show how it can assist in the development of fisheries research designs.

Environmental background

The Solomon Islands lie between 7° and 10°S and extend 1400 km eastward from New Guinea (Figure 1). The islands display remarkable diversity in both terrestrial and marine environments. The dominant island forms are volcanic, but examples of atolls and raised reef islands are also present. Extensive lagoon systems occur in Western Province.

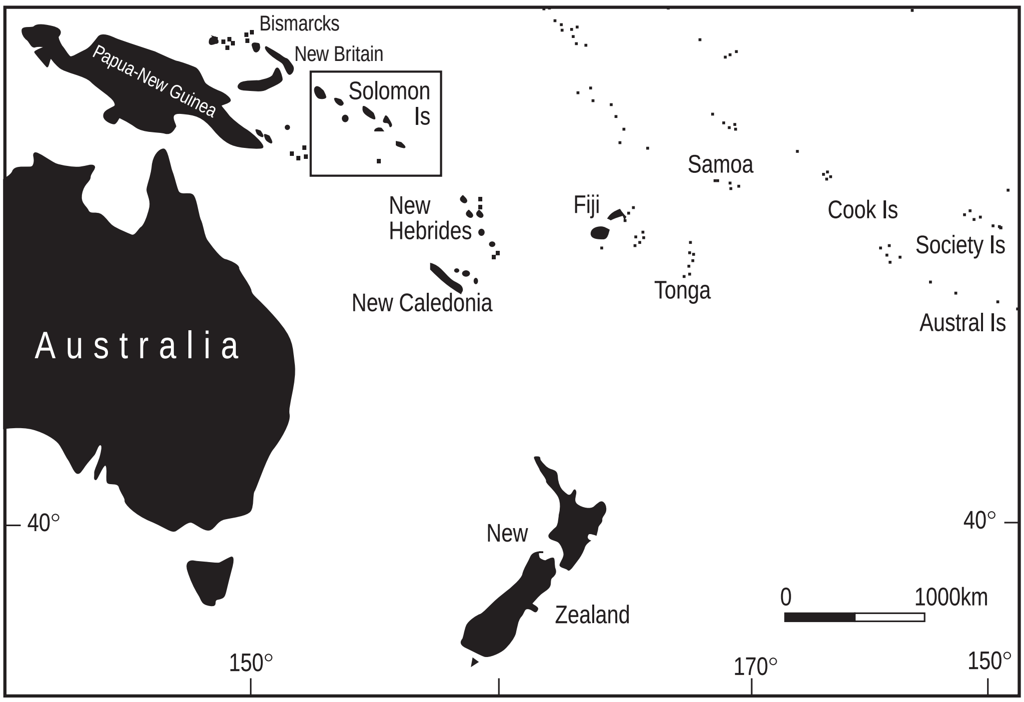

Figure 1. **The Solomon Islands in the Pacific (Survey and Mapping Division, Honiara)**

The New Georgia Group, in Western Province, is made up of nine main islands that extend for approximately 270 km. The largest island is New Georgia which is fringed by Roviana Lagoon to the south-west and Marovo Lagoon to the north-east (Figure 2).

Roviana Lagoon is a body of shallow water approximately 50 km long enclosed between the New Georgia mainland and a series of uplifted coral reef islands lying 2 to 3 km offshore. The lagoon supports a wide range of micro-environments including: estuaries, mangrove forest, river mouths, mudflats, coral atolls, barrier reefs, marine lakes and sea-grass beds (Aswani, 1997:245). Each of these, as well as the adjacent offshore zones, provides unique opportunities for the fishing communities of Roviana Lagoon. A number of major passages connect the open sea to the lagoon. These are remnants of earlier river systems that flowed through the now-flooded coastal plains. These passages contain a relatively high biodiversity and are consequently of especial significance in local fishing systems. Their rich biodiversity occurs partly because they connect several different ecological zones and many species utilise them to move between feeding areas.

Roviana Lagoon is occupied by a number of closely related tribal groups occupying a dozen or so large villages scattered along the mainland and barrier islands as well as a number of smaller residential clusters. Roviana is the most homogeneous linguistic region of New Georgia, where the Austronesian language of Roviana is spoken in all the villages. Elsewhere in New Georgia the 30,000 inhabitants speak at least seven major languages, including several non-Austronesian languages. The Roviana subsistence economy is based on shifting horticulture with an emphasis on the recently introduced sweet potato and cassava, as well as the traditional crops: taro, yam, banana and sago. The main protein intake is from marine sources (Aswani 1997:189) but pig and chicken husbandry and small-scale hunting also takes place. Today, these subsistence activities are often subsidised by waged labour and copra production.

Carangids were selected for this case study for several reasons. First, the ecology of carangids in tropical settings is poorly studied (Sudekum *et al.*, 1991). Second, the carangids are important in the Roviana subsistence fishery and thus the local body of knowledge was expected to be detailed and accessible. Third, there are potentially important trophic interactions between the Taiyo bait-fishery and carangids which were investigated as part of the field research, but are not reported here (see Hamilton, 1999).

The Carangidae is a family of strong swimming, open water carnivorous fishes known variously as trevally, kingfish, queenfish, jack, scad, mackerel, and rainbow runners (Gunn, 1990; Randall, 1990). Their habitats range from brackish water estuaries to deep offshore reefs, with a few species being pelagic in the open ocean (Holland *et al.*, 1996). At least 17 species of carangid are present in Roviana Lagoon, and all are important food fishes. In this

