

Community-Based marine biodiversity surveys and marine resource management plans (MRMPs) as a basis for the conservation and sustainable use of coral reef ecosystems in the Pacific Islands

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Introduction

This paper suggests that, in the Pacific Islands, where the biodiversity of coral reefs and associated marine ecosystems is usually controlled and best understood by the local, often indigenous, resource owners and users, one of the most effective ways of determining the status and promoting the effective management and monitoring of coral reef and associated marine ecosystems is the conduct of community-based coral reef biodiversity surveys and the use of the results to develop community-based marine resource management plans (MRMPs) for implementation at the resource owner and user levels. It suggests that such an approach may be the most cost-effective means of promoting *in situ* conservation, the sustainable use of coral reef biodiversity, and to protect, record and promote the use and application of indigenous or traditional knowledge to marine resource management as a basis for sustainable development for Pacific Island coastal communities.

It is further suggested that, although there is increasing emphasis internationally on the establishment of protected areas, protection of endangered species, protection of intellectual, biological and cultural property rights, the promotion of "profitable environmental projects" (e.g., "ecotourism"), sustainable development bills, the development of environmental impact assessment capabilities, and a range of international initiatives and legal instruments for the protection of endangered ecosystems, biota and intellectual property rights (e.g. the CBD, CITES), if such initiatives are not developed, implemented and experienced at the community level in the Pacific Islands, they will probably fail in the long run. This assumption forms the central component of both the South Pacific Regional Environment Programme (SPREP)'s South Pacific Biodiversity Conservation Programme (SPBCP), and a number of University of the South Pacific (USP)-based programmes. These include a MacArthur Foundation-University of the South Pacific Community-Based Biodiversity Conservation (CBBC) in Melanesia Project and a recently completed USP-Biodiversity Conservation Program (BCP) project to establish

marine reserves, gain local benefits from marine bioprospecting and to implement community-based marine resource monitoring networks. Work conducted under these projects (which is being continued with additional MacArthur and Packard Foundation funding) provides the basis for most of this paper which constitutes an analysis of a methodology, preliminary findings and resultant preliminary community-based biodiversity conservation action plans and actions that have resulted from work in Fiji and Tonga. Particular emphasis is placed on showing how community-based participatory marine surveys, involving both men and women, can: 1) facilitate coral reef biodiversity and ethnobiological inventories and contribute to regional biodiversity and ethnobiological data bases; 2) help preserve and protect traditional knowledge about marine biodiversity for the use and benefit of local communities; 3) identify coral reef and marine ecosystems and plants and animals that are rare, endangered or of particular economic, cultural or ecological importance to local communities, and which are in need of protection or enhancement; 4) identify types of development that are unsustainable or destructive of marine biodiversity at the community and national levels; 5) identify traditional and non-traditional actions that can be taken at the local, national and international levels to protect marine biodiversity and ethnobiological knowledge and to support the objectives of the SPBCP, CBD, CITES and ICRI. Emphasis is also placed on how the findings of such surveys can be extrapolated and duplicated at the community-level throughout the Pacific Islands in an effort to conserve and enrich both marine biodiversity and ethnobiological knowledge as the natural and cultural capital needed as the basis for sustainable development for future generations of Pacific Islanders.

The balance of the paper: 1) defines marine biodiversity and biodiversity conservation in the context of the Pacific Islands; 2) discusses the methodology used for community-based ethnobiological surveys; and 3) presents some of the results of a survey conducted in Ha'apai, which were the basis for the development of a community-based biodiversity management plan for the SPBCP Ha'apai Conservation Area, to show the types of in-depth information that can be generated using the methodology.

Marine biodiversity and biodiversity conservation in the context of community-based biodiversity conservation

The way in which the concepts of marine biodiversity and biodiversity conservation are defined are central to the success of ICRI, the CBBC, the CBD and other initiatives designed to protect marine biodiversity, or to promote the conservation and sustainable use of biodiversity more generally.

Definition of Marine Biodiversity

In the context of this paper "marine biodiversity" would include:

1. All marine and nearby coastal ecosystems that are under the direct influence of the marine environment or that directly affect the marine environment, and in particular coral reef ecosystems (e.g. fringing reefs, barrier reefs, patch reefs, deep reefs, lagoons, open ocean, mangroves, seagrass-algal beds, estuaries, and coastal strand forests, swamps, agricultural areas, and towns or villages, etc.);
2. All species and genetic varieties of plants, animals and microorganisms found in these ecosystems (e.g., all species of mangroves, sea grasses, seaweeds and microalgae, marine mammals, seabirds, fin-fish, turtles and other reptiles, shellfish, holothurians, crustaceans, scleractinian and non-scleractinian

corals, sponges, marine invertebrates and the almost infinite range of microorganisms, and all genetic varieties/races and cultivars of these plants, animals and microorganisms and a wide range of coastal strand and mangrove species, finfish, shellfish, lobsters, etc. that give our marine and nearshore coastal ecosystem additional resilience);

3. The knowledge, uses, beliefs and language ('ethnobiological knowledge') that local communities have in relation to their marine and coastal biodiversity. This would include the time-tested "biodiversity-management systems" which have served as a basis for the relatively sustainable habitation of the islands for thousands of years, beginning long before the expansion of the global market economy over the islands. This category can be referred to as "ethnobiodiversity"

In a sense, 1, 2 and 3, could together be seen as constituting "biocultural property", because in most Pacific Island countries, rural communities "own", control, use and manage the local coastal and marine ecosystems, the plants and animals found within them, and the ethnobiological knowledge about the ecosystems and plants and animals.

Marine Biodiversity Conservation in the Context of the Pacific Islands

In the context of the Pacific Islands, marine biodiversity conservation should be seen as synonymous with sustainable use. It is argued, based on the experiences of other areas of the world, that if the biodiversity, including the marine biodiversity, of Pacific Island communities is not conserved or used on a sustainable basis, and if traditional sustainable management practices, and the knowledge and language (e.g., the names of marine organisms and language associated with marine ecosystems, seasonal and diurnal rhythms and fishing techniques, seasons, tides, etc.) are not maintained or strengthened, that most other modern development (e.g., commercial fishing, live coral or aquarium fish export, timber exploitation, ecotourism, business, politics, social and health development, education, etc.) will ultimately fail in the long run. Moreover, as stressed in the SPBCP programme document, biodiversity conservation is best achieved if it is planned, implemented and monitored by, or in partnership with, the resource owners and users at the community level.

For most rural and many urban Pacific Island communities, their "biodiversity" is not just a matter of scientific, economic (in monetary terms), recreational or ecological value. It is a capital inheritance that has been passed on, relatively intact or in some cases enhanced, by past generations to current generations. Biodiversity is not income that should be spent or destroyed. It is the "capital" needed for development and maintenance of the local communities and upon which almost all "income" (both cash and non-cash) is derived. For many Pacific Island coastal communities, marine resources are by far their most important capital resource, a resource, without which they would be among the poorest of the poor.

