

International Coral Reef Initiative Regional Symposium

The Institute for Research in Development (IRD) and Secretariat of the Pacific Community (SPC), Nouméa, New Caledonia

Coral Reefs in the Pacific: Status and monitoring; Resources and management.

Workshop Report – Fisheries

Tuesday 23rd May 2000

Session leaders: Bob Johannes, Alison Green, Tim Adams

Introduction

Tim Adams, Director of the SPC Marine Resources Division, and former Director of Fisheries for the Fiji Government, gave an introductory address. This address is transcribed in Annex A, and provided a brief overview of Pacific Island coral reef fishery issues. Dr Adams suggested that a short workshop, without considerable preparation, could not expect to prioritise or even describe all of the problems of coral reef fisheries, and that the time of participants would be most productively spent in identifying and addressing some particularly recalcitrant, or newly-arising issues. The guidance arising from such a discussion, involving researchers, government staff, NGOs and IGOs, would be of immediate benefit both to Pacific Island reef fishery managers, and in helping institutions determine priorities and directions.

The questions initially suggested for debate by the workshop (Annex B) were briefly discussed, and accepted as being in the main useful, with certain additions. The session leaders instructed the meeting not to necessarily try and clear the entire list of issues, whose relative importance was subjective, but to follow up promising lines of discussion as appropriate, under the eye of the chair.

The following is a summary of the discussion under the topic areas that were considered by the meeting during the time available.

"Dataless management"

Arising from an issues raised in the introductory address, some clarification was sought from the floor on the concept of "dataless management", taking advantage of the presence of the coiner of the phrase, Dr Bob Johannes. It was appreciated that western-style, data-hungry fisheries management paradigms might be inappropriate in managing many small-scale fisheries, but were there cases where "data" was in fact appropriate? The chair referred the discussion to later in the day, under the planned question on "Monitoring", but it was clarified that there were indeed situations where data was necessary to answer certain questions. The main point behind the argument for "dataless management" was the huge disparity between the cost of data-collection programmes in most developing countries, and what was actually needed for effective monitoring and management decisions.

The Fiji government fisheries representative, Subodh Sharma, pointed out that most Pacific Island countries did not have many scientists, but still carried on with data-collection programmes that had been set up years or even decades ago. The local capacity to process and use this data was limited, and there was a possibility that data was even being collected for no reason at all. Some national fisheries departments, like Fiji, had reviewed their fisheries monitoring and research in relation to its needs, and had settled on what was felt to be the most appropriate and cost-effective – primarily monitoring of commercial outlets and occasional surveys of subsistence fisheries – but even the capacity to make this evaluation was limited. Some practical assistance to government staff on how to review information needs in relation to problems would be useful.

It was also suggested that culture was a factor that needed to be taken into account. In places like Palau it might be possible to manage fisheries at the local level without formal data, but in other places, particularly where communities were not so closely linked with the sea, more formal information mechanisms were needed to respond to problems. Traditional information, where it existed, was of great value.

Bob Johannes raised another, related, issue, pointing out that whilst there are a lot of recent articles and books on the subject of reefs and reef fisheries, most of these are about mechanisms, and about ways of "putting knowledge to work", but there are comparatively few people recording and studying the actual knowledge of local fishing communities.

It was pointed out by Foua Toloa, of Tokelau, that secrecy is often an issue with traditional knowledge – different elders, or clans, had different specialisations, and sometimes felt that their position in society might be threatened if this knowledge were available to all. In different circumstances different methods were useful. Sometimes it was better to interview individuals, sometimes a group meeting was better at "breaking the ice". In some cultures people would talk more freely to outsiders about specialised lore, whilst others talked more easily to their own kind. In some situations traditional knowledge could only be recorded, and not published or otherwise used.

Spearfishing

Tim Adams recalled that at the 1999 SPC Heads of Fisheries Meeting it was asserted by one participant that SCUBA spearfishing was "not a valid fishing method", and had been generally agreed by the meeting that **SCUBA** spearfishing should be tightly controlled. Bearing in mind the abilities of breath-holding divers to deplete certain species by spearing at night, how did this workshop feel about **non-SCUBA** night spearfishing?

Several participants reasserted that spearfishing with SCUBA was too efficient a way of taking certain species, and that SCUBA spearfishing at night was often deadly. But spearfishing whilst free-diving at night with flashlights had also been subject to traditional bans in several areas. Bob Johannes reckoned that there was a case for separately regulating both SCUBA spearfishing (at any time) and night-spearfishing (whatever the breathing apparatus, or lack of it). In some areas, such as the Philippines and eastern Polynesia, free diving to 30 metres was common, and a restriction on SCUBA gear was no guarantee of reduced spearfishing efficiency. And at night, certain species were extremely vulnerable and can rapidly be locally extirpated.

Foua Toloa pointed out that the question was not entirely clear-cut, since spearfishing was potentially a very selective fishing method, and the use of SCUBA (particularly by those less used to free-diving) could greatly increase the selectivity of spearfishing. If your time underwater and depth is limited, you have to shoot everything you see.

Ben Ponia, the Cook Islands representative, felt that spearfishing at night and using SCUBA both needed to be regulated. Although spearing was an important subsistence and traditional fishing method, flashlights and SCUBA gear were definitely not traditional, and used mainly in commercial fishing. However, it might be necessary to fight one battle at a time. Commercial SCUBA spearfishing was more easily regulated than commercial night spearfishing, but the awareness generated by addressing the SCUBA issue would also apply in the education of night spearfishers.

It was suggested from the floor that commercial fishers were always looking for new techniques, and that banning the use of SCUBA or fishing at night might just lead to the development of new methods which circumvented any ban. Also, it was not just enough to ban a method, but compliance had to be encouraged by providing alternative methods of making a living. It was then pointed out that in many parts of the Pacific, it was not so much a case of banning a long-established fishing method, but preventing difficult-to-control new methods taking root. Such methods were undoubtedly tempting because they provided large yields very quickly, but the traditional process, of waiting to see if this new method resulted in a long-term decline in traditional food-sources before taking corrective action, could in this case be short-circuited by publicising lessons learned from other areas. Most people were receptive to these lessons, but were often not aware of the consequences, particularly when their main source of external information was from inter-island commercial traders.

Flynn Curren, of American Samoa, said that his department was going through a process of public consultation on a proposed SCUBA spearfishing restriction. However, even if the capture was regulated, there was still a large commercial market for this kind of fish in American Samoa, and the administration was worried that a ban in American Samoa might simply "export the problem" across the water to Samoa, with a subsequent increase in such methods there in order to address the American Samoan market.

Johann Bell, of ICLARM, pointed out that although nobody was keen on undermining the prospect of new sources of livelihood, or desperately needed sources of cash, some species were very vulnerable to the new method of night spearfishing and experience had shown that populations, particularly of certain parrotfish, were usually rapidly decimated.

The session moderator did not see a consensus emerging from the meeting on the issue of night spearfishing. Night spearfishing was perceived to be too efficient a method when in widespread use – and it had a history of rapid spread within certain countries – but it did not appear to be something that was easily regulated separately from spearfishing in general.