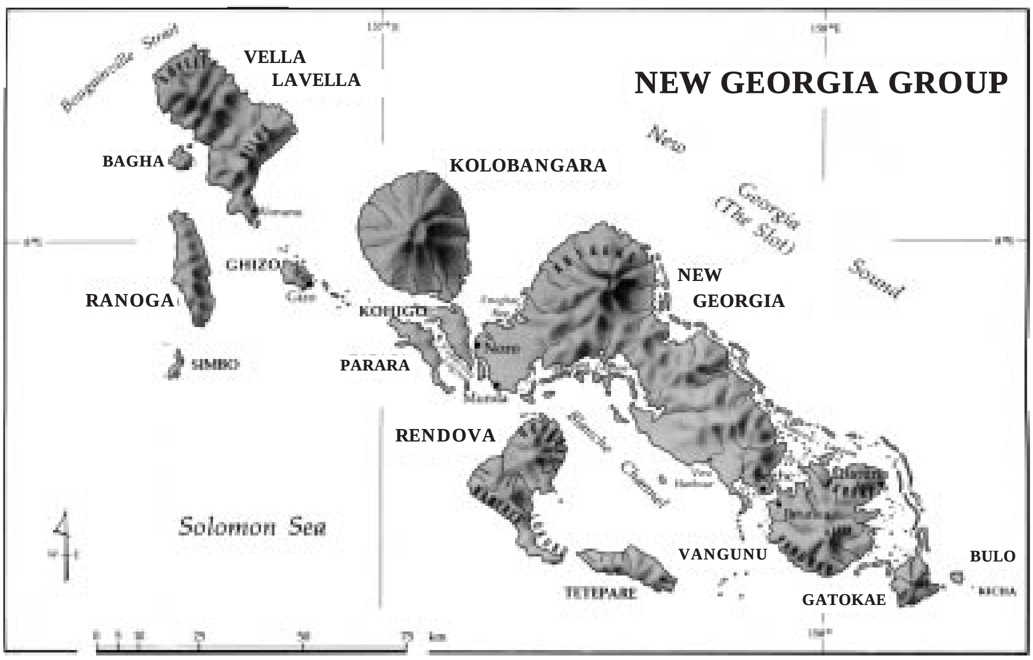

Figure 2. **The New Georgia Group (Survey and Mapping Division, Honiara)**

study we concentrate on three species, Bluefin trevally (*Caranx melampygus*), Golden trevally (*Gnathanodon speciosus*) and Bigeye trevally (*Caranx sexfasciatus*). with additional observations on other members of the genera Caranx and Carangoides.

Study area

The research was carried out in Honiavasa passage from a base in Nusabanga village, in the western part of Roviana Lagoon (Fig 3). Nusabanga village is a sister village to Sasavele village, located on the western bank of Honiavasa Passage. The two villages share very close ties, often participating in common fishing trips and other economic activities.

Honiavasa Passage is one of the main deep water passages connecting the inner lagoon to the outer sea. It is approximately 600 m across at the sea entrance and narrows to around 150 m at its narrowest point. The coral walls of the passage are nearly vertical, and descend to a maximum depth of 42 m. The passage environment is characterised by mainly dead corals to a depth of 15 m, although the submarine coral walls support large and diverse migrant vertebrate communities.

The field work reported here is a part of a larger project on fish ecology and indigenous subsistence practices carried out in 1996–1997. The full results of the complete project will be reported elsewhere. The field component of this study had two parts. The first involved gathering indigenous information on the behavioural ecology of Carangidae in Roviana Lagoon. This information forms the basis on which the traditional Roviana Carangidae fishery is structured. Using this data, a set of hypotheses linking environmental variables with Carangidae behaviour was established. The second part of the research involved testing these hypotheses using standard field survey techniques.

Ethnographic methods and results

The field component of the research discussed here was carried out from early- August until late-October, 1997. During this period one of the authors (RH) resided at Nusabanga village, where he participated in the daily life of the village and worked regularly with the local fishers, to gain as wide an understanding as possible of the local fishing system. This followed the viewpoint that empirical facts about biology or ecology can not be

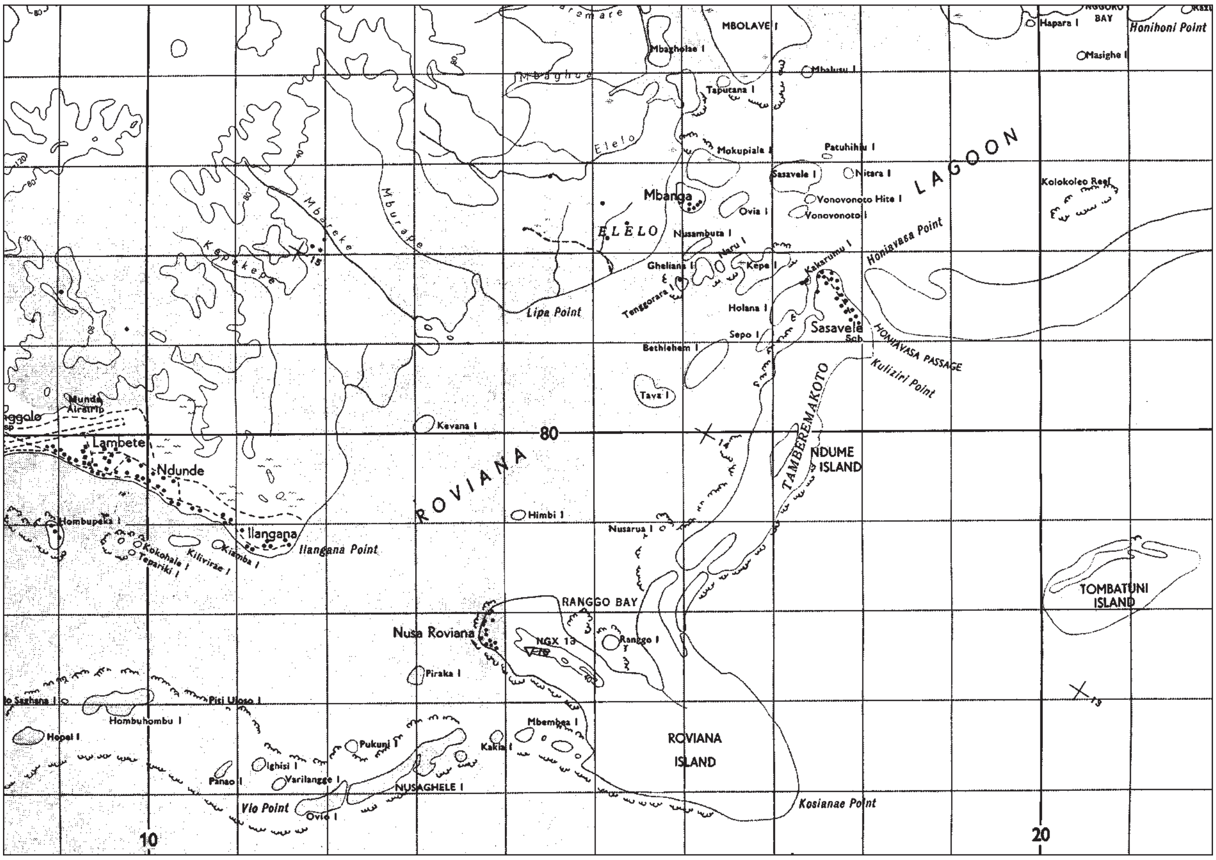

Figure 3. **The western part of Roviana Lagoon, showing Honiavasa Passage, Munda township and Nusabanga (Mbanga) and Sasavele village (Survey and Mapping Division, Honiara)**