The predominant focus for most rich-country motivated biodiversity conservation includes uniqueness or endemism, scientific importance, importance as potential gene pools for genetic engineering, biotechnology, plant breeding, medicinal discoveries or other technological breakthroughs for the benefit of humankind, export or touristic potential, or the ecological benefits of biodiversity and ecosystem preservation. For the people of the Pacific Islands, however, the focus of biodiversity conservation, and in the case of this paper marine conservation, should be the CONSERVATION OF THEIR BIODIVERSITY as the basis for the ecological, cultural and economic survival of THEIR local communities and cultures. Particular stress is placed on the fact that an estimated 25 to 90% of the real income of Pacific Island rural or outer island communities is in the form of non-cash income

derived from local terrestrial and marine plant and animal resources. Moreover, this income is relatively unaffected by inflation and deterioration in terms of trade which have historically caused imported goods (e.g., petrol, outboard engines, fishing gear, refrigerators, medicines, flour, sugar, kerosene, clothing, tinned fish, etc.) to increase in cost more rapidly than increases of wages in the cash economy or payments received in return for products exported overseas or sold locally (e.g., fish, cash crops, handicrafts, etc). The availability of such locally available products is also not effected by the unreliability, breakdown or non-existence of transportation networks.

Moreover, if cultural survival and sustainability (i.e., the “reproduction” of existing systems of cultural and economic activity) are our main goals, the focus of biodiversity conservation programmes must include not only endemic or larger “charismatic megafauna”, such as the whales, humphead wrasses and parrotfish, dugongs, sea turtles, giant clams, birds-of-paradise, etc., but must also include a wide range of endangered or ecologically and culturally important ubiquitous smaller finfish, shellfishes, seaweeds, etc. that are so important to everyday life and the functioning of the marine ecosystem. This is seen as particularly critical in the context of smaller islands and atolls that have limited terrestrial and freshwater and few if any endemic plants or animals of global scientific interest, but where the protection of a wide range of often ubiquitous plants and animals and marine organisms must be given at least equal priority as the protection of rare, highly endemic biota of larger islands, because it is their **ONLY** biota.

For example, a large proportion of the common small nearshore seaweeds, finfish, shellfish, crustaceans, echinoderms, corals and common coastal and mangrove flora, which are of considerable cultural and economic importance in Tonga, Kiribati, and in coastal or outer island Fiji, are now rare or endangered due to overexploitation, destruction by natural events (cyclone, El Nino ...), sedimentation and pollution of reefs and lagoons, habitat degradation, or the failure of the current generation to replant, replace or use sustainably. As a result, many of these more common organisms are in need of protection or re-establishment. Because of situations like this, the marine and coastal biodiversity of many small islands, which have far less diversity at the ecosystem and species levels, is much more endangered and much more in need of management than that of the larger islands in the western Pacific, such as most of the larger islands of Papua New Guinea, Solomon Islands and Fiji, which have lower human population densities and greater biodiversity at all levels.

Community-based marine biodiversity surveys

Using the model proposed here, one of the first steps in the promotion of community-based biodiversity conservation (CBBC) and the development of marine resource management plans (MRMPs) is the conduct of community-based marine biodiversity inventories or baseline studies. The paper suggests that the conduct of participatory “ethnobiological inventories” of marine biodiversity (the recording, analysis and application of local ethnobiological knowledge/traditional environmental knowledge, by local people, and for **their** use) is perhaps the most appropriate way of doing this. The information gained from these ethnobiological surveys can, of course, be usefully supplemented by more in-depth scientific surveys of threatened species, critical or threatened habitats, such as designated marine reserves, proposed ecotourism sites, known spawning or nesting grounds, etc., or to identify endemic or rare organisms, many of which have no local names and no local cultural uses (e.g., many of the smaller reef fish species).

The biodiversity surveys discussed here were conducted using a Community-Based Biodiversity Conservation (CBBC) questionnaire survey and participatory methodology developed over a six-year

period as part of a MacArthur Foundation-funded University of the South Pacific Community-Based Biodiversity Conservation (CBBC) Project working in Fiji and Vanuatu. Additional testing, use and development of the questionnaire and associated community workshop methodology have been carried out during community-based resource-use planning workshops; during community-based planning sessions during the preparation of the Project Planning Documents (PPDs) for the Ha'apai Conservation Area in Tonga (Jan. & Apr. 1995) and the North Tarawa and Kiritimati Island Conservation Areas in Kiribati (1996; 1997) under the South Pacific Biodiversity Conservation Programme (SPBCP); and during the SPBCP community-based biodiversity survey conducted in the Ha'apai Conservation Area (Sept. 1997).

The survey methodology has also been an integral component in the curriculum of biogeography classes at USP over the past eight years, during which time students have carried out surveys in some ten different coastal and inland villages in Fiji. The methodology was also used to conduct a community-based biodiversity inventory in Niue as part of a USP Geography Department research project in 1999. In January 2000, a similar survey was conducted under partial funding from Turtle Island Resort to develop a community-based biodiversity management plan for the communities on the six islands of Nacula Tikina (Yasawa Islands -western Fiji), the origin of the majority of the local staff working on Turtle Island. In most of these surveys, the main researchers have been undergraduate and postgraduate Pacific Island students and staff from The University of the South Pacific, plus team members and informants from the study communities. All interviews were conducted in the indigenous vernacular languages. The marine components of the questionnaires used in these surveys are available from the senior author of this article («Randy Thaman» thaman_r@usp.ac.fj).

Objectives of Survey

The overall objective of the community-based biodiversity surveys and associated community workshops and informal discussions was to rapidly gather and discuss, relatively in-depth information on biodiversity that could be used by the communities themselves to clearly identify actions that can be taken at the community or resource owner/user level to protect, improve and sustainably use their terrestrial, freshwater and marine biodiversity as the basis for almost all cash and non-cash income, now and in the future.

It must be stressed that all of the previous studies have focused on all biodiversity, and not just on marine or coral reef biodiversity, because, for most Pacific Island communities, the terrestrial, freshwater and nearshore marine environment are seen as inseparable, interrelated and all part of a conceptualisation of "land", not as a commodity that can be individually owned, but as an all-encompassing concept with spiritual, physical and temporal significance. This feeling is variously expressed in Pacific vernacular languages as **kastom** or **ples** in Melanesia Pidgin, **terroir** in the French Pacific, **vanua** in Fijian, **fenua**, **fanua**, **fonua**, **enua** or **whenua** in Polynesia, and **te aba** in Kiribati in Micronesia. There are, of course similar terms for the ocean, such as **bigsolwara** and **bigsea**, **wasawasa**, **moana** or **tari**, in Melanesian pidgin, Fijian, Polynesian and I Kiribati, respectively, as well as terms for the nearshore marine environment throughout the Pacific.