The representative of Palau pointed out that it would indeed be extremely difficult to enforce a ban on night spearfishing without banning entirely the possession of spearguns, and that it would be more effective to concentrate on controlling exports of certain species, and on maintaining protected areas where all fishing was restricted, particularly spawning aggregation sites.

Bob Johannes agreed that this was most appropriate in the Palau context, but that in some other areas, night spearfishing WAS being effectively regulated, usually at the level of the individual village, and this could be possible in some other places. It was also pointed out from the floor that in many countries the fish products resulting from night spearfishing were not exported, but sold in local outlets, usually in capital cities, and these were much harder to oversee than exports.

The representative of Vanuatu explained the local situation in Vanuatu, where SCUBA is not allowed and commercial spearfishing is not yet a major problem. Many villages had protected areas under 3-5 year moratoria which, when opened, were only subject to hand-spearing. The alternatives available for commercial fishers were handlining for reef fish and tuna fishing

outside the reef. The fish seemed to be coming back around Port Vila very quickly as a result of these moratoria.

The representative of Tuvalu suggested that restricting these new methods would not affect subsistence lifestyles since SCUBA and flashlights were only used by commercial fishermen. In Tuvalu, a major issue was Funafuti fishermen going to the outer islands but not involving the people of the outer islands themselves.

The meeting agreed that there would not be one Pacific-wide solution to the problems caused by commercial night spearfishing, but that awareness of the results of this fishery in certain areas, and various regulatory experiences, would be valuable in promoting local solutions.

Source & Sink Reefs

Tim Adams explained that there has been some recent debate about the main sources of larval recruits to coral reef fish populations. The meeting was asked, for the benefit of Pacific Island fishery managers, just how important are **distal** sources of recruitment when compared to **local** recruitment for different groups of species – and not only reef-fishes, but invertebrates?

It was pointed out from the floor that larval source and sink reefs had been identified for the purpose of fisheries management in some areas by studying surface currents. However, although the idea was appealing, current patterns are complex, particularly with time, and many fish and invertebrate larvae had been proven to swim against currents. It would be wise to be cautious about identifying larval source and sink reefs purely on the basis of hydrodynamic models. Peter Doherty at AIMS had demonstrated this complexity in some of his recent work.

Rene Galzin made another point, that evidence from recent work in population genetics suggests that island marine populations are more genetically isolated than previously thought. However, the fact that spawning aggregations occur in small discrete areas, but recruitment is more widespread, shows that distal larval sources are important for many species, particularly groupers. As in most things, there will be a range of attributes, with some species being widely distributed as larvae and some locally.

Alison Green described recent experiences in the rezoning of marine protected areas by the Great Barrier Reef Marine Park Authority. A fundamental principle had been to take *connectivity* into account, but nobody really knew how to achieve this in practice. Population genetics could help in the identification of metapopulations, but the requirements of fine-scale zoning required reliable fine-scale connectivity models, which did not yet exist. There was no point in going ahead with such zoning until there was confidence in the methodology since it might just make matters worse. She provided several examples, including dugong and giant clam studies, where population genetics can be used to identify metapopulations and show connectivity, or lack of it, on a broad geographical scale, but the current state of knowledge did not allow this to be done at the scale of individual reefs, and could not identify source and sink reefs for the purpose of practical management of fishing on reefs.

The representative of French Polynesia said that the identification of larval sources and sinks was an issue with invertebrates. In French Polynesia there are three ways of supplying seed oysters to black pearl farms – from natural spatfall, from broodstock held in the lagoon, or from spawning in tanks. Population genetical techniques were not detailed enough to study dispersal within lagoons, and it was already known that dispersal patterns were very complex. Other methods of identification of larval source will be tested in future.

Bob Johannes suggested that whatever the state of knowledge of general biological connectivity between reefs, we already know that spawning aggregations are significant events in the life cycle of certain species. Many groupers were famous for this, but it was not so widely known that many other reef fishes, such as surgeonfishes, and even invertebrates exhibited breeding aggregation behaviour. In some cases the same spot was used by several different species at different times. More effort was needed to identify such sites and protect them, including factoring them into MPA boundaries. In the western Atlantic grouper spawning aggregation sites were fairly well protected but there were only two places in the Indo-Pacific where there were regulations dealing with aggregations – in Palau and Pohnpei. He also had heard of one village in Samoa which had a by-law protecting aggregation sites.

Claude Chauvet suggested that the fishing of spawning aggregations, since the two sexes would be differently vulnerable to fishing, would have an effect on the sex-ratio and demography of fish populations, even if the total catch were not considered to be excessive by conventional stock assessment.

Johann Bell was not in a position to comment on larval origins, but was able to describe some of the work that had been done on identifying "sinks" for blacklip oyster larvae in the Solomon Islands. Deploying spat collectors to identify the best sites for black pearl farms in Melanesia is a very practical example of the identification of larval sinks. Results had been unexpected, and the greatest settlements of blacklip oyster spat in the Solomons were not in lagoons, but in clear, more rapidly moving water away from lagoons. At this stage it is not known if this is a result of better conditions for settlement and survival on the spat collectors, or because of a higher concentration of larvae reaching these sites. However, it is possible to draw two very general conclusions from this: sinks *do* exist; but they are not always found where expected.

Foua Toloa explained that it was now a common view in the Pacific Islands that many resources were shared resources, and that when much effort had been put into cultivating a conservation ethic based on what appear to be firm scientific principles it was difficult to change views when the science was shown to be not so firm after all. But scientists should not be afraid to speak up about uncertainties, and allow people to make up their own minds. For example – turtles. Many Pacific Islands set up local turtle hatcheries in the 1970's in the expectation of assisting preserve local turtle populations, then had to close them down again in the 1980s when it was shown that turtles migrated long distances and that artificial rearing deranged natural migration patterns. The blacklip pearl oyster has been all but absent in Tokelau for a century, and spat collectors yield nothing but other species. It was probable that the source was not long-distance larval transport from French Polynesia as had once been suggested. There are obviously various levels of interconnection between islands.

In summarising the discussion around this question, Tim Adams said that the consensus seemed to be that it was not possible to practically manage individual reefs using the larval "sources and sinks" concept, at least not without a lot more information about those individual reefs, and the genetics of each individual population, particularly when results were often counter-intuitive to those based on simple hydrodynamic models. However, it was very firmly established that spawning aggregation sites were extremely important larval sources, and that several species often used the same site, presumably for hydrodynamic larval dispersal reasons. Aggregation sites were relatively easy to identify, were usually quite small in area, and could be targeted for protection at certain critical times of year without much fear either of scientific invalidity or of going against the grain of local custom. Traditional knowledge would be extremely important in identifying sites, seasons and species.

Marine Protected Areas

To introduce the topic, Tim Adams pointed out that at a previous SPC fisheries meeting it was stated by one participant that "marine reserves make politicians feel too safe and happy", meaning that emplacing an MPA may seem a sufficient conservation measure in itself, but may not actually solve any fishery problems if it is not rigorously enforced and if no other fishery management measures are in place for non-MPA areas. One night of poaching can undo months or years of expensive patrolling. Assuming enforcement is rigorous, MPAs appear to have 2 main advantages for fisheries management: they protect a proportion of the stock thus providing "insurance" against the failure of other management interventions; and they have the potential to provide recruits to surrounding fishable areas through "spillover".