extracted from TEK without an understanding of the structure and ideology of the wider cultural and subsistence systems of which it forms a part. During the fieldwork period records were taken of 51 fishing trips. Information was recorded on Catch Per Unit Effort (CPUE) and on the technological, meteorological and environmental details of each major fishing trip. Basic information on indigenous taxonomy and fish names were acquired through formal interviews conducted in Solomon Island Pidgin, the local lingua franca. Local fish names were collected and then cross checked against standard fish guides (Allen & Swainston, 1992; Randall *et al.*, 1990). Local informants were also asked to identify species seen on underwater video footage taken in Honiavasa Passage. In addition, formal interviews were conducted with 11 fishers from Nusabanga and three from Sasavele. These persons were selected according to their recognised status as fishing experts within their respective villages. All interviews were conducted in both Roviana and Solomon Island Pidgin, and were recorded on videotape. Each fisher was asked to identify his main fishing locations, fishing methods used and the target species. Particular attention was paid to the spatial, temporal and technological structure of Carangidae fishing practices.

On the basis of the field participation results and interview data we can define the basic parameters of indigenous fish taxonomy and the Roviana fishing calendar. For the most part, we observe only minor deviation from the more detailed study recently reported in Aswani (1997). We can also describe aspects of Roviana folk ecology of Carangidae, with emphasis on tide related movements and lunar aggregations in Honiavasa Passage. These results are summarised below and reported in more detail in Hamilton (1999).

Taxonomy

The structure of Roviana fish taxonomy is almost identical to that of Marovo, well described by Hviding (1996), and also to that Nggela (Foale,1998b). All these systems differ considerably from Linnaean taxonomy, in that the level of classification reflects the value of the fish within the subsistence system, as well as basic morphology. For example, the small Damselfishes (Pomacentridae) are not eaten in Roviana and are all referred to using the generic term *kipa*. Although Roviana people are well aware of the variation within the Pomacentridae family, no further attempt is made at finer taxonomic discrimination. One the other hand, some members of the family Scaridae are very important in the subsistence economy, and this is reflected in their taxonomic treatment where different names are assigned to different size classes (Aswani, 1997:425). The actual names assigned to a fish taxa often reflect behavioural characteristics shown by that fish.

At least 17 species of Carangidae are recognised as taxonomically separate within the Roviana system. These names are listed in Table 1 below. *Mara* is a generic name covering a range of Carangidae species, each of which is additionally named using a more specific suffix. For example, the Orange spotted trevally (*Carangoides bajad*) is named *mara liu*. *Liu* (derived from Solomon Island Pidgin) translates as 'loiter', thus *C. bajad* is named 'the trevally that loiters', owing to its commonness in Roviana Lagoon.

Table 1. **Local Carangidae taxonomy**

Indigenousname	Commonname	Scientific name
Mara	Generic: Trevally	Carangidae
Balubalu	Rainbow runner	*Elagatis bipinnulata*
Ganusu	Smooth tailed trevally	*Selaroides leptolepis*
Lasilasi	Double-spotted queenfish (and perhaps other queenfish species)	*Scomberoides lysan*
Laqu belama	Tille trevally	*Caranx tille*
Mara batu batu	Griant trevally	*Caranx ignobilis*
Mara batu papaka		undetermined
Maaru hipu gele	Gold-spotted trevally	*Carangoides fulvoguttatus*
Mara hobu	Blue trevally	*Carangoides ferdau*
Mara labe	Pennantfish	*Alectes ciliaris*
Mara lamana	Bluefin trevally	*Caranx melampygus*
Mara liu	Orange-spotted trevally	*Carangoides bajad*
Mara madali	Bump-nosed trevally	*Carangoides hedlandensiis*
Mara popana	Golden trevally	*Gnathanodon specious*
Mara roba	Snub-nosed dart	*Trachinotus blochii*
Moturu	Bigeye trevally	*Caranx sexfasciatus*
Moturu kove	Black trevally	*Caranx lugubris*
Paki pakete	Black-spotted dart	*Trachinotus bailloni*

The Roviana lunar cycle

The lunar cycle plays a major role in the Roviana fishing system since there is a well-understood correlation between lunar phase and Carangidae (and other species) behaviours which can be exploited by local fishers. Many of the days of the lunar month are given specific names. A version of the Roviana lunar calendar collected in Nusabanga is included as Table 2. This example is based on a 30-day lunar month. A more detailed version has been collected by Aswani (1997:238) and Hviding (1996) provides a similar calendar from Marovo Lagoon.

Tidal movements of Carangidae

According to local informants, Carangidae movements within Roviana Lagoon correspond to tidal flows. The following species of Carangidae are said to move into the inner lagoon regions through Honiavasa Passage on the rising tide, and then move back into the passage and outer reef areas on the falling tide: *Carangoides ferdau*, *Carangoides fulvoguttatus*, *Carangoides bajad*, *Caranx tille*, *Caranx lugubris*, *Caranx sexfasciatus*, *Caranx melampygus* and *Gnathanodon speciosus*. Informants further state that these predictable movements are due to a predator-prey interaction. The carangids are following their prey species, the very small baitfish named *hinambu* (members of the families Engraulidae, Clupeidae, Apogonidae, and Atherinidae) and the large baitfish, *kutukutu* (*Herklotsichthys quadrimaculatus*).

The baitfish are said to move up into the inner lagoon to spawn among the mangrove roots on the high tide, and retreat back to sea on the falling tide, when the shallow inner lagoon areas become exposed. Thus the tides are considered to be one of the most important factors regulating the likelihood of a successful catch:

> Before I go fishing I must watch the movement of the sea, there are two good times for fishing, *pado gore* when the tide starts to fall, and *pado sage* when the tide starts to rise, close to flood or ebb tide the fish do not eat (pers. comm., Harry Kama, Nusabanga village, August 1997. Translated from Solomon Island Pidgin by the authors).

These two tidal terms, *pado gore* and *pado sage*, refer to the first 3–4 hours after flood and ebb tide, respectively. Nine of the fourteen fishers interviewed stated that the best times to catch carangids are during *pado gore* and *pado sage*.
The state of the tides not only influences the timing of a fishing event, but also its precise location within the lagoon:

> At high tide the baitfish move up into the mangrove areas, and they are followed by the trevally. So at high tide I fish for trevally in the inner lagoon, near the sea grass in the deep areas close to the mangroves. At low tide the baitfish move out of the mangrove and go to the passage, so I go and fish for trevally there (pers. comm. Diliva Dava, Nusabanga village, August 1997. Translated from Roviana by Gaudry Kama).

