Issues for Community-based Sustainable Resource Management and Conservation: Considerations for the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States

Volume 4: Synopsis of Information Relating to Sustainable Coastal Fisheries

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Participating Countries in the International Waters Programme

Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

Table of Contents

Foreword ..... **iv**

Introduction ..... **v**

About The Authors ..... **x**

1. Background **1**

2. Characteristics of coastal fisheries **1**

2.1 Species composition and biological aspects 1

2.2 Fishing methods 4

2.3 Coastal fishery yields 5

2.4 Effects of fishing on coastal resources 6

2.5 Socio-economic importance of coastal fisheries 8

3. Issues relating to resource management and governance **10**

3.1 The difficulties of centrally-based management 10

3.2 Support for community-based management 11

3.3 Potential limitations of CMT systems and community-based management 13

3.4 Towards the development of partnerships (co-management) 17

4. References **20**

Annex I: Additional sources of information on coastal fisheries development and management in the Pacific islands region **31**

A. Potential resource people 31

B. Web sites 32

Annex II: Fishery management priorities in the Pacific islands region **34**

Annex III: Demonstration projects **36**

A. Enhancement of women's participation in coastal fisheries 36

B. Co-management of marine resources adjacent to an urban centre 36

C. Co-management of live reef fish fisheries 37

List of Tables

Table 1. A summary of the principal components of the IWP including the broad Programme objectives and activity areas designed to address priority environmental concerns of participating countries ..... **vii**

Table 2. Aggregate composition of reef and lagoon fishery landings from 15 locations spanning the Pacific islands region (based on data in Dalzell et al., 1996) **2**

Table 3. Life span and age at sexual maturity of Pacific coastal fish **2**

Table 4. Life span and age at sexual maturity of Pacific coastal invertebrates **3**

Table 5. Catch rates of commonly used fishing gears deployed in reefs and lagoons in the Pacific islands [adapted from Dalzell (1996) and Dalzell et al. (1996)] **5**

Table 6. Annual volume and value of commercial and subsistence production in Pacific island coastal (non-tuna) fisheries (Dalzell et al., 1996) **9**

Table 7. The roles of government and communities in a fisheries co-management regime **17**

Table 8. Comparison of the fishery management priorities of the 1952 SPC Fisheries Conference and 1999 SPC Heads of Fisheries Meeting **34**

Table 9. Fishery management priorities of the 1995 SPC/FFA Fishery Management Workshop and an SPC/SPREP review of fishery management issues (Preston, 1997) **35**

FOREWORD

The South Pacific Regional Environment Programme (SPREP) has been involved in many large regional initiatives since it was established in 1982. Among the more notable are the National Environment Management Strategies, State of Environment Reports, regional preparations for the United Nations Conference on Environment and Development in Rio de Janeiro in 1992; the South Pacific Biodiversity Conservation Programme which also started in 1992 and concluded in 2001, preparations leading up to the World Summit on Sustainable Development scheduled for Johannesburg, South Africa in 2002 and this programme, the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States (the IWP).

The IWP is novel in many respects. It is the first large programme in which several Pacific regional organisations, united under the umbrella of the Council of Regional Organisations in the Pacific (CROP), are formally collaborating. While SPREP is the executing agency, responsibilities for the execution of the oceanic component of the Programme rest with the Secretariat of the Pacific Community (SPC), based in New Caledonia, and the South Pacific Forum Fisheries Agency (FFA), which is based in Solomon Islands. These two organisations are providing the science and the management advice respectively to assist the 14 countries participating in the Programme develop comprehensive conservation and management arrangements for the region's major renewable resource, tuna.

The Project Coordination Unit (PCU) of IWP is based at the SPREP Secretariat in Samoa. It is responsible for the implementation of the coastal component of the Programme. The objective of this component is to design and implement a project in each of the 14 participating countries that seeks to address priority environmental concerns in respect of coastal fisheries, marine protected areas, waste management or the preservation and conservation of freshwater resources. The focus of the projects, termed pilot projects in the Project Document, is to promote increased community involvement and responsibility for local resource management and conservation initiatives.

The Programme is an ambitious one. Involving 14 countries stretching over 30 million square kilometers of the western central Pacific, and working principally in isolated rural communities, there are bound to be many challenges encountered as the Programme is implemented over the next four years. Nevertheless, if in that short time frame we can learn more about processes that will motivate and support local communities to take a more proactive role in the sustainable utilisation and conservation of their renewable resources, we will have made a significant contribution to the future well-being of the Pacific region and the ecosystems it supports.

This report is one of six reports produced at the start of the Programme and, as such represents the first major output for the Programme. This series of reports seek to synthesize all the available information for each of the priority areas of interest to the IWP - coastal fisheries, marine protected areas, waste and freshwater as they relate to tropical island ecosystems, particularly in the western and central Pacific. The reviews of these four technical areas are supplemented with complementary reviews, in separate volumes, of economic issues to be considered in planning and implementing community-based sustainable resource management and conservation initiatives in island ecosystems, and of lessons learned from previous national and regional projects and activities related to the future areas of work for the IWP. Not only do these documents provide a useful reference for practitioners working on the priority environmental concerns of the region in relation to each of these four areas of interest but they also provide a comprehensive snapshot of our understanding of these critical issues in the region in early 2002.

As a result, these reports will provide a useful reference for understanding the baseline situation that existed in the region at the start of the IWP. They provide a valuable reference against which the situation in 2005 may be assessed. This will be a measure of whether progress was made in addressing these pressing issues during the Programme or if we continue to threaten the future of our fragile environment through poor management of the natural systems and resources with which we are blessed.

SPREP looks forward to working with participating countries on the successful execution of this Programme.

Tamari'i Tutangata
Director
SPREP

INTRODUCTION

Background

The member countries and territories[1] of the South Pacific Regional Environment Programme (SPREP), at their 8th Annual Meeting in October 1995, endorsed a project to prepare the Strategic Action Programme (SAP), under the International Waters focal area of the Global Environment Facility (GEF).

The GEF was created in 1994 to fulfill a unique niche – that of providing financing for programmes and projects to achieve global environment benefits in four focal areas: biodiversity, climate change, international waters, and ozone layer depletion - and in land degradation as it relates to these focal areas.

According to the GEF definition, international waters include oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries as well as rivers, lakes, groundwater systems, and wetlands with trans-boundary drainage basins or common borders involving two or more countries. The ecosystems and habitats associated with these waters are essential parts of the system. Because the global hydrological cycle links watersheds, the atmosphere, estuaries, and coastal and marine waters through transboundary movement of water, pollutants and living resources, international waters extend far inland and far out to sea.

The Pacific region's premier political body, the Pacific Islands Forum, at its Annual Session in September 1996, requested SPREP to coordinate development of the project. Formulation of the SAP, funded by GEF through project development funds (PDF Block-B), began in April 1997. The SAP was to combine the following activity areas:

- Integrated conservation and sustainable management of coastal resources, including freshwater resources;
- Integrated conservation and sustainable management of oceanic resources;
- Prevention of pollution through the integrated management of land- or marine-based wastes; and
- Monitoring and analysis of shore and near-shore environments to determine vulnerability to environmental degradation.

The basis for developing a Programme focus in these areas is found in the joint regional position prepared by Pacific island countries for the 1992 United Nations Conference on Environment and Development (UNCED), the simultaneous preparation of National Environmental Management Strategies (NEMS) by Pacific island countries between 1990 and 1996, as well as the Action Plan for Managing the Environment of the South Pacific Region (1997-2000).[2]

A Regional Task Force (RTF) was established to oversee preparation of the SAP. It was composed of one representative from the Governments of Fiji, Marshall Islands, Samoa, Tonga, and Vanuatu, with additional members from the Pacific Islands Forum; SPC, SPREP, the three GEF Implementing Agencies (the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and The World Bank (TWB)), two international non-governmental organisations (the World Conservation Union (IUCN) and The Nature Conservancy (TNC)), and one private sector representative (Fiji Dive Operators Association, recommended by the Tourism Council of the South Pacific (TCSP)). The Asian Development Bank (ADB) and the Economic and Social Commission for Asia and the Pacific (ESCAP) also participated.

Work undertaken during the SAP formulation process resulted in the identification of three priority transboundary concerns related to International Waters:

- degradation of their quality;
- degradation of their associated critical habitats; and
- unsustainable use of their living and non-living resources.

The SAP was reviewed and subsequently endorsed by the Heads of Government of the Pacific Islands Forum at its Session in Rarotonga in 1997. Refinement over a period of almost two years resulted in GEF Council approval of the SAP in August 1999. Execution by SPREP commenced in early 2000.

[1] American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, France, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, United States of America, Vanuatu and Wallis and Futuna.

[2] Revised in late 2000 as the Action Plan for Managing the Environment of the Pacific Islands Region (2001-2004) adopted by the 11th SPREP Meeting, Guam, USA, 9-12 October 2000.

The International Waters Programme (IWP), or Strategic Action Programme (SAP) in GEF parlance, is designed to assist Pacific island countries[3] improve regional capacity for management of transboundary water resources and create improved management structures to address environmental degradation and ensure the long-term sustainability of ocean fisheries in the Western and Central Pacific ecosystem. The IWP also intends to promote improved integration of environmental concerns into local, national and regional policy, and improved water quality and the conservation of key coastal and ocean ecological areas.

The GEF and UNDP view the "pilot" or "demonstration" nature of the 14 projects to be implemented under the national components of the IWP as providing the basis for future funding opportunities from GEF facilities for participating countries. The IWP, as a Strategic Action Programme, is considered an initial step leading to the development of Medium-Sized (up to US$1 million) or Full Projects (in excess of US$1 million) for technical assistance, capacity building or investment. Such projects may be regional or national in scale. As a result, the later stages of the IWP are likely to devote considerable effort to analyzing the results of the IWP to assist countries with the formulation of follow-up activities supported through the GEF and alternative sources of financing assistance.

Key Elements and Assumptions

The Project Document is formulated on the basis that the International Waters in the Pacific region are subject to threats that give rise to transboundary concerns. During the formulation of the IWP, threats were examined from the perspective of critical species and their habitats and living and non-living marine resources. Identified threats include:

- pollution of marine and freshwater (including groundwater) from land-based activities;
- the long term sustainable use of marine and freshwater resources;
- physical, ecological and hydrological modification of critical habitats; and
- unsustainable exploitation of living and non-living resources, particularly, although not exclusively, the unsustainable and/or inefficient exploitation of coastal and ocean fishery resources.

The IWP formulation process examined each threat in a legal, institutional, socio-economic and environmental context. The ultimate root cause underlying imminent threats was identified as deficiencies in management. Factors contributing to the management root cause were grouped into two linked subsets: a) governance, and b) understanding.

The governance subset was characterised by the need for mechanisms to integrate environmental concerns, development planning, and decision-making. The understanding subset was characterised by the need to achieve island-wide ecosystem awareness through improved education and participation. Island-wide awareness and participation will facilitate the development and implementation of measures to protect International Waters.

The IWP analysis revealed a set of information gaps required by decision-makers to responsibly address ultimate root causes and respond to imminent threats. Particularly important is the lack of strategic information presented in an appropriate manner to decision-makers, resource users, managers and communities to evaluate costs and benefits of, and to decide among, alternative activities. Improving information input and exchange at the regional, national, and community levels is an objective of the Programme.

The IWP provides for targeted actions to address the root causes of degradation of International Waters. The actions are to be carried out in two complementary, linked consultative contexts: Integrated Coastal and Watershed Management (ICWM) and Oceanic Fisheries Management (OFM). Through the ICWM and OFM approaches, the IWP suggests a path for the transition of Pacific islands from sectoral to integrated management of International Waters as a whole, the evolution of which is essential for their protection over the long term.

The IWP will place priority on liaising with donors who are active in the region to plan and coordinate regional and national development assistance for International Waters to address imminent threats and their root causes more effectively. The IWP is designed to provide a framework for overall national and regional planning and assistance for the management of International Waters and provide a catalyst for leveraging the participation of other donors in the project.

[3] The 14 countries participating in the IWP are: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

The Project Document acknowledges that all sustainable development issues related to International Waters cannot be addressed at once. Therefore, four high priority areas have been identified for immediate intervention:

- improved waste management;
- better water quality;
- sustainable fisheries; and
- effective marine protected areas.

Targeted action within these activity areas is proposed in five categories:

- management;
- capacity building;
- awareness/education;
- research/information for decision-making; and
- investment.

Institutional strengthening is included under management and capacity building.

The principal components of the IWP, as described in the PD, are summarised in Table 1.

Table 1. A summary of the principal components of the IWP including the broad Programme objectives and activity areas designed to address priority environmental concerns of participating countries.

Goal	To achieve global benefit by developing and implementing measures to conserve, sustainably manage and restore coastal and oceanic resources in the Pacific Region [Integrated sustainable development and management of International Waters]
Priority Concerns	Degradation of water quality • Degradation of associated critical habitats • Unsustainable use of resources
Imminent Threats	Pollution from land-based activities • Modification of critical habitats • Unsustainable exploitation of resources
Ultimate Root	Management deficiencies • Governance • Understanding
Solutions	• Integrated Coastal and Watershed Management, and • Oceanic Fisheries Management. (ICWM), (OFM)
ICWM Activity Areas	• Improved waste management • Better water quality • Sustainable fisheries • Effective marine protected areas
OFM Activity Areas	• Sustainable ocean fisheries • Improved national and regional management capability • Stock and by-catch monitoring and research • Enhanced national and regional management links
Targeted actions	• Management/institutional strengthening • Capacity-building/institutional strengthening • Awareness/education • Research/information for decision-making • Investment

UNDP is the GEF Implementing Agency and SPREP is the Executing Agency, on behalf of other CROP agencies associated with the Programme, the SPC and FFA.

This Review

This review is one of six reviews that were compiled during the early stages of IWP implementation for two reasons.

The first reason is to provide a source of current information for practitioners – principally those practitioners associated with the implementation of the pilot projects in each of the participating countries as it relates to the areas of primary interest to the IWP (waste, freshwater, marine protected areas and coastal fisheries). To provide as much practical benefit as possible, these reviews are supplemented with additional synopses of information concerning economic issues and lessons learned in the design and implementation of community-based sustainable resource management and conservation initiatives.

The second reason for these reviews is to provide a snapshot of what is known about each of the four areas of primary interest to the IWP in 2001 and early 2002. This is done to provide a baseline overview of available information in the areas of primary interest at the commencement of the Programme. As a result, any review of these areas of interest towards the end of the Programme, in 2005, will have a useful reference for assessing change in relation to the management and conservation of these resources in the Pacific region.

The first of the six reviews was prepared by Mike Huber and Kerry McGregor who comprehensively reviewed activities and current thinking in relation to marine protected areas (MPAs) and their application to the management and conservation of coastal resources. While the focus of the review is the Pacific islands region, their presentation is supplemented with examples from other ocean regions. The review examines resource conservation and related habitat issues, management approaches, governance, and past and current priorities in respect of marine protected areas at the national level within the 14 countries participating in the Programme and regional initiatives relating to marine protected areas.