Types of Information

The types of information needed by local communities to help them plan the protection and sustainable use of their marine biodiversity and that the survey methodology was designed to gather include:

1. Marine plants and animals that are of commercial and cultural importance.
2. Marine plants and animals that are rare or endangered and the reasons that they are rare endangered.
3. Marine ecosystems that are threatened, being degraded or used unsustainably.
4. Marine biodiversity management and use practices that seem to be unsustainable and contributing to the overexploitation, endangerment or extinction of a given species or ecosystem.
5. Existing, former or potential marine biodiversity management and use practices or activities that could be promoted by local communities to ensure the sustainable use of marine biodiversity to satisfy the subsistence and monetary needs of the local community, now and in the future.
6. Actions that can be taken by local communities to protect or replenish/rehabilitate overexploited, threatened or endangered marine plants, animals and ecosystems.
7. Organisms or indicator species that could be used to monitor or evaluate, at the community level, the effectiveness of marine biodiversity conservation efforts.
8. External assistance that is needed by local communities from government and non-government organisations to assist their efforts in the promotion of sustainable use, protection and rehabilitation of their marine ecosystems and biodiversity.

Organisation of the Survey and Conservation Planning Workshops

In most cases, the community-based biodiversity survey questionnaires (available from senior author) were translated into the local language, e.g., into Tongan, Fijian or Kiribati and supplied to the persons responsible for the administration of the surveys (e.g., Conservation Area Support Officers, USP student researchers, NGOs, local counterparts, etc.), along with guidelines for the conduct of the survey. The nature, objectives and conduct of the survey were then discussed with community representatives (e.g., village chiefs, district and town officers, heads of women's organisations, and relevant government and non-government persons). Preliminary meetings were held between community leadership responsible for organising the surveys and associated workshops and conducting and organising the actual biodiversity questionnaire survey component of the workshop. This was to make clear the objectives of the biodiversity survey and workshop, the procedures that would be followed, and to explain clearly how the questionnaire survey should be conducted. It was stressed that the survey and discussions were designed to help them develop an action plan for the conservation and sustainable use of their biodiversity resources, and that they would be contributing their time for the benefit of future generations of their own people. It was stressed that participation by as wide a cross section of the community as possible was important (e.g., male and female, young and old, high-ranked and low-ranked, farmers and fishers, long-term and short-term residents, formally educated and non-formally educated, etc.). Wide participation was seen as particularly important during the public presentation and compilation of the questionnaire survey results. Wide participation was also important in the identification and discussion of: 1) ecosystems, plants and animals that were rare, endangered or of particular cultural or economic importance; 2) activities that threaten these ecosystems, plants and animals; 3) activities that could form part of a Community-Based Biodiversity Conservation Action Plan (CBBCAP), or in the case of this paper for a Marine Resource Management Plan (MRMP). Both processes, the actual administration of the questionnaire survey about the biodiversity resources of the community and the presentation and discussion of results, showed to be highly educational and informative, and should help to gain consensus, on a long-term basis, in terms of total village support of the resultant Action Plan and its suggested actions/activities.

It must be stressed that in some cases, it was not possible to hold true workshops, but only community-based discussions off the preliminary results, often held during the actual biodiversity survey. In some cases, in-depth community-based workshops will be/were held and organised to discuss the finalised results and the draft or suggested Community-Based Biodiversity Conservation Action Plans (CBBCAP). In some cases the preliminary analysis of the results were used to prepare SPBCP "Project Preparation Documents", e.g., for the Ha'apai and North Tarawa Conservation Areas.

Important Assumptions and Considerations

The questionnaire is designed to ask questions about types and uses of marine biodiversity in a manner that most closely approximates the classification and use systems found in Pacific Island rural areas. Although the questionnaire may not fit the specific needs, ecosystems or perceptions of all coastal communities (e.g. Lofanga in Ha'apai has no extensive intertidal reef flats), and may lead to some duplication or confusion, either between communities or within a given community, experience shows that variable interpretation, in fact, commonly yields valuable answers or information that may not be anticipated by the persons conducting the questionnaire survey, and may open up new areas of inquiry, or areas of concern or opportunity for marine biodiversity conservation and use.

General Guidelines

The following guidelines for the conduct of the questionnaire survey were followed to obtain relatively unbiased and representative results and to maximise the educational and participatory impact of the survey and discussions within the participating communities.

1. The questionnaires were in most cases, filled in by groups rather than by individuals. This has shown to create greater interest and consensus, as well as increasing the educational impact and spread effect of the survey.

The groups were broken down into separate male and female groups because experience has shown that men and women have different information, some of which is often not forthcoming or expressed in the presence of the opposite gender group (e.g., women often know more about small fish, shellfish, crabs and seaweeds and men know more about large fish and deepwater species and about trees used for house construction).

To minimise duplication and bias in the results, the groups were discrete, in that no group included members from another group, and were physically separated so that no group could hear the answers of other groups (e.g., they were not allowed to sit next to each other in a community hall).

The ideal number of groups for a given community is 4 to 8, although the number per individual community can be reduced and the overall number of groups increased if there are a number of different participating communities in a given area that use the same marine resources, use a common language or will be part of a given conservation initiative. For example, in the Ha'apai, Tonga Conservation Area survey the aim was to complete 4 questionnaires per village for each of eight study communities, yielding a total of 32 questionnaires. In the end, for various reasons, it was only possible to complete 23 questionnaires. Similarly, in the recent survey of the communities in the Nacula Tikina in the Yasawa Islands of Fiji, 22 questionnaires were completed, one male and one female group questionnaire, for each of 7 villages and four tourist resort communities, all of which were seen as important stakeholders in the proposed biodiversity conservation initiative.

The reasons that there is generally no need to complete more than this number of questionnaires are: a) the questionnaire is very long and detailed and time and funds may not allow the completion of more questionnaires, b) by the time 4 or more questionnaires are analysed, for a given community, most of the main species that are of economic and cultural importance or rare, endangered or in short supply, the reasons why they are rare, endangered or in short supply, and the actions that need to be taken to protect these species will have been identified, and c) this number is usually sufficient to satisfy the educational and community awareness-raising objectives of the survey.

Use of results

Upon completion, the questionnaires from each village are subjected to a preliminary analysis and some of the results tabulated so that the persons responsible for the survey and the conduct of the workshop or preparation of management plans gain a general idea of: 1) what species, habitats and ecosystems are considered to be rare, threatened, endangered or of particular economic or cultural importance, and why; 2) what practices seem to be unsustainable or responsible for the loss or endangerment of marine biodiversity; and, 4) what can be done locally and by government to address these issues.