Rene Galzin pointed out that there were many aspects involved in the motivation and design of MPAs, and the concept of refugia for reef fishes was important, particularly to increase the stock of spawning adults and allow them to reach a ripe old age. Larvae resulting from big fish often had better survival than larvae produced by small fish and, whatever the debate about the relationship between stock size and recruitment, mature adults tended to produce much greater numbers of eggs than younger fish.

Bob Johannes felt that we did not know enough about the critical factors in the life-cycles of different reef species to decide what would constitute good refugia or nursery areas for many of them. Mangroves and seagrasses were likely to be at least as important as reefs themselves.

Alison Green pointed out that in this case, a precautionary approach would strongly suggest protecting at least a representative sample of all types of habitat within a given area.

Ben Ponia said that the Cook Islands Ministry of Marine Resources had been thinking very carefully about this after doing a lot of underwater visual census work in Rarotonga and talking to people about setting up customary moratoria, or ra'ui. Juvenile fish and juvenile invertebrates were seen grouped in many different places or zones on the reef and in the lagoon, and the diversity of habitat needs to be taken into account in deciding MPA and ra'ui.

Foua Toloa had been working with IUCN on a project in Samoa that built on the work of the Fisheries Division village fisheries co-management programme. The areas were picked by the villages themselves, and a lot of them covered mainly bare sand. Although siting decisions were based much more on reasons of social necessity rather than the available ecological science, marked improvements were still perceived.

The representative of Fiji said that the Fisheries Division was hoping to update the Fisheries Act soon, and that it would be useful to be able to take the need to protect aggregation sites into account. Given the lack of information available to government this would have to be framework legislation. There were a lot of species to consider and a lot of work to be done in identifying aggregation sites and seasons if protection were to be done at the government level. It was pointed out that traditional fishing rights owners in Fiji are already legally empowered to restrict or prevent commercial fishing on any area of their fishing grounds, and that local measures were sufficiently strong in most traditional fishing grounds to regulate non-commercial fishing. Thus there were already powers in place for the community protection of spawning aggregations in lagoons and passages, and it was only outside the barrier reef – outside the limit of Internal Waters, which also marks the usual limit of traditional fishing grounds – that this potential control did not extend.

On the effects of Marine Protected Areas on fishing, Ben Ponia said that although the evidence was only anecdotal, many Cook Islands fishermen reckoned they were obtaining better catches around closed areas, and were supportive of their continuation. Both Bob

Johannes and Alison Green suggested that it was important to consider people's *perceptions* as well as ecological evidence of the effects of protected areas.

The representative of the South Pacific Regional Environment Programme raised the issue of government input into MPA design, and said that it was best for governments not simply to try and impose MPAs as a result of hearing about results from other countries, but to fully involve the community in the decision.

The representative of Tuvalu was worried about the sustainability of MPA projects developed with SPREP GEF-funded support, particularly since the external support could not be continued for much longer. What could be done to prevent the degradation of MPA status once external support ceased? The SPREP representative drew the attention of the meeting to the subregional workshops organised by SPREP to develop alternative sources of revenue associated with areas now under MPA status, particularly eco-tourism. Small grants of \$5-10,000, for example, were being planned to help communities develop sustainable alternatives to making a living from areas now declared as MPAs.

The representative of Tuvalu was still concerned that too much was being asked of communities in order to keep MPAs going. There had been some failures in Tuvalu. The decision to develop an MPA had to *arise* from the community, not just involve the community, and external actors should not try too hard to motivate the community, either through short-term assistance or by raising expectations in an area where so much remained unknown.

Foua Toloa drew the attention of the meeting to a video from the Samoan Fisheries Division which showed how some villages were "graduating" themselves from government support, whilst continuing to monitor the progress of their own fishery management areas and MPAs. There seemed to be good progress here in developing sustainability, and good results from the measures themselves, with bigeye scad coming back to villages where it hadn't been abundant for years. But this whole process had been based on reviving a traditional idea, rather than imposing something new.

Atonio Mulipola, representing the Samoa Fisheries Division, demonstrated the vernacular manual that was being used to teach fisheries and environment extension officers. Some work was also going into the identification of target species for the government and village monitoring programmes. This pilot study still has some way to go before the data was fully synthesised.

Being Yeeting, the SPC Live Reef Fishery Specialist, gave an account of some aspects of marine area protection in Ontong Java in the Solomon Islands, which he had just visited. The people of Ontong Java are quite isolated, and are totally dependent on marine resources both for subsistence and cash. They have developed their own MPAs, but these might more appropriately be termed "marine *managed* areas". They are not "no-take" MPAs but are opened occasionally for fishing when the need for income is acute. Openings may be timed to coincide with the payment of school fees, for example. The traditional management system is quite successful, but there is little actual monitoring of the results of decisions. There was definitely scope for external assistance to develop certain kinds of knowledge that would provide further material on which to base community decision-making.

Bob Johannes also pointed out that there was also an excellent motivation for biologists and ecologists to work in partnership with these communities because of the fantastic experimental opportunities resulting from traditional management decisions. Not the least being the comparison of the biological status of open and closed areas.

Johann Bell briefly described some of the results of the Anarvon marine protected area trial in the Solomon Islands. Biological monitoring had showed a substantial recovery of trochus shell stocks in three years, but none of the fished sea-cucumber populations had fully recovered in that time. The Solomon Islands representative, Michelle Lam, said that the area management council (which was made up of several communities), was considering opening the area up to a trochus harvest, but continuing to prevent bêche-de-mer fishing. Another idea was to transplant some of these naturally regenerated trochus to other areas closer to the villages. There were three control (fished) areas included in this study of the effects of the fishing ban at Anarvon, so the analysis of results will be rigorous.

Ben Ponia said that the Cook Islands experience was that the fisheries benefits of MPAs were often over-rated by the people promoting them, but that the social benefits were often under-rated. Community interest in the ra'ui at Rarotonga and the proposed island council reserves at Aitutaki had been such that the younger generation now had a much better knowledge of the reef and its resources than previously. Many young Cook Islanders look towards New Zealand rather than home for their future, and local knowledge had been eroding at an alarming rate.

The representative of Tuvalu drew attention to one protected area in Fiji where, encouraged by SPACHEE, local people were themselves monitoring the recovery of *Anadara* shellfish populations. Although technical assistance was provided at the start, monitoring had continued locally for three years with only occasional visits from the University.

The representative of the Solomon Islands mentioned a project at Marovo where villagers are interested in monitoring their resources after being given some initial encouragement. In reference to earlier comments about Ontong Java, marine managed areas may appear to work for a time, but surely even a short time of opening is disastrous.

The representative of Papua New Guinea strongly emphasised the value of providing people with information. In collaboration with CSIRO and ACIAR, the PNG government had looked at ways of managing and conserving barramundi stocks. Population genetical sampling had looked at the possible linkages between the Western Province stocks and barramundi in the East. When local people were given the results, and realised the importance of the barramundi spawning area in their waters they were much readier to protect the area.

On the question of whether 20% would be a good proportion of coral reef to be set aside in Marine Protected Areas, the workshop felt that the exact proportion would depend on the sociology of the area and on the type of MPA.