Eight of the fourteen fishers interviewed also made the observation that on the rising tide carangids often swim near the surface in the passage, but on the falling tide they dive deeper into

Table 2. **The Roviana lunar cycle**

Roviana term	Lunar phase	Translation
Taloa Sidara	New moon	***Taloa*** : No ***Sidara*** : Moon
Tada Keke	Day 1	***Tada*** : refers to the first quarter, when the moon is first seen in the West and drops quickly below the horizon (before midnight).
Tada Karua	Day2	
Tada Ngeta	Day 3	
Tada Made	Day 4	
Tada Lima	Day 5	
Tada Onomo	Day 6	
Tada Zuapa	Day 7	
Noma Sidara	Days 8-14	***Noma*** : Big ***Sidara*** : Moon
Hobe Rimata	Full moon	***Hobe*** : Change ***Rimata*** : Sun. The moon changes the sun. As soon as the sun sets it is replaced by the moon.
Pae	Days 16-30	***Pae*** : "it is dark before the moon rises". The moon rises after 12 pm

the channel. Because of this, carangids are harder to catch by trolling or casting in the passage on the low tide, and alternative techniques must either be adopted, or other fishing locations selected.

Lunar-related aggregations

The subsistence fishers of Nusabanga and Sasavele recognise two main periods of the lunar cycle as ideal times for catching carangids. The first of these 'Carangidae seasons' is during the early part of the first quarter of the lunar cycle, and the second is around the full moon:

> *Mara* have seasons, so whenever we want to catch *mara* we must wait for its time. If you fish for *mara* when it is not the right time, you will not have much success (pers comm. Harry Kama, Nusabanga village, August 1997. Translated from Solomon Island Pidgin by the authors).

Thirteen of the fourteen fishers interviewed gave very specific and consistent information relating to passage and inner lagoon fishing in the first quarter of the lunar cycle. On *Tada keke*, *Tada karua* and *Tada ngeta*, fishing for Carangidae is highly productive, with all species being readily caught. Twelve of the fourteen fishers interviewed also recognised *Tada zuapa* as being a good time for catching *mara batubatu* (*Caranx ignobilis*). *C. ignobilis* appear within Honiavasa Passage of Roviana Lagoon several times during the first quarter of a lunar cycle between the months of June through to December.

> You can catch *mara batubatu* on *Tada keke*, *Tada karua* and *Tada ngeta*. From *Tada made* till *Tada onomo* you will not catch *batubatu*. On *Tada Zuapa* you will catch *batubatu*, and they will come in groups (pers comm., Simon Bae, Sasavele village, August 1997. Translated from Roviana by Gaudry Kama).

In the early hours of the morning on *Tada zuapa, C. ignobilis* are said to aggregate in large schools along the walls of Honiavasa Passage. The largest of these aggregations is reported to occur off the point of Honiavasa Island, where large groups gather in the shallow reef area on the eastern side of the channel, close to Site 3 (see below).

> In the early morning of *Tada zuapa*, before the sun is up, they start to arrive in groups. They don't all come in at once, you will see one group arrive then 5-10 minutes later another group will join them, then another group, and so on. I have never tried to count them, but in the end there is often over 100 fish. They aggregate between Honiavasa Island and Nitara Island, on the right-hand side of the passage. They also move up the left-hand side of the passage, but they do not go up as far as Vonovonoto Island, instead they will move into the small passage that breaks off before Vonovonoto Island. By the time the sun is up the schools will have gone (pers comm., Simon Bae, Sasavele village, August 1997. Translated from Roviana by Gaudry Kama).

All the persons who recognise these aggregations believe that they form as a result of a feeding opportunity when schools of *medomedo* (*Siganus argenteus*) and *suliri* (*Nematalosa come*) form. Jack Kari and Harry Kama both said that during *Tada zuapa* groups of *C. ignobilis* travel far up into the inner lagoon to feed, often travelling right up into the rivers which empty into the lagoon. This observation is consistent with reports from the Philippines, where *C. ignobilis* have been caught far up rivers (Manacop, 1952, cited in Westernhagen, 1974).

The second 'Carangidae season' occurs around full moon, a time which all the fishers interviewed recognised as being particularly good for carangid fishing. During this lunar stage *C. sexfasciatus* and *C. lugubris* are said to aggregate in the lagoon, often in schools. These species are predominantly targeted at night by droplining using *ganusu* (*Selaroides leptolepis*) for bait, or by casting non-weighted lines with *hinambu* (small baitfish) as bait. *C. fulvoguttatus*, the gold-spotted trevally, is also said to aggregate in schools during this lunar stage.

In addition to these two main 'Carangidae seasons' other minor periods of aggregation are known to local fishers, and exploited accordingly. Six of the fishers stated that *mara batu papaka* (unidentified Carangidae species) aggregate within the lagoon in large schools after the full moon, during *Pae*. Simon Bae of Sasavele stated that large schools arrive mainly during the last quarter, and that during this time they travel far up into the inner lagoon. It is also important to note that some of the Carangidae species that inhabit the lagoon are reported by local informants *not* to have a specific lunar season. For example, *C. bajad* is said to be constantly present within the lagoon, regardless of the lunar stage.

Marine survey methods and results

On the basis of the ethnographic survey we can define three testable hypotheses relating to

Carangidae behaviour in and around Honiavasa Passage:

1. Carangidae species move in and out of the passage with the tides;
2. *C. sexfasciatus* will be at their highest densities within the passage around full moon; and
3. *C. ignobilis* will aggregate in schools alongside Honiavasa Island before sunrise on *Tada zuapa*

To test these hypotheses a dive survey was carried out using Instantaneous Area Point Counts (IAPC) during flood and ebb tides at six sites in Honiavasa Passage. For the purpose of site selection, the passage was divided into three areas: Outer, Middle and Inner. Two sample sites were allocated within each area, one on the left-hand and one on the right-hand side of the passage (Fig 4). The three separate areas were chosen in order to determine if distance from the open sea influenced the distribution and abundance of fish. Two sites were allocated within each area in order to determine whether passage side had a significant effect on the abundance or movements of Carangidae.

This survey spanned two lunar cycles and was conducted using standard IAPC visual census methods. IAPCs were recommended by Thresher and Gunn (1986), who assessed the usefulness of many underwater visual transect and point count techniques for estimating biomass and abundance of Carangidae. The IAPC method used here involved underwater visual census carried out by two divers at selected times, locations and depths using SCUBA. In addition, underwater video footage shot from a fixed station was taken for identification and reference purposes. A total of 48 hours of video was recorded. A fibreglass canoe powered by a 15 hp motor was used during the field surveys.