The preliminary results of the questionnaire analysis are then presented and discussed in meetings of the communities. The results of the study can be discussed informally, hung on the walls of meeting houses, written on flip charts, blackboards or white boards (in fact, the preliminary analysis and listing of the species, results is often best done with community participation, in the community hall, and showing local participants, e.g., fishers, school children how to list and tabulate survey results). The sequential listing of what finfish, shellfish, seaweeds, resource use problems and solutions have been listed by different groups generates considerable interest among all participants and is almost seen as a bit of a game. If it is not possible to have a formal scheduled meeting of the entire community or specific management groups, experience has shown that it is best to have the meeting after dinner, when most men, women and children are available to attend and actively participate. During the day the best farmers, fishers, cooks and many community leaders either have community responsibilities or are acquiring or preparing food for the survey team or children and young adults are at school or playing sport and not free to participate in the discussion.

Field Verification

It must be stressed that the collection of the community-based data using questionnaire surveys does not eliminate the need for good complimentary scientific field data to back up and verify the findings of the questionnaire survey. Both during and after the preliminary analysis of the questionnaire results (e.g., after the listing of species considered to be important or increasingly hard to find) separate teams of person with sufficient knowledge of both the scientific names and/or local vernacular names to make field lists of organisms that can be correlated with the vernacular names that have been obtained during the questionnaire survey. In the cases of organisms which are not easily accessible in the field, the match of the vernacular names with scientific names must be done using photographs, digital photos, pictorial reference books on marine organisms, etc. (e.g., fish, bêche-de-mer names can best be confirmed using sources, such as *Fishes of the Great Barrier Reef and Coral Sea* (Randall *et al.* 1997) or *Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie* (Guille

et al. 1986)), in the cases of shellfish, with specimen collections than can be shown to informants. After the preliminary lists have been prepared, those species that can not be correlated with scientific names can be identified and attempts made to have local people collect samples or take field teams to locations where the unidentified organisms can be found or collected for subsequent identification.

Examples of Preliminary Results for Ha'apai, Kingdom of Tonga

To provide an example of the types of information on marine biodiversity that can be generated using this methodology, and which can be used in the formulation of community-based and national MRMPs, the following results are presented from surveys conducted in Ha'apai, Tonga in 1995 and 1996 to establish, the entire Ha'apai Group of islands as Tonga's Conservation Areas under the SPBCP.

The Ha'apai Group lies in the centre of the Kingdom of Tonga between 19° 35' and 20° 30' s. latitude and 174° 15' and 175° 6' w. longitude. It consists of 64 islands, plus numerous rocks, sandbars, and reefs. The islands range in size from less than 1 ha to 46.6 km² in the case of Foa Island. The extensive reef systems of Ha'apai, which include the entire spectrum of reef development, are of particular importance in terms of biodiversity conservation. These include a 130 km barrier reef along the eastern edge of the group complete with uplifted and submerged sections, as well as numerous fringing reefs, isolated patch reefs, newly established coral colonies on recently formed islands, and the absence of reefs on active volcanic structures. The Ministry of Lands, Survey and Natural Resources (MLSNR) reports that 15% of the Ha'apai area is coral reef (Thaman, Gillett and Faka'osi 1997). Preston and Lokani (1990) estimate that in the Hahake and Lulunga subregions of Ha'apai there are 263 km² of water 0 to 30 meters in depth. This relatively large area constitutes an ideal habitat for coral reefs and substantial populations of shellfish and other benthic invertebrates and sea-grasses, and for a wide range of shallow-water finfish and turtles, most of which occur in areas accessible to SCUBA divers.

One of the main reasons Ha'apai was selected as a conservation area (CA) under SPBCP is because of the high population pressure on land and marine resources and resultant high emigration, due largely to the limited opportunity for generating cash incomes in the group. The most recent population data for Ha'apai from the 1986 census show a total population of 8919 in 1,616 households. Presently there are 30 villages on 17 inhabited islands.

Marine biodiversity of economic and cultural importance

To stress the economic, in particular monetary, importance of marine biodiversity the target communities were asked to list those organisms they sold to earn money (see questionnaire available from senior author). The analysis of the results indicate that over 120 finfish species, over 40 shellfish and 20 crab species are eaten, many of which are also main sources of cash income to villages. Of interest from the non-marine perspective, the same surveys indicated that there are over 300 plants that have economic or cultural significance. For example, are at least 74 food plants, 66 plants used medicinally, 42 as fuelwood, 35 classified as sacred or fragrant **kakala** used for garlands and scenting coconut oil, 28 for timber, 27 for animal feed, 21 for woodcarving, 19 for living fencing and hedging and 15 each for weaving and plaited ware and as dyes.

The survey showed that there is a vast diversity of marine plants and animals of particular economic importance that are either sold locally or shipped to Tongatapu or overseas for commercial gain. The results of the survey clearly show: 1) the economic importance of marine biodiversity in terms of its cash-earning role; and 2) that, for isolated rural communities, for which there is generally no single terrestrial or marine product that can make them rich or provide them with sustainable incomes throughout the year, that the protection of the widest range of biodiversity is the best way of ensuring that rural families cash and subsistence incomes can be sustained.

The questionnaire survey indicated that over 50 named species of finfish are sold locally or transported for sale to Nuku'alofa. This number would be far higher if different species that are referred to by the same name were identified individually or if the respondents had been asked to list more commercial species. Those finfish that were reportedly sold by over a third of the 23 groups of respondents included: 1) rabbitfish (*Siganus* spp.); 2) parrotfish (*Scarus* and *Leptoscarus* spp.); 3) jobfish and deepwater snappers (*Apharaeus*, *Pristipomoides* and *Etelis* spp.); 4) goatfish (*Mulliodichthys*, *Parupeneus* and *Upeneus* spp.); 5) rockcods or coral trout, (*Cephalopholis*, *Plectropomus* and *Epinephelus* spp.); 6) surgeonfish (*Acanthurus* spp. and *Ctenochaetus striatus*); 7) seaperch (*Lutjanus* spp.); 8) big-eye scads (*Selar crumenophthalmus*); 9) unicornfish (*Naso* spp.); tunas (*Gymnosarda*, *Katsuwonus* and *Thunnus*); and 10) emperors (*Lethrinus* spp.). Other highly sought after fish that are sold include mullets (*Crenimugil* and *Liza* spp.); the sabre squirrelfish (*Sargocentron spiniferum*); trevallies (*Carangoides*, *Caranx* and *Gnathanodon* spp.); Japanese sea bream (*Gymnocranius euanus*); barracudas (*Sphyraena* spp.); and, Maori wrasses (*Cheilinus* spp.)(Table 1).