Richard Farman pointed out that a figure of 30% was put forward at the International Coral Reef Symposium in Panama in 1996 as being a reasonable proportion of the fishable area to set aside in a precautionary approach to the management of fisheries through area restriction methods. Not all fisheries were amenable to management by area restrictions though, particularly those for highly migratory species. Perhaps the 20% figure had arisen as a compromise.

Claude Chauvet outlined some experiences of working on the design on New Caledonia marine reserves. Research had been going on for 7 years on the topic in New Caledonia and a large body of information had been amassed worldwide. Some of the certainties found in the earlier literature have now disappeared and some reanalyses of old biological data using new methodologies have reached different conclusions. Social and cultural analyses are an additional factor making analysis of benefits and best design extremely difficult. Given this uncertainty it was wrong to encourage fishing communities to believe that an MPA will automatically improve nearby fisheries, and certainly not in the short-term. Fish are attracted to reserves themselves, not to surrounding areas.

Ben Ponia asked the meeting for opinions on whether MPAs should be permanent or rotational, since this was a question that was commonly asked in the Cook Islands. Claude Chauvet pointed out that fish get bigger and fatter if protected in permanent reserves, but that this benefit was wiped out as soon as a reserve was opened. In New Caledonia people time their annual leave to coincide with reserve openings, and the fishing pressure is more concentrated in 2 weeks than in an entire year's fishing of nearby non-reserve areas. However, the question asked by Ben Ponia really depends on what is the aim of the MPA. A ra'ui that is set up for the purpose of hoarding fishery wealth and then releasing it is different in aim to a reserve that aims to preserve breeding stocks, and which should be kept closed. And if the aim is a management tool for reducing effort, he felt that closed areas are generally less efficient than closed seasons.

Foua Toloa felt that marine protected areas were extremely valuable, for many reasons other than fishery management, but had a concern that too many were being initiated, or unduly encouraged, from outside. If Pacific Island MPAs were to be sustainable, they had to originate within the community. It was important that scientifically valid information should be available to the community, but they should make up their own minds, since they will be responsible over the long term.

The session moderator wished that he had never suggested MPAs as a discussion topic, since it always raised a heated debate. However, that was all the more reason to cut to the quick of the various opinions and provide some consistent advice to the people who have to manage reefs and reef fisheries.

He noted that other workshops would be commenting on Marine Protected Areas to plenary. Probably the main point to emerge from this Fisheries Workshop on this topic was the crucial importance of not only involving local people in making decisions about MPAs in their waters, but of allowing the decisions to actually originate from them. Also, that it was feasible for people to monitor the progress of their own protected areas, if they were monitoring something that was important to them, but any information that was collected and taken away by outsiders needed to be analysed, put into a wider context, and *returned* to the people to assist them in making decisions. This crucial feedback step was often forgotten by researchers, whose main information outlet is usually the scientific literature. Whilst there were many issues emerging from the discussion on the subject of community-managed MPAs, these were the two issues that appeared to be most often overlooked, and which needed to be emphasised.

Aquaculture

After lunch, under the rotated leadership of Bob Johannes, the meeting decided to tackle the subject of aquaculture. The written question originally posed to the participants was: "Commercial aquaculture is not currently a major reef-space user in most parts of the Pacific. Is it likely to become so in the near future? Can pearl-farming be said to use reef-space, and does pearl-oyster overstocking have an effect on the reef?". To start the ball rolling, the session moderator pointed out that he had observed severe interactions between aquaculture and fisheries in Indonesia, where algae can cover the reef and provide a poor habitat for fish.

The representative of the Cook Islands said that even in the relatively environmentally benign black pearl culture industry, oysters ingest much of the suspended particulate matter in the lagoon and accumulate sediments of pseudo-faeces on the lagoon floor below as well as depriving downstream filter-feeders. Bob Johannes pointed out that research on oysters in cold water suggests that such impacts are very localised. Ben Ponia explained that decreases

in water chlorophyll content had been observed up to 200m downstream of pearl oyster farms – decreases which disappeared when the oysters were removed. But because of the low current flow, most of the nutrient effects were probably in the immediate vicinity of the farms. Although Cook Islands farms had probably not yet reached the nutritional carrying capacity of their lagoons, the farmers themselves should be aware of the future need to bear the costs and consequences of any deleterious impacts.

The discussion led the representative of Fiji to observe that no study had yet been made of the environmental impacts of (*Kappaphycus*, *Eucheuma*) seaweed farming in Fiji. The initial trials were made based on the plant's lack of potential to escape and become invasive – a natural mutant variety was chosen for its lack of holdfast – rather than on any broader effects. Indeed, the environmental effects were felt at the time to be positive.

Steve Why amplified that *Eucheuma* is invariably grown over sandy lagoon bottoms in the Pacific Islands and the additional complexity and shading is attractive habitat to many fishes. In some areas seaweed farming had to be aborted when seaweed beds led to a boom in rabbitfish (*Siganus*) populations – a species which is heavily fished in parts of Fiji. However, the lessons from Indonesia – if seaweed is being cultivated over coral – need to be borne in mind.

Bob Johannes asked if *Te bun* (*Anadara* spp – a nutritionally important shellfish in several Pacific islands) beds were affected by *Eucheuma* seaweed cultivation in Kiribati? Steve Why said that there was some competition for space in the densely-populated capital atoll of Tarawa, but at Kiritimati and other outer islands this was not yet an issue.

The representative of French Polynesia wished to raise another issue – that of marine species introductions. French Polynesia had just introduced barramundi from Australia, and the consequences of its escape from culture were largely unknown. Some solution to the problems caused by species introductions was needed.

The session moderator introduced a new twist to the introduced species issue, bringing in the topic of global warming. If current warming trends continue then Pacific Island corals may be in trouble. Although there is understandably a general reluctance to introduce species, should the Pacific think about introducing more temperature-tolerant species from the Red Sea? Could this even be discussed?

Ben Ponia pointed out that discussion of the issue was not unthinkable. The Cook Islands paper to plenary had pointed out that it might be necessary for Cook Islanders to subsist on the introduced algal-grazing species, *Trochus niloticus*, when all the other reef food species had been wiped out!

Pierre Labrosse had recently participated in an expert consultation looking at problems in 2020 resulting from population growth and the evolution of the cash economy. It had been decided that fishing pressure in the Asia-Pacific region was likely to treble or even quadruple by that time, and that there was an urgent need to look at both the expansion and the potential problems of aquaculture and anticipate the future. At present only two aquaculture systems – black pearl and shrimp – between them provided more than 90% of the value of aquaculture in the Pacific Islands.

Bob Johannes suggested that what was happening right now in South East Asia was the potential future for the Pacific Islands, and that there were plenty of lessons to be learned. 90% of the mangroves in the Philippines had already been removed, with aquaculture a major culprit, and many of the results of this kind of unconsidered development could be observed simply by visiting.

Alison Green cautioned against the introduction of high temperature tolerant species, since most introductions had been shown to cause more problems than they solved. In the Great Barrier Reef Marine Park there is a strict ban on introductions and even on moving individual organisms or genetic material around. This policy had consequences for reef-restoration. If there has been an impact, does GBRMPA try to fix it or just leave it to nature? Currently the Authority waits to see if natural amelioration occurs before attempting radical solutions.