On arriving at a site, visibility was determined in order to define differences in average visibility between the six study sites. At a depth of 5 m a plastic silhouette of a fish (49 cm in length) was located on the bottom. One end of a fibreglass tape measure was attached to the silhouette, a diver then swam horizontally away from the silhouette reading the distance off the tape measure at which the silhouette became difficult to distinguish. Both divers then stationed themselves with their backs to the reef wall and fifteen point counts were carried out over 15 minutes. At 60-second intervals, the entire 180-degree area of the passage visible to the diver was scanned (a procedure taking 5-10 seconds) and all individuals in that area were recorded by species. Observations of the number of individuals of a given species, their length and their direction of movement (up or down the channel) were recorded. The amount of error in the length estimates was calculated throughout the field observations by periodically recording the 'estimated' and 'actual' length of coral heads. A total of 120 dives were carried out during the months of September and October 1997. These consisted of twenty dives at each site, ten on the falling tide and ten on the rising tide.
The analysis of the IPAC data looked for interactions between the following five variables:

1. State of tide (rising, falling);
2. Direction of fish movement (in, out);
3. Lunar stage (new moon, first quarter, full moon, second quarter);
4. Area (Outer, Middle, Inner); and
5. Side of passage (left, right).

Presence-absence data for the three most frequently sighted species of Carangidae, *C. melampygus*, *G. speciosus* and *C. sexfasciatus*, were analysed

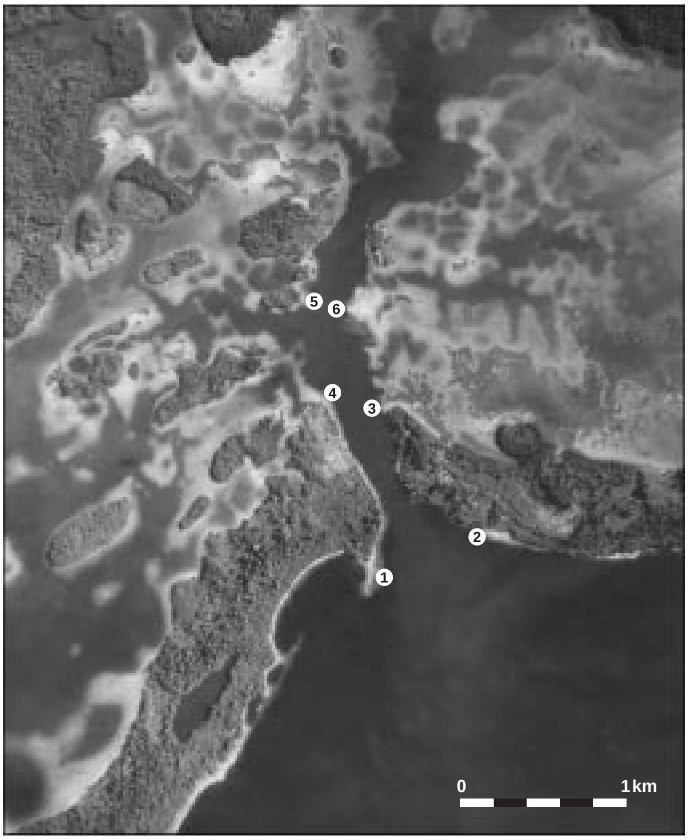

Figure 4. **Aerial photo of Honiavasa Passage showing the location of the six sites**

using a logistic linear model in the software package JMP™ on a Macintosh™ computer. A model of best fit was determined for each data set, then the significant terms in the chosen model were examined in detail.

Total abundance data for *C. melampygus* were transformed from dive log records using the standard log 10 transformation. These abundance data were then analysed using a general linear model, ANOVA, involving all main effects and interactions. This was carried out using DataDesk™ software on a Macintosh™ computer.

Carangidae movements with respect to tidal flows

The two most commonly sighted species of carangid, *C. melampygus* and *G. speciosus*, both showed a strong tendency to move in the direction of tidal flow. Analysis of the *C. melampygus* log data revealed a significant two way interaction between tidal flow and direction of fish movement (DF = 1, SS = 1.03, MS = 1.03, F-ratio = 11.76 and P value < 0.01) (Fig. 5).

Analysis of *G. speciosus* presence / absence data also revealed that the movements of fish within Honiavasa Passage correlate strongly with tidal flows (LR Statistic = 50.56, 1 DF; P < 0.01) (Fig. 6).

Lunar aggregations of Carangidae

C. sexfasciatus was the third most commonly seen Carangid in the dive survey. Presence / absence data analysis revealed that lunar stage influences their relative abundance within the passage (LR Statistic = 8.33, 3 DF; P = 0.04). *C. sexfasciatus* were

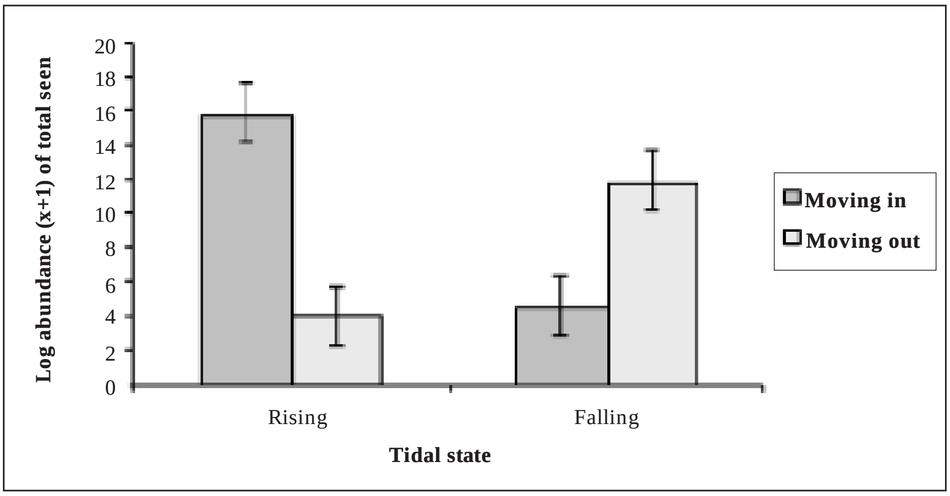

Figure 5. **Log value of the total number of *Caranx melampygus* seen moving in and out of Honiavasa Passage on 60 rising and 60 falling tides (Error bars = ±1 SE)**