The survey showed that there were over 20 shellfish species or groups of species sold and of commercial value in Ha'apai. This does not include a wide range of species, such as small cowries, cone shells, mitres, auger shells, tritons, conches and other shells used in handicrafts or sold to tourists as specimen shells or souvenirs. The most important species, which were reportedly marketed (often shipped to Nuku'alofa) by over half of the respondents, included ark clams, (*Anadara* spp.), turban shells (*Turbo* spp.) and giant clams (*Tridacna* spp.). Other species commonly marketed include venus clams (*Gafarium* spp.), palate tellin (*Tellina palatam*) and youthful venus clam (*Periglypta puerpera*). All of these species are considered delicacies and fetch good prices on the market. Also of considerable commercial importance are black-lipped pearl oysters, the shells of which are exported overseas as mother-of-pearl used in jewelry and button manufacture.

Nine species of bêche-de-mer or holothurians are sold commercially in Ha'apai. Most of these, with the exception of the **te'epupulu**, which is sold locally as a delicacy, have been heavily exploited for export to the lucrative Asian market where they are considered a delicacy and an aphrodisiac. 16 other marine invertebrates (excluding shellfish and beche-de-mer) were reportedly sold and of commercial value in Ha'apai. The most important are octopus, chitons, sea urchins and lobsters, all of which bring good returns to the producers. Other animals reportedly sold at one time or another include jellyfish, sea anemones, sea hares, crabs, fan coral, black coral and cuttlefish. All of these also constitute either important seasonal delicacies or subsistence foods that are eaten when available. 11 seaweeds reportedly sold and of commercial value in Ha'apai. The most important are sea grapes (*Caulerpa racemosa*), **limu tanga'u** (*Cladosiphon* sp.) and **limu te'epuaka** (?), **limu tanga'u** having been exported in large quantities to Japan from Tongatapu and Ha'apai in 1996-97. The other species constitute an important supplementary nutritional resource, although some are not edible.

Marine plants and animals and ecosystems considered rare or endangered

In order to focus the efforts of the Ha'apai CBBCAP and the Community-Based Biodiversity Conservation Action Plan on those species and ecosystems in greatest need of some form of protection, it was necessary to identify those categories of plants and animals and ecosystems most widely considered to be threatened by most communities of Ha'apai.

The survey results showed that there were over 150 species of marine plants and animals, and a number of sea birds that are considered by the people of Ha'apai to be rare or endangered due to overexploitation and a number of other reasons. These were grouped into 14 categories of plants and animal that are in need of some form of protection in Ha'apai. These are:

1. **All species of whales**, especially the humpback whale ^{which is seasonally abundant in Ha'apai.} and possibly other species of marine mammals in the dolphin family (Delphinidae);
2. **All species of marine turtles** due to destruction of nesting sites and overexploitation of eggs and live animals.
3. **Sharks and rays**, that are currently seriously overfished both by Tongans and foreign fishing fleets;
4. **Eels**, particularly the conger eel, snake moray eels, and large moray eels, that are rare due to the use of destructive fishing techniques and overfishing;
5. **Small reef and lagoon fish** that are rare due to the indiscriminate use of fish poisons,
6. **Commercially-important, mainly demersal, large finfish species** commonly targeted by spearfishers, hook-and-line fishers, deepwater line fishers, scuba fishers, and cyanide fishing for the live-fish export market;
7. **Seaweeds and seagrasses** that have been destroyed by natural or human actions or overexploited (in the case of edible seaweeds).
8. **Shellfish**, including giants clams, turban shells, black-lip pearl oyster, triton shell and a number of other species that are overexploited for food, commercial purposes or for their ornamental shells;
9. **Holothurians or beche-de-mer (sea cucumbers)** due to recent drastic overharvesting and use of unsustainable fishing practices for export to the lucrative East Asian market;
10. **Crabs and lobsters**, particularly the coconut crab, mud crab, and most lobster species, particularly the slipper lobster.
11. **Stony (Scleractinian) corals, and some other corals** (e.g. fan corals and black corals) that are currently exported or degraded by unsustainable fishing practice and other forms of human destruction which lead to coral stress or death.
12. **Other marine invertebrates**, including sea urchin and seahares.
13. **Wild coastal and mangrove trees and other plants** of critical economic, cultural and ecological importance that have been endangered by coastal deforestation, coastal reclamation and overuse, and the destruction of which can have a major effect on more strictly marine ecosystems.
14. **Sea birds**, most species sea birds are rare or endangered due to habitat destruction and overexploitation for human consumption.

Almost 100 species of marine vertebrates were reported to be rare, endangered or in short supply in Ha'apai. Of these, whales and all species of sea turtle are considered to be rare, and of the finfish, at

least 16 species are sharks or rays, and ten are eels. The balance is comprised of a wide range of smaller reef fish, large reef fish and deep water or pelagic species. The most highly threatened species and those in most need of some form of protection include: 1) whales and possibly dolphins; 2) all marine turtles, due to destruction of nesting sites and overexploitation of eggs and live animals; 3) sharks and rays, that are currently overfished both by Tongans and foreign fishing fleets; 4) eels, particularly the conger eel, the snake moray eels found on reef flats, and the large deeper water moray eels; 5) a number of smaller reef and lagoon fish that seem to be increasingly rare due to the indiscriminate use of fish poisons, small-mesh gillnets and overfishing in general; and 6) a number of large, commercially-important finfish species commonly targeted by spearfishers, hook-and-line fishers, deepwater line fishers, and cyanide fishing for the live-fish export market, the most common being large rockcods, coral trout or groupers, large parrotfishes, the humphead wrasse, large trevallies, jobfish and deepwater snappers, a number of other large commercial species, and billfish, which are commonly caught by longline vessels.

33 species or groups of species of shellfish were reported to be rare or endangered. Shellfish most commonly reported to be rare or endangered, and probably in need of some form of protection, were sea mussels, giant, turban snails, a variety of clams, the black-lip pearl oyster, the spider conch, the triton shell, the ark shell or cockle, and topshells or trochus. The declining yields of these shellfish constitute a serious nutritional and economic problem as they are one of the most reliable nutritional and commercial resources for most Ha'apai communities. Many of these shells are also used in the manufacture of handicrafts and sold as shells to tourists.

17 species of *bêche-de-mer* were reported to be rare or endangered in Ha'apai. This supports the current Secretary of Fisheries' warning, at the time of the survey, that stocks of almost all commercially important *bêche-de-mer* species in Tonga are severely depleted, some seriously, due to the recent Tonga-wide drive to export these species to east Asian markets. There were also over 40 other marine invertebrate animals considered to be rare or endangered. Some of these animals, such as lobsters, a wide range of crabs, the cake urchin, sea anemones, sea hares and octopi are delicacies and/or important commercial species and sources of cash income to local communities and in need of some form of protection, at least the designation of some local marine reserves or the enforcement of seasonal or size restrictions on their exploitation.