The second volume in the series addresses issues relating to the conservation and management of freshwater resources in the Pacific islands region. It was prepared by Tony Falkland who provides a review of published and other information relating to freshwater quality, supply, management and conservation. The review places emphasis on community-based issues associated with the conservation and sustainable management of freshwater resources, reflecting the planned focus of subsequent pilot projects that may be instigated under the International Waters Programme.

The third volume in the series provides an examination of issues relating to waste reduction, pollution prevention and improved sanitation in the Pacific islands region, and elsewhere, as it relates to the objectives of the International Waters Programme in terms of promoting management for improved waste reduction initiatives in communities. It was prepared by Leonie Crennan and Greg Berry who summarise activities in the region that have attempted to address low cost/no cost alternatives to reduce loadings of solid and liquid wastes, particularly in coastal and watershed communities where quality of drinking water resources is at risk. Information includes a review of priority waste concerns in Pacific island communities, management and governance issues, and options for increased community responsibility for managing waste problems.

In this, the fourth volume, Paul Dalzell and Don Schug review current information relating to sustainable coastal fisheries in the Pacific islands region and elsewhere as it relates to the objectives of the Programme in terms of promoting capacity building for improved coastal resource management responsibility in communities. Information presented includes a review of coastal fisheries in the Pacific region, discussion of resource management and governance issues, customary marine tenure (CMT), the role of MPAs and past and current priorities in respect of the sustainable management of coastal fisheries at local, provincial, national and regional scales. Their review includes consideration of gender issues and women's activities in the coastal zone including the role of women in subsistence and artisanal fisheries in the 14 countries participating in the Programme. They also discuss cases that illustrate particular issues in community-based management of subsistence and artisanal fisheries; including government support for community actions.

Padma Lal and Meg Keen present a review of economic issues that should be considered in the design, implementation, monitoring and evaluation of community-based resource management and environment conservation projects in island ecosystems – the fifth volume. They describe economic issues that require detailed consultation with community members during the design, implementation and monitoring of projects such as those to be supported under the Programme. This includes the identification of institutional issues, socio-economic implications for communities (benefit/cost analysis and cost effective analysis), and suggested strategies for promoting broad community participation and support in conservation and sustainable resource use initiatives (incentives and transaction costs).

In the sixth and final volume in this series, Jenny Whyte and her colleagues at the Foundation of the Peoples of the South Pacific International and affiliated organisations provide a review of information relating to lessons learned and best practices for resource and habitat conservation and sustainable management initiatives in the Pacific islands region. The review focuses on community-based (participatory) issues associated with the conservation and sustainable management of resources and habitats in island ecosystems with emphasis on the four focal areas for the International Waters Programme (sustainable coastal fisheries, marine protected areas, community-based waste reduction and preservation of freshwater resources). Issues are considered in context of the entire project cycle - from project planning and design; selection of sites; method of community entry; community baseline assessments; participation of communities; the role and participation of governments and, if they are involved, external agencies, NGOs and development assistance agencies; education and awareness activities, completion and exit considerations such as alternative income generation, and monitoring and evaluation. The review considers social, cultural, economic, environmental, administrative, managerial, legal and political dimensions of such projects.

As a supplement, each author was asked to consider examples of what a pilot project might look like. As a result, at the conclusion of each review, three examples of community-based initiatives that may serve as a model or a template for a pilot project are presented.

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Donald Schug has Masters' degrees in marine science and resource economics and a PhD in human geography. His professional experience includes a wide range of fisheries-related research and applied work in the United States and abroad, including areas of Polynesia, Micronesia and Melanesia. Most of his research activities have focused on the economic and social aspects of managing commercial, recreational and subsistence fisheries. Dr. Schug's articles on fishing communities in the Pacific islands have appeared in The Journal of Pacific History, Marine Policy, The Hawai'ian Journal of History and other publications. He is currently an independent consultant based in Hawai'i and California.

1. Background

The Strategic Action Programme for International Waters of the Pacific Small Island Developing States (IWP) is a five-year project funded by the Global Environment Facility, implemented by the United Nations Development Programme (UNDP) and executed by the South Pacific Regional Environment Programme (SPREP). One component of the IWP (of which this report is a part) is concerned with coastal and watershed issues and will focus on the implementation of 14 pilot projects, one in each island country participating in the IWP. The IWP aims to assist island states and their communities to improve their capacity to manage transboundary water resources, to create improved processes addressing environmental degradation and to promote resource sustainability.

During the planning phase of the IWP, four key focal areas were identified: sustainable coastal fisheries; freshwater quality and watershed management; marine protected areas; and waste management, pollution control and sanitation. This report provides an overview of information pertaining to sustainable coastal fisheries in the Pacific islands. A literature review examines the characteristics of coastal fisheries and their management throughout Melanesia, Polynesia and Micronesia. Among the topics covered are issues relating to resource management and governance (including issues associated with customary marine tenure and the role of marine protected areas) and the contribution of women in subsistence and artisanal fisheries. The extensive bibliography included in the literature review is supplemented by Annex I, containing lists of resource people and Internet web sites providing additional information on coastal fisheries in the region. Annex II contrasts past and current fishery management priorities in the Pacific islands. Annex III outlines three "model" community-based projects that could be implemented in sustainable coastal fisheries in the region under the IWP.

2. Characteristics of coastal fisheries

2.1 Species composition and biological aspects

2.1.1 Finfish

Coastal fishery resources in the context of this paper refer mainly to marine organisms that are caught and collected for food. Also included are molluscs, such as trochus, green snail and pearl oysters that are harvested mainly for shells containing mother-of-pearl. As the majority of the Pacific islands are atolls and small islands surrounded by coral reefs, the principal targets of coastal fisheries are fauna associated with coral reefs and lagoons. The only country with extensive estuaries is Papua New Guinea (Dalzell et al., 1996).

A typical small scale commercial reef fishery in the western and central areas of the insular Pacific may harvest between 200 and 300 species, although it is likely that only a few species will dominate landings. Table 2 is a composite "average" of landings from 15 Pacific islands. Note that approximately 20 per cent of the catch is categorised as undescribed "other species". This is typical of most reef and lagoon landings where only the major percentages of the catch, either the most numerous or readily recognisable species, are documented.

Approximately 50 per cent of the catch total is comprised of emperors (Lethrinidae), mackerel and tuna (Scombridae), surgeonfish (Acanthuridae) and snappers (Lutjanidae). Other important contributors to the catch include squirrelfish (Holocentridae), jacks (Carangidae), parrotfish (Scaridae), groupers (Serranidae) and mullet (Mugilidae). Smaller contributors to the catch total such as bonefish (Albulidae), goatfish (Mullidae) and rabbitfish (Siganidae) are also popular species with Pacific islanders. Some fish are universally esteemed (particularly the small scad, or jack, *Selar crumenophthalmus*) and there are very few fish that Pacific islanders will not eat.

There are also specialist fisheries throughout the Pacific that target predominantly small, iridescent reef fish for the export aquarium trade (Pyle, 1993; Betram, 1996; Graham, 1996; Dufour, 1997; and Baquero, 1999). According to Baquero (1999), the most popular ornamental species coming out of the Pacific are wrasse (Labridae), butterflyfish (Chaetodontidae), anemonefish and damselfish (Pomacentridae), angelfish (Pomacanthidae) and surgeonfish (Acanthuridae). Apart from catching ornamental reef fish, these fisheries may also harvest invertebrates such as anemones, crustaceans, fan worms and sponges. Depending on local regulations, live coral and *live rock* (coralline rock encrusted with algae and other marine life) may also be harvested.

Another fishery that has been expanding in the Pacific islands over the past 20 years is the catch of live reef fish for export to South-east and East Asia (Johannes and Riepen, 1995; Yeeting et al., 2001). Restaurants in China, the Philippines and Indonesia have a long tradition of displaying live reef fish in tanks from which customers select fish for their meal. The principal targets of the live reef fish trade are groupers, particularly the barramundi cod (*Cromileptis altivelis*), coral trouts (*Plectropomus spp*) and the large Napoleon wrasse (*Cheilinus undulates*). Also in demand are various *wire-netting* or marbled groupers such as *Epinephelus polyphekiadon* and *E. malabaricus.*

Table 2. Aggregate compositon of reef and lagoon fishery landings from 15 locations spanning the Pacific islands region (based on data in Dazell et al., 1996)

Scientific name	Common name	Per cent
Lethrinidae	Emperors	13.32
Acanthuride	Surgeonfish	10.91
Lutjanidae	Snappers	9.19
Carangidae	Jacks/scads	7.19
Serranidiae	Groupers	6.96
Mugilidae	Mullets	6.90
Scaridae	Parrotfish	6.58
Scombridae	Tuna/mackerels	5.53
Mullidae	Goatfish	3.25
Siganidae	Rabbitfish	2.92
Holocentridae	Solierfish/squirrelfish	2.69
Sphyraenidae	Barraccudas	1.53
Albulidae	Bonefish	1.36
Haemulidaei	Grunts	0.89
Belonidae	Needlefish	0.81
Balistidae	Triggerfish	0.74
Labridae	Wrasses	0.52
Gerridae	Mojarras	0.49
Hemiramphidae	Garfish	0.17
Chanidae	Milkfish	0.15
Theraponidae	Surf perches	0.03
Others		17.87

Table 3. Life span and age at sexual maturity of Pacific coastal fish

Species	Common name	Life-span (years)	Age at sexual maturity (years)	Trophic level	Reference
Euthynnus affinis	Mackerel tuna or kawa-kawa	5-6	1-2	Pelagic carnivore	Yesaki (1989)
Acanthurus lineatus	Blue lined surgeonfish	25	4	Reef herbivore	Craig et al. (1997)
Scarus sordidus	Bullet-headed Parrotfish	8	1	Reef herbivore	Page (1998)
Caranx melampygus	Bluefin trevally	8	2	Reef carnivore	Sudekum et al. (1991)
Lethrinus nebulosus	Spangled emperor	25	8-9	Reef carnivore	Loubens (1980)
Lutjanus quinquelinatus	Five-lined snapper	21	2-3	Reef carnivore	Loubens (1980)
Epinephelus maculates	Grouper	15-20	5	Reef carnivore	Loubens (1980)
Mulliodes flaolineatus	White goatfish	11	2-3	Reef carnivore	Holland et al. (1993)
Myripristis ameana	Brick soldierfish	14	6	Reef predator	Dee & Radtke (1989)
Siganus canaliculatus	Dusky rabbitfish	4	1	Reef herbivore	Al-Ghais (1993)
Chaetodon miliaris	Millet-seed butterflyfish	3	1	Reef coralivore	Ralston (1976)
Selar crumenophthalmus	Ox-eye scad	2-3	1	Pelagic planktivore	Kawamoto (1973)
Pomacentrus wardi	Damsel fish	10	3-4	Reef herbivore	Fowler & Doherty (1992)

It was previously believed that tropical fish (such as reef fish) grew faster than temperate fish and had relatively short life spans (e.g. Edwards, 1984). While an increasing volume of research indicates that longevities of reef fish are comparable with those of their temperate water counterparts (Table 3), many reef species have what are termed "square growth curves" (Williams et al. 1995). They grow to their maximum size early in their life span. This has important implications for coastal fisheries since it appears that many reef species have low natural mortality rates and therefore may be more vulnerable to over-exploitation (Williams et al., 1995). Coleman et al. (1999) suggests that the low natural mortality rates imply that only a small portion of the biomass (perhaps as low as 10 per cent) can be harvested annually. Furthermore, several important species groups such as emperors, soldierfish and groupers reach maturity between the thirtieth to fiftieth percentile of their lifespan. Species that become vulnerable to fishing gear before the onset of maturity are liable to recruitment over-fishing unless stocks are replenished. In multi-species coral reef fisheries (in which the fishing effort is generalised and all of the species are concurrently taken) the large, most vulnerable species face rapid local reductions in biomass and numbers of mature individuals. They may become over-fished while the less vulnerable, small species are harvested at levels below the maximum possible catch.

2.1.2 Invertebrates

There are several commercially valuable molluscs in the region, including trochus (*Trochus niloticus*), green snail (*Turbo marmoratus*) and the black lipped pearl oyster (*Pinctada margaritifera*). All these species are harvested primarily for mother-of-pearl which is used for button manufacture and furniture inlay. The black lipped pearl oyster is also harvested for the production of a dark silvery-grey pearl. The meat of giant clams of the family *Tridacnidae* also has both commercial and subsistence value.

The estimated 300 species of shallow water holothurians in the Indo-Pacific region account for about 27 per cent of the echinoderm species in the Pacific islands (Guille et al., 1986). Holothurians form part of the subsistence diet of many Pacific islanders. At least 22 species are commercially valuable as a dried product known as bêche-de-mer or trepang, which is exported mainly to Asia (Preston, 1993a; Adams, Dalzell and Ledua, 1999).

Pacific islanders also consume a variety of crustaceans found in the coastal zone, including crabs, lobsters and shrimps. The widely distributed mud crab (*Scylla serrata*), is caught for sale as well as for subsistence. Other reef-dwelling crabs such as the three-spot reef crab (*Carpilius maculatus*), the sand crab (*Portunus pelagicus*) and the red crab (*Etisus splendidus*) are also consumed for subsistence (Carpenter and Niem, 1998). Land crabs, such as the coconut crab (*Birgus latro*), have traditionally been a component of subsistence catches and may be caught for sale, particularly where there is a developing tourist industry. Other smaller land crabs such as *Cardisoma carnifex* and hermit crabs are a seasonally important subsistence resource (Carpenter and Niem, 1998).

Several spiny lobster species are found in the Pacific islands. *Panulirus penicillatus*, *Panulirus longipes*, *Panulirus versicolor* and *Panulirus ornatus* are found mainly on tropical reefs; and *Panulirus marginatus* and *Panulirus pascuensis* dwell on sub-tropical reefs. These lobsters, and the related slipper lobsters (*Scyllaridae*), are captured both for subsistence and commercial purposes. Other crustaceans that are harvested from the coastal zone include mantis shrimps (*Squilla spp*), mud lobsters (*Thalassina anomala*) and penaeid shrimps (Carpenter and Niem, 1998). Penaeid shrimps support small artisanal fisheries in many Pacific islands (Choy, 1988; Braley, 1979), but are only of major economic importance in Papua New Guinea along the Gulf of Papua and south-east coasts (Anon., 1994; Gwyther, 1982).

Other invertebrates and marine organisms that are consumed regularly or are regarded as delicacies by Pacific islanders include chitons, sea-hares, marine worms and seaweeds (Carpenter and Niem, 1998). Populations of the marine polychaete worm, *Eunice viridris* (*palolo* in Samoan and *balolo* in Fijian), undergo periods of mass spawning in coastal waters - usually during the full moon of the last three months of the year. The gamete-bearing segments of the worms rise to the surface, where coastal villagers collect them (Caspers, 1984; Itano and Buckley, 1988).