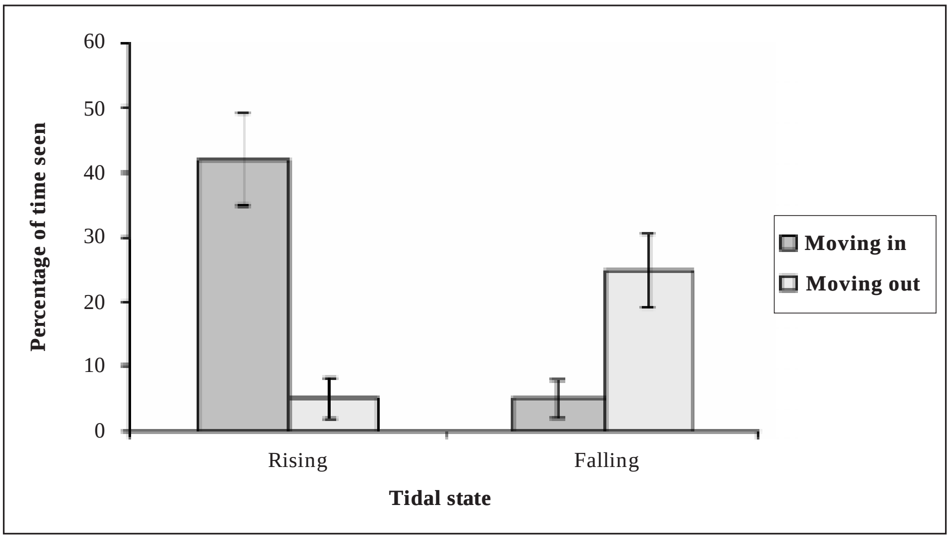

Figure 6. **The percentage of time that *Gnathanodon speciosus* were seen moving in and out of Honiavasa passage on 60 rising and 60 falling tides (Error bars = ±1 SE)**

seen the highest percentage of the time (15%) during the full moon lunar phase (Fig. 7). In the new moon and first quarter they were seen approximately 5% of the time and during the second quarter they were seen only 2% of the time.

There were insufficient sightings of *C. ignobilis* and *mara batu papaka* to warrant statistical analysis, but observations made during the dive survey and during other field exercises support local predictions about their aggregating behaviours. *C. ignobilis* were seen only once out of 120 survey dives, and this sighting occurred on *Tada zuapa* the lunar day that *C ignobilis* schools are reported by local fishers to form within Honiavasa Passage. The sighting occurred at Site 6 in the late afternoon of 10 Sep. 1997 on a rising tide. Further, the predicted aggregations in the early morning of *Tada zuapa* were observed the following month, on the 10th of October. The CPUE data also demonstrated *C ignobilis* aggregations around *Tada zuapa*.

Mara batu papaka were sighted only on three occasions out of a total of 120 survey dives. These sightings all occurred during *Pae*, the period following full moon. Again, this accords well with CPUE data and with the statements made by informants during the ethnographic survey (see above).

Discussion

As this study demonstrates, TEK systems contain knowledge that is relevant to many of the types of question asked by fisheries research scientists. In this case we were interested in carangid movements and aggregation patterns, a question of potential relevance in coastal resource management and development planning. Through anthropological field techniques we were able to acquire a ready-made model of these behaviours which could then be quickly and easily tested using standard marine science field methods. Through participant observation and interviews we identified two specific categories of Carangidae behaviour well understood by Roviana fishers. These categories pertained to the temporal and spatial patterning of fish activity at different scales. First, there was the relationship between tidal change and Carangidae movement. Second, the relationship between fish aggregating behaviour and the lunar cycle. We were then able to create a research design that would maximise the likelihood of us observing these predicted behaviours. In this case, the dive survey results verified local statements on marine ecology. Other, more complex, research questions are likely to reveal a more complex relationship between traditional and scientific knowledge systems.

In summary, we review in brief a number of benefits and motives for researchers to consider indigenous knowledge systems, and conclude by reiterating the argument for an holistic approach to coastal research in Melanesia.

1. TEK contains baseline information on local ecologies including information on what is present in the local ecosystems, and its temporal and spatial patterning.
2. By drawing on TEK at the early stage of research, scientists are able to develop testable models, and so target their research and efficiently budget their time and other resources.

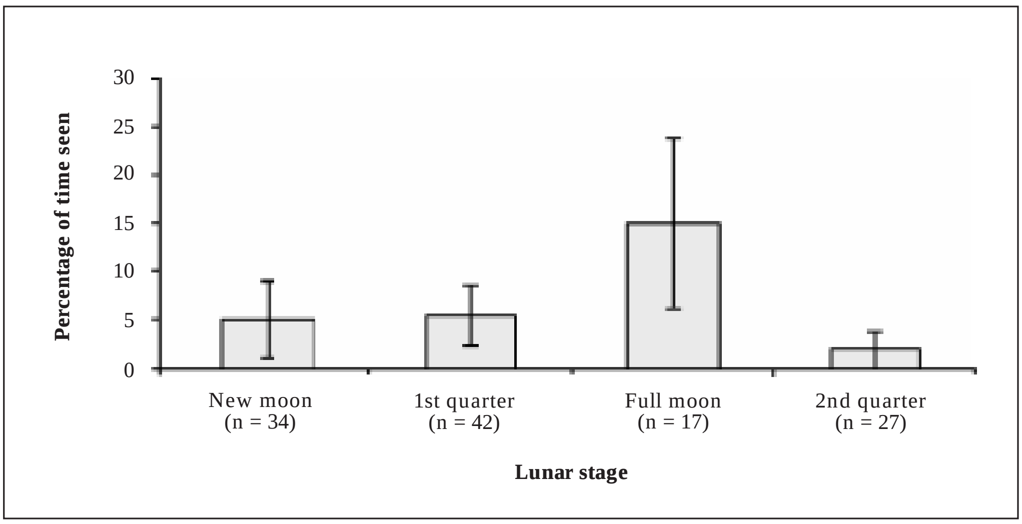

Figure 7. **The percentage of time that *Caranx sexfasciatus* were seen in Honiavasa Passage during the four lunar stages (Error bars = ± 1 SE)**

3. TEK and CMT evolved over generations of direct interaction between human communities and their environment and are likely to contain information and ideas not currently contained within scientific models (Lalonde & Akhtar, 1994).
4. If properly understood, there is a potential for resource managers to use CMT systems directly to manage stocks in development projects (Hviding, 1996; Ruddle *et al.*, 1992).