Survey results indicated that many seabirds that used to be extremely abundant on some of the uninhabited islands in Ha'apai, and which were important in the local diet and very important components in marine food chains, are now considered to be rare or endangered by most communities. These include noddies, terns, tattlers, godwits, and plovers, frigate birds, boobies, tropic birds, and petrels and shearwaters. Even the widespread Pacific reef heron and collared kingfisher are considered to be rare. In short, all birds should be given some form of protected status in Ha'apai and their preferred habitats, tree groves, remaining areas of coastal, mangrove and inland forest and uninhabited islands should be given protected status.

Reasons for the scarcity or endangerment of marine resources

Table 1 lists the most common reasons for the scarcity or endangerment of the strictly marine organisms. The most obvious reason was overfishing, which includes increasing commercial fishing activity, increasing fishing by foreign fishers, and the export of high value products such as *bêche-de-mer*

and seaweed to the rapidly expanding Asian market. Other factors include the use (often excessive) of fishing techniques that lead to the overexploitation of a wide range of target species. These include the use of gillnets (particularly small-mesh gillnets), fish fences or fish traps (**pa ika**), fish poisons, spearguns, line fishing, night fishing with waterproof flashlights or torches, dynamite fishing, and the use of scuba or hookah gear for commercial fishing. Other reasons included illegal fishing, consumption of undersized animals, consumption by natural predators, overconsumption, increasing population and food shortages in Ha'apai that have led to a shift dietary emphasis to marine foods. Coral destruction and the ineffectiveness of the Ministry of Fisheries to enforce fisheries regulations were also mentioned as problems. The most widespread concern, however, voiced during discussions of the results of the survey with the local communities, was the fact that local communities had little control over their own nearshore fisheries resources, and that outside fishers from other islands in Ha'apai or from Tongatapu would come into their inshore areas and deplete their stocks of important commercial species using sophisticated fishing equipment beyond the means of local fishers. Even if a community attempts to conserve and manage adjacent marine resources, it may be a useless exercise because outsiders can move in and over-harvest. Consequently, the major priority identified by the communities is that some form on increased control over local marine resources.

overfishing	10	weakness/ineffectiveness of the Fisheries Division	3
excessive use of gillnets	3	sale of seashells to tourists	3
excessive use of fish poisons	9	not allowed to regenerate	2
excessive use of gillnets	9	use of dynamite fishing	2
excessive commercial exploitation	7	eaten by their predators	2
increased spearfishing/shooting	7	species is slow growing	2
indiscriminate/inappropriate fishing	5	night fishing with underwater flashlights/torches	2
excessive consumption	5	excessive use of moveable fish drags/barriers	2
exploitation leading to total depletion	4	absence of protective areas	2
consumption of undersize fish	4	destruction/loss due to tropical cyclones	2
too much line fishing	4	illegal fishing by foreign fishermen	2
use of scuba for spearfishing	4	use of seashells for body ornamentation	2
too many foreign fishers	4	fishers are too greedy	2
excessive exploitation for export	4	easily exploited	2
destruction/degradation of coral	3	found very deep	2
illegal fishing	3	excessive trapping or snaring	1
too many fishers	3	eaten by pigs	1
night fishing with lights	3	disposal of rubbish in lagoon	1
naturally uncommon	3	nuclear testing	1
use of small-mesh gillnets	3	construction of causeway between islands	1
use of fish fences/fence traps	3	ban on whaling	1
slow or limited regeneration	3	food shortage	1
indiscriminate killing	3		
species considered a delicacy	3		

Table 1

Reasons that marine species (marine plants, finfish, shellfish and other vertebrates and invertebrates) are rare or in short supply based on a survey of 15 groups of men and women from target communities within the Ha'apai Conservation Area in September 1996 (Note: responses limited to 15 because some respondents did not answer this question).

The central problem is the open-access nature of fisheries in Ha'apai. This system may have worked reasonably well when people were mainly subsistence fishers. Today, however, the increasing com-

mercialisation of many resources, increased outside fishing activity, and the limited nature of inshore marine resources indicate that if the system is not changed to give local communities more control over their nearshore resources, that many of Ha'apai's marine plants and animals will become increasingly rare or extinct, and that the people of Ha'apai will no longer have many resources available to them to satisfy their subsistence and limited cash needs. Given the limited production of the lagoons and reefs of Ha'apai, the short-term benefits from this outside commercial activity appear to be, at least to some extent, at the expense of the subsistence food supply. It is somewhat ironic that the communities in the outer islands of Ha'apai who have such limited opportunities for nutritional or economic advancement are, in effect, subsidising outside commercial operations.

The increasing impact of outside fishing is caused by increased commercial catches, decrease in the availability of many species, and greater conflict between groups of fishermen. This contention is supported by the observations of the Ha'apai-based Ministry of Fisheries staff.

Although statistics on fisheries in Ha'apai are largely absent, a substantial amount of the commercial marine harvest in Ha'apai is sold through the Tuimatamoana Fish Market in Tongatapu. The market statistics can therefore serve as an indicator of changes in Ha'apai commercial fish landings. In January 1995 the market manager stated that about 65% of the 41,612 kg of fishery products sold in 1994 through the market (27,048 kg) originated in Ha'apai. In September 1996 the same individual stated that about 75% of the estimated 100,000 kg annual throughput (75,000 kg) originated in Ha'apai. This almost 3 fold increase suggests that commercial harvesting in Ha'apai has increased dramatically over the past two years (Thaman *et al.* 1997).

The increased exploitation appears to be created by increasing market opportunities, ease of access to these markets, and rising prices for fishery commodities, both locally and on the lucrative East Asian market. Population pressure and increasingly effective gear also are contributing to higher levels of exploitation. It should be noted that these factors are likely to become more pronounced in the future, suggesting the negative impacts of outside fishing activities on local communities are likely to become worse rather than improve, unless local communities are given increasing control over their lagoon and reef fisheries resources.

Overfishing, both for local consumption, but particularly due to increasing commercialisation of a wide range of species, seems to be the main reason for the scarcity of many species. Species under particular threat include large reef fish and deepwater snappers and jobfish, sharks and rays, eels, crabs, lobsters, and a number of shellfish, particularly giant clams. Also of great concern was the overharvesting of some seaweeds, particularly, **limu tanga'u**, which is exported to Japan, and all commercially important beche-de-mer.