Like reef and lagoon fish, most of the commonly harvested crustaceans in the Pacific islands have moderately long life spans, maturing between the twentieth to fiftieth percentile of their maximum age (Table 4). However, the sessile invertebrates found in shallow water may be even more vulnerable to over-exploitation than reef fish since their accessibility facilitates easy collection.

Table 4. Life span and age at sexual maturity of Pacific coastal invertebrates

Species	Common name	Life-span (years)	Age at sexual maturity in (years)	Reference
Trochus nioloticus	Top shell	10-15	2	Nash (1993)
Pinctada margaritifer	Black-lipped pearl oyster	10	2	Sims (1993)
Scylla serrata	Mangrove crab	5	2-3	Brown (1993)
Panulirus penicillatus	Spiny lobster	10	4-5	Pitcher (1993)
Holothuria, Actinopyga spp	Sea cucumbers	10	N/A	Preston (1993a)

2.2 Fishing methods

2.2.1 Subsistence and artisanal coastal fisheries

Various studies have documented the rich tradition of fishing techniques, beliefs and customs in the Pacific islands (Alkire, 1965; Cobb, 1901; Koch, 1961; Johannes, 1981a; Quinn et al., 1984; Titcomb, 1952, 1978). Most contemporary coastal fisheries in the region are characterised by small-scale fishing methods (Wright and Richards, 1985; Wright 1993; Dalzell, 1996; Dalzell et al., 1996). A considerable amount of fishing takes place from the shore or in shallow waters without the use of fishing vessels. Where fishing vessels are used, these are generally small canoes and dinghies powered by outboard motors or sails. Larger (8-20m) vessels powered by outboard motors or inboard diesel engines are used for commercial purposes (fishing for demersal species beyond the reef slope and for catching tuna on the open ocean).

Common gear includes hook and line, traps, nets and spears. Hook and line fishing may involve simple drop lines, bottom and surface long lines, or towed baits and lures. Traditional hooks and lines fashioned from shell, bone, wood and plant fibre have generally been superseded by metal hooks and mono-filament lines. Commercial drop lines for demersal species (such as snappers and groupers on the deep reef slope), or on banks and seamounts are mounted on reels to aid hauling from depths between 100 and 400m (Dalzell and Preston, 1992). Bottom long lines have also been used to catch demersal species, particularly in Fiji, where long lines of between 500 and 1,000 hooks are set on off shore banks and seamounts (Lewis et al., 1988). Pelagic long lines (between 300 and 2,000 hooks) are employed to catch tuna on the open ocean, particularly large yellowfin and big-eyed tuna (Boggs and Ito, 1993).

Gillnetting, beach seining and drive-in netting are conducted both in coralline and estuarine areas of the Pacific (Smith and Dalzell, 1993; Dalzell et al., 1996). In some island areas such as Kiribati, gillnets have become one of the most popular fishing gear (Yeeting and Wright, 1989). Other common net fishing techniques include cast netting and scoop netting (Gillett and Ianelli, 1991).

Spears may be single or multiple pronged and are propelled from both above the water and below. The development of masks, fins, SCUBA, steel spears and spear guns have substantially increased the fishing power of spear-fishers (Hensley and Sherwood, 1993).

Stationary fish traps are a common feature in the Pacific islands. The simplest structures are V-shaped stone and stick enclosures with an entrance that faces the shore, as found in Papua New Guinea (Hulo, 1984) and the Cook Islands (Baquie, 1977). More complex structures are found in French Polynesia (Grand, 1985), Guam (Amesbury et al., 1986), Tonga (Halapua, 1982), Palau (Johannes, 1981a), Samoa (Passfield and Vaofusi, 1999) and Kiribati (Andrew Wright, SPREP, *pers. comm.*). Fixed barrier traps effectively take advantage of the tidal foraging migration of different species of fish.

Today, the regular use of portable fish traps to catch reef and lagoon fish appear to be confined mainly to Micronesia and parts of French Polynesia, although traps were traditionally deployed in the coastal areas of other Pacific islands (Koch, 1961; Quinn et al., 1984). Johannes (1981a) describes the deployment of portable fish traps in the shallow coastal waters of Palau, and Smith and Dalzell (1993) give a brief account of trap-fishing in Woleai Atoll in Yap. Traps may be made of traditional material such as sticks and vines or made of welded steel bars and wire mesh. Floating traps made from bamboo and vines are frequently used to catch pelagic fishes, such as big eye scads and rainbow runners (*Elegatis bipinnulatis*) by the Tolai people of the Gazelle Peninsula, in Papua New Guinea (Anon., 1968; Dalzell, 1993).

Many invertebrates such as molluscs, crustaceans and echinoderms are collected off reefs at low tide by hand. This harvest is performed mainly by women and children and may form a significant proportion of the total reef catch (Wass, 1982; Mathews and Oiterong, 1991; Rawlinson et al., 1994). More exotic fishing gear employed in coastal fisheries include the “bêche-de-mer bomb” (Preston, 1993a), kites (Johannes, 1981a; Hulo, 1984) and nooses (Cusack, 1987; Kohnke, 1974). Fishing methods most commonly employed to catch aquarium fish include hand nets, small barrier nets and syringe-like “slurp” guns (Pyle 1993; WESPAC, 2000).

Certain methods of fishing particularly destructive to fish populations and marine habitat have been banned in many Pacific islands. For example, the use of dynamite or toxins, such as cyanide and bleach to kill or stun fish is widely prohibited (Dalzell et al., 1996; King et al., 2001).

2.2.2 Industrial scale fisheries

The coastal areas of most Pacific islands are unsuitable for conducting trawl-fishing because of steeply shelving slopes and surrounding coral. Only Papua New Guinea has established commercial trawl fisheries and these target shrimp.

The lagoons and sheltered embayments of the Pacific islands often contain small coastal pelagic fish which can be used as live bait for industrial scale, off shore, pole and line tuna fishing (Dalzell and Lewis, 1989). The small gracile anchovies belonging to the genera *Encrasicholina* and *Stolephorus* and the sprats of the genus *Spratelloides* are the principal targets of tuna live bait fisheries. Pole and line tuna fishing has largely been superseded by purse seining as the principal industrial scale fishing method in the region and is now confined chiefly to the Solomon Islands and Fiji (Anon., 2000).

2.3 Coastal fishery yields

Catch rates in coastal fisheries are generally modest, rewarding fishers with only a few kilograms of fish for several hours of effort (Table 5). Sophisticated pelagic and bottom fish hand-line fishing vessels operating in Hawaii and low-tech reef hand liners operating on the Great Sea Reef in Fiji must stay several days at sea to generate a substantial catch volume. The constraints imposed by these modest catch rates on coastal fisheries development in the region has begun to be appreciated by fishery development specialists only within the last decade.

Table 5. Catch rates of commonly used fishing gear deployed in reefs and lagoons in the Pacific islands [adapted from Dazell (1996) and Dazell et al. (1996)]

Fishing method	Catch rate	Catch rate range	Catch rate mean	N	Target species
Shallow handline	kg/line-hr	0.40-3.50	1.90	14	Reef fish
Deep handline	kg/line-hr	1.40-7.00	5.00	10	Deep slope snappers and groupers
Spear fishing	kg/man-hr	0.41-8.5	2.97	13	Reef fish
Gillnet	kg/set	3.0-39.0	15.79	7	Reef fish
Drive in net	kg/set	14-350	80.90	7	Reef fish
Trolling	kg/line-hr	1.80-8.80	4.60	14	Large pelagics

One of the major objectives of studies on coral reef fisheries has been to determine the sustainable yields of fish and invertebrates from reef and lagoon environments. Dalzell (1996) and Polunin et al. (1996) reviewed reported reef and lagoon fishery yields from all oceans and found that finfish yields in excess of 20 t/km^2/yr were not uncommon in the Pacific and South-east Asia. They also found that in the Pacific, combined yields of finfish and invertebrates may exceed 30 t/km^2/yr. Polunin et al. (1996) noted, however, that estimates of reef fishery yields were somewhat confounded by being inversely proportional to the area of reef being studied and by the inclusion of catches from adjacent habitats such as the lagoon, mangrove habitat and outer reef slope.

Using a simple surplus production model and data from reef fisheries in Melanesia, Micronesia and Polynesia, Dalzell and Adams (1997) estimated sustainable yields of between 4 and 22 t/km^2/yr. They also concluded that fishing pressure on Pacific island coral reefs and lagoons is largely a function of population density. Applying a method originally suggested by Munro (1978), Dalzell and Adams (1997) generated a global estimate of Pacific island reef finfish as a sustainable yield to be about 16 t/km^2/yr, with population density acting as a proxy for fishing effort. However, such analyses ignore the long-term effects of heavy fishing pressure on reef fish communities. High yields may be the result of a shift from highly valued, large, long-living reef fishes to the more resilient, smaller, faster growing species that are lower in value (Munro, 1999).

Dalzell (1996, 1998) suggests that perceptions about reef fishery yields may be distorted by the short time series of some contemporary studies. He notes that historical and archaeological data indicate that sites in Papua New Guinea have been fished continuously for as long as 40,000 years and that reefs in the more recently settled Pacific islands have been fished for at least 1,000 years. On the other hand, a short time reference may also lead to overestimates of long-term yields. Pauly (1995) states that there is a psychological tendency for fishery scientists and managers to relate changes in biological systems to conditions at the time of their professional debut. Accounts of former great abundance are discounted as anecdotal or methodologically naive, or are simply overlooked. Kurlansky (1997), for example, notes the optimism greeting the discovery in 1996 of a modest remnant amount of Atlantic cod (*Gaddus morrhua*) in a Newfoundland bay following the wholesale collapse of the North Atlantic cod fishery. This was despite the fact that the volume of fish discovered was one hundredth of the cod biomass normally associated with this fishing ground.

The limited harvest potential of shallow water reef fish stocks in the Pacific islands prompted exploration of deep reef slope fisheries in the 1970s. However, fisheries targeting aggregations of large snappers, groupers and emperors on deep slopes were found to be subject to the same limitations as shallow water reef fish fisheries (Dalzell and Preston, 1992; Itano, 1996; Dalzell et al., 1996). Small pelagic fish such as ox-eye scads and round scads are also targeted by Pacific island fishers, although inter-annual variation in the abundance of these species can be extreme, particularly with the ox-eye scad which may be virtually absent one year (or for years) and plentiful the next (Helm, 1992; Dalzell, 1993).

2.4 Effects of fishing on coastal resources

2.4.1 Finfish

Russ (1991), Jennings and Lock (1996), and other contributions in Polunin (in press), Lock Roberts (1996) and Munro (1999) summarise potential effects of fishing on reef fish populations. These effects include:

- decline in the catch rates of principal target species;
- potential increase in the abundance and catch rates of small incidental prey species;
- decrease in average size of species in the catch;
- shift in sex ratios of hermaphrodite reef fishes and sexually sized dimorphic reef fish;
- reduction of population fecundity as the average size decreases within reef fish populations;
- change in behaviour, such as targeted reef species moving from reef flat to reef slope;
- degradation of coral reef habitat; and
- change in community structure, such as a decline in the abundance of large predatory species and a possible increase in small herbivores.

It might be expected that target species in a reef fishery would be spared total elimination by over fishing, as increasing scarcity would eventually render the fishery uneconomical. However, spear fishing (particularly with SCUBA), has reportedly driven some species to extinction or to very low levels in Guam (Charles Birkeland, University of Hawai'i, *pers comm*.; Hensley and Sherwood, 1993), Palau (Johannes, 1981a), American Samoa (Charles Birkeland, University of Hawai'i, *pers. comm.*) and Woleai Atoll in Yap (Smith and Dalzell, 1993). Another problem associated with SCUBA-assisted spear fishing is a modification of fish behaviour over time, such that reef fish normally found in shallow water move down the reef slope to escape fishing pressure. This causes fishers to dive deeper to the margins of safety for SCUBA diving, with concomitant increase in health risks (Anon., 1999). As a result of these threats to both the resource and resource users, some Pacific island governments are considering, or have implemented bans on the use of SCUBA assisted spear fishing (WESPAC, 2000; Todd Pitlik, Guam Division of Aquatic and Wildlife Resources, *pers. comm.*; Chris Evans, American Samoa Department of Marine and Wildlife Resources, *pers. comm.*).

Other conventional gear can also be responsible for driving reef fish populations to near extinction, particularly in areas where catchability is increased, or where populations are isolated by physical factors. In 1967, fish populations on a newly discovered small pinnacle reef off North-western Guam were fished down over about six months and have not recovered after 34 years (Birkeland 1997). Similarly, a grouper spawning aggregation was extirpated by a Chinese handline vessel in the Denges Channel of Palau in 1986, and the grouper population has not returned after 15 years (Johannes et al., 1996). It is also important to note that because many of the fishing gear used in coastal fisheries are relatively non-selective, depleted species may continue to be taken as by-catch.

The targeting of large predatory species for the live reef fish market has generated particular concern due to the relative ease with which most of these fish can be caught. Groupers are particularly vulnerable, as they aggregate to spawn in reef passes. Johannes (1981) and Johannes et al. (1999) note that grouper spawning aggregations have been fished to near extinction levels in many locations worldwide including the Pacific: Palau, French Polynesia, Cook Islands, and on the Australian Great Barrier Reef. Further, Richards (1993) showed rapid declines in catch rates and average size of *E. polyphekiadon* and *C. undulatus* during 18 months of intensive fishing by an Asian live reef fish company in the Hermit Islands of Papua New Guinea. Further, wrasses and groupers are *protogynous hermaphrodites*, changing from females to males as they age and increase in size. Intensive fishing may have the effect of creating a major sex ratio imbalance in the population of wrasses and groupers through depletion of the larger male fish.

The use of cyanide to catch live reef fish creates impacts at various levels, including the killing of corals and other benthos (Jones 1997), high mortality rates among the captured fish (Pyle, 1993), and the mining of the fish biomass to extinction levels (Johannes and Riepen, 1995). The harvest of live coral and *live rock* for the aquarium trade has also aroused concerns about long-term ecological effects, and Hawaii and other island areas have prohibited fisheries from harvesting these resources.

However, some perceptions about the impacts of fishing may be coloured by the short time series of studies. This is well illustrated by the ongoing debate on the role of fishing pressure on Caribbean herbivorous reef fish populations (particularly in Jamaica) where some coral reefs have been overgrown with dense growths of macro-algae.

Some researchers maintain that over fishing of reef herbivores (such as surgeonfish and parrot fish) coupled with a pathogen-borne mass mortality of herbivorous sea urchins and hurricane damage, led to the macro-algal blooms. Aronson and Precht (2001), however, argue that studies over a longer time frame may demonstrate that periodic macro-algal dominance of Caribbean reef communities is not unusual. They note that the initial baseline studies were conducted coincidentally during a period when hurricanes were infrequent, leading to skewed perceptions that high levels of coral cover were the norm.