Conclusions

All knowledge systems, including scientific knowledge systems, are culturally structured and there are potential dangers in extracting information from one system, and applying it in another. For that reason, research scientists working with TEK should attempt to develop a holistic understanding of those systems, so as to understand the context of the information they hold. In coastal research, this would include information on folk taxonomy and ecology, fishing technologies and the social and symbolic context of fishing activities.

Knowledge is often stratified by gender, age and geographical location (Hviding, 1996; Christie & White, 1997). For example, in Roviana Lagoon, women fishers hold traditional knowledge on mangrove clams, as it is almost exclusively women who collect these food species. It would thus be difficult for male researchers to gain access to that information, and potentially misleading if they were to ask only male members of the community about the exploitation of mangrove clams (although they would undoubtedly get an answer).

We also note that in Roviana, knowledge pertaining to specific families of fish is sometimes restricted to fishers who specialise in targeting those species. Several of the fishers in this study when asked questions on the ecology of Carangidae made statements similar to that of Enele Garata: 'Oh no, I don't know about *mara*, I only know about *pazara* (Serranidae) and *pipo* (Sphyraenidae), ask the old man Simon Bae at Sasavele, he knows about *mara*' (pers comm., Enele Garata, Nusabanga village, August 1997. Translated from Solomon Island Pidgin by the authors).

It is also important to appreciate that most indigenous knowledge of marine ecologies is ultimately directed towards identifying patterns which maximise capture success. Thus some details of fish behaviour which may be irrelevant to a local knowledge base (since they have no influence on subsistence practice) may be of immense importance to a marine biologist studying reef ecology. Further, whereas indigenous knowledge of fish behaviour will often be very accurate, local explanations for the mechanisms underlying these behaviours may not be compatible with scientific paradigms.

In Nusabanga, local fishers believe that *mara* movements through the passage relate to predator–prey relationships with baitfish (see above). Our research shows, however, that while the predicted movements of fish is accurate, the explanation probably varies amongst species (Hamilton 1999). Ruddle *et al.*, (1992:262) make a similar point, 'In some places declining yields may be attributed to sorcery or a failure to propitiate the gods'.

In conclusion then, indigenous knowledge is an enormously valuable resource base but one which is often treated in a far too casual manner by research scientists. We advocate an holistic approach incorporating the strengths of anthropological and marine science methods and techniques. In a cross-disciplinary approach, each discipline provides the other with a degree of accountability and more accurately represents the knowledge base of the indigenous peoples of Melanesia who have been living and acting in these landscapes for up to 30,000 years.

Acknowledgements

We would like to acknowledge a number of people for their support during various phases of the project. In the field, the assistance of Bailey Kama, Gaudry Kama and other members of the Nusabanga community is gratefully acknowledged. We would especially like to thank the paramount chiefs, Chief Joseph Kama and Chief John Roni, for giving us permission to work in the area. Mariana and Dave Cooke (Solomon Sea Divers) provided equipment and Johnson Seeto provided expert guidance with taxonomy. Finally, we thank the New Georgia Archaeological Survey who provided logistical field support.

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New publications

Traditional marine resource management and knowledge

Community-level sea use management in the Grenada beach seine net fishery: current practices and management recommendations.

by J.A. Finlay, M.Sc.Thesis, University of the West Indies, Cave Hill, Barbados (1996).

This study identified and characterised a community level, self-regulating Territorial Use Rights in Fisheries (TURF) system within the Grenada beach-seine fishery. The TURF system serves as a useful example of an alternative management system and involves 41 large beach seines and 289 fishers, operating at 97 shallow water fishing sites (hauls) along the coasts of the islands of Grenada and Grenadines. Although all hauls are open to all seine nets, nets are observed to cluster in nine fairly discrete zones along the coast and tend not to move far from the fishers' places of residence.

The beach-seine fishery targets a multi-species stock of mainly juvenile coastal pelagics. Two species of Carangidae (big eye scad, called jacks, *Selar crumenopthalmus*; and red tail scad called 'round robins', *Decapturus tabs*) account for 90 per cent of catches. The remaining catch comprises juvenile oceanic pelagics (6%) and other small-sized coastal pelagics (4%). Although species vary in abundance seasonally, a fairly constant overall abundance of seine fish maintains a year round fishery with relatively constant fishing effort.

Ten traditional rules are identified within the TURF system and these effectively allocate fishing opportunity to beach-seine nets through the recognition of temporary exclusive ownership at hauls. A number of conflicts are presently threatening the TURF system. These include intra-fishery conflicts between beach-seine fishers and relate to non compliance with TURF rules; inter fishery conflicts, between seine fishers and other fishers generated by competition for sea space (by anchoring boats, motorised trolling boats, motorised fishing boats landing catches ashore); and competition for the target fish by ringnets operating adjacent to the haul; extra fishery conflicts, between beach seine fishers and mainly tourist-related activities which are now being viewed as having greater economic importance. Beach-seine TURF fishers view these conflict situations as devaluing their traditional property rights.

Suggestions for solutions from both seine fishers and their competitors for sea use, indicate that government should initiate urgently some form of localised management. Seine fishers felt strongly that legalisation of the TURF rules would serve to legitimise and enhance their property rights. Both seine fishers and their competitors for sea use felt that a rationalisation of entitlements, expectations and obligations within the context of a co-management approach was needed.

Contributed by:

Dr. Robin Mahon, 48 Sunset Crest, St. James, Barbados. E-mail: rmahon@caribsurf.com

Sacred Ecology:Traditional Ecological Knowledge and Resource Management

by Fikret Berkes

Professor of Natural Resources, University of Manitoba, Winnipeg.

Published by: Taylor & Francis, Philadelphia (1999); Soft cover: US$ 26.00
Order via Website: www.taylorandfrancis.com

Ecology has its roots in conventional science, with an emphasis on the quantitative analysis of relations between organisms and their environment. However, in recent years there has been a renewed interest to encompass a more holistic vision of the earth as a system of interconnected relationships. A major issue today is how humans can develop a more acceptable relationship with the environment that supports them. With this comes a surge of interest in the traditional ecological knowledge of indigenous peoples as a source of valuable information on how to use and respect our natural resources.