The use of gillnets, both in lagoons and outside the reefs in deeper waters, the use of fish traps or fish fences (**pa ika**), and the use of more traditional fish drive methods that employ ropes or coconut frond sweeps (**uloa** and **toho'au**) are also responsible for overfishing. Fish that are increasingly rare due to these fishing techniques include hardyheads, mullets, trevallies, rabbitfish, barracuda, *Abudefduf* spp., mackerel, big-eye shads, parrot fishes, damselfishes and goat fish. The use of larger gillnets has had a devastating effect on turtles and sharks. Fish which seem to be increasingly rare due to shallow water spearfishing, mainly the use of slings, include flatfishes, mullets, *Acanthurus triostegus*, murray eels, conger eels, goat fishes, parrotfishes, surgeonfishes, squirrelfish, maori wrass and diodontidae.

Fish which are caught line fishing include inshore species, such as *Lethrinus harak*, surgeonfish, gerreidae, goat fish, Maori wrass and the eels. Increased line fishing in deeper water has led to the scarcity of species such as sharks, marlins and other billfish, yellowfin tuna and deepwater snapper.

Fish which seem to be most commonly scarce due to overfishing, mainly spearfishing include the larger species such as eels, groupers, and “pokulu”, red sea bass, yellow lip emperor, large parrotfish, Maori wrass, *Bolbometopon murricatum*, *Gymnocranius* spp., trevalies barracuda, milfish, large Lutjanidae and the deepwater fish such as Etelinae, deep water Serranidae, *Caranx lugubris* and dog-tooth tuna and the larger sharks and stingrays. Such overexploitation has been drastically increased with the use of scuba gear for spearfishing which has allowed divers to seriously deplete stocks of larger species such as *Scarus microrhinos*, *Bolbometopon murricatum*, maori wrass, *Naso* spp. and other large parrot fish.

Fish which are increasingly rare due to the use of fish poisons include damselfishes, *Acanthurus triostegus*, sifisifi, *Plotosus lineatus*, hemiramphus spp., rabbitfish, mullets, gobies, blennies and murray eels, many of which live in the coral. Fish reportedly affected by dynamite fishing include sharks and rays, whereas illegal fishing by foreign fishermen has reportedly been responsible for the overfishing or depletion of giant clams, sharks and whales.. Species reportedly indiscriminately killed, sometimes for no reason, include eels, rays, sharks. Fish that seem to be naturally uncommon include stone fish, triggerfish, **hoosi tahi**, mullets, some eel and crab, and **finematua**. Fish reportedly eaten by their predators include blennies, gobies, and juvenile milkfish by the tilapia.

Excessive trapping (**tauhele**) was thought to be responsible for the disappearance of the coconut crab, although it was also suggested that they have become locally extinct on many islands because of natural decline, possibly referring to habitat destruction or modification. Tropical cyclone, such as Tropical Cyclone Isaac in 1982 also seem to be responsible for the decline in abundance of some species, the most commonly mentioned being shellfish such as small venus clams, *Lioconcha* and *Pitar* spp., *Codakia* spp. and *Turbo* spp. and the sea anemone. Species that do not seem to be allowed to regenerate include the mud crab and eels.

Shellfishess that are rare because of their use for body ornamentation, particularly for the traditional Tongan dance, the **tau’olunga**, are the black-lipped pearl oyster, surf calms, and cowries, particularly the small white cowries and egg cowries which are referred to as *Calpurnus verrucosus* and *Ovula costellata*. A wide range of shells are also collected both dead and alive for sale to tourists, either locally in Ha’apai, or after shipment to Tongatapu. Among the most common of the rare or endangered species include triton shells, giant clams, cowries, trochus shells, tapestry turban shells, and murex. Species reportedly rare because they are easy to exploit were eels, the spider conch, the clam and seaweeds.

Actions that could be taken to project marine resources

Table 2 lists 37 actions suggested by the local communities to address that loss of the marine plants and animals in Ha’apai. Many of them overlap, but give a good indication of actions that could provide some of the main components of a Marine Resources Management Plan.

Based on both the questionnaire survey and in in-depth discussions with local communities and local Ministry of Fisheries personnel, the two actions that seems to be most needed to address the problems of overfishing and loss of important marine plants and animals in Ha’apai are: 1) the need for increased control by local communities over their inshore fishing areas, and, 2) the associated need to establish local marine reserves or areas of restricted fishing that could be patrolled by local communities. There was also suggestion of the need to provide strengthened local surveillance, and to set up a network of Town and District Officers and other community leaders or members that could be made

responsible for patrolling and reporting offenders and malpractices. For this to be successful, the current initiative by the Ministry of Fisheries to give local communities greater control over their nearby inshore fisheries resources is imperative.

Among the most widely suggested actions was the prohibition of commercial fishing for endangered species and the return to subsistence fishing so that people only take what they need for their own use, rather than trying to maximise their catches and their cash incomes. It was also suggested that all outside fishers, particularly foreign fishing vessels, should be banned from fishing in Ha'apai waters, particularly from inshore areas near inhabited islands and reefs around uninhabited islands.

There was also very strong support for either a total ban on the use of gillnets, but more often suggestions that there be strict enforcement of the prohibition of the use of gillnets with mesh sizes below 6.3 to 7.5 cm (2.5 to 3 inches). Similarly, there was very strong support for a total or partial ban, in sensitive areas, of the use of fish fences/traps (**pa ika**) which are believed to be responsible for the rapid depletion of fish resources in lagoons. Other fishing practices that local communities thought should be banned or in some way restricted include use of fish poisons (including cyanide fishing for the live-fish trade), scuba spearfishing, hook-and-line fishing, and night spearfishing with underwater torches (flashlights).

Other means of protection such as seasonal restrictions on fishing for some species and the use of size or catch limits were also supported. There were also suggestion that moratoria be placed on the catching or consumption of particularly endangered species, or at least a ban on commercial fishing for, and the sale of, some endangered species. Such moratoria would hopefully allow stocks of endangered species to regenerate. There were also suggestions of the need to reduce the destruction of coral and to ban coral extraction in Ha'apai, and to protect seagrass beds from overexploitation and destruction due to their importance as habitats for macro- and micro-algae, fish, shellfish, beche-de-mer and other marine plants and animals of considerable economic and cultural importance.

To implement such activities, there was strong support for the need to formalise, publicise and strongly enforce fisheries regulations to limit overfishing and the use of illegal and destructive fishing practices. In this context, there was a perceived need to strengthen the capability of the Ministry of Fisheries. Associated with all of the suggested actions, including improved enforcement, was an urgent need for increased awareness of all fisheries issues at all levels of society. It was also suggested that public awareness campaigns and community workshops focussing on options to promote sustainable marine resources use should be a priority activity of the HCAP in the area of marine biodiversity conservation.