2.4.2 Invertebrates

Commercial harvests of invertebrates from coral reef ecosystems in the tropical Pacific islands are characterised by boom and bust cycles. In some cases the *bust* part of the cycle has persisted, as the harvestable biomass has effectively been driven to very low levels with no indication of recovery (Dalzell et al., 1996).

Pearl oyster resources in the Pacific islands appear to be especially vulnerable to overfishing and long-term depletion. For example, over a hundred tons of black lipped pearl oysters were taken from the population on Pearl and Hermes Reef in the Hawai'ian Islands in 1927 (Landman et al., in press). The population has not recovered after more than 60 years and only a few shells were found during a recent survey (Landman et al., 2001; Moffitt, 1994). Similar collapses or severe depletion of pearl shell fisheries have been reported at Penrhyn and Suwarrow Atolls in the Cook Islands (Sims, 1992), at Abaiang (Preston et al., 1992) in French Polynesia (Intes, 1986) and on Kiritimati Island in the Line Islands (Sims et al., 1989).

There are also reports of the rapid and wholesale exploitation of stocks of bêche-de-mer in the region. In Fiji, once abundant bêche-de-mer resources were exhausted in the 19th century following the export of about 1500 tonnes over a 24 year period (Ward, 1972; Adams, 1992). Anecdotal accounts from the period suggest that sea cucumber populations on some reefs recovered quickly from this over-exploitation, while others showed no signs of recovery after 20 years (Adams, 1992). More recently, over 30 million sea cucumbers were exported from Micronesia during the 1930s, especially from Chuuk. Surveys conducted in 1988 found only two specimens of the commercially valuable *Holothuria nobilis* from over eight sites in Chuuk Lagoon (Birkeland, 1997).

The top shell (*T. niloticus)*, appears to be more resilient to intensive harvesting. Originally found throughout Melanesia, Wallis, Palau and Yap (Nash, 1993), this mollusc has been successfully transplanted to over 50 separate islands beyond its natural range in an attempt to extend the economic benefits of trochus harvesting (Gillett, 1993). It is important to note that trochus fisheries are better managed than many other fisheries for export commodities in the Pacific. Management measures in many locations include a mix of total allowable catches, harvesting seasons and moratoria, maximum and minimum size limits, and individual transferable quotas (Clarke and Ianelli, 1995). In addition, hatchery methods for trochus have been optimised over the past ten years. Cultured juveniles might be used to restock those reef areas that have been depleted, and recruitment enhancement is being tested in Palau, Vanuatu, Fiji and New Caledonia (Clarke and Ianelli, 1995). However, the results to date have not been promising.

Like trochus, green snail has been commercially harvested from the Pacific islands since the start of the twentieth century (Yamaguchi, 1993). Green snail production is restricted to Melanesia, Papua New Guinea, the Solomon Islands and Vanuatu (Yamaguchi, 1993). Specimens from Vanuatu were successfully transplanted to French Polynesia (followed by occassional harvests) and have recently been introduced to Tonga, but attempts to transplant green snails to New Caledonia and the Cook Islands have failed.

The main spiny lobster species present in the Pacific islands do not enter traps or pots readily particularly the lagoon species (Adams and Dalzell, 1993). In addition, since commercially important species such as *P.penicillatus* are found mainly in a narrow band along the face of reefs, the estimated sustainable catch rate is low. Ebert and Ford (1986) calculated that reefs around Enewetak Atoll in the Marshall Islands could only support a harvest of around 20kg of whole lobster per kilometre of reef face per year.

Lobster larvae can float freely as pelagic plankton for a year or more, and recruits may thus come from a considerable distance away. Even if one island area tries to implement a policy of minimal harvesting in an effort to maintain a lobster fishery, its stock may decline if other island groups have depleted their own lobster resources (Adams and Dalzell, 1993). Furthermore, lobster recruitment may be affected by long-term climatic cycles. For example, the crash of the lobster fishing industry in Hawai'i in the early 1990s has been attributed to over fishing and recruitment failure due to a major oceanographic regime shift (Polovina, 1989; Clarke and Yoshimoto, 1990; Polovina and Mitchum, 1993; Polovina et al., 1994).

2.4.3 Marine protected areas

As discussed above, modern coastal fisheries can result in a dramatic change in the structure of fish assemblages and can have broader ecological impacts. An increasing number of fishery scientists are advocating an approach to fishery management that rebuilds depleted marine ecosystems or maintains the ecological and trophic diversity by restricting fishing effort (Halpern, in press; Pitcher, in press; Pitcher and Pauly, 1998; Polunin, in press; Sladek-Nowlis

and Friedlander, in press). A key component of this approach is the establishment of *no-take* marine protected areas (MPAs). According to a recent review of 89 MPAs by Halpern (in press), the diversity of communities and average size of organisms are reportedly 20-30 per cent higher within MPAs than within unprotected areas. Further, the review states that MPAs can roughly double the density of organisms and triple the biomass.

In the Pacific islands, the number of MPAs that have been established or are in the planning stages has rapidly increased, but there are still many questions about their effectiveness as a fisheries management tool. MPAs can protect a proportion of the fish biomass which, in turn, may "seed" fished areas through emigration of adults and exports of recruits. However, there is still no conclusive proof (or at best only weak evidence) that MPAs can help surrounding fisheries, particularly for species with limited home ranges or with larvae that do not drift very far and are locally recruited (Adams et al., 1999b). Further, the exclusion of fishermen in areas of heavy subsistence fishing pressure may increase fishing activity and hence fishing mortality on the remaining fishable stocks, with the risk of fishery collapse (Adams et al., 1997).

Benefits to fisheries may only accrue if relatively large fractions of the fishing grounds (more than 20 per cent) are set aside as MPAs (Beverton and Holt, 1957; Genette and Pitcher, 1999; Lundberg and Jonzén, 1999; Sladek-Nowlis and Roberts, 1999). MPA size is particularly critical in the majority of Pacific islands because of their small size and limited reef and shelf areas. Small MPAs may be appropriate for strongly site attached and sedentary species such as trochus, bêche-de-mer and pearl oysters, as has been demonstrated in the Cook Islands (Adams et al., 1999a; Ian Bertram, Cook Islands Ministry Marine Resources *pers.comm.*), in Solomon Islands (Mayer and Brown, 2001) and in Vanuatu (Amos, 1995).

Polunin (in press) concludes that the fisheries benefits that might be expected from MPAs on coral reefs are as yet unknown. Two studies that assessed the effectiveness of coral reef MPAs reported different results. McClanahan and Kaunda-Araba (1996) found that an MPA comprising 60 per cent of the fishing ground produced no increases in catch after seven years, while Alcala and Russ (1990) reported that an MPA comprising only 25 per cent of the ground produced higher catches. As Polunin points out, a range of factors impinge on the effectiveness of MPAs. Consequently, implementation of MPAs may also need to be accompanied by other management actions such as training fishermen to make greater use of pelagic stocks to take fishing pressure off reef and lagoon fish (Dalzell, 1993; King et al., 2001). It is also important to note that MPAs may be established for economic reasons other than fishing, including the protection of coral reef areas as tourist attractions. For this reason, Halpern (in press) cautions that it is important to state the goals when creating an MPA since these will help guide the design of the MPA and are critical for assessing whether or not an MPA has functioned successfully.

2.5 Socio-economic importance of coastal fisheries

During the 1980s, most Pacific island governments were preoccupied with the sweeping political and economic changes that occurred in oceanic fisheries as a result of the new international *Law of the Sea Convention*. Furthermore, the commercial potential of conventional capture fisheries in the coastal waters of most Pacific islands was viewed as being limited by a host of ecological and economic factors (Kearney, 1979).

Recent technological and market developments however, have begun to shift attention toward reef and lagoon resources. Furthermore, the considerable subsistence value of coastal fisheries is receiving increased recognition. A characteristic of Pacific island countries is the large number of people who derive most of their basic needs from non monetary subsistence production (Preston, 1997). Estimates of annual nominal per capita fish consumption based on domestic fish production and population figures range from 7-40kg or a mean of 23kg for Melanesia. While for Polynesia and Micronesia the ranges are 6-121kg and 4-170 kg, with means of 61 and 63kg, respectively (Dalzell et al., 1996).

Subsistence production is especially important in islands and villages away from the main population centres where the cash economy and formal job opportunities are limited (King and Lambeth, 2000). As many as 83 per cent of the coastal households of the Solomon Islands; 35 per cent of the rural households of Vanuatu; 99 per cent of the rural households of Kiribati; 87 per cent of the households in the Marshall Islands; and half of the rural households in Upolu, Samoa, fish primarily for local consumption (The World Bank, 1995). Further evidence that Pacific islanders depend heavily on subsistence fisheries for their food security, are statistics indicating seafood comprises 28, 33, 67 and 77 per cent of the animal protein consumed in Fiji, Vanuatu, Kiribati and the Solomon Islands, respectively (The World Bank, 2000).

On the other hand, the increase in wage labour in the Pacific islands now means that money is available to purchase imported animal protein, and in some areas there has been a decrease in the reliance on local fisheries (Ruddle, 1994a). However, much of the imported food is nutritionally inferior to a diet based on subsistence products, and accounts for many of the lifestyle-related diseases and nutritional disorders in Pacific island populations (Preston, 1997). King and Lambeth (2000) state that after many years of rapidly changing lifestyles, people are being encouraged to eat more local foods, that is, to eat plants and meat that are traditional and healthy. They point out that one of the most traditional and appropriate foods for people living in islands is, naturally, seafood.

Apart from their importance in terms of dietary health and household food security, subsistence fisheries support national economies by fulfilling a valuable import substitution function (Preston, 1997). Most countries in the region seek to minimise imports of food-stuffs, and significant foreign exchange savings can be attributed to subsistence fisheries throughout the region. Yet, national accounts statistics greatly understate the economic contribution of the fisheries sector as they fail to take full account of artisanal and subsistence production (The World Bank, 2000). It is estimated that some Pacific island countries would have to spend an additional US$7-18 million a year for imported protein substitutes if subsistence fisheries did not exist (The World Bank, 2000).

Of course, people in island communities are in many cases no longer satisfied with subsistence and have acquired higher material aspirations. Coastal fisheries are often the only direct way in which rural communities can obtain the cash necessary to support the increasingly money driven lifestyles dictated by modernisation and development (Adams, 1996a). This source of income is especially attractive to villagers, as it does not require a major investment, major disruption in lifestyle or members of the family drifting to an urban area to remit cash (Adams, 1996b). Moreover, in contrast to the market for copra, the market for non-perishable fishery commodities (like bêche-de-mer and mother-of-pearl shell) continues to expand. Current statistics indicate that many Pacific households supplement their income through the occasional sales of fishery products. According to a report by The World Bank (1995), for example, the sale of fishery products is currently practiced by 31 per cent of the income-earning households of Kiribati; 17 per cent of the income-earning households in the Solomon Islands; 40 per cent of the fishing households of Vanuatu; and 36 per cent of the fishing households in Upolu, Samoa. The report indicates that village sales appear to be replacing traditional bartering systems in many areas.

Estimates of the volume and value of commercial landings in Pacific island coastal fisheries are provided in Table 6. As shown, the commercial fish production is far exceeded by the subsistence catch. These figures should be treated as rough estimates as it is difficult to separate domestic fishery production into commercial and subsistence components. Most Pacific island fishing communities both consume and sell part of their catch

Table 6. Annual volume and value of commercial and subsistance production in Pacific island coastal (non-tuna) fisheries (Dalzell et al., 1996)

Catch	Weight (t)	Value (US$)
Commercial reef and deep-slope fish	10,414	27,258,964
Commercial coastal pelagic species	4,252	14,028,423
Commercial estuarine fish	1,688	3,417,745
Commercial crustaceans	1,839	14,250,593
Commercial bêche-de-mer (processed to 10% fresh wt.)	1,604	10,070,966
Other echinoderms	30	31,087
Commercial trochus, green snail and pearl snail	2,495	10,995,145
Other molluscs	2,003	1,747,741
Total commercial catch	24,325	81,800,664
Total subsistence catch	83,914	179,914,623
Total coastal fisheries catch	108,239	261,715,287

The development of most of the current commercial fisheries in the region has been market-led, and has generally happened independently or in spite of government initiatives (Preston, 1997). While domestic fish sales are expanding, there is little evidence that government sponsored marketing facilities and distribution centres are responsible for this trend (The World Bank, 1995). Often, the most rapidly expanding markets have been informal village outlets, unstructured roadside sales and direct sales to private outlets in major urban areas. Government projects to develop coastal fisheries in the Pacific islands have a very high failure rate and only occasionally meet with long-term success (Preston, 1993). In numerous cases, the failure of small scale fisheries development projects has been attributed to a failure to take into account prevailing social circumstances and to implement development activities in a way that reinforces the goals and aspirations of the community targeted by the project. Case studies that illustrate the importance of considering the cultural context of coastal fisheries development in the Pacific islands include Carrier (1981a); David and Cillaurren (1992); Itano (1996); Meltzoff and LiPuma (1986); and Rodman (1989).

Some types of fishing in the Pacific islands are performed primarily by women (Kailola, 1996). For example, women do much of the hand harvest of invertebrates on reefs at low tide.

Because women participate in fishing activities that can be done all year round and typically fish on a daily basis, they supply a great deal of the protein obtained in many subsistence diets. There is a growing body of literature about contemporary women's roles and concerns in the region's coastal fisheries (e.g., Kailola, 1996; Lambeth, 1999, 2000a, 2000b; Lambeth and Abraham, 2001; Lambeth and Santiago, 2000a, 2001b; Mathews, 1995; Tuara, 1998a, 1998b, 2000). Additional relevant reports and news items can be found in the *SPC Women in Fisheries Information Bulletin*. While there is still little quantitative information on the contribution fisherwomen make to village economies, the increasing number of publications suggests that the significant role women play in the capture, post harvest and marketing sectors is receiving more recognition. In addition, there is a growing appreciation of the intimate knowledge of the marine environment that women acquire as a result of their extensive fishing activities. Nevertheless, women still fail to be significantly represented in most fishery agencies in the Pacific islands, and fisherwomen are seldom consulted in the development of coastal fishery management regimes (Adams, 1998; Kailola, 1996; King and Lambeth, 2000).

While it is important to recognise the significant role coastal fisheries play in contemporary Pacific island economies, it is equally important to keep in mind that their value extends beyond subsistence and the generation of income. Fishing activities have been interwoven into the daily lives of the people of the Pacific islands for hundreds, if not thousands of years. Over time, local communities developed a close emotional, as well as utilitarian, association with the marine environment. Fishing activities have shaped their social organisation and cultural values e.g. Lieber (1994). Although many customs, traditions, taboos and rituals have been eroded in Pacific island fishing communities, the importance of fishing to the cultural identity of the community remains very strong (King and Lambeth, 2000). Furthermore, fishing continues to be an important social activity in the Pacific and contributes to the social cohesion of island communities (King and Lambeth, 2000).