The representative of the New Caledonia Southern Province, Richard Farman, recalled an SPC fisheries meeting in 1986 where Pacific Island States and Territories took a position on the introduction of giant clams and trochus, and it would be useful to remind people of this. Perhaps it could be updated and submitted to the next SPC meeting. In considering questions of competition between aquacultured organisms and reef fisheries, the cost-benefit ratio was likely to be important. In New Caledonia the main aquaculture was shrimp (*Penaeus stylirostris*), but this had not required the cutting of mangroves since shrimp farms were zoned behind the mangrove belt specifically to avoid this impact. The impact of shrimp faeces had been investigated and did not appear to be significant, but this might not be true of more intensive farming.

Alison Green said that the impact would also depend on the distance from the outfall to the sensitive area. The GBRMPA guideline is that the outfall must be indistinguishable from ambient waters before it reaches the reef. In some Pacific Islands however the reef would be very close to any outfall.

Bob Johannes warned that the effluent from intensive shrimp farming in Asia is devastating, and that this could happen here despite the lessons afforded. He hoped and prayed that aquaculture in the Pacific Islands would not follow the same path. Steve Why had just returned from the Philippines and said that people there were now realising that mistakes had been made. The Visayas was now zoning areas for marine use, and making habitat assessments *before* making development decisions.

Bob Johannes told the meeting that alternative employment in Southeast Asia, whilst mangroves were regenerating, was catching post-larval groupers as they emerged from the plankton and using these in aquaculture. In theory this is not detrimental to wild grouper survival since there is huge natural mortality after this stage of the life-cycle and it is not numbers that limit recruitment, and in theory it takes pressure off the capture of wild stocks for the live reef fishery. A lot of former dynamite and cyanide were now doing it, and even stopping other people using dynamite and cyanide to prevent them wiping out the wild broodstock that supply these larvae. Some day this may become cost-effective here, and there are potential multiple pay-offs for the live reef fishery.

Johann Bell brought the attention of the meeting back to shrimp farming, where New Caledonia had proven that it could be carried out with low environmental impact. He felt that the Pacific Islands, building on these lessons, had a chance to institute "environmentally-friendly" aquaculture, and almost to rehabilitate the name of aquaculture itself. It was not so much the idea of marine farming that was wrong, any more than farming on land was wrong, but that it had been carried out without any regard to the impacts. The ocean is the last remaining frontier for most people, and we are treating it much as we have our previous frontiers on land. But Pacific Islanders are much more aware of the sea than other people, and do not see it as a frontier, but as an existing part of their territory. The methods that have been successful in the Pacific, like black pearl culture, concentrate on the lower end of the food-chain and have little environmental fallout. If the Pacific ever develops grouper aquaculture on a *large* scale then we will have to beware of major effects on the food chain but, in general, the Pacific has the potential to corner its own part of the market by concentrating on high-value low-impact species. We are at a crossroads.

Marine "bioprospecting"

The question put to the meeting to initiate discussion was, "Is marine bio-prospecting or genetic exploration for new pharmaceuticals a fisheries management issue or does it need a different kind of control"?

The representative of Palau mentioned that marine bioprospecting was a significant issue for the government of Palau, which would be interested to hear the views of the meeting.

It was pointed from the floor out that marine bioprospecting in the Pacific was focussing on sessile species and often required large amounts to obtain an active fraction from the sample. The momentum of this activity was disturbing. Some of the potential financial benefits suggested to local peoples were large, but very few actual benefits had been realised, and intellectual property rights were not well defined or always agreed by all parties. One of the fundamental bases of all bio-property claims was the identification of the species or variety, and with the desperate state of marine taxonomy in the Pacific Islands it would be difficult to claim rights.

The representative of American Samoa confirmed that, whilst in some cases pharmacologically active biochemicals picked up by bioprospecting could be artificially synthesised, many of the homeopathic "pharmaceuticals" could only be cost effectively obtained by processing large amounts of raw material, such as *Cladosiphon* seaweed. Tim Adams asked if the taxonomy of the *Cladosiphon* seaweed being exported from Tonga to Japan for homeopathic medicinal purposes had been clarified yet. The representative of the University of the South Pacific said that the USP Marine Studies Programme was working on it.

The representative of the USP also pointed out that USP was undertaking a major bio-prospecting project and had indications of a promising extract from a sponge found at Beqa in Fiji. An agreement had been drawn up involving the local community and the government. The University had produced generalised guidelines for how such agreements might be drafted.

The representative of the Solomon Islands recalled that the Solomons had been visited by an expedition from the Santa Cruz campus of the University of California in 1996, but the Fisheries Department had not been aware of this at the time and only received a brief report afterwards. Attention needed to be paid to situations where bioprospectors might appear to be tourists, and collection take place without any licencing or oversight.

Tim Adams said that UC Santa Cruz had sent expeditions to Fiji several times in the 1980's, prospecting primarily for anti-cancer properties of sponges at Beqa, and had developed a good relationship with the Fisheries Division, and had followed all the requirements. It was possible that they had obtained permissions from a different department in the Solomons. There were however less scrupulous operators anxious to avoid making commitments, and there needed to be some nation-wide agreement for handling marine collectors. At the moment, in most Pacific Island countries, marine bioprospecting clearly fell under the purview of the fisheries legislation since it was taking living organisms from the sea. Most countries had very comprehensive measures in place for controlling the activities of foreign fishermen but perhaps felt that collection of such small quantities by bioprospectors should not invoke such rigorous measures. Although the future payoff might be enormous, that might only be realised from a minute fraction of the collection and the current market value of the collection was minuscule. How should it be valued? It definitely required a lot of thought before applying or adapting existing policies and regulations designed for commercial fisheries.

Richard Farman pointed out that SPREP and SPC had recently held a workshop in Fiji on intellectual property rights. It mainly covered the terrestrial biota, and included traditional knowledge and culture, but some of its outputs were significant to the marine question. Legal instruments have been developed under the Convention on Biological Diversity (CBD) to cover research permit conditions. On balance, this is probably a CBD rather than a fisheries management issue. But if a "prospected" organism or gene is developed for aquaculture production then it perhaps becomes a fisheries issue.

The session moderator asked if it would be fair to sum up the view of the workshop, in response to this question, as being to study approaches to the regulation of terrestrial bio-prospecting and to adapt these to the marine area, rather than regulating bio-prospecting through the fishery management legislation?

Alison Green was afraid that the regulation of marine bio-prospecting would continue to "fall between the cracks" as it had already for several decades. It urgently needed to be agreed which department would be responsible. It also needed to be agreed who would receive any benefit that resulted and at what level. The country as a whole? The province where the organism was discovered? The nearest village? The way it is currently being handled by the Great Barrier Reef Marine Parks Authority in Australia is to allow easy permitting for taking small amounts of organisms for testing, with more restrictive special permits if larger amounts are required. The fundamental questions for any Pacific Island country to ask when approached by a bioprospector for a permit are "who owns the specimens you pick up", and "how will the profits be shared out if a cure for cancer is discovered"? GBRMPA offers to assist any Pacific Island country representative who would like advice on this issue.