Fish farming was also suggested as an important way of addressing the problem of shortage of some marine species. This often included the establishment of giant clam sanctuaries, black-lip pearl oyster culture, and seaweed farming. All of these require some technical expertise, and have not yet been proven to be effective in the long term in Ha'apai.

return to subsistence fishing	8	set strict mesh limits on gillnets	3
formalise and publicise fishing regulations	7	public awareness/education	3
promote sustainable/wise fishing	7	restrict the export of endangered species	3
enforce bans on fish poisoning	7	report people who break fishing laws	3
establish marine reserves	6	allow fish to regenerate	3
promote fish farming/domestication	6	ban commercial fishing for some species	3
seasonal restrictions on certain species	6	ban all outside or foreign fishers	3
place catch limits on fishing for some species	5	temporarily ban on consumption of some species	2
restrict the use of gillnets	5	ban night fishing	2
ban or control the use of fish fences	5	reduce fishing pressure	2
moratorium on fishing for endangered species	5	obey fishing laws/regulations	2
ban use of scuba and hookah gear for fishing	4	reduce coral destruction	2
restrict or limit linefishing	4	provide strong local surveillance	2
strict enforcement of fishing laws and regulations	4	fish unselfishly	1
strengthen the Fisheries Division	4	designate uninhabited islands as tourist attractions	1
set size limits for some species	4	protect seagrass/seaweed beds	1
ban/control spearing of some species	4	ban reef gleaning	1
ban net fishing	4	stop shark lassoing	1
recognise local fishing rights	3	ban oceanic gillnetting	1

Table 2

Suggested means of protecting endangered marine species (marine plants, finfish, shellfish and other vertebrates and invertebrates) that are rare or in short supply based on a survey of 15 groups of men and women from target communities within the Ha'apai Conservation Area in September 1996 (Note: responses limited to 15 because some respondents did not answer this question).

Development of community-based marine resources management plans (MRMPs)

The results of the community-based biodiversity survey presented above served as a basis for the preparation of a Community-Based Biodiversity Conservation Action Plan (CBBCAP) for the people of the Ha'apai Conservation Area (HCA). The CBBCAP has served as a guideline for the promotion of ongoing SPBCP-funded activities and the conservation and sustainable use of terrestrial and marine biodiversity in the HCA over the past 5 years. It represents a commitment by the participating communities of the HCA to protect their islands and marine environment and to protect, re-establish and use wisely their land and marine plants and animals as a foundation and living bank account for their own development and for the development of future generations in Ha'apai. It is based on what the communities themselves said were the priority species, issues and actions needed for promoting the conservation and sustainable use of biodiversity in Ha'apai. The Action Plan included: 1) a commitment of the communities of Ha'apai to protect their islands and marine environment; 2) reasons for

protecting their environment, plant and animals; 3) important environments or ecosystems where land and marine plants and animals live and which should be protected; 4) important plants and animals that must be protected as a foundation and bank account for the future; 5) plants and animals that are now rare or endangered in Ha'apai; 6) reasons for the loss of plants and animals in Ha'apai; 7) actions that can be taken to protect plants and animals; 8) necessary support services and activities; and, 9) a "Ten Commandments for the Protection of Life in Ha'apai".

Conclusion

In conclusion, it is beyond the scope of this paper to present the entire action plan, as this paper is only a first attempt to show how participatory community-based marine biodiversity and ethnobiological surveys and the information from such surveys (THEIR living biocultural property) can be used for, and by, the communities concerned to develop "Marine Resource Management Plans". Such plans could theoretically be developed by all rural and urban communities in the Pacific Islands to protect their coral reef ecosystems and marine biodiversity inheritances, not only for the benefit of the expanding global market economy and genetic engineering and academic "communities", but for themselves, their countries and for future generations, many of whom, if such programs are not implemented, will undoubtedly lose contact with the Pacific Island marine environment and lose the treasure chest of traditional knowledge of coral reefs and the marine biodiversity that has been built up over millennia. If not protected and actively fostered, such marine biological and ethnobiodiversity inheritances will probably be replaced by global-market-economy or genetic engineering heritages, theoretically unproven heritages developed only during the past 200 and 20 years respectively.

It is argued that if such knowledge is not recorded, made available to the younger generations, and used as a basis for the protection and sustainable use of marine biodiversity at the community, national and regional levels within the Pacific Islands, intergenerational equity, in terms of both cultural and economic inheritances, and cultural and economic sustainability, will be seriously eroded, thus ushering in an unprecedented (at least in the Pacific Islands) period of unsustainable exploitation, economic extinction and extirpation (local extinction) of Pacific Island marine biodiversity for short-term gains (often gains to outsiders). In short, if we become preoccupied with legal and political instruments designed to protect biodiversity globally, we may lose the more important battle of empowering local communities to protect the marine biodiversity, including their coral reef ecosystems, and the local knowledge of these systems. It is these local communities and resource users that ultimately hold the key to successful marine resources management. It is these very same communities who have very few opportunities to benefit significantly and sustainably from the global market economy, and for whom their biodiversity, and their knowledge of it, has been a foundation or capital bank account for sustainable living for thousands of years, a bank account which if used sustainably will be their only source of biodiversified cash and non-cash income for millennia to come.

As a footnote, this is not to argue that the development of legal instruments, memoranda, guidelines and other initiatives to control marine bioprospecting, marine biodiversity research and the exploitation of marine biodiversity, to protect intellectual, cultural and biological rights, and to promote the establishment of marine conservation areas and the protection of endangered marine ecosystems and biota are not important. They unreservedly are!! But, at least for most isolated Pacific Island rural communities, such as those on the islands of Ha'apai, and many Pacific Island urban and peri-urban communities, the active development of diversified, multi-purpose, multi-ecosystem, multi-gender, even multi-cultural Community-Based Marine Resources Management Plans, based on, and tailored

for, the marine resources and knowledge of local communities, would seem to be of greatest priority if we are really worried about realising the objectives of the Convention on Biological Diversity, the SPBCP, CITES, ICRI and other worthy biodiversity conservation initiatives for the benefit of the resource-base communities of the Pacific Islands for whom their biodiversity has been and will continue to be, in the foreseeable future, their ONLY source of income, be it through their traditional highly biodiversified resource-use and marketing systems, or from a genetically-engineered sponge that will yield the latest “miracle cure”.

Finally, if there are any shortcomings in this paper or the MRMP, it is not the fault of the people or the communities and management of the Ha'apai Conservation Area. Rather, it is due mainly to the difficult task of trying to capture, digest and apply, in both Tongan and scientific terms, in a very short period of time, information that has been developed and passed on, orally and by seeing and doing, from generation to generation in Ha'apai and Tonga for over three thousand years! We wish to thank all those persons who assisted in the Community-based Biodiversity Survey. We hope that the information contained in this report will be of value to you all and to future generations of Ha'apai.

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Adjeroud M. *et al.*, 2000. Premiers résultats concernant le benthos et les poissons au cours des missions TYPATOLL.
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