3. Issues relating to resource management and governance

3.1 The difficulties of centrally-based management

In most countries of the region, the government agency nominally responsible for managing coastal fisheries is also responsible for promoting their economic development. Generally, this latter role has been given a much higher priority (Preston, 1997). Yet, most fisheries agencies and fishing communities acknowledge that catch rates of fish and shellfish from the lagoons and inshore reefs of many areas have been declining for a number of years (King and Lambeth, 2002)

Increases in the fishing pressure on coastal fishery resources have resulted from changes in village lifestyle that create economic pressures to increase production to satisfy higher material aspirations; the adoption of more efficient fishing technology that greatly increase each person's fishing power and mobility; and increases in rural populations so that more people are fishing the same resource than ever before. In addition, because of their proximity to land, coastal fisheries are vulnerable to the environmental impacts of land development and pollution.

In most Pacific islands the legal authority to manage coastal fisheries lies with the government. Government departments responsible for promulgating and administering regulations generally have adopted the Western models for fisheries management. These models attempt to mitigate the biological and economic waste inherent in an intensively used open-access fishery through an array of government-instituted restrictions on fishing areas, seasons, gear and catch levels (Cycon, 1986).

However, even the temperate-water, single-species coastal fisheries of Western countries have repeatedly proven both expensive and difficult to manage (Acheson and Wilson, 1996; Johannes, 1988; McGoodwin, 1990). The process of acquiring biological information on fish stocks, and collecting necessary catch and effort data from fishers needed to devise regulatory schemes and enforce regulations along large areas of coastline is costly, particularly if a consensus among the fishers regarding the regulations has not been reached (Johnson and Libecap, 1982).

Compared to the temperate water, single species coastal fisheries of Western countries, tropical coastal marine fisheries are even more complex and the resources for fisheries science, monitoring and enforcement are limited in most Pacific island countries. Johannes (1998a: 243) states that, "No other fisheries involve so many species, such complex and diverse habitats, so many fishers, gear types, landing sites and distribution channels per unit of catch". Furthermore, in the face of mounting foreign debts and budget deficits, most island governments simply lack the fiscal and administrative resources to effectively implement and enforce legislation aimed at environmental protection and resource management (Hamnett, 1990). Central authority is weak and limited in scope in some Pacific island countries, particularly in areas remote from the seat of government (Dahl, 1986). The fishery regulations implemented by bureaucrats residing in urban administrative centres are often based on an incomplete understanding of the ecological and social realities in outlying communities. Such regulations tend to lack legitimacy in the eyes of the residents of these communities (Johannes, 1981b), and they are evaded at every opportunity. Typically, government-management consists of a proliferation of regulations that government fisheries departments do not have the resources to enforce (Johannes, 1994a).

In short, governments in the region may be empowered to exercise some degree of jurisdiction over coastal fisheries, but in reality their effective control is often negligible. In 1988, participants in the *SPC Workshop on Pacific Inshore Fisheries Resources* concluded that few, if any, Pacific island inshore fisheries were being successfully managed by government departments (Johannes et al., 1991). More recent assessments suggest that the majority of countries in the region are still not managing their coastal fisheries in any meaningful way (Preston, 1997). Furthermore, it is unlikely that they will have the resources to do so in the foreseeable future (Johannes, 1998a). At best, the majority of governments have resorted to crisis management, usually in response to the boom and bust cycle of a coastal fishery producing an export commodity (Adams, 1996c).

3.2 Support for community-based management

Given the pressing need for management of coastal fisheries in many Pacific island nations, alternative management models have been proposed that recognise the traditional role of village communities in the allocation and management of fishery resources (Adams, 1998; Johannes, 1998b; Ruddle, 1998). The central argument is that as resources are mainly used (and depleted) at the community level, participation by local communities is indispensable (SPREP, 1996).

Customary Marine Tenure (CMT), legally recognised or *de facto*, is the foundation on which this move towards decentralised community-based management is based (Johannes, 1994a). Following Hviding's (1989) definition, most researchers have taken CMT to mean a social process of activities maintaining control over marine waters and access to resources with continuous links to the past being applied to the handling of contemporary issues.

Traditionally, the area to which CMT systems applied, typically, extended from mangrove swamps and shoreline, across reef flats and lagoon, to the outer reef slope (Johannes, 1982). Often, the lateral boundaries of marine territories were seaward extensions of the boundaries of landholdings. In certain cases marine boundaries were influenced by the location of physical marine features, such as patch reefs, reef holes and reef passages, that could be used for demarcation purposes (Iwakiri, 1983). Ruddle (1996) explains that the boundaries of some CMT systems were complex and abstract.

Rights to use and manage resources within marine territories were held by virtue of membership within a social group and were generally inherited or acquired through marriage, by traditional purchase or in return for services rendered (Ruddle, 1988). In some island communities, however, provisions in the system of marine tenure permitted temporary and occasional shared use of specific territorial units by people outside the rights-holding group (Ruddle, 1988). This flexibility in allocating fishing rights allowed island populations to maintain equable access to limited subsistence resources (Johannes, 1978).

Stimulated by early anthologies (e.g. Ruddle and Akimichi, 1984; Ruddle and Johannes, 1985; Ruddle and Johannes, 1990), research on CMT in the Pacific islands has greatly expanded during the last decade and has generally been focused on the documentation of a number of extant CMT systems and their potential role in fisheries management. A small but illustrative set of examples from the region includes: the Solomon Islands (Hviding, 1996; Aswani, 1999), Fiji (Fong, 1994; Cooke and Moce, 1995), the Cook Islands (Munro, 1996), the Federated States of Micronesia (Foster and Poggie, 1993) and Palau (Graham and Idechong, 1998). Additional literature related to CMT can be found in recent bibliographies (e.g. Gillett et al., 1993; Schug, 1994), collections of articles (e.g., FAO, 1993; South et al, 1994), literature overviews (e.g., Hyndman, 1993; Ruddle, 1994b, 1995) and the *SPC Traditional Marine Resource Management and Knowledge Information Bulletin*.

The work of these researchers has resulted in many different interpretations of CMT systems, and much that has been written about these systems is positive (Anderson, 1999). While sustainable coastal fisheries are generally the central benefit ascribed to devolving managerial responsibilities to local communities by supporting CMT systems, other potential advantages have been identified. Drawing on a discussion of the contemporary role of CMT systems in the Pacific islands by Schug (1996), the following sections provide an overview of some of these benefits.

3.2.1 Management efficiency

An increasing number of theorists argue that vesting of sea rights at the community, rather than the national level, may provide a non-regulatory incentive for fishers to conserve, thereby lowering costs to government of achieving resource management goals (McGoodwin, 1990). The crux of the argument is that fishers who are allowed to restrict access to marine resource areas will voluntarily institute means for limiting fishing effort because they can protect the future benefits to be gained from doing so. Indeed, under the CMT systems of some Pacific island communities, almost all of the basic fisheries conservation measures that Western governments developed in the past 100 years have been in use for centuries: closed areas, closed seasons, size restrictions and restricted entry (Johannes, 1978). Johannes et al. (1991) add that CMT can provide culturally sanctioned rules for allocating marine resources equitably, apprehending and punishing transgressors and adjudicating disputes, all often without recourse to government thereby greatly reducing administrative costs.

A number of Pacific island governments appear to have accepted this rationale for a more decentralised approach to fisheries management, if for no other reason than financial necessity. Anderson et al. (1999) explains that the responsibilities of some government agencies lie not with one community fishery but perhaps with hundreds, that are individually small-scaled, geographically dispersed and both culturally and ecologically diverse. With the limited funds at their disposal, many government agencies are looking to decentralised approaches to improve their capacity to contribute to the effective management of their nation's resource portfolio. While the degree of autonomy granted to communities varies among island countries, it is important that government officials realise that it may be cost-effective to delegate more of the responsibility for managing resources to local-level authorities.

3.2.2 Rural development and local autonomy

As discussed in Section 2.4, coastal fisheries are particularly important in outer-island rural communities in terms of income and employment, domestically generated food security and improved nutrition. A partial or total reliance on coastal fisheries creates a certain imperative that communities manage their limited natural resources effectively (Anderson, 1999). Proponents of CMT systems argue that these systems provide the means for communities to control access to these limited natural resources, and that CMT systems are the key to maintaining the sustainability of coastal fishery harvests and the benefits from a well-managed resource (e.g. Johannes et al., 1991).

The ability of CMT holders to police their tenured waters may prove useful in aquaculture as well as capture fisheries (Johannes, 1993). The development and dissemination of advanced techniques for the culture of high-value species of seaweed, molluscs and crustaceans has led many Pacific island fisheries departments and donor agencies to promote aquaculture as a rural development tool (Tanaka, 1991). The granting of exclusive-use rights over reef and lagoon areas is expected to encourage residents of coastal communities to adopt new aquaculture technologies, as the residents would be assured of capturing the returns from investments of labour and capital (Johnson, 1977; Fairbairn, 1999; Office of Technology Assessment, 1987). Similar economic incentives apply to investments in other coastal resource-enhancement activities, such as the construction of artificial reefs and fish aggregation devices in deep-water fishing grounds (Beddington and Rettig, 1983; Johannes, 1993). These various activities are promoted not only for their potential for rural income generation but also as a means of relieving the pressure on coastal fisheries and, in the case of aquaculture, restocking species that have been over-fished (King and Lambeth, 2000).

Other developments in the fisheries sector have also shown the importance of CMT in providing income-earning opportunities for coastal village residents. The dependence of pole and line tuna fishing fleets on coastal fisheries for bait is a case in point. The recognition by some Pacific island governments (including those of Papua New Guinea and Solomon Islands) that villagers residing near bait fishing grounds exercise property rights over bait resources has placed villagers in a better position to demand monetary compensation from the tuna vessel owners for the use of those resources (Hviding, 1989; Otto et al., 1990). In Fiji, the government informally recognises the right of a community to exact a levy on outsiders wishing access to the resources of a customary fishing rights area (Adams, 1996d). Such levies, or goodwill payments, have been introduced to compensate communities for pole and line bait fishing and other types of fishing conducted by individuals outside the rights-holding group (Tim Adams, SPC, *pers.comm.*). In this way, villagers reap a portion of the financial benefits from the development of industrial scale fisheries.

Admittedly, most aquaculture in the Pacific islands is experimental, and the economic viability of the large majority of aquaculture ventures in the region has yet to be demonstrated (Adams et al., 2000; Munro, 1993). Moreover, baitfish grounds have generated economic benefits for rural populations in only a few areas of the Pacific islands region, and commercial production in coastal fisheries generates a fraction of the profit made by offshore fisheries. Yet, these cases support the notion that CMT systems have the potential to contribute to the achievement of rural development objectives.

Finally, some researchers argue that CMT should be viewed in the broader context of political autonomy and economic self-determination. Hviding (1994), for example, contends that CMT systems also reflect the more general struggle within societies for political power and control over valuable resources among individuals and groups. He emphasises that CMT systems are not just institutions involved with traditional village fishing, they also constitute part of people's mechanisms for handling the wider world in economic and political terms. As Johannes (1993) states, if their rights are secure, CMT owners can exert control over other types of local development, such as marine tourism and coastal development. Hviding and Baines (1994) illustrate this point with a case study of the CMT system of Marovo Lagoon in the Solomon Islands. They conclude that: "CMT systems like that operating in Marovo, building not just on local autonomy and self-reliance, but also on highly detailed knowledge of the coastal marine environment and day-to-day monitoring of resource bases, offer potential for appropriate 'self-regulation' of fishing effort…traditional resource managers like those of Marovo are proponents of de-centralized resource management, participatory planning and a non-sectorized approach to rural development."

3.2.3 Reinforced cultural values

Other researchers emphasise the socio-cultural aspects of CMT. Their key point is that CMT systems are inextricably linked with the wider social and cultural contexts from which they emerge and continue to be important not only in terms of fulfilling the sustenance needs of the rights holding groups but also in terms of preserving their history and identity (Hviding, 1996). As Johannes (1993:3) notes, "[CMT] forms an important part of the framework for regulating social and political relationships and defining cultural identities in cultures where individuals and society are often looked upon as integral parts of nature. The physical, economic and spiritual life of island communities is thus often centered on their natural resource assemblage and the resource space containing it."

Studies that highlight the socio-cultural dimensions of CMT include those by Carrier (1981b), and Carrier and Carrier (1983) conducted in Ponam Island, Papua New Guinea. The researchers stress that the underpinnings of the system of marine ownership is not about who gets what, but about who is what, about which lineages there are and who belongs to them – a matter central to Ponam social existence. Similarly, in a study of CMT in Marovo Lagoon, Solomon Islands, Hviding (1996) underscores the point that, by using the *puava* (territory) of their *butubutu* (group) and by participating in the management of it, people learn to know the area and its history, and thereby learn about their own association with a culturally and socially distinct side of group and territory.

Researchers also maintain that the cultural aspect of CMT systems is the foundation of one of the advantages of CMT - its capability to govern individual behaviour and foster collective action. Anderson et al. (1999) comment that group or community values, behavioural norms of trust and reciprocity, social networks and other culture attributes are keys to the enforcement of exclusive rights to harvest resources in certain areas of a reef or lagoon. The strength of self and community sanction can play a very important role in providing censure of fishing activities that are detrimental to a community's marine resources.

A third cultural aspect of CMT relates to a resurgence of ethnic pride in the region that has introduced forces to enhance local authority and revive an awareness of local knowledge (Ruddle, 1994a). As Pacific island nations increasingly reassert their traditional heritage and cultural identity, the propriety and wisdom of Western approaches to fisheries management may be challenged in areas where they were previously accepted. In the following passage Teiwaki (1988:157) expresses the sentiments behind this potential trend in the context of fisheries management in Kiribati: "The traditional marine tenure has been substantially eroded by Western concepts. Existing marine legislation and practice reflect the dominance of Western values in Kiribati political philosophy. There has been some shyness and lack of confidence on the part of the State and the local bureaucracy to formulate and apply government policies on the strength of Kiribati's value systems. The Western model of development is still regarded as the paragon for national growth and economic prosperity in spite of its failure in similar situations. Inevitably, this trend will continue for some time, but I am optimistic that i-Kiribati will begin to reassert its own conceptions and philosophy into the national policy process, including the management of marine resources."

3.3 Potential limitations of CMT systems and community-based management

At the same time that researchers have extolled the virtues of CMT and community-based management, they have acknowledged that community capacity to effectively manage coastal fisheries is vulnerable to all manner of undermining influences. The principal external forces affecting CMT systems are demographic changes and urbanisation; modernisation and economic development; contemporary government policy and legal change; and, national policies for economic sectors other than fisheries (Johannes, 1978; Ruddle 1993). Moreover, some observers have raised questions about the social equity of CMT regimes and whether the scale of CMT regimes is appropriate for effective fisheries management (e.g. Anderson et al., 1999).