The meeting thus did not reach any major consensus after this brief discussion, but participants took away considerable food for thought.

Monitoring

The chairman drew the attention of the meeting to the question previously posed for discussion:

"Bearing in mind that we, and FAO, spent much of the 1970s and 80s trying to get comprehensive national fisheries monitoring and catch-recording systems in place, and today's feeling that western "data-hungry" models for fisheries management are inappropriate, how much, and what kind of reef fishery monitoring is appropriate?

- ? Are indicators or proxies any use?
- ? How is the precautionary approach to be applied to multispecies fisheries? How do we define, and monitor approaches, to "precautionary" and "limit" reference points?
- ? How can tiny island countries, with only a handful of government staff, ever hope to effectively monitor reef fisheries? Are occasional surveys an acceptable alternative to continuous monitoring?

Flynn Curren felt that the identification of appropriate proxies, if possible, was a good approach to the problem of monitoring, balancing the costs against the data needs of government.

Richard Farman described the setting-up in 1997 of an "observatory" in New Caledonia, monitoring some human-affected sites and some pristine sites. This required quite a lot of money and commitment, and one of the main problems was continuity. The original mode of operation was through NGOs, but volunteers usually rotated rapidly, and responsibility had

later been handed to a consultancy. He wondered if any tools or "how to do it" reports had emerged from ICRI on this kind of monitoring.

Alison Green attacked the issue from first principles and pointed out that we need to know what question we are trying to answer before we design the monitoring programme. Certain issues – like assessing the causes of coral bleaching – may require a very scientific approach. But for questions like "do we have any Maori wrasse left" then almost anybody can do this, with a little motivation. For most governments, their data needs will be satisfied by a combination of both: community-level monitoring providing a long-term base, with occasional in-depth scientific surveys. For communities to become interested in monitoring, government officers have first to sit down with them and ask them what *they* want to know. Independent advisers can usually be called in to help with more occasional scientific work, and this might be best tackled on a 5-year cycle. The scientific work can both fill in the gaps, and provide a cross-check on the community monitoring, which may otherwise tend to "drift" from the standards set at the start.

The representative of Papua New Guinea pointed out that a lot of government-level monitoring was done in Papua New Guinea. Indeed, a major proportion of staff are data collectors and most people don't really know what to do with the information that is resulting – the data sits in the files and there is little awareness of what the next step should be. The problem is how to translate this information into advice that can be passed back to the decision-makers.

Pierre Labrosse said this illustrated the general need to identify the question before collecting the information. SPC had come across this situation in several Pacific Island fisheries departments, where resource assessment and research programmes had been set up years ago but not adapted to changing circumstances. Often these programmes were initially well-designed, but the analytical expertise was ephemeral and when this was discontinued (either because of the ending of a project, or withdrawal of expatriate staff, or movement of highly-educated local staff) the data collection tended to carry on regardless. SPC would be taking a region-wide look at this situation in the near future, developing standardised reef fisheries assessment and monitoring tools and assessing how they might fit with local situations, and then helping with their adaptation to future circumstances. A major 5-year South Pacific Regional Comparative Assessment of Reef Fisheries project is currently under consideration for funding by the European Commission.

Ben Ponia pointed out that community monitoring has awareness benefits in itself, particularly if schools can be encouraged to incorporate some practical exercises into the curriculum.

Other issues

Rene Galzin was surprised that nobody at the workshop had raised the issue of (human) populations in relation to reef fisheries. The session moderator pointed out that a one-day workshop of fisheries specialists couldn't hope to cover many topics, particularly something subject to as many different opinions as *population*. Other topics that could have been usefully considered, given time, included *corruption*, *pollution*, and *enforcement*.

The additional issue of *cultural practises* was raised from the floor, when it was pointed out that some Pacific Island fishing methods are highly destructive. Were there any studies of this? Bob Johannes was of the opinion that not enough credit was given to the villages that had already introduced their own controls on such methods as using traditional botanically-based fish stupeficients, and crowbars to break out giant clams from coral heads.

Foua Toloa said that a UNESCO-sponsored study in Tokelau had recorded local marine management practices, both good and bad, but this information was recorded in the local language. It was owned by the masterfishermen who provided it and could only be released with their permission. If it had been recorded in English it would not have been understood by them, and there was the worry that the recorder would claim ownership through authorship.

Being Yeeting pointed out the common concern amongst the local community in Kiribati about "giving away knowledge". When people are approached for the purpose of documenting practises for their use, and their descendants, then they start to open up. This knowledge will never be useful in the context of ICRI but it is definitely useful to communities. Steve Why also mentioned that Francis Hickey at the Vanuatu Cultural Centre is involved in recording traditional information, including fishing practices, in the 130 languages of Vanuatu.

Changing the subject, Rene Galzin introduced the topic of alternatives. The first reflex of most government fisheries managers is to prohibit something. There is a need to identify promote alternative livelihood methods to compensate for the restrictions.

Bob Johannes pointed out that a lot of the management of fisheries in the Pacific is not done by governments, but by local communities. Communities didn't want to be told what to do, but to be given information and options. If governments are not involved in prohibiting things then they don't need to worry about providing alternatives. In Vanuatu, many millions of vatu had been spent by the Fisheries Division in divert fishing effort from reefs, but Moses Amos, had achieved a more lasting effect for the expenditure of a few thousand vatu providing information and suggesting that communities protect their own reefs.

Conclusion

To present its report the workshop allocated responsibility as follows –

- ? Bob Johannes would present a summary of the main discussion points to plenary
- ? Alison Green would explain in more detail to plenary one of the particularly significant outcomes of the discussion, on cost-effective coral reef monitoring programmes.
- ? Tim Adams would prepare the written report (this text)

Annex A

Problems of managing reef fisheries

by Tim Adams

(transcript of session introduction)

Good morning ladies and gentlemen. I was only recruited recently to lead this workshop so please forgive my stumbles and blunders when they occur, as they inevitably will.

Workshop purpose

My brief, in essence, is to set the stage with some general background comments, and launch you into a discussion about specific issues. **The subject** is the problem of managing Pacific Island reef fisheries. **The output** of this workshop will be, I hope, some agreement on how to tackle some of these problems, and perhaps some new ideas, or even new problems brought to the attention of the world.

I don't think that a short meeting like this has any hope of producing a structured response to the entire issue – an action plan. We would require months of preparation and correspondence before meeting to decide the exact final words if it were to be of any value. Also, an international action plan is only of any use if there is an international structure capable of taking effective international action. But most coral reef issues are not international, and action is taken at the national or the local level, with different kinds of actions needed in different areas depending on local social and environmental conditions. In the Pacific, much of the local infrastructure for doing this is already in place, particularly within traditional culture. In many cases this infrastructure needs no external support. In others it may need strengthening. But please note: in all cases *the local infrastructure needs to be taken into account*.

I feel that the main value of an international meeting about coral reef fisheries is communication – the sharing of ideas and experiences, rather than planning international action. International co-ordination is essential on many other issues, such as the management of highly migratory fish stocks, and transboundary issues such as carbon dioxide emissions, but with coral reef fisheries the focus of the action in the Pacific is at the local level. People are starting to worry that international *control* is beginning to become more prevalent than international *co-ordination*, and international organisations have to be very wary of taking too much upon themselves.