This comprehensive, absorbing and extremely useful book by Fikret Berkes is a major and most welcome contribution to focusing that interest. Although not focussed directly on the Pacific Islands, readers of this Information Bulletin will undoubtedly find this book by Berkes a very rewarding investment. The contents of the book are as follows:

Part 1: Concepts

Chapter 1: Context of Traditional Ecological Knowledge
- Defining Traditional Ecological Knowledge
- Traditional Ecological Knowledge as Science
- Differences: Philosophical or Political?
- Knowledge-Practice-Belief: A Framework for Analysis
- Objectives and Overview of the Volume

Chapter 2: Emergence of the Field
- Evolution of International Interest
- Cultural and Political Significance for Indigenous Peoples
- Questions of Ownership and Intellectual Property Rights
- Practical Significance as Common Heritage of Humankind

Chapter 3: Intellectual Roots of Traditional Ecological Knowledge
- Ethnobiology and Biosystematics: A Good Fit
- More on Linguistics and Methodology: How to Get the Information Right
- Exaggeration and Ethnoscience: The Eskimo Snow Hoax?
- Human Ecology and Territoriality
- Integration of Social Systems and Natural Systems: Importance of Worldviews

Part II: Practice

Chapter 4: Traditional Knowledge Systems in Practice
- Tropical Forests: Not Amenable to Management?
- Semiarid Areas: Keeping the Land Productive
- Island Ecosystems-Personal Ecosystems
- Coastal Lagoons and Wetlands
- Conclusions

Chapter 5: Cree Worldview 'from the Inside'
- Animals Control the Hunt
- Obligations of Hunters to Show Respect
- Importance of Continued Use for Sustainability
- Conclusions

Chapter 6: A Story of Caribou and Social Learning
- 'No One Knows the Way of the Winds and the Caribou'
- Aboriginal Hunters and Traditional Knowledge of Caribou
- Caribou Return to the Land of the Chisasibi Cree
- A Gathering of the Hunters
- Conclusions

Chapter 7: Cree Fishing Practices as Adaptive Management
- The Chisasibi Cree System of Fishing
- Subarctic Ecosystems: Scientific Understanding and Cree Practice
- Three Cree Practices: Reading Environmental Signals for Management
- A Computer Experiment on Cree Practice and Fish Population Resilience
- Traditional Knowledge Systems as Adaptive Management

Part III: Issues

Chapter 8: How Local Knowledge Develops: Cases from the West Indies
- Mangrove Conservation and Charcoal Makers
- Dominican Sawyers: Developing Private Stewardship
- Cultivating Sea Moss in St. Lucia
- Rehabilitating Edible Sea Urchin Resources
- Conclusions: Lessons in Commons Management

Chapter 9: Challenges to Indigenous Knowledge
- Limitations of Indigenous Knowledge and the Exotic Other
- Invaders and Natives: A Historical Perspective

Integrated Coastal and Ocean Management: Concepts and Practices

by Biliana Cicin-Sain & Robert W. Knecht

Center for the Study of Marine Policy, Graduate College of Marine Studies, University of Delaware, USA

Published by: ISLAND PRESS, Washington, D.C. & Covelo, California (1998).
Price: US$ 65.00 hardcover & US$ 32.50 soft cover.

It is the authors belief that a book on ICM is especially needed at this time because of the recent recognition of the necessity of employing more integrated approaches to management of the earth's resources. Better integrated resource management is a fundamental prerequisite of sustainable development. Mandates for the use of more integrated management approaches were prominent in the recommendations in Agenda 21, an action program emanating from the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil, in June 1992 (also known as the Earth Summit or the Rio Conference). Such mandates are also found in the 1982 United Nations Convention on the Law of the Sea, which entered into force in November 1994. In addition, measures for protecting marine biodiversity are called for in the 1992 Convention on Biological Diversity. To succeed, these measures require integrated approaches such as those embodied in the ICM concept. Moreover, ICM has been singled out by the Intergovernmental Panel on Climate Change (IPCC) as a key tool for dealing with the threat of accelerating sea level rise in low-lying coastal areas. The Global Programme of Action on Protection of the Marine Environment from Land Based Activities, emanating from the 1995 Washington Conference on Land Based Activities Affecting the Marine Environment, also points out the importance of better integrated coastal management measures to control land based sources of marine pollution.

Having said that, the authors emphasize that resources and space should be as fully integrated as are the interconnected ecosystems making up the coastal and ocean realms. But at the same time they stress that ICM does not replace traditional single sector resources management. For example, ICM is not intended to replace coastal water quality management and fisheries management programs but to ensure that all their activities function harmoniously to achieve agreed water quality and fisheries goals. Obviously, if a degraded coastal habitat affects the attainment of fisheries management goals, management of that habitat should be within the ambit of an integrated coastal management process.

In this publication, Cicin-Sain and Knecht present an account of the concept of integrated coastal and ocean management (ICM) and illustrate how it can be accomplished by describing ways in which particular nations or their sub-national governments (provinces, localities) have implemented various aspects of it. The authors' major goals are to provide:

- a synthesis and analysis of international prescriptions for ICM;
- a presentation of the major concepts and methodologies of ICM;
- a practical guide to the establishment, implementation, and operation of ICM programmes; and
- an analysis of different patterns of ICM followed in different countries.

They also provide their own prescriptions for approaches that seem to be most successful, based on their own experience, a cross-national survey they conducted, and the relevant scholarly literature.

Contents

New international course announcement

New international course:

'Alternative approaches to fisheries management; the relevance of co-management'.
Date: 17 January –10 March 2000
Place: Wageningen, the Netherlands
Organiser: International Agricultural Centre, in co-operation with Wageningen Agricultural University

For details contact:

The Director, International Agricultural Centre,
P.O. Box 88,
6700 AB Wageningen,
the Netherlands.
Fax: +31 317 418552; e-mail: iac@iac.agro.nl

Course description:

The course is organised by the International Agricultural Centre in co-operation with the Fish Culture & Fisheries Group and the Chair of Agrarian Law & Rural Development of the Wageningen Agricultural University.

It is intended for professionals of governmental and non-governmental institutions working in fisheries management and development (policy & planning officers, programme or project officers responsible for implementation of fisheries management projects and for coastal development projects with a fisheries management component).

Course objectives:

- To appraise the present fisheries management activities in the regions of the participants;
- To learn about, and examine the relevance of international agreements such as the Code of Conduct for Responsible Fisheries;
- To become familiar with co-management concepts, and explore their possibilities, limitations, as well as preconditions and consequences.
- To learn and practise social and biological techniques relevant to the introduction of fisheries co-management arrangements.
- To develop appropriate personal action plans for the work situation of the participants.

The course has a practical focus and joins state of the art knowledge from fisheries science with insights from social sciences such as law, anthropology and public administration. The management of fisheries in coastal waters and inland water bodies will be highlighted; industrial fisheries and aquaculture will only play a minor role.

The course consists of three blocks:

1. Important issues in fisheries management today;
2. Experiences with various management models and approaches, analysis and evaluation; and
3. Working on new scenarios, where and how to practise co-management in fisheries.