3.3.1 Demographic change and urbanisation

Currently, more than 35 per cent of Pacific islands people live and work in towns, and by 2020 it is estimated that this will increase to more than 50 per cent (The World Bank 2000). Doulman (1993) argues that it is fisheries close to urban and peri-urban communities that are most in need of management but which hold the poorest prospect for the implementation of management regimes. The movements of people and growth of towns and cities result in the gradual collapse of CMT systems preventing open access to the fisheries, as outsiders tend to fish in areas close to where they live without regard to traditional rights (Pauly, 1994). Johannes (1988) provides the example of Koror Municipality in Palau wherein migrants now outnumber traditional residents, so much so that it is impossible to either determine or define traditional fishers. Similar conditions exist in South Tarawa in Kiribati, Funafuti in Tuvalu, Majuro in the Marshall Islands, Rarotonga in the Cook Islands and Suva lagoon in Fiji (Adams et al., 1996). Strong market demand in centres of high population and the need for migrants to earn cash income cause overfishing of coastal fishery resources (Doulman, 1993; King and Lambeth, 2000).

In addition, coastal fishery resources in these locales face the special environmental degradation problems of urbanisation – increased erosion, siltation and eutrophication (Adams, 1996a). All these factors combine to make coastal fisheries close to urban areas one of the main priority targets for improving the governance aspects of fisheries management in Pacific island countries (Adams, 1996c).

Ruddle (1993) argues that the breakdown of community-based management systems in the vicinity of urban centres is not only inevitable but also probably desirable, if it is not to interfere with the rational development of the coastal zone. He suggests that weakening or invalidating traditional systems is a course of action that can be justified where such systems impede alternative and more important uses of coast marine space (Ruddle, 1998). Similarly, a report by The World Bank (1995) states that urban areas represent a case in which stronger government intervention in fisheries management and enforcement may be required.

3.3.2 Modernisation and economic development

Chapman (1991) states that one of the basic elements required for the sustainable development of fisheries resources is a perception within the community that the resources are limited. Furthermore, the community must be both willing and able to forego short-term benefits to ensure long-term yields.

Several researchers have documented the body of sophisticated ecological knowledge that many Pacific island communities have acquired over centuries of marine resource use (e.g. Carrier, 1982; Hamilton and Walter, 1999; Hviding, 1996; Johannes, 1981a; Klee, 1976). However, such knowledge may or may not be linked with a traditional resource conservation ethic (Ruddle et al., 1992). Local knowledge tends to be focused on how to locate and maximise catches of marine species (Foale, 1998). Unless village fishers have personally experienced the collapse of a fishery, they may still believe in the inherent capacity of an ecosystem to restore itself, regardless of the destabilising effect of increasing effort (Veitayaki, 1994).

Even if communities possess an awareness of people's ability to deplete their natural resources, the introduction of new fishing technologies or the development of markets for species that were not previously exploited may result in problems outside the scope of traditional modes of information gathering and assessment (Anderson et al., 1999). Furthermore, some principles of fisheries management cannot easily be learned simply through experience on the fishing grounds (Johannes, 1994a). For example, fishers are often familiar with the location and seasonal timing of migrations and spawning aggregations of target species but have limited knowledge of aspects of the life histories that are important in the design of effective management strategies (Johannes, 1998b).

King and Lambeth (2000), on the other hand, caution that community knowledge should not be underestimated. They argue that the use of damaging fishing methods, such as dynamiting, does not necessarily indicate community ignorance; it may mean that such methods are used for economic reasons. The use of dynamite may result in large fish catches in the short term, although destroyed coral reefs and reduced fish stocks will result long term. As Adams and Dalzell (1995) explain in the passage below, export commodities such as bêche-de-mer are particularly susceptible to the boom and bust cycles that result from a disinterest in or financial inability to save for the future: "What is the point of conserving something that you don't rely upon? The exporter will only be in the area to buy the product if there is a sufficient volume guaranteed and, if this volume only lasts for a short time, so what? Pacific island culture does not usually reward people who try to accumulate capital, but rather those who share what they have with the community. There is no incentive to set up sustainable business growth but rather to make enough cash to cover your immediate needs, such as fuel for the outboard motor and the children's school fees."

3.3.3 Equity considerations

As noted above, rights in traditional CMT systems are generally held by a group in a common property arrangement. However, not all organisational forms used in the past to manage these systems were egalitarian in structure. For instance, on some Pacific islands, fishing rights to specific areas were controlled by local chiefs or simply claimed as their own personal property (Klee, 1985).

Today, the traditional power structure may continue to prevent fair and equitable treatment of participants in fisheries, and customary rules and behaviour may still discriminate against certain groups in the community (Willmann, 2000). Moreover, given the ideology of competitive individualism that is gradually infiltrating island societies, one might expect that CMT systems may be more exclusionary or privatised. In particular, competition for cash has likely contributed to the erosion of traditional principles of reciprocity and redistribution while discouraging conformity and compliance with kinship obligations.

According to Johannes (1982), when fish that are surplus to a village's needs come to represent cash at the market, villagers begin to guard fishing rights jealously. Arguments develop over exactly where the traditional boundaries lie and who, by virtue of clan or village ties, has the right to fish within those boundaries. In addition, commercial exploitation can lead to an entrenchment of reciprocity and weakening of secondary rights (such as inter-village access rights), which, in turn, can result in conflict between adjacent communities and between fishers and custodians (Anderson

et al., 1999; Turner, 1994). Turner suggests that such changes may not always be motivated by greed; they may also arise from the recognition that a resource that is plentiful in a situation of subsistence exploitation becomes scarce in the context of commercial harvesting.

With respect to opportunism by individuals, a recent study by The World Bank (1999) found cases of non-local commercial fishing enterprises circumventing local management rules by forming alliances with local leaders. The study noted that many communities seemed to lack ways to prevent their leaders from engaging in private business interests that may conflict with their responsibilities toward the community. Hviding (1989) describes the case of a formalised system of exclusive rights over tuna baitfish grounds implemented in the Solomon Islands. Some village leaders tended to view themselves as sole owners of these grounds and to monopolise the right to profit from access fees paid by outside tuna vessel operators. However, even in situations involving the exercise of individual authority the motivation may not necessarily be personal gain. Adams (1998), for example, notes that traditional leaders may abuse their powers of resource custodianship for what they may genuinely feel is the benefit of the community income from a boom and bust fishery.

CMT systems may also reflect and reinforce gender inequality within the traditional power structure. Decisions about controlling access to fishery resources in CMT areas are typically made by the men of a community because of women's subordinate role in many Pacific island communities (Kailola, 1996). Yet, women are often the ones mainly affected by reef closures and other fishing restrictions. These restrictions can impinge on the ability of women to provide fish for subsistence needs or to earn income from the fish they harvest.

It is also important to recognise that issues of equity can arise in areas subject to CMT independently of human manipulations of the system. Sims (1990), for instance, reports that if CMT is reinstated in the Cook Islands, opportunities for involvement in the pearl-culture industry will be unequal because it is likely that only those with lagoon rights near the villages will be able to provide sufficient surveillance to maintain their pearl oyster farms.

Anderson et al. (1999) points out that Pacific islanders themselves are reassessing the impact of customary tenure on the distribution of wealth and on social democracy. The authors suggest that the increased economic independence of individuals and families within a community can lead to a demand for increased accountability and transparency in decision-making.

3.3.4 Transboundary concerns

Anderson et al. (1999) highlights the importance of asking whether the scale of customary fishing rights areas is appropriate, in other words, to what extent do the boundaries of a CMT system reflect the underlying distribution of coastal fishery resources? As Haines (1982) points out, where fish resources migrate across the boundaries of multiple CMT areas, local limitations of fishing effort do not result in effective resource conservation as the fishing pressure on the resources is the total of all the small pressures through their range. The conservation problems that result from an inappropriate scale can, in turn, lead to social conflict. Hviding (1998), for example, states that the trade for live reef fish in the Solomon Islands has created disputes between groups who allow such activities in their marine territory (in one case reportedly with dire consequences for an annual spawning aggregation of coral trout) and those who prefer to forego the money in the name of conservation.

Anderson et al. (1999) examine the influence of social and physical factors on the scales of CMT systems in Fiji and Vanuatu. In the latter country, rights-holding groups are relatively small. A community may represent a single clan or small group of clans. This feature determines the long shore extent of CMT areas. The offshore extent of CMT areas is largely determined by attributes of the environment.

Fringing reefs in Vanuatu are typically a narrow strip along the coast, and the open water beyond the reef is not an environment over which tenure can be easily claimed. Consequently, in coastal areas where the population density is high, the size of individual CMT areas may be very small. Anderson et al. (1999) suggests that the CMT system of Vanuatu is an appropriate conservation tool for sedentary resources such as trochus but not for resources that make either daily long shore movements, or offshore breeding, or ontogenic (growth) migrations. In contrast, a single rights-holding group in Fiji can encompass many villages and thousands of people and the CMT areas can be significantly larger. Again, the physical environment plays a role, with expansive areas of lagoon and shallow waters providing opportunities for the offshore expansion of fishing rights areas.

Many Pacific island countries are characterised by a patchwork of CMT areas along the coast, each having different sets of rules controlling access to or use of resources. This makes development of larger scale fisheries (not to mention coherent national systems of fishery management) difficult (Preston, 1997).

3.3.5 Legal and policy issues

When Pacific island areas became self governing and independent, land policies were often directed toward the return of land to the traditional owners and the reassertion of traditional rights (Eaton, 1985). Recognition of

customary law and systems of tenure in the constitutions of newly independent states was seen as essential to national identity and interest (Pulea, 1993). Few countries, however, give any formal statutory recognition or authority to CMT (Preston, 1997), nor are there detailed national policy statements and resultant national planning documents that define the exact role CMT is to play in national fisheries administration, and the processes and mechanisms that are to be applied to ensure the appropriate of CMT with state legal codes (Hviding and Rudle, 1999).

Ruddle (1998) maintains that the present unsystematic and *ad hoc* statutory framework relating to community-based marine resource management claims in most Pacific islands is a principal reason why traditional management systems have been undermined. Theorists have also emphasised the importance of a supportive legal structure to the stability of community-based resource management institutions (Ostrom, 1990). Hviding's (1996:291) observations of the CMT system in Marovo Lagoon substantiate this point: "The single most important right of a corporate *butubutu* concerning the sea is precisely its recognised power to formulate and enforce management of its own marine territory. A firm recognition of this right by other parties in Marovo and beyond is important not only for the capability of the tenure system to handle change and development, but also the maintenance of group identity."

Nevertheless, there is a range of views as to whether CMT would benefit from legal "codification" (Fong, 1994). Some researchers claim that if CMT rights are not legally defined, the potential for increasing conflicts and the uncertainty attendant on fisheries development will remain (Fong, 1994). Ruddle and Johannes (1985), for example, emphasise the need to identify and define traditional marine resource boundaries, in order to provide an effective legal basis for traditional activities while accommodating compatible development in fisheries and other sectors of the economy. Likewise, in a study of systems of CMT in Roviana Lagoon, Solomon Islands, Aswani (1997) argues that the formalisation and codification of boundaries could help prevent social conflict among rights-holding groups.

Conversely, Turner (1994) contends that attempts at unraveling overlapping claims and identifying all those with rights in specific reefs or stretches of water may generate disputes rather than prevent them. In addition, some researchers caution that codifying CMT could *fossilise* tradition and undermine the contextual flexibility that appears to be a prerequisite for the future influence of local groups over the management of local fisheries resources (Johannes, 1978; Hviding, 1998). Unwritten and uncodified, CMT allows for adaptation to shifting social, political, economic or ecological circumstances on the micro level (Hviding and Ruddle, 1991).

Yet, other observers point to the sheer logistical and practical complexity of attempting to incorporate customary rights into a system of legal norms (Ruddle, 1998). Hviding (1996:361-2) maintains that: "It is not possible to construct an orderly model of Marovo marine tenure in the form of a listed 'inventory of fishing regulations'. In Marovo, each fishing technique, each marine resource type, and each economic context has specific regulations applying to it. Moreover, the role played by these regulations in marine resource use may fluctuate from occasion to occasion."

As Turner (1994) notes, rights in CMT systems may be continually contested, redefined, extended or curtailed, and these processes are often messy and full of conflict.

Fong (1994:65) suggests that to give effect to CMT it may be unnecessary to legislate in the detail: "A distinction needs to be made between giving flesh to the constitutional recognition of custom in general and the more specific legislation in certain areas such as fisheries which recognise an existing system of customary tenure. Regarding the latter type of legislation, there is a further distinction between providing 'explicit, detailed legal definitions in terms of the State law' and a legal framework which does not so provide but rather, for example, recognises the power of resource authorities to attach legally enforceable conditions to their consent to fish regarding their own areas."

Hviding (1994:101) states the argument more succinctly, declaring that what is required is simply to "codify a large area so that people can do what they like within it".

Perhaps the crux of this debate is that efforts to provide a legal foundation for CMT systems and community-based management involves, in the words of Hviding and Ruddle (1991:8): "Political issues far beyond the restricted field of fisheries legislation, relating to local-level autonomy, rural influence on development policy, and recognition of hereditary claims and customary rights, all issues of high importance in the contemporary South Pacific."

Some of these political issues relate to national development priorities. For example, Hviding and Ruddle (1991) note that, frustrated by a seeming lack of integration between CMT and national fisheries management needs, some fisheries department officers in the Pacific islands, and also some of their expatriate counterparts, have expressed a concern that CMT systems hamper the development of a modern, efficient, national coastal fishery sector, thereby dissipating its potential contribution to a country's economy. As Haines (1982) points out, CMT may result in economic inefficiencies because those with the capital and expertise to develop a fishery may be prevented from doing so. Rent seeking behaviour by customary resource owners seeking to extract from commercial fishing vessels operators royalty payments, can likewise result in considerable loss of national earnings and employment (Preston, 1997). Moreover, the complexity of CMT systems complicate the overall picture of who may do what, where and when, and add to the inherent lack of clarity that, according to some observers, inhibits the systematic and scientific planning and implementation of effective resource management (Hviding, 1998).

It is also likely that a reduction in the powers of central governments, while placing responsibility on traditional rights-holders, is construed as a disadvantage by vested interests (Ruddle, 1998). With the exception of the largest islands, virtually all settlement and development activities occur in the coastal zone, and the political and economic stakes associated with the control and use of coastal waters are particularly high (Baines, 1985). Consequently, devolving and delegating management rights and responsibilities to resource users and communities must be examined in the broader political economic context of marine resource use. Given these far reaching implications, it is no surprise that Ruddle (1998:123) concludes that "the question of traditional fishing rights is one of the most interesting, vexing and emotionally highly charged practical, political and philosophical problems confronting fisheries management in the Pacific islands region.