However, most of the activity of international regional organisations in the Pacific is about getting people together from different countries to talk about how best to take action at the local level. We may be able, at this workshop, to decide on some truly international coral reef fishery issues – for example: the relative importance of long-range larval transport in fishery recruitment (sources and sinks) is something we might want to talk about later – but mostly I suspect we will concentrate on how international knowledge and assistance can best benefit national and local processes.

That's a long-winded way of saying that we are not expecting this workshop to come up with a detailed structured action plan, nor to address and prioritise absolutely all coral reef fisheries issues, but rather to talk about a few specific issues which are either interesting, topical, urgent, or in need of further definition. And hopefully we will come up with some answers and be able to plant the seeds of some new activities. And because we have such a broad

spectrum of people here, from scientists to administrators, working internationally or nationally, it is inevitable that we will learn something new – even if it is only about other people's priorities.

I will give you a general introduction to Pacific Island reef fisheries issues (as I see them from SPC, naturally), and I have suggest a list of topics that we might seek answers to, or otherwise talk about during the rest of the session. These were circulated to you yesterday so you can think about them. We can then talk about what the final list of topics should be – hopefully it won't be too long, as we only have a day to get through them.

We're running a simultaneous French-English interpretation service here, so I am sticking fairly closely to a prepared script. This is to give the interpreters a bit of a holiday before we launch into the discussion session, where no preparation will be possible. Because of the interpretation I would ask you to please make a conscious effort to speak slowly and clearly.

Another rule I would ask you to follow is that, if you wish to say something, that you request the permission of the chair before speaking, and speak into a microphone. The interpreters are in a soundproof room at the top of the building and cannot hear anything that doesn't go through a microphone, and can't cope if several people try to talk at once. It doesn't make for a very free-flowing debate, but it does tend to make you think carefully about what you are going to say, if you first have to grab the attention of the chair.

So – administrative details out of the way – let's go on to coral reef fisheries.

"Taxonomy" of reef fisheries

From our perspective at SPC, where a major component of our work is guided by the requests we receive from member countries, we have tended to classify reef fisheries into two main types: export fisheries and domestic food fisheries.

"Export fisheries" – fisheries such as bêche-de-mer, trochus shell, deepwater snapper and aquarium fish – do not interact a great deal with "domestic food fisheries". They target species which are of comparatively high value in overseas markets, and which are of comparatively low, or sometimes zero, value domestically. Another characteristic of export fisheries is that they are the fisheries which occupy much of the time of most Pacific Island fisheries departments, which lead to most overfishing worries, and which generate most requests to SPC for advice and help.

"Domestic food fisheries" are the multispecies artisanal fisheries that put most of the protein on Pacific Island tables, particularly in rural areas. We do not get asked very often by SPC member governments for assistance in managing these. They tend to be managed at the local level, through selective access and occasional moratoria, and are generally only a major worry when external factors are involved. And by external factors, I don't mean just other fishermen, but urban pollution and agricultural runoff – subsistence food fisheries around Pacific Island capitals (as opposed to outer islands) are often in trouble.

The general perception amongst national governments – that domestic food fisheries are less of an immediate worry than export fisheries – is an interesting debating point in itself. Does it reflect the fact that local systems are in control and preventing most overexploitation, or is it just that problems are not being made known because they are internal? We suspect the former – that reef export fisheries are much more prone to overexploitation than reef domestic food fisheries, and hope to have some hard information to contribute to the discussion once our SPRCARF (South Pacific Regional Comparative Assessment of Reef Fisheries) project gets under way next year. Pierre Labrosse may talk more about this later.

This distinction that I make between reef export fisheries and reef food fisheries is not absolute, of course. Several species are highly valued in both export markets and domestic culture, and it is perhaps significant that the two primary examples of "crossover" – giant clams and turtle – are now subject to comparatively strong restrictions on taking across almost all of their range.

The newest example of "crossover" is the Live Reef Food Fishery. I say "new" because, although it has been in the region for nearly 10 years (or around 15 years in the case of Palau – Palau is an early warning for the rest of the Pacific in a number of issues because of its proximity to Asian markets), it does not have the 200-year history of the *bêche-de-mer* export trade, or the 100-year history of the trochus trade.

Previously, the only thing that kept domestic reef food species from becoming export fisheries was the isolation of the Pacific Islands, and the high cost of trade. You will notice that most of the reef export fisheries that I mentioned previously produced comparatively non-perishable commodities, shell, or smoke-dried products, that can last for several months for transport aboard scheduled shipping. The high value of live reef fish in Asia, like the value of giant clam in the 1970s and 80s, now makes it profitable to send specialised vessels all the way down here or to use air-transport. And like giant clams before them, the highest-value live reef fish are ecologically vulnerable. Eating them is a display of status. They are of high value precisely because they are rare, and their value will continue to increase as they become rarer.

This creates a dilemma for Pacific Island fishery managers. On the one hand, these same species are being harvested for the local market and fetching a much lower price dead than they would if shipped alive to Hong Kong – money that could considerably increase the earnings of rural villagers. On the other hand, the very high price means the temptation to overexploit is high. Does the foreign trade substitute for local consumption, or does it just add to it?

The main problem in Pacific Island reef fisheries management

Compared to Southeast Asia, Pacific Islands coral reefs have been relatively isolated from fishery problems and less stressed by other anthropogenic pressures. However, the erosion of trade barriers, both bureaucratic barriers and barriers due to the cost of transport versus the per-unit value of exports, will put increasing pressure on traditional reef fishery management systems, and stress on Pacific Island government policies. Most governments have to deal with these reef fishery management problems on a reactive basis – they simply do not have the specialist expertise or resources to do more than address crises and "fight fires". But also unlike Southeast Asia, Pacific Islands often have a local and traditional infrastructure in place that can deal with many local issues, almost without anyone outside noticing.

However, despite recent trends towards the strengthening of these customary mechanisms, and government-community linkages, the pressures continue to mount, and the cash economy inevitably continues to overtake the subsistence lifestyle. (Human societies tend to work more efficiently when communities are composed of different specialists than as groups of similar generalists, and the cash economy enables humans to specialise to a high degree.) As well as fighting reef fishery management "fires", Pacific Island societies need to have plans, or policies, in place to deal with potential change, and to try and guide the future, not just to react to it.

Fine words, I know. But plans are very difficult to formulate at the government level for one main reason – a lack of knowledge about what is happening in Pacific Island reef fisheries.

Now, I have to be careful about what I say here, with Bob Johannes sitting in the meeting, but I should first make it clear that I believe in Bob's views about "dataless management". And I believe that there is little point in trying to set up western-style fishery management models, that can only run with a huge investment in scientific data, unless you have a western-style, commercial, user-pays fishery. I also believe that we are desperately in need of fault-tolerant management solutions – solutions that include insurance against inadequate stock assessment or a lack of fundamental ecological knowledge, or over-optimistic fishing effort allocations.