3.4 Towards the development of partnerships (co-management)

In recognition of the shortcomings of both strictly centrally-based and community-based management regimes for coastal fisheries, it has been suggested that in many areas CMT might eventually benefit by becoming embedded in the framework of co-management, the basic concept of which is the mutual accommodation and sharing of management responsibility between local and national systems (Ruddle et al., 1992).

3.4.1 Defining roles

According to The World Bank (2000), effective co-management should identify clear institutional roles for each partner that builds upon their comparative strengths. Table 7 highlights the potential roles of government and communities in a co-management partnership as identified by The World Bank (2000) and Anderson et al. (1999).

Table 7. The roles of government and communities in a fisheries co-management regime

Sector	The World Bank (2000)	Anderson et al. (1999)
Role of Government	Provide a legal framework that supports community user rights over coastal areas (preferably exclusive user rights) and recognises community management rules as by-law.	Provide legislative framework
	Reduce the harvesting of coastal resources through export or point of collection restrictions and limits on commercial harvesting licenses.	Identify sites under potential threat
	Carry out awareness activities aimed particularly at community leaders.	Assist management to plan development
	Support collaborative enforcement with communities.	Provide technical assistance
	Facilitate consensus building and conflict resolution between communities for the management of larger areas of the coast.	Conflict resolution
	Ensure adequate incentives and technical back up for extension staff.	Provide training and extension
Role of Communities	Adapt and enforce local management rules. Control poaching by people outside of the community (in collaboration with the government).	Identify management objectives Implement management plan: • develop management plan; • set fishing rules; • set institution rules; • contribute to monitoring; and enforcement. Develop mechanisms for effective communication and coordination within: • the community; • immigrant stakeholders; and • government and NGOs.

While opinions diverge as to the specific responsibilities of governments in an optimal co-management regime, there is general agreement that government can be most effective at providing the framework within which community decision-making can operate and providing appropriate information to provide a rational basis for community decision making (Adams, 1998).

Non-governmental organisations (NGOs) can play a pivotal role in improving the outreach capabilities of many fisheries departments and catalysing community action (Anderson et al., 1999; The World Bank, 2000). Adams and Yeeting (1998) indicate however, that NGOs are not yet a major force within the fishery sector in the Pacific islands. They speculate that this is because of the strength of the several regional intergovernmental organisations in the Pacific islands.

Nevertheless, NGOs are beginning to play an increasingly influential role in marine resource issues in some Pacific islands. Adams and Yeeting (1998) state that The Nature Conservancy (TNC) is one of the more effective NGOs in the Pacific marine field, perhaps because it tries to work with government departments rather than in opposition. At present, The Nature Conservancy is involved in community-based marine conservation projects in Palau, Papua New Guinea, Solomon Islands and the Federated States of Micronesia. It has been most active in Palau, where it has sponsored an assessment of near shore marine resources (Maragos and Cook, 1995), assisted in the development of a sport fishery (Idechong and Graham, 1998) and promoted the management of the live reef fish trade (Johannes et al., 1999). Other NGOs active in coastal fisheries management in the Pacific islands include the World Wide Fund For Nature, Conservation International, International Center for Living Aquatic Resources Management, Marine Aquarium Council and International Marinelife Alliance.

Chapman (1991) affirms the significant role NGOs can play in fisheries management through their valuable community contacts but cautions that not all of these organisations necessarily reflect the views of the community. It is important that NGOs be able to contribute to capacity building within a community without imposing their own values and biases on the community.

3.4.2 Seeking solutions

As more Pacific islands move towards adopting a co-management approach, a number of innovative solutions to the problems of coastal fisheries management have emerged. This section examines some of those solutions as well as identifies areas where additional work is needed.

While there have been few, if any, attempts to formalise co-management in new fisheries legislation, some Pacific island governments have instituted co-management programmes based on existing legislation. In Samoa, the *Fisheries Act of1988* was specifically designed to include provisions dealing with procedures whereby a village could declare its own fisheries management rules as by-laws, which, after government approval, become enforceable under national law (Fa'asili and Kelekolo, 1999). This statute became the basis for a co-management scheme whereby fishery officers assist communities to develop rules to solve fisheries problems that they themselves have identified (King and Fa'asili, 1999a). In Fiji, the linkage between community and government is assisted by a statute that prohibits government fisheries officers from issuing a fishing license to any person who has not already obtained the written permission of the representative of the customary fishing rights area where that person intends to fish (Adams, 1996d). The Fijian government formally recognises the right of communities to recommend restrictions on fishing gear, area or target species on any such fishing license. In additon, the Native Lands and Fisheries Commission in Fiji has identified, surveyed and registered over 200 customary fishing rights areas (Adams, 1993).

With respect to fulfilling the role of information provider, a number of Pacific island governments are assisting village communities to make resource use decisions that are consistent with the objective of ensuring a sustainable harvest. The Vanuatu Department of Fisheries, for example, has initiated an outreach program to offer fisheries management advice to owners of customary fishing rights areas (Amos, 1993). Department personnel spend extended periods of time in villages discussing management problems and attempting to devise solutions. Villagers are allowed to develop management plans that balance biological considerations with local, social and economic concerns (Johannes, 1998b). Other island areas in which the government or NGOs have taken a prominent role in providing information to communities seeking to manage coastal fisheries include the Solomon Islands (Mayer and Brown, 1998) and the Cook Islands (Adams, 1998).

To mitigate potential equity problems, co-management schemes typically attempt to ensure the widest community participation. Within the community, this may require the development of new fora for contribution by community members (Anderson et al., 1999). Fisheries officers in Samoa sought to broaden participation in the preparation of Village Fisheries Management Plans by involving all groups (including women and untitled men) in the village Fisheries Management Advisory Committees formed to develop the plans (King and Fa'asili, 1999a). In seeking ways to facilitate a more equitable distribution of the benefits from fisheries management, it is important that both government and NGOs consider the villagers own perceptions of fairness and equity. For example, communities in Marovo Lagoon requested that more of the "community resource conservation" funds distributed by a NGO be directly allocated to meetings

organised around traditional hierarchical structures, rather than around the more egalitarian, participation by all approach favored by community oriented NGOs (Hviding and Baines, 1994). It is also important to acknowledge that co-management involves the whole local community, not just the fishing community, and should take into account the requirements of other local interests, such as those involved in tourism and other forms of marine resource use (Preston, 1997).

To be effective, a co-management regime must be underpinned by major changes in training and design of both fisheries research and extension work (Johannes, 1994a). According to Johannes (1994b), an appropriate extension programme not only transfers technology and explains conservation to villagers; it is also concerned with explaining fisher's customs and knowledge to government. Learning how to carry out the appropriate interviews, discussions and other activities with fishers requires training that is not normally a part of a fisheries biologist's curriculum (Johannes, 1998b). Ideally, a community-based extension officer should have a balance of basic scientific knowledge, community facilitating and motivating expertise (King and Lambeth, 2000). In Vanuatu, training to develop communication and facilitation skills has reportedly been made available to those supervising extension officers in the fisheries department and, through them, to the extension officers themselves (Johannes, 1998b). However, few other Pacific island fisheries departments have initiated comprehensive programs to build the capacity of officials to work with communities. It should also be taken into account that having female fisheries extension staff often makes it easier, or culturally more acceptable, to facilitate community meetings involving women (King and Lambeth, 2000).

Another concern related to co-management that needs more attention is the establishment of some form of co-ordinated management across adjacent individual CMT areas to address the transboundary problem. In Samoa, there is currently a proposal to subsume several existing small, single village fish reserves within two larger marine protected areas. These areas would be managed by districts rather than by single villages (King and Fa'asili, 1999b). Similar attempts to develop innovative structures for coordination are needed if co-management is to be widely applied to coastal fisheries in the region.

A third area that requires further examination is the establishment of co-management arrangements for fisheries in the vicinity of urban areas. While it is true that CMT systems have lapsed beyond the point of possible revival in most urban centres (Ruddle, 1998), it is important to recognise that co-management can also be a process of social creation in which a government and a community work together to develop new participatory institutional structures for managing fisheries (Jentoft et al., 1998). For example, fishery co-operatives use non traditional means with local authority to pursue management objectives (Johannes, 1988; Office of Technology Assessment, 1987). The failure rate of co-operatives in the region has been high, at least in part, because the initiatives came from outside the fishing communities rather than from the fishers themselves, and they were not based on local customs and values (Johannes, 1993). To create and maintain robust community-based management regimes for coastal fisheries near urban areas, the development and implementation of innovative co-management mechanisms involving new types of community associations and special interest groups may be necessary (Adams, 1996c).

Of course, there are circumstances where the process of developing co-management structures and arrangements may have to go hand in hand with measures that are geared towards reducing fleet sizes and the number of participants in coastal fisheries (Hviding, 1994; Pauly, 1993; Willmann, 2000). In fisheries where the harvest rate exceeds the capacity of the resource to regenerate, government and NGO support should be directed towards creating alternative employment opportunities to fishing.

The measures taken may be small scale as in a sewing project developed in the Solomon Islands to provide local women with the income they have lost by not harvesting and selling shells during a temporal closure of selected mangrove habitats to protect various crustaceans and bivalve species (Aswani, 2000).

Finally, it is important to understand that, while co-management programmes can be maintained at relatively low cost (Johannes, 1998b), they need continued government support to be sustainable. As indicated by The World Bank (2000), it takes a long time for communities to absorb and process information provided by external partners such as a government or NGO. In Yap, for example, Smith (1993) found that working with traditional leaders and associated groups to try and incorporate as much of the customary structure and procedures as possible into a community-based fishery management plan is extremely time consuming. It may take many months of facilitated discussions by community groups before a plan can be regarded as owned by the community (King and Lambeth, 2000). Furthermore, it is imperative that government extension personnel maintain regular contact with participating communities after their plans are developed and implemented (King and Lambeth, 2000). One way, suggested by The World Bank (2000) to ensure that governments have the human and financial resources for this level of community out reach, is to earmark a portion of fishing license revenues in support of co-management.

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Annex I: Additional sources of information on coastal fisheries development and management in the Pacific islands region

A. Potential resources people

A primary source of useful contacts with respect to sustainable coastal fisheries in the Pacific islands is the Fisheries Address Book published annually by the Coastal Fisheries Programme of the Secretariat of the Pacific Community (SPC). A hard copy of this document can be requested from the SPC, BP D5, Noumea, New Caledonia or an electronic copy can be downloaded in various formats from the SPC Coastal Fisheries Programme web site (see web site listings below).

The government fishery departments of 35 countries and territories are represented in the Fisheries Address Book, including New Zealand, Australia, the independent Pacific island nations, and the Pacific island territories of France, Britain and the United States. Other countries featured include Britain, Canada, France, Italy, Japan, Korea, Philippines, Taiwan, Thailand, and the United States. The state or provincial fishery offices of the larger countries are listed. In addition, the Fisheries Address Book identifies relevant regional organisations, academic institutions, commercial fishing companies, seafood processors and fishing gear suppliers, fishermen's associations, marine engineering firms and fishery and marine consultants. Contact details include mailing addresses, fax and telephone numbers and e-mail and web site addresses.

The Fisheries Address Book provides contact details for many of the authors cited in this report. Some individuals not included in the Fisheries Address Book but who are knowledgeable in various aspects of sustainable coastal fisheries are listed below.

Contact	Comments
Vaughan R. Pratt President and Executive Director International Marinelife Alliance (IMA) 83 West Capitol Drive, Bo. Kapitolyo Pasig City, Metro Manila, Philippines Tel: (632) 6387118/ 6353530/ 6387146 Fax: (632) 6387119 E-mail: info@imamarinelife.org	Dr Pratt is involved in live reef fish fishery management in South-east Asia and the Pacific islands.
Yvonne Sadovy Department of Ecology and Biodiversity Room 3S-01 The Kadoorie Biological Sciences Building University of Hong Kong, Pok Fu Lam Road, Hong Kong China Tel: (852) 2299 0603 Fax: (852) 2517 6082 E-mail: yjsadovy@hkusua.hku.hk	Dr Sadovy has researched aspects of the live reef fish trade, including the biology of target species and public health concerns related to imports of ciguatoxic fish.
Daniel Pauly Fisheries Center 2204 Main Mall The University of British Columbia Vancouver, B.C. Canada V6T 1Z4 Tel: (1 604) 822 2731 Fax: (1 604) 822 8934 E-mail: d.pauly@fisheries.ubc.ca	Dr Pauly has experience in the assessment of tropical coastal fish stocks in the Pacific.
Edvard Hviding Department of Social Anthropology University of Bergen Fosswinckelsgate. 6 5007 Bergen Tel:(47) 5558 9264 E-mail: Edvard.Hviding@sosantr.uib.no	Dr Hviding has studied systems of customary marine tenure in the Pacific islands.

Contact	Comments
Tim Bayliss-Smith Department of Geography University of Cambridge Downing Place Cambridge CB2 3EN Tel: 44 1223 333378 Fax: 44 1223 333392 E-mail: tpb1001@hermes.cam.ac.uk	Dr Bayliss-Smith has investigated various aspects of the exploitation and management of terrestrial and marine natural resourcein the Pacific islands.

B. Web sites

Many organisations are involved in coastal fisheries development and management in the Pacific islands region, and most of these organisations have web sites describing their objectives and accomplishments. Rather than attempt to provide an exhaustive list of these web sites, this report identifies and describes those sites that provide users with access to large data bases and information repositories relevant to coastal fisheries.

Fishfolk
http://web.mit.edu/seagrant/advisory/fishfolkfaq.html

Fishfolk is an email list server discussion group providing anthropological, sociological, economic, political, historical and other perspectives on fishers, fishing communities and fishery management. Subscription information is available at the above web site address. There is a searchable index of previous Fishfolk postings at the US South Atlantic Fisheries Management Council library web site: http://safmc.noaa.gov/safmcweb/library/Databases/bibsearch.html.

Food and Agriculture Organization Fisheries Department
http://www.fao.org/fi/

The mission of the Fisheries Department of FAO is to facilitate and secure the long-term sustainable development and utilization of the world's fisheries and aquaculture.

The Fisheries Department is constructing the Fisheries Global Information System- a global network of integrated information on aquatic resources and their exploitation. When the system is completed it will allow the user to retrieve, collate and analyse the broad range of fisheries thematic data available world-wide. The Management link leads to pages containing the Code of Conduct for Responsible Fisheries and echnical guidelines the Department has published in support of the implementation of the Code. The Statistics link leads to a catalogue of fisheries software produced in FAO and to FISHSTAT+, a set of downloadable fishery statistical databases together with data retrieval, graphical and analytical software.

INFOFISH
http://www.jaring.my/infofish/

INFOFISH is an intergovernmental organisation providing marketing information and technical advisory services to the fishery industry of the Asia Pacific region. Subscription information to the many publications of INFOFISH is available at the above web site address.

International Center for Living Aquatic Resources Management (ICLARM)
http://www.cgiar.org/iclarm/

ICLARM is a non-governmental and non-profit international scientific and technical centre organised to conduct, stimulate and accelerate research on all aspects of fisheries and other living aquatic resources.

The Co-Management Project link leads a description of a collaborative research project involving ICLARM, the Institute for Fisheries Management and Coastal Community Development and national research partners in Asia and Africa. The project aims to a) gain practical experience in research in fisheries co-management; b) demonstrate the applicability of co-management as a sustainable, equitable and efficient management strategy; and c) develop models for use by governments, fishing communities, NGOs and other groups. FishBase links to a global information system containing practically all fish species known to science, and ReefBase links to a global information system providing

access to data and information on coral reefs and associated shallow tropical habitats. The ICLARM Library Databases link leads to an array of databases containing a wide assortment of bibliographic records.

International Association for the Study of Common Property (ISCAP)
http://www.indiana.edu/~iascp/

IASCP is a non-profit association devoted to understanding and improving institutions for the management of environmental resources that are (or could be) held or used collectively by communities in developing or developed countries.

The CPR Library Resources link leads to the CPR Bibliography containing 24,000 citations. The CPR Digest link leads to downloadable back issues of the IASCP publication, *The Common Property Resource Digest*.

oneFish Community Directory
http://www.onefish.org/index.html

The oneFish Community Directory is an online database and directory of fisheries research and development information, supported by major donor agencies and managed by a community of leading researchers and fisheries experts around the globe.

Secretariat of the Pacific Community Coastal Fisheries Programme
http://www.spc.org.nc/coastfish/

The Secretariat of the Pacific Community (formerly the South Pacific Commission) is an intergovernmental technical advisory and networking organisation. The Coastal Fisheries Programme of the SPC Marine Resources Division concentrates its development and advisory activities within the territorial and archipelagic waters of Pacific islands.

The Publications link leads to the following pages: The Newsletters and Information Bulletins page contains downloadable current and past issues of the *Women in Fisheries Information Bulletin*, *Beche-demer Information Bulletin*, *Trochus Information Bulletin*, *Ciguatera Information Bulletin*, *Fish Aggregation Device Information Bulletin*, *Fisheries Education and Training Information Bulletin*, *Live Reef Fish Information Bulletin*, and *Pearl Oyster Information Bulletin*. Also available are issues of the *Fisheries Newsletter*. The Handbooks and Manuals page contain a number of downloadable documents, including *Fisheries Management by Communities: A Manual on Promoting the Management of Subsistence Fisheries by Pacific Island Communities*. The Technical Reports page contains: downloadable copies of the reports of the role of women in fisheries; publications produced by the UK/SPC Integrated Coastal Fisheries Management Project; and publications produced by the former UK/SPC Inshore Fisheries Research Project. The Fisheries Address page contains a downloadable copy of the *Fisheries Address Book 2001*. The Miscellaneous page contains a number of documents on regional issues, including *Aquaculture in the Pacific Islands Region* and *Review of Fishery Management Issues and Regimes in the Pacific Islands Region*.

The World Bank
http://www.worldbank.int/

The World Bank is the world's largest source of development assistance.

The Topics link leads via the Fisheries and Aquaculture link to the Fisheries and Aquaculture Network (FishNet) page. FishNet Resources contains: links to an on line discussion on ecosystem based fisheries management; lessons learned from the last decade of World Bank experience in the global fisheries and aquaculture sector; case studies detailing successful attempts by the World Bank to increase fish catches for small-scale fishers, improve marketing and processing facilities, and strengthen institutions and services for the fishing industry; publications relevant to fisheries and aquaculture topics; and links to selected fisheries and aquaculture related web sites.

Annex II: Fishery management priorities in the Pacific islands region

The first fisheries conference on Pacific island fisheries hosted in 1952 (SPC, 1952) and the last SPC fisheries meeting of the 20th century (SPC, 2000) are convenient foci for examining changes in fishery management priorities in the region (Table 8). In contrasting the priorities of the 1952 and 1999 meetings, data collection, research and training have not changed as concerns of Pacific island fishery agencies, but the general topic areas identified in 1952 have been replaced by more sharply focused priorities that reflect trends in the region. These trends include the expansion of aquaculture, commercial and sport oceanic fisheries and, most recently, live reef fish fisheries. In addition, the past few decades has seen the emergence of new environmental concerns such as the impacts on marine biota and coastal habitat caused by the accumulation of marine debris.

Table 8. Comparison of the fishery management priorities of the 1952 SPC Fisheries Conference and 1999 SPC Heads of Fisheries Meeting

Priority	1952 SPC Fisheries Conference	1999 Heads of Fisheries Meeting
Dietary studies to identify role of fish in the diet and in combating dietary deficiencies	X	
Regular compilation of basic fisheries data	X	
Establishment of national fisheries administrations	X	
Provision of advice on fishery development projects	X	
Increase in fisheries and oceanographic research	X	
Promotion of the benefits of commercial fishing	X	
Training in fisheries development and administration	X	
Study of economics of Eucheuma farming		X
Implementation of an aquaculture programme, including quarantine capabilities for species introductions		X
Management of live reef fish fisheries		X
Promotion of safety at sea		X
Role of SPC's Ocean Fisheries Program in future international management of tuna in the Central-west Pacific		X
Mitigating marine debris in collaboration with SPREP		X
FAD design and moorings		X
Implementation of a gamefish catch/effort data program		X

Additional information on contemporary fishery management themes and priorities in the Pacific islands is available from the proceedings of the 1995 SPC/FFA Fishery Management Workshop (Adams et al., 1997) and a 1997 SPC/SPREP review of fishery management issues prepared by Preston (1997). As shown in Table 9, new topic areas identified in these documents support community-based initiatives to promote sustainable coastal fisheries

Table 9. Fishery management priorities of the 1995 SPC/FFA Fishery Management Workshop and an SPC/SPREP review of fishery management issues (Preston, 1997)

Priority	1995 SPC/FFA Fishery Management Workshop	Preston (1997)
Establishment of a live reef fish network	X	
Sustainable harvests of groupers	X	
Identification of source and sink reefs for reef fishery recruitment	X	
Rapid appraisal methods for coastal fishery stocks, including habitat area, catch rates and yields	X	X
Species introduction protocols	X	
Economic and trade data on Pacific island marine exports such as trochus and beche-de-mer	X	X
Compilation of a regional register of international companies exporting marine products from Pacific islands	X	
Development of regional seafood quality standards and introduction of modern quality assurance procedures	X	
Habitat degradation	X	
Coastal zone management and coordination between fisheries and other sectors in the coastal zone	X	X
Women in fisheries in the Pacific islands	X	
Co-management of coastal fisheries	X	X
Use of selective bans on gear, methods or fisheries	X	
Ecosystem level fishery research management of coastal and pelagic fisheries		X
Diversion of coastal fishery effort to oceanic stocks		X
International tuna management in the Pacific islands region and institutional restructuring of FFA and SPC's Oceanic Fisheries Program for international tuna management		X
Assessment of by-catch species in tuna fisheries		X
Provision of management guidelines for key coastal fisheries		X
Development of domestic tuna fisheries in the Pacific islands		X

Annex III: Demonstration projects

A. Enhancement of women's participation in coastal fisheries

The concepts and strategies for this demonstration project are based on recommendations by Kailola (1996), King and Lambeth (2000) and King et al. (2001).

Context

The economic importance of the fish harvested by women and consumed by fishing households, or sold in local markets, tends to be underestimated by national fisheries planners. The contribution of women in the fisheries sector and their impact on resources will likely increase as island populations grow and the desire for cash income by village households escalates. On the other hand, the time that women have to go fishing to feed their families or to sell fish is limited due to their many other household responsibilities.

Objective

This project demonstrates the significant benefits to communities of women's fishing activities and enhances the capability of women to participate in coastal fisheries development and management. The overall objective is to prepare for and encourage the involvement of women in the fisheries sector by directing it along pathways that ensure resource sustainability and the highest financial return per unit of effort.

Possible Strategies

The demonstration project would consist of a series of on-site workshops that:

- train women in income control, book-keeping skills and simple accounting;
- introduce appropriate technologies for post-harvest handling and product development;
- advise women on the selection of a site for seafood markets and improvements in marketing an product transportation;
- develop a village-based financing mechanism such as a micro-credit scheme; and
- identify small income-generating activities for women that are unrelated to fishing in order to reduce the harvesting pressure on coastal fishery resources.

In addition, the opinions and perspectives of women should be integrated into a village fishery management plan. This could be accomplished with the assistance of government fisheries extension officers by arranging a series of meetings for village women. Each group meeting should have a trained facilitator and, if possible, a second person to act as a recorder of the discussions. At the first group meeting, women should be encouraged to analyse the condition of the marine environment and fish stocks adjacent to the village. This could include making an assessment of changes in fishing, seafood catches and the marine environment over recent years. Any important local information on biology and habitat of species should also be discussed. At a second group meeting, women should discuss problems relating to fisheries and the marine environment as the first step in the construction of a problem/solution tree. At a third group meeting, women should be encouraged to discuss the causes of key problems and propose possible solutions. At a final group meeting, women should be asked to nominate two or three of the most active members to participate in a village Fisheries Advisory Committee (FAC). The FAC would further consider the problems and solutions identified by the women's group and other community groups. In a village fisheries management plan, the FAC would determine how the solutions could be made to work, which actions are required from the village community, and what type of support will be required from the promoting agency. The plan would then be presented to village leaders by the FAC at a formal and culturally appropriate meeting. If the plan is approved, a fisheries management committee would be appointed by the village leaders to administer the implementation of the plan. This committee should include women representatives. Once the village's fishery management plan is formally agreed to, the promoting agency would make regular contact with the management committee and provide the agreed technical support.

Expected Results

Sustainable fish harvests, better fish prices and higher household incomes through the acquisition of business and marketing skills and improved post-harvest handling practices.

B. Co-management of marine resources adjacent to an urban centre

The concepts and strategies for this demonstration project are drawn largely from Hunnam et al. (2001).

Context

An increasing number of Pacific islanders are choosing to live in urban areas. A range of marine environmental issues are developing in these areas, including sewage pollution, solid waste disposal, stormwater runoff, soil erosion, fuel oil spillage, shoreline construction, overfishing of selected marine invertebrates and fish, damage to island vegetation and to corals at nearby recreational and tourist sites and conflicting demands on resources from tourism operators, artisanal and recreational fishers. There is a priority need to devise and develop systems for managing marine resource uses and activities that impact on marine environments in the vicinity of coastal towns.

Objectives

The objective is to facilitate the participation of multiple stakeholders in an appropriate area-wide management regime for long-term sustainable use and protection of marine resources.

Possible Strategies

The demonstration project would introduce and test a broad range of approaches and processes for planning and managing the diversity of uses of marine resources in the vicinity of an urbanized area. Specific strategies may include:

Establishing a "Marine Centre" in the selected locality that would function as an information and education facility, a resource centre, planning office, meeting house and training centre. Centre staff would organise public displays, workshops, talks and video nights, visits to local schools, offices and businesses, and guided information tours by boat, vehicle and foot around the locality. The programme of activities would disseminate information on natural resources and wildlife, local geography and environmental processes, urban development impacts, resource ownership and law, sustainable use and development, options for rural villages, tools for community planning and traditional and current methods of natural resource management.

Employing a participatory planning process to develop an integrated management plan for the target area. Key participants would include local and national government authorities, local chiefs and community leaders, private sector companies and resource user groups in fishing, tourism, shipping, infrastructure development and coastal agriculture, non-government organisations concerned with conservation and development, and local schools, colleges, research and training institutions.

Organising and co-ordinating a range of research and monitoring activities, covering use activities, specific impacts, people's values and attitudes and changes in the condition of the resource and quality of the environment. The underlying purpose would be to provide sound technical advice for resource users, planners and decision makers on how to manage the area effectively.

Expected Results

The implementation of a management plan to control the impacts on coastal resources, and potential conflicts among resources users and to facilitate conservation-oriented development of the area.

C. Co-management of live reef fish fisheries

The concepts and strategies for this demonstration project are based, in large part, on discussions by Johannes et al. (1998) and Yeeting et al. (2001).

Context

Live reef fish fisheries are expanding in the Pacific islands in response to a rising demand for live reef fish in Asia, particularly China, and in response to the depletion of East Asian and South-East Asian reef fish populations. These fisheries target many of the same species of fish eaten and esteemed by Pacific islanders, and uncontrolled fishing may represent a threat to subsistence and small scale commercial reef fisheries. The prospect of income from the live reef fish trade may exacerbate conflicts among villages over customary tenure of reef areas. Further, over fishing of reef fish populations may reduce their attractiveness for tourist oriented diving and snorkeling. However, properly managed live reef fish fisheries may provide an additional income source for Pacific island populations without threatening food security or the continuation of other revenue generating uses of the coastal environment.

Objectives

The objectives of this demonstration project are to prevent over fishing of reef fish populations targeted for the live reef fish trade, to ensure a reasonable economic return to villages from live reef fish fisheries and to minimise conflict among resource owners.

Possible Strategies

The demonstration project would adopt a co-management approach to ensure sustainable live reef fish fisheries. The basis of this approach is a collaboration between government and communities to find together specific solutions to specific problems, jointly defined. The overall strategy may include:

- documentation of local knowledge relevant to the management of live reef fish fisheries. The archive of local knowledge would be supplemented with research findings on target species.
- development of a management plan by the government and a consortium of villages seeking to manage live reef fish fisheries in customary marine tenure (CMT) areas. Creation and implementation of the plan would be coordinated by a committee of village and government representatives and live reef fish fishery operators. The government's role would include dispute mediation, licensing of live reef-fish fishing as a special fishing activity and providing information on the pros and cons of a live reef- fish fishery. The management plan could contain a variety of input and output controls on live reef fish fishing to minimise impacts on reef fish stocks. One possible measure might be a rotation scheme whereby fishing would be conducted within different CMT areas in successive years so that fish stocks have an opportunity to recover from fishing. Such a scheme could include an annual basic payment to all villages each year and additional revenue for the village(s) where fishing actually occurs. Additional measures could include a ban on the harvesting of spawning aggregations, fishing gear restrictions, minimum and maximum size limits and a harvest quota for high value species such as the Napoleon wrasse and barramundi cod.
- establishment of a market information service to provide villagers with periodic updates on developments in the Asian live reef fish trade. For example, current information on fish prices in export markets would be important in the negotiation of payment scales for target species.

Design and implementation of a fishery data collection system and other methods of monitoring the condition of fish stocks such as periodic visual assessments. Monitoring programmes could also include cross checks of catch data with export records.

Expected results

Live reef fish fisheries that are sustainable, that provide communities with an equitable return, minimise threats to village food security, and reduce disputes among neighboring villages.