But "data-less" does not mean "information-less". Local management actions take place at the local level based on local knowledge, and this is the strength of Pacific Island traditional systems – a local feedback loop between knowledge and decision-making is usually in place. But national plans and actions are also necessary, particularly when dealing with external issues, and governments do not always have access to this local knowledge, nor to enough international knowledge about biology and ecology, to make the planning process effective.

So, in short, information and knowledge – "intelligence", if you like – is a major lack, and is what we look to develop in initiatives like ICRI. Pacific Islanders manage fisheries at the local level through village-based customary systems, and at the national level through fisheries departmental policy and regulation. National-level fisheries management planning and action needs to draw upon knowledge from all levels, including the international.

Conclusion

Incidentally, a major fault of mine is to continually point out at meetings like this that, all too often, the search for knowledge about reef *fisheries* has concentrated on reef *fishes*. That doesn't sound so illogical, but, in the Pacific Islands, at least, reef fisheries take a lot of *invertebrates*. Indeed, reef export fisheries are usually dominated by invertebrates, and reef export fisheries are usually where Pacific Islands need most help.

The other point I try to make, wherever possible, is that *fisheries* always involve *people*, and if we are trying to manage fisheries we need to know at least as much about the people doing the fishing as we need to know about the fish. Luckily people are easier to study than fish because they don't live permanently underwater, and there is much more background data available about people than about fish from the many different kinds of scientists working in social fields. But it has been all too common in the past for people studying fisheries ecosystems to leave out the most significant predator of all..

Anyway. I'm afraid I haven't given you too many facts this morning. Just a bunch of rhetoric. I sincerely hope that you will be able to put a little more substance into the debate as the day wears on...

Following this I will present the list of issues that we think would be useful to talk about. Some of these I have just touched on. Others I haven't. I'll stop here and ask if anyone has any comments, alternatives, additions, or deletions. Or indeed if anyone would prefer to work in a different way (although in that case they would need to be prepared to come up and take this chair, which I would be very happy to relinquish)

Annex B

Questions that might be considered by the Fisheries Workshop

These questions are suggested for the purpose of providing potential talking points at Workshop session 2. It may not be possible to answer some of them because we lack the expertise, whilst others may be trivial and dismissed immediately.

Some of these questions may possibly even be considered politically "loaded" in some circles, but the intention is not to be provocative. These items arise mainly from questions that have been asked in SPC fisheries meetings, and to which it is difficult to provide definitive answers.

A consensus opinion of the workshop, or a catalogue of specific experiences, or guidance on the priority of a particular issue, or a suggestion for future work to answer the question, would be a useful output in each case.

Please think over the following and come prepared to lend your expertise, your experience, or your opinions in answering them, or in raising other, more important, questions.

1. **Spearfishing** – a specific question, to start the ball rolling. At last year's SPC Heads of Fisheries Meeting it was said by one participant that SCUBA spearfishing was "not a valid fishing method", and it was generally agreed that SCUBA spearfishing should be tightly controlled. Bearing in mind the abilities of breath-holding divers to deplete certain species by spearing at night, how does the meeting feel about **non-SCUBA** night spearfishing?
2. **Sources and sinks** – There has been some recent debate about the main sources of larval recruits to coral reef fish populations. For the benefit of the Pacific Island fishery manager, just how important are **distal** sources of recruitment when compared to **local** recruitment for different groups of species – and not only reef-fishes, but invertebrates?
 - ? What are the consequences for management under the different scenarios? – should we concentrate on the purely local level or is inter-island co-operation necessary?
 - ? What are the consequences for MPA design (see Q4)?
3. **Monitoring** – Bearing in mind that we, and FAO, spent much of the 1970s and 80s trying to get comprehensive national fisheries monitoring and catch-recording systems in place, and today's feeling that western "data-hungry" models for fisheries management are inappropriate, how much, and what kind of reef fishery monitoring is appropriate?
 - ? Are indicators or proxies any use?
 - ? How is the precautionary approach to be applied to multispecies fisheries? How do we define, and monitor approaches, to "precautionary" and "limit" reference points?
 - ? How can tiny island countries, with only a handful of government staff, ever hope to effectively monitor reef fisheries? Are occasional surveys an acceptable alternative to continuous monitoring?
4. **Marine Protected Areas** – At a previous SPC fisheries meeting it was stated by one participant that "marine reserves make politicians feel too safe and happy", meaning that emplacing an MPA may seem a sufficient conservation measure in itself, but may not actually solve any fishery problems if it is not rigorously enforced and if no other fishery management measures are in place for non-MPA areas. One night of poaching can undo months or years of expensive patrolling. Assuming enforcement is rigorous, MPAs appear to have 2 main advantages for fisheries management: they protect a proportion of

the stock thus providing "insurance" against the failure of other management interventions; and they have the potential to provide recruits to surrounding fishable areas through "spillover".

- ? What evidence do we now have for the "spillover effect" outside the borders of MPAs, and just what do we tell village leaders when they ask how long it is likely to be before they notice a difference in fishable stocks outside reserve boundaries?
- ? There are anecdotal indications that some MPAs may show a much greater increase in fish stock density within their borders, and of more larger sized fish, than can be logically explained by recruitment and growth alone within the time available. What is the actual evidence for population density change with time in newly-established MPAs, in places where monitoring has taken place?
- ? Do rotating reserves work, or should they be permanent?
- ? Are long-term moratoria (a traditional Pacific Island fishery management tool) any different, in fisheries management terms, from MPAs? Do community-initiated MPAs provide the best of both worlds?
- ? (This is tied up with question 1) If reef fish recruitment is mainly local, and there is little mixing between reefs, then should MPAs be small and numerous, reserving a portion of each reef to provide insurance? If recruitment is distal then should a few whole "source" reefs be identified as MPAs?

5. **What new factors** need to be taken into account by Pacific Island reef fisheries managers?

- ? Is marine bio-prospecting or genetic exploration for new pharmaceuticals a fisheries management issue or does it need a different kind of control?
- ? Commercial aquaculture is not currently a major reef-space user in most parts of the Pacific. Is it likely to become so in the near future? Can pearl-farming be said to use reef-space, and does pearl-oyster overstocking have an effect on the reef? How many countries have legislation, or policies, in place for managing potential future reef-aquaculture joint-ventures?
- ? The US Coral Reef Task force is aiming for at least 20% of the coral reefs under US government ownership to be legislated as "no-take" marine reserves, mainly outside the three-mile limit of territorial waters. Is that percentage appropriate for those Pacific Island countries with largely subsistence economies? How long before the subsistence economy gives way entirely to the cash economy in those places?

6. **Additional questions** suggested during the course of the workshop:

- ? What projects involving Pacific Island reef fisheries are currently being carried out by institutions?
- ? What is the current status of aquarium fisheries in the Pacific Islands?
- ? Has restocking or artificial enhancement yet come of age as a mechanism for fast-tracking the rehabilitation of overfished areas by overcoming the natural recruitment "bottleneck". Can artificial enhancement increase productivity?
- ? What can be done to maintain the livelihoods of fishers displaced from fisheries or areas where fishing has to be reduced or stopped? Are there positive incentives that can be used to persuade fishers to move away from overstressed fisheries without requiring areas to be formally closed, with expensive enforcement schemes?